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Trends in hospital admission and infant mortality from diarrhea: Brazil, 1995-2005

ABSTRACT

OBJECTIVE: To analyze trends in hospitalization and mortality rates for diarrhea in children less than one year old.

METHODS: An ecological time-series study, between 1995 and 2005, was performed for Brazil as a whole and for the state capitals. Secondary data from the Ministry of Health was utilized, obtained from the Hospital Information System and from the Mortality Information System. During the study period, 1,505,800 hospitalizations and 39,421 deaths from diarrhea were registered among children under one year. Polynomial regression models were used to analyze the trends in hospitalization and mortality rates.

RESULTS: There were reductions in hospitalizations and in infant deaths from diarrhea in the country and in 13 capitals. Eight capitals experienced reductions only in mortality from diarrhea, whereas three showed decreases only in hospitalization rates from diarrhea. In the combined analysis of diarrhea indicators and of general indicators, reductions in all the historical series were observed only in Brazil as a whole and in four capitals.

CONCLUSIONS: The reduction in hospitalization and mortality rates from diarrhea observed through the time-series could be the result of prevention and control measures implemented.

DESCRIPTORS: Diarrhea, Infantile, mortality. Hospitalization. Infant Mortality, trends. Time Series Studies.

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INTRODUCTION

Diarrhea, a common manifestation of intestinal infectious diseases, is still one of the main causes of morbidity and mortality in children under five years of age in developing countries, especially among children under one year. This is because a complex of environmental, nutritional, socioeconomic and cultural factors are involved, directly or indirectly.[10]

Global analyses of childhood diarrhea trends since 1980 show a decline in mortality but not in the incidence of disease.[3,10,18] Despite reduction efforts, diarrhea continues to be a serious public health problem in countries with inequities in wealth distribution.[6] Disparities in global morbidity and mortality rates between regions, statuses and social classes have been observed in practically all the countries of the world, developed or not.[1]

In Brazil, the reduction in mortality from diarrhea happened in the second half of the 20th century. Basic sanitation policies implemented in the country since 1970 played an important role in the reduction of infant mortality, mainly through reductions in mortality from intestinal infectious diseases.[12] Other measures (such as oral rehydration therapy, reduced infant malnutrition and improved access to health services) can be considered principle reasons for the decline in mortality from diarrhea in Brazil.[2,3]

Considering the heterogeneity of Brazil and with the goal of understanding the impact of diarrhea in the country from 1995 to 2005, the objective of this study was to analyze temporal trends in infant hospitalization and mortality from diarrhea in Brazil and in the state capitals.

METHODS

An ecological time series study was carried out on infant hospitalization and mortality rates due to diarrhea from 1995 to 2005 for Brazil and for the state capitals. It was decided to work with data on state capitals due to the greater coverage of the Mortality Information System of the Brazilian Ministry of Health (SIM-MS) in these locations. According to data from the Monitoring System for Infant Mortality Indicators of the *Fundação Oswaldo Cruz* (Fiocruz – MonitorIMI), during the period from 2001 to 2003, only six capitals had coverage estimates under 80% for infant deaths (Rio Branco, Manaus, João Pessoa, Natal, Belo Horizonte and Florianópolis). In regards to coverage of live births, all locations reached 100% coverage during this period.

Other indicators related to diarrhea rates were analyzed, such as historical time series trends for the rates of infant mortality and overall hospitalization among children within the study's age range and for the postneonatal infant mortality rate (from 1995 to 2005). The last indicator is important because deaths from diarrhea occur mainly during the postneonatal period.

The data regarding the number of hospitalizations and the number of infant deaths, during 1995 to 2005, were obtained from the SUS Hospital Information System (SIH-SUS) and the Ministry of Health's Mortality Information System (SIM-MS), available at the website of the SUS Health Information Department (DATASUS). In order to calculate the hospitalization and mortality rates, the number of live births was used as the denominator, obtained through the Live Birth Information System (SINASC), also available at the DATASUS website.

During the time period analyzed, the ninth and tenth revisions of the International Classification of Diseases were in effect (ICD-9[14] and ICD-10[15]). For hospitalizations and deaths from diarrhea during 1995, codes 001 and 009 of the ICD-9 were used, and for the period from 1996 to 2005, codes A00 and A09 from ICD-10 were used.

