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ENVIRONMENTAL HEALTH PROJECT

WASH Reprint: Field Report No. 398

A Comparison of the Health Effects of
Water Supply and Sanitation in Urban and Rural
Areas of Five African Countries

O. Massee Bateman
Shelley Smith
Philip Roark

June 1993

Prepared for the Office of Health
Bureau for Research and Development
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WASH and EHP

With the launching of the United Nations International Drinking Water Supply and Sanitation Decade in 1979, the United States Agency for International Development (USAID) decided to augment and streamline its technical assistance capability in water and sanitation and, in 1980, funded the Water and Sanitation for Health Project (WASH). The funding mechanism was a multiyear, multimillion-dollar contract, secured through competitive bidding. The first WASH contract was awarded to a consortium of organizations headed by Camp Dresser & McKee International Inc. (CDM), an international consulting firm specializing in environmental engineering services. Through two other bid proceedings, CDM continued as the prime contractor through 1994.

Working under the direction of USAID's Bureau for Global Programs, Field Support and Research, Office of Health and Nutrition, the WASH Project provided technical assistance to USAID missions and bureaus, other U.S. agencies (such as the Peace Corps), host governments, and nongovernmental organizations. WASH technical assistance was multidisciplinary, drawing on experts in environmental health, training, finance, epidemiology, anthropology, institutional development, engineering, community organization, environmental management, pollution control, and other specialties.

At the end of December 1994, the WASH Project closed its doors. Work formerly carried out by WASH is now subsumed within the broader Environmental Health Project (EHP), inaugurated in April 1994. The new project provides technical assistance to address a wide range of health problems brought about by environmental pollution and the negative effects of development. These are not restricted to the water-and-sanitation-related diseases of concern to WASH but include tropical diseases, respiratory diseases caused and aggravated by ambient and indoor air pollution, and a range of worsening health problems attributable to industrial and chemical wastes and pesticide residues.

WASH reports and publications continue to be available through the Environmental Health Project. Direct all requests to the Environmental Health Project, 1611 North Kent Street, Suite 300, Arlington, Virginia 22209-2111, U.S.A. Telephone (703) 247-8730. Facsimile (703) 243-9004. Internet EHP@ACCESS.DIGEX.COM.

WASH Field Report No. 398

A COMPARISON OF THE HEALTH EFFECTS OF WATER SUPPLY AND SANITATION IN URBAN AND RURAL AREAS OF FIVE AFRICAN COUNTRIES

Prepared for the Office of Health, Bureau for Research and Development,
U.S. Agency for International Development
under WASH Task No. 171

by

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Shelley Smith
and
Philip Roark

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RELATED WASH REPORTS

A Comparison of Health Effects of Water and Sanitation Programs in Urban and Rural Guatemala. WASH Field Report No. 352. December 1991. Prepared by O. Massee Bateman and Shelley Smith.

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

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

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

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

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

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ACRONYMS

A.I.D.	U.S. Agency for International Development
DHS	Demographic and Health Surveys (Project)
GLSS	Ghana Living Standards Survey
IRD	Institute for Resource Development (Columbia, MD)
LGC	Local government councils (Nigeria)
MLG	Ministry of Local Government (Uganda)
MWEMEP	Ministry of Water, Energy, Mineral and Environment Protection (Uganda)
NCHS	National Center Health Statistics
NWSC	National Water and Sewerage Corporation (Uganda)
ROR	Relative odds ratio
RWS	Rural water supply (program)
SWA	State water agencies (Nigeria)
VIP	Ventilated improved pit (latrine)
WASH	Water and Sanitation for Health Project
WDD	Water Development Department (Uganda)
WHO	World Health Organization
WS&S	Water supply and sanitation

EXECUTIVE SUMMARY

The health benefits of improved water supply and sanitation (WS&S) services have been well established. They include decreased morbidity and mortality due to diarrhea and other WS&S-related diseases, improved nutritional status of children, and overall decreases in infant and child mortality.

Many people in developing countries lack basic water and sanitation services. In Africa it is estimated that only about one third of the rural population has access to improved water supplies and 22 per cent to adequate sanitation facilities. Urban areas are somewhat better served with 79 percent of the population receiving potable water and 68 percent with sanitation in spite of the extremely large 79 percent increase in urban population during the 80s. About 262 million Africans remain without improved water and sanitation services.

Recognizing that resources for addressing these needs are limited, information about the relative health benefits of different types of WS&S facilities, levels of service, and how these differ in urban and rural settings is important in setting development priorities. At the request of the Africa Bureau of A.I.D. WASH has undertaken a study of five African countries (Ghana, Nigeria, Mali, Uganda, and Zimbabwe) to assist planners in improving designs and policies related to WS&S projects.

To that end three hypotheses potentially important to development planners are examined: (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 in this analysis, gathered under the Demographic and Health Surveys (DHS) program, were from nationally representative household surveys conducted in five African countries. Each of the country surveys was conducted within the last five years with large sample sizes ranging from 3,200 to 8,781 respondents. The respondents were women between the ages of 15 and 49. The surveys collected information on fertility and childhood mortality levels, use of family planning, breastfeeding, various maternal and child health indicators, anthropometry, and socioeconomic characteristics.

An analysis was performed of the association of stunting in children and individual access to water and sanitation service. A multi-variate 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. The risks of stunting associated with the cluster and individual level of sanitation were compared.

The study produced the following conclusions;

- The level of WS&S service is often different from official estimates sometimes by a very wide range.
- In *urban* areas, improved water services are consistently associated with decreased risk of stunting in children, except in Nigeria.
- The association between stunting and level of water services is less consistent or clear in *rural* areas.
- The association between poor sanitation and risk of stunting is stronger and more consistent across countries than is the association between poor water services and risk of stunting.
- There was no apparent lower risk of stunting in families who had access to a latrine when compared to families with no access to sanitation services.
- The community, or cluster, level of low sanitation coverage was generally associated with a higher risk of stunting in children.
- When viewed from a health benefit perspective, community level sanitation is a more important measure than individual household access to improved sanitation.

These conclusions are the basis for the following recommendations for planners of WS&S projects or policies.

- Increased emphasis on improved sanitation relative to improved water supplies is needed to maximize health benefits especially in urban areas.
- Water supplies should be as close to the point of use as possible to maximize the health benefit. In order of priority services should be provided as follows -- in house connection, yard connection, and finally placing the stand pipe or well as close to the user as feasible.
- To assure health benefits of improved WS&S services, education campaigns are needed to influence consumers so that services are used, used properly, and by the whole family.
- The goal of sanitation projects should be to provide communities with greater than 75 percent coverage with improved sanitation rather than reaching a simple proportion or number of individual households with access to improved sanitation.
- Sanitation services in the form of latrines must assure that the latrines are sanitary by adhering to appropriate design standards.
- Attention must always be given to assuring the operational status of WS&S services by establishing appropriate institutional structures to manage, operate, and maintain the services. Health benefits are closely tied to the sustainability of services which focus on many issues including cost, choice of technology, management organization, and community participation.

Chapter 1

INTRODUCTION, BACKGROUND, AND RATIONALE

1.1 Introduction

At the request of the Africa Bureau of A.I.D., the WASH project undertook a study of the health effects of water and sanitation in five African countries—Ghana, Mali, Nigeria, Uganda, and Zimbabwe. The study presented herein is based on an analysis of data collected in the five countries as part of the Demographic and Health Surveys (DHS) Project.

The DHS Project assists developing countries in conducting 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 in 25 countries are planned. The purpose of the DHS program is to assist developing countries in conducting surveys on population and health providing information for policy and program decision-making. WASH previously carried out an analysis of the DHS data from Guatemala, the basic approach of which was duplicated in the present study (see WASH Field Report No. 352).

The choice of the five countries was based on the following criteria:

- a DHS survey has been recently carried out
- the countries are part of A.I.D.'s health sector program focus in Africa
- the countries are representative of a range of conditions in Africa including climate, geography, government, and economic development.

The objective of this analysis is to better understand 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, especially in the African country context. 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
- community coverage vs. individual access to sanitation.

The primary audience is policy-makers and program planners who wish to maximize the health benefit of WS&S programs in Africa. It is expected that the results of this study will be useful to the Africa Bureau of A.I.D., as well as to other international development organizations, in programming and fine-tuning WS&S projects within specific country health strategies. This report contains specific recommendations to improve design of WS&S projects.

1.2 Water Supply, Sanitation, and Health

The health benefits of improved 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		
RANGE	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 (e.g. 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 far behind urban coverage for both water and sanitation, and sanitation coverage lags behind water coverage in both urban and rural settings.

Table 2

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

	Rural		Urban		Rural		Urban	
	1980	1990	1980	1990	1980	1990	1980	1990
Africa	22	32	66	79	20	22	54	68
Americas	42	52	78	90	20	36	56	82
Southeast Asia	31	64	64	73	6	12	30	50
Eastern Mediterranean	30	51	83	91	7	20	57	79
Western Pacific	41	66	81	91	63	76	93	92
Global Totals	34	59	75	85	31	40	60	74

Source: UNDP 1992.

1.3 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 individual 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.

1.4 Results of Previous Study from Central America

In an earlier study by WASH, data gathered under the DHS Project in Guatemala during 1987 were analyzed to examine the program and policy issues described above (Bateman and Smith 1991). In that study, it was found that individual access to improved water and sanitation services was associated with a lower risk of stunting in children between 6 and 36 months old. In urban areas of Guatemala, the risk of stunting in children was almost doubled if the family lacked in-house, piped water *or* if the family did not have a flush toilet. In rural areas, the risk of stunting was not as strongly associated with lack of an improved water supply as in urban areas. The risk of stunting in children was more than doubled in rural areas if the family lacked access to a flush toilet. In both urban and rural areas, low community level of sanitation was associated with a higher risk of stunting than was lack of individual access to a flush toilet.

These results support the conclusion that improved water and sanitation services are important interventions for improving child health in both urban and rural environments. There is an apparent greater association between stunting in children and sanitation services than with water supply, particularly in rural areas. The most important finding in the analysis of the Guatemala data is the association of community level of sanitation with health outcomes. 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* there is a flush toilet in their own household.

1.5 Limitations of Using DHS Data to Examine Water and Sanitation/Health Relationships

The analysis of DHS data from Guatemala summarized above also served to examine the appropriateness of DHS data to study the health effects of water and sanitation. While it is clear that general associations can be studied, a number of limitations were found. First, there is no clear or consistent definition of urban and rural areas. There may also be limitations of using older census data to take the sample, leading to an under-representation of urban slum areas. It must be accepted in these analyses that comparing urban and rural strata is largely comparing larger towns to smaller towns, so that urban-rural differences that exist may not be found. Secondly, intermediate levels of service lacked sufficient definition and other information was not gathered. Important information to examine health effects, such as sanitary vs. non-sanitary latrines, use vs. non-use of latrines where they exist, consistency of water availability from water sources, water carrying and storage practices, hygiene behavior, and other factors, was not examined.

The analysis of data from Guatemala yielded some useful findings, and an analysis of DHS data from five African countries is undertaken here. DHS data from Guatemala were chosen for analysis because they best met the requirements for sample size and variability in water and sanitation services. The African countries analyzed here are, therefore, in varying degrees less well suited for a complete analysis. In practical terms, this means that some analyses cannot

be performed in some countries and, in general, interpretation of results and conclusions must be based on consistent trends rather than statistically significant associations.

Chapter 2

METHODOLOGY

2.1 Data

The data used in this analysis were gathered under the Demographic and Health Surveys (DHS) Project. The DHS Project 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, breastfeeding, 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 anthropometric measurements for children (20 of the 29 countries surveyed under DHS-I gathered anthropometric data on children). 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.

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.

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.

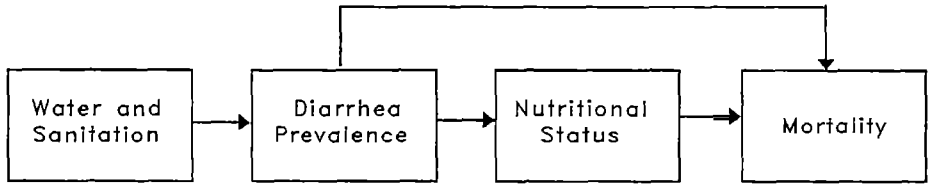


Figure 1

Relationship Between Water and Sanitation and Child Health Outcomes

"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, i.e., deaths occuring between birth and exact age one, 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; sample size may be problematic since infant mortality is a relatively infrequent event; and potential problems may arise with the level of WS&S 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 short-term effect resulting in a single 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

anthropometric measurements 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 the five countries, although in recent years Mali and Uganda have experienced drought and political turmoil respectively which may have had an effect on some of the respondents. Based on these considerations, a measure of height for age was chosen as the outcome measure for this study.

2.2.2 Definition of the Outcome Variable

Stunting—Anthropometric measurements of 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

A 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 can 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 which varied slightly between countries depending on how they categorized responses. For Zimbabwe and Uganda, the categories were piped in-house, yard tap, and outside household (which includes communal tap, rainwater, and dam). In Nigera and Ghana, the categories were piped in-house, public standpipe, and non-piped, (which included well with and without handpump, river, spring, stream, lake, tanker and rainwater). The categories in Mali were piped in-house, household well, and non-piped, outside household, (which included spring, well outside house, borehole, river/stream and lake/creek).

Sanitation—Each respondent was asked, "What kind of sanitary services does this house have?" In all countries responses were divided into three categories: flush toilets, latrines, and no facilities. The definition of latrine varied depending on what was available in the country. In Zimbabwe it included blair toilets and pit latrines, and in Ghana it included pan, pit, and KVIP. Only in Nigeria did the definition of flush toilets vary to include buckets.

Cluster level of sanitation—Sanitation was redefined as a dichotomous variable. In Mali and Ghana, a child was coded (0) for improved sanitation services if a flush toilet or latrine was present or (1) if no service was present. In Zimbabwe, Uganda, and Nigeria a child was coded (0) for improved sanitation services 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 access to improved sanitation services. The cluster level was coded (1), "low level of sanitation," if less then 75 percent of the children in the cluster had access to improved sanitation services. Each child was assigned a value, 0 or 1, for the level of sanitation in the cluster in which he or she lived. The optimal cutoff level for low or high level of sanitation was determined during a previous study (Bateman and Smith 1991).

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 was 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 at the time of the child's birth 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 breastfeeding 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). Breastfeeding as used here refers to *any* breastfeeding, exclusive or supplemented. Data on exclusive breast-feeding were not available in these data sets.

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 appropriate authorities in each country. No information is available 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 and stunting in children 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

GHANA

This chapter and the following chapters focus on the individual countries involved in the study—Ghana, Mali, Nigeria, Uganda, and Zimbabwe. Each chapter provides a brief country overview, methodology, and results of the research.

3.1 Country Overview[1]

During the past two decades, Ghana has been plagued by problems of periodic drought, a stagnant economy, and poor fiscal management. Large budgetary deficits, high inflation, and decreasing exports led to acute food shortages in 1983-84 and the exodus of many professionals and skilled workers seeking employment. However, government services and the economy have improved significantly in recent years under an economic recovery program. Ghana's economy has of late been one of the better growing economies in Africa. Rainfall has also generally returned to normal in Ghana's tropical to semi-arid climate. Ghana covers an area of 238,537 km^2.

The government agency responsible for water supply, Ghana Water and Sewerage Corporation (GWSC), has achieved a high coverage rate of water supplies in urban areas, including about 200 centers with populations ranging from one million to 5,000. To improve service, GWSC is in the process of rehabilitating and expanding existing facilities. Water supply coverage in rural areas is about 40 percent. Some 8,600 pumps have been installed mainly via handpump-based projects financed by Canada, Germany, Japan, the Catholic Church, World Vision, UNICEF, France and the Netherlands, Norway, Switzerland, and the World Bank. A WS&S sector workshop held in February 1991 recommended that GWSC form an independent rural water supply department to manage a shift to community managed maintenance of rural water supply facilities.

Institutional responsibility for sanitation in Ghana is fragmented. At the ministerial level, responsibility is split between the Ministries of Works and Housing, Local Government, and Health; and at the operational level, GWSC is responsible to sewered sanitation and district assemblies for nonsewered sanitation. There are two main levels of service in urban areas. One is flush toilets connected to septic tanks or conventional collection systems, and the other

[1] A country overview and statistics are provided for each country for the water and sanitation sector. These data are taken from the World Bank Water and Sanitation Program (UNDP/WB 1992). WS&S coverage figures are based on individual government definitions of access to improved facilities. For communal facilities such as standpipes, wells, or springs, access is typically defined as the percentage of population living within a specified distance, usually 200 meters, of an improved facility. Such coverage figures are understood to be estimates but are included to provide a reference point to compare government estimates of coverage with those determined from the DHS survey. Definitions of urban and rural are also country specific and depend on census bureau classifications which may vary among countries.

is bucket and unimproved pit latrines. Communities in rural areas often use trench latrines, however, work is under way in some regions to develop VIP latrines that are affordable to rural households.

COUNTRY STATISTICS (1991)

Population: 14.9 M	Urban: 33%	Rural: 67%
GNP per capita: $390		
Child mortality rate: 143		
Water coverage:	Urban: 93%	Rural: 39%
Sanitation coverage:	Urban: 64%	Rural: 15%

3.2 Methodology

The general methodology used is described in Chapter 2. Issues specific to the Ghana analysis are noted here.

3.2.1 Demographic and Health Survey

The Ghana DHS is a stratified, nationally representative, self-weighting probability sample survey. The data were gathered between February and June 1988. The survey was conducted by the Ghana Statistical Service with technical assistance, provided by IRD (Institute for Resource Development) through the DHS Project.

The sample frame was based on that used for the Ghana Living Standards Survey (GLSS), with 150 clusters selected from a sample of 200. All enumeration areas were first stratified by ecological zones into namely Coastal Savanna, Forest, and Northern Savanna. These were further stratified into urban, semi-urban, and rural enumeration areas. In order to achieve an optimum sample take of about 40 interviewed women per enumeration area in rural and semiurban areas and about 20 per enumeration area in urban areas while maintaining a self-weighting sample, all 72 urban areas from the GLSS sample and 78 rural enumeration areas were selected for the sample.

Respondents for the survey were 4,488 women between the ages of 15 and 49. 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.

3.2.2 Water and Sanitation Variable Definitions

Water—Each respondent was asked the question: "What is the major source of drinking water for members of your household?" Responses were grouped into three categories:

- Piped in-house: Running water piped to a location inside the house
- Public standpipe: Running water available from a public standpipe, outside of the house or household compound
- Non-piped water: This includes rainwater, wells, boreholes, and surface water sources such as streams, lakes, and rivers.

Sanitation—Each respondent was asked the question: "What kind of toilet facility does your household have?" Responses were divided into three categories:

- Flush toilets
- Latrines: This includes pan latrines, pit latrines, and KVIP latrines
- No sanitary facilities

Cluster level of sanitation—Sanitation was redefined as a dichotomous variable. A child was coded (0) if a flush toilet *or* latrine were present in the household or coded (1) if no sanitary facilities were available. The cluster level of sanitation was then coded (0) for "high cluster level of sanitation" if 75 percent or more of the children in the cluster had access to a flush toilet *or* latrine or coded (1) for "low cluster level of sanitation" if less than 75 percent of children in the cluster had access to either a flush toilet or a latrine. Each child was then assigned a value, 0 or 1, for the level of sanitation in the cluster in which he or she lived.

3.2.3 Selection of Children for Analysis

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) 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 1,826 children meeting the inclusion criteria, 336 or 18 percent were excluded based on the above criteria.

