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Improvement in access to safe water, household water insecurity, and time savings: A cross-sectional retrospective study in Kenya

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ABSTRACT

This study uses a cross-sectional survey (n = 557) with a retrospective design to examine relationships between improvement in access to safe water supply (i.e. extension of municipal piped water) and a range of social outcomes including water insecurity, household time savings and allocation, and household water expenditure in Usoma, Kenya. Data were collected in July 2016, about 3 years after the intervention, using a modified version of the Household Water Insecurity Access Scale (HWIAS). Having assessed the validity and reliability of the modified HWIAS, we examine how differences in levels of access to safe water influence reported levels of water insecurity as well as amount of money and time savings, post the water intervention. Findings suggest that higher levels of access reduce risk of water insecurity. Households with piped water on premises scored 2.95 points less on the water insecurity scale compared to households with access to unimproved sources. As anticipated, time saved on water collection was re-directed to income generating activities, while money saved was spent primarily on food. Important gender differences were reported, with female headed households having 1.15 points less on the HWIAS than male headed households. This study establishes an innovative approach to evaluating water interventions that can be used in program design and evaluation. The study also emphasises the need for universal access to safe water as envisioned in the Sustainable Development Goals (SDGs).

1. Introduction

In the year 2000, the Joint Monitoring Program (JMP) developed a standard set of drinking water and sanitation categories (improved vs unimproved) for monitoring progress in access to water and sanitations in low- and middle-income countries (WHO/UNICEF, 2015). In 2008, these categories were further expanded into a service ladder to better understand disparities in access beyond the typical improved (a water source that is protected from outside contamination) and unimproved categories. For example, within access to improved drinking water category, distinctions were made between access to piped water on premises and access to other improved sources such as public boreholes and standpipes (WHO/UNICEF, 2017). Building on these developments, the post-2015 water and sanitation monitoring framework seeks to refine the service ladder by incorporating *safety*, *reliability* and *accessibility* of the various water sources into the classification system (Shaheed et al., 2014: Moriarty et al., 2011; WHO/UNICEF, 2015). A key component of *accessibility* within the service ladder is the recognition of differences in amount of time spent fetching water, even among households with access to an improved source (For example, see Table 1 for distinctions between access to a *safely managed source* and *basic access*).

The classification in Table 1 provides opportunities for practitioners to better understand inequalities and appreciate the critical role of service levels and water collection time in promoting wellbeing (Shaheed et al., 2014). Already, studies have shown that time and money spent on water collection due to inadequate access have adverse impacts on households, including but not confined to depletion of household savings and productive time (Bisung et al., 2015; Ilahi and Grimard, 2000; Devoto et al., 2012). Aside from savings on water expenditure and time allocation, studies have also drawn on food insecurity literature to provide measures of water insecurity that can be used to assess inequalities in access and outcomes of water interventions (Stevenson et al., 2012, 2016; Subbaraman et al., 2015; Wutich and Ragsdale, 2008). Within this literature, water insecurity is conceptualized as a consequence of inadequate *access* to and/or *supply* of water to promote an active and healthy lifestyle (Wutich and Ragsdale, 2008; Wutich, 2009). While inadequate supply may exist because a water source does not provide adequate and reliable quantities of safe water, access on the other hand mostly reflects inadequate resources or

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Table 1
Drinking water service ladder.
Source: Adapted from Joint Monitoring Program (2015)

Service Level	Definition
Access to a safely managed source	An improved drinking water source which is on premises, available when needed, and free of faecal and priority chemical contamination.
Basic access	Access to an improved drinking water source (piped water into dwelling, yard or plot, public taps or standpipes, boreholes or tube wells, protected dug wells, protected springs and rainwater) with a total collection time of no more than 30 min for a roundtrip including queuing.
Limited access	Drinking water from an improved source for which collection time exceeds 30 min for a roundtrip including queuing
Unimproved	Drinking water from an unprotected dug well or unprotected spring

power to pay for or secure the most desirable water source (Wutich and Ragsdale, 2008; Wutich, 2009). Thus, even when water intervention is provided at the community level, water insecurity could exist among poor individuals who lack resources to extend piped water closer to their premises. In such circumstances, experiences related to water insecurity – including water insufficiency, water safety, and financial barriers to water collection (Stevenson et al., 2012, 2016; Subbaraman et al., 2015) – is disproportionately felt by the poor.

