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.

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 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 12059 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
rim and dipped into the water. Sometimes a person would have to put his or her whole arm inside the air to fill the can. Drinking water was not collected from the water that seeped through the air walls.

Figures 1-3 show pictures of 'public' Egyptian air, identical to the ones used inside the home. The 'public' air is 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' air. Figure 2 shows a more typical condition of 'public' air that were supported by stone. Note that there were two lids for three air 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 air and the woman had to retrieve it from the bottom, mixing up sediment as she did so.

These pictures are typical of air 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 AIR**

Air 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 air. Moreover, the tap water in these homes was routed through the air. Tap water stored in the air 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 was used for cooking or drinking was drawn from the household air(s). Sometimes the air provided the water for washing utensils or clothes. Water for personal hygiene including ablution and madu (anal cleaning) could also be taken from the air, but demands on the air supply other than drinking and cooking varied widely.

A air with heavy demand may be filled more than once a day. Typically, water was added to the air 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 air 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 air out twice a week, but never more often. Soap was not used for cleaning the air, as it would be difficult to rinse the soap from the porous walls. Although maintenance of the household air varied greatly, frequently air were seen with a confluent growth of algae on their sides, evident of being left undisturbed for long periods. Many air would be embedded or fixed in their stands

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

<table>
<thead>
<tr>
<th>Region</th>
<th>Piped Inside House</th>
<th>Hand Pump Inside House</th>
<th>Canal Supply</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upper</td>
<td>2.1</td>
<td>16.1</td>
<td>4.9</td>
</tr>
<tr>
<td>Middle</td>
<td>1.1</td>
<td>30.3</td>
<td>5.1</td>
</tr>
<tr>
<td>Lower</td>
<td>4.1</td>
<td>90.6</td>
<td>&lt;1.0</td>
</tr>
</tbody>
</table>

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

**Table 2.** Relationship between different types of water supply and infection by any protozoan.

<table>
<thead>
<tr>
<th>Type of Water Supply</th>
<th>Water Supply Present</th>
<th>Water Supply Not Present</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Piped inside</td>
<td>36.1</td>
<td>36.3</td>
<td>NS</td>
</tr>
<tr>
<td>Piped outside</td>
<td>38.0</td>
<td>35.5</td>
<td>P&lt;0.001</td>
</tr>
<tr>
<td>Canal supply</td>
<td>30.8</td>
<td>37.0</td>
<td>P&lt;0.001</td>
</tr>
<tr>
<td>Hand pump supply</td>
<td>37.8</td>
<td>36.3</td>
<td>NS</td>
</tr>
<tr>
<td>Inside</td>
<td>38.8</td>
<td>36.8</td>
<td>NS</td>
</tr>
</tbody>
</table>

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

**Discussion**

Air 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 air regardless of the source or type of water supply. Unfortunately, no microbial studies of water drawn from air were made. Such data for air 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 microorganisms 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 air are so great, that contamination of the air has to be assumed. Once the air 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 air is clearly too low. The porous nature of the inside container walls will probably impair even a vigorous effort at disinfection. Probably associated with this has been the failure to disinfect the inside walls of wooden 'hot tubs' in the USA for Pseudomonas aeruginosa (McCutchin et al. 1982). Organic material will accumulate on and within the rough porous walls of the air, further inhibiting efforts to provide a clean safe storage vessel. Finally, the incomplete emptying of the air 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 air throughout the study were heavily contaminated by the users, and probably provided a readily available transmission route for water-related infections. If this 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.

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References

