The impact of changing health indicators on infant mortality rates in Brazil, 2000 and 2005

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ABSTRACT

Objectives. *To investigate the associations between changes in indicators of health-related resources and coverage, and variations in infant mortality rates (IMR) in Brazil's 27 states in 2000 and 2005.*

Methods. *Data were obtained from the Ministry of Health's online database, DATASUS. Stepwise multiple regressions were performed to model changes in IMR and its components (early, late, and post-neonatal mortality), using changes in the selected health indicators as predictors.*

Results. *Regression analysis showed that improving access to prenatal care (B = –0.89 per 1 000; P < 0.001), increasing public expenditure on health as a proportion of gross domestic product (GDP) (B = –0.72 per 1 000; P = 0.031), and increasing access to the water supply (B = –0.22 per 1 000; P = 0.033) were associated with significant reductions in IMR. Declining early neonatal mortality rates were associated with prenatal care (B = –0.14 per 1 000; P = 0.026) and access to sanitation services (B = –0.05 per 1 000; P = 0.026). Reductions in late neonatal mortality rates were associated with prenatal care (B = –0.12 per 1 000; P = 0.003) and inversely correlated to the rate of cesarean deliveries (B = 0.13 per 1 000; P = 0.005). Post-neonatal mortality rate reductions were associated with prenatal care (B = –0.64 per 1 000; P < 0.001), increasing public expenditure on health as a proportion of GDP (B = –0.76 per 1 000; P = 0.005), and access to the water supply (B = –0.17 per 1 000; P = 0.037).*

Conclusions. *Improving access to prenatal care, increasing public expenditure on health, and access to sanitation and water supply were all independently correlated to declining IMR; however, higher rates of cesarean deliveries were associated with higher late neonatal mortality rates. Continuous collection and analysis of relevant health indicators is recommended for developing evidence-based health policies and accurate predictions of how specific public health interventions might impact IMR.*

Key words Infant mortality; health status indicators; health investments; health policy; child health; Brazil.

Infant mortality rates (IMR) in Brazil have declined steadily during recent decades, from 86 per 1 000 in 1980 to 19 per 1 000 in 2006 (1). Despite a significant reduction, this figure is still unacceptable considering the country's consistent economic development. In 2006, among 193 countries, Brazil's IMR was ranked 86th (1), while its gross domestic product (GDP) was 10th (2). Of the countries in Latin America, Brazil had the highest GDP and the 10th highest IMR (Table 1). In addition, inequalities in social and economic development exist among Brazil's diverse geographic areas and states, and these are apparent in the inequities in health indicators as well.

Public health interventions depend on prospective evaluation to ensure that

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TABLE 1. Countries of Latin America by gross domestic product (GDP) and infant mortality rate (IMR), 2006

Country	GDP (× US$ 1 000)	IMR[a] (per 1 000)
Brazil	US$ 1 647 110 100	19
Mexico	1 263 050 580	29
Argentina	456 693 780	14
Venezuela	298 285 270	18
Colombia	279 270 540	17
Chile	186 054 500	8
Peru	179 052 610	21
Ecuador	89 905 620	21
Guatemala	66 708 480	31
Costa Rica	40 558 780	11
El Salvador	37 934 820	22
Bolivia	35 638 740	50
Uruguay	33 110 140	13
Panama	28 572 720	18
Paraguay	24 304 640	19
Honduras	23 833 980	23
Nicaragua	15 047 040	29
Suriname	3 512 600	29
Guyana	2 519 990	46
Belize	1 996 560	14

Source: WHOSIS (1).
[a] Infant mortality rate: number of infant deaths (less than 1 year of age) divided by total live births.

they are, in fact, efficient. Until recently, studies that focus on how to further reduce mortality rates in Brazil have been limited by the lack of periodic, official information on health status, resources, and coverage. In order to understand the impact of the many possible interventions and to determine an optimal allocation of resources, a longitudinal approach considering health indicators and their impact on infant mortality rates may be more straightforward than cross-sectional analyses.

