WASH Field Report No. 352

A COMPARISON OF THE HEALTH EFFECTS OF WATER SUPPLY AND SANITATION IN URBAN AND RURAL GUATEMALA

Prepared for the Office of Health,
Bureau for Research and Development,
U.S. Agency for International Development
under WASH Task No. 191

by
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December 1991

Water and Sanitation for Health Project
Contract No. DPE-5973-Z-00-8081-00, Project No. 836-1249
is sponsored by the Office of Health, Bureau for Research and Development
U.S. Agency for International Development
Washington, DC 20523

Related WASH Reports

Planning for Water and Sanitation Programs in Central America. August 1991. WASH Field Report No. 334. Prepared by Michelle Mendez.

Health Benefits from Improvements in Water Supply and Sanitation: Survey and Analysis of the Literature on Selected Diseases. July 1990. WASH Technical Report No. 66. Prepared by Steven A. Esrey, et.al.

The Value of Water Supply and Sanitation in Development: An Assessment of Health-Related Interventions. September 1987. WASH Technical Report No. 43. Prepared by Daniel A. Okun. Also available in French and Spanish.

Linking Water Supply and Sanitation to Oral Rehydration Therapy. July 1985. WASH Technical Report No. 31. Prepared by Raymond B. Isely.

Relating Improvements in Water Supply and Sanitation to Nutritional Status. October 1982. WASH Technical Report No. 16. Prepared by Raymond B. Isely.

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ACKNOWLEDGMENTS

The authors are indebted to many individuals for their contributions to various aspects of this work. We wish to acknowledge the contributions made by Shea Rutstein and Elisabeth Sommerfelt of DHS, Pamela Johnson and John H. Austin of the A.I.D. Office of Health, and to the technical staff of WASH during the data analysis and preparation stages of this document. In addition, special thanks go to Betsy Reddaway and Carol Stuart of the WASH staff for their tireless and cheerful contributions to the final editing, word processing, and production of this document.

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ACRONYMS

A.I.D.	U.S. Agency for International Development
DHS	Demographic and Health Services (Project)
INCAP	Instituto de Nutrición de Centro América y Panamá
NCHS	National Center for Health Statistics
PAHO	Pan American Health Organization
WASH	Water and Sanitation for Health Project
WHO	World Health Organization
WS&S	Water supply and sanitation

PREFACE

This report is based on a presentation at the Demographic and Health Surveys World Conference, which was held in Washington, D.C. on August 5 - 7, 1991. As with the other presentations at that conference, the analysis presented here is based on data collected in one of the country-wide Demographic and Health Surveys (DHS). The DHS Project conducts nationally representative surveys of women between the ages of 15 and 49 years, with sample sizes ranging from 3,000 to 10,000 respondents. Under DHS-I, 34 surveys were conducted in 29 countries; for DHS-II, an additional 25 surveys are planned. The purpose of the DHS Project is to assist developing countries in conducting surveys on population and health providing information for policy and program decision-making and for scientific research.

The objectives of this analysis are twofold. First of all, we are interested in understanding better the relationship between water supply, sanitation, and health. The general relationship between improved water supply and sanitation (WS&S) and improved health is well established. The key issues at this point are how to maximize the health benefits of WS&S. With this in mind, three hypotheses are developed relating to the relative health benefit of improved sanitation vs. improved water supply, urban-rural differences in the health benefits of improved WS&S, and community coverage vs. individual access to sanitation. These hypotheses are examined to provide guidance to the policymaker, programmer, and project manager when designing, implementing, monitoring, and evaluating WS&S programs and projects.

Secondly, we wished to examine the suitability of DHS data sets for WS&S and health analyses. Indicators of health status and WS&S service are discussed, both in general terms and in terms of availability and quality of data available in the DHS data sets. Both the strengths and limitations of DHS data are examined and suggestions for modifying and improving WS&S data collection are offered.

There are two primary audiences for this report. One audience is policymakers and program planners in WS&S who wish to maximize the health benefit of WS&S programs and projects. A second audience is those who work with DHS data, both as collectors and users of the data. In addition, this report should be of interest to those more generally interested in performing or interpreting analyses of the relationship between WS&S and health. Finally, this report should be of interest to those who are involved in the technical issues of analysis of survey data collected by cluster sampling, particularly those interested in the analysis of community-level variables.

EXECUTIVE SUMMARY

The health benefits of improved water supply and sanitation (WS&S) services have been well established. They include improved nutritional status of children, decreased morbidity and mortality due to diarrhea, decreases in morbidity and mortality of other WS&S-related diseases, and overall decreases in infant and child mortality. At present, it is estimated that worldwide (not including China), about 1 billion people lack access to safe water supplies, and about 2 billion to adequate sanitation facilities. In terms of coverage, rural services lag behind urban services and sanitation services lag far behind water services. Recognizing that resources for addressing these needs are limited, information about the relative health benefits of different types of WS&S, levels of service, and how these differ in urban and rural settings to program and policy personnel is important in setting priorities. This analysis examines three hypotheses important to policy makers: (1) improved sanitation, defined as sanitary disposal of feces, is more strongly associated with improved child health than is improved water supply; (2) improved sanitation is more strongly associated with improved child health in urban settings than in rural settings; and, (3) community measures of sanitation are better indicators of child health risk than is individual access to improved sanitation.

The data used in this analysis, gathered under the Demographic and Health Surveys (DHS) Project, are from the 1987 DHS survey in Guatemala. Respondents for the survey were 5,160 women between the ages of 15 and 44 years. A child level file was created including 2,008 children between 6 and 36 months of age with anthropometric measurements.

An analysis was performed of the association of stunting in children and individual access to water and sanitation service. A multivariate model was designed controlling for age of child, sex of child, age of mother, education of mother, birth order, breastfeeding, and articles owned. All analyses were stratified by urban/rural areas. A variable representing the community (cluster) level of sanitation was created and assigned to each child who lived in the cluster. The risks of stunting associated with the cluster and individual level of sanitation were compared. Individual access to improved water and sanitation service was associated independently with a lower risk of stunting in children. The relative odds ratios for stunting in urban areas were 1.79 in children without access to in-house piped water and 1.87 for those without access to a toilet. Rural findings were similar with relative odds ratios of 1.33 and 2.21 respectively. Low community level of sanitation was associated with a higher risk of stunting than was lack of individual access to a toilet.

These results support the conclusions that improved water and sanitation services are important interventions for improving child health in both urban and rural environments. There is an apparent, though not statistically significant, greater association between child health and sanitation services than with water supply. Improved sanitation appears to be as or more strongly asssociated with improved health in the rural setting than in the urban setting in this analysis. The most important finding in this analysis is the association of cluster or community level of sanitation with health outcomes. This finding is plausible, even expected, when it is realized that how everyone else in the community disposes of feces is of primary importance to an individual's health. Of special interest is the finding that children living in a community with a high level of sanitation coverage have the same low risk of stunting whether or not they have individual access to a toilet.

From a program and policy point of view, these findings have several implications. First of all, sanitation should receive the same degree of attention and resources as water supply in a water and sanitation program that expects to improve health. Second, there are apparently no settings where the primacy of sanitation in producing health benefits does not apply, at least no such setting was found within the limitations of this analysis. Thirdly, in order to maximize the health benefit of sanitation improvements, the most important goal and evaluation indicator is not improved individual level of service, but reaching an improved community level of sanitation so that at least 75% of the community has access to adequate sanitation services and uses them properly.

Finally, it must be remembered that this analysis focuses on the health benefits associated with improved water supply and sanitation. In practice, water supply and sanitation programs and projects must also consider other factors that affect the feasibility and long-term sustainability of the program. These include issues such as cost, choice of technology, community organization and participation, and resource availability. Health benefits in the long term depend not only on initial design, coverage, and usage, but also on the long-term sustainability of the program.

