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Formative Ethnographic Research to Improve Evaluation of a Novel Water System in Ghana

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Abstract. The accessibility of potable water is fundamental to public health. A private for-profit company is installing kiosk-based drinking-water systems in rural and peri-urban villages in Ghana, and we evaluated their performance. Preceding an observational study to measure the effect of these kiosks on the incidence of water-related disease in recipient communities, we conducted ethnographic research to assess local water-related practices and the ways these practices would affect adoption of the new technology. We conducted fieldwork in two communities in Ghana and interviewed stakeholders throughout the water sector. Our findings illustrate the complexity of water-related behaviors and indicate several factors that may sustain disease transmission despite the presence of the new technology. This formative ethnographic research also improved the precision of our subsequent evaluation of the intervention by providing a site-specific, culturally-appropriate knowledge base. This study demonstrates the value of incorporating qualitative research techniques into evaluations of water-related projects.

INTRODUCTION

It is well accepted that increasing the accessibility of improved drinking-water sources is an effective means for improving global health. This knowledge has galvanized scientists and activists to repeatedly call for the prioritization of improved water supply in the international development agenda, beginning in 1965 with the initiation of The International Hydrological Decade by the United Nations Educational, Scientific and Cultural Organization (UNESCO), followed by the United Nations General Assembly's declaration of The International Water Supply and Sanitation Decade in 1980, and their subsequent initiation of the International Decade for Action – Water for Life in 2005. However, over the past 30 years, the absolute number of persons without access to a clean water source has barely changed.[1] Even more discouraging, many of the recommendations made three decades ago still define the limits of our knowledge.[2]

Problems of water supply and public health span the globe but they are embodied locally, within the specific circumstances that pertain to individual communities. Policymakers today benefit from meta-analyses that attempt to divine optimal methods for intervention towards the end of generating the largest improvements in health at the lowest cost, but there is still little to guide them about which interventions are the most appropriate for specific settings.[3] As a result, efficacious interventions for improving access to clean water may prove ineffective in practice because implementers fail to understand how the intervention will be used within a specific social and geographic context.[4] These interventions waste money, engender donor fatigue, cheat beneficiaries of improved health outcomes, and provide little knowledge to future decision-makers with which to design improved policies.

We argue that an ethnographic approach to water supply research, as exemplified by this investigation, can be helpful in identifying these context-specific factors. Ethnography is a qualitative research method that attempts to describe and interpret the behaviors and beliefs of a group, relying on diverse sources of information including in-depth interviews and direct observation. Although ethnographic methods have been used to develop evaluation tools in other public health settings, their application in the water sector has rarely been documented.[5] Our research demonstrates how the incorporation of these research methods into evaluations of water-related interventions can enable a more holistic consideration of the unique epidemiologic, hydrologic, and sociopolitical context presented by individual locales. This approach increases the precision and plausibility of the results of the overall evaluation, enhances the external validity of its conclusions, and provides fertile ground for hypothesis-building towards future research.[6]

BACKGROUND

As a country, Ghana exemplifies the trends of heavy burden of water-based disease and inadequate access to clean water that are characteristic of lower-income countries. Although the mortality rate in children less than five years of age was halved during 1957–1990, it stagnated thereafter and surveys indicate that it worsened slightly during 1995–2007.[7] As of 2008, one of every twelve children born in Ghana will die before the age of five years. Water-related diseases contribute significantly to the burden of morbidity and mortality borne by children in the country, and diarrhea is implicated in 18% of deaths in children less than five years of age.[8] Schistosomiasis is also endemic to areas of Ghana, and until 2007 the country bore the heaviest disease burden of Guinea worm in western Africa, although targeted public health efforts have recently interrupted its transmission.[9] The percent of the population with access to improved water sources has increased since 1990 but remains low; the most recent national survey indicated that in 2006, 21.9% of the population did not use an improved drinking-water source for their main supply. This figure masks a pronounced difference in coverage between rural and urban residents, with 90% of urban residents reporting the use of an improved source but only 70% of rural residents doing so.[10]

WaterHealth International, a private U.S.-based company, developed a kiosk-based system for supplying clean water. Already managing active operations in other regions of the world, this company installed its first facilities in Africa in Ghana in 2007 through its subsidiary, WaterHealth Ghana (WHG). The kiosk, known as a WaterHealth Center (WHC), uses multi-stage filtration and a trademarked ultraviolet disinfection technology known as UV Waterworks™ to produce