The infant mortality rates for diarrhea were calculated by dividing the total number of under one year old deaths from diarrhea by the number of live births and multiplying the quotient by 1,000. The calculation for infant mortality divided the total number of under one year old deaths by the number of live births and multiplied the quotient by 1,000. The postneonatal infant mortality component was calculated by dividing the number of deaths, occurring between the 27th day until one year, by the number of live births and then multiplying the quotient by 1,000.

To calculate the infant hospitalization rates for diarrhea, the number of hospitalizations for diarrhea among under one year olds was divided by the number of live births, and the quotient was multiplied by 100,000. The overall infant hospitalization rates were calculated by dividing the number of hospitalizations from any causes among under one year olds by the number of live births and then multiplying the quotient by 100,000.

A combined analysis of hospitalization and mortality indicators was done with the goal of identifying patterns, according to study location.

In the regression trends analysis, a polynomial model was used in which the hospitalization and mortality rates were considered to be dependent variables (Y) and the calendar years as independent variables (X). In order to avoid self-correlation between the terms of the regression equation, the year variable was transformed to a year-centralized variable (X minus the midpoint of the historical series).[11]

Initially, dispersion diagrams for the indicators and the years studied were made in order to visualize the function that could describe the relationship between trends for hospitalization rates with trends for mortality rates and to chose the degree of the polynomial for analysis.[11]

A trend was considered significant when its estimated model obtained $p<0.05$. A residual analysis was performed, and for all the models, the assumption of homoscedasticity and adherence to the normal distribution was followed.

The trends analysis used the SPSS program (version 12.0)

RESULTS

According to the official data, in the period from 1995 to 2005, 39,421 deaths from diarrhea and 1,505,800 hospitalizations associated with this disease occurred in children under one year old in Brazil. The Brazilian capitals contained 23.8% of these deaths and 12.8% of these hospitalizations.

Table 1 shows the results of the trends analysis for infant mortality from diarrhea and for hospitalizations from diarrhea in children under one year old.

Brazil and 13 Brazilian capitals displayed reductions in hospitalizations from diarrhea, as well as in infant mortality from diarrhea (Macapá, Palmas, Fortaleza, Natal, João Pessoa, Salvador, Maceió, Belo Horizonte, Rio de Janeiro, Curitiba, Porto Alegre, Campo Grande and Cuiabá). The capitals Boa Vista, Belém, Teresina, Recife, Aracajú, São Paulo, Florianópolis and Goiânia had decreases only in mortality from diarrhea, while Rio Branco, Porto Velho and São Luís showed decreases only in the hospitalization rates for diarrhea. In Manaus and Brasília, there was an increase in the hospitalization rate and fall in the infant mortality rate from the disease. Only in Vitória was there an increase in hospitalizations and stability in mortality from diarrhea.

Table 2 shows the temporal trends of the historical series for overall infant mortality and hospitalizations among children of the same age group, during the period studied.

Brazil and the capitals São Luís, Fortaleza, João Pessoa, Belo Horizonte and Rio de Janeiro presented reductions in overall hospitalizations and in infant mortality among under ones. Ten capitals had reductions only in infant mortality rates (Rio Branco, Boa Vista, Macapá, Natal, Aracajú, Curitiba, Florianópolis, Porto Alegre, Campo Grande and Goiânia). On the other hand, Porto Velho and Maceió showed a fall only in overall hospitalizations. In Manaus, Belém, Recife, São Paulo and Brasília there was a fall in infant mortality and increase in hospitalizations. Vitória showed an increase in hospitalizations only, and Palmas, Teresina, Salvador and Cuiabá showed stability in both historical series.

Table 3 presents the patterns from the combined analysis of trends for the four indicators of hospitalization and mortality. To facilitate comparisons, the component of postneonatal infant morality was also included in the table. The Figure illustrates the patterns found.

In Brazil and in the capitals Fortaleza, João Pessoa, Belo Horizonte and Rio de Janeiro there was a reduction in all the historical series, as Pattern 1 shows. This pattern was observed in capitals where the infant mortality rate is high (in the capitals of the Northeast), as well as in locations where this indicator is at an intermediate level (Belo Horizonte, Rio de Janeiro and Brazil as a whole). The postneonatal infant mortality component was above 4.5 deaths per 1,000 live births in all these locations.

