REGIONAL WATER USE PRACTICES IN THE KWAHU EAST DISTRICT OF GHANA AND THE POTENTIAL INFLUENCE ON DIARRHEAL DISEASE

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Abstract

Background: In low income countries, the Daily Adjusted Life Years (DALYs) of unsafe water, sanitation, and hygiene is 530/100,000 and is the 6th leading cause of death in children. Ghana, located in West Africa, is greatly impacted by poor sanitation and unsafe water supply. The objective of this study is to assess local water use and sanitation practices in the Kwahu East district of Ghana and how they relate to diarrheal disease.

Methods: A cross-sectional survey was administered to 236 households in the Kwahu East district. It was divided into four sections: demographics, water use practices, water related illness, and water related sanitation. Prevalence data for certain variables were calculated and simple t-tests compared difference in water practices for different demographic groups based on gender, age, and education status.

Results: Surface water and pump-well/borehole were the main sources of water for this area. Household demographics played a role in determining the household water collector. Over 95% of the responders did not treat their water. Moreover, gender, education, and age played significant roles in the degree of knowledge about diarrheal disease.

Conclusions: Gender, education, age, and household size are all key factors that impact water practices. The results of this study can be used for the development of culturally sustainable interventions directed towards the improvement of access to safe drinking water, and in turn, reduce waterborne illness.

Keywords: Ghana, water use practices, waterborne disease, diarrheal disease, sanitation hygiene

Introduction

It has been estimated that 663 million people worldwide still lack access to clean, reliable water sources, with the majority located in Sub-Saharan Africa. In low-income countries, unsafe water, sanitation, and hygiene is the 4th leading cause of death overall, and the DALYs of unsafe water, sanitation, and hygiene for low-income countries is 530/100,000 (World Health Organization [WHO], 2009). In rural communities, it is estimated that eight out of ten people still do not have access to improved water sources (United Nations Children's Fund [UNICEF] and WHO, 2015).

Ghana ranks 138 out of 187 on the Human Development Index (HDI), a measurement of human development (United Nations Development Programme [UNDP], 2014) but still struggles with poor sanitation and non-potable water. With an estimated population of 25.9 million people (WHO and UN partners, 2015), 89% of Ghanaians have access to improved water sources with the majority living in urban settings (WHO/UNICEF, 2015). These improved water sources include piped water, public tap/standpipe, borehole, protected dug wells/springs and rainwater harvesting and have increased overall access. Unfortunately, studies in both urban (Kwakye-Nuako et al., 2007; McGarvey et al., 2008) and rural (Anim, Nyame and Armah, 2010) settings have shown that improved water sources are often contaminated.

It has been well established overall country mortality is attributable to the lack of access to potable water sources, specifically the mortality due to diarrhea (Green, Small & Casman, 2008; Whelan & Willis, 2006). Water quality improvements may have a minimal impact when sanitation conditions are poor (Eisenberg, 2007). According to UNICEF, only 15% of Ghanaians have improved sanitation facilities which would ensure hygienic separation of human excreta from water and/or soil (WHO/UNICEF, 2015). This problems is most apparent in rural communities where sanitation can include open pit latrines near surface waters that double as primary water sources. A local water quality study in the region in 2011 (Ayeh-Kumi, personal communication, November 2011) and another study of similar water sources in Ghana (Kumasi, Obiri-Danso, & Ephraim, 2011) have

confirmed high levels of fecal contamination. A substantial number of people continue to use these contaminated ponds and rivers as primary water sources. (Anim et al., 2010).

This lack of sanitation can lead to a cycle of diarrhea disease especially in vulnerable populations such as pediatric. For children under 5 years of age, diarrheal disease remains the 6th leading cause of death (WHO, 2015; GSS, 2010). A survey from Ghana Statistical Services (GSS), Ghana Health Services (GHS) and ICF Macro (2009) reported at least 20% of children under 5 years old had diarrhea in the past 2 weeks. In a recent study of diarrheal disease in infants and young children in communities from Africa and Asia, Kotloff et al. (2013) found there was a common pattern of illness due to four common waterborne pathogens: rotavirus, Cryptosporidium, Escherichia coli, and Shigella. By preventing fecal contamination through education and appropriate water treatments, this disease burden can be reduced (Opryszko et al., 2013). The lack of water infrastructure requires point-of-use treatment at individual households but several recognized barriers exist to the treatment of drinking water. They include cost to treat, knowledge of proper treatment methods, and access to necessary materials (Phaswana-Mafuya, 2005).

We believe this study will establish an understanding of local water use practices and how they relate to diarrheal disease in the Kwahu East district of Ghana. This information is fundamental in determining the most sustainable methods of improving water access and quality.

