Who really benefits from environmental sanitation services in the cities? An intra-urban analysis in Betim, Brazil

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SUMMARY: *The paper presents the findings of research in Betim (Brazil) which looked in some detail at the association between health and provision for water supply (including water quality, per capita consumption, regularity of supply, household hygiene practices and extent of indoor plumbing), waste water and excreta disposal, garbage disposal (including frequency of collection and quality of refuse storage by households) and provision for drainage. It shows the limitations in official statistics for such services - for instance in their inaccuracy regarding who is served and in their limited range (for instance the lack of attention given to service quality and to provision for drainage). It also shows how the population benefiting from these services is not necessarily the same as that connected to public systems. The paper ends with recommendations for public urban policies and for the collection of data and research to ensure that environmental sanitation services better address health risks.*

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I. INTRODUCTION

CONVENTIONAL STATISTICS ON the efficiency of environmental sanitation services are generally based on an evaluation of the coverage of collective systems for water supply and sanitation and, where available, on information about the existence and frequency of garbage collection. These statistics are quantitative evaluations which consider neither the quality of the public services nor the quality of the solutions adopted by the population not covered by these collective systems.

These surveys, which are usually the only source of information, have been used in providing estimates of the population who have benefited, with the results applied to public policies including evaluations of necessary financial resources and of the population's sanitary status.

This paper discusses the profile of the population who benefit from environmental sanitation services, taking into account

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mainly the health impacts of the different service levels. It also discusses the distortions which result from considering that the population served by the collective systems is the same as the population who benefit from environmental sanitation services.

Data from the Brazilian urban area of Betim (with 160,000 inhabitants) were used to support the analysis. Betim is located in the metropolitan region of Belo Horizonte (3,500,000 inhabitants), which is the fourth largest city in Brazil and the capital of the state of Minas Gerais. Data collection was part of a case-control epidemiological study developed with the purpose of investigating associations between environmental sanitation conditions and health.[1] In the study, diarrhoea morbidity in children under the age of five was adopted as a health indicator. About 1,000 cases and 1,000 controls were studied, the latter being a random sample of the child population.

II. STATISTICS ON ENVIRONMENTAL SANITATION IN BRAZIL

IN BRAZIL, THE main surveys used as references on environmental sanitation coverage are:

- The Brazilian Catalogue of Sanitary and Environmental Engineering[2] published by the non-government association ABES - the Brazilian Association of Sanitary and Environmental Engineering. It surveys population coverage and other qualitative and quantitative indicators for water supply and sanitation in each of the 27 states in Brazil. The information for each state is provided by the State Sanitation Companies although these public companies are concessionaires for only some of the municipal systems - 71 per cent of the water supply and 12 per cent of sanitation, as shown in Table 1. However, they are responsible for all information, including that for cities where they do not operate, which probably results in data bias.

1. Heller, Léo (1995), *Associação entre Cenários de Saneamento e Diarréia em Betim-MG: O Emprego do Delineamento Epidemiológico Caso-controle na Definição de Prioridades de Intervenção,* PhD thesis in epidemiology, Federal University of Minas Gerais, Belo Horizonte, Brazil.

2. ABES - Associação Brasileira de Engenharia Sanitária e Ambiental (1994), *CABES XVII: Catálogo Brasileiro de Engenharia Sanitária e Ambiental*, Rio de Janeiro.

