

Household water insecurity and psychological distress in Eastern Ethiopia: Unfairness and water sharing as undertheorized factors

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ABSTRACT

Elevated levels of mental health symptoms – especially related to depression and anxiety – are observed in water-insecure communities. A small set of ethnographic studies have suggested that inadequate safe and sufficient water does not in itself well explain observed patterns; rather the social contexts of water is critical. The most commonly theorized explanatory mechanism is the distress of perceived unfairness acting as a psychosocial stressor, although direct empirical tests of this are currently lacking. Another theorized and untested mechanism is the stress of social interactions around household water (like participation with neighbors in water sharing systems). Based on a sample of $N = 1543$ women ages 18–49 years (all with young children in the home) collected in Eastern Hararghe, Oromia, Eastern Ethiopia from June to September 2019, we tested the effects of two theorized mechanisms potentially implicated in why water causes psychosocial distress: perceived unfairness in the water system and level of participation in informal water sharing systems. In these predominantly smallholder agricultural households, and taking into account expected covariates like role-responsibility for water and household food insecurity, we find that perceived unfairness accounted for two-thirds of the effect of household water insecurity on individual depression/anxiety symptom levels. Even taking all these factors into account, high (and assumably predictable) levels of participation in water borrowing were associated with better mental health. However, less frequent (and assumably less predictable) borrowing was associated with worse outcomes. Together these findings provide needed empirical support for the propositions that the negative mental health effects of water insecurity are fundamentally tied to the dynamic social mechanisms around and meanings of water in water insecure communities, much more so than water access in itself.

1. Introduction and background

1.1. Introduction

An increasingly robust literature establishes household water insecurity's association with elevated emotional and psychological distress, including signals of depression and anxiety. The first studies included ethnographic observations in rural Mexico of suffering from water, characterized by anger, worry, and frustration, followed by similar observations in urban Bolivia (Ennis-McMillan, 2001; Ennis-McMillan, 2006; Wutich & Ragsdale, 2008). In the years since, associations between household water insecurity and elevated depression and anxiety have been repeatedly reported for a wide array of water-insecure settings using standard and locally-adapted scales (Cooper-Vince et al., 2018;

Kangmennaang et al., 2020; Stevenson et al., 2012), see detailed summaries in (Brewis et al., 2020a; Wutich, 2020; Wutich et al., 2020a). These studies together suggest many different—but largely untested – candidate mechanisms to explain why water insecurity cascades into heightened risk for common mental illness. As specified by Wutich, Brewis and Tsai (Wutich et al., 2020b), these theorized emotion-based mechanisms include the stress effects of material uncertainty, shame of failures to meet social expectations, worry about harm to physical health, loss of socially valued identities or connections, frustrations stemming from reduced autonomy or opportunity (e.g., with time spent fetching or queuing), elevations of interpersonal conflicts (both community or within the household), and the psychological impacts of perceiving unjust treatment.

While the associations between worsening water insecurity and

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worsening mental health appear robust, and the list of possible theorized explanations for why is growing, the *dynamics* of underlying mechanisms remain poorly specified in empirical terms. That is, there is little direct evidence explaining with any specificity when and why household water insecurity may be more versus less harmful to mental health. To advance theorization, we need to explicate with greater precision what local variations in these types of hypothesized socio-cultural arrangements ameliorate and which attenuate the mental health effects of water insecurity. From the biocultural perspective adopted here in this study, socio-cultural arrangements (beliefs, rules, norms, practices) can act as a stressor [explained in detail in (Brewis et al., 2020a)]. But they can also provide the means to cope with resource challenges like water insecurity (Wutich et al., Unpublished). Understanding how socio-cultural institutions around water interact in relation to each dynamically within water insecure communities then allows theory-building beyond simply saying water insecurity predicts worse mental health, to recognizing how specific arrangements around water might act as a mediating *mechanism* between the challenge of water insecurity and its impacts on mental health. This effort matters greatly for improved theorizing around why (or why not) water insecurity has mental health effects, but also for application of such knowledge to the goals of improved community wellbeing. One important longitudinal test of the effect of a community water infrastructure and governance intervention, in Ethiopia on 233 women using the SRQ-20, showed that the resulting significant improvements in water quality did not shift scores (Stevenson et al., 2012, 2016). Stevenson's subsequent reflection on the finding (using qualitative data collected concurrently) suggests that perhaps the relevant stressor is some unresolved stress related to community arrangements, like how people feel about the new water committee and the use-rules and charges set up to manage the improved water source (Stevenson, 2019).

