HHS Public Access

Author manuscript

Soc Sci Med. Author manuscript; available in PMC 2021 January 01.

Published in final edited form as:

Soc Sci Med. 2020 January ; 245: 112561. doi:10.1016/j.socscimed.2019.112561.

"When you have no water, it means you have no peace": A mixed-method, whole-population study of water insecurity and depression in rural Uganda

Rumbidzai C. Mushavi[1,7,8,*], **Bridget F.O. Burns**[2,3], **Bernard Kakuhikire**[4], **Moran Owembabazi**[4], **Dagmar Vořechovská**[3], **Amy Q. McDonough**[3], **Christine E. Cooper-Vince**[1,3], **Charles Baguma**[4], **Justin Rasmussen**[3], **David R. Bangsberg**[6], **Alexander C. Tsai**[1,4,5]

[1]Harvard Medical School, Boston, MA [2]Massachusetts Institute of Technology [3]Massachusetts General Hospital, Center for Global Health, Boston, MA [4]Mbarara University of Science and Technology, Mbarara, Uganda [5]Massachusetts General Hospital, Chester M. Pierce, MD Division of Global Psychiatry, Boston, MA [6]Oregon Health Sciences University-Portland State University School of Public Health [7]Brigham and Women's Hospital [8]Massachusetts General Hospital

Abstract

Background: Lack of access to clean water has well known implications for communicable disease risks, but the broader construct of water insecurity is little studied, and its mental health impacts are even less well understood.

Methods and Findings: We conducted a mixed-methods, whole-population study in rural Uganda to estimate the association between water insecurity and depression symptom severity, and to identify the mechanisms underlying the observed association. The whole-population sample included 1,776 adults (response rate, 91.5%). Depression symptom severity was measured using the 15-item Hopkins Symptom Checklist for Depression. Water insecurity was measured with an 8-item Household Water Insecurity Access Scale. We fitted multivariable linear and Poisson regression models to the data to estimate the association between water insecurity and depression symptom severity, adjusting for age, marital status, self-reported overall health, household asset wealth, and educational attainment. These models showed that water insecurity was associated with depression symptom severity (b=0.009; 95% confidence interval [CI], 0.004-0.15) and that the estimated association was larger among men (b=0.012; 95% CI, 0.008-0.015) than among women (b=0.008; 95% CI, 0.004-0.012. We conducted qualitative interviews with a sub-group of 30 participants, focusing on women given their traditional role in household water procurement in the Ugandan context. Qualitative analysis, following an inductive approach, showed that water insecurity led to "choice-less-ness" and undesirable social outcomes, which in turn led to emotional distress. These pathways were amplified by gender-unequal norms.

[*]Corresponding Author: rmushavi@post.harvard.edu (RCM), 75 Francis Street, Boston, Boston, MA 02115.

Conclusions: Among men and women in rural Uganda, the association between water insecurity and depression symptom severity is statistically significant, substantive in magnitude, and robust to potential confounding. Data from the qualitative interviews provide key narratives that reveal the mechanisms through which women's lived experiences with water insecurity may lead to emotional distress.

Keywords

depression; mental health; psychological distress; resource insecurity; stress; sub-Saharan Africa; Uganda; water insecurity; water security

INTRODUCTION

Mental and substance use disorders – particularly depressive disorders – are the leading cause of years lived with disability worldwide (1, 2). Social determinants are well-recognized risk factors for depression and common mental disorders in resource-limited settings. These include factors like conflict, poverty, food insecurity, social isolation, violence and HIV stigma (3-8).

Water insecurity, defined as limited access to water or limited ability to secure good quality or safe water in socially acceptable ways, has emerged as a novel risk factor for a wide range of stressed mental states, including anxiety and depression (9-13). As one of the most fundamental forms of resource or material insecurity, water insecurity can produce profound psychological or emotional distress(9, 12-16). Most studies of water insecurity and its psychological impacts have been qualitative in nature (10, 11) although there are important exceptions(12, 13, 15, 17). Other studies have focused specifically on developing valid instruments for measuring water insecurity (10, 12, 18-20). These advances have contributed greatly to our understanding of water insecurity and its relationship to psychological distress and mental well-being (13, 17, 21).

We sought to contribute to this literature by conducting a whole-population, mixed-methods study to quantitively assess the association between water insecurity and psychological distress and to quantitatively explore the channels through which the association is manifest. Based on prior research findings, we expected that the psychological distress associated with water insecurity would disproportionately affect women due to gendered norms governing how women (and girls) in most countries throughout sub-Saharan Africa must shoulder the dominant burden of collecting water for the household (12, 13, 22-28). The stress associated with water insecurity has further been shown to induce physiological changes in health outcomes, for example as shown by Brewis et al (2019) in demonstrating an association between water insecurity and systolic and diastolic blood pressure among women in Nepal (29). While there are many studies exploring the psychological effects of water insecurity among women, the effects of water insecurity among men are relatively understudied. Wutich (2009) found that at extremes of water insecurity (i.e. in the setting of frank shortages requiring coping strategies such as purchasing water), men appeared to be equally affected by stressful water-related experiences(10).

In further establishing psychological distress as a dimension of water insecurity, researchers have called for culturally-grounded research into the process or context-specific mechanisms that mediate psychological distress(9, 12). Our study aims to take a biocultural approach (30) trying to understand how the social, environmental and biological lived experience in Mbarara produces emotional distress. Specifically, in order to explore the gendered, context-specific mechanisms that lead to psychosocial distress in rural Uganda, we conducted a whole population epidemiological study of water insecurity and depression, and then conducted a companion qualitative study among women with varying levels of psychosocial distress and water insecurity. These data were then used to elaborate a conceptual model of the mechanisms linking water insecurity and depression.

