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Diarrheal diseases and hospitalization of children under five years of age according to population-based surveys in the State of Pernambuco, Brazil, in the years 1997 and 2006

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Abstract *The scope of this paper was to assess the temporal and geographical trends of diarrhea and its implications on the demands of hospitalizations of children under five years of age in the state of Pernambuco in 1997 and 2006. Databases of two population-based surveys were assessed with probabilistic samples of 2078 children (1997) and 1650 children (2006) evaluated in 18 municipalities of Pernambuco, including the Metropolitan Region of Recife, Urban Interior and Rural Interior. Prevalence was considered to involve the occurrence of cases on the day or in the two weeks prior to the interview and as admissions, service cases with minimal hospital stay of 24 hours in the period, covering up to one year before the interview. The prevalence of diarrhea in Pernambuco had a statistically non-significant decline (19.8% to 18.1%; p = 0.192). However, a statistically-significant reduction was observed (16.9% to 10.5%; p = 0.003) in the Metropolitan Region of Recife. The number of admissions increased by more than double (2.7% to 5.5% in the State and from 1.6% to 3.8% within the Metropolitan Region of Recife), in contrast with national trends. Therefore, diarrhea in the State appears as the main component of the demands of pediatric hospitalizations during the period under scrutiny.*

Key words *Diarrhea, Prevalence, Hospitalization and child health*

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Introduction

During the last 100 years and, in a more peculiar way, over the last five or six decades, the nosographic history of humanity has presented surprising changes in relation to previously known models of morbimortality[1]. In a simplified configuration, a rapid process of epidemiological transition was outlined, characterized by the substitution of a model where infectious diseases were dominant, to one where there is a striking predominance of non-communicable chronic diseases (NCDs), that were responsible for 68% of causes of death worldwide in the year 2012, and for 72.4% in Brazil, in 2009[2,3]. The decline of infectious diseases and the emergence of NCDs in epidemic proportions are based on a substrate structure of economic growth, the political and social conquests achieved in the twentieth century, demographic changes (especially rural/urban migration and the rapid decline of fertility rates), modern and efficient means of communication, new values and life-styles, and scientific and technological progress, including instruments to prevent and cure infectious diseases and to partially control chronic diseases[4,5]. In the characterization of this generic context of great changes, some infectious diseases were practically eradicated, others are thought to be controlled and, in rare cases take a rather different turn, such as emerging and re-emerging diseases[1]. Others, meanwhile, involve more complicated trajectories of systemization, as in the case of diarrhea, especially in children[6].

Involving a varied and complex etiology, this usually occurs and develops in contexts where there is acknowledged poverty, a low level of schooling, precarious home and peridomicile conditions of hygiene, limited access to health services, deficient food and nutritional conditions, as well as other related and synergetic factors[7-12]. In this context, the cases of diarrhea are distributed in unusual and, in many aspects, surprising ways, and continue to be a health policy and program priority, even in developed countries[8,9,13]. Estimates produced by the World Health Organization (WHO) state that diarrhea still represents the second cause of death among children under the age of five worldwide, causing around 760,000 deaths per annum[14].

Next to health promotion actions, and specific protection offered by Oral Rehydration Therapy (ORT), which alone represented a historic breakthrough in reducing the level of damage (especially deaths) caused by diarrhea, the widespread use of which is calculated to represent a reduction of between 61% and 75%, in the hospitalization rates for diarrhea between 1980 and 2008[3,6]. Brazil has kept up with international trends with regards to the reduction of deaths due to diarrhea, but it seems the same is not the case in terms of prevalence and as a reason for hospital admission, probably due to the inadequacy of the actions employed[15,16]. Based on data from the Unified Health System (SUS), which evaluates the time trends of overall mortality and hospital deaths in children under the age of five, Mendes (2013) noted a slow reduction in levels between 2000 and 2010. He also states that the greatest coefficients of mortality and hospitalization occur in the North and Northeastern regions of the country[17].

The case of Pernambuco represents an unusual element, since this is one of the states in the country that, according to the Ministry of Health (2011)[18], still has the highest number of deaths due to diarrheal diseases. So, whether this is caused by inter-regional differences or not, time trend discrepancies, the relative uniqueness of the case of Pernambuco and the existence of research related to the problem through population-based surveys[19,20], and even the forthcoming new inquiry scheduled for 2015, it has become pertinent, relevant and opportune to focus on diarrheal diseases in children from this State.

