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2004

Problems of water storage in the rural village home: the Egyptian zir

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Summary

Although the potential adverse health impact of domestic water storage vessels that are used frequently in developing countries has been widely recognized, a search for systemic investigations found little data. This report describes the use of water storage vessels in rural Egyptian homes. This system of storage was found to have a number of implications: (1) for quality and quantity of water used in the house, (2) for undermining the potentially positive health benefits of current and new water supply programmes and (3) for confounding the interpretation of epidemiological investigations on water-related disease transmission.

to improving the safety of water supply in rural areas of developing countries. The example chosen to illustrate the potential health hazards of domestic water storage is the Egyptian zir. This is a very common water storage vessel found throughout the Middle East and northern Africa. A detailed description of the zir, its use and distribution throughout rural Egypt, its potential role in the transmission of certain water related diseases, and some suggested solutions are discussed below.

Methods

As part of a country-wide epidemiological study of schistosomiasis and enteric parasitic infections 3120 village dwellings were randomly selected from 35 villages throughout Upper (South), Middle and Lower Egypt (Nile Delta). Each dwelling was visited and the type of domestic water storage vessel was recorded. Other relevant data were systematically collected on the type of water supply and excreta disposal. Anecdotal observations on numerous environmental factors were recorded when the data form was being completed in the dwelling.

The residents of each dwelling were examined for enteric protozoan infections. A formalin-ether concentration procedure for the identification of protozoan cysts in the stool was used (Blagg *et al.* 1955). From the 3120 village dwellings 12 059 persons were examined. The epidemiological details of this survey have been published (Miller 1980, 1981).

Results

DISTRIBUTION OF WATER STORAGE VESSELS IN RURAL EGYPT
More than 95% of the dwellings in each of the

Introduction

In most rural and in many of the semi-urban areas of the developing world, water for domestic use is first drawn from a supply at some distant place from the family dwelling. The water brought into the dwelling that is not used immediately is either left in the collection vessel or more often transferred to some type of storage vessel (Miller 1981). It seems reasonable that the storage of water in the home or dwelling before it is consumed could impair the quality of water consumed. Water storage systems, however, have been consistently ignored when designing domestic water supply improvements. The literature revealed many investigations on the relationship between the type of water supply and various enteric infections, but none which documented the hazards of domestic water storage or any that suggest solutions (Miller 1981).

The aim of this study was to direct attention to the role of domestic water storage in relation

15N 8613
203.1 84PR

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Table 1. Percentage of dwellings with different types of domestic water supply in rural Egypt, by region*

Region	Piped supply		Hand Pump		Canal supply
	Inside house	Outside house	Inside house	Outside house	
Upper (South)	2.1	81.3	16.1	4.9	1.9
Middle	1.1	30.3	5.1	65.6	3.2
Lower (Nile Delta)	4.1	90.6	<1.0	<1.0	18.7

*Classification was not mutually exclusive, as more than one type of supply may be used.

rim and dipped into the water. Sometimes a person would have to put his or her whole arm inside the *zir* to fill the can. Drinking water was not collected from the water that seeped through the *zir* walls.

Figures 1-3 show pictures of 'public' Egyptian *zirs* identical to the ones used inside the home. The 'public' *zirs* are set out and maintained by shop keepers or by other individuals in places where there was a perceived community need for a 'street side' source of drinking water. Any passer-by could freely draw a drink. Figure 1 shows a well maintained example of a 'public' *zir*. Figure 2 shows a more typical condition of 'public' *zirs* that were supported by stone. Note that there were two lids for three *zirs* and that one had a bad break. In Figure 3 a mother fetches a drink for her child seen in the background. The drinking cup was inadvertently dropped into the *zir* and the woman had to retrieve it from the bottom, mixing up sediment as she did so.

These pictures are typical of *zirs* both inside the home and out, throughout the study region. Apparently, this popularity stems, in part, from the cooling effect of the evaporating water which is promoted by the hot dry climate.