METHODS

Field site and study setting

This study was conducted in Mbarara District, which lies approximately 260 km southwest of Kampala, the capital city of Uganda. According to the 2014 census, Mbarara District had an estimated population of 474,144 people. Mbarara Town is the semi-urban commercial center of Mbarara District, but most residents live in the outlying rural areas. Participants for the present study were recruited from the rural administrative sub-unit of Nyakabare Parish, which lies approximately 20 km outside of Mbarara Town. The parish covers a geographical area of roughly 10 – 15 square km and is culturally, economically, and geographically similar to surrounding regions. Most residents rely on subsistence farming and animal husbandry for seasonal income and livelihoods, and men often engage in migratory work to supplement family incomes. Parish residents entirely depend on seasonal rainfall for food production, and in this context both food and water insecurity are common (18, 31, 32). Water for daily needs is obtained from several personal or public water sources distributed throughout the parish. These water sources vary in quality from “improved” (i.e., sheltered and protected from run-off contamination) to “unimproved” (i.e., unprotected from contamination) (18).

Ethics statement

Ethical approval for this study was received from the Partners Human Research Committee at Massachusetts General Hospital and the Research Ethics Committee at Mbarara University of Science and Technology. Consistent with national guidelines, we also received clearance for the study from the Uganda National Council of Science and Technology and the Research Secretariat in the Office of the President.

Research design and data collection

We enumerated all eligible adults aged 18 years and older, and emancipated minors aged 16-18 years, currently living in Nyakabare Parish. The two inclusion criteria for this census were: capacity to provide informed consent, and stable residence in the parish. We administered a baseline survey to all eligible persons included in the census, excluding persons who could not communicate meaningfully with research staff, e.g., due to deafness, mutism, or aphasia; persons with behavioral problems thought to represent psychosis,

neurological damage, or acute intoxication; or and persons too cognitively impaired to provide informed consent. Our total response rate was 1776/1942 = 91.5%.

In order to better understand the mechanisms through which water insecurity was associated with depression, we conducted one-on-one, in-depth qualitative interviews with a subset of 30 participants. Due to gendered norms governing responsibility for water collection within Ugandan households (13, 18), we specifically sought to enroll women of reproductive age who were the primary caregiver of a child under the age of 5. We purposively sampled women with varying degrees of water insecurity (ranging from water secure to severely water insecure) and depression symptom severity (ranging from few symptoms to symptoms indicative of probable depression) so that diverse perspectives would be represented in the data.

Potential participants were contacted to assess their interest in the study. Written informed consent was obtained in the field before all study procedures. The informed consent document was reviewed verbally with potential study participants, and they were probed for comprehension and given opportunities to ask questions. Potential study participants who could not sign their names were permitted to indicate consent with a thumbprint. Interviews were conducted by a research assistant fluent in the local language (Runyankore) using a semi-structured interview guide with open-ended questions in key topic areas. The interview guide was modified to accommodate exploration of newly emergent themes as needed. Interviews were audio-recorded and lasted approximately 1-2 hours. They were conducted in a private area of the participant's choosing, typically within the participant's home and where the interview could not be overheard by others.

Measures

Depression symptom severity was measured using the Hopkins Symptoms Checklist for Depression (HSCLD-15), a 15-item self-report assessing the severity of depressive symptoms over a 7-day period. This scale has been modified for use in the local context, has a coherent factor structure, and shows strong evidence of reliability and validity (32, 33). Water insecurity was measured using the Household Water Access Insecurity Survey (HWIAS), a scale developed for the local context by Tsai et al (18). The HWIAS consists of 8 items eliciting uncertainty of access to water, quality of water used, and coping behaviors. The scale has shown good psychometric properties with strong evidence of reliability and validity (18). In addition to these two primary variables of interest, we also collected data on study participants' ages, marital status, self-reported overall health, household asset wealth (34, 35), and educational attainment.

In the qualitative portion of the study, we explored the following main topics: 1) accessibility of water; 2) sex differences in water collection and utilization, and study participants' perceptions of the gendered norms about these functions; 3) factors that improved or worsened accessibility to water; and 4) the emotional impact of stressors related to uncertain water access and insufficiency of water.

Data analysis

For the quantitative analysis, we excluded study participants who did not have data on depression symptom severity or water insecurity (Appendix Figure S1). We fitted linear regression models to estimate the association between depression symptom severity and water insecurity, adjusting for age, marital status, self-reported overall health, household asset wealth, and primary education completion. In a secondary analysis, we used Poisson regression (36) to model the relationship between probable depression and water insecurity, adjusting for the same covariates noted above. Probable depression was defined as HSCLD>1.75, a threshold which is traditionally used as an indicator of clinically significant depressive symptoms (37). As discussed previously, women in this context have primary responsibility for household water acquisition and may therefore be at heightened risk of experiencing water insecurity-related psychosocial distress (13, 18). We therefore stratified our analyses by sex to explore the extent to which sex modified the association between water insecurity and depression symptom severity. Cluster-correlated robust standard errors were employed to adjust for potential clustering at the level of the village. All statistical analyses were conducted using the Stata statistical software package (version 14.0, College Station, Tex.).

To probe the robustness of our findings to unobserved confounding, we used methods proposed by VanderWeele and Ding (25). Specifically, we performed an e-value analysis to determine the minimum strength of association on the risk ratio scale that would be required for an unobserved confounder to have with the exposure and outcome (conditional on the measured covariates) in order to explain away the observed association.

For the qualitative portion of the study, in-depth interviews were audio recorded and then translated into English transcripts (“streamlined” transcription) (38), with field notes that documented observations about participants and about how the interview progressed. We reviewed transcripts iteratively to identify emerging themes and, if needed, to guide modifications of the interview guide. Transcripts were imported into NVivo qualitative data analysis software (QSR International Pty Ltd, Doncaster, Australia; version 11.4.2). The qualitative analysis was aimed at understanding the stressors experienced by participants in fetching and using household water and how these stressors affected their emotional well-being. Also of interest were potential moderating factors, i.e., those that buffered study participants against the mental health impacts of these stressors or those that intensified their mental health impacts.

Five representative transcripts were initially selected to develop a codebook for data analysis. We extracted content related to the pre-defined topics of interest using a deductive approach as well as any themes that emerged subsequent to the initial preparation of the interview guide. We used an inductive approach to capture novel themes that were generated through our interviews and developed categories. These categories were named and defined. We extracted illustrative quotes that captured the meaning of each category and its attendant definition; these quotes were included in a draft codebook circulated among collaborating investigators for feedback and revision. The final codebook was developed through an iterative process. Two investigators (RCM, BFB) double-coded 25% of the sample of transcripts, iteratively reviewing any discrepancies and making adjustments to their coding

practices and, if necessary, to the codebook. The iterative review to finalize the codebook and streamline the coding process was repeated until overall, inter-rater reliability was excellent (Cohen's κ=0.78). The remaining 75% of the transcripts were coded independently.