Pattern 2 shows a fall in the mortality series and stability or reductions in the hospitalizations series in capitals from all regions, except the Southeast. Despite the marked fall throughout the study period, infant mortality rates remained high in 2005, in the capitals Macapá (20.1 deaths per 1,000 live births) and Natal (16.4 deaths per 1,000 live births). On the other hand, Curitiba, Porto Alegre and Campo Grande had rates lower than 14 deaths per 1,000 live births. The capitals Macapá and Campo Grande presented the lowest values for the postneonatal infant mortality: 2.5 and 3.7 deaths per 1,000 live births, respectively.

For Pattern 3, reductions in the mortality series were observed along with stable or increasing trends for the hospitalization series, among capitals from all the Brazilian regions. The capitals from the North and the Northeast showed high infant mortality rates at the end of the period, such as Belém (20 deaths per 1,000 live births) and Aracaju (22.4 deaths per 1,000 live births). In the capitals from the Southeast and Central-West, these indices were at intermediate levels, such as São Paulo (12.9 deaths per 1,000 live births) and Brasília (13.6 deaths per 1,000 live births). Florianópolis reduced infant mortality from 23 deaths per 1,000 live births in 1995, to 8.9 deaths per 1,000 live births in 2005, with a significant fall in the postneonatal component, which became 2.0 deaths per 1,000 live births in 2005, thus being the two lowest levels in the country.

Pattern 4 has mixed trends for hospitalization and mortality, mainly in the capitals of the North and Northeast, in Vitória and in Cuiabá. Except for Palmas and Vitória, these capitals still have infant mortality rates above 17.0 deaths per 1,000 live births in 2005. Postneonatal mortality remained above 4.2 deaths per 1,000 live births in all these locations in 2005. In 2005, the highest level of negative results were in Porto

Table 1. Trends in mortality and hospitalization from diarrhea among children under one year. Brazil and state capitals. 1995 to 2005.

	Infant mortality rate from diarrhea				Infant hospitalization rate from diarrhea			
Location	*Model	R^2	*p*	Trend	**Model	R^2	*p*	Trend
Brazil	y = 1.18 - 0.15x	0.83	<0.001	Decreasing	y = 45.06 - 4.01x	0.79	<0.001	Decreasing
Northern Region								
Rio Branco	y = 1.34 - 0.13x	0.35	0.057	Stable	y = 44.59 - 5.07x	0.55	0.009	Decreasing
Manaus	y = 1.43 - 0.22x	0.90	<0.001	Decreasing	y = 23.01 + 4.38x	0.82	<0.001	Increasing
Boa Vista	y = 1.34 - 0.27x	0.78	<0.001	Decreasing	y = 15.35 - 1.99x	0.31	0.074	Stable
Belém	y = 0.92 - 0.15x	0.72	0.001	Decreasing	y = 61.08 + 0.88x	0.13	0.274	Stable
Macapá	y = 0.75 - 0.18x	0.66	0.002	Decreasing	y = 30.34 - 2.10x	0.39	0.039	Decreasing
Porto Velho	y = 1.33 - 0.15x	0.22	0.143	Stable	y = 46.04 - 2.41x	0.53	0.011	Decreasing
Palmas	y = 1.13 - 0.15x	0.48	0.016	Decreasing	y = 32.73 - 3.03x	0.42	0.031	Decreasing
Northeast Region								
São Luís	y = 1.33 - 0.22x	0.36	0.053	Stable	y = 33.81 - 4.78x	0.59	0.005	Decreasing
Teresina	y = 1.00 - 0.09x	0.69	0.002	Decreasing	y = 47.32 - 1.90x	0.36	0.051	Stable
Fortaleza	y = 2.71 - 0.76x	0.79	<0.001	Decreasing	y = 58.51 - 4.49x	0.66	0.002	Decreasing
Natal	y = 1.32 - 0.35x	0.66	0.002	Decreasing	y = 28.29 - 3.42x	0.64	0.003	Decreasing
João Pessoa	y = 0.92 - 0.19x	0.64	0.003	Decreasing	y = 48.50 - 2.70x	0.42	0.030	Decreasing
Recife	y = 1.10 - 0.21x	0.77	<0.001	Decreasing	y = 22.28 -0.49x	0.17	0.201	Stable
Salvador	y = 1.08 - 0.20x	0.77	<0.001	Decreasing	y = 15.14 - 1.70x	0.89	<0.001	Decreasing
Maceió	y = 2.45 - 0.43x	0.61	0.005	Decreasing	y = 106.50 - 5.84x	0.77	0.006	Decreasing
Aracajú	y = 1.89 - 0.36x	0.68	0.002	Decreasing	y = 24.96 + 0.32x	0.14	0.267	Stable
Southeast Region								
Belo Horizonte	y = 0.62 - 0.17x	0.66	0.002	Decreasing	y = 27.55 - 2.30x	0.89	<0.001	Decreasing
Vitória	y = 0.57 - 0.11x	0.31	0.075	Stable	y = 17.66 + 1.09x	0.43	0.028	Increasing
Rio de Janeiro	y = 0.34 - 0.06x	0.67	0.002	Decreasing	y = 7.08 - 1.16x	0.61	0.004	Decreasing
São Paulo	y = 0.56 - 0.09x	0.89	<0.001	Decreasing	y = 7.39 - 0.44x	0.17	0.201	Stable
Southern Region								
Curitiba	y = 0.30 - 0.06x	0.73	0.001	Decreasing	y = 11.42 - 1.80x	0.67	0.002	Decreasing
Florianópolis	y = 0.25 - 0.07x	0.45	0.024	Decreasing	y = 9.05 - 0.21x	0.08	0.399	Stable
Porto Alegre	y = 0.20 - 0.04x	0.52	0.012	Decreasing	y = 15.33 - 1.73x	0.78	<0.001	Decreasing
Central-West Region								
Campo Grande	y = 0.57 - 0.09x	0.53	0.011	Decreasing	y = 33.50 - 3.20x	0.72	0.001	Decreasing
Cuiabá	y = 0.53 - 0.09x	0.67	0.002	Decreasing	y = 11.21 - 1.76x	0.69	0.002	Decreasing
Goiânia	y = 0.42 - 0.10x	0.59	0.006	Decreasing	y = 36.12 - 0.63x	0.07	0.436	Stable
Brasília	y = 0.44 - 0.05x	0.73	0.001	Decreasing	y = 12.97 + 0.98x	0.58	0.006	Increasing