3.3 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 (28.9%) than in rural areas (1.0%). Similarly, a higher percentage of children had access to public standpipes in urban areas (37.5%) than in rural areas (9.3%). A much higher percentage of children had access only to non-piped water sources in rural areas (89.6%) than in urban areas (33.6%).

Availability of sanitation services was also better in urban than in rural areas (Figure 3), but without the extreme discrepancy seen for water services. Flush toilets were available to 9.5% of urban children and only 0.6% of rural children. Most children, both urban and rural, had access to a latrine, 74.7% and 67.4% respectively. Twice as many rural children (31.9%) as urban children (15.8%) had access to no sanitary facilities whatsoever.

The age distribution of stunting was similar in both urban and rural settings (Figure 4). However, the proportion of children stunted is consistently lower in urban children than in rural children in each age grouping. Overall, about a quarter of urban children were stunted (27.1%) and about a third of rural children were stunted (32.9%).

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 about half that of children in households with non-piped water(16.0% vs. 34.5% for urban children, and 18.2% vs. 33.5% for rural children, respectively). The level of stunting was intermediate for children in households with access to public standpipes, 29.0% and 28.0%, urban and rural respectively. There were no urban-rural discrepancies in the association between water supply and stunting, with a similar percentage of urban and rural children stunted for each type of water supply.

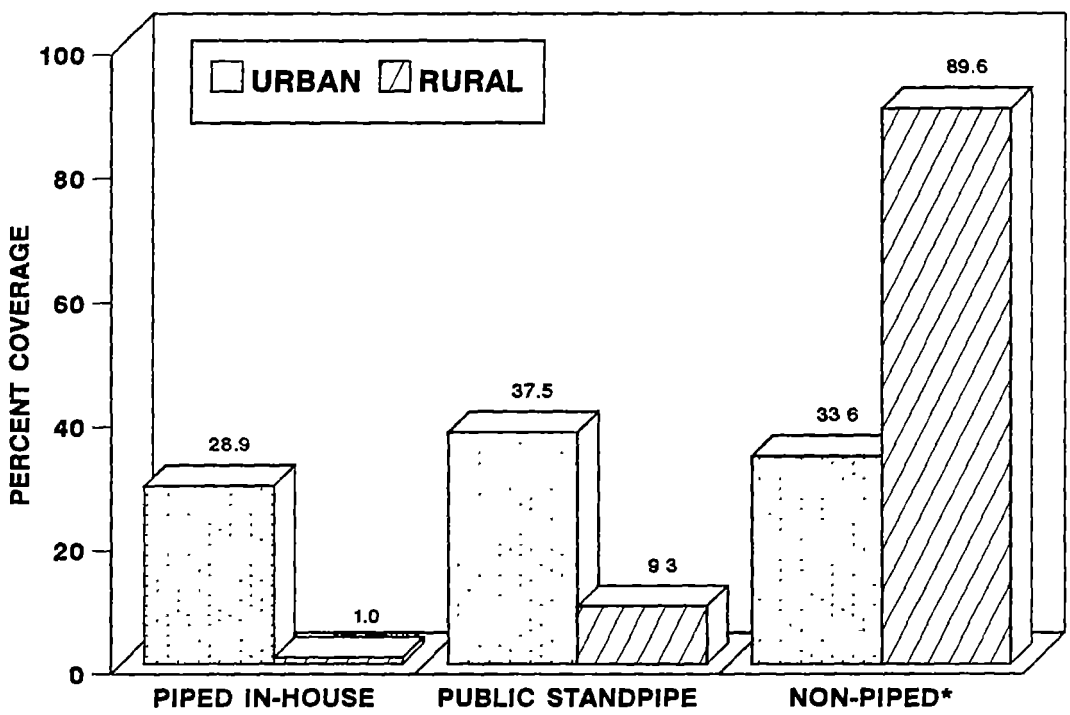
The relationship between stunting and level of water service was examined using a logistic regression model controlling for potential confounders including the child's age and sex, mother's age, mother's education, birth order, breast-feeding history, number of articles owned, and level of sanitation 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 who use non-piped water (urban, 2.59 and rural, 1.72). Relative odds ratios of stunting were also greater than 1 in households with public standpipe water sources (urban, 1.68 and rural, 1.37). Relative odds ratios estimate the risk of stunting, so children in urban Ghana in a household with access only to non-piped water have about two and one half times the risk of stunting (ROR 2.59) when compared to children living in a household with a piped water supply.

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 (17.1% and 0.0% respectively) when compared to those with access to latrines (urban, 26.7% and rural, 31.2%) and to those with no access to sanitary services (urban, 35.3% and rural, 36.7%). This association was also examined in the logistic regression model controlling

for level of water service and other variables as in Table 3. In this model, there is no apparent large difference in the risk of stunting in children associated with type of sanitation service in urban settings (Table 4). This test could not be performed for rural children because of the small number of rural children with access to a flush toilet.

The proportion of children stunted is similar in urban and rural areas with high or low community (cluster) levels of sanitation (Figure 7). When the risk of stunting associated with lack of individual access to sanitation services and the risk of stunting associated with low community levels of sanitation are compared, there is little apparent difference (Table 5). In general, little association between stunting and type of sanitation service is seen in Ghana, but the level of sanitation service is, in general, very low.

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 6. The risk of stunting is highest in children with non-piped water in both urban(Relative Odds Ratio,ROR, 2.39) and rural (ROR, 2.14) areas. There is little association of stunting with level of sanitation service in this analysis.

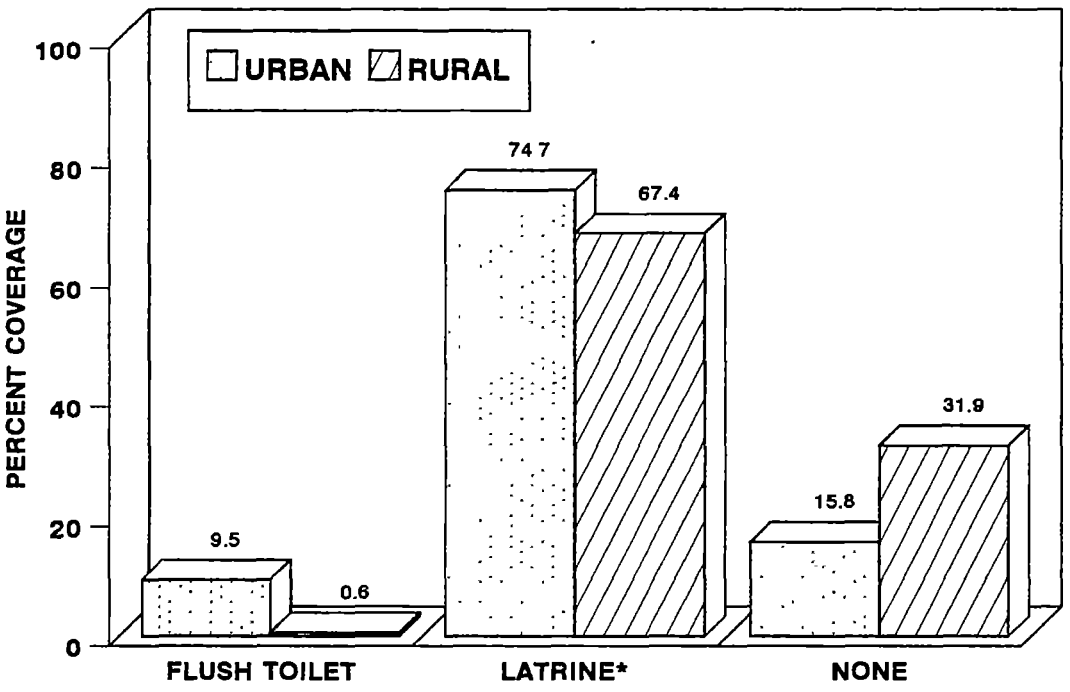


URBAN (n=432) RURAL (n=1072)

*Rainwater, well, borehole, stream, lake, river

Figure 2

Individual Level of Service - Water
Children 6-36 Months of Age - Ghana

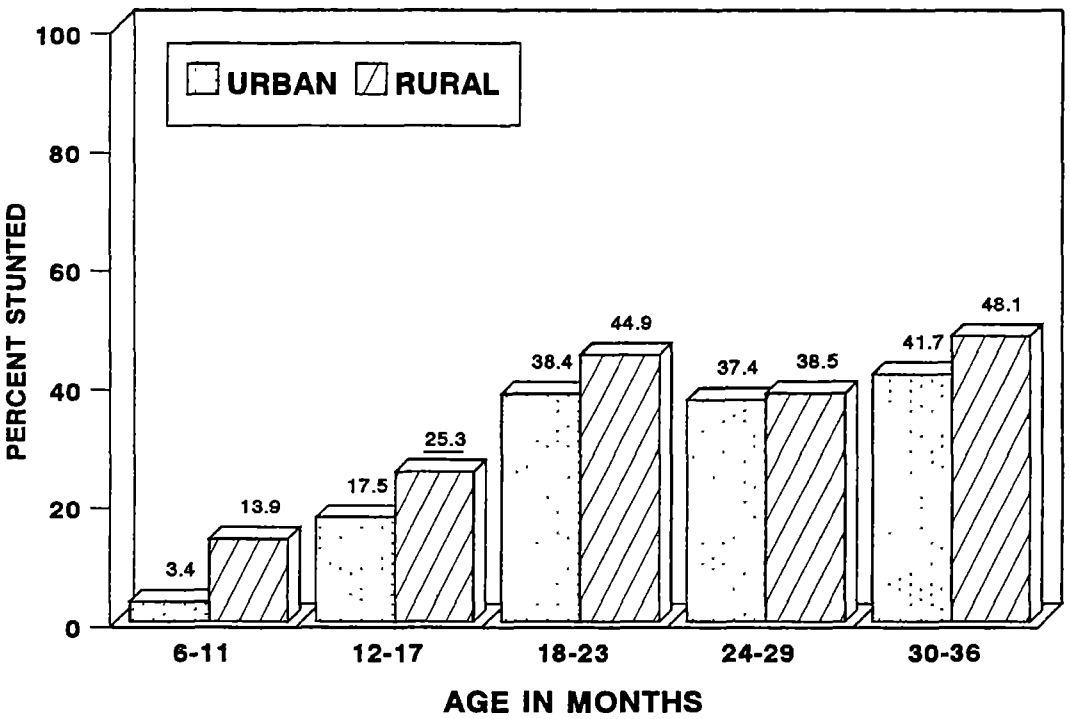


URBAN (n=431) RURAL (n=1084)

*Pan, Pit, KVIP

Figure 3

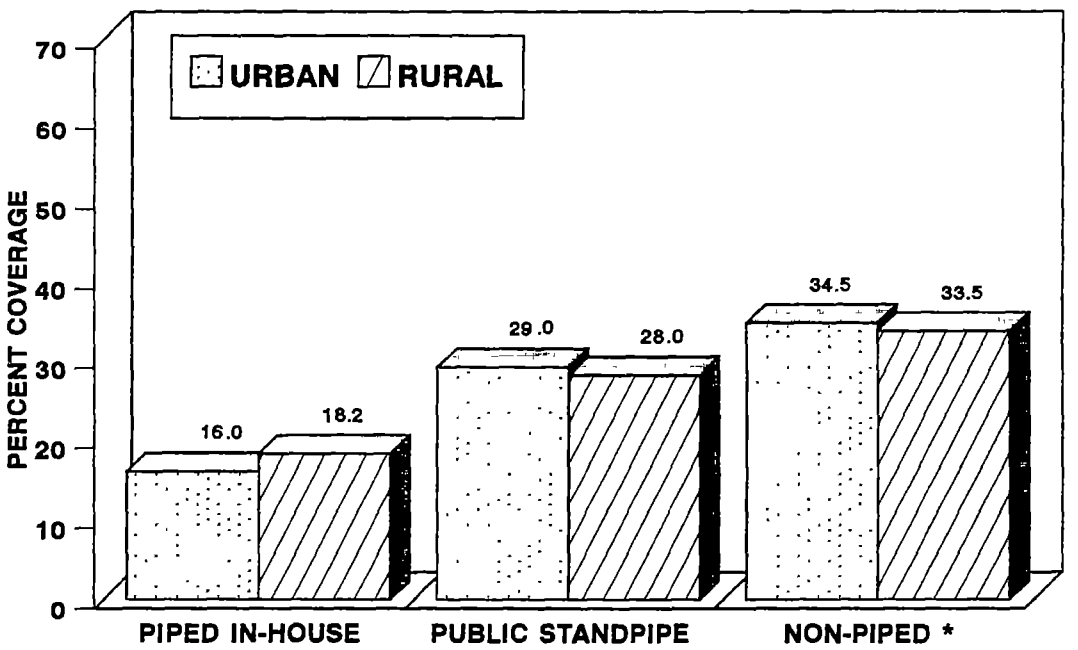
Individual Level of Service - Sanitation
Children 6-36 Months of Age - Ghana



URBAN (n=432) RURAL (n=1088)

Figure 4

Percent of Children Stunted, by Age
Children 6-36 Months of Age - Ghana



URBAN (n=432) RURAL (n=1072)

*Rainwater, well, borehole, stream, lake, river

Figure 5

Percent of Children Stunted, by
Individual Level of Service - Water
Children 6-36 Months of Age - Ghana

Table 3

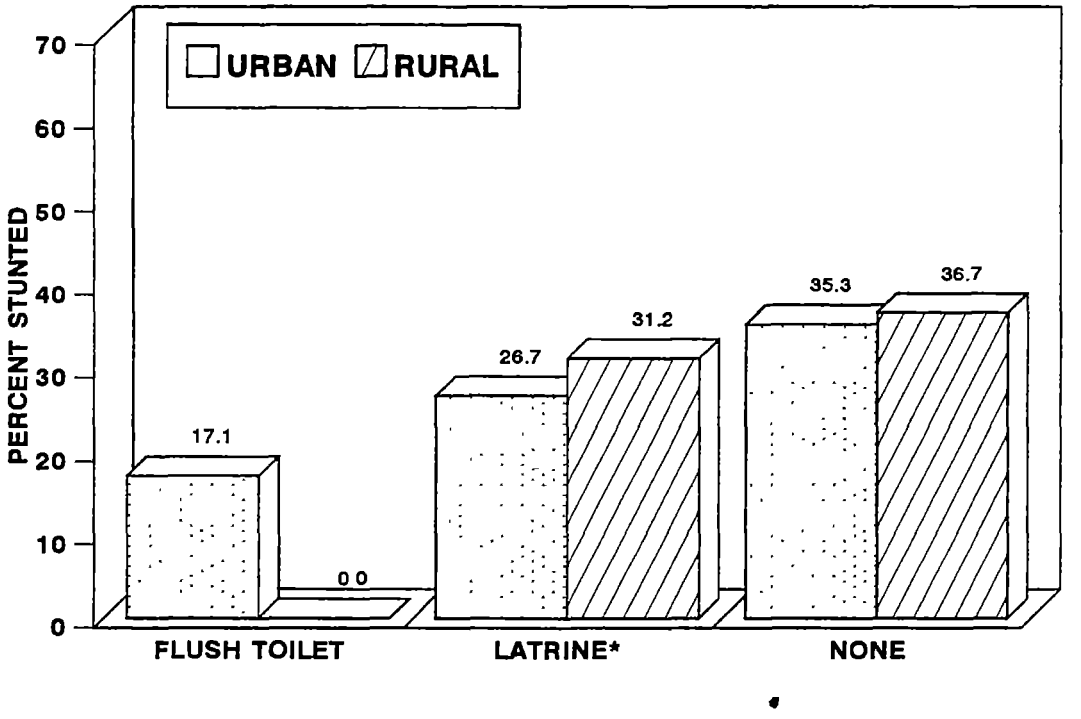
Relative Odds Ratio of Stunting by Individual Level of Service—Water

Children 6-36 Months of Age—Ghana Logistic Regression Model

	Urban	*Rural*
Piped In-house	1.0	1.0
Public Standpipe	1.68	1.37
Non-piped	2.59‡	1.72

URBAN (n=431)
RURAL (n=1059)

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



URBAN (n=431) RURAL (n=1084)

* Pan, Pit, KVIP

Figure 6

Percent of Children Stunted, by
Individual Level of Service - Sanitation
Children 6-36 Months of Age - Ghana

Table 4

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

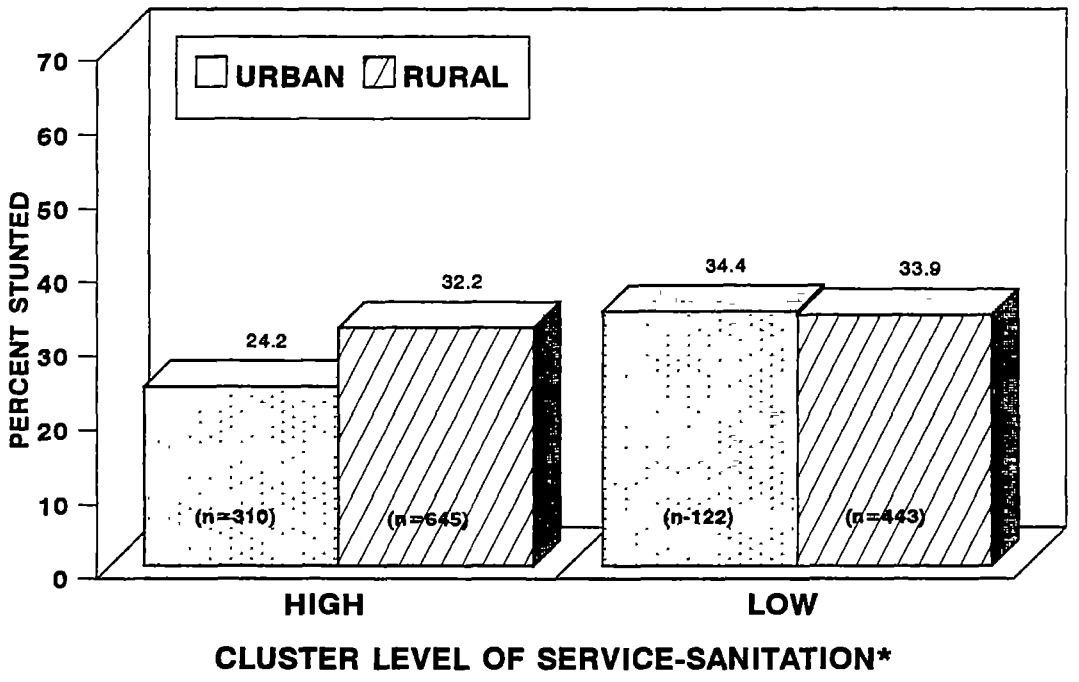
Children 6-36 Months of Age—Ghana
Logistic Regression Model

	Urban	*Rural*
Flush Toilet	1.0	N/C
Latrine	1.02	N/C
None	1.35	N/C

URBAN (n=431)
RURAL (n=1059)

* P≤ .10 † p ≤ .05 ‡ p ≤ .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.



*High=Flush Toilet, Pan, Pit, KVIP Latrine
Low=None

Figure 7

Percent of Children Stunted, by
Cluster Level of Service - Sanitation
Children 6 - 36 Months of Age - Ghana

Table 5

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

Children 6-36 Months of Age—Ghana
Logistic Regression Model

Individual Level	*Urban*	*Rural*
Flush Toilet/ Latrine	1.0	1.0
None	1.31	1.31*

URBAN (n=431)
RURAL (n=1059)

Cluster Level		
High	1.0	1.0
Low	1.47	1.07

URBAN (n=432)
RURAL (n=1063)

*p ≤ .10 † p ≤ .05 ‡ p ≤ .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.