Since 1996, the Interagency Network of Information for Health (RIPSA), a conjunct initiative of the Ministry of Health of Brazil and the Pan American Health Organization that comprises several government agencies, research and teaching institutions, and non-governmental organizations, has endeavored to collect, analyze, integrate, and disseminate health information (3). This institution annually publishes a set of health indicators for use in public health planning and strategy development that includes indicators of health status, health-related resources, and coverage.

The objective of this study was to investigate associations between changes in the indicators of health-related resources and coverage and variations in IMR and its components in Brazil's 27 states between 2000 and 2005.

MATERIALS AND METHODS

This study used an ecological design. Data were obtained from the Ministry of Health of Brazil, through its online database, "DATASUS" (4). Data were for the 26 states and the Federal District from the years 2000 and 2005—the most current, official data available for all indicators.

Dependent variables

The Ministry of Health directly registers mortality data in the Mortality Information System (SIM), and birth data, in the Live Birth Information System (SINASC). The consistency and coverage of these systems varies among the diverse states of Brazil, being less reliable in the North and Northeast areas, than in the rest of the country. Following RIPSA methodology, IMR were determined by one of two methods: (a) direct calculation—dividing the number of infant deaths (less than 1 year of age) by the total number of live births, or (b) indirect estimation—using community survey data where undernotification of births or deaths was significant (3).

The components of neonatal mortality were defined as follows: early neonatal mortality (ENM) as the number of deaths in 0–6 day-old residents per the number of live births for each state; late neonatal mortality (LNM) as deaths in 7–27 day-old residents; and post-neonatal mortality (PNM) as deaths in 28–364 day-old residents.

Predictor variables

The set of indicators selected for analyses was defined according to: (a) availability as a temporal series, and (b) the major components of health policy, i.e., public health financing (expenditure on health), promotion (water supply, sanitation), and assistance (prenatal consultations, proportion of hospital and of cesarean deliveries). For each component, other possibly relevant indicators were not considered because the small sample size (27 states) limited the available degrees of freedom. For example, public expenditure on health has seven different indicators, of which we included only one. Also, socioeconomic indicators of distal determinants of health, such as GDP and education, were not considered because they are not directly influenced by health policies.

Total public expenditure on health (PEH) as a proportion of GDP was defined as the percentage of GDP equivalent to federal, state, and municipal resources allocated to health services and actions in each year. Prenatal assistance coverage (PN) was calculated by dividing the number of live births among women who had at least one prenatal consultation, by the total number of live births in each state. The proportion of hospital deliveries (PHD) was defined as the percentage of live hospital births in each state. The proportion of cesareans (PC) was calculated as the percentage of live births delivered via cesarean. Water supply coverage (WS) was defined as the proportion of the total resident population in private, permanent domiciles supplied by the public waterworks, irrespective of the existence of indoor plumbing. Access to sanitation services (S) was defined as the percentage of the resident population served by the public sewage system or a septic tank. Proportion of low birthweight was the number of live newborns weighing < 2500g divided by the total number of live births. Vaccine coverage was based on Diptheria–Pertussis–Tetanus (DPT) coverage in 2000 and tetravalent (DPT + Haemophilus influenzae type B) coverage in 2005, defined as the proportion of children up-to-date on their scheduled immunizations (3). The methodology for data collection and processing of each predictor variable is presented elsewhere (3).

Analyses

With the purpose of correlating changes in predictor indicators to variations in IMR, we calculated the differences between 2005 and 2000 for each indicator and for each component of infant mortality, and these differenced values were used for the subsequent analyses.

Predictor indicators were not intercorrelated in preliminary analyses. Stepwise multiple regressions were performed to model each type of mortality rate separately (IMR, ENM, LNM, and PNM) encompassing all selected predictors (PEH, PN, PHD, PC, WS, S, and LW), with alpha set at 0.15. Variables remained in the models when alpha was < 0.05. Differences between 2005 and 2000 IMR, LNM, and PNM were not normally distributed. Using square-root transformed dependent variables in regression calculations produced very similar results, thus, for the sake of simplicity of interpretation, the original nontransformed values were preferred. Residual analyses were performed to assess the fitness of each model.

RESULTS

Baseline values and changes in health indicators and IMR are presented in Table 2.