*****Model: y = infant mortality rate from diarrhea (per 1,000 live births) and x = year - 2000
******Model: y = infant hospitalization rate from diarrhea (per 100,000 live births) and x = year - 2000
Source: Brazilian Ministry of Health: Hospital Information System; Mortality Information System; Live Birth Information System

Velho, which at the end of the period still had an infant mortality rate of 25.6 deaths per 1,000 live births, and in Rio Branco, with a postneonatal mortality rate of 8.0 deaths per 1,000 live births.

DISCUSSION

To diagnose the behavior of a given disease in a population, monitoring the historical series of morbidity and mortality is necessary. Analyzing the hospitalization and mortality trends allows for an evaluation of not just disease behavior, but also, in an indirect manner, the primary and secondary prevention measures implemented to control it.[11]

Despite the marked number of hospitalizations and deaths among children under one year during the decade, this study revealed a predominant trend, in Brazil and in most capitals, of decreases in hospitalization from

Table 2. Trends in overall mortality and hospitalization among children under one year. Brazil and state capitals, 1995 to 2005.

	Infant mortality rate				Infant hospitalization rate			
Location	*Model	R^2	*p*	Trend	**Model	R^2	*p*	Trend
Brazil	y = 21.48 - 1.24x	0.92	<0.001	Decreasing	y = 246.00 - 8.00x	0.80	<0.001	Decreasing
Northern Region								
Rio Branco	y = 26.49 - 1.41x	0.81	<0.001	Decreasing	y = 211.13 - 4.63x	0.14	0.254	Stable
Manaus	y = 28.85 - 2.46x	0.94	<0.001	Decreasing	y = 137.29 + 16.50x	0.83	<0.001	Increasing
Boa Vista	y = 18.66 - 1.85x	0.59	0.006	Decreasing	y = 99.39 - 3.26x	0.07	0.432	Stable
Belém	y = 25.44 - 0.76x	0.54	0.013	Decreasing	y = 263.33 + 15.41x	0.91	<0.001	Increasing
Macapá	y = 26.02 - 0.88x	0.71	0.001	Decreasing	y = 142.18 + 0.44x	0.00	0.899	Stable
Porto Velho	y = 27.55 + 1.54x	0.27	0.105	Stable	y = 221.40 - 11.71x	0.60	0.005	Decreasing
Palmas	y = 19.09 - 0.73x	0.29	0.088	Stable	y = 281.46 - 3.58x	0.09	0.377	Stable
Northeast Region								
São Luís	y = 25.54 - 2.48x	0.63	0.003	Decreasing	y = 216.48 - 10.74x	0.59	0.006	Decreasing
Teresina	y = 19.73 + 0.21x	0.16	0.217	Stable	y = 205.43 - 1.10x	0.02	0.689	Stable
Fortaleza	y = 29.72 - 3.09x	0.74	0.001	Decreasing	y = 314.47 - 11.82x	0.67	0.002	Decreasing
Natal	y = 22.02 - 1.37x	0.63	0.004	Decreasing	y = 187.78 - 3.61x	0.25	0.116	Stable
João Pessoa	y = 19.34 - 0.94x	0.58	0.007	Decreasing	y = 202.78 - 11.26x	0.55	0.009	Decreasing
Recife	y = 20.99 - 1.34x	0.91	<0.001	Decreasing	y = 282.05 + 7.73x	0.83	<0.001	Increasing
Salvador	y = 25.44 - 0.26x	0.08	0.408	Stable	y = 209.71 + 4.23x	0.32	0.071	Stable
