Impact of Improvement of Water Supply on Reduction of Diarrheal Incidence in a Squatter Area of Manila

Hirotsugu AIGA*¹ *⁴, Yumiko ARAI*², Eiji MARUI*³ and Takusei UMENAI*⁴

*¹ Human Resource Development Directorate, Ministry of Health, Ghana

*² Research Unit of Nursing and Caring Sciences, National Institute for Longevity Science, Aichi

*³ Department of Community Health and Medicine, Research Institute, International Medical Center of Japan, Ministry of Health and Welfare, Tokyo

*⁴ Department of Health Policy and Planning, School of International Health, Faculty of Medicine, The University of Tokyo, Tokyo

Abstract

To improve the quality of life in squatter settlements, the Zonal Improvement Program (ZIP), which aims to provide direct water connection and a private toilet to every housing unit, has been implemented in Metro Manila, Republic of the Philippines, since 1985. To estimate the impact of the program, particularly the improvement of the water supply, on diarrheal incidence among under-five-year-old children, a comparative survey between a ZIP area and a non-ZIP area was conducted. A significantly higher diarrheal incidence among under-five-year-old children was observed in the non-ZIP area. This may be attributed to the increase in water consumption as a result of the improvement of the water supply in the ZIP area. The Relative Risk (RR) of water consumption with diarrheal incidence was 2.67, indicating a positive association. A water supply that provides for consumption of 60 (lpcd) could be a possible appropriate measure to reduce diarrheal cases.

Key words: Urban slum/squatter, water supply, water consumption, diarrheal incidence, Philippines

Introduction

In the cities of many developing countries, rapid urbanization has been accompanied by an increase in the squatter population, which has caused many social and health problems⁽¹⁾. The population of squatter areas in Metro Manila, Republic of the Philippines, was estimated to be 2.39 million, which accounts for 30.5% of the total of Metro Manila⁽²⁾. According to a rough estimation by the Philippine Government, approximately 70% of the households residing in the squatter areas in Metro Manila have to purchase water for drinking and for all other purposes from public water faucets, spending more money and a longer time⁽³⁾. Although the details regarding water supplies for squatters at the household level have not been well documented, it is generally known that a lack of access to safe water leads to higher diarrheal incidence^{(4), (5), (6)}. Given this situation, access to safe water in squatter areas needs to be documented more precisely in relation to diarrheal incidence.

In the Philippines, diarrhea is the third leading cause of infant mortality and is counted as the seventh leading cause of

mortality for the general population^{(7), (8)}. Since many diarrheal cases occurring in the squatter areas are not accurately reported, the actual diarrheal incidence in Metro Manila is estimated to be much higher⁽⁹⁾.

The Philippine Government in collaboration with the World Bank introduced the Zonal Improvement Program (ZIP) in Metro Manila squatter areas in 1985. The ZIP aims to provide squatter settlers with land ownership and basic infrastructures such as private water faucets, a private toilet, electricity to every housing unit and paved roadways to the community. As a result of the introduction of the ZIP, settlers in squatter areas can be legitimized as legal residents of the relevant area without being relocated to another area^{(10), (11)}.

This paper gives an estimation of the impact of the water supply provided by the ZIP on the reduction of diarrheal incidence. Diarrheal incidence is assessed among under-five-year-old children inhabiting a typical squatter area in Metro Manila and compared with the incidence in a former squatter area positively affected by the ZIP.

Methods

Sample selection

Data regarding diarrheal incidence prior to the implementation of the ZIP was not available. This study, therefore, compared the incidence between a ZIP area (study

Received Mar. 15 1999/Accepted Jun. 28 1999

Reprint requests to: Hirotsugu AIGA,
Human Resource Development Directorate, Ministry of Health,
P.O.Box M-44 Accra, Ghana (West Africa)
TEL & FAX: +233(21)660472
E-mail: aiga@ghana.com.

