Cholera in Brazil during 1991-1998: Socioeconomic Characterization of Affected Areas

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ABSTRACT

The paper describes the trends in, and spatial patterns of, the incidence of cholera in Brazil from 1991 to 1998. During this period, 161,432 cases and 1,296 deaths from cholera were reported. The poorest (North and Northeast) regions of the country had the highest morbidity and mortality rates. The remaining regions had self-limited outbreaks. Seventy-eight percent of affected municipalities had populations of fewer than 30,000, and about 65% of them lived in rural areas. The affected municipalities of the North and Northeast regions had consistent indications of deprivation: average Human Development Index was 0.41, infant mortality rate 90.3%, average life expectancy 59.4 years, and adult illiteracy rate 46.5%. The epidemiological profile of the disease in Brazil highlights intra- and inter-regional socioeconomic differentials in the country and indicates the importance of planning and implementing public-health interventions and specific policies aimed at reducing health inequalities.

Key words: Cholera; Vibrio cholerae; Disease outbreaks; Epidemiology; Mortality; Socioeconomic factors; Brazil

INTRODUCTION

After almost 100 years of absence from Latin America, cholera re-appeared in January 1991 and spread rapidly. Vibrio cholerae O1 El Tor caused the disease. Peru was the first country affected, with an explosive outbreak. There were 420,000 cases and 3,300 deaths during the first 15 months of the epidemic. During 1991-1996, Latin America reported 1.4 million cases and nearly 10,000 deaths (1).

Increase in international commerce and travel during the last decades and high rate of symptom-free infections due to V. cholerae O1 El Tor contributed to the worldwide spread of cholera. The seventh cholera pandemic affected several countries with different levels of socioeconomic development. In countries with higher standards of living and sanitation, cholera was not a continuous important public-health problem. However, it was a recurrent problem in several poor countries, especially those with high infant mortality rate and incidence of childhood diarrhoea (2).

In April 1991, cholera emerged in the Amazonian region of Brazil and spread throughout the major part of the North within a few months. By the end of 1992, most states of North and Northeast regions of Brazil had been affected by cholera, and from 1991 to 1996, all regions
of the country experienced outbreaks of cholera, with varying intensity and characteristics (3).

The objectives of the present study were to describe the trends in, and spatial patterns of, the spread of cholera in Brazil during 1991-1998 and to describe the social development indicators for the affected areas.

MATERIALS AND METHODS

Data on cholera cases in Brazil by year, state, and municipality, from 1991 to 1998, were drawn from the Brazilian cholera surveillance carried out by the National Centre of Epidemiology (National Foundation of Health), Brazilian Ministry of Health. Mortality data by year, from 1991 to 1998, refer to cholera as the underlying cause of death; these data refer to code 001 of the International Classification of Diseases—ICD-9, and code A00 of the ICD-10. The data were provided by the Brazilian system of mortality data, coordinated by the National Centre of Epidemiology.

The case definition of cholera, adopted by the Brazilian Ministry of Health in 1991, required laboratory identification of \textit{V. cholerae} O1 in stool or vomitus culture (4). After 1992, the case definition changed to include the following criteria (5):

(i) \textit{In areas with evidence of the presence of \textit{V. cholerae}}: (a) any patient aged five years or more with acute diarrhoea and without any other confirmed diagnosis by clinical symptoms or laboratory tests; (b) any patient aged less than five years with acute diarrhoea and contact with a confirmed case of cholera during the previous 10 days, without any other confirmed diagnosis by clinical symptoms or laboratory tests;

(ii) \textit{In areas without evidence of the presence of \textit{V. cholerae}}: any patient aged five years or more with acute diarrhoea, coming from an area with the presence of \textit{V. cholerae} and without any other confirmed diagnosis by clinical symptoms or laboratory tests.

Censuses performed by the Foundation for the Brazilian Institute of Geography and Statistics in 1980 and 1991 and the population count in 1996 provided population data for estimating morbidity and mortality rates. For data analysis, some variables were measured at the regional level (South, Southeast, Centre-West, North, and Northeast). The regional division of Brazil is a geographical division of its states to enable planning of services and targeting of resources, albeit with reduced political and legislative importance. Figure 1 presents a graphic display of Brazilian regions, and Table 1 synthesizes some of their characteristics.