Maceió	y = 26.39 - 0.98x	0.15	0.236	Stable	y = 339.63 - 3.09x	0.38	0.045	Decreasing
Aracajú	y = 30.58 - 1.75x	0.78	<0.001	Decreasing	y = 141.80 + 0.82x	0.06	0.483	Stable
Southeast Region								
Belo Horizonte	y = 19.19 - 1.68x	0.84	<0.001	Decreasing	y = 303.86 - 4.96x	0.68	0.002	Decreasing
Vitória	y = 14.31 - 0.60x	0.36	0.052	Stable	y = 201.90 + 6.34x	0.41	0.035	Increasing
Rio de Janeiro	y = 17.43 - 0.77x	0.91	<0.001	Decreasing	y = 142.32 - 2.57x	0.43	0.030	Decreasing
São Paulo	y = 17.16 - 0.94x	0.94	<0.001	Decreasing	y = 155.46 + 8.30x	0.67	0.002	Increasing
Southern Region								
Curitiba	y = 14.70 - 0.82x	0.90	<0.001	Decreasing	y = 194.12 + 1.02x	0.19	0.176	Stable
Florianópolis	y = 13.43 - 1.37x	0.72	0.001	Decreasing	y = 170.02 - 2.67x	0.31	0.076	Stable
Porto Alegre	y = 14.81 - 0.58x	0.71	0.001	Decreasing	y = 353.90 + 2.70x	0.08	0.406	Stable
Centralwest Region								
Campo Grande	y = 17.26 - 1.03x	0.93	<0.001	Decreasing	y = 239.87 - 0.76x	0.02	0.681	Stable
Cuiabá	y = 18.93 - 0.12x	0.03	0.641	Stable	y = 164.06 + 0.85x	0.06	0.463	Stable
Goiânia	y = 17.28 - 1.10x	0.62	0.004	Decreasing	y = 276.27 + 0.77x	0.01	0.802	Stable
Brasília	y = 15.54 - 0.56x	0.88	<0.001	Decreasing	y = 207.80 + 12.33x	0.73	0.001	Increasing

*Model: y = infant mortality rate (per 1,000 live births) and x = year - 2000
**Model: y = hospitalization rate among children under one year old (per 100,000 live births) and x = year - 2000
Source: Brazilian Ministry of Health: Hospital Information System; Mortality Information System; Live Birth Information System

diarrhea as well as in infant mortality from this cause. Research done in Brazil[4,5,9,19] and in other parts of the world[3,10,16,18] also revealed this pattern in mortality from diarrhea.

In regards to hospitalizations, some findings in the literature diverge from the results presented in this study. An American study that analyzed the period from 1979 to 1992 did not find a substantial decrease in annual hospitalization rates from diarrhea among children under five years, with 97 hospitalizations per 10,000 children.[8] Another study, a retrospective data analysis of hospitals near to indigenous reserves in the United States, found a fall of 76% in the annual hospitalization rate associated with diarrhea in children under five years, going from 276 hospitalizations per 10,000 children in 1980, to 65 per 10,000 in 1995.[7] The same study found a reduction from 7.9 hospitalizations per 10,000 live births of under ones, in 1995, to 3.1 per 10,000 in 2005.

Table 3. Trends of the time series for indicators of hospitalization and mortality from diarrhea and the postneonatal infant mortality component. Brazil and state capitals, 1995 to 2005.