Table 1 Socioeconomic status of Leveriza (LE) and Maestranza (MA)

	LE: Leveriza		MA: Maestranza
	prior to ZIP 1985	after ZIP 1993	non-ZIP 1993
Estimated population	3,859	6,752	1,374
Existing water supplies	7 public faucets	2.1 private faucets in every housing unit	3 public faucets
Population per water faucet (person/faucet)	551.3	3.2	458.0
Number of household members (person/household)	6.2 ^a	6.5 ^a	5.2 ^a
Number of under-five year old children per household	(n.a.)	0.91 ^b	0.94 ^b
Number of persons per room (person/room)	(n.a.)	3.88 ^b	4.52 ^b

^a Significant difference was not detected between MA and LE as of both 1985 and 1993. ($p > 0.05$)

^b Significant difference was not detected between MA and LE as of 1993. ($p > 0.05$)

group) and a non-ZIP area (control group) during the period from August to September 1993. Leveriza (LE), one of the typical ZIP sites, was selected as the ZIP study area. Maestranza (MA), a squatter area, was selected as the non-ZIP control area. The residential environment and the level of water supply of MA were, to a large extent, similar to those of LE as of 1985 prior to the implementation of the ZIP as shown in Table 1. In this study, therefore, it was assumed that the diarrheal incidence in LE prior to the implementation of the ZIP was at the same level as the one in MA.

LE is situated in Malate, a commercial town in the southeastern part of the City of Manila. It is a large squatter area that faces a small river. LE consists of eight community zones called "barangays", which are the minimum social and political units in the Philippines. MA is situated in Intramuros, an important historical site, and five kilometers away from LE, in the northeastern part of the City of Manila. MA also faces the Pasig River and is contained in only one barangay.

The sample size was calculated with α (error) = 0.05 and $1 - \beta$ (power) = 0.90 in terms of both water consumption per capita per day in the households and diarrheal incidence among under-five-year-old children. The treatment records of the reported diarrheal cases during last five years were available at Rosario Reyes Health Centre which covers both LE and MA. Based on the frequency of diarrheal cases obtained both from the results of the pilot pretests in 33 households and from the above treatment records, 172 under-five-year-old children were calculated¹² as the desired sample size. Given the mean of the number of under-five-year-old children per household in LE and MA (0.90) obtained by the pilot pretests, the number of households required was estimated as: $172/0.90 = 191$. Accordingly, to secure a sufficient number of samples, 204 households were determined to be the required sample size.

In MA, there were a total of 306 housing units in 102 clusters. Each cluster had three housing units. Out of which, two housing units were selected from each cluster by systematic sampling. The first and third housing units in the initial cluster were selected by random sampling. Subsequently, the first and third housing units in all the other clusters were selected. Respondents were housewives in the households in the 204 housing units. When more than one household were residing in one housing unit, one of them was selected by random sampling. The same method was used to select the samples in LE.

Variables associated with diarrhea

The WHO's definition of diarrhea was adopted for the study: namely, passing watery or bloody stools more than three

times during 24 hours¹³. Esrey S. A. has reported that the major variables associated with diarrheal incidence are x_1 : microbiological water quality; x_2 : water consumption (quantity); x_3 : type of major excreta disposal; and x_4 : hygienic behaviors¹⁴. The other variables tend to confound the above four variables. For instance, household income is supposed to reflect water consumption and excreta disposal. Similarly, education attainment of housewives or household heads will reflect hygienic behavior. The above four variables, therefore, were adopted as the major ones to simplify the structure of variables in this study.

The Coliform test was conducted to examine microbiological water quality, for three private piped-water faucets sampled randomly in LE, and for all three public piped-water faucets in MA. LE has three main water pipes that distribute private piped-water faucets to every housing unit. One private piped-water faucet was randomly sampled from each of the main water pipes. Multiple tube fermentation method at 37 degrees centigrade for both 24 and 48 hours was adopted to examine total numbers of Coliform.

Household interviews

To obtain data on water use, types of major excreta disposal, hygienic behaviors and diarrhea episodes among under-five-year-old children, structured interviews with housewives were conducted at households by using questionnaires. This is because housewives have the main responsibility for caring for the children and for water use in the households. Diarrhea episodes over the previous two weeks were queried because mothers' memory is generally reliable over this period¹⁵. Interviews with the housewives were carried out in Tagalog, the local language. The questionnaire was filled out by the interviewer during the interview. Repeated visits were made until all the target interviewees were covered by this study.