Methods

This involves a population-based cross-sectional study, based on data from the II and III State Health and Nutrition Surveys (PESN) carried out in 1997 and in 2006, respectively, to enable relative comparisons to be made regarding the prevalence and creation of hospital demands in the State of Pernambuco, due to diarrheal diseases in children under five.

The aim of the two aforementioned surveys, was to update and broaden a diagnosis of the situation relating to health, nutrition, food, environmental and socio-economic conditions and the provision of health care within the State of Pernambuco, with emphasis on the maternal-child sector[19,20]. Two large geo-economic areas were surveyed: Urban (Metropolitan Region of Recife – MRR) and Urban Interior (UI and Rural Interior (RI). Pernambuco covers an area of 98,146,315 km^2, divided into 185 municipal regions with an estimated population in 2010 of 8,796,032 inhabitants, 80% of which were predominantly urban[21].

Ciência & Saúde Coletiva, 23(3):715-722, 2018

The samplings studied in 1997 and 2006 were probabilistic, with a spatial distribution that was pre-determined by the first survey (1991). In the case of PESN II, the sampling included 2,078 children, of whom 737 (35.4%) came from the MRR, 687 (33.1%) from the UI, and 654 (31.5%) from the RI. The PESN III was represented by 1,650 children under the age of five, 431 (26.1%) being from the MRR, 421 (25.5%) from the IU and 798 (48.4%) were from the RI. The differences in the sample sizes in some of the findings are due to observation losses caused by incomplete questionnaires or those that were excluded due to data inconsistency.

The sampling selection was developed in three stages: a) selection of municipal regions with proportional probability to their population according to proceedings adopted in the first survey (1991); b) selection of census sectors in each municipality; c) selection of homes/cases (children) in each census sector (40 to 45 children per census sector).

Field work was carried out by a team of interviewers, anthropometric experts, and a technical assistant in charge of collecting blood samples for laboratory tests. Data collection was done by using questionnaires with pre-codified answers.

The mothers, or persons responsible for the children selected, were interviewed in their own homes, filling out the "reported morbidity" questionnaire: this included cases of diarrhea during the previous 15 days, medical consultations for cases of diarrhea over the previous three months and hospitalizations for diarrhea during the previous 12 months. This also included a joint registration of "other diseases" for comparative purposes. Cases of diarrhea were considered to be those when three or more bowel movements occurred per day, the stool being of a watery or semi-liquid consistency, accompanied or otherwise by mucus or blood.

With hospital admissions, those taken into consideration involved cases when children with diarrhea had been admitted to healthcare facilities, with a hospital stay equal to or longer than 24 hours, reported during the previous 12 months.

Data was processed using the Epi Info - 3.5.4 (Center for Disease Control and Prevention) and Stata 12.1 programs. A comparison of hospitalization prevalence for diarrhea between the years 1997 and 2006 was carried out using Pearson's chi-squared test. Prevalence comparisons between pairs of geographic areas, were implemented using the Marascuillo Method of Multiple Comparisons[22].