Methods

Data collection

A cross-sectional study using a home sampling approach was conducted among the following villages in the Kwahu East district of Ghana: Awisesu, Chunwa, Deduekro, Miaso, Nteso, Odumase, Oframase, Ohemaa, and Oworobong. The survey and methods were approved by the New York Institute of Technology Institutional Review Board (BHS-629) and reviewed by the Noguchi Memorial Institute for Medical Research, University of Ghana, Legon-Accra.

This survey consisted of four main sections: demographics, water use practices, water related illness, and water related sanitation. The questionnaire was translated into a standard version of the native language of the region, Twi, by trained translators provided by The Rohde Foundation, a 501(c)(3), Non-Governmental Organization (NGO). The collection of survey data was completed in June 2010.

Data Analysis

Statistical analyses were performed using SPSS, version 18.0 for Windows (SPSS Inc; Chicago, IL). Descriptive statistics were calculated for

each variable and reported as mean and standard for quantitative variables and counts and percentages for qualitative variables. Comparisons of continuous variables were performed using Student's t-test for independent samples and analysis of variance (ANOVA). Comparisons of categorical variables were performed using χ^2 tests. P-values less than 0.05 were considered significant.

Results

Demographics

There were 236 household surveys completed with 44.5% (n = 105) surveys answered by a male, 55.0% (n = 130) surveys by a female, and 0.4% (n = 1) unreported. For study participants location, 28.9% (n = 68) were from Oworobong , 21.2% (n = 50) from Odumase , 11.0% (n = 26) from Miaso, 9.3% (n = 22) from Ohemaa, 6.4% (n = 15) from Awisesu , 4.7% (n = 11) from Chunwa , 4.2% (n = 10) from Deduekro, 3.4% (n = 8) from Oframase, 2.1% (n = 5) from Nteso, 0.4% (n = 1) from Accra, and 8.5% (n = 20) unreported. Respondents between the ages of 18-29 years made up 38.7% (n = 91) of survey participants. As for other age groups, 17.4% (n = 41) were between the ages of 30-39 years, 11.9% (n = 28) between 40-49 years, 16.6% (n = 39) between 50-59 years, and 15.3% (n = 36) over 60 years. The average number of people in a household was 6.43 (SD = 4.25). The number of children under the age of 18 living in a household was 2.94 (SD = 2.59).

Education

Respondents who reported no formal education made up 27.1% (n = 64) of survey participants, 11.9% (n = 28) reported 1-3 years, 14.8% (n = 35) reported 4-6 years, 22.5% (n = 53) reported 6-8 years, and 23.7% (n = 56) reported 8 or more years. Based on these groupings, there was no significant difference in education level between genders [$\chi 2(4) = 8.403$, $p = 0.078$]. The variable was recoded into a continuous variable by taking the average of each grouping. For example, those who reported 1-3 years were re-coded as having 2 years of education. Males had a mean number of years of education of 5.35 (SD = 3.42), and for females, the mean years of education was 4.17 (SD = 3.56). Results from a Student's t-test for independent samples showed that males had a statistically significant greater number of years of education than females [$t(233) = 2.579$, $p = 0.011$].

There were significant differences between age groups and level of education [$\chi 2(16) = 36.401$, $p = 0.003$]. Those in the $\geq$ 60 years age group were more likely to have no formal education as were those in the 50-59 years age group. In contrast, those in the 19-29 years age group were more likely to have a formal education.

Water collection practices

The majority of respondents reported surface water and/or pump-well/borehole as their main sources of water. More than 90% of respondents indicated that they thought water collection took "very little time" out of their day. Seasonal variation of water collection was noted.

One hundred-forty one (141) households reported females as the sole water collector, and 58 households reported males as the sole water collector. Thirty-five (35) households reported both males and females water collectors. The most frequently reported water collector was a female over the age of 15 years. Household size and number of children under the age of 18 years in the household affected who collected water. In larger the household sizes, younger children (males aged 10-14 years and females aged 10-14 years) collected more frequently.

The mean household size that used a male collector between the ages of 10-14 year was 8.07 (SD = 6.09), and for those who did not, the mean household size was 6.03 (SD = 3.59) which was significantly different [$t(229) = 2.943$, $p = 0.004$]. There was also a statistically significant difference [$t(228) = 4.465$, $p < 0.001$] in household size who used a female collector between that ages of 10-14 years (mean = 9.07, SD = 6.40) and those who do did not (mean = 5.88, SD = 3.46). (Figure 1). The mean number of children in a household who reported a male collector over the age of 15 years was 2.09 (SD = 1.96) compared to a mean number of children of 3.15 (SD = 2.69) who did not use a male collector over the age of 15 years. This difference was statistically significant with smaller households using males over the age of 15 years more often [$t(88.625) = -2.993$, $p = 0.040$].