In this study we use a large, randomly selected sample of women in households in a predominantly rural zone in eastern Ethiopia (mainly smallholder farmers) to test the roles of two different types of theorized locally-constituted socio-cultural institutions – one based in experiences of fairness and one in systems of reciprocity – in explaining the consistent associations observed between water insecurity and mental health status.

1.2. Background: Water, unfairness, and psychological distress

One of the most clearly theorized social factors shaping mental ill-health is perceived unfairness. The “Perceived Unfairness Model”—emerging from psychology, epidemiology, and justice studies—strongly indicates, leveraging empirical and theoretical scholarship, that the belief that one is being treated unfairly negatively impacts mental health (Jackson et al., 2006). In this approach, perceived unfairness can be defined as a violation of socio-cultural norms, entitlements, or expectations for treatment. Perceived unfairness in itself is associated with negative psychological outcomes, though most studies to date have been conducted in workplaces; more work is needed in a wider range of contexts and settings (Lee & Kawachi, 2019). Factors related to perceived relative unfairness—including stigma, discrimination, social failure and possibly income inequality—can also be powerful drivers of common mental disorders (Patel & Kleinman, 2003).

In water research, environmental justice is the theoretical lens through which most scholars explore the forms and impacts of unfairness (Agyeman et al., 2003). Water-related unfairness is typically conceptualized in three main ways: distributive injustice, procedural injustice, and interactional injustice (Schlosberg, 2007; Walker, 2012). In distributive injustice, people receive an allocation of a valuable resource that is perceived to be unfair. In procedural injustice, the rules and norms that determine how resources are allocated are considered unfair. In interactional injustice, an individual is treated unfairly even where overall rules, norms, and allocations are perceived to be fair. The bulk of the water literature—including the water insecurity literature—has focused on distributive injustice: that is, whether or not people *receive* enough water of adequate quality (Jepson et al., 2017a). Recent influential work

has argued for a shift toward a “relational” conception of water insecurity: one that takes into account procedural and interactional considerations (Jepson et al., 2017b). This aligns with exploratory cross-cultural scholarship that hints that in the most water-scarce conditions interactional injustices are particularly salient and possibly more distressing than distributional or procedural injustices (Wutich et al., 2013).

The foundational ethnographic scholarship establishing a connection between water and mental health strongly indicated that unfairness (or injustice) was a major factor (Stevenson et al., 2016; Wutich et al., 2016, 2020a, pp. 57–72). Ennis-McMillan's (Ennis-McMillan, 2001; Ennis-McMillan, 2006) Mexican research found that women and people in lower socio-economic categories reporting being most affected, and this made sense in terms of the social dynamics his research documented, including unfair and unequal treatment that led to differently-felt experiences of suffering from water. Sultana's qualitative research (Sultana, 2011) in Bangladesh, too, described how unfair treatment around water pumps and household water arrangements created emotionally-distressing experiences for women. Wutich's mixed-methods ethnographic research in Bolivia built on these findings by testing the association between emotional distress and water insecurity's dimensions: institutional access, water availability, seasonality, and gender (Hadley & Wutich, 2009; Wutich, 2009; Wutich & Ragsdale, 2008). The results indicated that people who accessed water via water sharing and markets were *more likely* to report distress, and emphasized the role of social tensions and unfair treatment as they were obtaining water in explaining these findings.