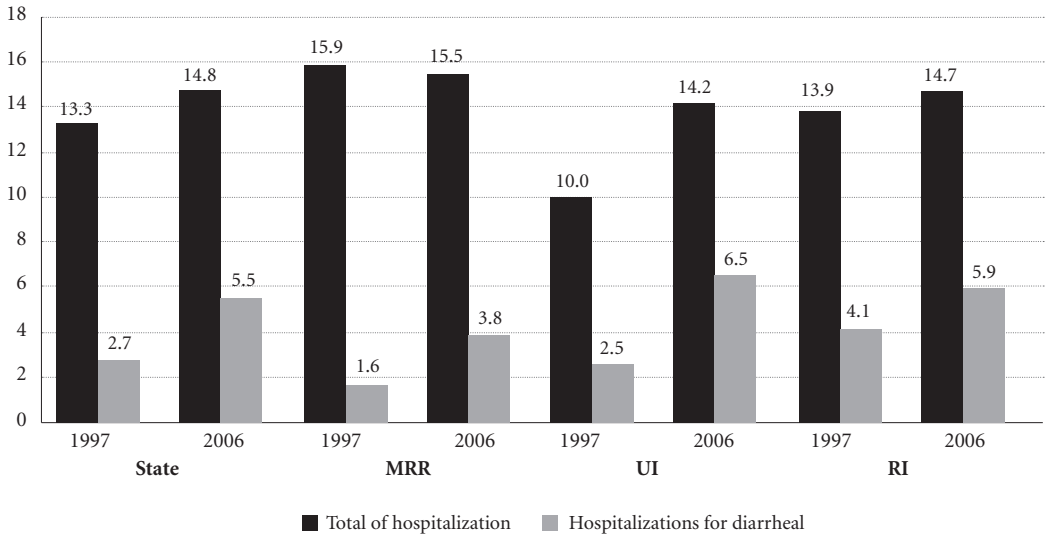
The PESN II and III projects were approved, respectively, by the Research Ethics Committee at the Center for Health Sciences at the Federal University of Pernambuco (UFPE), on February 27, 1997, and by the Professor Fernando Figueira Institute for Integral Medicine (IMIP), dated November 5, in accordance with Resolution 196/96 issued by the National Health Council.

Findings

In relation to the inclusion of diarrheal diseases in the overall group of diseases within the State of Pernambuco, and in all geographic areas, in relative terms, there was a great increase in the percentages of hospital admissions due to all causes between the years 1997 and 2006. With exception of the rural area, where cases of diarrhea show an increase from 4.1% to 5.9%, thereby representing a rise of 44%, the hospitalization rates for diarrhea doubled or almost tripled in other geographical areas. As can be seen from the graphic illustration, there was a rapid increase in cases of diarrhea in comparison to all other diseases registered at the time children were hospitalized (Graph 1).

With regards to the prevalence of diarrhea in children under the age of five in the State of Pernambuco, between 1997 and 2006, there was a reduction of 19.8% to 18.1%, however, without a statistical significance. When analyzing the geographical areas, it was observed that only the Metropolitan Region of Recife (MRR) showed a significant decrease ($p < 0.003$) in the temporal prevalence of the problem during the years assessed, dropping from 16.9% to 10.5%. The differences in prevalence were statistically significant between the MRR and the UI ($p= 0.021$) in 1997, while in 2006, the MRR presented a situation that was certainly much better in relation to the other two geographical areas (Table 1).

When specifically analyzing the temporal and spatial evolution of hospitalizations for diarrhea between 1997 and 2006, it was seen that there had been an increase from 2.7% to 5.5% in the whole State; thus, more than double the previous records for this disease. With regards to the geographical strata, with the exception of the rural area, a significant increase in the number of hospitalizations was observed in the Metropolitan Region of Recife ($p = 0.022$) and urban interior ($p = 0.001$), as can be seen in Table 2.



Graph 1. Temporal evolution of hospitalizations of children under five years of age in the State of Pernambuco and its geographic strata, with emphasis on the participation of diarrheal diseases in 1997 (II PESN) and 2006 (III PESN).

Table 1. Prevalence of diarrhea in children under five years of age in the State of Pernambuco, by geographic strata, in the years 1997 (II PESN) and 2006 (III PESN).

Geographic strata	II PESN1997			III PESN 2006			Statistic
	Sample	Diarrhea		Sample	Diarrhea		
	N	n	%	N	n	%	* p value
MRR	735	124	16.9	427	45	10.5	0.003
Urban Interior	686	156	22.7	416	81	19.5	0.200
Rural Interior	653	130	19.9	789	169	21.4	0.481
State	2074	410	19.8	1632	295	18.1	0.192

* * Pearson's chi-squared test. Multiple comparisons performed with the Morascuillo test: 1997: MRR x UI: p = 0.021; MRRxRI: p = 0.346; UIxRI: p = 0.449. 2006: MRR x UI: p = 0.001; MRRxRI: p< 0.001; UIxRI: p = 0.725.

Table 2. Hospitalizations due to diarrhea in children under five years of age in the State of Pernambuco, in the years 1997 (II PESN) and 2006 (III PESN).