USE OF THE ZIR

Zirs were used regardless of the type of water supply available. Most often the water supply in rural Egypt was from a protected source and pumped to a public tap. Infrequently, the domestic water supply was obtained from nearby canals. Table 1 shows the distribution of water supply in the study. Even the very few homes,

less than 1%, that had an inside piped water supply (usually a single tap) had *zirs*. Moreover, the tap water in these homes was routed through the *zir*. Tap water stored in the *zir* was said to be cooler to drink, tastier (probably because of the increased aeration) and it was there when desired. The last point was a reflection of the irregular nature of the piped water supplies in the rural areas.

All water in the home to be used for cooking or drinking was drawn from the household *zir(s)*. Sometimes the *zir* provided the water for washing utensils or clothes. Water for personal hygiene including ablution and *wadu* (anal cleaning) could also be taken from the *zir*, but demands on the *zir* supply other than drinking and cooking varied widely.

A *zir* with heavy demand may be filled more than once a day. Typically, water was added to the *zir* before it was completely empty and usually before the level was down to less than a quarter or a fifth full. Although specific data were not collected, it seemed unusual for a *zir* in a household not to have been refilled at least once every three or more days, with a likely mean resident time for the stored water of a day and a half.

Some villagers claimed to wash the *zirs* out twice a week, but never more often. Soap was not used for cleaning the *zir*, as it would be difficult to rinse the soap from the porous walls. Although maintenance of the household *zir* varied greatly, frequently *zirs* were seen with a confluent growth of algae on their sides, evident of being left undisturbed for long periods. Many *zirs* would be embedded or fixed in their stands

Table 2. Relationship between different water supplies and infection by any protozoan

Type of water supply	Percent positive for any protozoan infection*		
	Water supply present	Water supply not present	Significance
Piped inside	44.3	36.2	$P < 0.005$
Piped outside	38.0	35.5	$P < 0.009$
Canal supply	30.8	37.0	$P < 0.001$
Hand pump supply			
inside	37.8	36.3	NS
outside	34.8	36.8	NS

*Percent positive infected with either one or more of the following protozoan parasites: *Entamoeba histolytica*, *Entamoeba coli*, *Entamoeba hartmanni*, and *Giardia lamblia*.

making it impossible to up-end the container prohibiting a thorough rinsing. Some form of sediment was usually present in the bottom of many of the vessels.

The amount of water consumed per capita per day may be affected by the *zir* method of water storage. On-site observations suggested that more water would be consumed per capita as the number of *zirs* present in the dwelling increased.

THE ZIR AND PROTOZOAN INFECTIONS

Table 2 shows the relationship between the type of water supply and the percentage of persons infected with one or more of the following protozoan species. *Entamoeba histolytica*, *Entamoeba coli*, *Entamoeba hartmanni*, and *Giardia lamblia*. Contrary to the expected outcome, infection was slightly more frequent in individuals who had safer water supplies. No other combination of environmental factors or species of protozoan was found to be significantly associated. An analysis to compare infection between groups who had or did not have *zirs* was not possible because too few were in the latter group.

Discussion

Zirs were found to be the sole method of domestic water storage in rural Egypt. All domestic water for drinking and cooking was cycled via the *zir* regardless of the source or type of water

supply. Unfortunately, no microbial studies of water drawn from *zirs* were made. Such data for *zirs* does not seem to be available from other sources other than work by Tomkins *et al.* (1978), who found large numbers of coliform bacteria present in earthenware containers sampled in Nigeria. Naturally, the documentation of pathogens or indicator micro-organisms for faecal pollution is very important at this stage. Enteric illness, particularly diarrhoeal diseases caused by viruses, bacterial, and protozoan organisms have been frequently described in Egypt (Bennett *et al.* 1979) and are known to be in circulation throughout the rural areas. Morbidity and mortality due to these agents is very high.