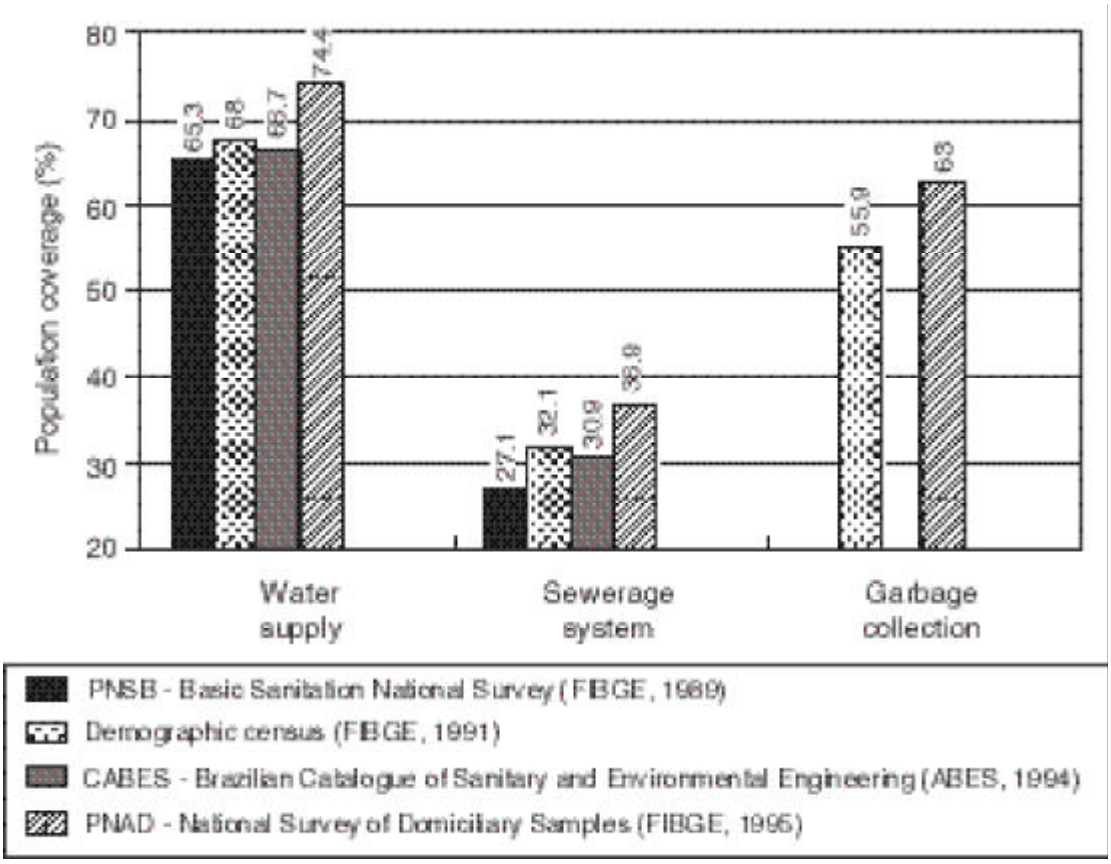
Table 1: Management of Water Supply and Sanitation Services in Brazil: State Sanitation Companies (SSC) Concessions in 1992

	Water supply		Sanitation	
Management category	Number of towns[c]	Population served ('000 inhab.)	Number of towns[c]	Population served ('000 inhab.)
Total country (A)	4,754	101,627	4,754	47,067
SSC concessions (B)	3,366	79,883[a]	570	30,452[b]
(B)/(A) (%)	70.8	78.6	12.0	64.7

a. Corresponds to 52.4 per cent of total country population.
b. Corresponds to 20.0 per cent of total country population.
c. In the Brazilian federal structure, corresponds to the main city of the municipality.

SOURCE: ABES - Associação Brasileira de Engenharia Sanitária e Ambiental (1994), *CABES XVII: Catálogo Brasileiro de Engenharia Sanitária e Ambiental*, Rio de Janeiro.