Chapter 1

BACKGROUND AND RATIONALE

1.1 Water Supply, Sanitation, and Health

The health benefits of improved water supply and sanitation services (WS&S) have been well established and documented (McJunkin 1982, Esrey and Habicht 1986, Esrey et al. 1990). Specific health benefits documented in recent literature include improved nutritional status of children (Henry 1981, Hebert 1985, Esrey et al. 1988, Bertrand 1988, Rutstein and Sommerfelt 1989), decreased morbidity and mortality due to diarrheal disease, decreased morbidity due to intestinal helminths, decreased guinea worm disease, decreased schistosomiasis, and decreased trachoma, as well as a dramatic effect on child survival (Esrey et al. 1990). The results of this most recent review of the health benefits of WS&S are summarized in Table 1.

Table 1

EXPECTED REDUCTION IN MORBIDITY AND MORTALITY FROM IMPROVED WATER SUPPLY AND SANITATION*

	ALL STUDIES			BETTER STUDIES		
	NO.	MEDIAN	RANGE	NO.	MEDIAN	RANGE
DIARRHEAL DISEASES						
· MORBIDITY	49	22%	0%-100%	19	26%	0%-68%
· MORTALITY**	3	65%	43%-79%	-	—	—
ASCARIASIS	11	28%	0%-83%	4	29%	15%-83%
GUINEA WORM	7	76%	37%-98%	2	78%	75%-81%
HOOKWORM	9	4%	0%-100%	-	-	—
SCHISTOSOMIASIS	4	73%	59%-87%	3	77%	59%-87%
TRACHOMA	13	50%	0%-91%	7	27%	0%-79%
OVERALL IMPACT ON CHILD MORTALITY	9	60%	0%-82%	6	55%	20%-82%

SOURCE: ESREY ET AL. (1990).

* INDICATES MORBIDITY REDUCTION UNLESS NOTED OTHERWISE.
** THERE WERE NO "BETTER" STUDIES.

WS&S promotes improved health through several mechanisms. Clean water prevents the spread of waterborne diseases, such as common diarrheas and the classic waterborne disease, cholera. Increased quantity and access to water provides the opportunity to improve hygiene, such as washing hands and cooking utensils, and prevents the direct spread of pathogens through contamination of food, water, and other objects, e.g., hands, that may be put in the mouth. Improved WS&S may lead to decreased contact with unsafe, unimproved water sources and prevent health problems such as schistosomiasis and drownings. Water-based disease vectors may be controlled by improving water sources and eliminating breeding sites of insects that carry a variety of diseases, including dengue and malaria.

The importance of sanitation in preventing disease is often underestimated and understated. In fact, if a perfect system of sanitation and control of fecal contamination were possible, most water-related diseases would be eliminated. Some sanitation-related diseases, however, such as hookworm and strongyloidiasis, are unlikely to decrease in the presence of improved water supplies. In order to reap the potential benefits of WS&S, effective health education and appropriate hygiene behavior change must take place.

At present, not counting China, an estimated one billion people lack access to safe water supplies, and an estimated two billion lack access to adequate sanitation. Estimates of developing-world coverage of water and sanitation, by region and urban/rural areas, are presented in Table 2. Clearly rural coverage lags behind urban coverage for both water and sanitation, and sanitation coverage lags far behind water coverage in both urban and rural settings.

Table 2

Evolution of Water and Sanitation Coverage Percentages
By Region, 1980 and 1990

	Water				Sanitation			
	Rural		Urban		Rural		Urban	
	1980	1990	1980	1990	1980	1990	1980	1990
Africa	22	29	83	74	18	19	67	74
Latin America and the Caribbean	41	51	83	88	11	21	74	82
Asia and the Pacific	31	57	66	69	13	13	42	44
Middle East	51	56	95	100	34	15	79	100
Global Totals	30	50	75	77	14	15	58	63

Source: UNICEF 1989.

1.2 Program and Policy Issues

It is clear that improved WS&S will promote improved health in situations in which inadequate services exist. Recognizing that resources for addressing these needs are limited, the next logical step is to determine the health benefits of specific types and levels of WS&S service in order to inform decision makers about expected health benefits. This analysis will examine three issues relevant to policy decisions based on the health impact of improved water supply and sanitation: improved sanitation versus improved water supply, urban and rural differences regarding improved sanitation, and community versus individual access to sanitation.

The first issue is the relative weight or emphasis given to different aspects of WS&S. There are four distinct WS&S components: water quality, water quantity and access, sanitation, and hygiene behavior change. All of these are important and the best projects will include all components. Nonetheless, all components are not equally emphasized, when present, and decisions have to be made about the relative priority (investment) in the various WS&S components. Review of the literature shows an overall greater decrease in diarrheal disease in children with improved sanitation (a 36 percent decrease) than with improved water supplies (a 17 percent decrease) (Esrey et al. 1990). This finding is based on very few studies but is not surprising, since adequate sanitation, i.e., adequate disposal of feces, is the primary barrier to fecally transmitted diseases (Bateman 1991). Nonetheless, access to adequate sanitation lags far behind access to adequate water supplies (Table 2). In terms of health benefits, therefore, it appears that increased emphasis should be given to sanitation.

Second, there may be important urban/rural differences in the relative health benefits of improved water supply and sanitation. Areas in which such data are available are childhood diarrhea and environmental contamination: Environmental fecal contamination is high and childhood diarrhea rates at least as high in peri-urban slums as in rural settings (Lopez de Romana et al. 1989, Schorling et al. 1990). In crowded urban settings, when sanitation is inadequate, fewer opportunities exist for people to defecate away from others than in rural settings. Therefore, sanitation would appear to be a more critical investment in areas of crowding, such as peri-urban shantytowns, than in more dispersed rural settings.

Finally, and related to the two issues above, the community level of sanitation may be more important than individual access to sanitation. For the transmission of viral and bacterial diseases, the feces of an individual are not dangerous to that same individual. Rather, it is the ill neighbor who may transmit disease to an uninfected person. In practical terms, the critical measure of sanitation from the point of view of invididual health is the level of sanitation of all of the *other* individuals in a community. If the community level of sanitation is the key measure of sanitation service for achieving health benefits, the appropriate measure of sanitation for program design and evaluation purposes is not the number or proportion of individuals with access to improved sanitation but, rather, the number or proportion of communities with a high level of improved sanitation service and appropriate usage of those services.

1.3 Specific Hypotheses

Based on the policy issues discussed above, three testable hypotheses are formulated:

1. Improved sanitation, defined as sanitary disposal of feces, is more strongly associated with improved health than is improved water supply.

2. Improved sanitation is more strongly associated with improved health in urban settings than in rural settings.

3. Community measures of sanitation are better indicators of health risk than is individual access to improved sanitation.

These hypotheses will be tested using data from the Demographic and Health Surveys (DHS). The analysis will focus on child health and the choice of variables will conform to the constraints of the DHS data set.

Chapter 2

METHODOLOGY

2.1 Data

The data used in this analysis were gathered under the Demographic and Health Surveys (DHS) Project. DHS conducts nationally representative surveys of women between the ages of 15 and 49, with sample sizes ranging from 3,000 to 10,000 respondents. Under DHS-I, 34 surveys were conducted in 29 countries; for DHS-II, an additional 25 surveys are planned. For the majority of countries, data are collected on fertility and childhood mortality levels, use of family planning, breast feeding, various maternal and child health indicators, anthropometry, and socioeconomic characteristics. The purpose of the DHS Project is to assist developing countries in conducting surveys on population and health, providing information for policy and program decision making and for scientific research.

For the proposed analysis a country's data set needed to satisfy certain criteria. First, at least 25 percent of the total population had to be urban to allow for rural/urban comparisons. Second, it was necessary to have anthropometrics for children (20 of the 29 countries surveyed under DHS-I gathered anthropometrics). Third, some variance in the level of water and sanitation services in the urban and rural settings was necessary to make comparisons of their effect.