This field of scholarship has since enormously improved the measurement of water insecurity and mental health outcomes. Recent work has developed a range of scales to measure water insecurity in a range of low and middle-income countries (Agyeman et al., 2003; Young et al., 2019) and incorporated cross-culturally validated measures of mental health (Wutich, 2020). This work demonstrates that there is a clear and robust association between water insecurity and mental health, but still does very little to explain *the mechanisms that produce it* (Wutich et al., 2020b). Other than Stevenson et al.'s (Stevenson, 2019) aforementioned study and Tallman's (Tallman, 2019) research in Peru, few of the recent water-mental health studies have engaged with the theoretical implications of Ennis-McMillan's (Ennis-McMillan, 2001), Wutich's (Wutich, 2009), Sultana's (Sultana, 2011) formative findings: that perceived unfairness and injustice in water institutions (norms and rules) may be the primary driver of water-related distress. Moving forward, what is required is confirmatory tests of the hypothesis that perceived unfairness in water is associated with worse mental health outcomes, using larger samples with greater control of other known covariates (like food insecurity). The potential implications of this for water interventions are enormous: if borne out, it suggests that justice must be at the core of water interventions, because even “successful” projects that improve water security can do significant harm if they are perceived as unfair or unjust.

1.3. Background: Water sharing as a dynamic mechanism linking Water and psychological distress

An additional mediating social-institutional mechanism we propose to test here is household water sharing, which could both potentially worsen and alleviate the distressing, negative mental health effects of water insecurity. By household water sharing, we mean private transfers of water between households that help meet immediate personal needs, such as for drinking, cooking, washing clothes, cleaning, and bathing (Brewis et al., 2019; Rosinger et al., 2020; Stoler et al., 2019; Wutich et al., 2018). There is, by comparison with the studies considering unfairness, even less empirical evidence. But there is solid theoretical rationale to suggest it none-the-less could matter, and that participation in water sharing could be, on balance, associated with psychosocial distress in water-insecure communities.

Regardless of how household water is acquired (purchased, piped

from mains, privately pumped, or hauled from a community source), once it enters the household it is a privately-owned and controlled resource. The possibility of household to household water transfers (“sharing”) provides a self-organized way for households to help each other cope with water insecurity, either as generalized reciprocity (with no expectation of direct or immediate payback) or some form of balanced reciprocity (with an understanding of some form of payback, perhaps at a later time). Recent research has clarified that such water sharing is a very common activity in low water communities, both urban and rural. For example, in a cross-sectional sample of 24 global sites ($n = 5,495$), sharing activity was strongly predicted by degree of water insecurity, and the percentage of households receiving water from others ranged within the last month ranged from 10.6% in Kathmandu, Nepal to 88.3% in Punjab, Pakistan (Rosinger et al., 2020). In another analysis of the same data set, frequency of receiving water (hereafter “borrowing,” $n = 4,267$) was also consistently associated with reports of feeling angry or upset (Wutich et al., Unpublished). Relatedly, ethnographic observations suggest that water sharing obligations and expectations (e.g., being expected to share, or to reciprocate later) can be a substantial source of worry, frustration, and anger [summarized in (Kessler et al., 1985; Wutich, 2020)].

So, water sharing could have both costs and benefits relevant to mental health impacts. Knowing you could rely on socially supportive relationships to provide water should reduce the worry, distress, frustration, and so on of water insecurity. The theoretical rationale for this is the large literature establishing the positive association between social support and better mental health outcomes (Taylor and Friedman, 2011; Uchino, 2006). We speculate that, particularly if water sharing is based in *reliably* socially supportive relationships, the psychological stress of living with water insecurity should be reduced. To date, the literature does indicate that people are more likely to benefit from water sharing arrangements if they are linked together in broader sharing arrangements (Schnegg & Linke, 2015; Wiessner, 2002; Wutich, 2011), which may include broader reciprocal and affective relationships, but a possible link to mental health outcomes has not yet been investigated.

Yet, the earlier ethnographically-focused studies provide clues that this isn't necessarily the case. As noted, people who engaged in household water sharing in Bolivia exhibited greater emotional distress (measured on a 4-item scale of negative water-related emotions) than those who did not (Wutich & Ragsdale, 2008). Similarly, water sharing in communities with arsenic contamination of groundwater in Bangladesh has been described as emotionally fraught (Sultana, 2011). This exemplifies how water sharing is not just about getting water in itself, but always complexly embedded in the performance of role expectations and social relationships, cultural identities, and the local exercise of power (Wutich et al., 2018). Qualitative findings from Bolivia indicated that unpredictable and unreliable water sharing relationships are distressing (and shameful) (Wutich, 2009; Wutich et al., 2016, pp. 57–72), but the suggested link to common mental disorders has never been systematically tested.