Synthesis of quantitative and qualitative data

Following a "sequential" data collection approach (39), we used the quantitative findings to inform the design of the qualitative study. First, the reports of quantitative and qualitative findings were developed separately. We then examined both reports to identify those findings that were congruent with, or diverged from, each other. Finally, both the quantitative and qualitative findings, and the conceptual model that emerged from the qualitative data, were reviewed with key informants. Thus, the quantitative and qualitative methods interfaced primarily at the stage of data interpretation (40).

RESULTS

Sample characteristics

Of the 1,776 study participants, 1,642 (92.5%) had non-missing values for both depression symptom severity and water insecurity and were therefore included in the quantitative analysis. Characteristics of these participants are displayed in Table 1. The median age of participants was 34 years (interquartile range [IQR], 25-47 years). Approximately half (891 [54%]) of the participants were women. Among women, 343 (38%) had Hopkins Symptom Checklist scores >1.75 indicative of probable depression. In contrast, only 129 (17%) men in the study population had probable depression. The mean water insecurity score was higher among women compared with men (8.07 vs. 7.28; t = −2.38, P=0.02).

A subsample of 30 women was selected for one-on-one, in-depth qualitative interviews. Demographic characteristics of the qualitative sub-study participants are summarized in Appendix Table S1. Seven women were water secure and screened positive for probable depression; 9 women were water insecure and screened positive for probable depression; 7 women were water insecure and screened negative for probable depression; and 7 women were water secure and screened negative for probable depression.

Quantitative findings

We estimated a positive and statistically significant association between water insecurity and depression symptom severity in the general population (Table 2). The estimates were slightly larger for men compared with women. When water insecurity was specified as a categorical variable, some nonlinearities were observed (Table 3). Mild water insecurity did not have a statistically significant association with depression severity. Participants who were moderately water insecure had a 0.12-point increase (95% confidence interval [CI], 0.05 – 0.18; p<0.01) in depression symptom severity, while participants who were severely water insecure had a 0.15-point increase (95% CI, 0.10 – 0.21; p<0.001). The coefficient estimates on the water insecurity categories were also slightly larger for men compared with women.

These estimates were small to moderate in magnitude. The effect of severe water insecurity among women was 0.14/1.72 = 8% relative to the sample mean HSCLD score and 0.14/0.48 = 29% of the sample standard deviation. For men, the effect of severe water insecurity was 0.17/1.47 = 12% relative to the sample mean and represented 0.17/0.36 = 0.47 standard deviation units.

In a secondary analysis specifying probable depression as a binary dependent variable, each one-point increase in water insecurity was associated with an increased risk of probable depression among women (RR=1.01; 95% CI, 1.00-1.03) and a greater increased risk of probable depression among men (RR=1.05; 95% CI, 1.03-1.08) (Appendix Table S2). Men who were moderately or severely water insecure had a greater than twofold relative risk of probable depression (moderate water insecurity, RR=2.41, 95% CI, 1.53-3.80; severe water insecurity, RR=2.46, 95% CI, 1.62 – 3.74) (Appendix Table S3). Among women, the estimated risk ratios were smaller in magnitude: moderate water insecurity was associated with a 1.47 relative risk of depression (95% CI, 1.13 – 1.90) whereas severe water insecurity was associated with a 1.52 relative risk of depression (95% CI, 1.17 – 1.97).

We explored the robustness of our findings to potential confounding from unobserved variables. Using the pooled Poisson estimate for severe water insecurity, we obtained an e-value of 1.71 + sqrt(1.71 × [1.71-1]) = 2.81 (95% CI, 2.04-3.78). Thus, an unobserved confounder would require a strength of association, on the risk ratio scale, with both water insecurity and probable depression of 2.81 to move our estimated association to include a risk ratio of 1.

Qualitative findings

Several main themes emerged from the qualitative interviews: “bother” associated with water procurement, insecurity associated with lack of regular access to water, constraints on adaptive coping, gender-unequal norms, social problems resulting from water insecurity, “choice-less-ness”, emotional distress, adaptive coping, and sense of well-being. Each of these themes is reviewed in more detail below.

Bother.—In this context, “bother” was defined as *daily or seasonal stressors requiring undue or excessive effort to overcome*. Women described significant daily stressors in securing sufficient quantities of water that was of sufficient quality for household use. Stressors included factors like distance or environmental barriers, e.g., steep hills increasing the amount of physical exertion needed to acquire water. Many participants also described how significant logistical planning was necessary to secure water on a daily basis: the need to acquire water governed many aspects of their day to day schedules, including when they could prepare food or complete other household chores. There was little margin for error, so water acquisition occupied significant mental bandwidth when it came to time and schedule management.

Maintenance failures (e.g., breakdown of borehole pumps) and seasonal changes in water availability, though not daily occurrences, altered water availability in ways that increased *bother*. For example, at many popular public sources, the flow of water dropped precipitously or stopped altogether during the dry season. Consequently, wait times at water

sources increased or participants were forced to travel even farther than usual to obtain water at alternative sites, which typically yielded water of poorer quality.

