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The Effect of Improvements in Water Supply on the Incidence of [illegible] in Guatemala

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Abstract

A recent study of the impact of improved water supply, latrines, and health education in Guatemala showed no decline in diarrhoeal morbidity. A re-analysis of the data using a different control group shows that there was a significant decrease in rates of diarrhoeal morbidity in the community which received the intervention. Children aged one to seven who experienced the greatest incidence of diarrhoea at the inception of the study benefitted most from the improved conditions.

As participants in the United Nations Water Decade, development agencies have placed much greater attention on improvements in rural water supply and sanitation, as a means of improving health conditions for the poor majority of the underdeveloped countries of the world. This greater level of involvement has not as yet, however, been supported by studies which substantiate the hypothesis that improved water supply and sanitation produce improved health in developing countries (Kawata, 1978).

The uncertainty of the relationship between improved water supply and health

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has affected the funding of projects by the United States Agency for International Development (AID). In AID, water projects are funded under the health sector budget. The four key components of the health sector are primary health care services including maternal and child health, nutrition, and family planning; improved water and sanitation; selected disease control; and health planning. Each segment of the programme competes for funding within an overall budget. Some of the components of the health sector such as oral re-hydration and immunization have low capital costs as well as proven impacts on health. Water supply projects on the other hand, have high capital costs, are difficult to sustain, and have unproven or uncertain results on the health of those served (Biswas, 1981). Such programmes where costs are known but benefits are uncertain lose comparative advantage to those in which benefits are known to occur and where net benefits are clear.

As a result of a continuing interest in determining the impact of various interventions on the health of recipients, AID supported a study by the University of North Carolina at Chapel Hill (UNC) and the Institute of Nutrition of Central America and Panama (INCAP) in Guatemala (University of North Carolina at Chapel Hill and the Institute of Central America and Panama, 1978a; 1978b; 1978c. The study was designed and carried out for the purpose of determining if improvements in water supply alone, or in conjunction with a programme of latrine construction and health education, would diminish diarrhoeal morbidity. It compared diarrhoeal morbidity of groups within the experimental community with and without access to piped water by means of a private, household water connection, and it found that there was no significant difference. The purpose of this paper is to present an alternate conclusion based upon choice of a different control group. This alternate analysis resulted in findings of significant health impact not found by the original researchers.

Background

The study, entitled *The Food Wastage/Sanitation Cost-Benefit Methodology Project*, was carried out in two villages, an experimental and a control community, in the rural lowlands of Guatemala between 1973 and 1976. The study design used in the UNC-INCAP study follows the method most recently suggested by Carincross *et al.* (1980) as the recommended protocol for measuring health benefits of improved supplies. Comparative and follow-up approaches are combined using two samples: an intervention sample and a control sample.

> *The intervention sample is the community which is about to receive the improvement to its water supply. The control sample is a community which is not receiving an improved water supply and which is not affected by the activities surrounding the village water supply programme . . . . . If (diarrhoeal morbidity) falls markedly more in the intervention sample when compared with the control sample, we would then tend to infer that, although there have been changes due to other factors, the water supply on top of these other factors has caused an added improvement in the (diarrhoeal morbidity). (Cairncross et al., 1980).*

The design of a study which uses only a single test and a single control community is also addressed.

> *To avoid (such) difficulties, several villages are needed in each sample; but this may be logistically impracticable and one just has to take the risk (that an extraordinary epidemic won't occur in either community. (Cairncross et al., 1980).*

The UNC-INCAP study did as far as is practicable select two comparable communities and did monitor changes that occurred. The concept of a paired, test and control, village was part of the research design, therefore the selection of the villages was a critical decision. A list of 100 communities was prepared; 36 were selected for close study over a four-month period. The criteria for selection included similarities in population, socio-economic levels, stability of population, dietary habits, and morbidity for the past five years and for 15 days immediately prior to the field investigation.

Procedure

This process resulted in the selection of the paired communities of Florida Aceituna and Guanagazapa. While some of the characteristics for the two communities such as ethnic origin, occupational structure and literacy levels were different, morbidity experiences were comparable. The extended period of data collection began six months before any improvement in water supply or sanitation was made. During this initial six-month period, diarrhoeal morbidity continued to be comparable. For example, in the 1 to 7 year age group, the rate in the experimental community of Guanagazapa was less than four per cent higher than the rate for the comparable group in the control community of Florida Aceituna. The study monitored population changes over time and the differences are unexceptional.

Florida Aceituna, the control community, received water from shallow wells and from a river. Over 70 per cent used their own or a neighbour's well, while 9 per cent used the river. Additional sources of water for the community were unspecified or undetermined. No improvements, neither water supply, latrine construction, nor health education programmes, were implemented in the control community.

Interventions in the experimental community, Guanagazapa, included a new piped water system, latrine construction, and a health education programme directed at minimizing faecal contamination and increasing water use for hygienic purposes. By the end of the project, 65 per cent of the experimental community (164 homes) had piped chlorinated water metered to their individual patios, while 5 per cent (13 homes) received piped, unchlorinated water from a system existing prior to project inception. However, virtually all members of the experimental community had access to the improved water supply because of water sharing practices prevalent in the community. In addition, 79 latrines were constructed and all members of the community received instruction on sanitation improvement practices.