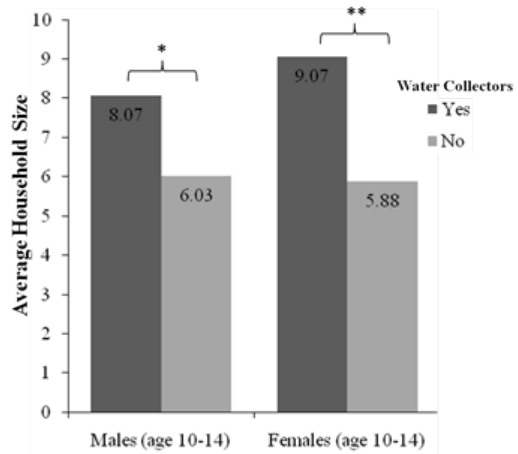

Figure 1. Differences in average household size between those who use female or male water collectors ages 10-14, and those who do not. Households reporting both males and females ages 10-14 as water collectors were significantly larger than those that did not. (*$p < 0.05$; **$p < 0.01$)

Water treatment and sanitation

The majority of respondents (90.3%) not treating water prior to consumption indicated that there was "there is no need" (46.5%). Data also indicated 95.1% (n = 224) of survey participants were willing to learn water treatment techniques if taught. When asked about their primary toilet facilities, 97.0% (n = 229) of respondents reported using a pit latrine as their primary toileting facility. The survey also revealed that 66.5% (n = 157) of respondents believed human waste remained in the soil or ground and 25.2% (n = 59) reported that "they did not know. "

Knowledge surrounding waterborne disease

There were significant differences in identification of symptoms between genders, education level and age groups.

Gender

There was a significant difference between genders in the correct identification that diarrhea comes from contaminated water [$\chi 2(1) = 10.058$, $p = 0.002$]. Males selected diarrhea more frequency than expected. There was also a significant difference in gender for the "disease does not come from water" [$\chi 2(1)= 7.643$, $p = 0.006$]. With this, females selected "diseases does not come from water" with greater frequency than expected.

Education

There were differences between education levels in possible symptoms from the ingestion of contaminated water. In particular, the correct identification of diarrhea [$\chi 2(4) = 9.773$, $p = 0.040$], eye/vision problems [$\chi 2(4) = 14.415$, $p = 0.006$] and the selection of "disease does not come from water" [$\chi 2(4) = 9.680$, $p = 0.046$] were significantly different between those who self-reported a formal education and those who self-reported no formal education.

Age

There were also significant differences between age groups in the correct identification of diarrhea [$\chi 2(4) = 20.524$, $p < 0.001$], stomach pain [$\chi 2(4) = 24.200$, $p < 0.001$], weight loss [$\chi 2(4) = 19.512$, $p = 0.010$], malnutrition [$\chi 2(4) = 19.218$, $p = 0.001$], eye/vision problems [$\chi 2(4) = 19.502$, $p = 0.001$] and fever [$\chi 2(4) = 25.432$, $p <0.001$] (Figure 2). Respondents in the ≥ 60 years age group failed to identify diarrhea, stomach pain, weight loss and more frequently than expected. Those in the 19-29 years age group identified diarrhea, malnutrition, weight loss, vision problems, and fever with better frequently than expected. Finally, three groups were created based on the number of symptoms identified: 1) 0-2 symptoms, 2) 3-5 symptoms, 3) 6-7 symptoms. There was a significant association between age group and the number of symptoms identified [$\chi 2(8)$

= 33.053, p < 0.001]. The youngest age group identifying more symptoms associated with contaminated water than the older age groups.

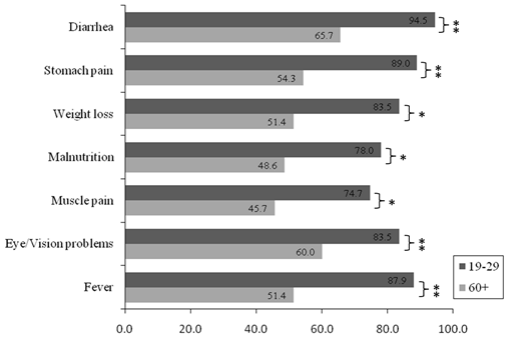

Figure 2. Differences between age groups in symptom identification. There were significant differences between the 19-20 and the 60+ age group each of the items depicted. (*p < 0.05; **p < 0.01)

Discussion

This study gathered information regarding current practices related to water collection, water treatment, and perception of waterborne illness in the Kwahu East district of Ghana. Several significant factors were investigated in this survey that provided insight in creating culturally appropriate and sustainable health interventions.