One woman who typically fetched water from a protected spring near her home described having to fetch water from a more distant and less accessible open well when the protected spring closer to her home ran dry:

> When we were fetching water [from the open well] up the hill, we felt bad because the water that you have to get from afar is stressing… We had to go and get the water up the hill. And when coming back, you would feel pain in your chest… Because we had to fetch the water and carry it on our head for a long distance… [I would go] like twice a day. And then you had to use the water sparingly because you would not want to make another trip… It was just stressing to know that I had to fetch the water from very far.
>
> -- 24-year-old mother of two

Overall, many participants described how fetching water "disturbed" them, meaning that this activity disrupted or took over their daily schedules. One woman in her last month of pregnancy had to walk over 30 minutes while climbing a steep hill with a 20L jerry can of water balanced on her head -- in addition to her other daily chores. She described how collecting water "disturbs":

> If water is far, there is no way you cannot be disturbed. The time you spend fetching the water will disorganize your chores and then you will not even be able to do something you wanted to because of this water… I am not happy. How can you be happy while you carry a jerry can up the hill? You can be happy and maybe forget when you are already here [at home] and relaxed but when you are fetching the water, there is no happiness there.
>
> -- 29-year old mother of one

Water insecurity.—The conventional definition of water insecurity in the literature (i.e., a state of having *limited access to water or limited ability to secure good quality or safe water in socially acceptable ways*) captures well our participants' lived experiences(13). Faced with daily stressors or significant seasonal barriers to accessing adequate quantities of water from desirable sources, and having limited ways to cope and adapt with lack of adequate access, many participants recounted extreme experiences with water insecurity. Many participants described having to use water from undesirable sources as in the case of one woman, who was forced to fetch water from a swamp when the tap near her home ran dry:

> You find water that has mud in it. It's like just getting mud and putting it in the water. That's how [the water] is… Now if you have fetched water from the swamp with its dirtiness, and you have no other way of getting cleaner water, you have to use it because there is no way out. Even when you use it for cooking, the food turns dark. I feel bad. Because really, if you cook food and it turns black, you cannot even get the appetite to eat it.
>
> -- 44-year-old mother of two

Acquiring water in socially unacceptable ways was common, especially when participants were confronted with time constraints or when desirable water sources were inaccessible. One woman, who was recently separated from her partner and children, described having to steal water from a neighbor:

> For example, stealing can also happen. I can go to my immediate neighbor and get some water even if she has not seen me. I get a little water and go and use it. Like if there is no water at the tap and I am cooking and need just a little water that I do not have, I go to her house and get some water and [will then] fetch [the remainder of the water I need] later. She will not have seen me and besides, I do not take a lot in that situation. Just a little, like 1 liter.
>
> -- 36-year-old mother of three

Such instances of water-stealing not only epitomized some women's extreme experiences with water insecurity but also contributed to fraying of the social fabric, which represents a significant community-wide consequence of water insecurity (discussed below).

Constraints on adaptive coping.—Many participants described factors that constrained their ability to cope with *bother* (in the short term) and to adapt to water insecurity (in the long term). Of the various factors that reduced women's capacity to respond to water insecurity, poverty was the most commonly mentioned. In the local context, a standard, short-term strategy to improve efficiency of water collection was to hire laborers, cyclists, or *boda-boda* (motorcycle taxi) drivers to assist with fetching water. Long-term solutions included building rainwater harvesting tanks or installing a tap stand on one's personal property that was connected to the local infrastructure. Both short-term and long-term adaptive strategies, particularly the latter, required significant disposable income. However, in this context women were primarily occupied with household management or engaged in subsistence agriculture. Consequently, financial resources for adaptive coping far exceeded what was realistically within reach. As described by one single mother:

> There are times when you can want to wash your clothes and you need 3 jerry cans of water but do not have the money. You worry about it…about where you will get the money…Where and when you will be able to get water to complete your chores.
>
> -- 45-year-old mother of two

Gender-unequal norms (discussed below) governing the distribution of household chores and the manner in which those chores could be accomplished also constrained women's ability to cope with water insecurity. For example, using a vehicle (e.g., bicycle or *boda-boda*) to assist with water collection could alleviate *bother*. However, in this local context women generally did not ride bicycles or *boda-bodas* because such activities were strictly reserved for men. As described by one woman who used to carry water on her head:

> You know it is mostly the women that fetch the water, and women do not know how to ride a bicycle. So, they will walk and go and fetch this water.
>
> -- 37-year-old mother of four

The same norms that constrained women from implementing adaptive coping strategies also constrained women from relying on men for assistance with coping.

Gender-unequal norms.—In the local context, *traditional gender roles constrained the behavior of both women* and *men in ways that led to disparities in water insecurity and coping*(18). Study participants unanimously expressed that water fetching, regardless of the level of physical exertion required, is a task that is traditionally reserved for women in Runyankore culture. Below, the same woman who previously described having to steal water further elaborated:

> For me, by the time I grew up I realized that it was the norm for the women to fetch water. I heard that men do not fetch water; how does he fetch water when the woman is around? It is all because most of the chores that need water are done by the woman; cooking, cleaning, washing and the rest. So, such roles are for the woman and so that is why they expect the woman to fetch the water themselves.
>
> -- 36-year-old mother of three

This norm significantly limited the level of instrumental support women could expect from their male partners in collecting water and managing the household water supply. The simple act of even *asking* a male partner to assist with water collection was generally regarded as tantamount to witchcraft -- an intolerable offense in the community. One woman described having many painful experiences related to water insecurity and, at many points in time, regrets about her marriage. She explained:

> You are there heavily pregnant, the man just walks away without fetching any water, there is no worker to help; and for us in this area, it is hard to see someone walking by and ask them to fetch some water for you…You feel extremely bad; you go into regrets but there is nothing to do about it… Nowhere is it written [in the Bible] that a man should fetch water for you… It is not written [in the Bible] that it should be done in your marriage… It is voluntary business for him to do anything. For the woman, it is written [in the Bible]… she is the man's helper… And even if you go and complain to your elders and your parents that the man is not helping you to fetch water, they will even laugh because it is not something that he should do. Yes, he can try and help, and even if he continues to fetch water day in and day out, they will think that you bewitched him. They will say, 'This man was bewitched already and now he is going to fetch water for the woman '. Even if he is just helping. So, when you complain about water, you have to tread slowly; you will be misunderstood. [emphases added]
>
> -- 37-year-old mother of four

Ultimately, gender-unequal norms regulating water collection and use of water amplified the social problems and emotional distress women experienced as a result of water insecurity. These themes are discussed below.