A two-week training activity, including practice of the pilot pretests in LE and MA, was carried out to develop six skilled interviewers. These interviewers were recruited from the students of the College of Public Health (five) and the College of Dentistry (one), University of the Philippines.

Observation of water acquisition

In LE, a direct water supply and its meter were provided to every housing unit through the implementation of the ZIP. Water consumption, therefore, was computed by recording the water meter reading at an interval of seven or 14 days.

In MA, to enable the charge for water to be easily calculated based on volume, the owners of public water faucets accepted only 16-liter plastic containers which were originally used for

lubricating oil. In addition, it was a habit with every household to consume the definite number of plastic containers of water each day. Water consumption in the households of MA, therefore, was computed both by counting the number of plastic containers and by asking how many containers of water each household used in practice. In MA, at least two hours were needed to acquire water at the public water faucets due to long queues with a large number of containers. In order to minimize the time for water collection, the barangay rules of MA prohibits the inhabitants and children from bathing or playing at/around the public water faucets. Therefore, it is assumed that water consumption was made by using only water collected in 16-liter plastic containers. This observation can be applied to other squatter areas in Manila.

Data analysis

The annual diarrheal incidence rates in LE and MA were computed using WHO's methodology¹⁶. The treatment records of the reported diarrheal cases during the last five years were used to estimate seasonality of frequency of diarrheal cases necessary for calculating the annual diarrheal incidence rates. Those were available at Rosario Reyes Health Centre which covers both LE and MA.

The obtained data were field checked, entered into a microcomputer and analyzed using SPSS. The frequency distributions of water consumption were expected to be different between LE and MA. Therefore, the non-parametric technique was used in analyses. The association between diarrheal incidence as outcome and water consumption as exposure was examined by using Relative Risk (RR). Contingency tables were used to assess the association between water consumption and diarrheal incidence. Since the Metropolitan Waterworks and Sewerage System (MWSS) regards 60 (lpcd) as the minimum requirement for water consumption¹⁷, this figure was adopted as the cut-off value for calculating RR of water consumption. Availability of own private toilets, which is another basic service provided by the ZIP, was tested also by RR to examine its association with diarrheal incidence.

Results

Observation of water consumption

In LE, the provision of direct water supply to households improved population per water faucet from 551.3 in 1985 to 3.2 in 1993. The population per water faucet in MA as of 1993 was at the similar level to that of LE as of 1985 prior to the implementation of the ZIP (Table 1).

Five of 206 households (2.4%) in LE and three of 204 households (1.5%) in MA refused to take part in the study. Illegal water acquisition by disconnecting pipes before the meter was observed in 31 households (15.4%) of LE. One household (0.5%) in MA was unaware of the number of plastic containers used for obtaining water and the frequency of water collection. These 32 households and 39 under-five-year-old children from these households, therefore, were excluded from the analyses and discussions on water consumption.

In LE, all the 201 households used only water from a private water faucet whose source is the city water supply system, for drinking and all other purposes. They enjoyed access to water within the housing unit. On the other hand, in MA, all the 201 households used only water from the public water faucet available in the community, whose source is also the city water supply

system, for drinking and for all other purposes. In MA, 126 of 201 households (62.7%) collected water only once per day; 51 (25.4%) twice per day; and 24 (11.9%) three times per day.

Annual diarrheal incidence rate

As shown in Table 2, MA had a significantly higher proportion of 2-week diarrheal cases ($p < 0.01$) among under-five-year-old children than LE.

The annual diarrheal incidence rates are shown in Table 3. The rate in LE (2.68 episode/child/year) was at the similar level to the average rate among under-five-year-old children in the Philippines (2.20 episode/child/year). The rate in MA (9.31 episode/child/year) was four times as high as the average rate in the Philippines.

Variables associated with diarrheal incidence

The Coliform test revealed that all the water samples from both LE and MA were negative. Accordingly, it was assumed that there was no difference in microbiological water quality between the two areas.

No household machines and equipment which cause consumption of large quantities of water were observed in the study households. (The availability of laundry machines, dish washing machines, bathtubs, flush toilets, and vehicles was observed.) Therefore, the ways in which the water was consumed in the two areas were assumed to be similar. Water consumption per capita per day in LE was significantly higher (Wilcoxon's test: $p < 0.01$) and its frequency was more widely distributed than in MA (Figure 1).