Per-capita household income refers to the Brazilian standard for measuring income—the ‘minimum wage’—

![Graphic display of Brazilian regions](source: Brazilian Institute of Geography and Statistics)

Table 1. Characteristics of Brazilian regions

<table>
<thead>
<tr>
<th>Region</th>
<th>No. of states</th>
<th>Proportion of population (%)</th>
<th>Urban population (%)</th>
<th>Infant death rate (%)</th>
<th>Households with tap water (%)</th>
<th>Per-capita income*</th>
</tr>
</thead>
<tbody>
<tr>
<td>North</td>
<td>7</td>
<td>6.98</td>
<td>57.83</td>
<td>50.98</td>
<td>43.81</td>
<td>0.89</td>
</tr>
<tr>
<td>Northeast</td>
<td>9</td>
<td>28.90</td>
<td>60.64</td>
<td>82.45</td>
<td>51.26</td>
<td>0.65</td>
</tr>
<tr>
<td>Centre-West</td>
<td>4</td>
<td>6.42</td>
<td>81.26</td>
<td>32.46</td>
<td>65.35</td>
<td>1.45</td>
</tr>
<tr>
<td>Southeast</td>
<td>4</td>
<td>42.65</td>
<td>88.01</td>
<td>32.17</td>
<td>83.42</td>
<td>1.77</td>
</tr>
<tr>
<td>South</td>
<td>3</td>
<td>15.05</td>
<td>74.12</td>
<td>29.04</td>
<td>68.84</td>
<td>1.38</td>
</tr>
</tbody>
</table>

* Urban and rural areas
† Brazilian ‘minimum wages’

which has traditionally been lower than US$ 100 per month, though not constant throughout the period. Information on social development characterizing the affected areas refers to the 1991 census, the most recent source of information on general population, and the Human Development Index (HDI), a variable defined by the United Nations Development Programme measuring overall achievements in terms of longevity (life expectancy), educational attainment (adult literacy and combined primary, secondary and tertiary enrollment), and adjusted income (6).

We used the Map Info software for displaying data on charts and the SPSS for statistical analysis of results.

RESULTS

According to official data for the 1991-1998 period, 161,432 cases of cholera were identified, and 1,296 deaths occurred in Brazil. The most severely-affected regions of the country were the North and Northeast regions, accounting, respectively, for 7.0% and 92.2% of the cases and 6.6% and 90.5% of the deaths.

Figure 2 shows maps to indicate the trends in, and spatial patterns of, the spread of cholera in the affected municipalities. As the municipalities in the North region have low population-density and comprise small villages surrounded by the rain forest, the areas are larger than those of the municipalities in the Northeast region. The charts may, thus, provide over-estimated indications of spread of the disease in the North. Figure 2 indicates that outbreaks of cholera in the remaining regions of the country were scarce, affected a reduced number of people, and were not repeated in subsequent years.

Figure 3 shows rates of incidence of cholera and mortality due to cholera in the North and Northeast, the only two Brazilian regions presenting continuous cases and deaths throughout the study period. The graphic device quantitatively points out the trends indicated by the maps. In the North where cholera broke out earlier, the highest incidence and mortality rates were observed in 1992. The highest incidence in the North was 40.7 cases per 100,000 inhabitants in 1992, with the state of Amapá ranking the highest for the state-specific figure: 111.3 per 100,000. In the Northeast, peaks were in 1993. The Northeast presented 135.1 cases per 100,000 inhabitants in 1993, with the state of Ceará ranking the highest for the state-specific figure: 347.7 per 100,000. During the whole study period, the cumulative incidence of cholera in the Northeast was 350.6 cases per 100,000 inhabitants, while the figure for the North ranked lower: 109.8 per 100,000. Both the regions presented similar case fatality rates (0.79% and 0.76% respectively).