Geographic strata	II PESN1997			III PESN 2006			Statistic
	Sample	Diarrhea		Sample	Diarrhea		
	N	n	%	N	n	%	* p value
MRR	737	12	1.6	425	16	3.8	0.022
Urban Interior	687	17	2.5	416	27	6.5	0.001
Rural Interior	654	27	4.1	783	46	5.9	0.133
State	2078	56	2.7	1624	89	5.5	<0.001

Multiple comparisons performed with the Morascuillo test: 1997: MRR x UI: p = 0.029; MRRxRI: p = 0.973;UIxRI: p = 0.018. 2006: There were no multiple comparisons between the strata because the chi-square test of comparisons between the strata was not significant, p = 0.176. * Pearson's chi-squared test.

Ciência & Saúde Coletiva, 23(3):715-722, 2018

Discussion

Diarrheal disease in children under five years of age is still at significant levels, generating high morbidity and mortality statistics, influencing the demands of health services in a major way and thereby representing a priority public health problem[6,15,16,23].

In terms of morbidity, an annual prevalence of 3.2 cases was estimated in children under five years of age in the period from 1992 to 2000 based on a study that examined publications from several countries[13]. More recently, by matching cohort studies in low- and middle-income countries between 1990 and 2010, an average of 2.9 episodes per year was estimated, with much higher frequencies in the age range of 6 to 11 months[24]. In Brazil, the two most recent national surveys (National Demographic and Health Surveys - 1996 and 2006)[25,26], revealed that the prevalence of diarrhea in children under five years of age dropped from 13.1% to 9.4%. There was a reduction in the prevalence of diarrhea in all macro-regions of the country, with the exception of the North (13% increase), whereas in the Northeast there was a decrease of 25%. In relation to the urban/rural dichotomy, at the national level the decrease was far more pronounced in the urban area (33%) than in the rural area (12%). With regard to hospitalizations, studies using national data show a reduction of approximately 40% to 60% in the rate of hospitalization in children under one year of age[15,27], with unequal evolution between the Brazilian regions[15]. Another study, evaluating the trend of diarrheal disease in children under five years of age, from 2000 to 2010, with data from the Unified Health System (SUS), observed a slow annual reduction in the rate of hospitalization due to diarrhea in children under one year of age and a discreet decline between one and four years of age, showing that the hospitalizations remained practically stable, despite the slight increase in some regions of the country (North and Northeast)[17].

Regarding mortality, global statistics revealed that between 2000 and 2003, diarrheal diseases accounted for 18% of the 10.6 million deaths of children aged under five, most of which occurred in the poorest countries and regions and having, as a very peculiar epidemiological characteristic, a close association with protein-energy malnutrition (PEM). In Brazil, from 1980 to 2005, namely a period of 25 years, there was a 93.9% decrease in infant mortality due to diarrhea (SIM/MS)[28]. In reports for a shorter period of ten years (1995/2005), 39,421 deaths and 1,505,800 hospitalizations were reported in children under one year of age due to diarrhea and ensuing complications[27].

From a descriptive point of view, it was seen that in the State of Pernambuco, the prevalence of diarrheal diseases in children under the age of five practically remained at the same levels between 1997 and 2006, bearing in mind that a decrease of only 1.7% in nine years is much lower, for example, than the standards established at the New York World Summit (1990)[29]. In fact, in the case of Pernambuco, what is pointed out here is the great reduction in the occurrence of this problem of the MRR (62%), together with a much lower reduction in the urban interior and a discreet increase in the rural area. Thus, there were three distinct movements within the geographical area of the State, representing a curious form of epidemiological kinetics. This already implies a wider question: does this involve a particular process relating to the case of Pernambuco, or is this a phenomenon that is being replicated in other states or regions of the country, involving a triangle of metropolitan regions, non-metropolitan urban spaces and rural populations? This is an issue that should be duly considered.

Another interesting contrast is seeing that, in the sample space where the prevalence for diarrheal diseases had decreased the most, namely within the MRR, there was, in relative terms, the greatest concentration of hospitalizations attributed to this disease. On a second level, statistics are shown for children who are resident in urban areas in the interior of the State. With regards to rural areas, where the prevalence did not statistically differ between 1997 and 2006, information registered about cases of hospitalization showed a much lower result than expected when temporal trends, verified in the urban area surveys, were maintained, especially within the MRR.