Trends from 1995 to 2005					Brazil/Capital	1995		2005	
Pattern	IMRD	IMR	IHRD	IHR		PNMR	IMR*	PNMR	IMR*
					Brasil	12.5	28.9	5.6	17.0
					Fortaleza	27.2	53.6	7.0	20.6
1	↓	↓	↓	↓	João Pessoa	9.7	25.4	5.2	17.5
					Belo Horizonte	11.5	30.9	4.5	14.5
					Rio de Janeiro	7.7	22.4	4.6	13.9
					Macapá	9.1	32.6	2.5	20.1
			↓	↔	Natal	14.1	35.2	4.4	16.4
2	↓	↓		OR	Curitiba	7.7	20.3	4.0	11.9
			↔	↓	Porto Alegre	8.9	18.7	5.6	12.9
					Campo Grande	8.1	23.9	3.7	13.6
					Manaus	17.1	42.4	6.6	17.7
					Boa Vista	11.6	32.3	4.7	14.3
					Belém	7.2	28.4	5.9	20.0
			↑	↔	Recife	9.4	29.8	4.9	16.6
3	↓	↓		OR	Aracaju	12.7	36.6	4.7	22.4
			↔	↑	São Paulo	8.5	23.0	4.4	12.9
					Florianópolis	11.8	23.0	2.0	8.9
					Goiânia	9.4	29.7	3.5	13.7
					Brasília	5.5	19.2	4.6	13.6
					Rio Branco	16.5	35.3	8.0	20.4
					Porto Velho	4.8	8.3	7.2	25.6
					Palmas	7.4	17.3	4.7	14.9
					São Luis	15.4	49.3	6.4	17.7
4		Mixed			Teresina	5.7	20.5	5.9	19.9
					Salvador	9.5	27.8	5.0	21.8
					Maceió	13.4	31.0	6.4	20.7
					Vitória	6.5	19.0	4.2	13.6
					Cuiabá	6.4	14.4	6.9	17.3

IMRD: infant mortality rate from diarrhea
IMR: infant mortality rate
IMR*: infant mortality rate per 1,000 live births
PNMR: postneonatal mortality rate per 1,000 live births
IHRD: infant hospitalization rate from diarrhea
IHR: overall infant hospitalization rate
Source: Brazilian Ministry of Health: Hospital Information System; Mortality Information System; Live Birth Information System

The combined analysis of the four hospitalization and mortality indicators, together with the postneonatal component of infant mortality rates, are normally used to analyze a region's health situation[5] and allow important aspects to be discussed. Considering the existence of inequalities in Brazil, especially in regards to wealth distribution, quality of life, access to basic sanitation and the quality of health services, the variability in the series studied was foreseeable.

The occurrence of Pattern 1 may reflect more effective actions in the prevention of the disease, such as the increase of the water supply and sewage network and the use of oral rehydration therapy. It is also possible that the reduction in hospitalization and death from diarrhea were reflected in the overall infant mortality and hospitalization rates among children under one year. Nonetheless, the presence of this pattern in locations, where the infant mortality rate is high or intermediate and where postneonatal infant mortality still has an important impact, indicates that it is necessary to strengthen prevention measures against infant death from diarrhea and also other causes.

In the capitals where Pattern 2 was observed, the situation may indicate the realization of good basic health

Figure. Type of pattern for the mortality and hospitalization indicators. Brazil and state capitals. 1995 to 2005.

care with the reduction of serious cases that necessitate hospitalizations, as well as indicating a possible reduction in access to hospital services. In the combined analysis of the indicators, it was observed that this occurred in locations with good infant mortality rates, such as Curitiba, Porto Alegre and Campo Grande, as well as locations with indicators greater than the acceptable level, such as the capitals Macapá and Natal. When analyzing the combination, Pattern 2 showed the best patterns of postneonatal infant mortality at the end of the study period. Therefore, efforts to prevent infant deaths, throughout all phases that deaths can occur, as well as the maintenance and evaluation of actions already implemented at the local level are necessary.

The existence of Pattern 3 may be the result of failures in secondary prevention, which causes an increase in the number of serious cases and therefore hospitalizations, as well as the result of improved access to hospitals in the population. The presence of this pattern in capitals with such variable rates of infant mortality and postneonatal mortality (ranging from 8.9 and 2.0 deaths per 1,000 live births to 17.7 and 6.6 deaths per 1,000 live births, respectively), suggests that localized studies should be done in order to obtain more detailed diagnostic. Thereby, it would be possible to not only detect areas to improve but also to detect successful preventive interventions and the causes of infant deaths.