All indicators of infant mortality decreased from 2000 to 2005, in every state. Although baseline inequities in mortality rates were evident, the states with the highest IMR in 2000 were also the ones with the greatest reductions. However, variances of IMR in 2000 and 2005 were not significantly different (Bonferroni´s $P = 0.114$), indicating that between-state inequities persisted.

Variation in total IMR were determined by reductions in all three age-defined mortality indicators (ENM, LNM, and PNM), but PNM contributed 45.5% of the sum of squares, while ENM contributed 40.2%, and LNM, the remaining 14.3%.

Results of stepwise multiple regression analyses of the predictors of the differences in mortality indicators are shown in Table 3. Low birthweight, DPT (or tetravalent) immunization coverage, and the proportion of hospital deliveries did not significantly co-vary with infant mortality indicators, and thus were not presented.

A 1.0% increase in access to at least one prenatal consultation (PN) was associated with a 0.89 per 1 000 reduction in IMR. Similarly, for a 1.0% increase in public expenditure on health as a proportion of GDP, a reduction of 0.72 per 1 000 in IMR occurred. A 5.0% increase in water supply coverage corresponded to a 1.1 per 1 000 reduction in IMR.

Regarding early, late, and post-neonatal mortality: ENM showed a 1 per 1 000 reduction when PN increased 7.1% or when access to sanitation improved 20.0%; LNM declined 1 per 1 000 for each 8.1% increase in PN, and reduced 1 per 1 000 for each 7.5% rise in cesarean deliveries. A 1.0% increase in PN was related to a 0.64 per 1 000 improvement in PNM. Additionally, a 1.3% rise in PEH was related to a 1 per 1 000 reduction in PNM, but a 5.8% increase in water supply corresponded to a 1 per 1 000 decline in PNM.

Although ENM and LNM models were less robust than IMR and PNM models, the residuals for every model were normally distributed.

DISCUSSION

Availability of valid and reliable information is fundamental for planning and developing health-related public actions. Health-related indicators synthesize relevant information about the status of a population, but it is worth noting that many of them also reflect distal determinants of health and socioeconomic status (employment, income, education, etc.) (5). For the purpose of public health strategies, health indicators must be standardized and regularly produced, i.e., on an annual basis (3). In Brazil, the standardized, official registration of basic data, from which health indicators are derived, is fairly recent. The quality of information provided by DATASUS (4) still varies among the states, with the more populous Southern states having more reliable birth and mortality data (3).

To the best of our knowledge, no prior study has correlated the rates of change, rather than the point estimates, of health indicators and infant mortality rates. This longitudinal approach was, therefore, novel, and allows for the direct estimation of how a change in health indicator can impact IMR. With this approach, the implications for relevant public health decision-making may be more directly drawn.

Similar to our findings, PNM has been previously shown to be the first component of infant mortality to be reduced in a specific location, while neonatal mortality is more resistant to public interventions, in Brazil and in the world (6–8).

Low birthweight has been considered an important predictor of infant mortality and morbidity, especially in the neonatal period (9). However, including the indicator of change in LW in the model did not influence regression results. LW rates varied little in this period, and in general, have been considered low in most areas of Brazil (5). The main causes of LW are premature delivery and retarded intrauterine growth (5), a combination of problems potentially influenced by adequate access to prenatal care.

Increasing prenatal care coverage (at least one visit) was a significant, independent predictor of declining IMR. Interestingly, the effects of this predictor were not limited to neonatal mortality; actually, they impacted post-neonatal infant mortality rates even more significantly. Although it is possible that the prevention of obstetric complications and the adequate monitoring of pregnancy may directly impact infant health in the long term, it must be considered that PN is an indicator associated with the general quality and accessibility/usage of health services, consequently related to the quality of pediatric follow-up.

Quantitative indicators do not describe thoroughly the quality of prenatal care. The content, frequency, and timing of antenatal visits vary among countries and have cost-efficiency implications (10). Brazil's officially-recommended model of prenatal care requires a minimum of six visits, starting in the first trimester of pregnancy, conducted by family physicians and nurses, and including group educational activities (11). However, economic and outcome studies of whether or not this is the optimal approach are lacking. As the number of visits in DATASUS is presented in categories instead of means, it was not possible to analyze what critical number would be associated with reductions in IMR.