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clean drinking water from a locally available surface-water source.[11] The water is drawn mechanically to the WHC where it is disinfected, stored, and disbursed at a series of spigots. Customers come to the kiosk, pay for the water with cash or pre-purchased coupons, and transport it back to their households themselves. At the time of our data collection in 2008, the price levied for 18 liters of water was approximately 0.05 Ghanaian cedis (U.S. $0.05), and the revenues net of operation and maintenance costs are used to repay the capital costs for the facility. The community contributes 10% of the capital cost to establish the WHC and a philanthropic organization lends the community the remaining 90%; WHG helps manage the kiosk over the first eight years of service. On the basis of their existing operations in India, WHG expressed confidence that net revenues from the sales of water would be sufficient to repay the capital investment over that period. The small scale of the kiosk, with a maximum capacity of 65,000 liters per day or more than 20 liters per capita in a community of 3,000, is appropriate for small remote communities. Also, the demand-driven management contract provided by WHG attempts to make the operation economically and technically viable over the long term. Inherent in this model is the assumption that the installation of a new source of clean, affordable water will significantly improve the health of the target community.

This research was undertaken as part of an evaluation of the first WHCs installed in Ghana. The overall evaluation, implemented by the Johns Hopkins University Center for Water and Health, takes the structure of a prospective observational study and is being implemented in five low-density communities. The ethnographic component of the research chronicled here took place before implementation of the baseline survey of the overall evaluation, and was conducted in Afuaman, a pilot village that had received the WHC but was not participating in the overall evaluation, and Oduman, which was participating in the study but at that time had not yet received its WHC. Both villages are of similar size and demographic composition, and are located in the peri-urban areas of Ga West district approximately 20 km from the center of Accra. At the time of this study, Afuaman had the only operational WHC in Africa, and Oduman was chosen because of its demographic similarity and geographic proximity to Afuaman.

The WHCs efficaciously filter and disinfect water in a laboratory setting but there is little evidence of their effectiveness in practice. An evaluation that took place in a group of villages in Mexico found that the installation of UV Waterworks™ technology had no significant impact on measured health indicators, which the investigators ascribed to the infrequency with which the residents used the technology.[12] However, their experience is not comparable with the systematic installation and management of the WHCs by WHG in Ghana, the subject of our study. The overall evaluation is thus concerned with the community-level effect that the installation of a WHC has on the quality of water consumed, the prevalence of water-related disease, and the distribution of these impacts across the population in a group of villages in Ghana. The ethnographic component of our research is concerned primarily with how the WHC is used in practice and how this use modulates various impacts within households. Specifically, we pursued three main research questions, concentrating on identifying behaviors that might inform further development of the subsequent household survey. 1) How do households collect and use water when multiple heterogeneous sources are available? 2) What behaviors aside from a household's choice of drinking-water source affect its exposure to water-borne disease? 3) What household and community factors have the potential to limit access to improved water sources?

METHODS

The ethnographic component of the evaluation was initiated in March 2008. The proposal was submitted to the Johns Hopkins University Institutional Review Board, who determined that it did not qualify as human subjects research and was therefore exempt from Institutional Review Board review.

We obtained data in Ghana during June and July 2008, a period that enabled a member of our team to live for two weeks in the communities of Oduman and Afuaman and to conduct ethnographic fieldwork with the residents of each village.[13] After an introductory meeting with local traditional leaders, housing was arranged with a local resident and the team member settled into the community and participated in all activities of day-to-day life. In each community, a young bilingual resident served as a guide and interpreter. Residents were verbally informed on an individual basis of the purpose of our research and were notified of their ability to participate or refuse to participate. The team member identified local sources of water and then used direct observation methods to obtain data on the water-related practices in the community, including collection, transport, storage, and use.

Informal interviews were also conducted with an opportunistic sample of the residents encountered during daily life in the villages, including local political leaders, religious leaders, men, women, and health care workers. Audio-visual recordings were made during much of the fieldwork, which enabled us to revisit those experiences at a later date, thereby increasing the fidelity of data collection. Field notes were written daily, and video recordings were logged and captured with a non-linear editing system.

Additionally, the team member conducted in-depth interviews with 10 stakeholders in Accra, including but not limited to government bureaucrats, WHG managers and employees, non-governmental advocates, academic researchers, and small-scale private water service providers. The interviews were semi-structured but broadened depending on the informants' knowledge and willingness to speak. Audio-visual recordings were made whenever possible.