Figure 1: Coverage of Brazilian Total Population by Environmental Sanitation Services, According to Four Different Sources



- The First National Diagnosis of Municipal Sanitation Services,[3] carried out by the FNS (National Health Foundation) and the ASSEMAE (National Association of Municipal Sanitation Services) in 1995. It surveyed several characteristics of water supply and sanitation directly operated by the municipalities. Data were collected through a questionnaire sent to the 914 cities, with a special follow-up sample of 255 representative cities.
- Surveys developed by IBGE (Brazilian Institute of Geography and Statistics Foundation), the government institution responsible for demographic and economic statistics. This government foundation undertakes a national demographic census every ten years in which water supply, sanitation and solid wastes are investigated with a survey of all Brazilian dwellings. A national survey of domiciliary samples takes place nearly every year using the same variables in a sample of Brazilian dwellings. Finally, a Basic Sanitation National Survey[4] was carried out in 1989, in which data on water supply, sanitation and solid wastes were collected from all areas of the country through questionnaires sent to the responsible institutions.

3. FNS - Fundação Nacional de Saúde and ASSEMAE - Associação Nacional dos Serviços Municipais de Saneamento (1995), *1º Diagnóstico Nacional dos Serviços Municipais de Saneamento*, Água y Vida, São Paulo.

4. FIBGE - Fundação Instituto Brasileiro de Geografia e Estatística (1989), *Pesquisa Nacional de Saneamento Básico*, Rio de Janeiro.

These surveys have been developed with different methodological approaches and objectives. They provide basic information for planning although the data from different surveys are not always consistent or coherent. Figure 1 shows the extent of provision of environmental sanitation services for the whole of the Brazilian population according to four different sources. Differences of almost 10 per cent can be seen between the different sources. The same is true for figures relating to coverage by sewerage systems, which must be due to differences in the dates of the various surveys.

III. POPULATION SUPPLIED WITH WATER FOR HUMAN CONSUMPTION

WATER SUPPLY COVERAGE is usually given as the ratio of the population officially connected to the distribution system to the total population. With this in mind, we address some unanswered questions.

a. What Proportion of the Population is Effectively Connected to the Collective Network?

In the research developed in Betim, it was found that the proportion of the population connected to the public water supply network is, actually, higher than that officially registered. Table 2 shows coverage according to three different sources.

When comparing the figures from the three different sources, a statistically significant difference in the proportion of covered population can be noted, with chi-square test analysis showing a significance level of 5 per cent. This difference, with greater coverage indicated by the epidemiological research which is

Table 2: Betim: Public Water Supply Coverage According to Three Different Sources

Source	Water supply coverage (% of residential properties)	
	Connected to the network	Unconnected to the network
COPASA-MG (state concessionaire)[a]	91.6	8.4
Demographic census[b] (n=36,238)	80.1	19.9
Epidemiological survey[c] (n=1,000)	98.4	1.6

a. Extracted from COPASA-MG - Companhia de Saneamento de Minas Gerais (1993), *Informações e Indicadores Globais* e *Informações e Indicadores Gerenciais*. Data refer to December, 1993.

b. Extracted from FIBGE - Fundação Instituto Brasileiro de Geografia e Estatística (1991), *Censo Demográfico*, Rio de Janeiro. Values estimated from the ratio between the total number of residential domiciles connected and the number of urban residential domiciles (94.6 per cent of all domiciles).

c. Heller, Léo (1995), *Associação entre Cenários de Saneamento e Diarréia em Betim-MG: O Emprego do Delineamento Epidemiológico Caso-controle na Definição de Prioridades de Intervenção,* PhD thesis in epidemiology, Federal University of Minas Gerais, Belo Horizonte, Brazil. Values estimated from household survey of dwellings with children under the age of five, randomly selected in the urban area.

based on household sample, is due to the high incidence of clandestine connections which are neither accounted for in the official statistics of the concessionaire nor in the demographic census. On the other hand, the smaller coverage observed in the census can probably be explained by the fact that the survey was undertaken two years before the other surveys.

b. To what Risk is this Population Exposed?

In the study in Betim, the 1.6 per cent of the population which is supposedly unconnected to the water distribution network, and which is basically supplied by shallow wells, showed no statistically significant relative risk of diarrhoea. There are two possible explanations. The first would be the insufficient sample size which prevents the identification of any statistically significant associations; the second would be the absence of risk to this population which would compensate for a deficient water supply through adequate hygiene practice.