The worst situation observed was the variable mortality and hospitalizations series and the high infant and postneonatal mortality rate, observed in Pattern 4. For these locations, the value of the indicators at the end of 2005 was sometimes higher than the indicators for the rest of Brazil in 1995. The comparison of the trends in these rates indicates a very bad health situation that may be the result of ineffective policies to prevent serious diarrhea cases and infant deaths in these locations.

The reductions in hospitalizations and mortality from diarrhea indicate that the measures implemented to prevent and control this disease are being adopted in an efficient manner, except in some capitals. Besides the positive effect from specific control programs, such as the introduction of oral rehydration therapy and the Maternal Feeding Program, the data suggest that

the implementation of health programs, mainly in the mid-1990s, such as the Community Health Workers Program and the Family Health Program, may have also contributed to the decreasing trend of the disease.[17] Close monitoring of patients can prevent the development of more serious cases of diarrhea, which increase hospitalization and mortality rates from the disease.

However, despite the significant decrease in the magnitude of the disease, diarrhea appears to represent an important public health problem for part of Brazil.

The persistence of social inequalities and the maintenance of the chain of events that culminates in infant death from easily avoidable causes may have been aggravated by the economic model to which the population is subject. Another negative point is when health services do not assume responsibility for timely and effective care and are incapable of preventing the occurrence of serious cases and deaths from the disease.[4] Diarrhea, though, is an easily manageable disease that does not require high cost technologies.

The study's limitations are as follows. The study was undertaken with data from capitals, where the number of health establishments and the availability of basic sanitation and of human and therapeutic resources are different than in the interior of the Brazilian states. These factors have an important role in the prevention of cases and of deaths from diarrhea.

This study exclusively utilized data on hospital and vital statistics from the country's information system. It is known that this type of data is an important tool for inferring temporal patterns in serious cases from diarrhea.[9] Despite this, the use of these statistics has limitations and some precautions should be taken when making epidemiological inferences.

When using hospital statistics, the main limitation found is the selectivity, since the system is not universal and hospitalizations in private hospitals are not included. Therefore, the results reflect morbidity trends and patterns only for the population assisted by the SUS.

The biggest problem that restricts mortality analysis in Brazil is the under-registration of deaths, which is expressed most notably in the North and Northeast regions mainly in children under one year old. This under-notification has been slowly and gradually reduced, since the SIM-MS has been implemented. Another difficulty faced when interpreting this type of data, specifically when analyzing mortality by cause, is the proportion of deaths from poorly defined causes. In the capitals as a whole, this indicator did not vary during the years analyzed (4.8% in 1995 to 3.4% in 2005), and in no capital was the proportion of deaths from poorly defined causes over 10% at the end of the study period. Nonetheless, some capitals had indicators greater than 10% at the beginning of the study, which varied with time (data not shown).

In regards to the quality of the information on the registration of live births, it is thought that the data can be used starting from 1994, according to successive evaluations that have been done. In July of 1995, the SINASC had been implemented in 80.4% of municipalities, and in 1998, it worked all over the country.[13]

Despite these limitations, it is necessary to use these tools for epidemiology. The analysis of hospital and vital statistics is not only an essential part of the monitoring process for infant mortality and morbidity; it also allows problems to be identified with capacity and data registration, providing impetus for the formulation of public policies in areas that need greater investment. Therefore, it can be said that the present study provides an approximation of the actual evolution of infant mortality and hospitalization indicators.

In conclusion, deeper investigations based on local studies are necessary, with the goal of producing more detailed evidence about diarrhea-associated patterns in children under one year old.