The digital recordings were transcribed by using Roni Music's Amazing X software to decelerate the audio files without shifting the pitch; the recordings were then double-checked for accuracy at regular speed. Many of the conversations recorded in the study communities were conducted in local languages (Ga, Ewe, or Hausa); these recordings were transcribed and then translated into English by students in the linguistics department at the University of Ghana. Textual analysis was performed continuously, concurrent with data collection, according to a case-study approach. Relevant quotes were flagged in the transcripts and a review of these new materials helped further refine the main research questions.

RESULTS

Ethnographic techniques yielded a variety of data that would not have been readily discerned by other more quantitative research methods. First, we attempted to assess the ways

that households collect and use water when multiple heterogeneous sources are available. Our observations strengthen the findings of other authors that community members use different water sources with different qualities for different purposes, not a single main water source for all uses as might be typically assumed.[14] For example, households routinely stored different qualities of water in different containers, oftentimes alongside one another. One household reported paying for the delivery of a barrel of river water for the purposes of laundering and bathing but also reported accessing water from the WHC for cooking and drinking. In some households, different family members used different water sources for the same activity; water from an improved source might be used for bathing but only by the senior member of the family. Characterizing household water use is thus much more complicated than identifying a single main source for all members and all activities.

Accordingly, we observed that the availability of improved drinking water did not eliminate the demand for unimproved sources, especially if they provided a different price/quality mixture. Routine collection of water from unimproved sources may thus maintain secondary pathways of disease transmission even in households that patronize the WHC for drinking water. This finding undermines the notion that provision of a clean water source through the WHC will be sufficient to interrupt disease transmission, a perspective exemplified by a statement given by the Secretary of the Water and Sanitation Board in Oduman in regards to schistosomiasis in the area: "When we get this pipe-borne water, nobody will fetch water from the river, because when you send [your child] to fetch water from the river, he ends up swimming in it. Before you know it there's blood in his urine, and he's complaining of stomach pains and there's something in the water, a leech, and next thing you know there's one on your child's body. It has sucked all your child's blood. By the time you take him to the hospital to get the leech removed, he's dead. But if we have this pipe-borne water, they will stop going to the river. And the deaths will be curtailed."

Our observations of the continued use of unimproved sources in Afuaman after the installation of the WHC there suggest that the Secretary's confidence may prove inordinate. Although informants generally expressed awareness that the consumption of contaminated water could cause disease, they continued to practice other behaviors they perceived to be less risky, such as full-body immersion during water collection. This finding is consistent with predictions based on the Health Belief Model, which suggests that persons are less likely to take action in response to risks for which they believe they are less susceptible.[15]

In addressing our second research question, we identified several behaviors that may increase exposure to water-borne disease irrespective of choice of drinking-water source. First, we identified several mechanisms by which water quality may be attenuated between collection at the WHC and consumption at the household. For instance, we observed that most customers who collected water at the Afuaman WHC used their own vessels for water collection as opposed to the narrow-necked jerry cans that WHG had attempted to distribute. Many persons with whom we spoke also reported having given their containers only a cursory rinse with clean water before refilling them, even if they had just used them to transport water from unimproved sources. Other studies have identified recontamination of clean water during transit and storage as a key obstacle to the success of community-based interventions.[16,17] Our observations add context to this finding.

Second, our research suggests that non-drinking behaviors may remain an important vector for water-borne pathogens in the study communities. For example, when we observed children collecting water from a river for the purposes of bathing, we found that they often casually drank water from the source while they were there (Figure 1 and Figure 2). However, households reported that children only obtained water from the source for household activities and did not consider it a drinking-water source. This finding illuminates a potential source of reporting bias in surveys that fail to characterize the full spectrum of an individual's water-related behaviors.

Third, our research suggests that spatial proximity and economic cost are important determinants of access to improved water sources and may limit household use of the WHC. The sensitivity of household water-source choice to these factors could have consequences for the distribution of the intervention's impact on population health. The impact of spatial location was particularly evident in Afuaman because the WHC was located on the periphery of the community and residents on the distant side of the village did not report accessing it. Some residents who demonstrated a strong preference for water of improved quality continued to purchase water by the bucket from a neighbor's large plastic cistern at a cost of U.S. $0.10–15, two to three times higher than the price at the more distant WHC.

