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The effects of distance and season on the use of boreholes in northeastern Imo State, Nigeria

D. Blum, R. G. Feachem, S. R. A. Huttly*, B. R. Kirkwood* and R. N. Emeh†

*Department of Tropical Hygiene, *Tropical Epidemiology Unit, The London School of Hygiene and Tropical Medicine and †Ministry of Economic Development, Imo State, Nigeria*

Summary

A study was conducted in a rural area of northeastern Imo State to examine the effect of distance and season on the use of boreholes, provided at a borehole-to-population ratio of 1 to 440. The type of water source used by households varied according to season. In the water-scarce dry season, 98% of households used borehole water: 64% as their sole source, a further 26% as their main source, and 8% as a secondary source. The use of borehole water as the main source was little influenced by distance until the household-to-borehole distance reached approximately 2 km. The situation was different in the wet season when the availability of water sources was much greater. In this season, rainwater was the main water source for 64% of households. Borehole water was the main source for only 31% of households. In the rainy season, the use of borehole water as the main source showed a significant decrease with increasing household-to-borehole distance.

The provision of one borehole for 400–500 people was associated with a high rate of use as the main water source only in the dry season. However, the use of boreholes as either a main or alternative source was high in both seasons and it is possible that those households that used boreholes as an alternative source used the water for drinking. In any case, in both dry and wet seasons, the great majority of households (90% and 94%, respectively) used a clean water source (a borehole or rainwater) as their sole or main source. It is suggested that such health-promoting behaviour be encouraged by incorporating measures to ensure the hygienic collection and storage of rainwater into water supply programmes in areas having seasons with adequate rainfall.

Correspondence: Dr D. Blum, Department of International Health, The Johns Hopkins University School of Hygiene and Public Health, 615 North Wolfe Street, Baltimore, Maryland 21205, USA.

Introduction

Unprotected traditional water sources in developing countries can be heavily contaminated with faecal viruses, bacteria and protozoa and can assist in the transmission of a variety of diseases, including diarrhoeal diseases and typhoid fever. Additionally, in certain regions, polluted traditional drinking water sources, typically ponds in the dry season, can transmit guinea worm. Decisions taken by households to use an improved water source, rather than an unimproved source, represent a balance between health, aesthetic, social, economic, technical and convenience considerations (White *et al.* 1972; Feachem *et al.* 1978). One of the important determinants of a household's choice of water source is likely to be distance.

The Imo State Drinking Water Supply and Sanitation Project in southeastern Nigeria was launched in late 1981. The project seeks to:

(1) provide boreholes with handpumps;

(2) promote the construction of ventilated improved pit latrines;

(3) train village-based workers as health and hygiene educators.

A health impact evalution, focusing particularly on childhood diarrhoea, was conducted in five villages in northeastern Imo State—three villages in which the project was implemented during the course of the evaluation (intervention villages) and two villages which will receive

the intervention package at a later date (control villages).

In conjunction with this health impact evaluation, a study was carried out in the three intervention villages to examine the effect of distance and season on borehole use. In the Imo State project, the number of boreholes provided per village was determined on the basis of village population, using a borehole-to-population ratio of approximately 1 to 500 or 1 to 1000. In these three study villages, the implemented borehole-to-population ratio was 1 to 440. Households within these villages are dispersed and, therefore, a proportion of households are not located close to a borehole. This presents a potential health problem if the people living at some distance from the nearest borehole continue to use a polluted traditional water source for drinking in preference to a borehole.

Materials and methods

Every compound in the three intervention villages studied in the health impact evaluation was visited by an enumerator during November and December 1985. An adult in the compound was questioned about the three major sources of water used in the dry season. These were listed in decreasing order of importance, in the sense of the proportion of the water needs supplied by each source. At the same time, identical information was sought for the wet season. The enumerator then walked to the named source(s), using a stride which had been measured beforehand. Where the distance could be motored, the distance was recorded using the mileage indicator of the vehicle. In some cases, the distance was partially measured in strides and partially motored. In order to examine the relationship between compound-to-borehole distances and borehole use, the compound-to-nearest-borehole distance was determined for those compounds that did not use borehole water in either season.

The data are presented in terms of households rather than compounds in order to be consistent with the analysis of the other evaluation data. Most compounds (65%) surveyed contained a single household. Since all households in the same compound generally use the same water sources, this was assumed to be the case for the analyses presented in this paper. Information was obtained from 893 households in the three intervention villages. These households represent 100% of the households included in the health impact studies and 65% of the total number of households in these villages. In this paper, data are presented for only 881 households since 12 households in one village were not allowed to use a borehole due to a village dispute.

Table 1. Distance to nearest borehole for 881 households in three villages

Borehole distance (m)	Households	
	No.	Per cent
<250	205	23
250–499	233	26
500–999	304	35
1000–1999	109	12
≥2000	30	3

Results

DISTANCE TO THE BOREHOLE

The borehole-to-population ratio in the three villages was 1 to 440. The effect of this on household-to-borehole distance in this dispersed population is shown in Table 1. Fifty per cent of households were located more than 500 m from the nearest borehole, and 15% of households had a journey of over 1 km (or over 2 km if the round trip is considered).