Table 6

Relative Odds Ratio of Stunting by
Explanatory Variables

Children 6-36 Months of Age—Ghana
Logistic Regression Analysis

Variable	*Reference Category*	*Urban*	*Rural*
Age of Child	(6-month intervals)	‡	‡
Sex of Child	Male	1.00	1.00
	Female	1.23	.87
Age of Mother	< 20 years	2.91†	.68
	20-34 years	1.00	1.00
	≥ 35 years	.64	1.31
Education of Mother	None	1.95	1.82
	Primary school	1.62	1.74
	Secondary or higher	1.00	1.00
Birth Order	First	.46†	1.34
	2-5	1.00	1.00
	Sixth or higher	1.21	.69*
Breast-feeding	≥ 6 months	1.00	1.00
	< 6 months	1.39	.98
Articles Owned	One or more	1.00	1.00
	None	1.08	.96
Individual Water Supply	Piped in-house	1.00	1.00
	Public standpipe	1.68	1.60
	Non-piped	2.39*	2.14
Cluster Level of Sanitation	High	1.00	1.00
	Low	1.47	1.07

URBAN: n=432, 27.1% stunted
RURAL: n=1063, 32.9% stunted

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

Chapter 4

MALI

4.1 Country Overview[1]

Mali covers 1,240,192 km^2 in the Sudano-Sahelian belt with more than half its territory in lightly populated semi-desert zones. A large majority of the population are rural farmers. In spite of great potential within the vast alluvial plains of the Niger River, production remains low and per capita income is among the lowest in the world. Two major rivers, the Niger and Senegal, flow through its territory and groundwater yields are generally high.

During the past decade, Mali has implemented a significant rural water supply (RWS) program with strong support from the donor community. Handpumps (India Mali) are locally manufactured, and solar pumping has been developed with external grants. Policies for financial participation of beneficiaries in the capital and recurrent costs have been defined, but implementation has produced mixed results. The government is concerned with sustainability in the sector and plans to (a) enhance the role of communities in decision-making including financing of facilities, (b) increase the participation of local entrepreneurs in construction activities, and (c) improve handpump technology and distribution.

The urban water supply sector has been less successful, due to difficulties in promoting in-depth reorganization. Various institutional changes are recommended before significant investment is undertaken in the capital city and secondary cities.

Apart from the center of Bamako, where an old sewerage network is still in operation, disposal of human excreta is mostly by traditional latrines. Solid waste collection and disposal are a major concern to the government, which has recently launched environmental sanitation awareness and promotion activities. Improved latrines have recently been promoted as part of some WS&S projects.

COUNTRY STATISTICS (1991)

Population:	8.5 M	Urban: 19% Rural: 81%
GNP per capita:	$270	
Child mortality rate:	287	
Water coverage:	Urban: 35%	Rural: 36%
Sanitation coverage:	Urban: 94%	Rural: 5%

[1]A country overview and statistics are provided for each country for the water and sanitation sector. These data are taken from the World Bank Water and Sanitation Program (UNDP/WB 1992). WS&S coverage figures are based on individual government definitions of access to improved facilities. For communal facilities such as standpipes, wells, or springs, access is typically defined as the percentage of population living within a specified distance, usually 200 meters, of an improved facility. Such coverage figures are understood to be estimates but are included to provide a reference point to compare government estimates of coverage with those determined from the DHS survey. Definitions of urban and rural are also country specific and depend on census bureau classifications which may vary among countries.

4.2 Methodology

The general methodology used is described in Chapter 2. Issues specific to the Mali analysis are noted here.

4.2.1 Demographic and Health

The Mali DHS was conducted in 1987 between March and August by the Department of Socioeconomics and Demography of the Sahel Institute (now known as CEDPOD). Technical assistance for the survey was provided by IRD through the DHS Project.

The sampling frame of the survey is national and covers the urban and rural areas. One hundred percent of the urban areas are represented, while the rural areas are represented due to the nomadic population of Tombouctou and Gao. There were 60 urban enumeration areas and 88 rural enumeration areas in total.

Respondents for the survey were 3,240 women between the ages of 15 and 49. Data were collected from each women 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 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.

4.2.2 Water and Sanitation Variable Definitions

Water—Each respondent was asked the question: "What is the principle source of potable water for members of your household?" Responses were grouped into three categories:

- Piped in-house: Running water piped to a location inside the house.
- Household well: Wells within the household compound.
- Non-piped water, outside the household: This includes springs, wells outside of the household compound, handpumps, and surface water sources (rivers, streams, creeks and lakes).

Sanitation—Each respondent was asked the question: "What kind of toilet do you have in this household?" Responses were divided into three categories:

- Flush toilets
- Latrines: No specification of latrine type was made
- No sanitary facilities

Cluster level of sanitation—Sanitation was redefined as a dichotomous variable. A child was coded (0) if a flush toilet or latrine was present in the household or coded (1) if no sanitary facilities were available. The cluster level of sanitation was then coded (0) for "high

cluster level of sanitation" if 75 percent or more of the children in the cluster had access to a flush toilet *or* latrine or coded (1) for "low cluster level of sanitation" if less than 75 percent of children in the cluster had access to either a flush toilet or a latrine. Each child was then assigned a value, 0 or 1, for the level of sanitation in the cluster in which he or she lived.

4.2.3 Selection of Children for Analysis

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) 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 825 children meeting the inclusion criteria , 40 or 4.8 percent were excluded based on the above criteria.

4.3 Results

The percentage of children with access to each of the three levels of water service varied between urban and rural areas, with rural areas demonstrating the usual pattern of a lower level of service (Figure 8). A higher percentage of children had access to water piped in-house in urban areas (12.3%) than in rural areas (0.0%). Similarly, a higher percentage of children had access to public standpipes in urban areas (34.8%) than in rural areas (12.2%). A higher percentage of children had access only to non-piped water service outside of the household in rural areas (87.8%) than in urban areas (52.9%).

Availability of sanitation services was also better in urban than in rural areas (Figure 9). Few flush toilets were available in urban areas (1.2%) and none were available in rural areas. Most children, both urban and rural, had access to a latrine(97.4% and 57.5%, urban and rural, respectively). Many more rural children (42.5%) than urban children (1.4%) had access to no sanitary facilities whatsoever.

The age distribution of stunting was similar in both urban and rural settings (Figure 10). The proportion of children stunted is consistently lower in urban children than in rural children in each age grouping. Overall, about a fifth of urban children were stunted (20.5%) and about a third of rural children were stunted (32.1%).

Although the proportion stunted was generally higher in rural than in urban children, the proportion of children stunted showed little association with the level of water service within urban and rural strata (Figure 11). In urban areas, a similar proportion of children were stunted at each level of water service: 15.7 percent of children with in-house piped water, 21.5 percent of children with a household well, and 20.1 percent of children in a household with a non-piped water source outside of the household. In rural areas, 38.6 percent of children

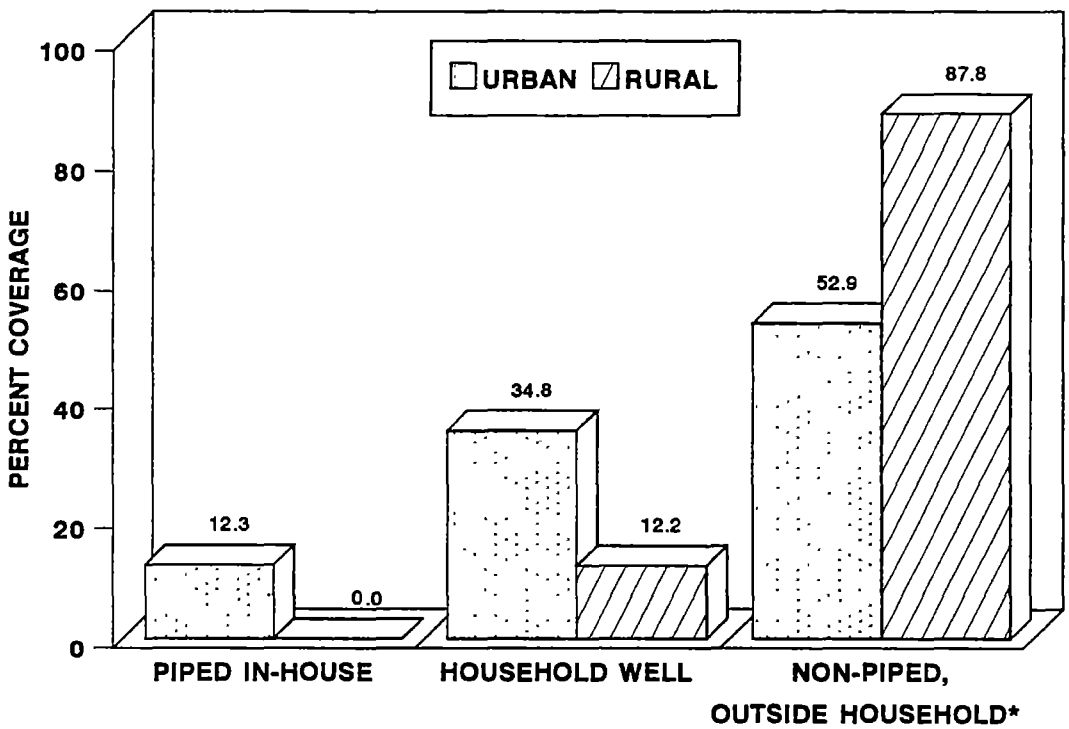
with access to a household well and 31.2 percent with access to a non-piped water source outside of the home were stunted, a higher level than seen in urban areas.

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 7). Having a household well as a water source was associated with an increased risk of stunting in both urban and rural areas. This finding was not statistically significant and must be interpreted with caution.

The proportion of children stunted was apparently associated with the sanitation level of service (Figure 12). None of 5 children with access to a flush toilet in urban areas was stunted, compared to 20.4 percent with access to a latrine, and 33.3 percent stunted among those children without access to any sanitation services. In rural areas, the proportion stunted was less for those with access to a latrine (28.6%) compared to those without access to any sanitation service (34.5%). This association was also examined in the logistic regression model controlling for level of water service and other variables as in Table 7. In this model, there are no apparent large difference in the risk of stunting in children associated with type of sanitation service in urban or rural settings (Table 8). Because of the small number of children in households with flush toilets in Mali, the effect of access to a flush toilet alone could not be examined.

In rural Mali, there is an apparently lower proportion of stunting in children living in communities with a high level of sanitation, defined here as a cluster with greater than 75 percent of the sampled households having access to a flush toilet or latrine, with 28.0 percent stunted in communities with a high level of sanitation and 35.3 percent stunted in communities with a low level of sanitation (Figure 13). When the risk of stunting associated with lack of individual access to sanitation services and the risk of stunting associated with low community levels of sanitation are compared, there is little difference (Table 9). Low cluster level of sanitation does appear to be more strongly associated with stunting than does poor individual access to sanitation, but this is not statistically significant. In general, little association between stunting and type of sanitation service is seen in Mali.

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 10. There is little apparent relationship between the level of water and sanitation service and the risk of stunting in Mali, but the level of sanitation service is, in general, very low.

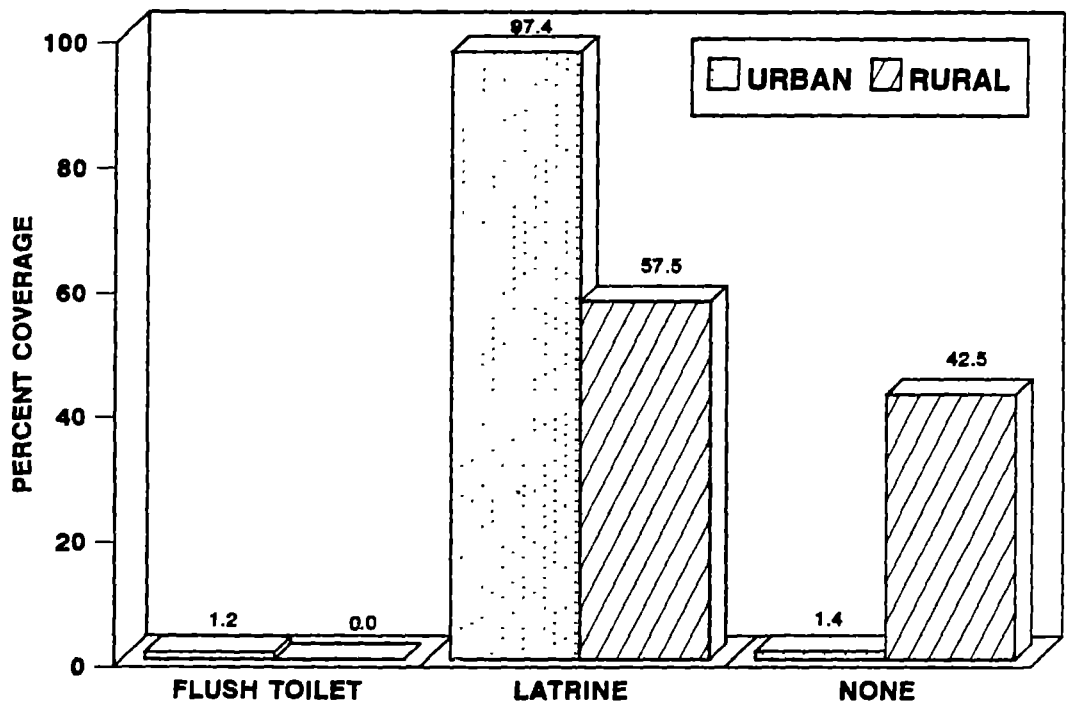


URBAN n=414 RURAL n=361

* Standpipe, well (outside HH), borehole, river/stream, lake/creek

Figure 8

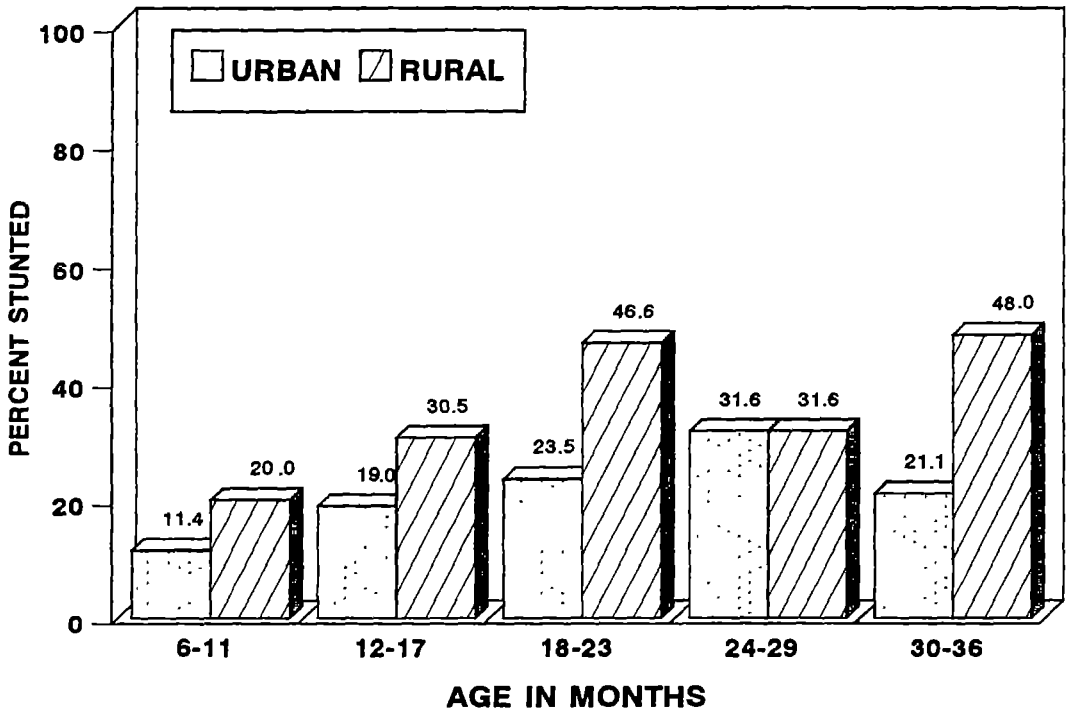
Individual Level of Service - Water
Children 6-36 Months of Age - Mali



URBAN (n=418) RURAL (n=341)

Figure 9

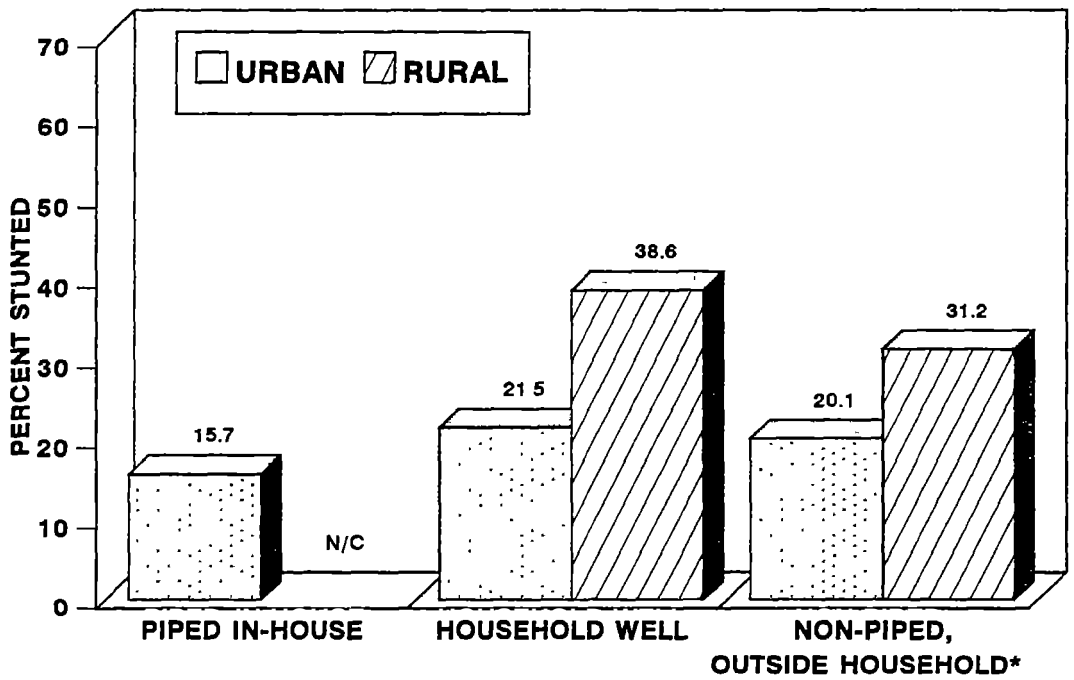
Individual Level of Service - Sanitation
Children 6-36 Months of Age - Mali



URBAN (n=424) RURAL (n=361)

Figure 10

Percent of Children Stunted, by Age
Children 6-36 Months of Age - Mali



URBAN n=414 RURAL n=361

* Standpipe, well (outside HH), tubewell, river/stream, lake/creek

Figure 11

Percent of Children Stunted, by
Individual Level of Service - Water
Children 6-36 Months of Age - Mali

Table 7

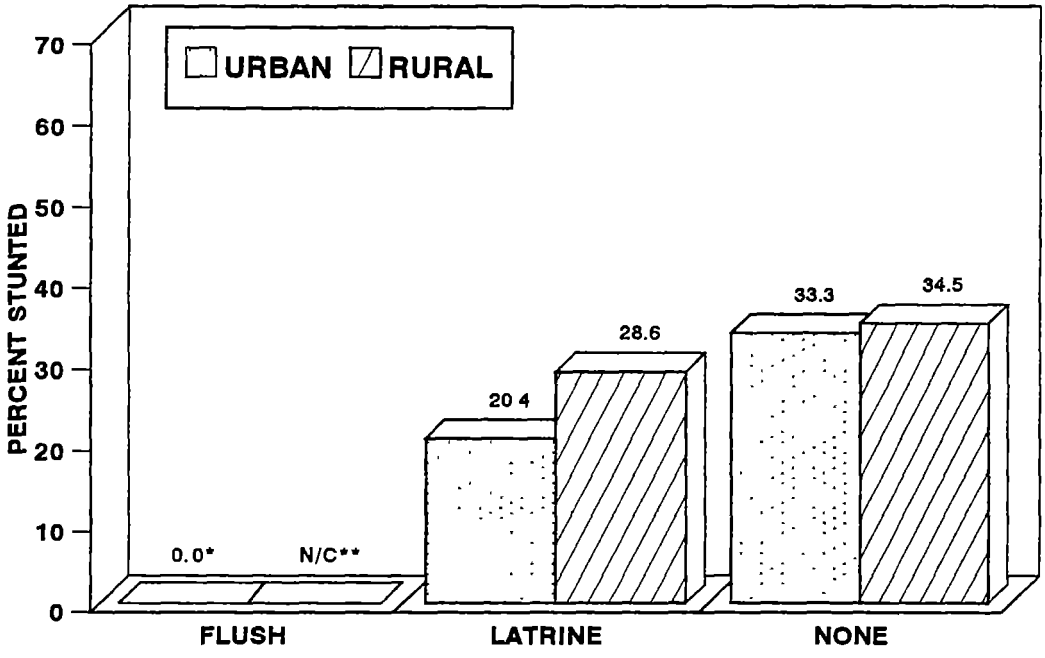
Relative Odds Ratio of Stunting by Individual Level of Service—Water

Children 6-36 Months of Age—Mali
Logistic Regression Model

	Urban	*Rural*
Piped In-house	1.0	N/C
HH well	1.52	1.0
Non-piped, outside HH	1.28	0.64

URBAN (n=389)
RURAL (n=331)

* $p \leq .10$ † $p \leq .05$
Model controls for age of child, sex of child, age of mother, education of mother, birth order, breastfeeding, articles owned, and individual level of sanitation service.