The data set from Guatemala met the necessary criteria. The data were gathered in 1987 under the *Guatemala—Encuesta Nacional de Salud Materno Infantil*. The survey was conducted by INCAP, with technical assistance from the DHS staff.

The sample design included the entire country, with the exception of the El Peten region, which was excluded because of inaccessibility and because it contained only 2 percent of the national population. The sample was designed to allow inference at three levels: national, regional, and urban/rural strata. The sampling frame was adapted from the "Sociodemographic Questionnaire," also performed in 1987. The country was divided into 16 sections. Within each section a two-stage cluster sampling procedure was followed. In the first stage, census tracts (clusters) of approximately 100 households were selected systematically and with a probability of selection proportional to size based on the 1981 census. In the second stage, individual households were selected to respond to the questionnaire. The expected number of selected households per cluster was 20 households in urban areas and 40 households in rural areas. The actual mean size of the clusters selected was 150 households (range 63 to 261). A total of 240 clusters were selected, 118 urban and 122 rural, with a mean of 11 respondents per urban cluster and 28 respondents per rural cluster.

Respondents were 5,160 women between the ages of 15 to 44. Data were collected from each woman on various topics, including a complete birth history, health information on her children under 5 years of age, and anthropometric measurements of her children between the ages of 3 and 36 months. The data file constructed for this analysis is a child level file, i.e., each record is a child with the mother's information attached.

Inclusion criteria for this analysis were live children, 6 to 36 months of age at the time of the questionnaire, who had height measured and age recorded. Excluded from analysis were children who were twins, children not currently residing in the mother's (respondent's) home, children whose mother (respondent) who was a visitor in the current household, and families that had changed residences since the child's birth. Also excluded were children who lived in a cluster containing a total of less than four children under 5 years of age. Of a total of 2,198 children meeting the inclusion criteria, 190, or 8.6 percent, were excluded based on the above criteria.

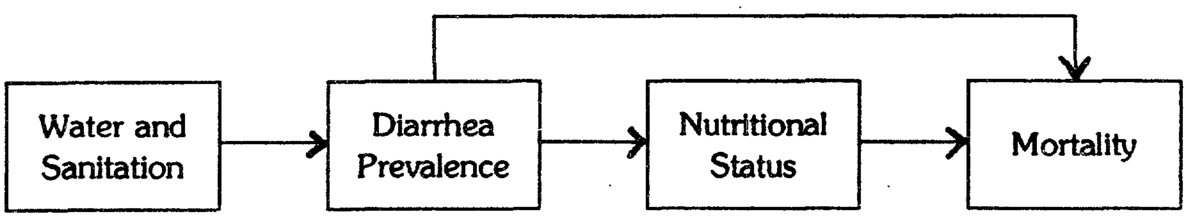
2.2 Variable Selection and Definitions

2.2.1 Indicators of Health Status

Three measures of child health are available in this data set: diarrhea prevalence, nutritional status, and mortality. The relationships between these three measures and WS&S are illustrated in Figure 1. Note that this model is extreme in its simplification and excludes factors other than WS&S that are associated with infant and childhood diarrheal disease, nutritional status, and mortality. Also not represented are other paths of association between WS&S and child health.

Figure 1

Relationship Between Water and Sanitation
and Child Health Outcomes



Diarrhea prevalence in children was measured as 24-hour and 2-week recall by the mother. There are several advantages of using diarrhea prevalence as an indicator of health status. There is a direct relationship between improved WS&S and diarrhea prevention. Diarrhea is an acute disorder reflecting environmental risks at the time of the diarrheal episode. Both diarrhea and environmental variables are measured at the same time. There are also several disadvantages to using diarrhea prevalence as a measure of child health. Diarrhea prevalence is collected by one-time recall of the mother; therefore, errors in recall are likely to be large. "Diarrhea" is not defined by the interviewer; instead the mother responds based on her own definition. The "diarrhea" recalled is likely to vary from mother to mother and culture to culture, and probably with social and educational level. There is, in addition, a general limitation of using diarrheal disease prevalence in a cross-sectional study for risk-factor analysis. A survey of diarrhea prevalence divides children into two groups: those with and those without diarrhea. In reality, however, there is a spectrum of diarrhea risk in children from those with very low rates of diarrhea to those with very high rates. When two groups are formed based on the prevalence of diarrhea in one period, there will be misclassification, with some "low diarrhea" children having diarrhea during the period and a large proportion of "high diarrhea" children being diarrhea-free during the period.

Infant mortality is a common measure of infant health status. Disadvantages of using infant mortality as a measure include the following: classification of deceased infants, although based on history, is subject to problems of recall and truthfulness; diarrhea and associated water- and sanitation-related problems are only one cause of mortality and are associated with about 23.8 percent of infant mortality in Guatemala (PAHO 1990); sample size may be problematic since infant mortality is a relatively infrequent event; and potential problems may arise with the level of service changing over time. Additionally, in infant deaths during the past five years, some infants were exposed to a different environment from that described at the time of the questionnaire. Misclassification of the environmental factors such as water and sanitation services, may occur if they have changed in the intervening period.

Nutritional status is measured in a survey by three anthropometric indices: weight for age, height for age, and weight for height. Of these, height for age and weight for age are best for identifying medium- and long-term influences on growth, such as water and sanitation services in the home (Bairagi 1987). There are several advantages to using nutritional status as an outcome measure for analysis of health benefits. First, it is an objective measurement that does not depend on recall, interpretation, truthfulness, or other pitfalls of responses to questions. Second, long-term measures, especially height for age, reflect the environment of the child since birth rather than a single short-term effect resulting in an episode of diarrhea or death. Low height for age reflects long-term experience with diarrhea, an effect that has been well described (Lutter et al. 1989, Henry et al. 1987, Matorell 1975). The disadvantage of using anthropometrics is that the determinants of nutritional status are not restricted to diarrhea history, but include other factors, particularly caloric intake.

While the discussion of the precise relationship between diarrhea and nutritional status continues, it is clear that diarrhea incidence and growth retardation are closely associated under a variety of circumstances (Briend 1990). The circumstances in which nutritional status will most closely reflect diarrhea history are those in which the burden of diarrhea is high and food availability is not unusually limited as in famines or near famines. These conditions are met in Guatemala.

2.2.2 Definition of Outcome Variable

Stunting—Anthropometrics on children between the ages of 6 and 36 months were analyzed. Heights were taken by having the children lie down on a specially constructed measuring board. A child was considered stunted if the recumbent length for age was more than two standard deviations below the NCHS/WHO reference median.

2.2.3 Indicators of Water and Sanitation Level of Service

The combination of four indicators describes water and sanitation services: water quality, water quantity, sanitation, and hygiene behavior.

Water quality is the degree to which water is free of contamination from bacteria, viruses, and parasites. Microbiologic quality of water is typically determined by culturing water for indicator bacteria. Water source is the most common proxy for water quality.

Water quantity is the volume of water used for personal and domestic needs, measured in liters per capita per day. Water quantity may be measured using water meters, monitoring household water tanks, self-reporting, or direct observation. A common proxy for water quantity used is distance to the water source, though the relationship between distance and quantity used is not always clear (Mertens et al. 1990, White et al. 1972, Feachem et al. 1978, Cairncross 1987).

Sanitation refers to the sanitary disposal of human feces, typically in a flush toilet or latrine. Adequate sanitation means the sanitary disposal of the feces of family members of all ages all of the time. Methods of measuring sanitation include self-reporting, direct observation (unusual), and observation of proxies, such as level of feces in latrines, growth of grass on the path to the latrine, and so on. The presence of a physical facility is commonly used as an indicator of sanitation, but may not correlate well with actual use.