So, this emerging literature on water sharing suggests several different possibilities, and our study is an attempt to begin to disentangle these. It could be that (A) more frequent borrowing activity alleviates mental health impacts of water insecurity because it provides more reliable access to water (i.e., reduces your material uncertainty). If so, more borrowing might predict less distress. Or perhaps instead (B) water sharing activity – via intensification of burdensome material and social obligations – elevates distress and so symptoms of depression and anxiety. Then we should observe the opposite. However, it may be that a crucial factor that determines how water insecurity impacts mental health is more generally related to the number of people you can *rely* on, and not exactly what you share, the number of people you share with, nor how often you share. That is, improved emotional wellbeing is embedded in a more reliable and/or expansive social support network that may be tangibly related to water but has much more important symbolic meanings. So, (C) if the buffering effects of water sharing on mental

health emerge from its being a form of social support more so than simply a source of water, then membership in larger or more active water sharing networks could then be associated with better social networks/support and so then better mental health.

1.4. Study approach and research questions

We begin our study with the theorized assumptions that perceived unfairness would be important to explaining how water insecurity and depression/anxiety are linked, and greater perceived unfairness around water institutions in general should predict worse mental health outcomes. But also, with the recognition that the specific act of water sharing (specifically, borrowing water from others) can potentially act as social-emotional stressor (and hence a potential exacerbating factor in depression/anxiety). But, in a complex way, water sharing could provide the means to assist with coping with the stress and depressive-effect of household water insecurity. So, we sought to first confirm that unfairness mattered, and to what degree, and then to identify how water sharing mattered (positively or negatively) once perceived unfairness was taken into account.

We focus on the impacts of these socio-cultural institutional dynamics on women's depression and anxiety outcomes herein, because all prior research on the psychological and emotional stress of household water insecurity has shown that negative effects disproportionately fall to women in line with their gender-based socially-expected domestic roles [e.g., (Adams et al., 2020; Cooper-Vince et al., 2018; Sultana, 2011; Wutich, 2009)]. In Eastern Ethiopia where our study is set, women are more likely to have primary responsibility for obtaining and managing water for the household, and for rural households particularly this can require multiple trips per day to shared water sources like wells, ponds, or stand pipes. Specifically, using population-representative samples of reproductive-age adult women in predominantly-smallholder agricultural zone households in Eastern Ethiopia, we test the extent to which associations between individual mental health outcomes (depression/anxiety) and household water insecurity are explained by household participation in water sharing arrangements and perceived unfairness related to water access, while controlling for likely covariates like household food insecurity and responsibility for household water.

Our guiding questions were:

- [A] First, can we confirm in this Ethiopian mainly-rural zone, using a relatively large sample where control of key covariates is possible, that the level of household water insecurity is associated with higher levels of depression/anxiety symptoms (direct effect)?
- [B] Taking the level of household water insecurity into account, can we then confirm that perceived unfairness in water arrangements plays a substantial role in this relationship (indirect effect)? If confirmed, this suggests it is a key mechanism that mediates (and so helps explain) how water insecurity and depression/anxiety outcomes are linked.
- [C] Then, taking the effects of perceived unfairness into account as well as actual household water status, can we identify any additional role of active participation as a borrower in water sharing systems in mediating the effects further — either (Ennis-McMillan, 2001) reducing or (Ennis-McMillan, 2006) increasing – the effects of water insecurity on mental health outcomes? If hypothesis 1 is supported, then it suggests borrowing is better understood as an effective buffering mechanism. If hypothesis 2, then as a potentially costly means of coping, with detriments to mental health.
- [D] Finally, can we identify if any such observed indirect effects from water borrowing are additionally tied to network size or not (if yes, suggesting this is related to social connection and support as much or more so than the action of borrowing water from others)? Again, given the discussion above, there is currently insufficient primary literature to posit a prediction one way or the other. But if

larger networks have a positive and mediating effect, this then suggests it is sharing as emblematic of social connection and support, rather than the transfers of water per se, that might be what is protective of mental health. Then these should be mediated by the size of networks, so that membership in larger water sharing networks would then be associated with better mental health.