As shown in Table 4, types of major excreta disposal were "wrap and throw" (104 households: 51.4%) in MA; and "own private toilet" (181 households: 90.0%) in LE. The proportion of use of own private toilet in LE was significantly higher ($p < 0.01$) than in MA.

The mothers were asked the questions on hygienic behaviors, namely the frequency of boiling drinking water for under-five-year-old children, the frequency of washing hands after using the toilet, and the frequency of washing hands before cooking. Since

Table 2 Number of under-five-year-old children with/without diarrhea in Leveriza (LE) and Maestranza (MA)

Recall period	LE: Leveriza	MA: Maestranza	p-value
(+)	7	18	
(-)	176	171	
total	183	189	
(+)	27	97	
(-)	156	92	
total	183	189	

(+): with diarrhea

(-): without diarrhea

^a chi-square test

Table 3 Annual diarrheal incidence among under-five yearold children in Leveriza (LE) and Maestranza (MA)

Annual diarrheal incidence rate (episode/under-five year old child/year)	
LE: Leveriza	2.68
MA: Maestranza	9.31
Philippines*	2.20
Rural area of Zaire**	2.2

data source: * College of Public Health, University of the Philippines

**Tonglet, R., et al. (19)

Table 4 Variables associated with diarrheal incidence in Leveriza (LE) and Maestranza (MA)

Variable	LE: Leveriza	MA: Maestranza	
x ₁ Microbiological water quality	no Coliforms	no Coliforms	
x ₂ Water consumption per capita per day			$p < 0.01^a$
mean (lpcd)	118.99	30.43	
median (lpcd)	110.53	27.43	
s.d.	59.67	14.94	
x ₃ Type of major excreta disposal			$p < 0.01^b$
own private toilet	181 (90.0%)	47 (23.4%)	
neighbor's private toilet	13 (6.5%)	6 (3.0%)	
public toilet	0 (0%)	32 (15.9%)	
wrap and throw	7 (3.5%)	104 (51.4%)	
in the river	0 (0%)	12 (6.0%)	
x ₄ Frequency of boiling drinking water for under-five-year-old children			$p = 0.396^b$
usually (3 times per day)	32 (17.5%)	26 (13.8%)	
sometimes (2-4 times per week)	80 (43.7%)	61 (32.3%)	
seldom (2-4 times per month)	8 (4.4%)	20 (10.6%)	
no (2-4 times per year or less)	63 (34.4%)	82 (43.4%)	

^a Wilcoxon's test^b Chi-square test

many responses to the questions of frequency of washing hands after using the toilet and before cooking in both LE and MA were inconsistent with the practice observed, all the responses to these two questions were excluded from data analysis due to their unreliability. As a result, the frequency of boiling drinking water for under-five-year-old children became the only variable representing hygienic behavior in this study (Table 4). No significant difference between LE and MA was obtained in terms of the proportion of the households who usually boiled drinking water for under-five-year-old children ($p = 0.396$).

Association between diarrheal incidence and exposure

Two variables, i.e. x₂: water consumption and x₃: type of

excreta disposal, showed a significant difference between LE and MA. Therefore, the associations with 2-week diarrheal incidence were furthermore examined for these two variables. The RR of water consumption per capita per day in the household and use of own private toilet with 2-week diarrheal incidence were 2.67 and 2.17 respectively. Both variables were positively associated with diarrheal incidence. Water consumption showed slightly stronger association with 2-week diarrheal incidence than use of own private toilet.

As shown in the top part of Figure 1, 46.0% of under-five-year-old children from the households whose water consumption was less than 60 (lpcd) had diarrhea within the last two weeks. 17.2% of under-five-year-old children from the households

Fig. 1 Water consumption per capita per day in Leveriza (LE) and Maestranza (MA)

whose water consumption was greater than or equal to 60 (lpcd) had diarrhea. And a significant difference was confirmed between the above two groups ($p < 0.01$). This also supports the idea that increasing water consumption leads to a lower number of diarrheal cases.