For other persons, economic cost clearly obstructed access to the WHC. Even with water at the WHC priced at only U.S. $0.05, residents were observed walking past the facility to collect untreated water from a river further along the path. The strength of a person's aversion to paying for water compared with collecting it for free at an unimproved source is their price elasticity of demand for clean water. Our observations are consistent with those of other investigators in speculating that low-income rural households are quite sensitive to changes in the price of water, in contrast to middle-income

FIGURE 1. Children drinking water as they collect water at a surface source, Afuaman, Ghana.

FIGURE 2. Boys washing and gargling at water-collection point, Oduman, Ghana.

urban residents with piped connections who have generally been found to exhibit an inelastic demand for clean water.[18,19] The factors that influence elasticity of demand for clean water will thus have important implications for the distribution of health consequences engendered by the kiosk, and remain an important topic for future research.

DISCUSSION

This ethnographic research demonstrates the value of incorporating qualitative techniques into future evaluations of water-related projects. First, ethnographic methods can improve the precision of other research techniques by informing development of assessment tools. Ethnographic research during the formative stage of this evaluation enabled us to identify and adopt local vocabulary and concepts in our subsequent survey instrument. For example, we adopted emic descriptors of water sources drawn from local usage such as 'polytanks', 'tanker-trucks', and 'sachets'. Consequently, the survey instrument was better adapted to the study communities. Additionally, our observations of the diversity of water sources at use in the study communities and the complexity of the use behavior pursued by their residents enabled us to better specify our research questions for the overall evaluation. As a consequence of this ethnographic component, the overall evaluation explored why households chose particular water sources for specific uses such as drinking, bathing, and cooking. We also adjusted the survey instrument to better disaggregate the intervention's effect on drinking-water collection and use from its effect on general water-related practices. Finally, our identification of the strong influence that spatial proximity has on choice of water source led to the incorporation of geographic data collection in the overall evaluation to further examine the impact of distance on water choice. In this way, residual spatial variation in demographic and use-related variables will not be overlooked or bias estimates. For all of these reasons, this qualitative research has contributed to the accuracy of the subsequent findings of our overall evaluation.

Second, ethnographic research can contextualize results produced by other means, thereby increasing their plausibility. For instance, our direct observation of water collection behavior at the WHCs suggested that the use of contaminated containers for transporting the clean water might be contributing to the attenuation of water quality between the kiosk and the point-of-use. This finding has been subsequently confirmed by water quality evaluation of samples taken at the source, kiosk, and household-level. Also, our identification of apparent economic obstacles to use of the WHC could render interpretable the finding that residents with a higher price elasticity of demand for water experience smaller improvements in health as a result of the installation of the WHC. Additionally, our finding that WHC customers may continue accessing unimproved water sources for non-consumption uses (such as bathing and cleaning) may explain how non-drinking, water-related behavior can still affect health outcomes, particularly in regards to pathogens acquired through transdermal routes such as schistosomiasis. The overall evaluation will draw extensively from these findings.

Third, ethnographic research techniques provide fertile details from which to generate new hypotheses or to operationalize new solutions to problems of water supply. In regards to this intervention, spatial and economic obstacles had an apparent impact on the uptake of the new technology. Interviews with residents and policymakers suggested that an ambulatory vendor system or a rudimentary standpipe network might help expand the accessibility of the otherwise highly-centralized WHC. The economic obstacle is more tenacious because there is an inherent tradeoff between the affordability of the water provided by the system and the financial integrity of the WHC itself; the facility must be economically viable but to have an impact on health it must also remain affordable for the population. The WHC in Afuaman appears to be operating sub-optimally because residents were observed traveling past the kiosk (entailing a greater distance) to acquire free water from the unsanitary surface source, while at the same time the WHC was running at below its full capacity. Our ethnographic research suggests that the health of the community and the profitability of the WHC may be improved if demand for water is segmented such that water purchases are subsidized for a certain economic class of users. This could be facilitated at the point-of-purchase by distributing coupons to poorer residents who fall beneath a certain income threshold, or to those households whose members are particularly vulnerable to water-related disease, such as families with young children. This scheme would likely broaden access to the improved water source and might contribute disproportionately to health improvements in the community because diarrheal disease in the population in Ghana is concentrated in lower income quintiles.[20]

In conclusion, this research has demonstrated the value of incorporating ethnographic methods into evaluations of water-related interventions. Our results have improved the precision of subsequent research instruments, increased the plausibility of expected quantitative findings, and suggested hypotheses for future research.

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