In other similar epidemiological studies, the lack of a water supply was also associated neither with diarrhoea in Panama[5] nor with infant mortality up to the age of five in rural Malawi.[6] However, other studies have shown epidemiological associations between an unsafe water supply and enteric infections in Canada;[7] the use of shallow wells and giardiasis in the USA;[8] and the absence of piped water and enteric infections in Bangui, Central African Republic.[9] In Brazil, one study[10] identified the impact of the construction of a water distribution network on the incidence of diarrhoea in Belo Horizonte and another[11] showed the significant health risk of infant mortality from diarrhoea in families without piped water. Thus, the results of the epidemiological studies developed for several socio-economic and water supply conditions do not allow a definitive statement about the health risk of the population not supplied by public systems, regardless of the specific reality.

c. Can it be Assumed that the Population Connected to the Distribution Network has a Safe Supply?

To answer this question, the following aspects were analyzed:

- the quality of the water
- the existence of an intermittent supply, with the consequent risk of water contamination
- the per capita water consumption

Any violation of the drinking water standards imposes both biological and chemical health risks to consumers.[12] Moreover, it is important to recognize the distribution network's own dynamics which may cause a deterioration in the water quality through biofilm formation (an organic or inorganic surface deposit inside pipe walls which can cause the growth of pathogenic micro-organisms)[13] or the introduction of contaminants. The latter can take place as a result of intermittent supply or factors which cause low water pressure in the mains.

5. Ryder, R.W., Reeves, W.C. and N. Singh et al. (1985), "The childhood health effects of an improved water supply system on a remote Panamanian island", *American Journal of Tropical Medicine and Hygiene* Vol.34, No.5, pages 921-924.

6. Lindskog, U., Lindskog, P. and J. Carstensen et al. (1988), "Childhood mortality in relation to nutritional status and water supply - a prospective study from rural Malawi", *Acta Paediatr. Scand*. Vol.77, pages 260-268.

7. Chambers, L.W., Shimoda, F. and S.D. Walter et al. (1989), "Estimating the burden of illness in an Ontario community with untreated drinking water and sewage disposal problems", *Canadian Journal of Public Health* Vol.80, No.2, March/April, pages 142-148.

8. Chute, C.G., Smith, R.P. and J.A. Baron (1987), "Risk factors for endemic giardiasis", *American Journal of Public Health* Vol.77, No.5, May, page 585-587.

9. Georges-Courbot, M.C.G., Beraud, A.M.C. and I. Gouandjika et al. (1990), "A cohort study of enteric campylobacter infection in children from birth to two years in Bangui (Central African Republic)", *Transactions of the Royal*

Society of Tropical Medicine and Hygiene Vol.84, pages 122-125.

10. Gross, R., Schell, B. and M.C.B. Molina (1989), "The impact of improvement of water supply and sanitation facilities on diarrhoea and intestinal parasites: a Brazilian experience with children in two low-income urban communities", *Revista Saúde Pública* Vol.23, No.3, pages 214-220.

11. Victora, C.G., Smith, P.G. and J.P. Vaughan (1988), "Water supply, sanitation and housing in relation to the risk of infant mortality from diarrhoea", *International Journal of Epidemiology* Vol.17, No.3, September, pages 651-654.

12. Mara, D.D. and G.P Alabaster (1995), "An environmental classification of housing related diseases in developing countries", *Journal of Tropical Medicine and Hygiene* Vol.98, pages 41-51.

13. USEPA - United States Environmental Protection Agency (1992), "Control of biofilm growth in drinking water distribution systems", seminar publication, Cincinnati.

14. Eighty-six per cent of dwellings investigated in Betim reported domestic tank use, 5.8 per cent of them without coverage; 44.1 per cent washed their tanks more than once every six months.