Discussion

Significant differences were confirmed only for two variables, i.e. x_2 : water consumption and x_3 : type of excreta disposal. Therefore, of the four variables assumed at the outset of the study, only the above two variables contributed to the significant differences in 2-week diarrheal incidence. In both LE and MA, no household machines and equipment causing consumption of large quantities of water were observed in common. Moreover, all the interviewers, based on their observations, believed that more water was being used in practice for hygienic purposes, e.g. more frequent washing of clothes and bathing outside in front of the housing unit or along the footpath in LE than in MA. Therefore, the significant difference in water consumption between LE and MA may be due to the higher frequency of bathing, washing hands, cleaning dishes and washing clothes in LE. And it was implied that more volume of water might be used for the above-described hygienic purposes at a time.

Since data on water consumption and diarrheal incidence in LE as of 1985 was not available, it is difficult to conclude that diarrheal incidence in LE was reduced in effect. However, water consumption in LE as of 1985 seems to have been similar to that in MA as of 1993 because population per water faucet in LE as of 1985 was at a similar level to that in MA as of 1993 (Table 1). If the level of water supply in MA increases to the same level as in LE, diarrheal incidence in MA also could be reduced at a similar level to LE. Thus, the improvement of water supply would likely enhance the reduction of diarrheal incidence in MA.

The volume of water consumption of 60 (lpcd) as a minimum requirement arranged by the MWSS might be an appropriate criterion for urban squatters although further studies are needed to improve its accuracy. Agarwal A. similarly proposed that 5 (lpcd) was the minimum water requirement⁽¹⁸⁾. This level of consumption, however, does not secure less diarrheal incidence, but simply sustains basic needs. Therefore, a threshold level should be defined as a minimum requirement for water consumption based on diarrheal incidence. Tonglet, R. assumed 50 (liter/household/day) as the minimum requirement in the rural area of Zaire⁽¹⁹⁾. The figure's dimension, (liter/household/day), is different from the one discussed in the above, (lpcd, i.e. liter/person/day). Given the average number of household members (5.8 person/household), 50 (liter/household/day) seems to be similar to Agarwal's figure and may not be simply applied to the lifestyle of the urban poor.

There are some limitations in specifying the volume of water used for respective hygienic purposes in this study. Water consumption in this study is the average consumption by every household member but does not represent the volume of water consumed specifically by or for under-five-year-old children.

Moreover, maintenance of water in plastic containers up to 24 hours might have caused a change in the quality of the water in MA. In this connection, more precise and detailed surveys would be required. Another type of limitation we have in this study is that how paved roadways in LE, which MA did not have, were associated with diarrheal incidence was not examined. Paved roadways in the community might not only have reduced the risk of exposure to infection due to fewer opportunities of contacting unhygienic phases but might also have encouraged the residents to consume more water for the purpose of outdoor hygienic behavior, i.e. washing or bathing in front of the housing unit. This study adopted, as a study design, a comparison of incidence between an intervention community (LE) and a non-intervention one (MA) whose residential environment was at a similar level at which the intervention one (LE) used to be. It was unsurprisingly difficult to select a reasonably appropriate control group that enables us to estimate the impact of the past intervention where the proper baseline data were not available. Though this study was, in this sense, one attempt for estimating it, more robust methods should be explored.

There have been few published reports on the association between water consumption and diarrhea in comparison with the considerable number of studies on the association between water quality and diarrhea⁽²⁰⁾. Water consumption and access to safe water, however, are among the main preventive strategies against diarrhea as a water-washed disease^{(4), (21)}. From this point of view, it is crucially important to define the appropriate indicators for measuring access to a safe water supply.

Access to a safe water supply is generally discussed in relation to distance, e.g. a piped water or a public standpipe within 200 meters of a housing unit⁽²²⁾. Moreover, the association between the distance to the water supply and diarrheal incidence has been reported⁽²³⁾. This study revealed that, although the water faucets were only 100 meters away even from the farthest housing unit, at least two hours were needed in MA to acquire water. For this reason, actual water consumption per person or population served per water faucet should be considered in measuring accessibility, particularly for squatters inhabiting congested areas. Our results demonstrate, thus, also the importance of choosing an appropriate indicator for measuring access to a safe water supply.