URBAN (n=418) RURAL (n=341)

* Only five children had access to a flush toilet, none were stunted
** Not calculable

Figure 12

Percent of Children Stunted, by
Individual Level of Service - Sanitation
Children 6-36 Months of Age - Mali

Table 8

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

Children 6-36 Months of Age—Mali
Logistic Regression Model

	Urban	*Rural*
Flush Toilet/Latrine	1.0	1.0
None	.97	1.35

URBAN (n=389)
RURAL (n=331)

† $p \leq .05$ ‡ $p \leq .01$
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.

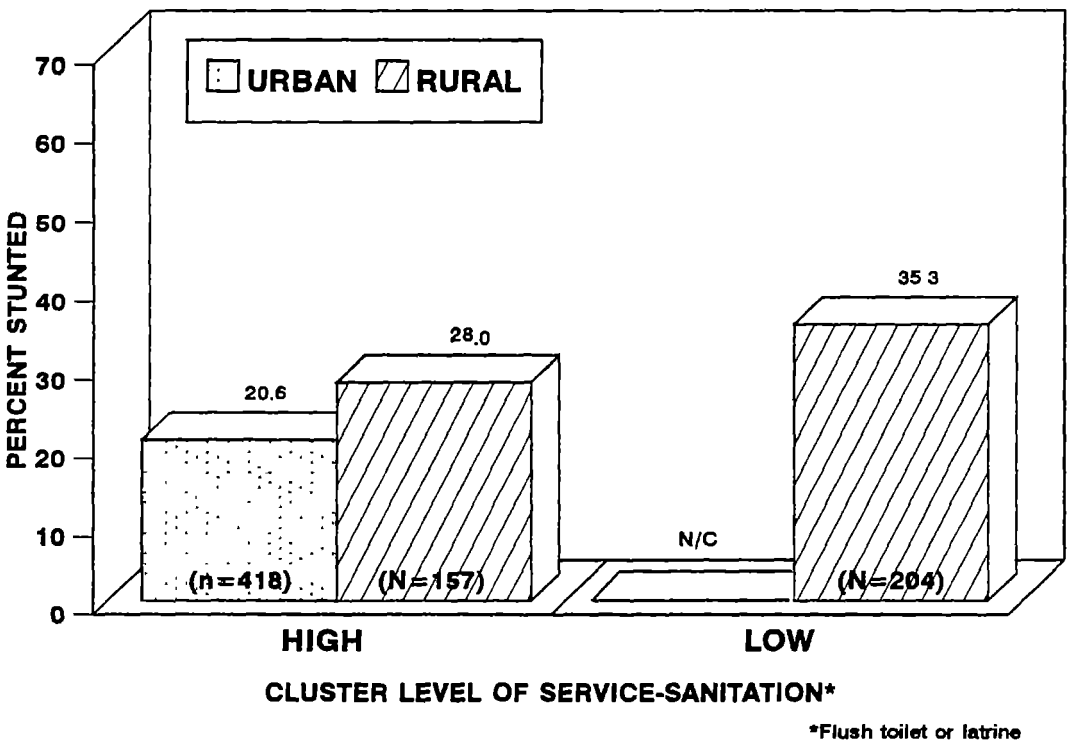


Figure 13

Percent of Children Stunted, by
Cluster Level of Service - Sanitation
Children 6-36 Months of Age - Mali

Table 9

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

Children 6-36 Months of Age—Mali
Logistic Regression Model

Individual Level	*Urban*	*Rural*
Flush Toilet/Latrine	1.0	1.0
None	.97	1.35

URBAN (n=389)
RURAL (n=331)

Cluster Level		
High	1.0	1.0
Low	1.3	1.50*

URBAN (n=395)
RURAL (n=349)

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

Relative Odds Ratio of Stunting by
Explanatory Variables

Children 6-36 Months of Age—Mali
Logistic Regression Analysis

Variable	*Reference Category*	*Urban*	*Rural*
Age of Child	(6-month intervals)	‡	‡
Sex of Child	Male	1.00	1.00
	Female	1.31	.90
Age of Mother	< 20 years	1.79	1.09
	20-34 years	1.00	1.00
	≥ 35 years	1.29	.85
Education of Mother	None	1.03	1.33
	Secondary or higher	1.00	1.00
Birth Order	First	1.52	.87
	2-5	1.00	1.00
	Sixth or higher	.65	1.32*
Breastfeeding	≥ 6 months	1.00	1.00
	< 6 months	1.05	N/C
Articles Owned	One or more	1.00	1.00
	None	1.47	1.05*
Individual Water Supply	Piped in-house	1.00	1.00
	Not piped into house	1.57	N/C
Cluster Level of Sanitation	High	1.00	1.00
	Low	1.30	1.50*

URBAN: n=395, 20.5% stunted
RURAL: n=349, 32.1% stunted

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

Chapter 5

NIGERIA

5.1 Country Overview[1]

The most populous country in Africa, Nigeria occupies 994,714 km^2. The climate varies from tropical rain forests in the south through Savanna and Sahelian zones in the north. Administratively, Nigeria is governed federally with 19 states having their own parastatal agencies for water supply.

A basic foundation exists for urban water supply under the responsibility of state water agencies (SWAs). The key issues in this sector are cost recovery, institutional development, and operation and maintenance. The foundation is much weaker for rural water supply and sanitation. The most significant water supply and sanitation programs in recent years have been implemented by UNICEF. However, the sustainability of rural programs is questionable.

In the past, responsibility for rural water supply was divided between the SWAs, and in some cases donor projects and the local government councils (LGCs), while rural sanitation remained the responsibility of LGCs only. LGCs have not had adequate funds or staff. The SWAs, stretched to meet demand in urban areas, have given little attention to rural water supply. In line with the current decentralization policy, responsibility for rural water supply is being transferred to LGCs and communities.

Several UN-related agencies provide assistance to the rural sector. World Bank program activities currently focus on rural water supply and sanitation. However, the program is in the process of establishing two training network centers and undertaking sanitation planning in several secondary cities. Through a sector strategy prepared with the assistance of the World Bank, the government is proposing a policy of community management of rural water supply systems. UNICEF, a major donor in the sector, has been closely associated to this exercise. Local and state governments will provide goods and services. Significant policy shifts have occurred in favor of community-managed rural water supply. With World Bank project assistance, the government has standardized on two high-lift handpumps by assisting local private-sector handpump manufacturers.

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[1]A country overview and statistics are provided for each country for the water and sanitation sector. These data are taken from the World Bank Water and Sanitation Program (UNDP/WB 1992). WS&S coverage figures are based on individual government definitions of access to improved facilities. For communal facilities such as standpipes, wells, or springs, access is typically defined as the percentage of population living within a specified distance, usually 200 meters, of an improved facility. Such coverage figures are understood to be estimates but are included to provide a reference point to compare government estimates of coverage with those determined from the DHS survey. Definitions of urban and rural are also country specific and depend on census bureau classifications which may vary among countries.

VIP latrines continue to be constructed in urban areas (including Lagos) where conventional sewerage is unaffordable and low-cost household latrines for rural areas are being developed. The World Bank has proposed preliminary work on urban sanitation in several cities. In general, however, little is being done.

COUNTRY STATISTICS (1991)

Population: 115.5 M	Urban: 35%	Rural: 65%
GNP per capita: $290		
Child mortality rate: 170		
Water coverage:	Urban: N.A.	Rural: 20%
Sanitation coverage:	Urban: N.A.	Rural: 5%

5.2 Methodology

The general methodology used is described in Chapter 2. Issues specific to the Nigeria analysis are noted here.

5.2.1 Demographic and Health Survey

Fieldwork for the Nigeria Demographic and Health Survey was conducted in two phases: from April to July 1990 in the southern states and from July to October 1990 in the northern states. The survey was implemented by the Nigerian Federal Office of Statistics with technical assistance provided by IRD through the DHS Project.

The sample frame was based on the national master sample for the 1987/1992 National Integrated Survey of Households program. A sample of 10,000 households was designed with twofold oversampling of the urban stratum, yielding 132 urban enumeration areas and 167 rural enumeration areas. The NDHS sample is a weighted sample.

Respondents for the survey were 8,781 women between the ages of 15 and 49. 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.

5.2.2 Water and Sanitation Variable Definitions

Water—Each respondent was asked the question: "What is the major source of drinking water for members of your household?" Responses were grouped into three categories:

- Piped in-house: Running water piped to a location inside the house or into the yard.
- Public standpipe: Running water from a public standpipe outside of the household compound.
- Non-piped water: This includes wells with or without handpumps, rainwater, springs, water delivered by tanker truck, and surface water sources-rivers,streams, creeks and lakes.

Sanitation—Each respondent was asked the question: "What kind of toilet facility does your household have?" Responses were divided into three categories:

1) Flush toilets

2) Latrines: Bucket or pit latrine

3) No sanitary facilities

Cluster level of sanitation—Sanitation was redefined as a dichotomous variable. A child was coded (0) if a flush toilet was present in the household or coded (1) if either a latrine or no sanitary facilities were available. The cluster level of sanitation was then coded (0) for "high cluster level of sanitation" if 75 percent or more of the children in the cluster had access to a flush toilet or coded (1) for "low cluster level of sanitation" if less than 75 percent of children in the cluster had access to a flush toilet. Each child was then assigned a value, 0 or 1, for the level of sanitation in the cluster in which he or she lived.

5.2.3 Selection of Children for Analysis

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) 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 3550 children meeting the inclusion criteria , 710 or 20 percent were excluded based on the above criteria.

5.3 Results

The percentage of children with access to each of the three levels of water service varied between urban and rural areas (Figure 14). A higher percentage of children had access to water piped in-house in urban areas (32.5%) than in rural areas (4.1%). Similarly, a higher percentage of children had access to public standpipes in urban areas (31.3%) than in rural areas (7.1%). A much higher percentage of children had access only to non-piped service in rural areas (88.7%) than in urban areas (36.1%).

Availability of sanitation services was also better in urban than in rural areas (Figure 15). Flush toilets were available to 30.5% of urban children and only 1.3% of rural children. Many children, both urban and rural, had access to a latrine, 40.1% and 62.4% respectively. A similar proportion of urban and rural children had access to no sanitary facilities whatsoever, 32.1% urban and 36.3% rural.

The age distribution of stunting was similar in both urban and rural settings (Figure 16). The proportion of children stunted is consistently lower in urban children than in rural children in each age grouping. Overall, about a third of urban children were stunted (32.6%) and almost half of rural children were stunted (44.6%).

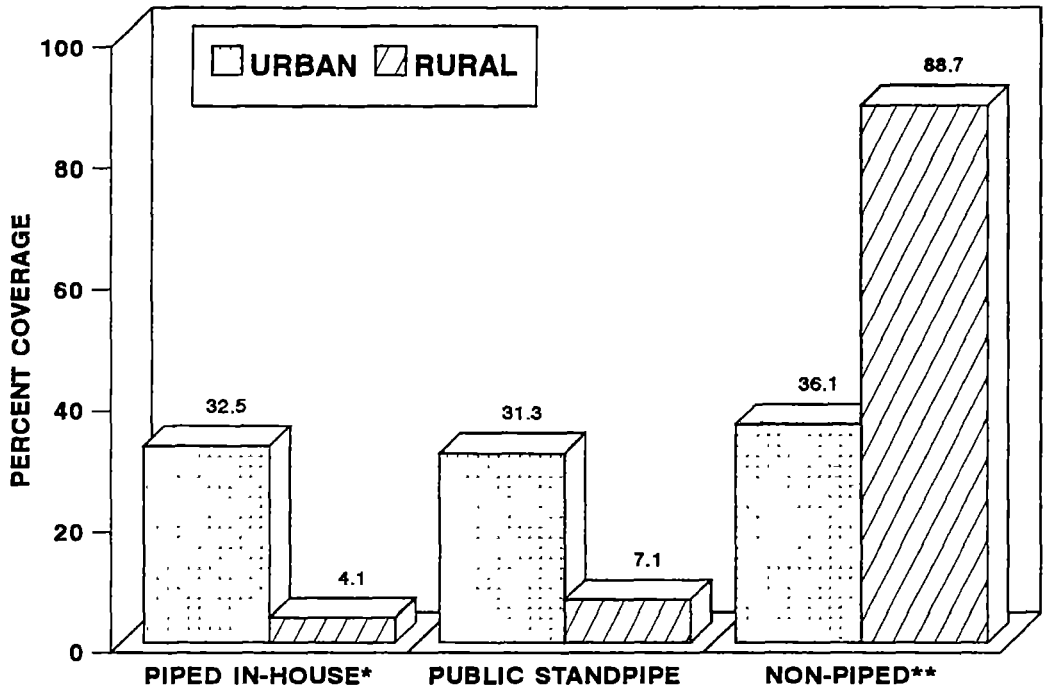
The proportion of children stunted showed little association with the level of water service (Figure 17). While in-house piped water appeared to be associated with a lower proportion of stunting in children in the urban areas (27.1% vs. 34.1% for public standpipes and 35.0% for non-piped water sources), the opposite trend was seen in rural areas (Figure 17).

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 11). Again, there was no significant difference noted between levels of water service and risk of stunting in children.

The proportion of children stunted was also associated with the sanitation level of service (Figure 18). Stunting was lower in children with access to a flush toilet in both urban and rural areas (17.5% and 26.1% respectively) when compared to those with access to latrines (urban, 40.1% and rural, 45.7%) and to those with no access to sanitary services (urban, 32.1% and rural, 43.3%). This association was also examined in the logistic regression model controlling for level of water service and other variables as in Table 11. In this model, there is an increased risk of stunting in children living in households with latrines or no sanitation services compared to those with flush toilets (Table 12). Interestingly, the risk of stunting associated with latrines appears to be higher than the risk of stunting associated with no sanitation services (ROR, 2.69 vs. 1.67 urban and ROR, 1.89 vs. 1.58 rural), though these differences do not reach statistical significance.

The proportion of children stunted is lower in urban areas with high community (cluster) levels of sanitation when compared to communities with low levels of sanitation (20.7% vs. 34.8%, Figure 19). The risk of stunting associated with lack of individual access to sanitation services and the risk of stunting associated with low community levels of sanitation can be compared only in urban areas in Nigeria (Table 13). The risk of stunting appears to be greater with a low individual level of sanitation (ROR 2.60) compared to the risk of stunting associated with a low cluster level of sanitation (ROR, 1.80), though these differences are not statistically significant.

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 14. There is no apparent relationship between level of water service and risk of stunting in urban or rural Nigeria. Low cluster level of sanitation is associated with a significant risk of stunting in children in urban areas (ROR 1.80).



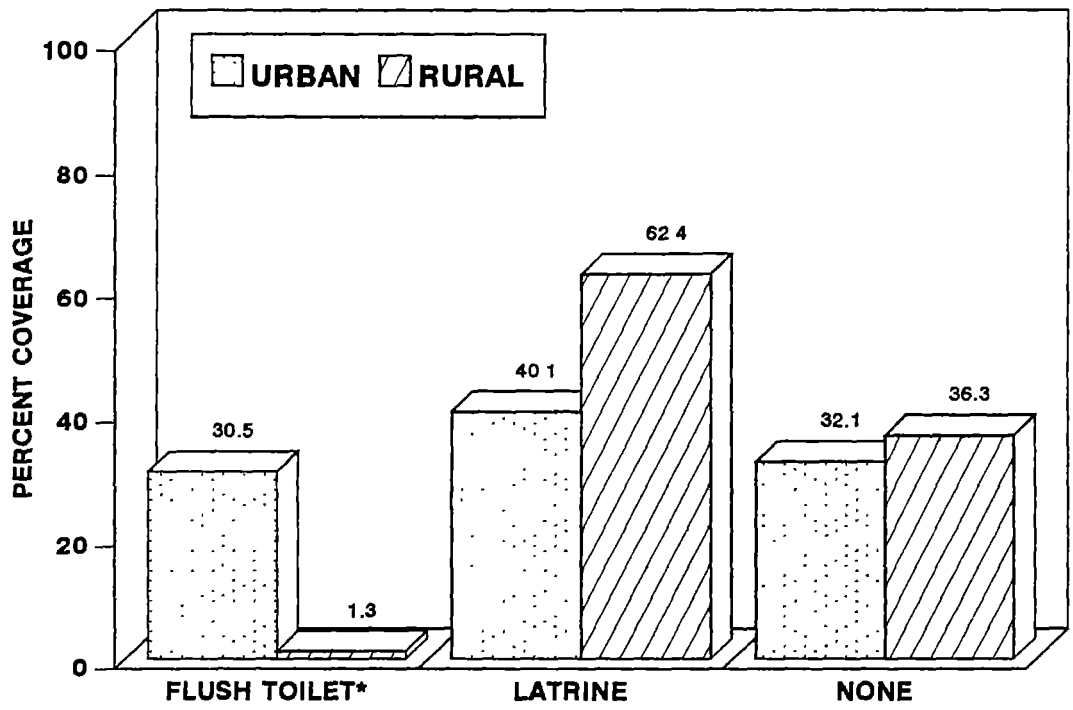
URBAN n=1021; RURAL N=1812

* Piped into residence; piped into yard

** Well with/without handpump, river, spring surface water, tanker truck, rainwater

Figure 14

Individual Level of Service - Water
Children 6-36 Months of Age - Nigeria

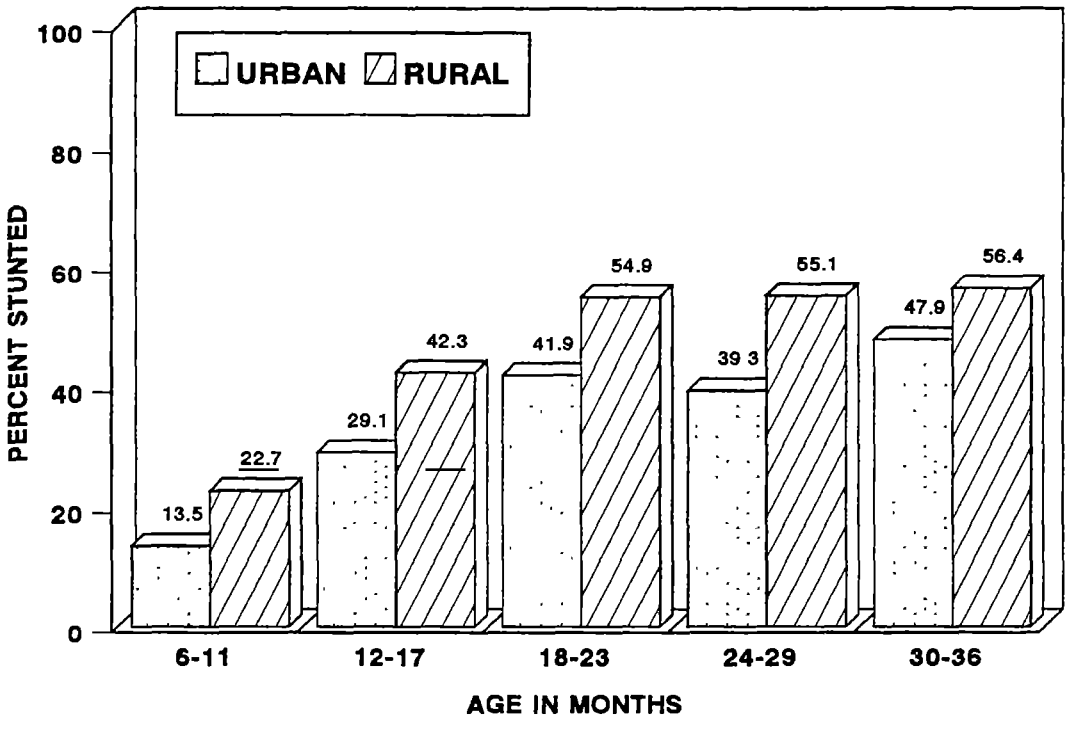


URBAN (n=1028) RURAL (n=1812)