Social problems.—A recurrent theme in the data was that water insecurity caused social problems, which routinely manifested in the form of *disrupted interpersonal relations within the household or within the community, leading to undesirable social outcomes or social*

discord. Gender-unequal norms amplified interpersonal difficulties, particularly between married or cohabitating partners. Failing to meet prescribed gender roles around water collection was frequently mentioned as a putative provocation for intimate partner violence. One woman described her struggle to fetch water from an open well/swamp each day before the cows got to it and turned it into *byagaano* (muddy water):

> There are times when you come home from digging [in the fields] and there is no water, you go to the well but you find nothing. In that case, we do not eat lunch. [The kids] will ask me where the food is, and I say there was no water. Sometimes they will think I am joking. Sometimes they try to go there to get some water… [and] they will even find when the water is still muddy. I feel so bad; very bad because even me I am hungry and I need to eat as well. It is not just the kids. I feel bad; I cannot be well. Even in myself, I feel disgusted but I have nothing to do about it. The kids will feel bad if they do not find the food but the man will even beat you up. He will beat you. He asks for food and you give an excuse about having no water? He will even kick you continuously. You can't give that excuse of dirty water. For him, he wants food; when he comes home from drinking alcohol, he wants the food there and ready… [emphasis added]
>
> -- 47-year-old caregiver of seven

Confronted with overwhelming pressure to secure sufficient quantities of water for the household and avoid physical reprisals from male partners, women routinely created unreasonable water fetching expectations for their children. Children who failed to meet these obligations, in turn, often faced physical punishment. Harsh or coercive parenting behaviors were the norm. As one woman recalled:

> They [children] come back from school hungry and they would want to first eat when they reach here and if they sit to first eat, it will then get late. So, I first tell them to bring the water first, fill up a jerry can each and then they can eat… I do not feel happy about it because I see one of them going while they have tears in their eyes. They even complain that they are hungry… They go reluctantly… And for me because of the urgency of my chores sometimes I say to them, 'I am going to spit on the ground and whoever finds my saliva dry, I will beat them.'…And so for those who come back when it is late, beatings it is. They will come saying that there was a long line of people… I feel angry and bad about it and then I wish that if I had water near here, these things would not even happen. I do not want to fight with the kids all the time. The reason I pressure them to come faster is that I have chores that I have to do and sometimes [I fail to complete them] because the water was not here in time. [emphases added]
>
> -- 30-year-old mother of 4

Women identified not only problems within the household but also instances of conflict with others in the community. For example, excess water demand at public water sources frequently caused verbal and physical disputes among people in the queue. One woman described such conflicts using military terminology:

> It's war [fetching water]. Yes, even us the older women, you find us fighting for a place, 'I came first', 'No I came first'.
>
> -- 29-year-old mother of four

As another example, maintenance of good personal hygiene is generally expected of women in the local context. For some women, water insecurity made it difficult for them to maintain good hygiene, which potentially jeopardized their standing with their partners and with others in the community. One woman who earlier described beating her children described the hazards of water insufficiency as they related to menstrual hygiene:

> [Not having water] can be disturbing actually because there are things [reusable sanitary pads] you always need to wash urgently. When there is no water, I end up piling them in a basin and waiting for a time I can fetch the water. But that should not even happen… you should be able to wash your stuff, whether it is underwear or what. I might just have the water for bathing and I fail to get water for washing. So I keep my used sanitary towels… You feel bad because those things are not supposed to be kept around. You are supposed to wash them [immediately]. I worry that someone might see them and I worry what they will think about me. It happened to me before but of course my husband did not say anything to me… but I felt bad. He probably understood that there was no water, but I felt bad and I wondered if he thought I was a dirty woman. [emphases added]
>
> --30-year-old mother of four

Choice-less-ness.—In our data, water insecurity forced participants into situations where they had to make an "impossible choice" (38) between two or more unpleasant, unacceptable, and unsatisfactory options. Such situations could be described with the adage *choosing between a rock and a hard place* (or, alternatively, *being on the horns of a dilemma*). In many circumstances, participants were essentially choice-less, and they described significant constraints on their abilities to make acceptable choices for themselves and for their families. The woman who explained how she could not ask for assistance from her partner lest she run the risk of accusations of witchcraft described how she regularly resorts to using poor quality water that is located near to her home. She stated:

> So, the clean water was always far. Maybe if the man helps and goes with a bicycle to fetch it [then we might be able to manage] but if not… for us we would [be resigned to] the situation and use the dirty water. You cook tea but it turns dark, you find the beans looking black… Same as [if you fetch water from] the borehole. The water has rust in it and if you cook tea with it, it will also turn dark. So, we had nothing to do… We would just cook with that water… nothing to do. [emphases added]
>
> -- 37-year-old mother of four

Women's choice-less-ness was often more pronounced when it came to their children. On many occasions, women reported having to choose between safeguarding their children's well-being and educational opportunities vs. asking them to assist with water collection. One

woman who relied heavily on her children for assistance with water collection elaborated this dilemma:

> You feel torn apart. You want the kids to get an education but you also want assistance in fetching water. Then you start agonizing… 'If we had a tap of our own …it would be easy.' You find yourself complaining. [emphasis added]
>
> -- 50-year-old mother of six

Emotional distress and *kutekateka munonga* (thinking too much).—*Bother*, gender-unequal norms that constrained their ability to cope with water insecurity, social problems, and choice-less-ness -- all of these themes frequently produced significant symptoms of emotional distress among our study participants. In many instances, the *psychological impacts of water insecurity* could be severe. For example, two women described intense ruminations about their water problems:

> But for us, we get tired in thoughts and in body. You come from the garden so tired and then you have many thoughts about where you will get water, and now your head is already tired because of thinking, and then you carry a jerry can on that same head which is tired and that makes it worse… Wondering where you will get water, constantly thinking about what to do about water. When you will go… Will you make it in time? The energy… [emphases added]
>
> -- 37-year-old mother of four

> I found that there was no one to help me. If only I had someone to bring the water…but I found myself here alone with no help… Aaaah…you know you start thinking a lot and even Satan can tempt you and you start thinking, 'Why did I even get married?' So that day, when you find yourself sick and when you have no one to help you fetch water…that day makes you think a lot. [emphases added]
>
> -- 28-year-old mother of four

These descriptions of having "too many thoughts" or "thinking a lot" are captured in the local language (Runyankore) by the term *kutekateka munonga* and are consistent with idioms of distress representing major depression, both in Uganda (41)) and in other settings worldwide (42-46). Women expressed worry, anger and frustration about water, frequently using other local idioms of distress to communicate their emotional suffering. One woman who only had access to very poor-quality water near her home, and who was forced to hire help for water fetching from a more distant source, reported:

> It is stressing for us. Now if you do not have any water, don't you see that in life you do not have any peace? When you have no water, it means that you have no peace. Your entire wellbeing is not ok… [emphases added]
>
> -- 52-year-old caregiver of 1 child (her grandchild)

Coping and adaptation.—Effectively *coping with water insecurity in the short term and adapting to persistent water security threats in the long term,* often required financial resources as discussed above. However, effective responses could also be achieved through non-financial means as well.