I suggest that the opportunities for these agents to be introduced into the *zir* are so great, that contamination of the *zir* has to be assumed. Once the *zir* becomes contaminated, either by family members or by a polluted supply, it will probably be difficult to disinfect. First, the frequency of cleaning the domestic *zir* is clearly too low. The porous nature of the inside container walls will probably impair even a vigorous effort at disinfection. Similar to this problem has been the failure to disinfect the inside walls of wooden 'hot tubs' in the USA for *Pseudomonas aeruginosa* (McCutchan *et al.* 1982). Organic-particulate material will accumulate on and within the rough porous walls of the *zir*, further inhibiting efforts to provide a clean safe storage vessel. Finally, the incomplete emptying of the *zir* on a daily basis allows sediment to accumulate and pollutants to be carried over from one day to the next.

For these reasons, I propose that the *zirs* throughout the study were heavily contaminated by the users, and probably provided a readily available transmission route for water-related infections. If this was true, it may explain why a more conclusive relationship between water supply and protozoan infection was not found. Such a conclusion assumes that the various water supplies were not a major source of infectious protozoan cysts.

Numerous other studies have attempted to seek correlations between environmental factors, especially water supply, and these and other enteric infections and have experienced

similar results (Levine *et al.* 1976, Curlin *et al.* 1977). Many reasons have been given for this seemingly unexpected lack of relationship (Briscoe 1978). Domestic water storage vessels like the *zir* may be a confounding factor in some of these studies.

These results have important implications for improvements in the quality and quantity of water supply projects where *zirs* are prevalent. Regardless of the type of water supply, the water was first stored in the *zir* before being consumed. If this behaviour of water storage remains unchanged, the quality of the water consumed would probably not be substantially improved with the expansion of protected supplies. This would be unfortunate, due to the substantial investment necessary to provide additional protected water supplies.

The amount of water available and used, i.e., the quantity of water, rather than its quality, also has important health implications for a large group of related water-washed diseases (White *et al.* 1972). The rationale is that by increasing the availability of protected water supplies more water will be used, and thereby improve personal hygiene. Too little is known about the impact of the *zir* storage system and the amount of water used by members of the family to predict its impact on increased water availability. It is quite possible that the size and number of *zirs* in a dwelling strongly regulates the amount of water available for domestic use regardless the type of water supply, of its distance from the house, its yield, and the community demands made on the supply. Therefore, it should not be assumed that programmes designed to increase the amount of water available in a village or region will result in a parallel increase in use by household members. This is an important aspect for which additional data are required.

IMPROVEMENTS IN HOUSEHOLD WATER STORAGE

In the short term, novel ideas for improving the *zir* abound. Most of these have been directed at making minor alterations in the structure of the *zir* to improve its overall sanitary design. A simple tap, built into the wall of the *zir* near the bottom of the container, during the construction of the vessel has been one of the most frequently suggested solutions. This design

would eliminate drawing water by hand from above. Whether this alteration would result in protecting the quality of water in the *zir* and be acceptable to the users has yet to be tested under field conditions.

Long-handled dippers, to draw water with, could also potentially reduce contamination by hands. This is an alternative to introducing taps and has the advantage of resembling the current pattern of drawing water. However, it is hard to imagine that the shaft of the dipper and the dipper itself would remain free of contamination for very long.

Another more complex alteration involves providing a filter built into the top half of portion of the container with a tap also included lower down. The top shelf of the vessel and the filter could be separated for cleaning. Neither of these solutions would overcome the problem of the porous and irregular interior walls which circumvent adequate cleaning. In fact, it is the hygienic maintenance of the vessel that is a central problem.

Many more speculative solutions could be provided here. The purpose, however, is to stress that a new emphasis is needed which will result in creative technical solutions that ultimately will be tested in the field. Obviously, this process will proceed slowly and with many set-backs without involvement and input from the potential users of new designs.

Acknowledgement

This work was carried out in rural Egypt as part of the joint University of Michigan-Academy of Scientific Research and Technology project entitled 'River Nile-Lake Nasser Project'.

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