Water Use Practices

Consistent with the DHS for rural Ghana, the majority of water collectors were females over 15 years of age (GSS et al., 2009). However, we also found larger households were more likely to report males and females between 10-14 years of age as water collectors. For smaller households with fewer children under the age of 18 years, males over the age of 15 years were also reported as the water collectors. The majority of respondents indicated water collection took very little time which is also consistent with the DHS findings that 8 in 10 rural households reported it took less than 30 minutes to obtain drinking water (GSS et al., 2009). Our survey indicated that community members used both improved water sources as well as surface water sources. The proximity to various sources may dictate which type is utilized more frequently.

When implementing any form of intervention targeting all age groups and genders, seasonal variations should be anticipated. Data for climate models have shown a temperature increase of 3.6 degrees Celsius in the Volta Basin in Ghana over the next century would decrease not only surface water sources but also shallow groundwater (McCartney et al., 2013). In the dry season with more water scarcity, community members may have a predilection for surface water even if they know it is contaminated because of ease of access (McClain, 2013). Conversely, climate change can also

result in an unpredictable increase in precipitation that can lead to flooding and runoff causing a higher risk of cross-contamination between clean water sources and fecal waste (McClain, 2013). With this evidence, there is a need for the ongoing development of improved water source infrastructure in the region.

Understanding of disease burden

Discrepancies in diarrheal disease understanding among individuals in our surveyed region may reflect confusion at the community level. A difference may exist between what individuals have been taught in the school setting versus at home. Gyimah (2003) found the risk of diarrheal disease was highest for children in households without toilets and piped water, but the risk was even higher for those whose mothers had less formal education. Another study found general community knowledge can affect the overall knowledge of the individual (Andrzejewski, Reed and White, 2009). These studies support a unified, community approach to diarrheal disease prevention.

Impact of gender on disease knowledge

In the survey, male participants were more knowledgeable about the association between the consumption of contaminated water and diarrheal disease. Our data attempts to explain this difference by showing males had significantly more number of years of education. This gender disparity in education indicates a greater need for education among women and girls as related to diarrheal disease.

Impact of age on disease knowledge

Younger age groups were more likely to associate the consumption of contaminated water with diarrhea and associated symptoms than older age groups. The difference may lie in the evolution of the education curriculum to include information about waterborne illness. In 2000, an educational intervention developed by United Nations Educational, Scientific and Cultural Organization (UNESCO), UNICEF, WHO and the World Bank was initiated in Ghana entitled Focusing Resources on Effective School Education (FRESH) (Joerger & Hoffmann, 2002). FRESH has worked with the Ghanaian government in order to introduce health, hygiene, and nutrition education into the formal curriculum of 577 schools reaching 83,000 students (The World Bank, 2011). Therefore, any interventional program should target non-school attending community members to address the shortcomings of prior educational practices.

Limitations

There were a number of limitations with this study. During the development of the questionnaire, some of the words could not be directly translated into Twi. The modification of words could have altered the meaning of the original questions and introduced a source of bias.

Furthermore, some villages spoke different dialects other than Twi requiring assistance from untrained translators. The cultural perception of the research team in the community may have also led to a Hawthorne effect. The clinic consistently received more patients during the days the research team physicians were present suggesting the local community viewed them differently. These physicians were also responsible for assisting in the conduction the survey creating the potential bias.

Future directions

The results of this study can be a basis for the development of site specific interventions for safe water practices and improved hygiene. Water issues can become major obstacles to the development of impoverished countries affecting health, social well-being, and economic productivity (Elimelech, 2006).The survey suggests there is a desire from the respondents to treat their water, but they lack the knowledge and materials to do so. There is a need for additional research to determine the most culturally appropriate interventions aimed at water treatment to prevent any hindrance for economic development within this district.

The survey results can also be used to develop programs to improve education among community members regarding health, sanitation, and waterborne illnesses. Survey responses suggest an educational intervention relating health outcomes with contaminated water consumption may be best targeted to older age groups. However, additional programs on this topic involving the general population would also benefit all age groups to ensure a complete and accurate knowledge. It would also be beneficial to provide educational programs about general sanitation and hygiene practices as well as the association between human waste and water contamination.

Conclusion

This study gathered information regarding cultural practices relating to water collection, water treatment, and perception of waterborne illness in the Kwahu East district of Ghana. Water collection and treatment methods were similar to other areas of rural Ghana. We found household demographics, gender, education, and age all play significant roles in water collection practices and knowledge about related diseases. This collective information is vital in determining potential interventions of improving access to safe drinking water thereby decreasing the risk of waterborne illnesses. More research is required to be able to provide effective interventions not only in the Kwahu East district of Ghana but also other regions of Ghana and low-income countries.

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