Hygiene behavior refers to water- and sanitation-related behaviors. This is the best indicator of water and sanitation because it measures actual usage. Various anthropological techniques and self-reporting are used to record hygiene behavior. The presence of physical services, such as a public standpipe or latrine, is often assumed to represent associated hygiene behaviors, though this is clearly not true in many cases.

2.2.4 Definitions of Water and Sanitation Variables

Water—Each respondent was asked this question: "What is the principal source of drinking water that is used by members of this household?" Responses were divided into three categories: piped in-house, public standpipe, and non-piped sources, which include wells, rivers, streams, springs, trucked water with storage tank, and rainwater.

Sanitation—Each respondent was asked, "What kind of sanitary services does this house have?" Responses were divided into three categories: flush toilets, latrines, and no facilities.

Cluster level of sanitation—Sanitation was redefined as a dichotomous variable coding a child as (0) if a flush toilet was present or (1) if no flush toilet was present. For each cluster an average level of sanitation was calculated for the children under five living in that cluster. The cluster level was then coded (0), "high level of sanitation," if 75 percent or more of the children in the cluster had a flush toilet. The cluster level was coded (1), "low level of sanitation," if less then 75 percent of the children in the cluster had a flush toilet. Each child was assigned a value, 0 or 1, for the level of sanitation in the cluster in which he or she lives. The optimal cutoff level for low or high level of sanitation was determined during exploratory analysis. Relative odds ratios were calculated separately for each of 21 cutoff points (0 to 100 percent sanitation in the cluster, in 5 percent increments) and the cutoff level with the highest relative odds ratio, 75 percent, was chosen.

Interaction of cluster and individual levels of sanitation—To analyze the interaction between the cluster level of service and the individual level of service, a variable with four categories was created. The four groups consisted of (1) children who live in a cluster with a high level of sanitation and in a household with a flush toilet; (2) children who live in a cluster with a low level of sanitation and in a household with a flush toilet; (3) children who live in a cluster with a high level of sanitation and in a household without a flush toilet; and (4) children who live in a cluster with a low level of sanitation and in a household without a flush toilet.

2.2.5 Other Determinants of Stunting

Other determinants of nutritional status, known or probable, were included as controls for confounding for use in a multivariate model. One key determinant, caloric intake, had no direct measure or proxy available. Socioeconomic status, represented here by mothers' education and articles owned, correlates with caloric intake of children in some settings (Bairagi 1980). Previous birth interval, coded as a dichotomous variable of greater than 24 months or fewer than or equal to 24 months, was initially included in the model but eliminated because of lack of association with stunting.

Age of child—Children between 6 and 36 months were divided into 6-month age intervals.

Sex of child—Male children were coded (0) and female children (1).

Age of mother—Mothers' age was divided into three categories: lowest through 19 years, 20 to 35 years (the reference category), and 36 years or more.

Education of mother—Mothers were grouped into three categories: no education, primary education (complete or incomplete), and secondary education or higher (the reference category).

Birth order—Children were grouped into three categories: first born, second through fifth born (the reference category), and sixth born or higher.

Breastfeeding—If the mother was still breast feeding the child or the mother reported having breast fed the child for six months or more the child was coded (0). If the mother reported having breast fed the child fewer than six months the child was coded (1). Breast feeding as used here refers to *any* breast feeding, exclusive or supplemented. Data on exclusive breast feeding were not available in this data set.

Articles owned—A proxy measure was created for socioeconomic status that included ownership of six articles—television, refrigerator, bicycle, motorcycle, car, and tractor. If one or more articles were present in the house, the child was coded (0). If none was in the house the child was coded (1).

2.2.6 Indicator of Urban/Rural Place of Residence

Urban/rural—Place of residence was divided into a dichotomous variable, urban or rural. These categories were used by this survey as defined by the National Bureau of Statistics in Guatemala for the 1981 census. The definitions were: "Urban: All populated centers which are officially defined as city, town, and small town" and "Rural: All populated centers which are officially defined as village, cluster of houses, and open space." No information exists about how these definitions relate to the size or density of the populated centers.

2.2.7 Statistical Analysis

The data were analyzed in three stages and all analyses were stratified by urban/rural residence. In the first stage, simple frequencies of water and sanitation levels of service were performed. Statistical tests of significance were not performed. In the second stage, bivariate relationships between water and sanitation level of service and the outcome variable, stunting, were examined. In the third stage, logistic regression analysis was used to examine the relationship of water and sanitation level of service while controlling for potential confounding variables. The beta parameters of the logistic regression model are estimated using the maximum likelihood method.

In addition to indicators of water and sanitation services, control variables were entered into each logistic regression equation. Elimination techniques to reduce the number of variables and select the most parsimonious model were not used. All variables were included in the final model regardless of significance.

A reference category, the category believed to be associated with the lowest risk of stunting, was established for each variable. For dichotomous variables, the reference category was coded 0 and the risk category 1, so that calculated relative odds ratios could be interpreted as the risk of stunting for children with the risk factor compared with children without the risk factor. For variables with more than two categories, a reference category was also established and every other category was compared directly with the reference category, allowing a similar interpretation of the relative odds ratios for categorical variables.

All analyses were performed with SPSS/PC+, version 4.0.

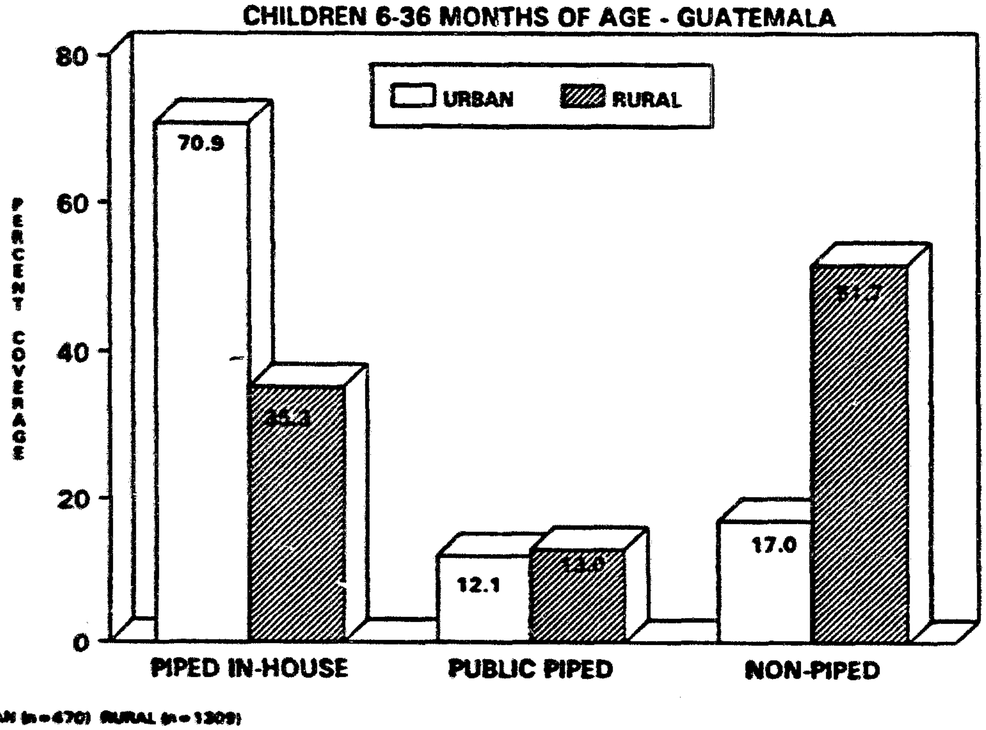
Chapter 3

RESULTS

The percentage of children with access to each of the three levels of water service varied between urban and rural areas (Figure 2). A higher percentage of children had access to water piped in-house in urban areas (70.9 percent) than in rural areas (35.3 percent), and a higher percentage of children had access only to non-piped service in rural areas (51.7 percent) than in urban areas (17.0 percent). A smaller percentage of children had access to public standpipes in both urban and rural areas (12.1 percent and 13.0 percent, respectively).