Assuming that the data collection from the surveys were carried out using the same questionnaires, the same interviewers, the same guidelines and the same criteria of consistency and validation of the data collected, it seems safe to say that the differences found are in fact valid for comparative inferences. The statistical disassociation, a type of inverse correlation, shows a marked reduction in the prevalence of cases of diarrhea (nearly 62%) between 1997 and 2006 within the MRR, in contrast to the increase in the hospitalization rates from 1.6% to 3.8%, which

involves a prevalence ratio of 2.37 times, namely a percentage increase of 137% in the hospitalization rates. These findings may be attributed to easier access to hospitals and a greater willingness on the part of the parents to seek these health care services. A third hypothesis is less acceptable, namely as a trend, cases of diarrhea are becoming less frequent, but far more serious. However, there is no empirical evidence in this respect in scientific studies, in technical reports or in the lay press. On the other hand, explaining this as being due to a greater demand and access to hospitals, gains greater consistency when one considers that, in all the areas of the State survey, there was a considerable increase in the general hospitalization rates for children due to all causes, which translates into a well-defined trend in relation to pediatric diseases, which is far more accentuated in cases of diarrhea.

It should be said that another factor that is of considerable geopolitical, demographic and epidemiological importance, is the rapid growth of urban populations, which has never occurred before in the whole history of humanity, especially in less developed or emerging countries. This process can represent a heavy burden for society, since the growth of cities does not always go hand-in-hand with the supply of adequate environmental sanitation, healthy domestic living conditions and the availability of a social service network, notably in the areas of health, education and social welfare. This is underlined in a special United Nations document[4]. Urban sanitation conditions, especially with regard to the supply of and access to clean drinking water and a sanitary sewage system, play a fundamental role in relation to the risks of diarrheal diseases[12,30]. In spite of the advances made in relation to the proportion of the population with access to basic sanitation improvements, which increased from 68% to 79% between 1990 and 2010, as well as the use of clean drinking water, which rose from 89% to 98% in Brazil, according to a UNICEF and WHO report, significant inequalities still exist between social groups in the country, which make it easier to understand the magnitude of the cases of diarrheal disease and their consequences[30]. In this respect, reference is made to a study of international projection, carried out in the city of Salvador (Bahia), which shows the importance of a supply of good quality water as a strategic requirement to promote child health[31].

It is therefore pertinent to analyze the results obtained in Pernambuco in view of the guidelines proposed by the United Nations for the decade of the 1990s, when cases of diarrhea appear as one of the 15 child health priorities[29]. It was therefore generally decided to adhere to the international goal of reducing by 25% the prevalence and by 50% the impact that diarrhea has on specific mortality rates, mainly by using Oral Rehydration Therapy (ORT). In the study quoted here, it was seen that the prevalence of the problem of diarrhea in the State of Pernambuco decreased by less than 2%. When analyzing data from the Ministry of Health/Datasus, with regard to deaths caused by diarrhea[32], it was seen that there had been a reduction from 2.6 to 0.6 per 1,000 children born alive in the State of Pernambuco, during the period from 2000 to 2010. This represents a reduction of almost 77%, which goes far beyond the United Nations goal. It is possible that, to a great extent, this significant difference may be attributed to the wider coverage and efficiency of hospital care[33], since this increased by 156% during the period surveyed. Bearing in mind that 97% of the cases of diarrhea are self-limited, namely only 3% require therapeutic interventions involving medical care and hospital assistance, the percentage of 3.8% for hospitalizations for cases of diarrhea in the MRR would fully cover this potential demand (3.8% versus 3%)[34]. It is clear that this study, working with aggregated statistical values and not with individualized data, cannot present these findings as proof of a hypothesis. This is not, after all, the aim of the work here presented.

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Ciência & Saúde Coletiva, 23(3):715-722, 2018

Collaboration

MJOB Vasconcelos carried out the data analysis, drafted and reviewed the text; A Rissin drafted and revised the text; JN Figueiroa carried out a statistical analysis of the research data, as well as drafting and reviewing the text; PIC Lira drafted and reviewed the text; M Batista Filho drafted and reviewed the text.

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