

THE IMPACT OF IMPROVEMENT OF WATER SUPPLY AND SANITATION FACILITIES ON DIARRHEA AND INTESTINAL PARASITES: A BRAZILIAN EXPERIENCE WITH CHILDREN IN TWO LOW-INCOME URBAN COMMUNITIES*

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ABSTRACT: During the second half of 1986 the impact of the improvement of water supply and excreta disposal facilities on diarrheal diseases and intestinal parasitosis was studied in 254 children up to six years of age from two *favelas* (shanty towns) of Belo Horizonte, Brazil. The estimated incidence of diarrhea was 6.2 episodes/child year and the estimated period prevalence reached 31.0 episode days/child/ year. The point prevalence of parasitosis was 70.7% (*Ascaris lumbricoides*: 55.4%, *Trichuris trichiura*: 19.6%, *Giardia lamblia*: 17.9%). The estimated prevalence of diarrhea decreased with improvement of water supply and sanitation facilities to 45% and 44% respectively, but no statistically significant impact was observed in the case of parasitosis. School education and weaning practice were found to be other important determinants of diarrhea.

KEYWORDS: Diarrhea, occurrence. Helminthiasis, occurrence. Water supply. Sanitation.

INTRODUCTION

In contrast to the dramatic decline in diarrheal disease morbidity and mortality rates in developed countries during the past century diarrheal diseases still represent one of the main problems in most of the developing world¹⁷. Many attempts have been made to reduce mortality and morbidity from diarrhea⁹. In particular, oral rehydration therapy (ORT) has been recommended by several national and international organizations as a basis for diarrhea control. ORT is an effective and relatively inexpensive method of reducing the mortality caused by dehydration accompanying diarrhea¹⁶. However, the adaptation of ORT could also increase the dangerous belief that this can control all diarrheal diseases. Our present knowledge

indicates that its effectiveness in preventing death from dysenteric or chronic diarrheas is limited⁷.

However, preventive, non-clinical measures for diarrhea control among young children can be justified. One of these preventive strategies is the improvement of water supply and sanitation facilities, so that transmission of the agent is prevented or at least impeded. In urban areas the improvement of water supply and sanitation facilities can be established only by the construction of high cost basic infrastructural systems. Considering the lack of capital in most developing countries, and also the lack of knowledge of the impact of water supply and excreta disposal on diarrhea, more field studies of the latter are required under different environmental and cultural conditions⁶.

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In the following study, incidence, duration and prevalence of diarrhea, and the prevalence of intestinal parasites were observed in two low-income communities of Belo Horizonte, Brazil. In both study areas a part of the population had benefited from newly introduced basic infrastructure facilities such as a water supply, excreta disposal facilities and public removal of refuse¹⁸. Therefore it was of particular interest to study the impact of these measures on diarrheal diseases and intestinal parasite prevalence and to compare them with other socio-economic and environmental variables.

MATERIAL AND METHODS

Population studied. Belo Horizonte is the capital of the federal state of Minas Gerais, and with 2.4 million inhabitants (1986) the third largest city of Brazil. In two conglomerations of this urban area, the State Secretariat of Employment and Social Action (SETAS) and the Deutsche Gesellschaft für Technische Zusammenarbeit — gtz — are carrying out an urbanization project to improve basic infrastructure. Both communities are located in the southern center of the city 4 km apart from each other and subdivided into several *favelas* (shanty towns). In "Alto da Serra", which consists of the *favelas* "Vila de Nossa Senhora da Conceição", "Vila de Santana do Cafezal", "Nossa Senhora de Fátima" and "Marçola", approximately 50 thousand inhabitants live in an area of 108.0 ha. In the second conglomeration of "Barragem de Santa Lúcia" and "Vila Rita de Cássia" an area of 43.7 ha is occupied by 25 thousand inhabitants.

Eighty households of "Serra" and 60 households of "Sta. Lúcia/Vila Rita", all having at least one child below six years of age, were visited during September and October 1986. Descriptions of the communities, study populations, and surveillance methodology have been published in detail elsewhere³.