Some adaptive coping strategies focused on household water management. Women routinely described recycling or rationing water, or using purification techniques (e.g., by running water through a cloth strainer) to improve water quality. However, they generally did not view these as comfortable or acceptable coping mechanisms.

Women reporting less uncertain access to water described successfully adapting to *bother* using strategies such as storing water in bulk or using paid labor and/or vehicles, but these strategies required significant personal financial resources. Alternatively, they coped with water insecurity by relying on household members for daily water fetching (namely children). Despite prevailing community perceptions and social norms, among a subset of women who reported less *bother*, having support in water collection from male partners appeared to be crucial. At its most extreme, this instrumental support manifested as gendered role reversals, i.e., male partners completely took over water collection altogether. One woman who owns a local beer brewery and bar and who received instrumental support from her husband around water fetching described:

> Most of the times my husband is the one that fetches. He likes to be the one to bring the water for me [Laughs]… So, he wakes up and fetches water in the early morning, and by the time I wake up, I find the water ready. But it is not that I am sick or anything. He likes to do it… I do not feel good [about it]… because he is straining himself. I feel bad and I cannot get what to do about it… The other women actually fetch the water themselves without help from their men… I think every home is different. But for me considering my husband, he does not want me to get strained. That is why he helps with the chores. [It is] just his will. He prefers to help me. Like I told you, this is not for everyone, but he just decides to make an effort to help and he does not complain… For me I think that most men are selfish and strain their wives, but for us, we cooperate… But most men do not think about it. But for those who understand, they help. So, for me I feel good that he tries to help… People talk [about how my husband fetches water]. They really talk. But my husband does not care about what others say. And also, I do not care what they say because it is not true about me. They talk about my relationship. They always do… [They say] negative stuff… Things like how I bewitched my husband, or that he is dumb. I do not feel good about this, but for us we never pay attention to this talk and we continue doing what we have to do… [emphases added]
>
> -- 30-year-old mother of one

At the community level, parish members collectively worked to build or maintain water sources. Community-wide coping sometimes took the form of water sharing, particularly in desperate situations. The woman who previously described heavily relying on her children for water-fetching also formed a reciprocal relationship around sharing water with her neighbors:

> The kids usually fetch the water I need, but there are times when I have to ask for some water; it is not like it is bad, because they say that ‘houses that are close together burn each other ‘ [whatever affects one house affects the neighbors as well]. So, when you have burning food [because you lack water], you can go to the neighbor and get some water to add in the food.

-- 50-year-old mother of six

Asking permission upfront to obtain water, rather than stealing water from a neighbor's water supply was important, as was reciprocating and sharing water when that same neighbor was in need of water.

Water security and sense of well-being.—Participants who effectively responded to the threat of water insecurity reported less rumination and emotional distress. They felt they had the time and mental space to focus on other priorities. They also reported having a general sense of good well-being. One woman who lived within a 2-minute walk from a protected spring and who received instrumental support in fetching water both from her husband and children, described the concept of well-being this way:

> Water is a need and water is life. So, having water in your house means that your wellbeing is okay. It means that your head will not be thinking about water. You can think about other things but water will not be part of them.
>
> -- 22-year-old mother of three

Conceptual framework

In our data, *bother* emerged as the primary determinant of *water insecurity. Gender-unequal norms* limited women's ability to adapt or respond effectively to *bother* and *water insecurity*. Water insecurity led to "*choice-less-ness* " and *social problems*, both of which produced significant *emotional distress* and, ultimately, depression and rumination. Through our analysis, we also identified coping mechanisms the women used to effectively address water insecurity. Adequate coping was linked to water security and generated appreciable mental health benefits and feelings of well-being. We summarized these themes into an explanatory logic, shown graphically in Figure 1.

DISCUSSION & CONCLUSION

In this mixed-method, whole-population study from rural Uganda, we found that water insecurity had a statistically significant association with depression symptom severity and probable depression. The estimated associations were clinically significant and robust to potential confounding. The complementary qualitative data revealed a number of mechanisms that could explain the quantitative findings among women, who are primarily responsible for household water procurement in this context.

Our primary finding of a robust association between water insecurity and depression is consistent with previously published work. In a study conducted in a Bolivian squatter camp, Wutich and Ragsdale (2008) found that water insecurity was associated with emotional distress. Moreover, they found that inequities in accessing water distribution systems, and not necessarily just insufficient water quantities, were associated with emotional distress. In their study on water insecurity and psychological distress in women in Ethiopia, Stevenson et al (2012) found a positive correlation between water insecurity and psychological distress. In this study, they used a culturally-grounded approach to develop a scale to assess water insecurity, which, beyond measuring the physical and logistical demands of water collection,

also included questions that assessed other cultural aspects of water scarcity that interact with mental and emotional well-being (12). Our study, while confirming these prior findings, contributes the only study based on whole-population data in the literature (17).