To highlight the overlap of these areas visually, Figure 4 displays charts showing (a) all the areas that were affected by cholera; (b) the municipalities with low HDI; (c) that less than 50% of the households were linked to the water supply network; and (d) that per-capita

![Figure 2](source: Brazilian Ministry of Health. National Health Foundation. National Centre of Epidemiology)
household income was lower than 50% of the Brazilian minimum wage.

Demographic information indicated that over 78% of the affected towns had fewer than 30,000 inhabitants, and nearly 65% of them had more than half of their population living in rural areas, while the overall proportion of rural population in Brazil was 24.5% in 1991 (42.2% in the North and 39.4% in the Northeast).

Table 2 summarizes the socioeconomic indicators of the affected areas, quantitatively pointing out the

<table>
<thead>
<tr>
<th>Socioeconomic characteristics</th>
<th>Affected cities in S, SE, and CW</th>
<th>State capitals in N</th>
<th>Other affected cities in N</th>
<th>State capitals in NE</th>
<th>Other affected cities in NE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average household income</td>
<td>1.14</td>
<td>1.43</td>
<td>0.51</td>
<td>1.39</td>
<td>0.37</td>
</tr>
<tr>
<td>(minimum wage)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Households with income lower than ½ minimum wage per capita</td>
<td>47.1%</td>
<td>35.6%</td>
<td>74.2%</td>
<td>45.4%</td>
<td>82.8%</td>
</tr>
<tr>
<td>Households linked to water supply network</td>
<td>78.6%</td>
<td>76.6%</td>
<td>39.2%</td>
<td>81.7%</td>
<td>55.0%</td>
</tr>
<tr>
<td>Households with sewer installations</td>
<td>56.9%</td>
<td>42.3%</td>
<td>15.1%</td>
<td>58.3%</td>
<td>22.3%</td>
</tr>
<tr>
<td>Human Development Index</td>
<td>0.646</td>
<td>0.769</td>
<td>0.483</td>
<td>0.758</td>
<td>0.401</td>
</tr>
<tr>
<td>Infant mortality rate</td>
<td>35.8‰</td>
<td>44.6‰</td>
<td>47.2‰</td>
<td>56.8‰</td>
<td>95.8‰</td>
</tr>
<tr>
<td>Rate of illiteracy</td>
<td>(over 15 years old subjects)</td>
<td>20.0%</td>
<td>10.8%</td>
<td>36.5%</td>
<td>15.2%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Years of schooling of household’s head</td>
<td>4.6</td>
<td>6.1</td>
<td>2.4</td>
<td>6.5</td>
<td>2.1</td>
</tr>
<tr>
<td>Urban population</td>
<td>79.6%</td>
<td>91.2%</td>
<td>42.8%</td>
<td>91.2%</td>
<td>46.0%</td>
</tr>
<tr>
<td>Average yearly incidence</td>
<td>0.65</td>
<td>9.31</td>
<td>32.11</td>
<td>52.94</td>
<td>52.33</td>
</tr>
<tr>
<td>(per 100,000 inhabitants)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

S=South; SE=Southeast; CW=Centre-West; N=North; NE=Northeast

Human Development Index: Martins (1998)
geographical patterns shown in Figure 4. The municipalities affected by cholera presented consistent indicators of deprivation, especially those in the North and Northeast, excluding the state capitals. About 80% of the households in these municipalities received less than half of the minimum wage per capita, and three-fourths of the municipalities presented less than 37.6% of the households linked to the water supply network. Their HDI figures, infant mortality rate, and illiteracy rate in over 15-year-old subjects also indicated poor living conditions. Despite having a better social development profile than in the remaining affected


Fig. 4. Charts highlighting (a) area occupied by municipalities affected by cholera in Brazil in 1991-1998; (b) municipalities with low Human Development Index of United Nations Development Programme, i.e. lower than 0.50; (c) municipalities with inadequate tap-water, i.e. less than 50% of households linked to the water supply network; and (d) insufficient income, i.e. per-capita household income lower than half the Brazilian minimum wage
municipalities, the state capitals of the North and Northeast were hit by outbreaks of cholera over successive years during the study period. Despite the higher overall social development profile in South, Southeast, and Centre-West regions, cities affected by cholera in these areas also presented poor figures for social conditions: nearly half of their households had insufficient income, and one in five adults was illiterate.