Hemoglobin. Hemoglobin concentration in the blood of the children was determined according to the hemoglobin cyanide method. The test was undertaken with the rapid test method of COMPUR Medical Technology (Equipment: COMPUR M 1000 D1; reagent: INSTANT M, Catalogue N° 6800-501) following the instructions of the manufacturer³.

Parasitology. Detailed instructions and a receptacle for the feces of the surveyed children

had been left with their mothers the day before collection. The feces were examined for parasites by the Central Laboratory of the Hospital of the Municipality of Belo Horizonte (PMBH). The feces were examined by the sedimentation technique as described by Goulart and Costa Leite¹⁰. All positive fecal specimens were examined once only; 31% of the examinations with a negative result were repeated, i.e., 15 cases.

Sociocultural survey. Questions on demographic, socioeconomic and environmental characteristics, as well as on diet and state of health, were answered by the mothers of the children. An auxiliary worker was present during the inquiry by the nutritionist in order to establish an atmosphere of confidence between the interviewer and the mother, since the nutritionist, unlike the auxiliary, was unknown to the community. The development of the specific questions on diarrhea was based on the suggestions from the WHO Diarrheal Disease Control Programme²⁰. The incidence data were drawn from the mother's observations of the beginning of a diarrheal episode during the previous two weeks. A diarrheal episode was defined as the occurrence of more than three liquid stools per day.

Data processing and analysis. Data were processed on the PC (Compaq II) of the "Instituto de Nutrição" of the Federal University of Rio de Janeiro. The prevalence of anaemia was defined as the percentage of the surveyed population falling below the cut-off point of 11 g/dl, as recommended by WHO¹⁹. Tests of specifically derived subhypotheses were carried out by a series of variance analyses with unequal sample size (one-factor ANOVA). This test avoids an exaggerated overestimation of smaller sample groups, which might occur in field studies. Furthermore it enables the statistical differentiation not only of continuous variables, such as age groups, but also of discontinuous variables, such as the type of water supply. Missing data accounted for less than 2% of the observations for all variables, with the exception of parasite load and hemoglobin, where 33.2% and 11.8% of observations were missing respectively.

RESULTS

Table 1 gives information about the living conditions in the two communities. The

TABLE 1

Selected characteristics indicating socioeconomic, housing and basic infrastructure conditions in the two urban areas studied in Belo Horizonte (1986).

Socioeconomics Characteristics	Serra	Sta. Lúcia/ Vila Rita	Total
Household members:			
Total	6.1 ± 2.7*	6.0 ± 2.6	6.1 ± 2.7
children < 6 years	2.3 ± 0.8*	2.2 ± 1.0	2.2 ± 0.9
working	1.9 ± 1.1*	1.8 ± 1.1	1.9 ± 1.1
Household monthly income**	2.5 ± 1.0*	2.7 ± 1.2	2.6 ± 1.1
Duration of residence (years)	12.0 ± 9.0*	8.5 ± 7.3	10.5 ± 9.0
Housing conditions:			
Brick houses (%)	96.3	88.3	92.9
No. of bedrooms	3.2 ± 2.0*	3.8 ± 1.5	3.4 ± 1.7
piped water (%)	45.0	76.7	58.6
flush toilet (%)	26.0	23.3	25.0
public removal of refuse (%)	16.3	16.7	16.5
electrification (%)	92.5	98.3	95.0

* Mean and standard deviation

** Expressed as official minimum income wage (1986: one official minimum income wage = 57.04 US\$)

surveyed households were generally characterized by **low-incomes** (around 150 US\$ per month during the study period in late 1986) and often by inadequate sanitation facilities. The parents had had a modest school education and approximately 20% of them were illiterate. A little more than two-thirds of the population originated from the interior of the federal state and one-quarter were from the capital of the state itself. Compared with "Sta. Lúcia/ Vila Rita" the households of "Serra" seem to be a little more established, taking into account the proportion of brick houses. On the other hand, some of the urbanization facilities such as piped water were superior in "Sta. Lúcia/ Sta. Rita". A detailed description of the living conditions has been published elsewhere³.