2. Material and methods

2.1. Study site, sampling, and data collection

The study location is Eastern Hararghe, Oromia, Eastern Ethiopia, specifically rural Haramaya and Kersa districts (~42,000 households) and the regional capital city of Harar (~12,000 households). Most rural households rely on low productivity smallholder mixed-crop farming of khat, maize, and sorghum, affected by unreliable or unequal access to water, small farm size, poor complementary services such as credit, market access, and infrastructure and high vulnerability to climatic factors such as drought and flood and crop price fluctuations (Wiessner, 2002). Rural households – even in the same village – have highly unequal access to water, based on such factors as well and pump ownership, access to electricity, variable distance from shared water sources, and access to donkeys to help fetch jerry cans. Food insecurity (and related undernutrition) is prevalent in the region, with seasonality (Roba et al., 2019).

Our household sampling leveraged the 10,000 household (N = 60,000 people) ongoing Haramaya University-led Kersa Health and Demographic Surveillance System (KHDDS) as a random household selection frame. We selected a random subsample of 2,000 rural and 500 town households (N = 2500). Interview respondents were all married women aged 15–49 years in these households who agreed to participate and provided data on all key study variables, yielding a final sample of N = 1534. Piloting of survey protocols took place in February 2019 with data collection in June to September 2019 (wet season). Recruitment and interviewing were conducted by trained enumerator teams in Oromia language (with verbal translation as needed into others by fluent team members), and included daily check-ins with the study leads that included GPS double-checks of households covered and data quality. Study protocols included informed consent, with oversight provided by Haramaya University (reference SHE/S.M/144/708/19).

2.2. Variable construction

2.2.1. Main predictor: household water status

Overall household water status was based on an adaptation of the validated Household Water Insecurity Experiences (HWISE) scale (Young et al., 2019), with a 4 week recall period, but with the “worry over water” item removed to remove potential confounding and a “water was not safe to drink” and “insufficient water for poultry” items as the appropriate local adaptations (Wutich, 2020; Wutich et al., 2020b) based on prior ethnographic work. This “household water insecurity score” potentially ranges from 0 (full water insecure) to 52.

2.3. Mediating predictor: perceived water unfairness

Respondent's sense of how unfair their water situation was compared to others was self-estimated on a 0–4 scale, based on 0 = never and 4 = always unfair. This was converted to a binary dummy variable (never/rarely (0) versus sometimes/often/always (1)). This item is designed to capture perceived and relative unfairness (including perceived distributional, procedural, and interactional injustices).

2.3.1. Main/mediating predictor: Household water borrowing

Household water borrowing was defined by the reported frequency of going to other households for water in a “normal” month, categorized

based on never (zero times in the last month) versus rarely (1–10 times) or sometimes (1–20), or often or always (>20).

2.3.2. Additional predictor: borrowing network size

This was based on the number of household respondents' said they could ask for water, if necessary. This variable was arranged into binary categories of whether they nominated three or more other households or not (cut at median of 2).

2.3.3. Main outcome: level of depression and anxiety

A continuous variable reflecting frequency and degree of women's depression and anxiety symptoms (as the assessment of individual common mental health status) was based on Patient Health Questionnaire 9-item version [PHQ-9], but with a local adaptation whereby the suicidal ideation item was removed and two anxiety-specific items were added (“cannot control worrying” and “feeling nervous”). The PHQ-9 scale has previously been validated for East Africa/Ethiopia (Gelaye et al., 2013; Woldetensay et al., 2018). Questions used a standard recall period of two weeks. “Not at all” was coded as 0, “several days” as 1, “more than half of days” as 2 and “nearly all or all days” as 3. This was then converted to a summary score that potentially ranged from 0 to 30. Average score was 10.3 (SD = 9.9, data range 0–30). To assist with sample size, we included cases where only 2/9 response items were missing and coded each as 0 [following (Roba et al., 2019)]. The scores were (as expected) left-skewed and so were transformed using their square-root. We note that the use of transforming continuous scores has advantages (taking into account extreme skew) and disadvantages (possible reduction in clarity of interpretation).