15. Burns, Cullivan and Dingman concluded that, in Beira, Mozambique, the intermittent water supply led to the search for alternative ground water supply sources; frequently, these sources were contaminated and their use was associated with increases in the occurrence of diarrhoea and cholera. See Burns, K., Cullivan, D. and J.S. Dingman (1993), "Water shortage and related public health problems: an action plan for the city of Beira, Mozambique", WASH Field Report No.389, Washington DC.

In Betim, intermittent supply was reported by 44 per cent of the residents interviewed, yet a significant risk of diarrhoea was not identified. It is possible that, because of the general Brazilian practice of domestic water storage,[14] people's perception of intermittence is biased due to their domestic water tank's capacity to absorb variations in flow. Intermittence may be identified by physical and continuous pressure measurements in the distribution system and, only with this information, is an epidemiological risk analysis feasible.[15]

The other health risk factor generally related to water supply is level of water consumption. In Betim, a possible risk of diarrhoea in children living in houses with low per capita water consumption (less than 125 litres/person/day in the lower socio-economic stratum and less than 75 litres/person/day in the higher socio-economic stratum) was identified.[16] The average consumption in the city was 145 litres/person/day.

More in-depth research on the link between water consumption and health in urban zones with high per capita consumption is still necessary. A large number of epidemiological studies have indicated the greater importance to health of water quantity over water quality. However, these studies were developed under conditions where per capita consumption was in the order of 10-40 litres/person/day, much lower than that of urban areas with in-house connections.

d. To What Extent does Intra-domestic Water-handling Influence Health Risk?

The following points were analyzed:

- the role of the domestic water tank
- provision for indoor plumbing
- hygiene practices

The research carried out in Betim examined the effects of having a domestic water tank. Households lacking such a tank (and presumably storing water in household vessels) were found to have a relative risk of diarrhoea of 1.91 (95 per cent confidence interval (CI): 1.01 - 3.60).[17] This result does not confirm the hypothesis that the existence of a domestic water tank implies a health risk due to inadequate maintenance. However, the study highlights the fact that the lack of a roof tank indicates the presence of only basic internal plumbing, usually only a water point on the plot, causing a risk of infectious and parasitic diseases.

The importance of hygienic practices was demonstrated in the Betim research. Four practices were investigated: washing and disinfection of fruit and vegetables; care of drinking water; hand-washing before eating; and hand-washing after defaecation. After a multivariate analysis,[18] only the first practice showed a statistically significant relative risk, of 2.87 (95 per cent confidence interval (CI): 1.61 - 5.10), the greatest relative risk found among all the environmental exposures investigated, pinpointing the role of hygienic practices in the control of infectious and parasitic diseases. The risks to health from eating fruit and veg-

16. Heller, L., Barros, A.C.M. and C.M.F. Antunes (1996), "Associação entre consumo per capita e saúde em uma área urbana brasileira", paper presented at the 7th Simpósio Luso-Brasileiro de Engenharia Sanitária e Ambiental, Lisbon, 25-28 March.

17. "Relative risk" (RR) is an epidemiological risk measure. The relative risk of a given disease as a result of exposure is defined as the ratio between the incidence rate of the disease among an exposed group and the incidence rate among an unexposed group. It represents how many times more likely it is that the disease will occur in the exposed group compared with the unexposed. If the 95 per cent confidence interval excludes the unity, then the study factor is significantly associated with the risk of disease at a statistical level of 95 per cent. For RR>1, the exposure is a risk factor; for RR<1, the exposure is a protective factor.

18. Multivariate methods are used in epidemiology for the statistical analysis of the joint effect of a set of variables on the risk of disease whereas, in the univariate analysis, only the association between the exposure factor and the disease is

etables that have not been washed suggests the use of irrigation water contaminated with sewage, a common practice in the metropolitan region of Belo Horizonte. The fact that the three other practices were not significant in the statistical analysis possibly means that food hygiene is a surrogate for general household hygiene.