* Flush, bucket

Figure 15

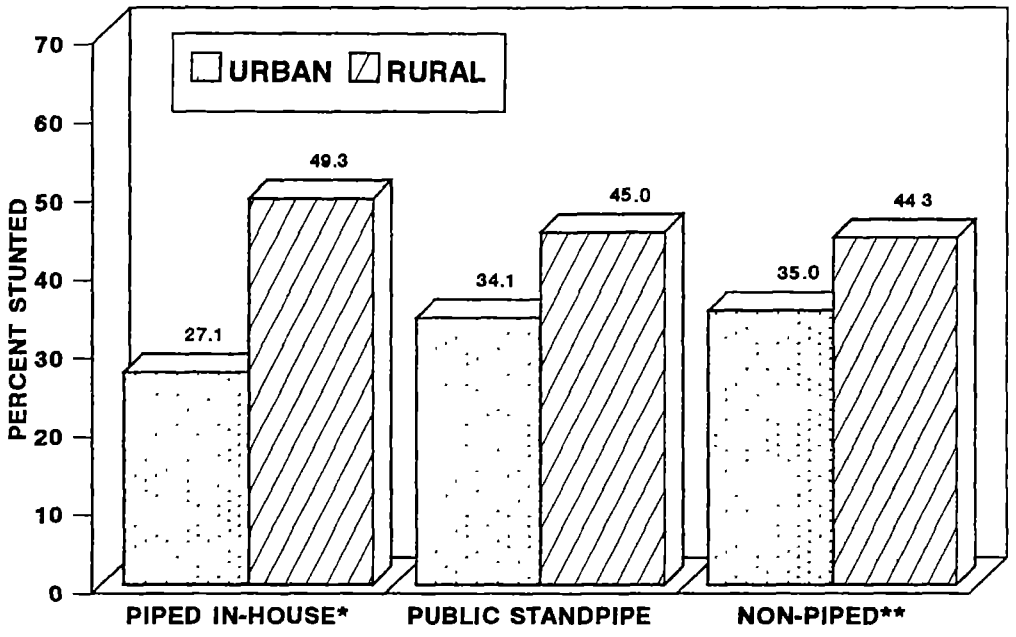
Individual Level of Service - Sanitation
Children 6-36 Months of Age - Nigeria



URBAN (n=1028) RURAL (n=1812)

Figure 16

Percent of Children Stunted, by Age
Children 6-36 Months of Age - Nigeria



(URBAN N=1021; RURAL N=1812)

* Piped into residence; piped into yard
** Well with/without handpump, river, spring, surface water, tanker truck, rainwater

Figure 17

Percent of Children Stunted, by
Individual Level of Service - Water
Children 6-36 Months of Age - Nigeria

Table 11

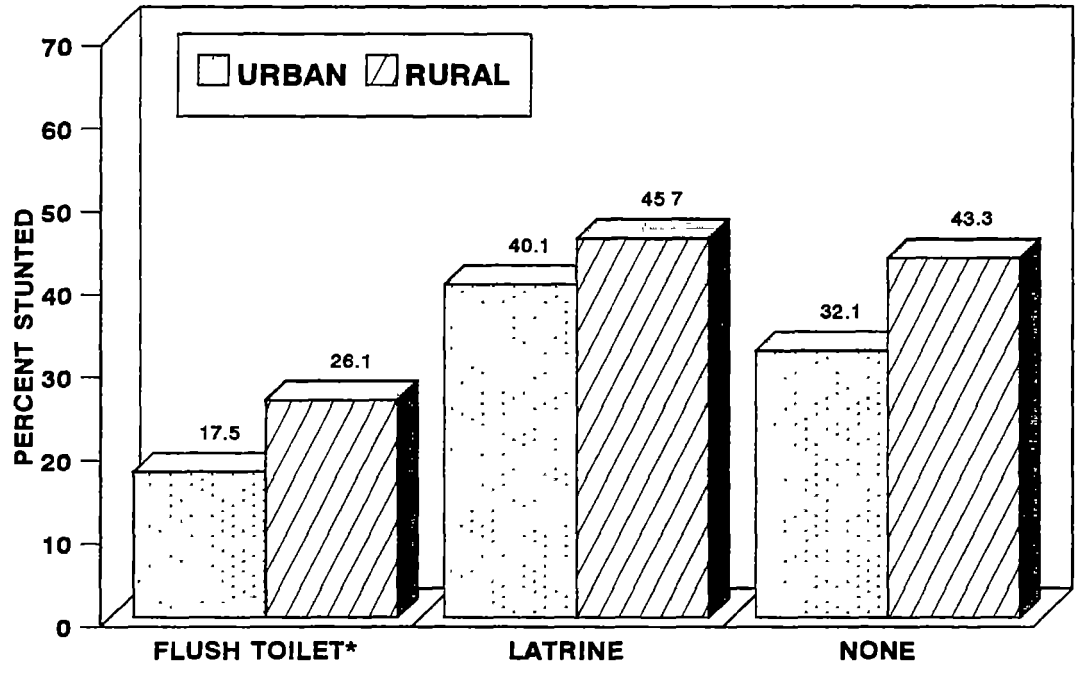
Relative Odds Ratio of Stunting by Individual Level of Service—Water

Children 6-36 Months of Age—Nigeria Logistic Regression Model

	Urban	*Rural*
Piped In-house	1.0	1.0
Public Standpipe	1.18	.93
Non-Piped	1.14	.81

URBAN (n=1020)
RURAL (n=1810)

* $p \leq .10$ † $p \leq .05$ ‡ $p \leq .01$
Model controls for age of child, sex of child, age of mother, education of mother, birth order, articles owned, and individual level of sanitation service.



URBAN (n=1028) RURAL (n=1812)

* Flush, bucket

Figure 18

Percent of Children Stunted, by
Individual Level of Service - Sanitation
Children 6-36 Months of Age - Nigeria

Table 12

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

Children 6-36 Months of Age—Nigeria
Logistic Regression Model

	Urban	*Rural*
Toilet	1.0	1.0
Latrine	2.69‡	1.89
None	1.67*	1.58

URBAN (n=1020)
RURAL (n=1810)

*p ≤ .10 † p ≤ .05 ‡ p ≤ .01
Model controls for age of child, sex of child, age of mother, education of mother, birth order, articles owned, and individual level of water service.

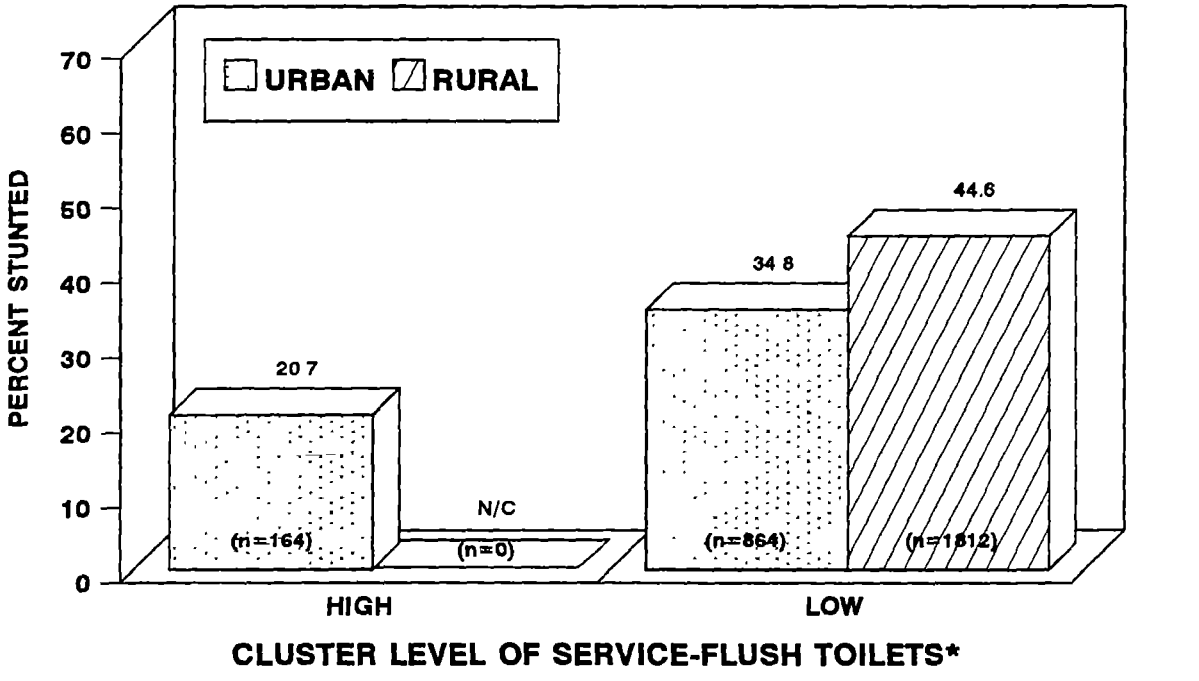


Figure 19

Percent of Children Stunted, by
Cluster Level of Service - Sanitation
Children 6-36 Months of Age - Nigeria

Table 13

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

Children 6-36 Months of Age—Nigeria
Logistic Regression Model

Individual Level	*Urban*	*Rural*
Toilet	1.0	1.0
Latrine/None	2.60‡	1.84

URBAN (n=1020)
RURAL (n=1810)

Cluster Level		
High	1.0	N/C
Low	1.80‡	N/C

URBAN (n=1020)
RURAL (n=1810)

† $p \leq .05$ ‡ $p \leq .01$
Model controls for age of child, sex of child, age of mother, education of mother, birth order, articles owned, and individual level of water service.

Table 14

Relative Odds Ratio of Stunting by
Explanatory Variables

Children 6-36 Months of Age—Nigeria
Logistic Regression Analysis

Variable	*Reference Category*	*Urban*	*Rural*
Age of Child	(6-month intervals)	‡	‡
Sex of Child	Male	1.00	1.00
	Female	1.03	.87
Age of Mother	< 20 years	1.93‡	1.37†
	20-34 years	1.00	1.00
	≥ 35 years	.78	.88
Education of Mother	None	1.91‡	2.40‡
	Primary school	1.43*	1.40
	Secondary or higher	1.00	1.00
Birth Order	First	.72	1.07
	2-5	1.00	1.00
	Sixth or higher	1.27	.88
Articles Owned	One or more	1.46†	1.18*
	None		
Individual Water Supply	Piped in-house	1.00	1.00
	Public standpipe	1.25	1.01
	Non-piped	1.19	.84
Cluster Level of Sanitation	High	1.00	1.00
	Low	1.80‡	N/C

URBAN: n=1020, 32.6% stunted
RURAL: n=1810, 44.6% stunted

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

Chapter 6

UGANDA

6.1 Country Overview[1]

Uganda is a landlocked country with 80 percent of its area (236,000 km^2) 1,000 to 1,500 m above sea level. It has few minerals, but rich soils and a favorable climate for agricultural production. It has extensive surface water resources with a vast hydro-electrical potential that is only partially exploited.

Much of the country's infrastructure was destroyed by civil war in the 1970s and early 1980s. Since 1986 the government has reinforced its commitment to the water supply and sanitation sector, and planning and implementation recently began to follow a rationalized approach for the rehabilitation and expansion of infrastructure.

Government institutions in the WS&S sector include: Ministry of Water, Energy, Mineral and Environment Protection (MWEMEP) oversees the Water Development Department (WDD) and the National Water and Sewerage Corporation (NWSC); Ministry of Health (MOH); Ministry of Local Government (MLG).

MWEMEP, through WDD and NWSC, is responsible for promotion of rural and urban water supply and piped sanitation. MOH is responsible for the promotion of rural sanitation, and MLG through town councils for urban nonpiped sanitation. WDD provides overall policy guidance in the sector. It is responsible for rural water supply and water resources development and for urban water supplies in towns not yet operated by NWSC. The National Planning Strategy -- Rural Water Supply Programme calls on WDD to promote community involvement in village water supply, including operation, maintenance, and acceptance of financial responsibilities. The Ministry is reviewing functions and responsibilities to make WDD more effective. NWSC is a parastatal body, established to take control gradually of all urban water supply and sewerage operations in the country and make them self-sustaining.

There are several constraints and weaknesses in the WS&S sector including: fragmented responsibility for urban areas with overlapping and inadequate coordination; inadequate decentralization of functions; development of projects without consideration of appropriate service standards and affordability; and salaries so low that they cause a shortage of qualified

[1]A country overview and statistics are provided for each country for the water and sanitation sector. These data are taken from the World Bank Water and Sanitation Program (UNDP/WB 1992). WS&S coverage figures are based on individual government definitions of access to improved facilities. For communal facilities such as standpipes, wells, or springs, access is typically defined as the percentage of population living within a specified distance, usually 200 meters, of an improved facility Such coverage figures are understood to be estimates but are included to provide a reference point to compare government estimates of coverage with those determined from the DHS survey. Definitions of urban and rural are also country specific and depend on census bureau classifications which may vary among countries.

and experienced staff, low morale in existing staff, and dependence on external technical assistance.

According to the World Bank, the government is aware of the problems and has started to address them. However, relieving those constraints will take time and effort. The policies for cost-sharing measures for services rendered are now well in place, and will be included in future development programs. The World Bank has and continues to place Uganda as a country of focus within its WS&S regional development program.

COUNTRY STATISTICS (1991)

Population: 16.3 M	Urban: 10%	Rural: 90%
GNP per capita: $220		
Child mortality rate: 167		
Water coverage:	Urban: 37%	Rural: 18%
Sanitation coverage:	Urban: 32%	Rural: 30%

6.2 Methodology

The general methodology used is described in Chapter 2. Issues specific to the Uganda analysis are noted here.

6.2.1 Demographic and Health Survey

The Uganda DHS was conducted between September 1988 and February 1989 by the Ministry of Health, with the assistance of the Statistics Department of the Ministry of Planning and Economic Development and both the Department of Geography and the Institute of Statistics and Applied Economics at Makere University. Technical assistance was provided by IRD through the DHS Project.

The survey used a stratified, weighted probability sample of women aged 15 to 49 selected from 206 clusters. Nine of the country's 34 districts were excluded from the sampling frame, due to security problems. They represented 20 percent of the country's population. Primary sampling units were sub-parishes in the rural areas and administrative units known as Resistance Council Ones in the urban areas.

Respondents for the survey were 4,730 women between the ages of 15 and 49. 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 0 and 60 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.

6.2.2 Water and Sanitation Variable Definitions

Water—Each respondent was asked the question: "What is the major source of drinking water for members of your household?" Responses were grouped into three categories:

- Piped in-house: Running water piped to a location inside the house.
- Yard tap: Running water from a tap outside of the house but within the household compound.
- Outside the household: This includes public standpipes, boreholes, wells, rainwater, protected and unprotected springs, water delivered by tanker truck, and surface water sources—rivers and lakes.

Sanitation—Each respondent was asked the question: "What kind of toilet does your household have?" Responses were divided into three categories:

- Flush toilets
- Latrines: Latrine or pit
- No sanitary facilities

Cluster level of sanitation—Sanitation was redefined as a dichotomous variable. A child was coded (0) if a flush toilet was present in the household or coded (1) if either a latrine or no sanitary facilities were available. The cluster level of sanitation was then coded (0) for "high cluster level of sanitation" if 75 percent or more of the children in the cluster had access to a flush toilet or coded (1) for "low cluster level of sanitation" if less than 75 percent of children in the cluster had access to a flush toilet. Each child was then assigned a value, 0 or 1, for the level of sanitation in the cluster in which he or she lived.

6.2.3 Selection of Children for Analysis

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) 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 2,111 children meeting the inclusion criteria, 204 or 9.6 percent were excluded based on the above criteria.

6.3 Results

The percentage of children with access to each of the three levels of water service varied between urban and rural areas (Figure 20). A higher percentage of children had access to water piped in-house in urban areas (7.0%) than in rural areas (0.4%). Similarly, a higher percentage of children had access to yard taps in urban areas (19.1%) than in rural areas (0.2%). A higher percentage of children had access only to water sources outside of the household in rural areas (99.4%) than in urban areas (73.8%).

Availability of sanitation services was also better in urban than in rural areas (Figure 21). Flush toilets were available to 27.5% of urban children and only about 1% of rural children. Most children, both urban and rural, had access to a latrine, 72.1% and 82.4% respectively. A smaller proportion of urban and rural children had access to no sanitary facilities whatsoever, less than 1% urban and 16.8% rural.

The age distribution of stunting was similar in both urban and rural settings (Figure 22). The proportion of children stunted is consistently lower in urban children, about half the proportion stunted in rural children in each age grouping. Overall, about a quarter of urban children were stunted (28.1%) and almost half of rural children were stunted (48.3%).

The proportion of children stunted varied according to the level of water service in both urban and rural areas (Figure 23). In urban areas, the percent of children stunted varied from 9.5% in children living in households with in-house piped water, to 21.1% for those with a yard tap, to 31.1% for those with water sources outside the household. In rural areas, the percent of children stunted in households with in-house piped water was 33.3% and in those with water sources outside the household the percent stunted was 48.4%.