All households in each community were surveyed using a questionnaire and recall method to determine the incidence of diarrhoea. Surveys were done on a monthly basis for 35 of the 42 months of the study. A trained female surveyor visited each household and asked a respondent, usually the mother, to recall the incidents for the 15-day period prior to the visit. A family member was recorded as a diarrhoea case on the basis of explicit criteria which included the number and nature of bowel movements. Physicians revisited 10 per cent of the households to verify the reliability of the interviewers.

Population Comparisons

In any research design evaluation of the effectiveness of any intervention must discriminate between those who receive the intervention and those who do not. We

have compared subpopulations within the experimental community to cohorts in the control community. In preliminary analysis, the UNC-INCAP researchers did the same and found that persons two to seven years old in the experimental community did have reduced rates of diarrhoea even though the overall rate of diarrhoea in the community was not decreased (Shneider *et al.*, 1978). Yet later analysis sought to compare the health of those who had piped water and those that did not within the experimental community. This intra-community analysis found no significant decrease in diarrhoeal morbidity for any age group (University of North Carolina *et al.*, 1978a).

Comparisons of those with and without piped water within the experimental community is flawed in three ways. First, the selection — those that have water and those that do not — is not random. Indeed, a substantial cash contribution was required to obtain a water tap. Self-selected groups should always be suspect and should be of particular concern where the bias for having piped water is so apparent. Second, all of those without water were exposed to the health education programme. Third, and of greatest importance, is that an intra-community comparison of those with and without piped water connections is compromised by the extent of water-sharing among people in the experimental community.

Water-sharing is a common practice in most developing country communities. In this study area, the tariff rates encouraged such sharing, and the data suggested that the practice was extensive. Basic evidence is that over 17 per cent of all withdrawals were given to other houses. This would mean that virtually all members of the experimental community had access to the piped water supply.

Further evidence of this water-sharing is provided by examining the quantity of water used in the experimental community. Eight per cent of all families used in excess of 205 litres per capita per day, and 35 per cent used more than 75 litres per capita per day. This heavy usage would be consistent with water-sharing practices. The existence of water-sharing practices invalidates the use of any intra-community analysis. Therefore, the population of Florida Aceituna was used as the control group since it represented a similar community with no interventions. Using the UNC-INCAP data, comparisons of diarrhoeal morbidity with sex, age and family size through time in the experimental and control communities were made.

Results and Discussion

The analysis indicates that diarrhoeal rates in the experimental community — when compared to rates in the control community — show a progressive decline over the period of study. The data show a statistically significant difference in diarrhoeal morbidity for all age groups except those over 45 (Table 1). Differences continue to be statistically significant after controlling for family size and for season.

Within the experimental community, the volume of water use is inversely related to the rate of diarrhoea for the season. The correlation coefficient between the rate of diarrhoea for the entire community and the average water use per capita is very high ($r^2 = 0.97$). The relationship is stronger for water use and diarrhoea in the dry season ($r^2 = 0.98$) than in the wet season ($r^2 = 0.85$).