Immunization coverage has been described as a significant predictor of change in IMR in cross-national data (12). In Brazil, however, immunization coverage, with DTP or tetravalent was, in general, appropriate in 2000 and 2005

TABLE 2. Infant mortality rate (IMR) and its components and predictor health indicators for each of Brazil's 27 states, 2000 and 2005

States	2000										2005									
	Mortality rates (per 1 000)				Health indicators (%)						Mortality rates (per 1 000)				Health indicators (%)					
(by geographic area)	IMR[a]	ENM[b]	LNM[c]	PNM[d]	PEH[e]	PN[f]	PHD[g]	PCD[h]	WS[i]	S[j]	IMR	ENM	LNM	PNM	PEH	PN	PHD	PCD	WS	S
North																				
Acre	35.7	16.6	3.5	15.6	11.5	20.2	90.7	25.6	34.1	28.7	29.5	12.8	3.1	13.6	7.2	15.4	87.5	32.9	45.0	40.3
Amapá	25.9	18.0	3.3	4.6	7.3	12.9	96.6	14.5	51.4	23.0	22.9	15.9	3.6	3.4	5.8	11.3	92.9	26.0	69.9	28.2
Amazonas	29.1	13.8	4.4	10.9	3.3	11.6	94.6	26.8	57.8	42.1	24.5	11.2	2.9	10.4	4.1	9.0	91.4	32.5	69.3	57.1
Maranhão	42.5	19.7	4.5	18.3	6.8	7.7	94.4	25.2	51.9	23.1	32.7	15.6	3.7	13.5	5.7	4.5	92.0	27.8	57.9	50.1
Pará	29.0	15.1	4.0	9.9	4.0	7.4	85.3	29.8	41.9	35.0	24.5	12.8	3.1	8.6	4.2	4.8	88.2	34.0	48.0	55.0
Rondônia	25.6	15.1	2.8	7.8	5.3	5.0	99.1	43.8	29.6	20.4	21.1	11.5	3.2	6.5	4.2	1.8	98.3	54.4	38.8	47.6
Roraima	22.5	8.4	4.8	9.2	11.0	14.4	85.8	26.0	77.9	60.8	18.1	7.1	2.6	8.4	6.8	7.3	87.3	25.6	83.8	71.9
Tocantins	29.4	14.6	3.1	11.7	9.8	3.8	97.6	30.2	65.9	18.9	23.2	10.6	3.3	9.3	6.5	1.6	97.6	34.5	79.8	21.0
Northeast																				
Alagoas	58.0	25.4	6.8	25.9	5.8	20.3	95.2	23.1	61.5	24.4	44.4	21.2	5.5	17.7	6.0	5.6	96.7	34.6	61.2	28.0
Bahia	37.4	19.2	3.8	14.4	3.6	11.9	90.1	22.4	67.9	40.1	29.2	16.7	3.6	8.9	4.1	5.7	93.5	28.2	75.6	50.2
Ceará	37.3	16.7	5.3	15.2	5.5	3.5	96.3	28.1	59.1	32.6	27.5	14.1	3.9	9.6	5.2	1.7	98.1	35.6	73.6	40.8