The children of the two communities generally showed high morbidity. At the time of the inquiry, 34.9% of the children suffered from acute respiratory infections (ARI) and 11.5% from diarrheal diseases. Episodes of diarrhea, in the total of 59, were reported in 247 children, beginning in the two weeks prior to the inquiry. Assuming little or no seasonal variation, this indicates an approximate incidence of 6.2 episodes per child per year. Since this incidence rate is based only on a short

period, comparison with longitudinal data has limited value, as this is obtained during at least one year, to include seasonal rate changes. According to information from the health post personnel, a high incidence occurs during the hot summer months between December and March, whereas the incidence of diarrhea decreases during the colder winter months when, conversely, the incidence of ARI rises. As the study was carried out during the transition of seasons, one cannot expect an extremely low or high incidence rate.

According to the mothers, the mean duration of diarrheal episodes was 5.0 days, so that the estimated period prevalence amounted to 31.0 episode days per child per year or 86.9 episode days per 1,000 child observation days.

Besides diarrheal diseases, the point prevalence of parasites also showed a high rate (Table 2). Of the studied children 70.4% were infected by at least one pathogenic intestinal parasite. The main agents were helminths, followed by amoeba. However, it has to be considered that other pathogenic intestinal agents such as enterobacteria and virus were not surveyed. There was a slight difference in prevalence between the two communities. In

“Serra” 69% were infected with parasites, whereas in “Sta. Lúcia/ Vila Rita” the rate was 73%.

TABLE 2

Point prevalence of specific parasites identified in the two communities

Parasites	Children	
	n	%
Children surveyed	168	100.0
Children with parasitosis	119	70.8
Parasite:		
<i>Ascaris lumbricoides</i>	93	55.4
<i>Trichuris trichiura</i>	33	19.6
<i>Giardia lamblia</i>	30	17.9
<i>Hymonolepis nana</i>	8	4.3
<i>Entamoeba histolytica</i>	6	3.6
<i>Strongyloides stercoralis</i>	2	1.2
<i>Enterobius vermicularis</i>	1	0.6

Table 3 lists various potential determinants for an increased risk of diarrheal diseases and parasitosis, with special consideration of the water supply and sanitation facilities. The type of water supply statistically affected the incidence but not the duration of diarrhea, whereas the type of sanitation facilities influenced not the incidence but the duration of diarrheal diseases. The types of water supply and fecal disposal facilities did not show any statistically-significant impact on the prevalence of intestinal parasitosis.

Furthermore, some other determinants were statistically evaluated to relate them to those of sanitation. No statistically-significant differences in diarrhea morbidity between the upper and the lower income groups was observed. In contrast, education was found to be an important social determinant. The more school education both parents had had, the less was the reported incidence of diarrhea in their

TABLE 3

Statistical significance of water supply and sanitation facilities upon diarrhea and parasites compared with some selected demographic, socioeconomic and environmental variables (one - factor ANOVA; - F-values)

Main effect	DF	Diarrhea		Parasites Point prevalence
		Duration	Incidence	
Water supply	3	1.40	7.07***	0.17
Excreta disposal facilities	3	2.61*	2.25	0.35
Age of children	5	0.48	4.17**	4.31**
Sex of children	1	0.12	0.17	<0.01
Number of siblings under 6 years	2	2.60	1.86	1.11
Household income/ family member	4	0.54	1.82	0.81
Instruction father	3	0.52	3.60*	1.08
mother	3	2.21	4.54**	0.33
Origin father	2	1.97	0.79	0.27
mother	2	3.31*	1.10	1.78
Time of residence	4	5.31***	1.14	0.56
Bedroom/person	4	2.17	0.96	0.50
Electricity supply	2	3.44*	1.12	0.84
Removal of refuse	3	3.06*	2.73*	0.73
Duration of breast-feeding	5	0.53	3.80*	0.46
Time of food supplementation	4	0.66	2.57*	1.96
Type of first food	5	1.64	2.47*	2.81*
Anemia	1	0.24	0.16	0.26
Study area	5	1.13	1.12	2.64*

Significance level:

* p < 0.05

** p < 0.01

*** p < 0.001

children. The longer a family lived in their community, the lower was the duration — but not the incidence — of diarrhea. Children of mothers originating from the interior of the state showed longer diarrheal episodes than those whose mothers were from Belo Horizonte.