IV. POPULATION WITH ADEQUATE SANITATION SERVICES

a. Waste Water Collection

GENERALLY, THE STATISTICS relate the existence of a connection to a sewerage system to a definition of adequate provision for waste water disposal. The assumption behind this is that residents of houses connected to sewers are protected and those of unconnected houses are exposed to health problems due to the presence of excreta and grey water (waste water from general household use) in the environment. Two questions arise:

- In a locality with only a partial sewerage system, is the connected population really protected against excreta and grey water presence in the environment?
- Do the solutions adopted by the unconnected population expose them to a risk of contamination?

The results obtained from the research in Betim illustrate this discussion. Two variables relating to waste water collection were analyzed, as shown in Table 3, namely, the kind of solution adopted and the free-flowing presence of waste water in the streets. In the univariate analysis, both these factors presented a significant risk of disease, with values for the relative risk ranging from 1.75 to 4.75.

Table 3: Betim: Relative Risk of Diarrhoea Morbidity Below the Age of Five Related to Sanitation Conditions (Univariate Analysis)[a]

Variable	Category	Relative risk (95% CI)[b]	
Waste water and excreta disposal	Sewerage system	1.00	
	Variants of pit	1.75	(1.43 - 2.13)
	Street surface or stream	2.86	(2.04 - 4.01)
	Within the house plot	4.75	(2.20 - 10.47)
	Other x sewerage system	1.97	(1.63 - 2.37)
Free waste water flowing in the street	No x yes	2.74	(2.27 - 3.32)

a. See reference 17.
b. See reference 18.

SOURCE: Heller, Léo (1995), *Associação entre Cenários de Saneamento e Diarréia em Betim-MG: O Emprego do Delineamento Epidemiológico Caso-controle na Definição de Prioridades de Intervenção,* PhD thesis in epidemiology, Federal University of Minas Gerais, Belo Horizonte, Brazil.

analyzed. The former analysis allows the reduction or elimination of confounding variables and the determination of an exposure effect on a disease, free of the influence of other factors. Logistic regression was used for the multivariate analysis in the Betim study control case. The analysis started with a model which included 43 variables, divided into eight sub-groups (family structure, socio-economic level, hygiene practices, water supply, sanitation, garbage disposal, drainage and the presence of vectors) and, after the statistical procedure, a final model with 14 variables was developed.

After applying a multivariate analysis, the variable relating to solutions for waste water disposal showed no statistical significance whilst the variable relating to the presence of free waste water flowing in the streets showed a relative risk of 2.38 (95 per cent CI: 1.87 - 3.03). From this result, one can conclude that the determinant factor linking health protection and waste water disposal is the absence of free-flowing waste water in the environment. House connection to the sewerage system is less relevant than the overall quality of the solutions adopted in each drainage sub-basin, and the upstream solutions determine the risks to downstream dwellings.

In practice, the study suggests that if waste water disposal is approached from a public health point of view, then the unit of intervention must be the drainage sub-basin. With this approach, all the waste water in each sub-basin needs to be disposed of, with connections to adequate sewer systems or with adequate on-site solutions in order to avoid overflows into the streets.

b. Interception and Treatment

It is not only local disposal of waste water but also interception and treatment which determine health risk for the population, although these are rarely referred to. Obviously, the risk affects specific populations, revealing again the perversity of exposure to waste water: inadequate solutions do not necessarily imply risk to the owners of the solutions, but to the population downstream.

In the case of lack of interception, those who live on the banks of the stream are specifically affected; and the absence of treatment exposes not only the population beside the water to risk but also all the urban population which is supplied with vegetables irrigated with contaminated water.

Statistics on levels of interception have not been developed in Brazil. Research into coverage by treatment utilities has been purely quantitative, with a generic classification of treatment processes and no evaluation of levels of pathogen removal nor any in-depth analysis of the health risk to downstream populations.