Paraíba	45.2	20.0	5.0	20.2	5.5	7.3	93.1	33.9	67.0	37.5	34.0	17.6	4.6	11.8	6.2	2.0	96.6	39.4	78.8	48.5
Pernambuco	44.7	19.9	5.1	19.6	4.4	9.1	96.2	30.3	69.0	41.8	32.2	16.4	3.9	11.8	4.7	3.5	98.3	36.1	74.7	39.6
Piauí	37.0	20.0	4.2	12.8	6.9	4.8	92.6	31.1	59.2	37.9	28.7	16.2	3.9	8.7	7.4	1.7	93.7	38.7	68.9	61.7
Rio Grande do Norte	41.5	20.9	4.6	16.0	5.9	6.4	90.8	29.4	77.5	39.5	33.6	18.8	4.8	10.0	6.1	2.0	95.8	37.8	88.4	45.1
Sergipe	39.0	20.4	5.3	13.3	4.2	5.9	88.4	20.1	74.4	41.5	32.2	15.8	5.8	10.6	4.6	2.4	92.0	27.0	89.5	72.6
Southeast																				
Espírito Santo	18.8	9.9	2.6	6.4	2.8	3.3	99.3	43.8	79.3	64.6	15.6	7.5	3.0	5.2	2.7	1.3	96.9	48.7	82.2	74.9
Minas Gerais	22.6	12.8	2.8	7.0	2.6	2.3	99.0	41.0	82.0	68.9	18.6	10.3	2.8	5.5	3.0	1.3	99.1	46.7	86.4	75.6
Rio de Janeiro	19.7	10.2	3.4	6.1	2.7	3.9	98.1	49.3	82.3	83.1	16.0	8.2	3.0	4.8	2.6	2.5	98.3	53.0	88.2	90.5
São Paulo	17.3	8.9	2.8	5.7	2.3	1.9	99.1	48.9	93.2	87.3	13.5	6.6	2.7	4.3	2.4	1.1	99.6	54.1	96.2	91.5
South																				
Paraná	19.6	10.5	2.4	6.7	2.2	1.2	98.9	43.9	82.6	51.6	14.6	7.6	2.5	4.5	2.7	0.7	99.2	50.5	87.7	69.5
Rio Grande do Sul	15.1	6.9	2.6	5.6	2.4	3.5	99.2	41.3	78.9	67.0	13.7	6.7	2.5	4.5	2.6	2.0	99.6	49.3	83.7	79.7
Santa Catarina	15.7	7.9	1.7	6.2	2.2	1.9	98.9	41.5	73.3	72.1	12.6	6.6	2.1	4.0	2.4	0.8	97.6	49.6	79.2	84.2
Center-West																				
Distrito Federal	14.4	7.7	2.4	4.4	1.8	3.5	99.9	39.7	88.3	89.3	13.6	6.4	2.6	4.6	1.3	2.4	99.9	47.7	90.3	95.1
Goiás	21.5	10.8	3.6	7.0	3.8	3.0	99.6	45.1	68.8	34.7	18.2	9.3	3.4	5.5	3.0	1.4	99.7	50.4	79.3	35.9
Mato Grosso	23.5	11.8	4.0	7.7	3.1	2.6	98.5	45.5	63.6	29.3	19.6	9.7	3.0	7.0	2.9	1.1	99.1	50.6	65.9	34.3
Mato Grosso do Sul	23.8	12.0	3.7	8.1	3.0	3.0	99.1	42.9	78.3	17.5	19.3	9.6	3.1	6.6	3.8	2.3	98.3	49.0	84.9	22.2