Type of electrical supply was also a determinant of duration. The duration of breast-feeding and the time of dietary supplementation was found to be an other determinant of diarrheal disease. Longer breast-feeding and late dietary supplementation were associated with a reduced risk of incidence. The type of weaning food was also a determinant, since the type of supplementation depended on age.

The prevalence of anemia or of parasites was not found to be associated statistically with the appearance of diarrhea. The point prevalence of parasitosis was influenced by the age of the children, since children older than one year showed higher infection rates. Further, there was a difference of prevalence between the "favelas" and significantly less parasitosis was found in one of the surveyed "favelas". Lastly, type of food was influenced on parasitosis prevalence. Children, who were fed with vegetables had a significantly higher prevalence.

Table 4 gives special attention to water supply and sanitation facilities, since those two factors are the most expensive and therefore reach the urban poor last. Households which had access to the public water supply showed a significantly lower incidence of diarrhea, whereas the duration hardly differed. However, the prevalence of diarrhea was reduced drastically (45%) in households with piped water. Children of those households which

were connected to the public sanitation system showed a lower incidence of diarrheal diseases and a shorter duration of episodes. The period prevalence for the children in households with flush toilets was 44% lower than in those without connection to the public sanitation system. But within this group the incidence and prevalence also differed quite notably, depending on the type of excreta elimination. Prevalence was highest in the group where household members deposited excreta in the backyard or in the road, leading to a prolonged episode duration in the children.

DISCUSSION

The population studied here is characterized by the high diarrhea morbidity, which in developing countries ranges between 4 to 12 episodes per child per year. The estimated annual incidence was quite similar to that of the child population of India², Bangladesh⁴, The Northeast of Brazil¹¹, Guatemala¹⁴ and the recently published data from a peri-urban child population of Lima¹³ and much higher than in a peri-urban child population of Santiago de Chile¹. Taking into consideration the point prevalence found here of 114 episode days per 1,000 child observation days, the duration of an episode averaged 6.6 days. This value approximates to that of another observation made by Kielmann et al.¹²

Period prevalence was only 76% of the point prevalence. This difference may be due to the fact that mothers tend to underestimate the duration of a diarrheal episode. Furthermore, it should be kept in mind that the estimated period prevalence is based only on the extrapolation of a two-week result.

TABLE 4

Estimated incidence, period prevalence (days/child/year) and duration (days) of diarrheal episodes according to water supply and sanitation facilities

Sanitation facilities	Children studied	Incidence	Duranton	Period prevalence
Piped water	139	5.2	5.0	26.1
Waterhose from neighbor	36	5.9	4.8	28.3
Water tanks	38	9.5	5.1	47.8
Public sanitation system	52	3.9	4.1	20.5
No connection to public sanitation system	195	7.1	5.2	36.6
Septic pit latrine	99	5.6	4.7	28.7
Pit latrine	42	10.8	4.7	39.7
Open air	54	7.0	6.3	42.5

The pattern of intestinal parasites found in the feces of the children was very similar to that of children of S. Paulo¹⁵. The higher prevalence of enteroparasitosis in the children of Belo Horizonte than in those of S. Paulo was due to the different social strata surveyed in the two studies. In S. Paulo, children of all social strata were studied whereas in Belo Horizonte only "favela" children of a poor stratum were surveyed.

The lack of a statistical association between the prevalence of parasites and the appearance of diarrhea confirms that many other microorganisms such as enterobacteria and virus which were not surveyed in this study are responsible for the manifestation of diarrhea⁵.