WATER SOURCE PREFERENCE

In the dry season, 64% of households used only one water source, 34% used two sources and only a small fraction used three sources. In the wet season, the use of multiple sources was much more common; only 7% of households used a single source, while 53% and 40% used two and three sources respectively. The types of water sources used by households in the three villages are listed in Table 2 according to season and preference. There are marked seasonal differences. In the dry season, almost all households (98%) used borehole water, usually as their preferred and only water source. In the

Table 2. Use of water sources by 881 households in three villages according to season and preference

Type of water source	Percentage of households using a listed type of source					
	Dry season			Wet season		
	Main source	Alternative source*	Either*	Main source	Alternative source*	Either*
Borehole	90	9	98	31	59	89
Rain	0	0	0	64	13	77
Pond	3	18	20	5	48	53
River	1	3	4	0	4	4
Unprotected spring	4	3	7	0	2	2
Traditional well	2	4	6	0	7	7
None	—	64	—	—	7	—

*Multiple responses.

wet season, although boreholes were used by a large majority of households (89%), only 31% of households used borehole water as their main water source. Rainwater was the most common main source in the wet season (64% of households). Pond water was also commonly used (53% of households), but usually as an alternative source (48% of households). The purposes for which the main and alternative water sources were used were not investigated during this particular study.

SOURCE CHOICE AND DISTANCE

The distance that household water collectors had to travel to get to their main water source was also seasonally influenced. In the dry season, this distance ranged from 0 m to 7530 m, with a mean and median value of 581 m and 429 m respectively. In the wet season the range was 0 m to 1660 m and the mean and median distances were 130 m and 0 m respectively, reflecting the popularity of rainwater, collected at home, as the main wet season water source.

DESIRABILITY OF SOURCE CHOICE

Five categories are described in Table 3, with regard to the use of the two relatively clean sources (borehole water and rainwater) and the relative distances to these and other sources. In the dry season, when rainwater is not available, the highly desirable choice (use of borehole water only) was practised by 64% of households

Table 3. The desirability of water source choice of 881 households in three villages

Water source choice	Dry season		Wet season	
	No.	Per cent	No.	Per cent
Highly desirable*	566	64	313	35
Desirable†	229	26	519	59
Showing some appreciation of the quality of borehole water‡	63	7	23	3
Undesirable§	7	1	15	2
Highly undersirable¶	16	2	11	1

*HIGHLY DESIRABLE Use of borehole or rain water only.
†DESIRABLE Use of borehole or rainwater as main source.
‡SHOWING SOME APPRECIATION OF THE QUALITY OF BOREHOLE WATER Making secondary use of a borehole more distant than main source.
§UNDESIRABLE Use of neither borehole water nor rainwater as the main source but making secondary use of rainwater or borehole water that is closer than main source (it may be that rainwater or borehole water was reserved for drinking).
¶HIGHLY UNDESIRABLE Use of neither rainwater nor borehole water for any purpose.

and the desirable choice (use of borehole water as the main source) by a further 26% of households. The highly undesirable choice (failure to make any use of borehole water) was practised by only 2% of households. In the wet season, when rainwater, a relatively good quality source, is readily available, the highly desirable choice (use of borehole or rainwater only) was practised by 35% of households, the desirable choice (use of borehole or rainwater as the main

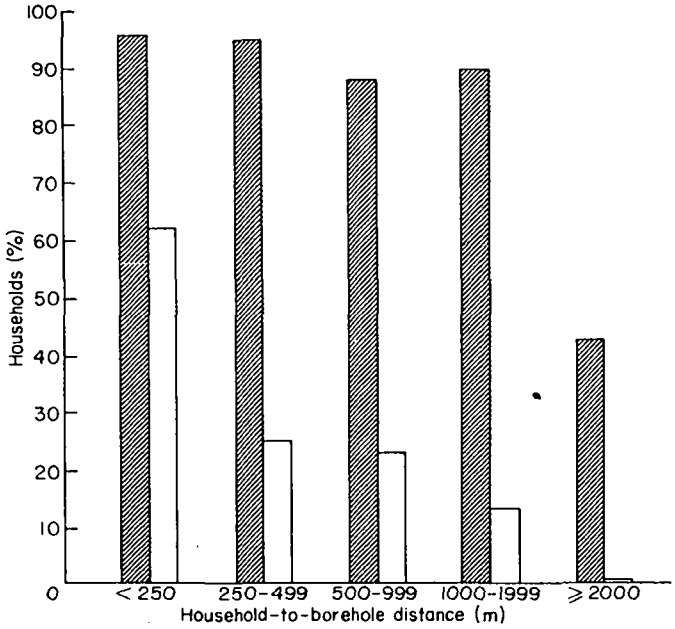

Figure 1. Use of borehole water as the main source by 881 households according to season. (▨) Dry season; (□) Wet season.

source) by 59%, and the highly undesirable choice (failure to make any use of either borehole or rainwater) by only 1%.