Source: Brazilian Ministry of Health, DATASUS (4).
[a] Infant mortality rate: number of infant deaths (less than 1 year of age) divided by the total number of live births.
[b] Early neonatal mortality rate: number of deaths in 0–6 day-old residents divided by the number of live births.
[c] Late neonatal mortality rate: number of deaths in 7–27 day-old residents divided by the number of live births.
[d] Post-neonatal mortality rate: number of deaths in 28–364 day-old residents divided by the number of live births.
[e] Total public expenditure on health as a proportion of the gross domestic product.
[f] Proportion of mothers with access to one or more prenatal consultations.
[g] Proportion of hospital deliveries.
[h] Proportion of cesarean deliveries.
[i] Water supply coverage: the proportion of the total resident population in private permanent domiciles that are supplied by general water network, irrespective of the existence of indoor plumbing.
[j] Sanitary services access: the percentage of the resident population served by sewage system or septic tank.

TABLE 3. Stepwise regression results for the change in mortality indicators as a function of the changes in selected health coverage and resources indicators in 27 Brazilian states, 2000–2005

Predictor	Infant mortality rate[a]		Early neonatal mortality[b]		Late neonatal mortality[c]		Post-neonatal mortality[d]	
	Coefficient %	*P*	Coefficient %	*P*	Coefficient %	*P*	Coefficient %	*P*
Prenatal coverage[e]	–0.89	< 0.001	–0.14	0.026	–0.12	0.003	–0.64	< 0.001
Expenditure[f]	–0.72	0.031	—[g]	—	—	—	–0.76	0.005
Water supply	–0.22	0.033	—	—	—	—	–0.17	0.037
Sanitary services	—	—	–0.05	0.026	—	—	—	—
Cesarean deliveries	—	—	—	—	0.13	0.005	—	—
Adjusted R2 (%)	57.80	< 0.001	24.80	0.012	37.80	0.001	55.90	< 0.001

[a] The number of infant deaths (less than 1 year of age) divided by the number of live births.
[b] The number of deaths in 0–6 day old residents divided by the number of live births.
[c] The number of deaths in 7–27 day old residents divided by the number of live births.
[d] The number of deaths in 28–364 day old residents divided by the number of live births.
[e] The number of live births among women who had at least one prenatal consultation, divided by the total number of live births.
[f] Public expenditure on health as a proportion of the gross domestic product.
[g] Not selected by the stepwise procedure. All coefficients are relative to a 1% increase in the predictor variable.

(medians over 97%). This is probably why including this indicator in the model did not affect regression results.

Improving birth assistance and newborn care has emerged as an important predictor of lowering IMR in developing countries (13). This includes broad access to hospital birth, an appropriate number of cesarean deliveries, obstetrician/pediatrician-assisted deliveries, and the availability of neonatal intensive care (5, 14).

The proportion of hospital deliveries in the study data was relatively high and showed small variation between states (85.3%–99.9%) and before/after the 5-year period (95.4% to 95.8%, nationally). This is probably why this variable was not statistically significant in the regression results. However, since neonatal mortality rates are still elevated, assessing the quality of hospital perinatal care seems mandatory (15, 16).

Brazil has one of the world´s highest cesarean delivery rates (1, 17), with figures still rising (34% in 2000; 41% in 2005), while WHO recommends no more than 15% (18). There are important variations among geographic areas; however, with the Southeast having the highest rate, and the Northeast, the lowest. Studies on the comparative neonatal risk of cesarean delivery have shown conflicting results, some indicating higher risks (19–21), some indicating protective effects (22–25), at both the individual and collective levels. In this study's results, the escalating proportion of cesarean deliveries was shown to be an independent predictor of rising LNM. Excessive medical intervention on delivery may result in preterm births, a possible path to neonatal mortality (19). Also, cesarean deliveries may result in reduced breastfeeding (26), thus, indirectly impacting LNM. On the other hand, improvement in early neonatal care associated with hospital perinatal assistance (19) may have a compensatory effect, explaining why ENM was not affected.

Increasing public expenditure on health does not necessarily produce the desired reduction effect on IMR. This has been shown in several cross-national studies (27–31), and was corroborated by our national results. Issa and Outara (32) disaggregated the analysis and found an independent negative effect of PEH on IMR, restricted to low-income countries. They also included in their model an indicator of good governance, which was a significant predictor of lower IMR. Similarly, Wagstaff (33) showed that public spending on health had a significant impact on child mortality only in the very poor countries. As a whole, these findings suggest that in order to efficiently reduce IMR, increasing PEH should be accompanied by optimal allocation of financial resources for health.

In the present study, PEH was significantly associated with reduced PNM, but not with neonatal mortality. Compared to the relatively expensive strategies for reducing neonatal mortality, PNM potentially can be cut down by low-cost public interventions, such as oral rehydration therapy, immunization, vitamin and mineral supplementation, encouraging breastfeeding, and implementing family health teams. Competing public health targets and a very recent national long-term strategy for improving public health may be the reasons for which increased PEH still has such a modest effect on infant mortality.

Access to sanitation and clean water is one of the most relevant factors influencing country-wide IMR (31, 34–36), and is also an indicator of inequalities in infant mortality (37). In Brazil, sanitation, education, and poverty have been identified as the most relevant determinants of child health (38, 39). Our results corroborate the relevance of water supply and sanitation to reducing infant mortality. The finding that access to sanitation was associated with lower ENM is probably an indirect reflection of the socioeconomic status of the mothers. However, since the prevalence of exclusive breastfeeding in Brazil's state capitals is estimated to be less than 50% (38% in the Southeast to 58% in the South) (40), it could be hypothesized that newborns are also at increased risk in the absence of water and sanitation services.