Though these experiences have tremendous impact on the health and wellbeing of individuals (see Bisung and Elliott (2017) for a scoping review on water insecurity and psychosocial health), there is scant literature on the pathways between water supply interventions and water insecurity. Only a recent intervention-control study by Stevenson et al. (2016) in Amhara Region of Ethiopia highlights the relationships between water supply interventions (i.e. protection of a previously unprotected source) and water insecurity. In this study, improvements in water supply were associated with a decline in experiences of household water insecurity; that is, households receiving the intervention had approximately 2 points decline on a standardized water insecurity scale, compared to the control group (Stevenson et al., 2016).

As the global community starts to document progress in access to water within the Sustainable Development Goals (SDG) framework, better understanding of the complexity of factors surrounding patterns of water access, impacts, and experiences will inform and promote equity in intervention design as well as maximise the benefits of water supply interventions for poverty reduction. In this regard, the aim of this study is to examine relationships between a water supply intervention (i.e. extension of municipal piped water) and patterns of household water insecurity, time savings on water collection, and financial savings on water. Specifically, the objectives of the study are to: (a) assess the validity and reliability of a household water insecurity tool, and (b) investigate the relationships between improvements in access to safe water supply and patterns of household water insecurity, household time savings and allocation, and household water expenditure. The study is based on cross-sectional retrospective analysis, as data on both pre and post-intervention exposures were collected about 3 years after the intervention. The study uses a modified version of the HWIAS developed by Tsai et al. (2016), and builds on prior work on water insecurity scale development by Wutich and Ragsdale (2008) and Stevenson et al. (2012) in Bolivia and Ethiopia respectively. Wutich and Ragsdale (2008) and Stevenson et al. (2012) used a grounded approach based on extensive field work to developed their water insecurity scales. The HWIAS however was adapted from the standard Household Food Insecurity Access Scale (HFIAS) (Coates et al., 2006, 2007).

2. Methods

2.1. Research context

The study was conducted in Usoma, a village located within the Kisumu Municipality on the shore of Lake Victoria in Kenya (Fig. 1). Most residents engaged in economic activities that were centered around the Lake, particularly fishing and car washing. A community survey conducted in 2013 captured 497 households, with a total population of 2131 individuals (Bisung et al., 2014). Daily water uses in Usoma mostly include water for drinking, bathing, washing, gardening, and rearing of animals. Residents in Usoma previously experienced widespread water insecurity and sanitation challenges. As at 2013, almost 38% of households reported using the lake as a major source of water for cooking, and 86% of households accessed lake water for domestic uses like bathing and washing clothes (Bisung et al., 2014). The nearest piped water source was a tap located on the premises of a Coca Cola bottling plant about 3 kms away. Residents who wanted piped water but could not make the journey relied on the services of water vendors. During focus group discussions and photovoice interviews conducted before the current intervention, residents expressed concerns about the opportunity cost of time and money expended on water (Bisung et al., 2015; Bisung and Elliott, 2016).

Following these findings, a water supply intervention was implemented by a local NGO together with a community water and sanitation committee in the last quarter of 2013. The intervention involved the extension of municipal piped water to a community water and sanitation facility with two options available to all households for accessing water. The first option involved fetching water in smaller quantities from the facility when needed, usually in 20-L plastic jerricans for a fee of 3 Kenyan Shillings (the equivalent of about USD 0.030 at the time of this survey). With the second option, households could make further extensions from the primary pipe line to their premises, and were required to bear the cost of connection, including construction of secondary water lines. Such households are also required to make monthly water bill payments to the municipal water company. The intervention targeted all households, and the community water and sanitation committee organised meetings prior to and during implementation to communicate these options to residents. At the time of data collection for this study (July 2016), about 20% of households had piped water on premises. Some households with piped water on their premises could resell in smaller quantities to their neighbours, usually at about the same fee as the community facility. Thus, about 72% often bought from the community facility or from a neighbour's tap. Some (8%) households also continued to use the lake water and other unimproved sources. Cost and management of each water source are provided as supplementary material (S1). Pictures are also provided as SI7.

2.2. Data collection

Data were collected through a cross-sectional survey. The sampling unit was the household – defined in this context as a person or group of persons that live together in a dwelling and share domestic resources including food stock. The sampling frame included all households who had resided in the community prior to the water intervention. Every household within the target population in all four quadrants of the community was earmarked for the survey. The quadrants are existing geographical units in the community made up of a cluster of houses. In each quadrant, the research team, led by a village elder, visited each household to administer the questionnaires verbally. Where the head was not available after repeated visits, we interviewed an adult household member capable of completing the questionnaire on behalf of the household head. The household questionnaire assessed water