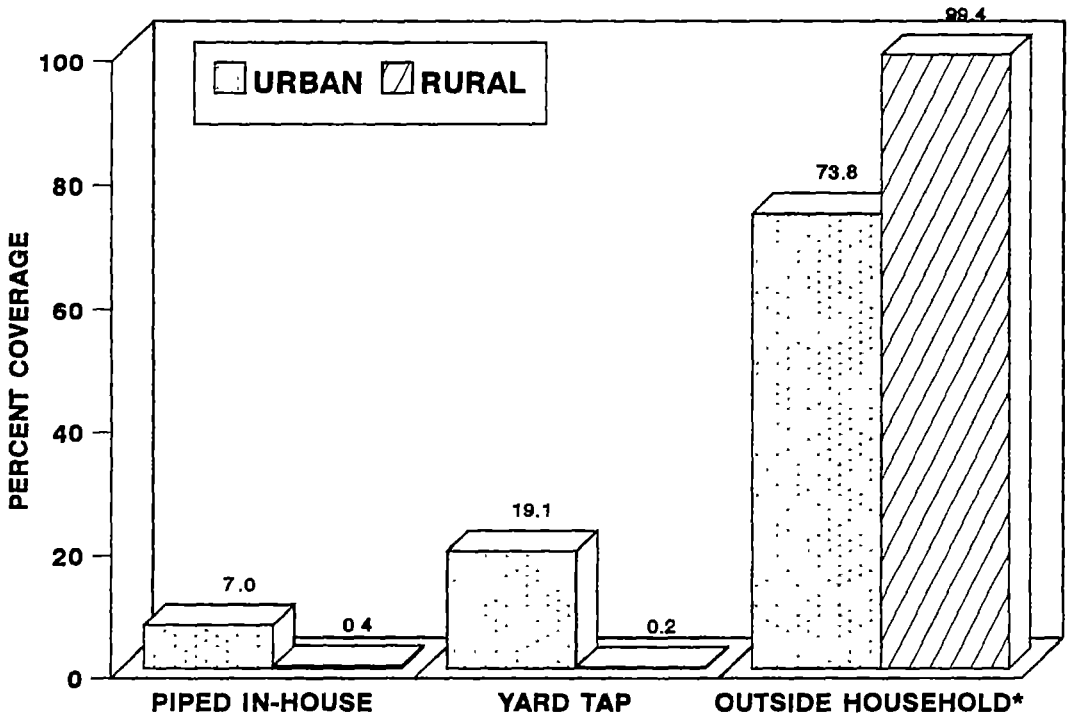
The relationship between stunting and level of water service was examined using a logistic regression model controlling for the child's age and sex, mother's age, mother's education, birth order, breastfeeding history, number of articles owned and level of sanitation service (Table 15). The increase in risk of stunting in children in urban areas seen in this analysis was similar to that in Figure 23, with ROR varying from 1 to 1.7 to 3.0 for children in households with access to in-house piped water, yard taps, and water sources outside of the household, respectively. Interestingly, in *rural* Uganda, when other factors are controlled for in this model, there is no difference in the risk of stunting in children in households with access to in-house piped water or with water sources outside the household.

The proportion of children stunted was also very clearly associated with the sanitation level of service (Figure 24). Stunting was lower in children with access to a flush toilet in both urban and rural areas (15.9% and 21.4% respectively) when compared to those with access to latrines (urban, 33.0% and rural, 47.9%) and to those with no access to sanitary services (rural, 51.5%; urban was not calculable because of the small number in this group). This association was also examined in the logistic regression model controlling for level of sanitation and other variables as shown for water in Table 15. In this model, there is an increased risk of stunting in children living in households with latrines or no sanitation services compared to

those with flush toilets (Table 16). The results of this model parallel those of the previous figure (Figure 24).

The proportion of children stunted is lower in urban areas with high community (cluster) levels of sanitation when compared to communities with low levels of sanitation (12.5% vs. 32.3%, Figure 25). The risk of stunting associated with lack of individual access to sanitation services and the risk of stunting associated with low community levels of sanitation can only be compared in urban areas in Uganda (Table 17). The risk of stunting associated with a low individual level of sanitation (ROR 1.40) is apparently lower than the risk of stunting associated with living in a community with a low level of sanitation (ROR 1.97), though this difference is not statistically significant. No such comparisons could be made for rural Uganda because no children in the rural areas lived in clusters with a high level of sanitation, by the definition used here (Figure 25 and Table 17).

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 18.

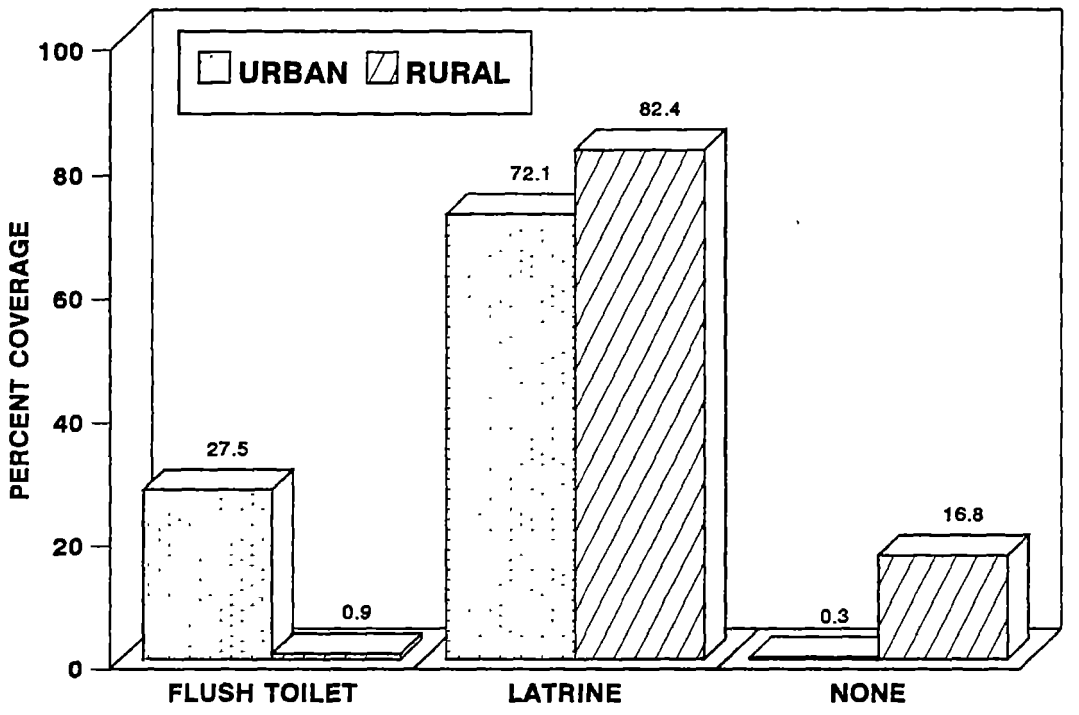


URBAN (n=298) (RURAL n=1630)

* Public standpipe, borehole, well, river, lake, unprotected source, protected spring, tanker truck, vendor, rainwater

Figure 20

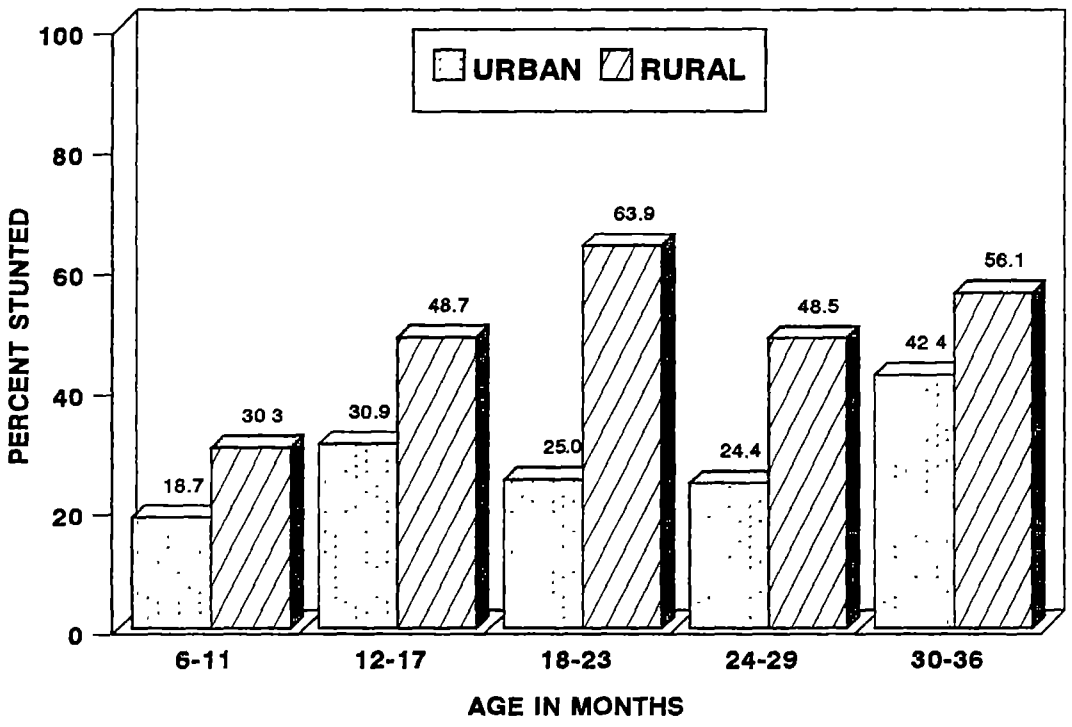
Individual Level of Service - Water
Children 6-36 Months of Age - Uganda



URBAN (n=298) RURAL (n=1621)

Figure 21

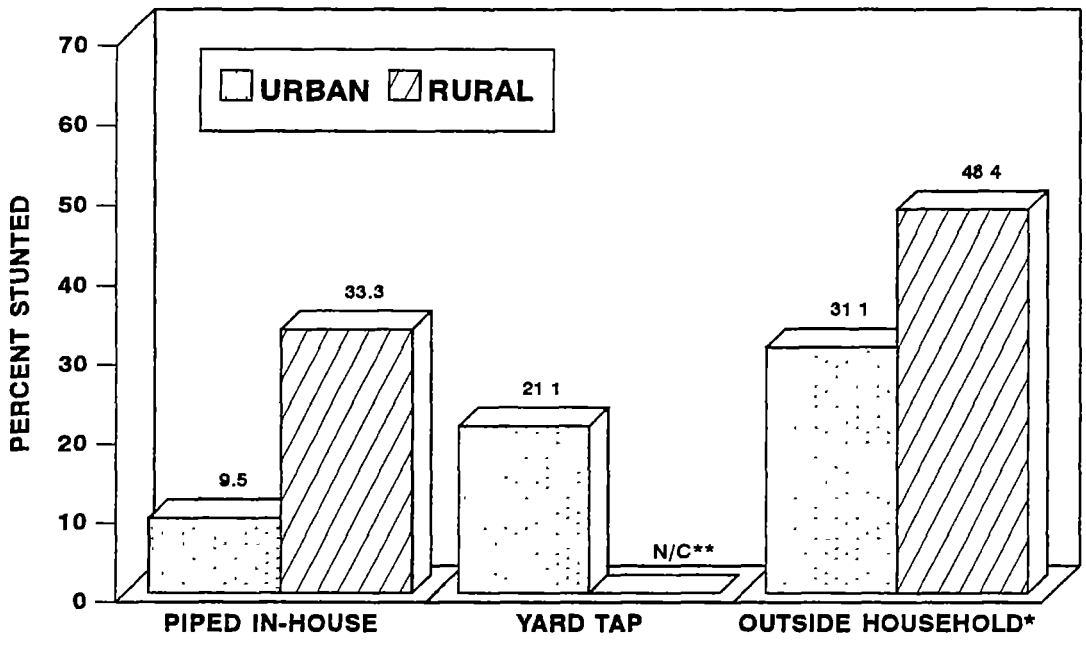
Individual Level of Service - Sanitation
Children 6-36 Months of Age - Uganda



URBAN (n=299) RURAL (n=1634)

Figure 22

Percent of Childrent Stunted, by Age
Children 6-36 Months of Age - Uganda



URBAN (n=298) (RURAL n=1630)

* Public standpipe, borehole, well, river, lake unprotected source, protected spring, tanker truck, vendor, rainwater

** Not calculable

Figure 23

Percent of Children Stunted, by
Individual Level of Service - Water
Children 6-36 Months of Age - Uganda

Table 15

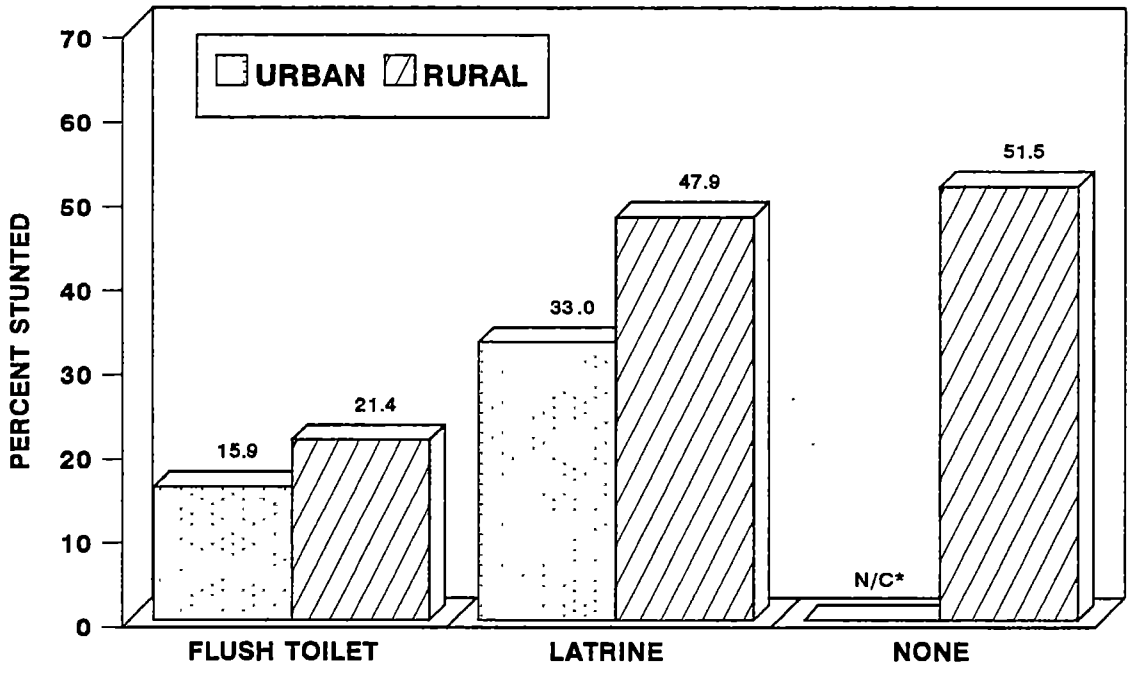
Relative Odds Ratio of Stunting by Individual Level of Service—Water

Children 6-36 Months of Age—Uganda Logistic Regression Model

	Urban	*Rural*
Piped In-house	1.0	1.0
Yard tap	1.7	N/C
Outside HH	3.0	1.0

URBAN (n=297)
RURAL (n=1610)

* $p \leq .10$ † $p \leq .05$
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.



URBAN (n=298) RURAL (n=1610)

* Not calculable

Figure 24

Percent of Children Stunted, by
Individual Level of Service - Sanitation
Children 6-36 Months of Age - Uganda

Table 16

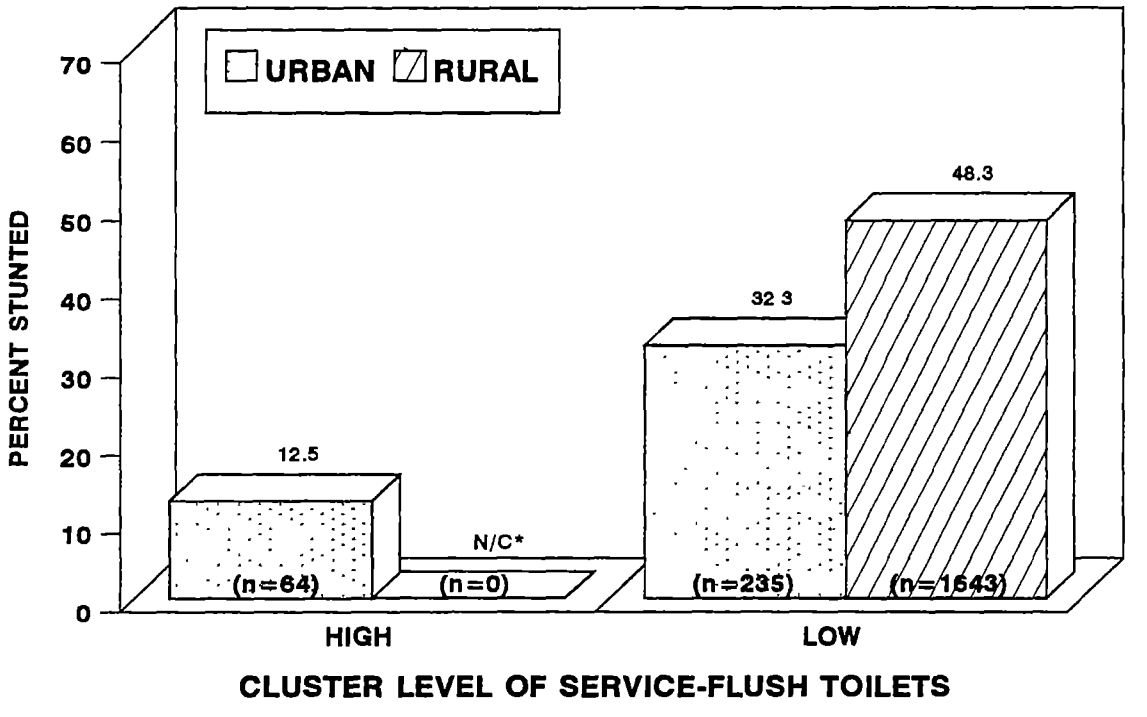
Relative Odds Ratio of Stunting by
Individual Level of Service—Sanitation

Children 6-36 Months of Age—Uganda
Logistic Regression Model

	Urban	*Rural*
Flush Toilet	1.0	1.0
Latrine	1.43	1.93
None	N/C	1.99

URBAN (n=297)
RURAL (n=1610)

† $p \leq .05$ ‡ $p \leq .01$
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.



* Not calculable

Figure 25

Percent of Children Stunted, by
Cluster Level of Service - Sanitation
Children 6-36 Months of Age - Uganda

Table 17

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

Children 6-36 Months of Age—Uganda
Logistic Regression Model

Individual Level	*Urban*	*Rural*
Flush Toilet	1.0	1.0
No Toilet	1.40	1.93

URBAN (n=297)
RURAL (n=1610)

Cluster Level		
High	1.0	N/C
Low	1.97	N/C

URBAN (n=297)
RURAL (n=1623)

† $p \leq .05$ ‡ $p \leq .01$
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 18

Relative Odds Ratio of Stunting by
Explanatory Variables

Children 6-36 Months of Age—Uganda
Logistic Regression Analysis

Variable	*Reference Category*	*Urban*	*Rural*
Age of Child	(6-month intervals)	‡	‡
Sex of Child	Male	1.00	1.00
	Female	.89	.74‡
Age of Mother	< 20 years	1.96	.67†
	20-34 years	1.00	1.00
	≥ 35 years	2.52	.68†
Education of Mother	None	3.92‡	1.44
	Primary school	1.00	1.43
	Secondary or higher	1.00	1.00
Birth Order	First	.76	1.32
	2-5	1.00	1.00
	Sixth or higher	1.20	.88
Breastfeeding	≥ 6 months	1.00	1.00
	< 6 months	.23*	.71
Articles Owned	One or more	1.00	1.00
	None	1.19	1.55‡
Individual Water Supply	Piped in-house	1.00	1.00
	Yard Tap	1.52	N/C
	Outside HH	2.69	1.75
Cluster Level of Sanitation	High	1.00	1.00
	Low	1.97	N/C

URBAN: n=297, 28.1% stunted
RURAL: n=1623, 48.3% stunted

* p ≤ .10 † p ≤ .05 ‡ p ≤ .01

Chapter 7

ZIMBABWE

7.1 Country Overview[1]

The landlocked country of Zimbabwe has a total area of 390,580 km^2. The climate is tropical but altitude is relatively high with significant variation in rainfall between valleys and mountains. Most of the country is underlain with granites and other igneous rocks which provide for Zimbabwe's significant mineral wealth. There are adequate supplies of surface and groundwater for electrical power, domestic, industrial, and irrigation use.