2.3.4. Key covariate: responsibility for household water

Who is primarily responsible for acquiring household water fetching (and/or domestic use-tasks) is a likely factor in explaining who is most vulnerable to water-insecurity related emotional-psychological stress (Adams et al., 2020; Geere et al., 2018; Mushavi et al., 2020). In many (but not all) Oromia households, this is the responsibility of an adult woman, sometimes alone and sometimes shared with others. We included in the model if the respondent had sole responsibility for collecting household water (1) or not (0).

2.4. Additional covariates

Additional covariates included in the model were otherwise known to affect depression/anxiety symptom levels. Household food insecurity status in the last four weeks was based on an 8-item adapted Household Food Insecurity Access Scale (HFIAS, Coates et al., 2007) capturing household food situation in the last 30 days (0 = never, rarely = 1, sometimes = 2, often = 3) (Bickel et al., 2000) that could range between 0 (fully food secure) to 24 (the most severely food insecure).

Theoretically, water insecurity very likely worsens food insecurity but not necessarily the converse (Brewis et al., 2020b). Household income, based on combined agricultural, remittance, wage, and other income over the last year, was categorized based on wealthiest through least wealthy fifths. Rural status was also taken into account; almost all rural households in this region are dependent on agriculture as the basis of their livelihoods.

2.5. Model construction

We used structural equation modeling (SEM) as our primary analytic approach for its strength in path analysis. Data management was handled in SPSS, and SEM analyses conducted in R using the SEM command in the lavaan package (Rosseel, 2012). Regression coefficients were considered non-random if *p* values were below 0.05. Mediation effects were assessed from reduction using bias-corrected bootstrap confidence intervals with 10,000 samples (Preacher, Kristopher and Hayes, 2004).

3. Results

3.1. Descriptives

Descriptive statistics for the final analyzed sample are provided in Table 1.

Based on the analytic sample of 1534 mothers of young children, their households varied in their levels of water and food insecurity, and in their water borrowing activity. Water insecurity scores and depressive/anxious symptom scores were positively associated (bivariate correlation = 0.200, $p < 0.001$). Those households that we categorized as borrowing water (ever versus never) indicated they also had larger networks of households they could potentially borrow from (<3 versus more) ($\chi^2 = 17.559$, $df = 1$, $p < 0.001$). Importantly for developing the model, the relationship between intensity of household water borrowing activity in the last 30 days and women's reported level of depressive/anxious symptoms was basically u-shaped (non-linear), as seen in Fig. 1.

For those 56% of respondents who identified their water situation as unfair, the main reasons they identified were all related to being Oromo (65%: as a marginalized ethnicity within Ethiopia, although a majority in the study zone) or other discriminations related to being poor, less educated, female, old, or disabled. No respondents selected the other offered institutional options related to such factors as corruption, unfair organization of local water systems, or water company/water sellers greed.

3.2. Model results

Our initial model (Model 0, not shown) included: household water insecurity, food insecurity, rural location, and income quintile, and individual women's age and water responsibility. Age is a known covariate of depression/anxiety but was removed once we identified that it did not increase depression/anxiety levels (which makes sense given that these women are all mothers of young children and so at a similar life stage). Similarly, rural location was also removed as it predicted no variation in the outcomes of interest. The initial and final model results are provided in the Appendix.

Table 1
Sample descriptives related to key model variables.

| Households (N = 1534) | |
|--|--------------------|
| Main household water source | |
| Pipe | 32.8% |
| Protected tube or bore well | 24.5% |
| Unprotected tube or bore well | 11.7% |
| Protected spring | 4.1% |
| Unprotected spring | 13.2% |
| Surface water | 12.2% |
| Other (rainwater harvest, tanker, cart, kiosk) | 1.4% |
| Extreme water insecurity (score ≥ 15) | 30.8% |
| Moderately water insecure (5–14) | 37.2% |
| Some water insecurity (1–4) | 15.1% |
| Water secure households (0) | 16.9% |
| Median size of water sharing networks | 2 households |
| Percentage of households borrowing any water in the last 30 days | 80.1% |
| Percentage of households borrowing often or always | 9.8% |
| Percentage of respondents stating their water situation is unfair compared to others | 55.9% |
| Percentage with their main water source in the house or house compound | 9.14% |
| Percentage of households with any food insecurity (score > 0) | 81.7% |
| Percentage severely food insecure (score ≥ 15) | 9.1% |
| Rural location | 92.0% |
| Women's average age in years | 30 (± 5.8) |
| Average depression/anxiety symptom score, 0–30 scale (SD) | 10.3 (± 9.9) |