This study demonstrates again, that the improvement of water supplies and excreta disposal facilities may drastically reduce the prevalence of diarrhea morbidity. In different studies, a reduction has been reported of up to 82% in the case of improvements in water quality and availability and of up to 48% in the case of excreta disposal⁶. The decrease of morbidity observed in the communities of "Serra" and "Sta. Lúcia/ Vila Rita" of 45% and 44%, respectively, can be explained only by the public sanitation system, since no other statistically significant difference in environmental or socio-economic determinants was found between the groups with or without piped water and flush toilets. This is due to the fact that connection to the public water and sanitation systems did not depend on an individual decision but on the plans of the state institution responsible for urbanization. Neither change showed any significant effect on intestinal parasitosis, which leads to the conclusion that the helminths and amoeba are transmitted mainly via food and their presence or absence is related to the state of personal hygiene.

A lack of basic personal hygiene probably caused the longer duration of diarrheal diseases. The households which deposited their excreta in a pit latrine had the highest incidence. This may be caused by insufficient isolation of the excreta so that the latrine is a permanent source of infection. The households which had a septic pit latrine demonstrated that, although they were not connected to the public sanitation system, it was possible to reduce the general prevalence of diarrhea with appropriate measures.

Besides water supply and sanitation, there existed other important determinants which indicated higher morbidity risks. Generally, income is expected to be an important social

determinant for diarrhea morbidity. However, this could not be established in this study. This may have been due to the fact that in other surveys the wages of different communities were compared, whereas here, even though wage differences within the community existed, socio-cultural and school educational variables played a much more important role. The same fact was found in the surveyed communities with regard to anthropometric variables³. Therefore it has to be kept in mind that the incidence depends more on preventive measures, whereas the duration is influenced more by curative actions. It seems that those mothers who had recently moved from rural areas into the community were less informed on how to treat diarrheal diseases.

The type of electricity supply serves as a socio-cultural and socio-economic indicator for a higher risk of prolonged episodes. Because of the relatively high economic costs of the installation, only 39.3% had received an official electric connection from the public system with the installation of an electric meter.

Generally, families from the interior with lower school education, use a electricity from their neighbors.

As found in other studies⁸ the duration of breast-feeding and the time of dietary supplementation were associated with diarrheal diseases and parasitoses. Children up to one year of age were significantly less infected than the other age groups. Since infants are less moribund and are breast-fed for at least some of this period, the risk of infection is much lower at this age.

As the main parasites were helminths, which are mainly transferred via food, it seems that the infections resulted mainly from a lack of food hygiene in the communities.

CONCLUSION

The health situation of the surveyed children is characterized by a high prevalence of diarrheal diseases and parasitosis. The present expansion of the basic sanitation infrastructure will considerably help to reduce the incidence of diarrheal diseases.

However, emphasis must also be given to other well known options, such as promotion of exclusive breast-feeding and better weaning practices, as well as personal, domestic and food hygiene, in order to reduce the morbidity of diarrheal diseases and intestinal parasitosis in the two communities⁷.

GROSS, R. et al. O impacto das medidas de melhoria do abastecimento de água e esgoto sobre a diarreia e parasitose intestinal: experiência brasileira com crianças de comunidades de baixa renda. *Rev. Saúde públ.*, S. Paulo, 23: 214-20, 1989.

RESUMO: Em 1986 pesquisou-se, junto a 254 crianças de até 6 anos de idade, residentes em duas favelas de Belo Horizonte (Brasil), o impacto das medidas de melhoramento do abastecimento de água e esgoto na incidência de diarreia e parasitose intestinal. Até então, a incidência de diarreia era estimada em 6,2 casos por criança e ano, com uma duração predominante de 31,0 dias por caso/criança/ano. A taxa de difusão de parasitose alcançava 70,7% (*Ascaris lumbricoides*: 55,4%, *Trichuris trichiura*: 19,6%; *Giardia lamblia*: 17,9%). Após os melhoramentos no abastecimento de água e esgoto, a incidência de diarreia caiu para 45% e 44%, respectivamente. Quanto à parasitose, entretanto, não se constatou nenhum impacto estatisticamente significativo. Também verificou-se que o grau de educação escolar e práticas de desmame são determinantes de grande importância na incidência de diarreia.

DESCRIPTORIOS: Diarreia, incidência. Helminthiase, incidence. Abastecimento de água. Saneamento

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