At independence in 1980, over 70 percent of Zimbabwe's population lived in rural areas, with the vast majority living in communal lands, characterized by very low socioeconomic status of households, lack of basic services, and a large undeveloped subsistence economy. In 1990, 82 percent of the rural population was in communal lands. By 1990, 55 percent of the rural population in communal areas had access to potable water compared to 33 percent in 1980; and 21 percent had access to sanitation facilities compared to 15 percent in 1980. In spite of this progress, enormous differences remain between levels of service in urban and rural areas.

The increase in service levels in communal lands has been made possible by the gradual development of a structured national program, Integrated Rural Water Supply and Sanitation Program, whose strategies are derived from a 1985 Water Master Plan and whose coordination has been ensured by an inter-ministerial National Action Committee.

The government and key donors have expressed increasing concern over the sustainability of the rural WS&S program in terms of continuing its impetus, maintaining facilities, and ensuring that it meets the needs of and benefits the rural population. These concerns extend beyond the specific program to the broader question of meeting the demands of the rural population for infrastructure services, and to even broader questions concerning the appropriate institutional and financial framework for rural development in Zimbabwe. A World Bank Sector Review carried out in early 1992 addresses these issues and focuses on major challenges and responses to sustaining rural WS&S services.

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[1]A country overview and statistics are provided for each country for the water and sanitation sector. These data are taken from the World Bank Water and Sanitation Program (UNDP/WB 1992) WS&S coverage figures are based on individual government definitions of access to improved facilities. For communal facilities such as standpipes, wells, or springs, access is typically defined as the percentage of population living within a specified distance, usually 200 meters, of an improved facility. Such coverage figures are understood to be estimates but are included to provide a reference point to compare government estimates of coverage with those determined from the DHS survey. Definitions of urban and rural are also country specific and depend on census bureau classifications which may vary among countries

COUNTRY STATISTICS (1991)

Population: 9.8 M	Urban: 28%	Rural: 72%
GNP per capita: $640		
Child mortality rate: 90		
Water coverage:	Urban: (1990) 100%	Rural: 55%
Sanitation coverage:	Urban: (1990) 100%	Rural: 21%

7.2 Methodology

The general methodology used is described in Chapter 2. Issues specific to the Zimbabwe analysis are noted here.

7.2.1 Demographic and Health Survey

The Zimbabwe Demographic and Health Survey was carried out by the Central Statistical Office as part of the Zimbabwe National Household Survey Capability Programme with technical assistance provided by IRD through the DHS Project. Fieldwork was conducted between September 1988 and January 1989.

The sample frame for the survey was based on the Revised Zimbabwe Master Sample which is a subsample of the original Zimbabwe Master Sample. The survey used a two-stage sample with census enumeration areas serving as the primary sampling unit. The sample included 167 of the 273 enumeration areas, of which 114 were rural and 53 urban. The second stage units, households, were drawn systematically from the households residing in the selected enumeration areas.

Respondents for the survey were 4,201 women between the ages of 15 and 49. 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 0 and 60 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.

7.2.2 Water and Sanitation Variable Definitions

Water—Each respondent was asked the question: "What is the major source of drinking water for members of your household?" Responses were grouped into three categories:

- Piped in-house: Running water piped to a location inside the house.
- Yard tap: Running water from a standpipe outside of the house but within the household compound.

- Outside the household: This includes public standpipes, boreholes, protected and unprotected wells, rainwater, protected and unprotected springs, water delivered by tanker truck, and surface water sources—rivers, lakes, and dams.

Sanitation—Each respondent was asked the question: "What kind of toilet facility do members of your household use?" Responses were divided into three categories:

- Flush toilets
- Latrines: Blair toilet or pit latrines.
- No sanitary facilities

Cluster level of sanitation—Sanitation was redefined as a dichotomous variable. A child was coded (0) if a flush toilet was present in the household or coded (1) if either a latrine or no sanitary facilities were available. The cluster level of sanitation was then coded (0) for "high cluster level of sanitation" if 75 percent or more of the children in the cluster had access to a flush toilet or coded (1) for "low cluster level of sanitation" if less than 75 percent of children in the cluster had access to a flush toilet. Each child was then assigned a value, 0 or 1, for the level of sanitation in the cluster in which he or she lives.

7.2.3 Selection of Children for Analysis

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) 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 1,374 children meeting the inclusion criteria, 191 or 14 percent were excluded based on the above criteria.

7.3 Results

The percentage of children with access to each of the three levels of water service varied dramatically between urban and rural areas of Zimbabwe (Figure 26). A higher percentage of children had access to water piped in-house in urban areas (82.0%) than in rural areas (1.9%). Similarly, a higher percentage of children had access to yard taps in urban areas (15.5%) than in rural areas (6.9%). A much higher percentage of children had access only to water sources outside the household in rural areas (91.1%) than in urban areas (2.5%). Overall, the pattern is for virtually all urban households to have access to piped water within the house or compound and for virtually all rural households to have access only to water sources outside the house and compound.

Availability of sanitation services was also dramatically better in urban than in rural areas (Figure 27). Flush toilets were available to practically all (98.0%) of urban children's households, but were available to only 3.6% of rural children's households. Virtually no urban children lived in households without access to a flush toilet, whereas 41.5% of rural children lived in a household with access only to a latrine and *over half* (54.9%) of rural children lived in a household with access to no sanitation services of any type.

The age distribution of stunting was similar in both urban and rural settings (Figure 28). However, the proportion of children stunted is consistently lower in urban children than in rural children in each age grouping. Overall, only 16% of urban children were stunted and over a third of rural children were stunted (34.9%).

The proportion of children stunted was associated with the level of water service in both urban and rural areas (Figure 29). Stunting in children of households with in-house piped water was about two-thirds that of children in households with yard taps in both urban and rural areas(14.9% vs. 23.1% for urban children, and 22.2% vs. 32.3% for rural children, respectively). The association between stunting and water source outside the household showed no clear pattern, with a percentage stunted in rural children similar to that of rural children with yard taps (35.4% vs. 32.3%, outside household vs. yard tap, respectively) and an apparently lower percentage of children stunted with water sources outside the household in urban areas (16.7% vs. 23.1%, outside household vs. yard tap, respectively).

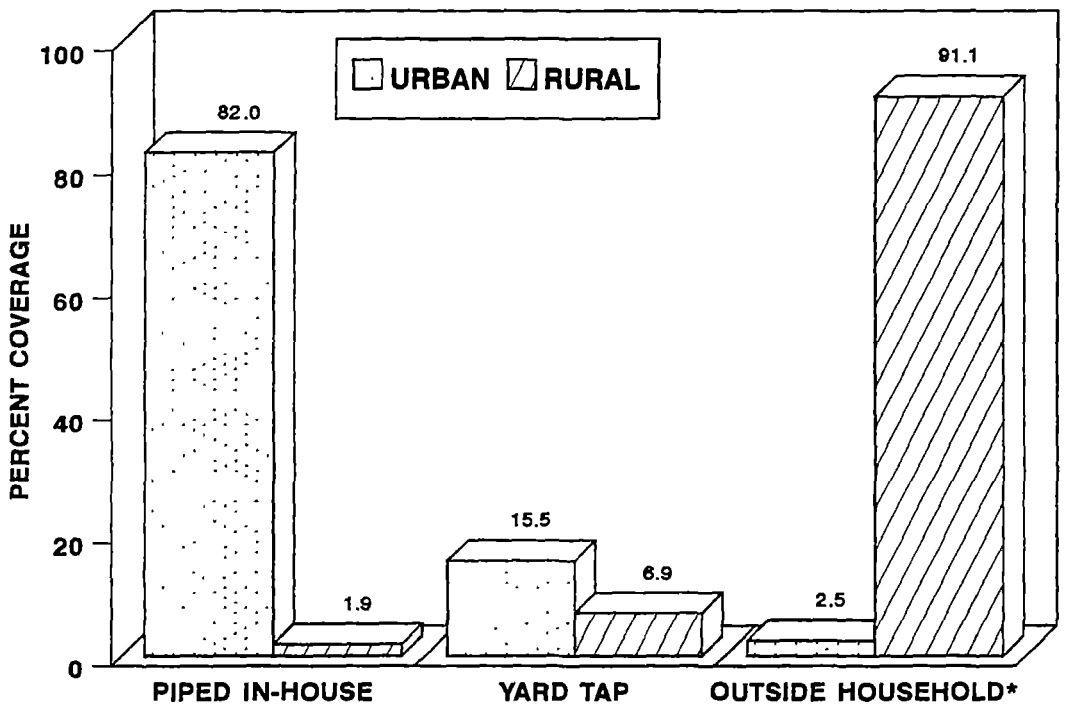
The relationship between stunting and level of water service was examined using a logistic regression model controlling for the child's age and sex, mother's age, mother's education, birth order, breastfeeding history, number of articles owned, and level of sanitation service (Table 19). Piped in-house water was used as the reference category in both urban and rural children. In urban areas, the highest relative odds ratio for stunting is in children in households with access only to water sources outside the household (ROR 2.02), a risk only slightly greater than that associated with yard taps (ROR 1.85). In rural areas there is a paradoxical effect of a decreased risk of stunting associated with lower levels of water service (ROR .55 for yard taps and ROR .52 for water source outside the household). It should be recalled that very few rural children live in households with access to in-house piped water (Figure 26), the estimates of ROR are not precise, and these results should be interpreted with caution.

The proportion of children stunted was also associated with the sanitation level of service (Figure 30). Stunting was lower in children with access to a flush toilet in both urban and rural areas (15.7% and 11.8% respectively) when compared to those with access to latrines (urban, 50.0% and rural, 28.8%) and to those with no access to sanitary services (rural, 41.1%, urban was not calculable due to the small number in this group). This association was also examined in the logistic regression model controlling for level of water service and other variables as in Table 19. In this model, the large effects of level of sanitation service on risk of stunting are clear and dramatic (Table 20). The risk of stunting in children living in households with access to a latrine was four times that of children living in households with access to a flush toilet, in both urban and rural areas. In rural areas, the risk increased to over six-fold (ROR, 6.45) when no sanitation services whatsoever were available to the household.

The proportion of children stunted was associated with the community (cluster) level of sanitation in urban Zimbabwe (Figure 31). The proportion of children stunted in communities with a low level of sanitation was over twice that of children living in communities with a high level of sanitation (33.3% vs. 15.9%, low cluster level of sanitation vs. high cluster level of sanitation). Of the four children who live in one community with a high level of sanitation in rural Zimbabwe, none were stunted. By comparison, 35% of the over 900 children who lived in communities with a low level of sanitation in rural Zimbabwe were stunted.

When the risk of stunting associated with lack of individual access to sanitation services and the risk of stunting associated with low community levels of sanitation are compared, the effect of poorer sanitation service on the risk of stunting is even more dramatic for community level of sanitation (Table 21). In urban areas, the risk of stunting associated with living in a household without access to a flush toilet is 2.32, whereas the risk of stunting from living in a community with a low level of sanitation is 4.19. In rural areas the similar risks are 5.20 and 30.40.

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 22. By comparison with cluster level of sanitation, the effect of different levels of water service on the risk of stunting in children is modest. Of all of the risk factors for stunting studied in Zimbabwe and presented in Table 22, community level of sanitation is by far the most important.

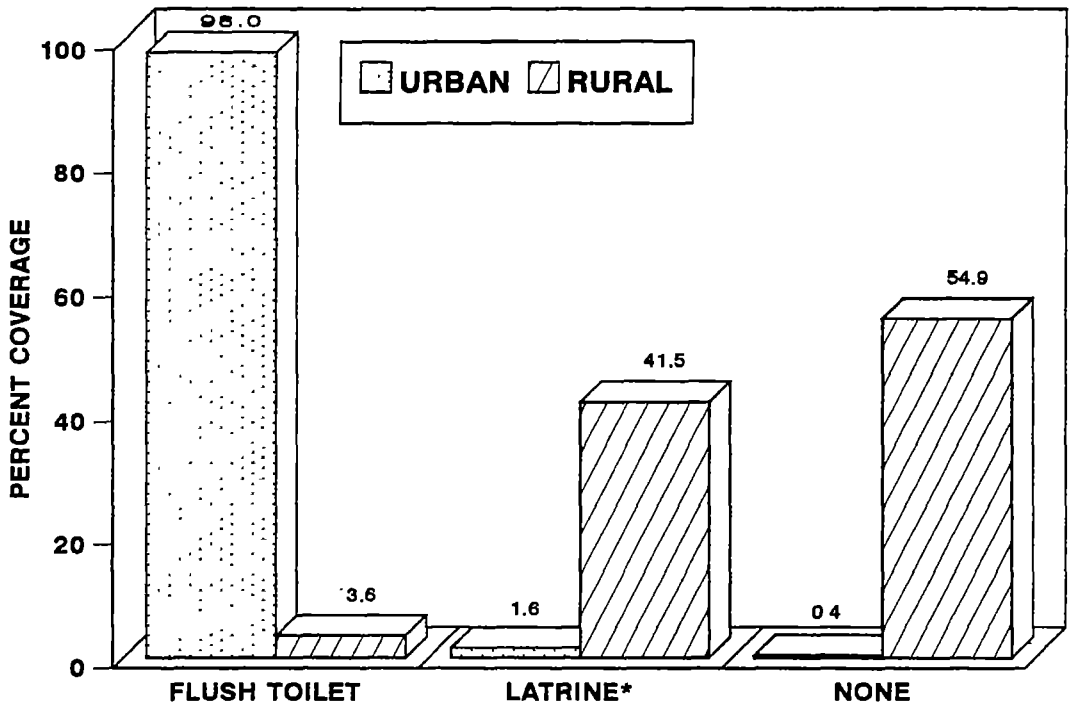


URBAN (n=254) RURAL (n=936)

* Communal tap, protected well, unprotected well, borehole, protected spring, unprotected spring, river/stream, Mufuku, tanker, rainwater, dam

Figure 26

Individual Level of Service - Water
Children 6-36 Months of Age - Zimbabwe

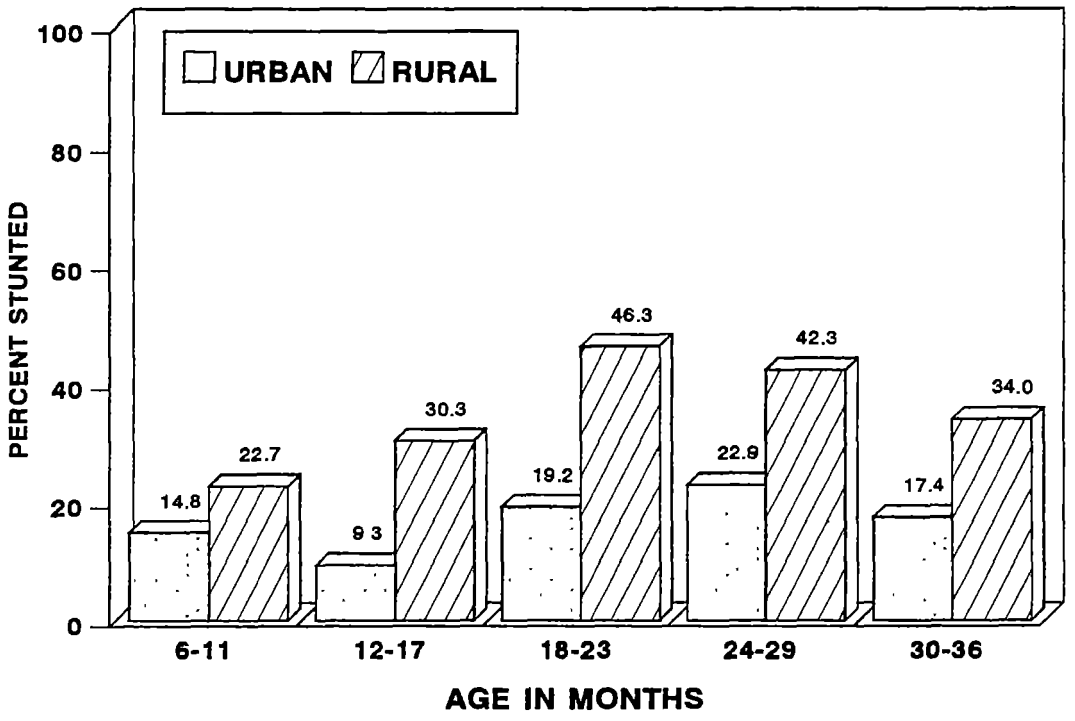


URBAN (n=253) RURAL (n=937)

* Blair toilet, pit latrine

Figure 27

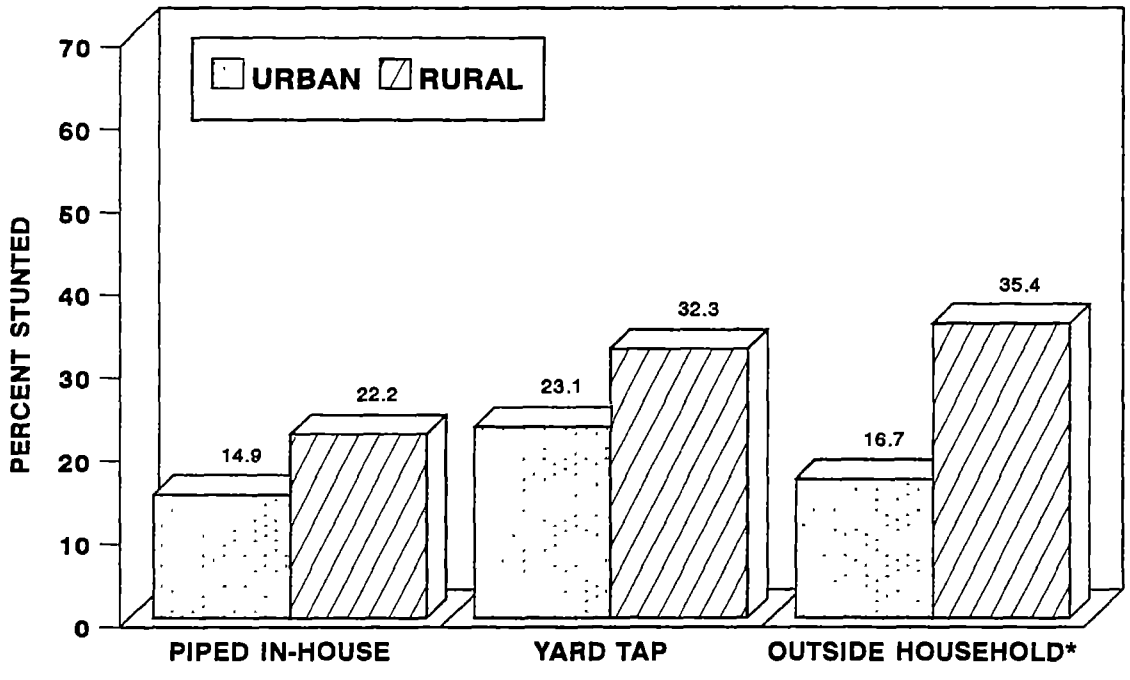
Individual Level of Service - Sanitation
Children 6-36 Months of Age - Zimbabwe