Acknowledgment

The authors would like to express their gratitude to S. T. Han, ex-Regional Director of the Western Pacific Regional Office, World Health Organization (WPRO/WHO), for the cooperation of his staff in facilitating the arrangements for this study.

We would also like to thank Ruben N. Caragay and Marilyn Crisostomo of the College of Public Health, University of the Philippines for their advice in processing data. Finally, a special word of thanks to Pascual R. Forteza of Leveriza and Russwell Vargas of Maestranza for their tremendous help in data collection.

References

- 1) Yusof K, Kwai-Sim L. Urbanization and its effects on health in squatter areas. *Journal of Human Ergology*, 1990, 19: 171-84
- 2) National Housing Authority (NHA). 1991 Annual Report,

- Quezon City, NHA, 1992, 5-6
- 3) Presidential Commission for the Urban Poor (PCUP). Urban Poor Situationer, Quezon City, PCUP, 1992, 8-14
- 4) Cairncross S, Carruthers I, Curtis D, Feachem R, Bradley D Baldwin G. Evaluation for village water supply planning, Chichester. John Wiley & Son Publication, 1980, 77-82
- 5) World Health Organization (WHO). Urbanization and its implications for child health. Geneva, WHO, 1988, 24-5
- 6) Blum D, Feachem R G. Measuring the impact of water supply and sanitation investments on diarrheal diseases. *Int J Epidemiol*; 1983; 12: 357-65
- 7) National Statistics Office (NSO). Philippine Statistic Handbook, Manila, NSO, 1990, 56-7
- 8) United Nations Children's Fund (UNICEF). Situation of Children and Women in the Philippines 1992, Manila, UNICEF, 1990, 56-7
- 9) International Development Centre Japan (IDCJ). Research Report of Economic Infrastructure Facilities, Tokyo, IDCJ, 1991, 88-9 (in Japanese)
- 10) National Housing Authority (NHA). ZIP Briefing Material, Quezon City, NHA, 1983, 1-5
- 11) World Bank. Project Completion Report/Philippines Third Urban Development Project, New York, World Bank, 1993, 19-20 (unpublished)
- 12) Controller Committee. Clinical Trial, Tokyo, Shinohara Publication, 1989, 173-9 (in Japanese)
- 13) World Health Organization (WHO). Reading on Diarrhoea (Student Manual), Geneva, WHO, 1990, 3-4
- 14) Esrey S A, Potash J B, Roberts L, Shiff C. Effect of improved water supply and sanitation on ascariasis, diarrhoea, dracunculiasis, hookworm infection, schistosomiasis, and trachoma. *Bull WHO* 1991; 69: 609-21
- 15) Kroeger A. Health interview survey in developing countries - A review of the methods and results-. *Int J Epidemiol* 1983; 12: 465-79
- 16) World Health Organization (WHO). Household Survey Manual, Geneva, WHO, 1989, K1-K3
- 17) Kunikane S, Tanahashi M. Status quo of water system facilities and environmental health in the Philippines. *Suido Kohron* 1992; 28: 66-71 (in Japanese)
- 18) Agarwal A. Water, Sanitation, Health - for All?, London, Earthscan Paperback, 1983, 34-5
- 19) Tonglet R, Isu K, Mpese M, Dramaix M, Hennart P. Can improvement in water supply reduce childhood diarrhoea? *Health Policy and Planning* 1992; 7: 260-8
- 20) for example; Moe C L, Sobsey M D, Samsa G P, Mesolo V. Bacterial indicators of risk of diarrheal diseases from drinking water in the Philippines. *Bull WHO* 1991; 69: 305-17
- 21) World Health Organization (WHO), Our planet, our health — Report the WHO commission on health and environment, Geneva, WHO, 1992, 115-40
- 22) United Nations Development Programme (UNDP). Cities, People & Poverty, New York, Oxford University Press, 1993, 54-5
- 23) for example; Gorter A C, Sandiford P, Smith G D, Pauw J P. Water supply, sanitation and diarrhoeal disease in Nicaragua (Results from a case-control study), *Int J Epidemiol* 1991; 20: 527-33