While we found that the association between water insecurity and depression was present for both men and women, we found an unexpectedly strong association between water insecurity and depression among men. Prior to initiating the study, we had hypothesized that the association between water insecurity and depression would be stronger among women because past studies have shown that women shoulder the burden of water collection and use (9, 10, 13). In addition, in the literature on food insecurity and depression, several studies have identified food insecurity to be a significant determinant of mental health problems among women, but not men, in sub-Saharan Africa (47, 48) as well as in higher-income countries (49, 50). This hypothesis was not borne out in our data, however, as the association between water insecurity and depression symptom severity was greater among men compared with women. However, we did find that the level of water insecurity was greater among women compared with men. Women also had higher levels of probable depression compared to men, which appears consistent with other trends throughout sub-Saharan Africa(51). One potential explanation for the discrepant finding is that perhaps women were better able to draw on social and emotional support, thereby more effectively buffering themselves against the deleterious effects of water insecurity. Data consistent with the "buffering hypothesis" have been described in these contexts(47, 52, 53) and would be consistent with the sociological literature showing that women appear better able than men to mobilize social support to cope with psychosocial stressors(54, 55). However, as described by Wutich and Brewis (2014) and in related comments by Piperata (2014), the literature on coping with resource insecurity – including both food and water insecurity – has been under-theorized and requires more empirical development(14).

Another potential explanation for the observed associations is that, while water collection and use remain the strict domain of women in the local context, seeing to the overall needs and well-being of the family is an expectation of men. Therefore, as Wutich (2009) suggests, it is possible that at extremes of water insecurity, men perceive the deleterious impacts of water scarcity and thereby experience similar concerns and emotional distress – and that failure to secure the financial resources to improve household water security can provoke more emotional distress in men. If men, for these gendered-cultural reasons, feel the most invested in providing the financial resources to make water available for the household, then they may also experience more guilt and shame when financial constraints erode this capability.

Extending beyond the epidemiological findings, a novel contribution of our study is our ability to pair complementary qualitative data with the quantitative findings to elaborate the putative mechanisms underlying the observed associations. Overall, our qualitative data showed that gendered constraints on women's ability to cope with water insecurity led to emotional distress and, in some cases, clinically significant rumination and depressive symptoms that were consistent with local expressions of major depressive disorder. Expressions of emotional distress frequently took the form of local idioms such as "thinking too much" (*kutekateka munonga*, in Runyankore, the local language), which is a well-

recognized representation of depression both in Uganda and in other places around the world (42-46). In addition, water insecurity often forced women to make impossible choices between equally bad alternatives. This finding, though somewhat unique in the water insecurity literature, is a concept discussed and explored in the context of HIV treatment by Ware et al (2009)(38).

Interpretation of our findings is subject to several limitations. First, exposure and outcome assessments were based on self-report scales, and the estimates were associational rather than causal. It is possible than an unobserved confounder could explain the observed associations. For example, severe food insecurity and/or food insufficiency have been associated with mental distress in previous studies, with approximate relative risk nearing 2(48, 56). If severe food insecurity is also associated with water insecurity (57) it could confound our estimates. However, the e-value analysis explicitly quantifies the extent to which unobserved confounding—even by a variable such as food insufficiency – would need to be quite strong, with a relative risk of association with both exposure and outcome exceeding 2.8. Second, while we made use of our conceptual framework to elaborate or outline potential mechanisms that could explain some of the associations in our primary and secondary quantitative analysis, it is important to note that since our qualitative study only enrolled women, the attendant mechanisms and findings gleaned from our qualitative study are not easily generalizable to men in our setting. Indeed, the gender-normative roles that govern water collection in Nyakabare constrain women and men in unique and specific ways. For these reasons, more exploratory, qualitative research will be required to elaborate the gendered-pathways that lead to depression among men. Perhaps at that point, the field will be able to advance a theory of water insecurity, gender and psychological distress that is more unifying than the simplified, gender-specific model described here.

These limitations notwithstanding, our study carries several significant implications for policy and program implementation. Historically, academic research and policy frameworks have focused on the physical health impacts of water scarcity, e.g., communicable disease threats to health. Our research adds to the growing body of knowledge showing that water insecurity has significant mental health consequences that have heretofore been underappreciated and understudied. Thus, the potential welfare benefits of interventions to improve water quality or water quantity are likely being undervalued. Future work should integrate both physical health and mental health assessments to accurately characterize the impacts of water scarcity and the benefits of water interventions. And finally, while social scientists have traditionally focused their qualitative and quantitative research on the impacts of water insecurity among women, the cultural and gender-specific pathways that lead to water-related emotional distress are poorly understood and require further exploration if we are to fully appreciate the impact of water insecurity on the family unit and on the community as a whole.

In summary, we found that among men and women, the association between water insecurity and depression symptom severity is statistically significant, substantive in magnitude, and robust to potential confounding. Data from the qualitative interviews provide key narratives that reveal the mechanisms through which women’s lived experiences with water insecurity may lead to emotional distress.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Highlights

- Water insecurity had a strong, robust significant association with depression
- The estimated association was stronger among men than among women
- In the qualitative data, bother emerged as the main determinant of water insecurity
- Gendered constraints limited women's ability to adapt to water insecurity
- Choice-less-ness and social problems produced emotional distress, depression, and rumination

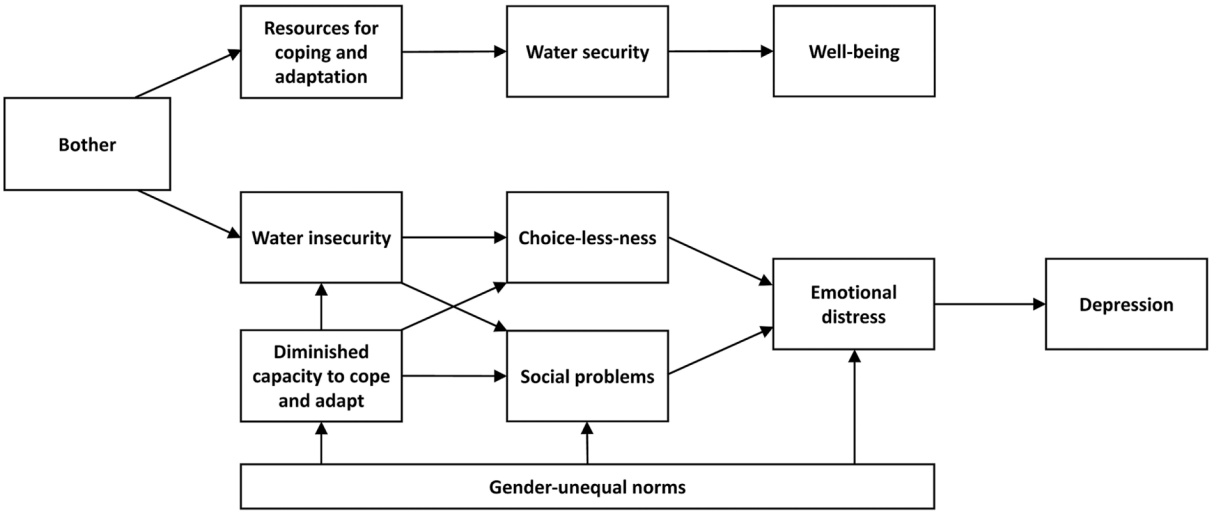

Figure 1:
Conceptual model of mechanisms linking water insecurity to depression

Table 1:

Summary statistics, stratified by sex

	Women (n = 891)	Men (n = 751)	Total Population (n = 1642)
Median age (yrs)	33 (IQR = 24 – 46)	35 (IQR = 25 – 48)	34 (IQR = 25 – 47)
Median HSCL_D scores	1.6 (IQR = 1.33 – 2)	1.4 (IQR = 1.20 – 1.67)	1.47 (IQR = 1.27 – 1.87)
Median HWIAS	7 (IQR= 2 – 13)	6 (IQR = 1 - 12)	6 (IQR= 2 – 13)
Probable Depression (HSCLD score > 1.75), (%)			
Yes	38	17	29
No	62	83	71
Water Insecurity categories (%)			
Water secure	19	23	21
Mild WI	9	9	9
Moderate WI	31	30	30
Severe WI	41	38	39
Age (%)			
18 - 25 years	29	28	29
26 - 35 years	28	25	26
36 - 45 years	16	19	18
46 - 55 years	14	15	14
56 + years	13	13	13
Marital Status (%)			
Married/cohabitating	58	63	60*
Separated, divorced, widow	24	7	16*
Single, never married	18	30	23*
Self-reported overall health (%)			
Very bad	1	1*	1
Bad	25	12*	19
Good	64	70*	66
Very good	10	18*	14
Asset Index (%)			
Poorest	23	15	19*
Poorer	21	19	20*
Middle	19	21	20*
Richer	18	21	19*
Richest	17	22	19*
No value	2	3	2*

	Women (n = 891)	Men (n = 751)	Total Population (n = 1642)
Primary education completed (%)			
No	49	35	43
Yes	51	65	57

* Figures do not add to 100% due to rounding

Table 2:

Estimates from multivariable linear regression (continuous water insecurity score)

	General Population		Women		Men	
	b	**95% CI**	**b**	**95% CI**	**b**	**95% CI**
WI Score	0.009**	0.004 – 0.015	0.008***	0.004 – 0.012	0.012***	0.008 – 0.015
Female	0.18***	0.14 – 0.23	N/A		N/A	
Age						
18 - 25 years	Ref	Ref	Ref	Ref	Ref	Ref
26 - 35 years	0.04	−0.01 – 0.10	0.06	−0.02 – 0.14	0.04	−0.04 – 0.12
36 - 45 years	0.03	−0.05 – 0.11	0.04	−0.05 – 0.14	0.04	−0.04 – 0.13
46 - 55 years	0.05	−0.04 – 0.14	0.004	−0.10 – 0.11	0.11*	0.02 – 0.20
56+ years	−0.01	−0.11 – 0.09	−0.10	−0.21 – 0.01	0.11*	0.01 – 0.20
Primary education completion	−0.14**	−0.22 to −0.06	−0.15***	−0.22 to −0.09	−0.12***	−0.17 to −0.07
Married	0.01	−0.03 – 0.05	0.01	−0.05 – 0.07	−0.02	−0.09 – 0.04
Asset Index	−0.01	−0.02 – 0.01	−0.01	−0.03 – 0.01	−0.01	−0.02 – 0.01
Self-reported overall health	−0.22***	−0.27 to −0.18	−0.29***	−0.34 to −0.24	−0.14***	−0.18 to −0.10

* p<0.05

** p<0.01

*** p<0.001

Table 3:

Estimates from multivariable linear regression (water insecurity categories)

	General Population		Women		Men	
	b	**95% CI**	**b**	**95% CI**	**b**	**95% CI**
Water insecurity category						
Water secure	Ref	Ref	Ref	Ref	Ref	Ref
Mildly water insecure	0.04	−0.04 – 0.12	0.08	−0.04 – 0.20	0.002	−0.09 – 0.09
Moderately water insecure	0.12**	0.05 – 0.18	0.11*	0.02 – 0.19	0.13***	0.06 – 0.20
Severely water insecure	0.15***	0.10 – 0.21	0.14**	0.06 – 0.22	0 17***	0.11 – 0.24
Female	0.19***	0.14 – 0.23	N/A		N/A	
Age category						
18 - 25 years	Ref	Ref	Ref	Ref	Ref	Ref
26 - 35 years	0.05*	0.00 – 0.10	0.07	−0.02 – 0.15	0.04	−0.03 – 0.12
36 – 45 years	0.04	−0.04 – 0.12	0.05	−0.04 – 0.15	0.05	−0.04 – 0.13
46 - 55 years	0.06	−0.03 – 0.15	0.02	−0.09 – 0.12	0.11*	0.02 – 0.20
56+ years	0.00	−0.09 – 0.09	−0.09	−0.20 – 0.02	0.11*	0.01 – 0.21
Primary education completion	−0.14**	−0.22 to −0.06	−0.15***	−0.22 to −0.09	−0.12***	−0.17 to −0.07
Married	0.01	−0.03 – 0.05	0.01	−0.05 – 0.07	−0.01	−0.08 – 0.05
Asset Index	−0.01	−0.02 – 0.01	−0.01	−0.03 – 0.01	0.004	−0.02 – 0.01
Self-reported overall health	−0.22***	−0.26 to −0.18	−0.29***	−0.34 to −0.24	−0.14***	−0.18 to −0.09

* p<0.05

** p<0.01

*** p<0.001