**DISCUSSION**

Despite the extensive Atlantic Coast of Brazil, where commercial interchange and migratory flows are more intense, cholera entered the country through its border with Peru and Colombia in the Amazonian region. The main features of the Atlantic Coast are: difficult access (reduced international contact, except countries sharing borders with the rain forest), low population-density, and fishing and extractive agriculture as the main economic activities. The high incidence of cholera in the Peruvian rain forest area in 1991 was probably the cause of emergence of cholera in Brazil through this unexpected route (7).

From there on (Fig. 2), since the rivers are the main routes of transport, the epidemic followed the course of the northern hydrographical basin into contiguous areas, affecting small communities located along the banks of large rivers in the Brazilian Amazonian forest. During the second year of the epidemic, cholera affected the Northeast region (Fig. 1), broadly beginning along the coast, rapidly advancing toward the interior, and even affecting non-contiguous areas. The disease spread faster in the Northeast than in the North, and morbidity and mortality figures ranked higher (Fig. 3). The highways were the main routes for the epidemic in the Northeast. The different epidemiological patterns of cholera in the Northeast region probably resulted from its higher population density—28.9 against 2.9 inhabitants/km² in the North (6); its more complex economic system; more intense commercial interactions; extended periods of drought mainly affecting the hinterland, and, as a consequence, its more dynamic migratory flows (8).

In both the regions, the most affected areas were small villages with a predominantly rural population, characterized by deprivation, low HDI ranking, poverty, high rates of infant mortality and illiteracy, and lack of sanitation (Fig. 4 and Table 2). A study in the Northeast state of Pernambuco revealed high incidence of cholera in municipalities with a low proportion of households with piped water supply and a high proportion of low-income families (9). An ecological study in Mexico also indicated high poverty and low urbanization levels as the most important predictors of cholera in that country (10). These observations are also consistent with the correlation between incidence of cholera and infant mortality, HDI, per-capita gross national product, and female literacy in Latin American countries (11).

Despite better social development figures, the state capitals of the North and Northeast regions had high incidence of cholera during subsequent years (Table 2). Similarities in the severity of the epidemic in the capital and non-capital cities of the North and Northeastern regions warrant further hypotheses. This epidemiological pattern probably resulted from the intensely-unequal income distribution and high social contrasts associated with heterogeneous living conditions in these towns. Despite having a population of more firmly-established middle- and upper-middle classes than in the remaining urban centres of these regions, which resulted in improved overall socioeconomic indicators, these cities also present large populations living in poverty with a deficient urban infrastructure. In particular, the state capitals of the Northeast region are very large cities, with 1.5-3.0 million inhabitants, with densely-populated impoverished shanty towns lacking sanitation and tap-water, and with a high proportion of illiteracy and low-income subjects (12). Additionally, the higher sensitivity of surveillance in the state capitals of the North and Northeast, in consequence of their greater healthcare structure, may have helped acknowledge the severity of epidemics in these cities, by allowing a higher identification of cases (3).

Although drought and scarce access to water may have contributed to the greater spread of cholera in the Northeast region, the same conditions can impair the persistence of *V. cholerae* in the environment. In the North, by contrast, a large hydrographical basin and the existence of different ecosystems, especially in the Amazon estuary, may contribute to its survival in the environment and establish similar conditions for the formation of endemic foci to those verified on the U.S. Gulf Coast and in Australia (13-15). The recent report on seasonal patterns of incidence of cholera in the state of Amazonas may be an early indication of this phenomenon (3). These observations stress the importance of new studies focusing on the synergism between the social and the physical environments to explain the epidemiological pattern of cholera (16). Figure 2 also indicates how the Brazilian border with
Peru had persisted as a route for continuous reappearance of *V. cholerae*, if the disease remained endemic in that country.