URBAN (n=254) RURAL (n=937)

Figure 28

Percent of Children Stunted, by Age
Children 6-36 Months of Age - Zimbabwe



URBAN (n=254) RURAL (n=936)

* Communal tap, protected well, unprotected well, borehole, protected spring, unprotected spring, river/stream, Mufuku, tanker, rainwater, dam

Figure 29

Percent of Children Stunted, by
Individual Level of Service - Water
Children 6-36 Months of Age - Zimbabwe

Table 19

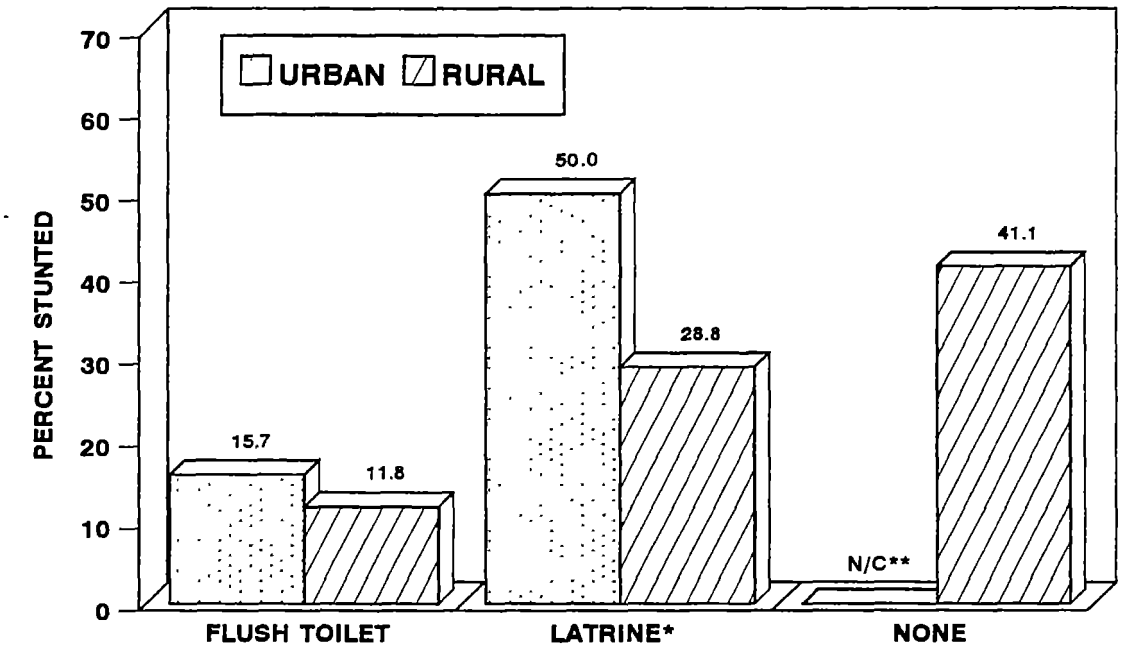
Relative Odds Ratio of Stunting by Individual Level of Service—Water

Children 6-36 Months of Age—Zimbabwe
Logistic Regression Model

	Urban	*Rural*
Piped In-house	1.0	1.0
Yard Tap	1.85	.55
Outside HH	2.02	.52

URBAN (n=251)
RURAL (n=932)

* $p \leq .10$ † $p \leq .05$
Model controls for age of child, sex of child, age of mother, education of mother, birth order, breastfeeding, articles owned, and individual level of sanitation service.



URBAN (n=253) RURAL (n=937)

* Blair toilet, pit latrine
** Not calculable

Figure 30

Percent of Children Stunted, by
Individual Level of Service - Sanitation
Children 6-36 Months of Age - Zimbabwe

Table 20

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

Children 6-36 Months of Age—Zimbabwe
Logistic Regression Model

	Urban	*Rural*
Flush Toilet	1.0	1.0
Latrine	4.10	4.19†
None	N/C	6.45‡

URBAN (n=251)
RURAL (n=932)

† $p \leq .05$ ‡ $p \leq .01$
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.

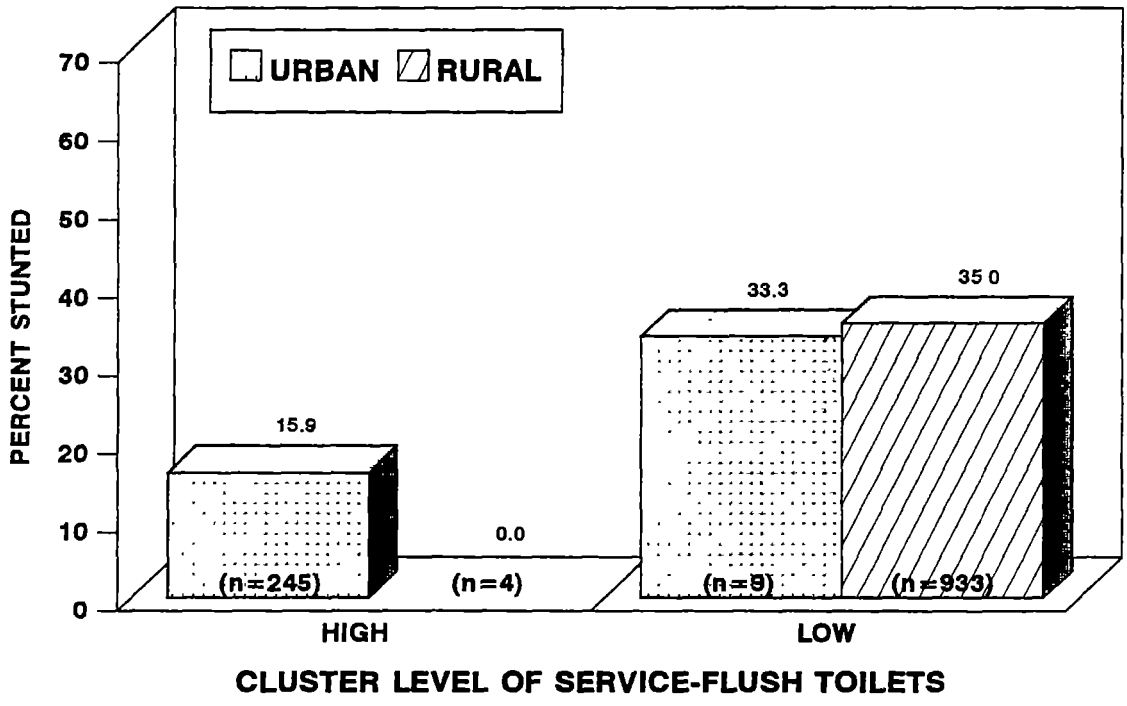


Figure 31

Percent of Children Stunted, by
Cluster Level of Service - Sanitation
Children 6-36 Months of Age - Zimbabwe

Table 21

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

Children 6-36 Months of Age—Zimbabwe
Logistic Regression Model

Individual Level	*Urban*	*Rural*
Flush Toilet	1.0	1.0
No Toilet	2.32	5.20†

URBAN (n=251)
RURAL (n=932)

Cluster Level		
High	1.0	1.0
Low	4.19*	30.40

URBAN (n=252)
RURAL (n=932)

* $p \leq .10$ † $p \leq .05$ ‡ $p \leq .01$
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 22

Relative Odds Ratio of Stunting by
Explanatory Variables

Children 6-36 Months of Age—Zimbabwe
Logistic Regression Analysis

Variable	*Reference Category*	*Urban*	*Rural*
Age of Child	(6-month intervals)	‡	‡
Sex of Child	Male	1.00	1.00
	Female	2.34†	.70*
Age of Mother	< 20 years	2.17	1.17
	20-34 years	1.00	1.00
	≥ 35 years	2.65	.92
Education of Mother	None	.23	2.14†
	Primary school	1.16	1.45
	Secondary or higher	1.00	1.00
Birth Order	First	.87	.98
	2-5	1.00	1.00
	Sixth or higher	1.05	1.18
Breastfeeding	≥ 6 months	1.00	1.00
	< 6 months	.41	.33
Articles Owned	One or more	1.00	1.00
	None	1.47	1.33†
Individual Water Supply	Piped in-house	1.00	1.00
	Yard Tap	2.11	1.15
	Outside HH	1.38	1.43
Cluster Level of Sanitation	High	1.00	1.00
	Low	4.19*	30.40

URBAN: n=252, 16.5% stunted
RURAL: n=932, 34.9% stunted

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

Chapter 8

CROSS-COUNTRY COMPARISONS

In the preceding chapters, individual country analyses have been presented. As the countries were chosen to provide a range of conditions in Africa, there are some interesting cross-country comparisons to be examined related to:

- Levels of service
- Relationship of stunting to water services
- Relationship of stunting to sanitation
- Interaction of water supply and sanitation services

8.1 Levels of Service (Table 23)

Water service: The level of water service is generally low. Rural water services lag behind urban level of service. In rural areas, the proportion of homes with in-house, piped water ranges from 0% in Mali to 4% in Nigeria. For urban areas, the range is from 7% in Uganda to an impressive 82% of families in Zimbabwe with in-house, piped water supplies.

Sanitation services: The level of sanitation services is lower than water supplies, and urban-rural disparities are even greater. In Zimbabwe, 98% of urban families have flush toilets, whereas 55% of rural families have no sanitary facilities at all—neither flush toilet nor latrine. In rural areas, the proportion of families without access to sanitary facilities ranges from 17% in Uganda to 55% in Zimbabwe. In urban areas, the proportion of families without access ranges from .3% in Uganda to 32% in Nigeria.

It is interesting to note, however, that sanitation coverage is generally higher, much higher in rural areas, than is estimated by government agencies.

8.2 Relationship of Stunting to Water Services (Table 24)

In *urban* areas, improved water services are consistently associated with decreased risk of stunting in children, except in Nigeria. This association is made with statistical certainty in one case, Ghana, where the risk of stunting in children in homes with non-piped water service is greater than the risk of stunting in children in homes with in-house, piped water supplies (relative odds ratio or ROR = 2.6).

The association between stunting and level of water services is less consistent or clear in *rural* areas. In Ghana, improved water services appear to be associated with a decreased risk of stunting, while in Mali, Nigeria, Zimbabwe, and Uganda no such association is found.

Conceptual models of multiple routes of transmission of water and sanitation-related diseases suggest that improved water supply alone may have no, or a very limited, effect on reducing the incidence of disease where the level of sanitation is low and environmental contamination is high. This may be the case here.

Table 23

Percent Coverage of Households with Various Levels of Water and Sanitation Services[1] Cross-Country Comparisons

	Ghana		*Mali*		*Nigeria*		*Uganda*		*Zimbabwe*	
	U	R	U	R	U	R	U	R	U	R
Individual Water										
In-house	29	1	12	0	33	4	7	<1	82	2
Improved[2]	38	9	35	12	31	7	19	<1	16	7
Unimproved[3]	34	90	53	88	36	89	74	99	3	91
Individual Sanitation										
Flush Toilet	10	1	1	0	31	1	28	1	98	4
Latrine	75	---	97	58	40	62	72	82	2	42
None	16	32	1	43	32	36	<1	17	<1	55

[1] Percent of households surveyed, rounded to the nearest percent.
[2] Improved water supply: Ghana—public standpipe; Mali—household well; Nigeria—public standpipe; Uganda—yard tap; Zimbabwe—yard tap.
[3] Unimproved water supply: Ghana—non-piped; Mali—non-piped, outside household; Nigeria—non-piped; Uganda—outside household (includes standpipe); Zimbabwe—outside household (includes standpipe).

8.3 Relationship of Stunting to Sanitation (Table 24)

The association between poor sanitation and risk of stunting is stronger and more consistent across countries than is the association between poor water services and risk of stunting.

This difference is most dramatic in rural Zimbabwe. Whereas water services had no association with risk of stunting, low level of sanitation had a dramatic association with stunting, with a risk of stunting 5 times greater in children in families with latrines or no sanitary services when compared to children in families with flush toilets.

Interestingly, there was no apparent lower risk of stunting in families who had access to a latrine when compared to families with no access to sanitation services. This is similar to previous findings from Guatemala (Bateman and Smith 1991) and is not surprising since the latrine category does not distinguish used vs. unused, sanitary vs. unsanitary, and well maintained vs. poorly maintained latrines. We cannot examine the health benefits of well maintained, sanitary latrines used by the whole family—where health benefits would be expected—using the data analyzed in this study.

The community, or cluster, level of sanitation had a closer association with risk of stunting in children than did individual family access to improved sanitation. This finding was, again, dramatic in Zimbabwe, and was consistently higher in Ghana, Mali and Uganda. In urban Nigeria, the association between stunting and community level of sanitation was slightly less than with individual family access to improved sanitation.

8.4 Interaction of Water Supply and Sanitation Services

A direct examination of the interaction of water supply and sanitation was not possible in this analysis. Nonetheless, we speculated based on the data that for health benefits (as measured by stunting) to be realized from water supply interventions, there must be a low level of environmental contamination (i.e., a high level of community sanitation). With a high level of environmental contamination, the beneficial impact on health of improved water supply may be greatly reduced or even nullified. The data collected show considerable variation in the relationship between water supply and risk of stunting in children (Table 24), perhaps because of the variations in community level of sanitation.

We can examine how this relationship between water supply and health varies with the level of sanitation in a simple fashion in this analysis. The availability of improved sanitation is relatively low and the proportion of families with no access to any type of sanitation service is relatively high in the rural areas studied (Table 23). There is little association between improved water services and reduced risk of stunting in these same rural areas (Table 24). Comparing the urban areas of Ghana, Nigeria, Uganda, and Zimbabwe is more interesting. Urban Mali is not included because of the absence of flush toilets and unique water supply definitions used there. In Table 23 we see that in urban Uganda and Zimbabwe there is relatively high coverage with flush toilets (28% and 98%, respectively) and a low proportion of families without access to any type of sanitation (<1% in each case). Inspection of Table 24 shows that there is an apparent association between poorer levels of water service and risk of stunting in these same areas (ROR 1.0, 1.7, 3.0 and ROR 1.0, 1.9, 2.0 for in-house, improved, unimproved water supply in Uganda and Zimbabwe, respectively). Similarly, in urban Ghana, with a lower proportion of flush toilets (10%) and a higher proportion of families with no access to sanitation services (16%), there is an apparent association between poorer levels of water service and risk of stunting (ROR 1.0, 1.7, 2.6).

Urban Nigeria has a relatively large proportion of families with access to a flush toilet (31%), but also has a relatively high proportion of families without access to sanitation services of any

type (32%). That this indicates that the urban Nigerian environment has relatively more fecal contamination is illustrated by the observation that, while the proportions of families with a flush toilet and the proportions of families living in a community with a high level of sanitation are similar in urban Uganda and Nigeria, the proportion of families in urban Nigeria that live in a community with a high level of sanitation is only 16 percent (calculated from data in Figure 19), only half the number of families that have flush toilets themselves (31%, Table 23). In this relatively contaminated urban environment in Nigeria, no association between level of water service and risk of stunting is seen (ROR 1.0, 1.2, 1.1). This rather crude analysis supports the speculation that the key intervention to increase the health benefits in urban Nigeria has less to do with the water services themselves, and more to do with the provision of sanitation services to the 32% of the population that currently lacks them.

Table 24

Relative Odds Ratios for Stunting by
Individual and Cluster Level of Service[1]
Cross-Country Comparisons

	Ghana		*Mali*		*Nigeria*		*Uganda*		*Zimbabwe*	
	U	R	U	R	U	R	U	R	U	R
Individual Water[2]										
In-house	1.0	1.0	1.0		1.0	1.0	1.0	1.0	1.0	1.0
Improved	1.7	1.4	1.5	1.0	1.2	.9	1.7		1.9	.6
Unimproved	2.6‡	1.7	1.3	.6	1.1	.8	3.0	1.0	2.0	.5
Individual Sanitation[3]										
Flush Toilet	1.0				1.0	1.0	1.0	1.0	1.0	1.0
Latrine	1.0				2.7‡	1.9	1.4	1.9	4.1	4.2†
None	1.4				1.7*	1.6		2.0		6.5‡
Individual Sanitation[4]										
Improved	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
None	1.3	1.3*	1.0	1.4	2.6‡	1.8	1.4	1.9	2.3	5.2†
Cluster Sanitation[4]										
High	1.0	1.0	1.0	1.0	1.0		1.0		1.0	1.0
Low	1.5	1.1	1.3	1.5*	1.8‡		2.0		4.2 *	30.4

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

[1] Relative odds ratio rounded out to the nearest 0.1. Those left blank are not calculable.
[2] From Tables 3, 7, 11, 15, 19
[3] From Tables 4, 12, 16, 20
[4] From Tables 5, 9, 13, 17

Chapter 9

CONCLUSIONS AND RECOMMENDATIONS

The results of this study provide several conclusions and recommendations that are addressed to planners of water supply and sanitation projects in Africa but also have broad applications elsewhere.

9.1 Conclusions

1) In Africa, as in other regions, rural areas lag behind urban areas in water supply and sanitation coverage, and sanitation lags behind water supply coverage in both urban and rural areas.

2) DHS estimates of access to WS&S facilities vary from government estimates of coverage, sometimes drastically so. Rural sanitation coverage is much higher than thought. DHS data on water supply coverage could not be compared to government estimates because of differing definitions.

3) The association between improved sanitation and health is as strong or stronger than the association between improved water supplies and health.

4) When viewed from a health benefit perspective, community level of sanitation is a more important measure than individual household access to improved sanitation.

5) Health benefits may not be seen with improved water supplies in areas where the overall level of sanitation is low—that is, where the overall level of environmental contamination is high. In some cases, such as urban Nigeria, the first priority for improving health may be to improve local sanitation, rather than to expand coverage of improved water supplies.

6) Water supplies should be as close to the point of use as possible to maximize the health benefit. Water supplies that are piped to the point of use are optimal because it is convenient to use much more water, and therefore to improve hygiene. Further, with piped-in water, there is no need for in-house storage of water, a common source of contamination.

7) Health benefits of improved water supply and sanitation services can be seen only if the improved services are used, used properly and by the whole family, and properly maintained. The simple physical existence of improved services (or improperly used services) provides no health benefit.

9.2 Recommendations

1) Increased emphasis on improved sanitation relative to improved water supplies is needed if health benefits are to be realized. Coordination and balance of water supply and sanitation services is necessary.

2) In projects where health benefits are an objective, the goal and evaluation indicator should be to provide improved sanitation to at least 75 percent of the community. Sanitation coverage of less than 75 percent still places those with improved sanitation in their homes at risk because of the poor environmental conditions surrounding them.

3) In areas where some improvement in water supplies has been achieved but sanitation coverage is low, the highest priority, from a health benefit point of view, is to improve sanitation coverage and reduce environmental contamination.

4) It is important to assure that improved water supplies are as close to the home as possible, preferably inside the house.

5) Attention must always be given to assuring sustainability of WS&S services by establishing appropriate institutional structures to manage, operate, and maintain the services. Appropriate use of improved services must also be assured. This requires a variety of strategies:

   - Services should be of culturally appropriate and affordable design. They should be culturally appropriate to assure acceptability and use, and affordable to allow initial acquisition of services and long-term sustainability of services.

   - Hygiene education should be a part of water and sanitation projects and programs to maximize health benefits through the proper use of services and facilities. This education requires monitoring, evaluation, and, where necessary, adjustments to assure its effectiveness in promoting appropriate, sustainable hygiene behavior.

   - These strategies will be greatly enhanced by assuring community participation so that the services are acceptable to the designated populations and meet their needs. This applies not only in construction and maintenance, but also in the design of hardware and software (hygiene education) components of the services.

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