Figure 2

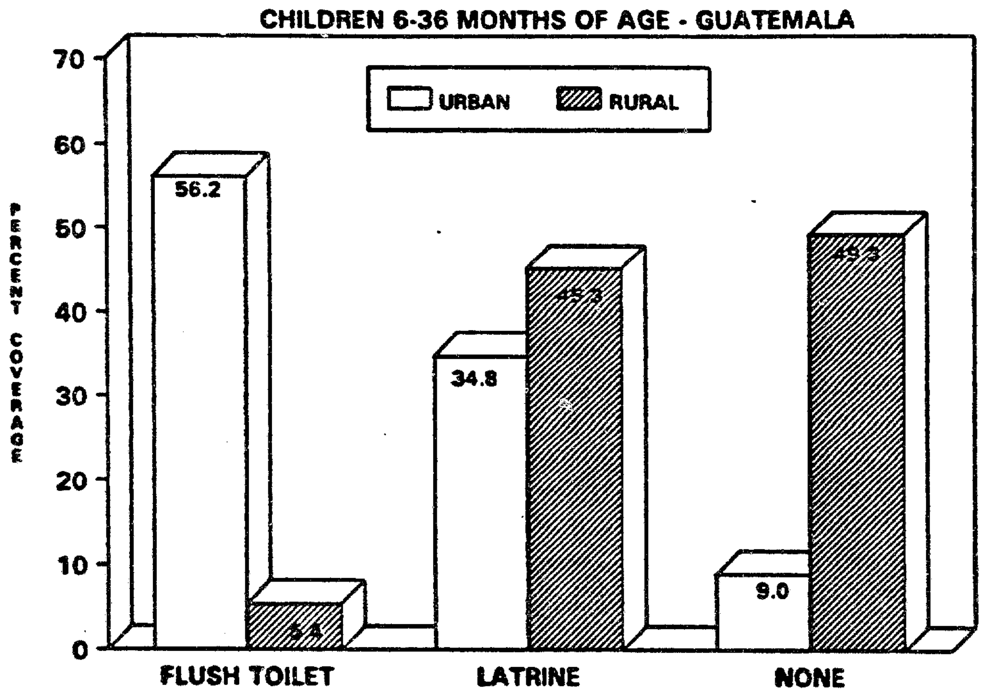
INDIVIDUAL LEVEL OF SERVICE - WATER



Availability of sanitation services was also better in urban than in rural areas (Figure 3). Flush toilets were available to 56.2 percent of urban children but only 5.4 percent of rural children. Almost half of the rural children (49.3 percent) had no sanitary facilities whatsoever, compared with only 9.0 percent of urban children. Latrine access was intermediate in both cases (urban, 34.8 percent and rural, 45.3 percent).

Figure 3

INDIVIDUAL LEVEL OF SERVICE - SANITATION

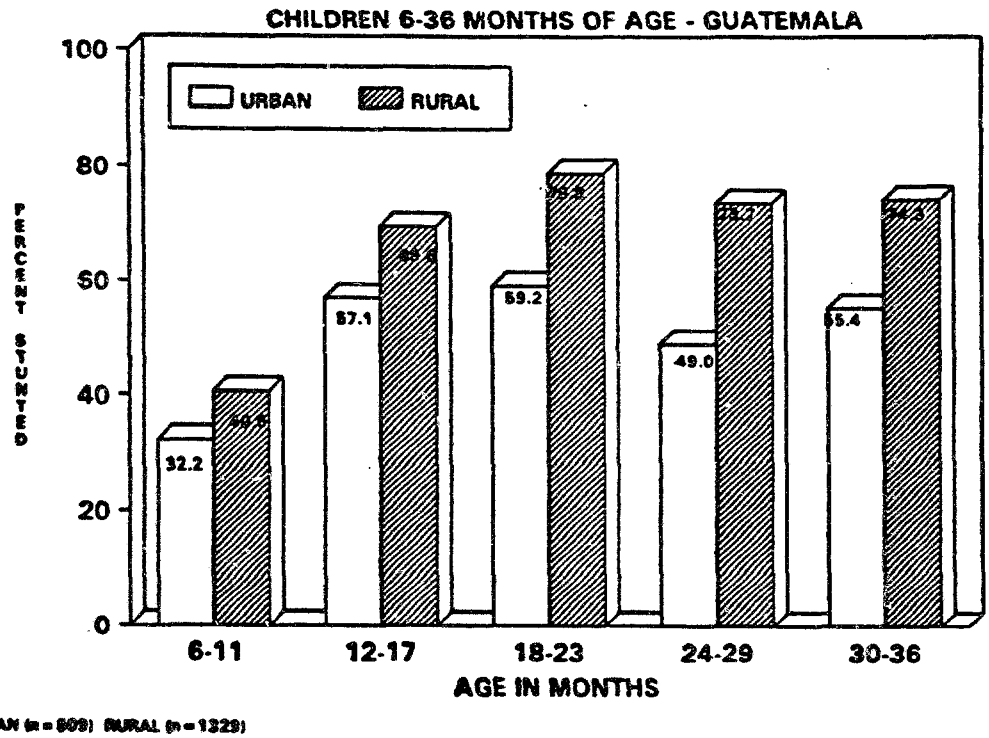


URBAN (n=500) RURAL (n=1294)

The age distribution of stunting was similar in both urban and rural settings (Figure 4). However, the proportion of children stunted is lower in urban children than in rural children in each age grouping. Overall, half of urban children were stunted (49.7 percent) and two-thirds of rural children were stunted (66.7 percent).

Figure 4

PERCENT OF CHILDREN STUNTED BY AGE



The proportion of children stunted was associated with the level of water service in both urban and rural areas (Figure 5). Stunting in children of households with in-house piped water was apparently lower in urban areas than in rural areas (42.9 percent and 60.0 percent, respectively). The percentage of children stunted was higher in children without individual access to piped in-house water. The percentage stunted was similar in urban and rural households with access to public piped water (78.9 percent and 74.7 percent, respectively) and in urban and rural households without access to piped water (70.0 percent and 69.9 percent, respectively).

The relationship between stunting and level of water service was examined using a logistic regression model controlling for the child's age and sex, mother's age, mother's education, birth order, breastfeeding history, number of articles owned, and level of sanitation service (Table 3). Piped in-house water was used as the reference category in both urban and rural children. The highest relative odds ratio for stunting is in children in households that use public standpipes for drinking water—urban areas, 2.43 (1.09-5.36)[1] and rural areas, 1.63 (1.06-2.49). Relative odds ratios of stunting were also greater than 1 in households with non-piped water sources—urban, 1.48 (.78-2.79) and rural, 1.27 (.96-1.69).