While interpreting the results of this study, the following should be considered: (a) stepwise variable selection methods are very reliant on the specific distribution and variation of the potential predictors, so statistic selection is not necessarily the most logical; (b) the ENM and LNM were not as robust as the PNM and IMR models; (c) if a predictor variable did not change substantially between 2000 and 2005, it would show poor correlations to IMR, though it would not necessarily be unimportant to health policy; (d) socioeconomic and educational indicators have been widely associated with IMR, nationally and globally (5–7, 19, 24, 30), and although not included in this study's predictive models, they may influence health indicators, and thus, be potential confounders between health policies and mortality rates; and lastly, (e) extrapolation of the present findings to other countries or time-periods should be made with caution.

Conclusions

Improving access to prenatal care, increasing public health expenditure on health, and broadening access to sanitation and water supply were all independently correlated with declining infant mortality rates in Brazil's states; however, higher cesarean delivery rates were associated with higher late neonatal mortality rates. These findings have implications for optimally allocating resources and setting priorities for public health policies.

Continued production and analysis of relevant health indicators are fundamental and recommended methods for providing evidence-based health policies aimed at specific public health targets. Longitudinal analyses involving long-term variations in health indicators will provide even more reliable forecasts predicting the impact of specific public health interventions on infant mortality rates.

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RESUMEN

Impacto de los cambios en los indicadores de salud sobre las tasas de mortalidad infantil en Brasil, 2000 y 2005

Objetivos. Investigar las asociaciones entre los cambios en los indicadores de recursos y cobertura relacionados con la salud y las variaciones en las tasas de mortalidad infantil (TMI) en los 27 estados de Brasil entre los años 2000 y 2005.

Métodos. Los datos se obtuvieron de la base de datos en línea del Ministerio de Salud, DATASUS. Mediante regresión múltiple paso a paso se modelaron los cambios en la TMI y sus componentes (mortalidades temprana, tardía y posneonatal), utilizando como predictores los cambios en indicadores seleccionados de salud.

Resultados. Según el análisis de regresión, el mejoramiento del acceso a la atención prenatal (B = –0,89 por 1 000; P < 0,001) y al suministro de agua (B = –0,22 por 1 000; P = 0,033), y el aumento del gasto público en salud como proporción del producto interno bruto (PIB) (B = –0,72 por 1 000; P = 0,031) se asociaron con reducciones significativas de las TMI. Las reducciones de las tasas de mortalidad neonatal temprana se asociaron con la atención prenatal (B = –0,14 por 1 000; P = 0,026) y el acceso a servicios de saneamiento (B = –0,05 por 1 000; P = 0,026). Las reducciones en las tasas de mortalidad neonatal tardía se asociaron con la atención prenatal (B = –0,12 por 1 000; P = 0,003) e, inversamente, con la tasa de partos por cesárea (B = 0,13 por 1 000; P = 0,005). Las reducciones en las tasas de mortalidad posneonatal se asociaron con la atención prenatal (B = –0,64 por 1 000; P < 0,001), el aumento en el gasto público en salud como proporción del PIB (B = –0,76 por 1 000; P = 0,005) y el acceso a fuentes de agua (B = –0,17 por 1 000; P = 0,037).

Conclusiones. El mejoramiento del acceso al cuidado prenatal, el incremento del gasto público en salud y el acceso al saneamiento y a fuentes de agua se correlacionaron independientemente con la reducción en las TMI; mayores tasas de partos por cesárea se asociaron con mayores tasas de mortalidad neonatal tardía. Se recomienda mantener la recolección y el análisis de los indicadores de salud relacionados con la TMI para desarrollar políticas de salud basadas en evidencias y elaborar predicciones precisas de cómo pueden intervenciones específicas en salud pública influir en las TMI.

Palabras clave Mortalidad infantil; indicadores de salud; inversiones en salud; política de salud; salud del niño; Brasil.