REFERENCES

1. Backlund E, Sorlie PD, Johnson NJ. The shape of the relationship between income and mortality in the United States: evidence from the National Longitudinal Mortality Study. *Ann Epidemiol.* 1996;6(1):12-20. DOI:10.1016/1047-2797(95)00090-9
2. Benício MHD, Monteiro CA. Tendência secular da doença diarréica na infância na cidade de São Paulo (1984-1996). *Rev Saude Publica.* 2000;34(6 Supl):83-90. DOI: 10.1590/S0034-89102000000700011
3. Bern C, Martines J, de Zoysa I, Glass RI. The magnitude of the global problem of acute diarrhoeal disease: a ten-year update. *Bull World Health Organ.* 1992;70(6):705-14.
4. Caldeira AP, França E, Perpétuo IH, Goulart EM. Evolução da mortalidade infantil por causas evitáveis, Belo Horizonte, 1984 – 1998. *Rev Saude Publica.* 2005;39(1):67-74. DOI:10.1590/S0034-89102005000100009
5. França E, Souza JM, Guimarães MDC, Goulart EM, Colosimo E, Antunes CMF. Associação entre fatores socioeconômicos e mortalidade infantil por diarréia, pneumonia e desnutrição em região metropolitana do Sudeste do Brasil: um estudo caso-controle. *Cad Saude Publica.* 2001;17(6):1437-47. DOI:10.1590/S0102-311X2001000600027
6. Guimarães ZA, Costa MC, Paim JS, Silva LM. Declínio e desigualdades sociais na mortalidade infantil por diarréia. *Rev Soc Bras Med Trop.* 2001;34(5):473-8. DOI: 10.1590/S0037-86822001000500011
7. Holman RC, Parashar UD, Clarke MJ, Kaufman SF, Glass RI. Trends in diarrhea-associated hospitalizations among American Indian and Alaska native children, 1980-1995. *Pedatrics*. 1996;103(1):E11. DOI:10.1542/peds.103.1.e11
8. Jin S, Kilgore PE, Holman RC, Clarke MJ, Gangarosa EJ, Glass BI. Trends in hospitalization for diarrhea in United States children from 1979 through 1992: estimates of the morbidity associated with rotavirus. *Pediatr Infect Dis J.* 1996;15(5):397-404. DOI:10.1097/00006454-199605000-00004
9. Kale PL, Fernandes C, Nobre FF. Padrão temporal das internações e óbitos por diarréia em crianças, 1995 a 1998, Rio de Janeiro. *Rev Saude Publica.* 2004;38(1):30-7. DOI:10.1590/S0034-89102004000100005
10. Kosek M, Bern C, Guerrant RL. The global burden of diarrhoeal disease, as estimated from studies published between 1992 and 2000. *Bull World Health Organ*. 2003;81(3):197-204. DOI:10.1590/S0042-96862003000300010
11. Latorre MRDO, Cardoso MRA. Análise de séries temporais em epidemiologia: uma introdução sobre os aspectos metodológicos. *Rev Bras Epidemiol.* 2001;4(3):145-52. DOI:10.1590/S1415-790X2001000300002
12. Mello Jorge MHP, Gotlieb SLD. As condições de saúde no Brasil – retrospecto de 1979 a 1995. Rio de Janeiro: Editora Fiocruz; 2000.
13. Mello Jorge MHP, Laurenti R, Gotlieb SLD. Análise da qualidade das estatísticas vitais brasileiras: a experiência de implantação do SIM e do SINASC. *Cienc Saude Coletiva.* 2007;12(3):643-54. DOI:10.1590/S1413-81232007000300014
14. Organização Mundial da Saúde. Centro da OMS para Classificação de Doenças. Manual da classificação estatística internacional de doenças, lesões e causas de óbitos. 3.ed. São Paulo: EDUSP; 1985. v.1.
15. Organização Mundial da Saúde. Centro da OMS para Classificação de Doenças. Classificação estatística internacional de doenças e problemas relacionados à saúde. 5. ed. São Paulo: Edusp; 1999. v.1.
16. Parashar UD, Bresee JS, Glass RI. The global burden of diarrhoeal disease in children. *Bull World Health Organ*. 2003;81(4):236. DOI:10.1590/S0042-96862003000400003
17. Silva LMV, Costa MCN, Paim JSP, Dias IB, Cunha ABO,Guimarães ZA, et al. Brechas redutíveis de mortalidade em capitais brasileiras (1980-1998). *Epidemiol Serv Saude.* 2005;14(4):203-22.
18. Snyder JD, Merson MH. The magnitude of the global problem of acute diarrhoeal disease: a review of active surveillance data. *Bull World Health Organ*. 1982; 60(4):604-13.
19. Victora CG, Bryce J, Fontaine O, Monasch R. Reducing deaths from diarrhoea through oral rehydration therapy. *Bull World Health Organ*. 2000;78(10):1246-55. DOI:10.1590/S0042-96862000001000010

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