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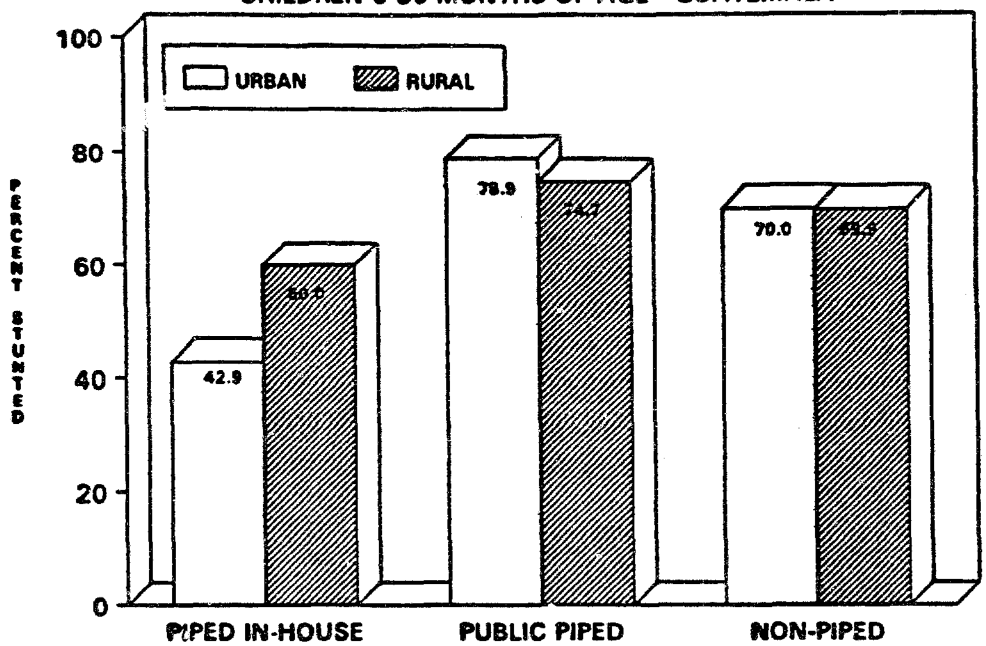
[1] Confidence interval is 95 percent.

Figure 5

PERCENT OF CHILDREN STUNTED BY INDIVIDUAL LEVEL OF SERVICE - WATER

CHILDREN 6-36 MONTHS OF AGE - GUATEMALA



URBAN (n=470) RURAL (n=1309)

Table 3

Relative Odds Ratio of Stunting by Individual Level of Service - Water

Children 6-36 Months of Age - Guatemala
Logistic Regression Model

	Urban	Rural
Piped In-house	1.0	1.0
Public Piped	2.43*	1.63†
Non-piped	1.48	1.27*

URBAN (n=459)
RURAL (n=1271)

* p ≤ .10 † p ≤ .05

Model controls for age of child, sex of child, age of mother, education of mother, birth order, breast feeding, articles owned, and individual level of sanitation service.

The independent relative odds ratios of the control variables used in this model are shown in Table 4. In this table, the reference categories are the categories *not* shown (also see the variable definitions in the "Methodology" section). It is interesting to note the striking effect of education in urban areas, with a relative odds ratio of 7.44 for stunting when the mother has no education, compared with when the mother has received secondary education or higher.

Table 4

Relative Odds Ratio of Stunting by Control Variables

Children 6-36 Months of Age - Guatemala
Logistic Regression Analysis

		Urban	Rural
Age of Child	(6-month intervals)	‡	‡
Sex of Child	Female	1.20	.78†
Age of Mother	< 20 years	2.18*	1.42
	≥ 35 years	.65	.82
Education of Mother	None	7.44‡	1.68
	Primary School	2.86‡	1.07
Birth Order	First	.55†	.68†
	Sixth or higher	1.07	1.41†
Breastfeeding	< 6 months	.89	1.03
Articles Owned	None	1.70†	1.79‡

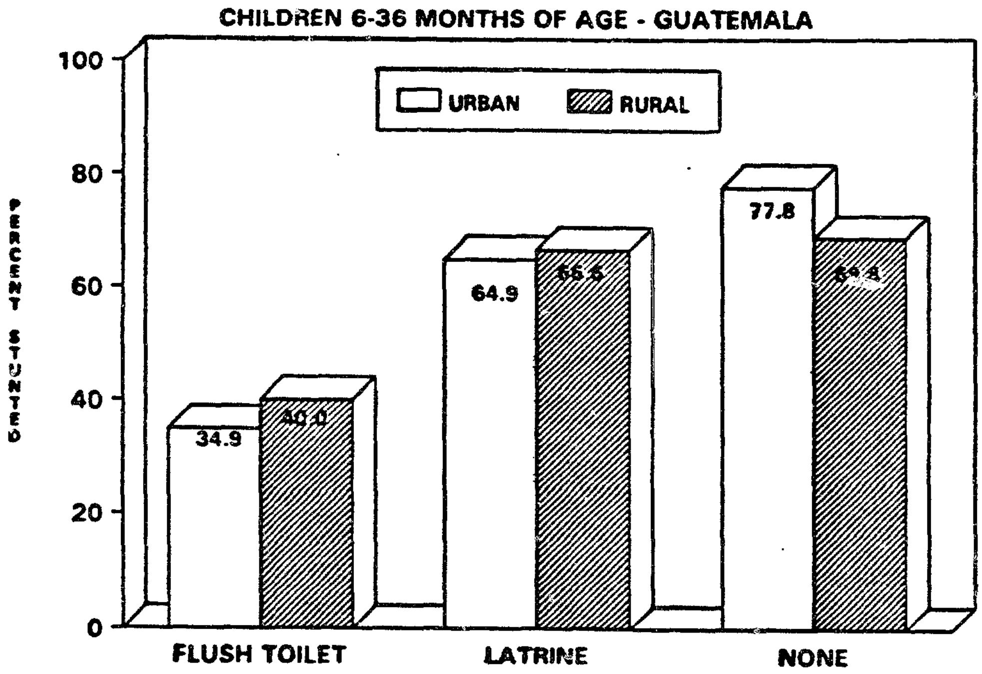
URBAN: n=507, 49.7% stunted
RURAL: n=1326, 66.7% stunted

* p ≤ .10 † p ≤ .05 ‡ p ≤ .01

The proportion of children stunted was also associated with the sanitation level of service (Figure 6). Stunting was lower in children with access to a flush toilet in both urban and rural areas (34.9 percent and 40.0 percent, respectively) when compared with those with access to latrines (urban, 64.9 percent and rural, 66.6 percent) and to those without access to sanitary services (urban, 77.8 percent and rural, 68.8 percent).

Figure 6

PERCENT OF CHILDREN STUNTED BY INDIVIDUAL LEVEL OF SERVICE - SANITATION



This association was also examined in the logistic regression model controlling for level of water service and the variables shown in Table 4. The risk of stunting was approximately doubled in children with household access to latrines in both urban and rural areas (urban, 1.90 (1.16-3.13) and rural, 2.23 (1.24-3.99). The risk of stunting was increased to a similar level in children with no access to sanitary services—urban, 1.75 (.72-4.24) and rural, 2.11 (1.15-3.88) (Table 5).

The levels of water service and sanitation service associated with increased risk of stunting are grouped to form dichotomous variables and presented in Table 6. The independent risk of stunting is similar in those without piped in-house water, 1.79 (1.04 - 3.12), and those without a flush toilet, 1.87 (1.15 - 3.40) in urban areas. In rural areas, however, there is a lower risk associated with lack of in-house piped water, 1.33 (1.01 - 1.75), compared with those without a flush toilet, 2.21 (1.24 - 3.95). There are no statistically significant urban-rural differences in risk associated with either water or sanitation services.

Table 5

Relative Odds Ratio of Stunting by
Individual Level of Service - Sanitation

Children 6-36 Months of Age - Guatemala
Logistic Regression Model

	Urban	Rural
Flush Toilet	1.0	1.0
Latrine	1.90†	2.23‡
None	1.75	2.11†

URBAN (n=459)
RURAL (n=1271)

† p ≤ .05 ‡ p ≤ .01

Model controls for age of child, sex of child, age of mother, education of mother, birth order, breastfeeding, articles owned, and individual level of water service.