IV. POPULATION WITH ADEQUATE GARBAGE MANAGEMENT

THE EFFICIENCY OF garbage management, when measured, is evaluated from a survey of the population served by collection services. In more detailed surveys, data on the frequency of collection are gathered although with no further information should collection frequency not be uniform in all the urban area. In these statistics, the conditions in which refuse is stored in-house and the presence of unauthorized refuse deposits are ignored.

Table 4 shows population coverage by urban refuse services in Betim.

Table 4: Betim: Population Coverage by Urban Refuse Services

Phase	Category	Proportion (%)
Refuse storage	Refuse bag	42.38
	Plastic bag	40.58
	Paper bag or cardboard box	3.41
	Can, basin or pail	6.51
	Not stored	7.11
Refuse disposal	In streets for collection	80.08
	Stationary container	1.91
	Burial	0.30
	Burning in the lot	10.46
	Empty lot, yard, street, erosion or uncontrolled tipping	6.74
	Stream	0.50
Frequency of public collection	Daily	3.20
	Weekdays	9.98
	Three times a week	66.13
	Twice a week	16.26
	Weekly	3.57
	Lesser frequency	0.86
Faeces disposal from diapers	Toilet or latrine	88.02
	Refuse pit	1.23
	Within lots terrain or street	2.46
	Laundry tray	7.99
	Stream or sewerage	0.31

SOURCE: Heller, Léo (1995), *Associação entre Cenários de Saneamento e Diarréia em Betim-MG: O Emprego do Delineamento Epidemiológico Caso-controle na Definição de Prioridades de Intervenção,* PhD thesis in epidemiology, Federal University of Minas Gerais, Belo Horizonte, Brazil.

In all areas of garbage management, precarious solutions showed a statistically significant relative risk for diarrhoea, with values ranging from 1.50 to 1.97, and always with a significant confidence interval, as shown in Table 5. All areas of garbage management are extremely important for public health, showing the need for a broad approach to interventions and surveys relating to this service. Improvements in some areas of the system, such as domestic storage, garbage disposal on sites where there is no collection and the disposal of faeces from diapers, are strongly linked with hygiene education.

Table 5: Betim: Relative Risk of Diarrhoea Morbidity Below the Age of Five Related to Garbage Management (Multivariate Analysis)[a]

Phase	Relative risk (95% CI)[b]	
Refuse storage in inappropriate bags	1.97	(1.55 - 2.50)
Street disposal, where collection frequency is less than twice a week, or disposal in streams or on empty lots	1.61	(1.11 - 2.34)
Disposal of faeces from diaper out of toilets	1.50	(1.04 - 2.19)

a. See reference 17.
b. See reference 18.

SOURCE: Heller, Léo (1995), *Associação entre Cenários de Saneamento e Diarréia em Betim-MG: O Emprego do Delineamento Epidemiológico Caso-controle na Definição de Prioridades de Intervenção,* PhD thesis in epidemiology, Federal University of Minas Gerais, Belo Horizonte, Brazil.

Another point generally neglected in statistics is the sanitary quality of the final disposal of refuse. Surveys on this are available for all Brazilian localities[19] and reveal that it is an extremely serious problem in the majority of Brazilian cities. In an estimated 80 per cent of them, refuse disposal occurs without even minimal sanitary care. It is important to note however that, although inadequate refuse disposal is a problem for the physical environment, only the population near the dumping ground is exposed to a health risk.

19. See reference 4.

V. POPULATION WITH ADEQUATE STORM WATER DRAINAGE SERVICES

INDICATORS FOR THE efficiency of drainage services have not been developed in Brazil. Only evidence of periodic flooding in critical regions of some cities where it is a frequent occurrence is reported. Neither is there much in the literature on the impacts on health of urban drainage problems.