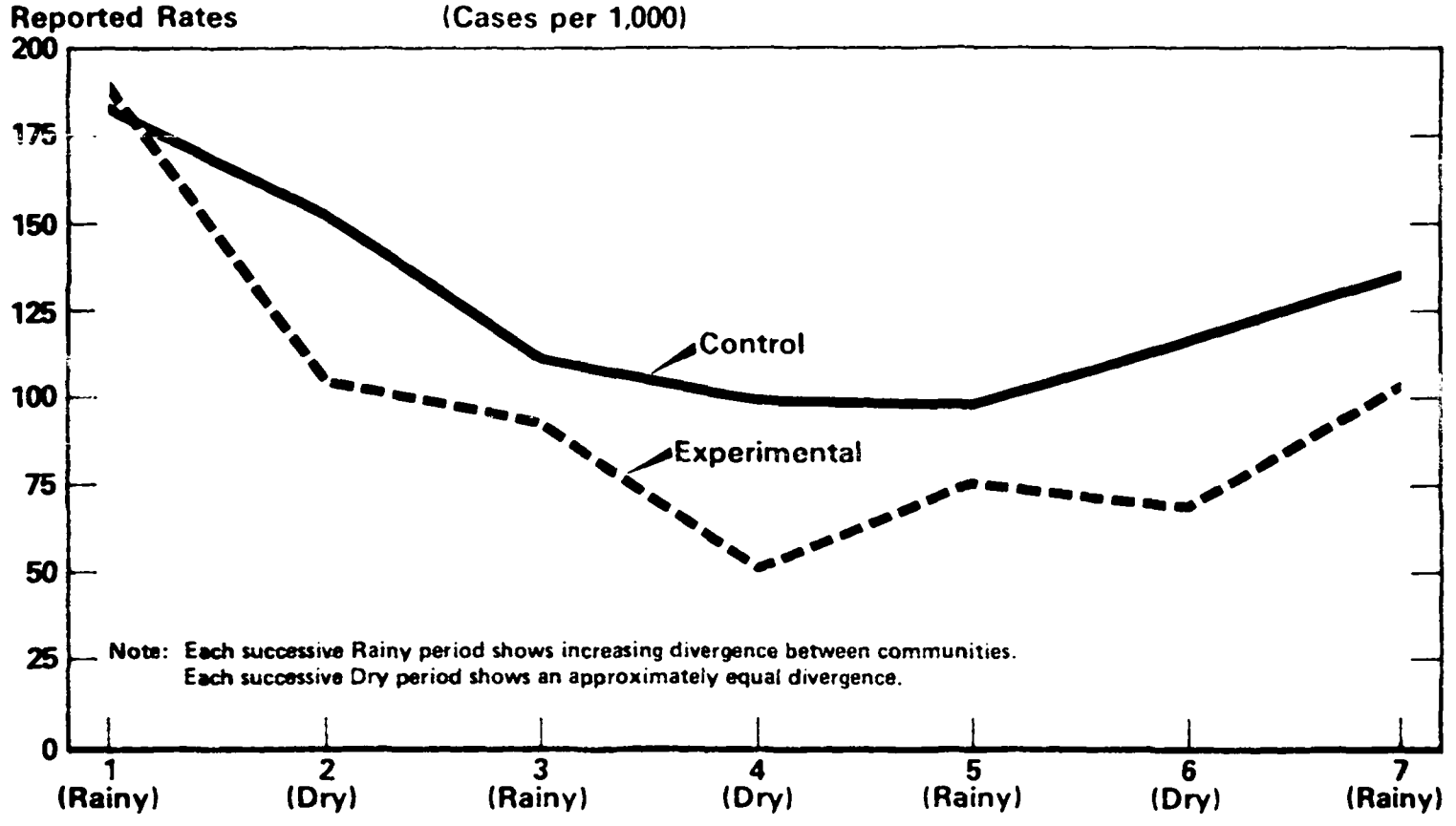
Children in the age group between one and seven are responsible for the majority of diarrhoea cases (53 per cent in each community). The incidence of disease in both communities was remarkably similar at the inception of the study and this rate is consistent with incidence of diarrhoea in Central America with unimproved supplies

TABLE 1
DIARRHOEAL MORBIDITY IN EXPERIMENTAL AND CONTROL COMMUNITIES

	Control Community				Experimental Community		
Age Group	Cases	Person Months of Observation	Rate (cases/1,000)	Expected Cases Based on Control Community Rate	Cases	Person Months of Observation	Rate (cases/1,000)
0 — <1	186	1,502	123	174	168	1,417	119
1 — <2	294	1,325	222	311	290	1,401	207
2 — <7	576	5,239	110	704	461	6,397	72
7 — <15	216	5,776	37	315	189	8,512	22
15 — <30	141	8,458	17	155	103	9,134	11
30 — <45	103	4,996	21	103	68	4,872	14
45 and over	131	5,110	25	129	133	5,165	26
	χ^2 value = 165.36[a]		Degrees of freedom = 6		Significance: $p = 0.0001$		

a. χ^2 computed independently for each age group. Total χ^2 and degrees of freedom is based upon a summation of the independent calculations. See Block Jr., H. M. 1960. *Social Statistics*. New York: McGraw Hill.

FIGURE 1: REPORTED CASES OF DIARRHOEA CHILDREN 1 TO 7 YEARS
FIFTEEN DAY PERIODS OF EACH MONTH OF DATA COLLECTION



as reported elsewhere (University of North Carolina, 1978a). It is this age group (one to seven) which benefitted most from the improved supply. The decline from the very high levels reported at the outset was rapid and rates in the experimental community never again reached the rates experienced in the control community. The decrease in morbidity rates is highly significant (Figure 1).

The effect of season can be shown most conclusively for the age group from one to seven. Diarrhoeal rates in the first dry season declined by 48 cases per two weeks per 1,000 and maintained approximately the same absolute difference throughout the project. The rainy season rates of the experimental community were higher at the start of the project, with each successive rainy season showing an increasing decline in both absolute rate and, with one exception, in percentage decline.

From re-analysis of the data, it seems that the UNC — INCAP conclusion that "the introduction of water and attempts to improve sanitation did not significantly affect diarrhoeal disease" (Biswas, 1981) is unwarranted. Indeed, the analysis shows that the introduction of the improved supply was accompanied by a significant decrease in the rates of diarrhoea in the experimental community as compared to the control community. The results of this project are limited by two weaknesses in data collection design. The recall of diarrhoeal incidents was recorded for less than 50 per cent of the total time period under investigation. This method was used in both communities and should not unduly bias the results. A more serious limitation results from the inability to blind surveyors from knowing which community and households received the intervention. Although there are limitations on the extent to which these conclusions can be extended, the evidence from these two small communities is important. For AID, where at present projects are approved and designed on the basis of theoretical merits, field supported results such as these can have a useful role in policy-making.

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