Table 6

Relative Odds Ratio of Stunting by Individual
Level of Service - Water and Sanitation

Children 6-36 Months of Age - Guatemala
Logistic Regression Model

	Urban	Rural
WATER		
Piped In-house	1.0	1.0
Public Piped/Non-piped	1.79†	1.33†
SANITATION		
Flush Toilet	1.0	1.0
No Toilet	1.87‡	2.21‡

URBAN (n=459)
RURAL (n=1271)

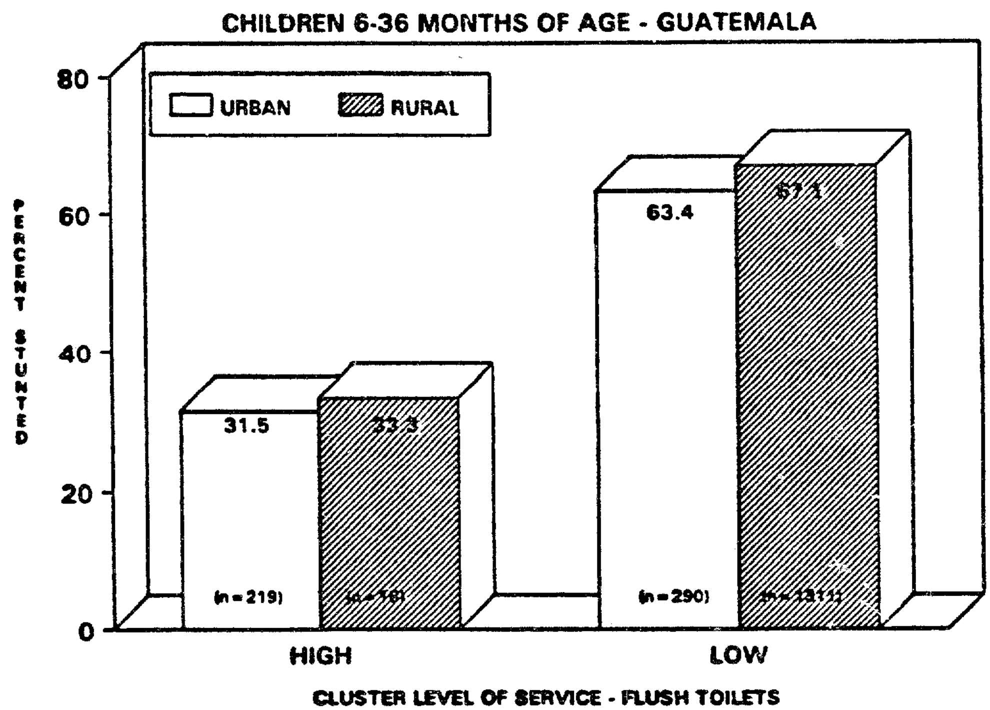
† p ≤ .05 ‡ p ≤ .01

Model controls for age of child, sex of child, age of mother, education of mother, birth order, breastfeeding, and articles owned.

Community (cluster) level of sanitation is generally higher in urban than in rural areas. In urban areas, 43.0 percent of children live in clusters with a high level of sanitation compared with only 1.4 percent in rural areas. Stunting is associated with community level of sanitation (Figure 7). In clusters with a high level of sanitation, defined as greater than 75 percent of children under age five with access to flush toilets in the cluster, there is a low proportion of stunted children in both urban and rural areas (urban, 31.5 percent and rural, 33.3 percent). The proportion of children stunted in clusters with low levels of sanitation, defined as less than 75 percent of children under age five with access to flush toilets, is high and similar in both urban and rural areas (urban, 63.4 percent and rural, 67.1 percent).

Figure 7

PERCENT OF CHILDREN STUNTED BY CLUSTER LEVEL OF SERVICE - SANITATION



When examined in the logistic regression model, the risk of stunting associated with living in a community with a low level of sanitation was 2.14 (1.32 - 3.47) in urban areas and 2.95 (1.01 - 8.32) in rural areas. Low community level of sanitation is associated with a greater risk of stunting than is the lack of individual access to toilets (Table 7). This difference in relative odds ratios is not statistically significant, however.

The individual effects of the control variables, individual water supply, and cluster level of sanitation on stunting in children in the logistic regression model are summarized in Table 8. The risk of stunting is higher for low cluster level of sanitation than for individual level of water service in both urban and rural areas.

Table 7

Relative Odds Ratio of Stunting by Sanitation
Comparison of Individual and Cluster Level of Service

Children 6-36 Months of Age - Guatemala
Logistic Regression Model

INDIVIDUAL LEVEL	Urban	Rural	
Flush Toilet	1.0	1.0	
No Toilet	1.87‡	2.21‡	
			URBAN (n=459) RURAL (n=1271)
CLUSTER LEVEL			
High	1.0	1.0	
Low	2.14‡	2.95†	
			URBAN (n=468) RURAL (n=1306)

† $p \leq .05$ ‡ $p \leq .01$

Model controls for age of child, sex of child, age of mother, education of mother, birth order, breast feeding, articles owned, and individual level of water service.

There is a lower proportion of stunted children in clusters with a high level of sanitation than in clusters with a low level of sanitation both in children with individual access to a flush toilet and in those without individual access to a flush toilet (Figure 8). This interaction of individual level of service and cluster level of service is further explored in the logistic regression model controlling for the control variables in Table 4 and individual level of water service (Table 9). An association similar to that shown in Figure 8 is noted. For children with individual access to a flush toilet, those living in a low sanitation cluster have 1.67 (.89 - 3.11) times the risk of stunting compared with those living in a high sanitation cluster in urban areas and 1.46 (.44 - 4.86) times the risk in rural areas. More remarkable is the finding that children with *no* individual access to a toilet, but who live in a cluster with a high level of sanitation coverage, do not have an increased risk of stunting (relative odds ratio = .99) compared with children *with* individual access to a toilet living in a cluster with a high level of sanitation coverage. This could only be tested in the urban stratum because of an insufficient number of children (only one) without a toilet living in a high coverage cluster in the rural stratum. The highest risk of stunting is in children with no individual access to a toilet who live in a cluster with a low level of sanitation coverage (urban, 2.58 and rural, 2.99).

Table 8

Relative Odds Ratio of Stunting by Explanatory Variables

Children 6-36 Months of Age - Guatemala Logistic Regression Analysis

		Urban	Rural
Age of Child	(6-month intervals)	‡	‡
Sex of Child	Female	1.17	.79*
Age of Mother	< 20 years	1.79	1.38
	≥ 35 years	.84	.81
Education of Mother	None	6.21‡	1.23
	Primary School	2.90‡	.83
Birth Order	First	.66	.68†
	Sixth or higher	.91	1.37*
Breastfeeding	< 6 months	.98	1.13
Articles Owned	None	1.17	1.64*
Individual Water Supply	Not piped in house	1.63*	1.30*
Cluster Level of Sanitation	Low	2.14‡	2.95†