BOREHOLE USE AND DISTANCE

When households were grouped by their distance from the borehole used (or from the nearest borehole in the case of households not using a borehole), it was found that, in the dry season, most households used borehole water as their main source, regardless of the distance of the household from the borehole (Figure 1), although there was a distinct fall-off in use among households located 2000 m or more from a borehole.

In contrast, in the wet season, when rainwater was most often the main source, there was a statistically significant decreasing trend in the use of borehole water as the main source as borehole-to-household distance increased ($P<0.01$), with a sharp fall-off in use at borehole-to-household distances of 250 m or more (Figure 1). None of the 30 households located 2000 m or more from a borehole used borehole water as their main water source in the wet season. The proportion of households not using borehole water at all in the wet season, either as a main or an alternative source, increased with increasing household-to-borehole distance ($P<0.001$).

Discussion

In this survey we attempted to assess quickly, cheaply, and through objective measurement the influence of distance and season on the use of boreholes. For reasons of time we did not explore with the water collectors the reasons for their particular choices of water sources, but this would have added more insight into our findings. The conclusions which can be reached about the influence of distance on water source preferences and about the desirability of water-seeking behaviour are limited for two reasons. First, we measured distances only to those sources which a household claimed to use, and therefore we do not know whether or not there was a closer source which was not used. This information would have required detailed mapping of these dispersed villages. Since we were mainly interested in the effect that a borehole-to-population design ratio of 1 to 500 has on the use of borehole water, we opted for a less

time-consuming (and less expensive) methodology. Second, in this particular study we did not ask respondents about the purposes for which water sources were used. However, these data have been collected in the health impact evaluation surveys and in a later publication will be linked to the findings presented here.

Nevertheless, a number of interesting findings emerge which have important policy implications. As expected, the type of water sources which households use is influenced by season. In the dry season, when water is scarce, the number of options is limited. In this situation, borehole water is used by the majority of households, usually as the main and sole source. The use of borehole water as the main source is little influenced by distance until a household-to-borehole distance of approximately 2 km is reached. In the dry season, households which use multiple sources of water are more likely to walk further to use borehole water as their main source than to opt for a closer traditional source.

In contrast, in the wet season, water is readily available and households are faced with having to choose among a number of accessible sources. In this situation, distance clearly plays a role in the choice of main water source. The majority of households opt for the closest source, which is rainwater collected at home. However, 36% of households do not choose to use rainwater as their main source either because they do not have the proper type of roofing or because factors other than distance determine their choice. Briscoe, Chakraborty and Ahmed (1981) believe that perception of water quality exerts a strong influence in the choice of drinking water in Bangladesh. This may be the case here where the great majority of households not using rainwater use borehole water as their main source, rather than other traditional water sources.

A striking finding of this study is the extent to which the people in these villages exhibit desirable water-seeking behaviour. In both the dry and wet seasons, the majority of households (90% and 94% respectively) used a clean water source (a borehole or rainwater) as their sole source or, where multiple sources were used, as their main source. Properly sited and constructed boreholes provide excellent quality water. Rainwater, if properly collected and stored, is also a good quality source of water. Thus it would be unreasonable for water supply projects to discourage people from using a supply which is of good quality and as, or more, convenient for the consumer. The policy implications are that in those parts of the developing world where rainfall is adequate for some part of the year, the hygienic collection of rainwater should be considered as an integral part of a water supply project. Projects could be designed explicitly to assist and encourage households to collect and store rainwater during the wet months, and to rely on boreholes during the dry months. Such a policy has cost implications but some, if not all, of the costs of improving arrangements for rainwater collection and storage could be met by the householders themselves.

The borehole-to-population ratio of 1 to 440 in these villages was associated with a high proportion of households using borehole water as their main source only in the dry season. In the wet season people turned to another clean water source, namely rainwater. It may be that the large proportion (59%) of people using boreholes not as a main but as an alternative source in the rainy season, reserved the borehole water for drinking. While the provision of more boreholes per unit population might further increase use, it is not clear that the additional cost would bring with it an increased health benefit. The best use of scarce resources may lie with hygiene education to ensure the proper handling of good quality water, be it borehole water or rainwater, after it is collected.

The effect of a borehole-to-population ratio on borehole usage will depend upon average distances and therefore on the local settlement pattern. Distances of 2 km or more would seem to be associated with marked decreases of borehole use as the main source (Figure 1). Distances, as well as ratios, will also be important in determining the time spent in collecting water (distances affect travel times and ratios affect queuing times). Provided distances are kept to below 2 km, arguments based on time-saving benefits may be more relevant than arguments based on anticipated usage in designing the appropriate density of boreholes.

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