In Betim, two drainage related variables were studied in relation to their impact on infant diarrhoea, namely, flooding and pooling in lots. Table 6 shows the relative risks. The results illustrate the greater importance of flooding over pooling in lots as a risk factor for diarrhoea, highlighting the role of street drainage, especially where lots are at a lower level than the streets. Except in those situations where flooding leads to human loss of life or to outbreaks of diseases such as leptospirosis, those who do not suffer periodic flooding in their lots are probably those who benefit from drainage services.

Table 6: Relative Risk of Diarrhoea Morbidity Below the Age of Five Related to Urban Drainage Conditions

Situation	Relative risk - univariate analysis (95% CI)[a]	Relative risk - multivariate analysis (95% CI)[a]
Flooding in lot	2.11 (1.75 - 2.56)	1.39 (1.09 - 1.76)
Pooling in lot	1.46 (1.19 - 1.80)	not significant

a. See references 17 and 18.

SOURCE: Heller, Léo (1995), *Associação entre Cenários de Saneamento e Diarréia em Betim-MG: O Emprego do Delineamento Epidemiológico Caso-controle na Definição de Prioridades de Intervenção,* PhD thesis in epidemiology, Federal University of Minas Gerais, Belo Horizonte, Brazil.

VI. CONCLUSIONS

THIS PAPER HAS demonstrated that those who benefit from environmental sanitation services are not necessarily those who are served by the public systems. One can now reflect on how to modify practices relating to the formulation of public policies and research on coverage.

a. Public Urban Policies Formulation

- For water supply, more attention should be paid to water availability to the population; to the quality of the water that is consumed, not just to that of the distributed water; to the need for complete indoor plumbing facilities; to adequate intra-domestic water-handling; and to adequate water use for personal and domestic hygiene.
- For sanitation, policy should aim at the elimination of free-flowing waste water in streets, gutters and lots through a comprehensive drainage sub-basin approach.
- For urban garbage management, a comprehensive sanitary policy also seems necessary, to include all phases of the process: domestic storage; a minimum three times a week collection; adequate refuse disposal in places where public collection is not possible; and all these supported by hygiene education programmes.
- For urban drainage, intervention planning is important, identifying critical areas for priority action, mainly in streets with lots subject to flooding.

b. Coverage by Environmental Sanitation Services

- With regard to water supply, there is a need for: the development of indicators to monitor a lack of pressure in the distribution network; a survey of per capita consumption showing intra-urban differentials; a survey of the quality of consumed water, particularly in countries such as Brazil where domestic water tanks are common; a survey of levels of conservation and maintenance in domestic water tanks.
- In the field of scientific research, efforts should be made to determine the minimum levels of per capita urban water consumption which do not pose a health risk.
- In sanitation, obtaining more information on solutions for disposing of sullage and excreta by populations without a sewerage system is an important issue.
- In urban garbage management, surveys on domestic solid waste handling are needed, including for domestic storage; the disposal of diaper faeces; and garbage disposal in places with no public collection.
- In the field of scientific research, a more accurate analysis of the optimal frequency of garbage collection and identifying intra-urban differentials can lead to a gathering of very useful information.
- The development of indicators for drainage coverage is essential, to include for each locality, for example: indicators of surface water inlet deficit; the extent of existing and required storm water sewers; the extent of valley bottom flow adequately treated and needing treatment; and the extent of streets with lots subject to flooding, all of which may be considered as potential health risks.

Obviously, determining new variables in environmental sanitation coverage surveys implies higher costs and different meth-

odologies. In some cases, information can be obtained from the institutions responsible for the services, thus saving time and money but with the disadvantages of data reliability. In other cases, household surveys might be necessary.

Nevertheless, it is widely accepted that a great effort to improve these surveys can play a fundamental role. A good picture of the sanitary conditions in any locality can increase the potential of public policies and may effectively benefit the population excluded from environmental sanitation services from a health point of view and through a broad social approach,