The low impact of cholera epidemic in the South, Southeast, and Centre-West reflects their favourable socioeconomic development profile (Fig. 4). The South and Southeast have a developed industrial structure and a high proportion of urban population, while the Centre-West presents a highly developed agriculture. These regions have high levels of households linked to the water supply network, an HDI score of over 0.84, less than 10% adult illiteracy, and an infant mortality rate near 32 per 1,000 livebirths (6,12). These indices indicate that the South, Southeast and Centre-West Brazilian regions have low risk for continued transmission of *V. cholerae* (11).

After 1995, the incidence of cholera fell sharply and quickly in the North and Northeast regions. This trend reflects the reduction of susceptible subjects among the vulnerable population and the improvement of cholera control programmes. It also probably reflects the favourable evolution of some health and social indicators. The mortality rates of diarrhoea fell sharply in the most-affected areas from 1980 to 1998, along with decreasing diarrhoea-related hospital admission rates for children (17). From 1991 to 1998, the infant mortality rate decreased from 82.5‰ to 58.3‰ in the Northeast and from 51.0‰ to 36.0‰ in the North. The percentage of urban population with piped water supply increased from 68.0% in 1991 to 70.9% in 1998 in the North region and from 78.4% to 87.8% in the Northeast during the same period. The illiteracy rate among subjects aged over 15 years fell from 24.1% in 1991 to 14.0% in 1998 in the North and from 36.6% to 32.0% in the Northeast (12).

Some limitations of the data analyzed in this study should be pointed out. The Brazilian cholera surveillance relied upon active and passive procedures, and the passive procedure under-estimates the incidence rates, particularly in small villages of the poorest regions of the country. The use of a highly specific case definition during the first year of the epidemic may have led to an under-estimation of the real extension of the beginning of the epidemic. Some Brazilian states kept the same highly specific case definition even after 1991, which may have biased state-level comparisons of cholera indicators and caused under-estimated figures of incidence in the region and in the country as a whole (18).

In 1991, when re-appearance of cholera in Brazil seemed imminent, official health agencies were deeply concerned about its potential impact and also about the ability of the country’s infrastructure to contain it, considering the near-continental dimensions of its territory (8.5 million km²), magnitude of its population (157 million inhabitants), and presence of severe social inequalities and deprivation—not only in its poorest regions, but also in large metropolitan areas of the Southeast, especially in São Paulo and Rio de Janeiro (12). These two regions have 17 and 10 million inhabitants respectively, many of them dwelling in slums and shanty towns (12).

Fortunately, the epidemic had less impact than had been feared. In the more-developed areas of the country, such as Centre-West, Southeast, and South, which have better urban infrastructure, health services, and educational levels, only self-limited outbreaks were observed, which did not recur over successive years (Fig. 2). This suggests an epidemiological pattern of cholera similar to that observed in rich countries which faced the emergence of the disease.

The re-appearance of cholera in Brazil occurred during a period of widespread changes in social and health indicators in the country. The fertility rate decreased from 4.3 in 1980 to 2.4 in 1998 (19); the adult illiteracy rate fell from 25.3% to 16.2%; the infant mortality rate dropped from 85.2% to 34.7%; the diarrhoea proportional mortality ratio in children aged less than five years decreased from 24.5% to 9.7%; and the prevalence of malnutrition in the same group came down from 18.4% to 5.9% (12). Despite these indications, improvements of the health profile and social indicators were not homogeneous in Brazil, and vast areas of its territory still present intense deprivation and health inequities, particularly in the North and Northeast (20). The re-appearance and spread of cholera during the 1990s bear witness to these heterogeneous living conditions. Cholera in Brazil broadly followed the map of social exclusion in the country, affecting more intensely those towns in which the health and socioeconomic profiles have not followed the recent favourable evolution of social development in the country.

The results of our study point out the importance of improving the cholera surveillance system and public-health initiatives aimed at controlling the disease and implementing specific policies intended to reduce the enormous intra- and inter-regional gulf in living
conditions nationwide. We also call for undertaking research to evaluate and monitor the risk of environmental persistence of *V. cholerae* in the North.

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REFERENCES