URBAN: n=468, 49.7% stunted
RURAL: n=1306, 66.7% stunted

* $p \leq .10$ † $p \leq .05$ ‡ $p \leq .01$

Figure 8

INTERACTION OF CLUSTER AND INDIVIDUAL LEVEL OF SERVICE - SANITATION

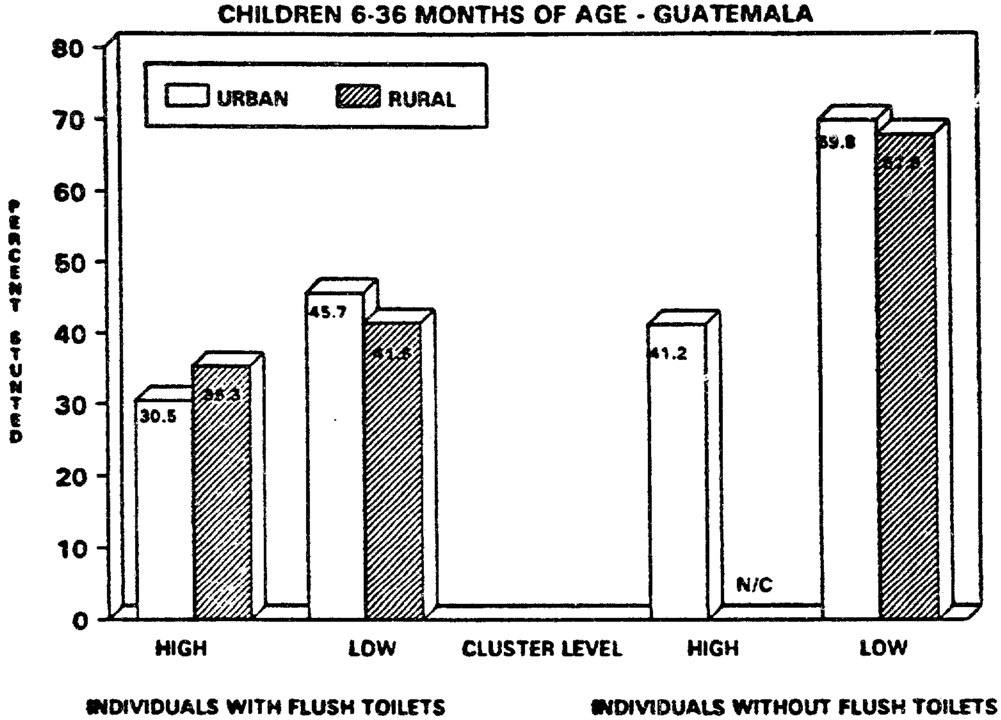


Table 9

Relative Odds Ratio of Stunting by
Interaction of Cluster and Individual
Level of Service - Sanitation

Children 6-36 Months of Age - Guatemala

Individual	Cluster	Urban	Rural
Flush Toilet	High	1.0	1.0
Flush Toilet	Low	1.67*	1.46
No Toilet	High	.99	—
No Toilet	Low	2.58‡	2.99†

URBAN (n=459)
RURAL (n=1271)

* p ≤ .10 † p ≤ .05 ‡ p ≤ .01

Model controls for age of child, sex of child, age of mother, education of mother, birth order, breastfeeding, articles owned, and individual level of water service.

Chapter 4

DISCUSSION

4.1 Conclusions about the Main Hypotheses

Both improved water supplies and improved sanitation services are associated with improved child health, where child health is measured as longitudinal growth in Guatemala. There is an apparent, though not statistically significant, greater risk associated with inadequate sanitation than with inadequate water supply (see Table 8). These findings support the first hypothesis, that improved sanitation is more strongly associated with improved health than is improved water supply. They also confirm the importance of sanitation in WS&S programs that are focused on health improvements.

The results of this analysis do not, however, support the second hypothesis, that improved sanitation is more strongly associated with improved health in urban settings than in rural ones. Instead, in this analysis, improved sanitation appears to be as or more strongly associated with improved health in the rural setting as in the urban setting. This may be explained by the observation that, in general, densely inhabited urban areas are not being compared with dispersed rural areas, but larger towns and small cities are being compared with smaller towns and villages. Also, the urban areas of most interest for this analysis, peri-urban shantytowns, were underrepresented in this sample, which was based on relatively old census tracts. An adequate test of the hypothesis that sanitation in urban settings is more strongly associated with improved health will require a more rigorous definition of urban, peri-urban shantytown, smaller town, and dispersed rural strata to be truly meaningful.

The third hypothesis, that community measures of sanitation are better indicators of health risk than is individual access to improved sanitation, is supported by the findings. The most important finding in this analysis is the association of cluster or community level of sanitation with health outcomes. This finding is plausible, even expected, when it is realized that how *everyone else* in the community disposes of feces is of primary importance to an individual's health. Of special interest is the finding that children living in a community with a high level of sanitation coverage have the same low risk of stunting *whether or not they have individual access to a toilet.*

From a program and policy point of view, these findings have several implications. First, sanitation should receive the same degree of attention and resources as water supply in a water and sanitation program that expects to improve health. Second, there are apparently no settings in which the primacy of sanitation in producing health benefits does not apply; at least no such setting was found within the limitations of this analysis. Third, in order to maximize the health benefit of sanitation improvements, the most important goal and evaluation indicator is not improved individual level of service, but reaching an improved community level of sanitation so that at least 75 percent of the community has access to adequate sanitation services and uses them properly.

Finally, it must be remembered that access to service is the proxy used in this analysis for appropriate usage of improved water and sanitation services. In this analysis, access to public standpipes was not associated with improved health (see Figure 5). Public standpipes are not as readily accessible as a water supply inside the house or in the family compound, and the quantity of water used is likely to be less than with in-house piped water. In addition, often the water supply is intermittent at standpipes and water gatherers must wait in line for limited quantities of water. When the supply is intermittent and pressure drops in the pipes, contamination of the pipes may occur and the water *quality* may also be poor. In any event, water from public standpipes will typically be stored in the home and may be contaminated during transport to the home, storage, and use. Improved water supply services offer health benefits only if they offer improved quantity and quality of water. While access to public standpipes was measured in this survey, quantity and quality of water were not measured. It may be the case that dependence on public standpipes for water supply in Guatemala offers no better, or, in some cases, poorer service than unpiped water sources.

No health benefit was seen for latrines in this analysis, though latrines are, when constructed appropriately, as reliable as flush toilets for the sanitary disposal of feces. Why then the difference between flush toilets and latrines in risk of stunting in this analysis? In some cases the latrines may have been unsanitary, improperly constructed, and simply physically inadequate. The larger problem is most likely that the latrines that were counted—that indeed existed—were not used properly, were not used all the time, were not used by every member of the family (especially the children), or were never used. Improved water supply and sanitation cannot be expected to lead to health benefits if they are not used and used properly.

The final pathway to improved health is hygiene behavior; physical infrastructure, such as latrines or piped water, is one support for improved behavior. Culturally appropriate design of water and sanitation facilities and hygiene education are equally important in ensuring that the services available are used in a way that will prevent the spread of disease and promote health.

4.2 Issues in Data Availability and Analysis

As mentioned above, the definition of urban and rural areas presented a problem for this analysis. As described in the methodology, the definitions used for urban and rural do not mention community or population size to be categorized as one or the other. Clear definitions are necessary if these differences are to be analyzed accurately. In addition, in this survey and most similar ones, the sample is based on census data. Informal urban populations, which are growing rapidly and are now recognized as populations at high risk for poor health outcomes, are typically uncounted or undercounted and, therefore, underrepresented in the survey. If these populations are to be described, special attention will need to be given to censusing informal urban communities and including them in the sampling frame.

A better definition of intermediate levels of service, especially for latrines, is needed. When sanitary latrines and unsanitary latrines are lumped together in one group, that category loses meaning. Information on water stored in the home would be useful for estimating the quantity of water used and the likelihood of contamination in the home. Key questions would include how often water is collected, what type of container is used for storage, access to the container, and an estimate of volume of the container. Estimates of time to collect water and distance to water source may be useful, though the lack of correlation between distance and quantity of water used in several studies makes these measures a lower priority.

Usage of services is not measured or estimated in this analysis. As discussed above, however, usage is the key issue and, particularly in the case of latrines, a measure of usage is necessary to interpret the significance of the presence of the service. Key questions include where each household member defecates and when, how often, and with what hands are washed. Spot checks for the presence of soap in the house and condition of the latrine are other proxies for hygiene behavior.

Cluster-level analysis is a useful approach to measure environmental variables. Not using an estimate of the environmental level of sanitation may lead to a sort of "reverse ecological fallacy" in which the effect of a variable that *is* ecological may be obscured by focusing on the individual level of sanitation.

Of course, the amount of time and effort that can be dedicated to the improved description of the water and sanitation component of any survey will be limited. In surveys in which there is a clearly stated priority to collect information on WS&S for subsequent analysis, the development of a WS&S in-depth module may be appropriate. In other cases, more limited objectives of better defining intermediate levels of service and adding indicators of sanitation usage and hand-washing behavior are appropriate.

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