3.2.1. Model 1: Testing the direct effect of household water insecurity on individual women's depression/anxiety symptom levels

Our initial model tested direct effects of household water insecurity on level of depressive/anxious symptoms, confirming basic expectations from prior studies. As seen in Model 1 results (Fig. 2), household scores of water insecurity predicted worse food insecurity, and level of food insecurity had a significant effect in elevating women's reported level of depressive/anxious symptoms. Similarly, increasing levels of household income had a reducing effect on the level of depressive/anxious symptoms. Being the person solely responsible for water in the household also predicted higher levels of anxiety/depression symptoms. Taking all these into account, increasing household water insecurity had a significant direct association with reporting of depression/anxiety symptoms. Specifically, the relationship between household water insecurity and level of depressive/anxious symptoms is generally linear; for each ten-point increase in HWISE household score, depression/anxiety worsened modestly but significantly by 2.1 units. If you live in an extremely water insecure household (score of 42) your risk of depressive/anxious symptoms would be predicted as 10.1 units higher than a fully water secure household. Model 1 fit the data well ($\chi^2 = 4.731$, $df = 1$, $p = 0.030$; CFI = 0.960; RMSEA = 0.05; SRMR = 0.014).

3.2.2. Model 2: Testing if perceived unfairness in water institutions mediates household water insecurity's effects on depressive/anxious symptom levels

Model 2 (Fig. 3) adds perceived unfairness in one's water situation into the model as a mediator, and shows it has a partial mediating effect when predicting the level of depression and anxiety from household water insecurity. Using a bias-corrected bootstrap confidence interval with 10,000 samples, the indirect effect of mediation was statistically significant (95% CI [0.108, 0.160] excluding zero). Inclusion of mediation in the form of perceived unfairness reduced the direct effect of household water insecurity from 0.21 to 0.074, a notable and statistically significant change. Compared to those who didn't perceive their water situation to be unfair, those who did had a predicted depression/anxiety symptom level that was 7.03 units higher on the 0–30 depression/anxiety symptom scale, even once taking into account their actual water situation and such factors as water responsibility. One interpretation in the reduction of the direct effect of water insecurity is that roughly 2/3 ([0.210–0.074]/0.210) of the increase in depression and anxiety symptom score produced by water insecurity is attributable to perceived unfairness. Additionally, household food insecurity still had a significant effect on depression/anxiety symptom level but this effect was reduced from Model 1 (from 2.22 to 1.7 units). Model 2 also explored the relationship between perceived unfairness and being the person solely responsible for water fetching in the household. Responsibility of water fetching actually *decreased* the chance one reported their water situation unfair by 0.10 (a numerically small but still statistically significant change). Model 2 fit the data well ($\chi^2 = 17.772$, $df = 3$, $p < 0.001$; CFI = 0.974; RMSEA = 0.057; SRMR = 0.022).

3.2.3. Model 3. Adding water borrowing activity as a mechanism that could either worsen or buffer the effects of water insecurity on depressive/anxious symptom level

As noted in Model 2 results, the mediating effect of perceived unfairness on depressive/anxious symptom levels was substantial. So, in Model 3 (Fig. 4) we retained the effects of perceived unfairness in the model and then considered if the addition of water borrowing activity might either additionally buffer or exaggerate the negative effects of water insecurity on mental health outcomes (i.e., contribute a negative or positive mediation). Similar to Model 2, the indirect effect household water insecurity on depressive/anxious symptom levels through perceived unfairness was statistically significant using a bootstrap procedure (95% CI = 0.07, 0.1, excluding zero).

In constructing Model 3, we took into account that the relationship between water borrowing activity and depressive/anxious symptom level is non-linear (see Fig. 1 – a phenomenon that might be expected

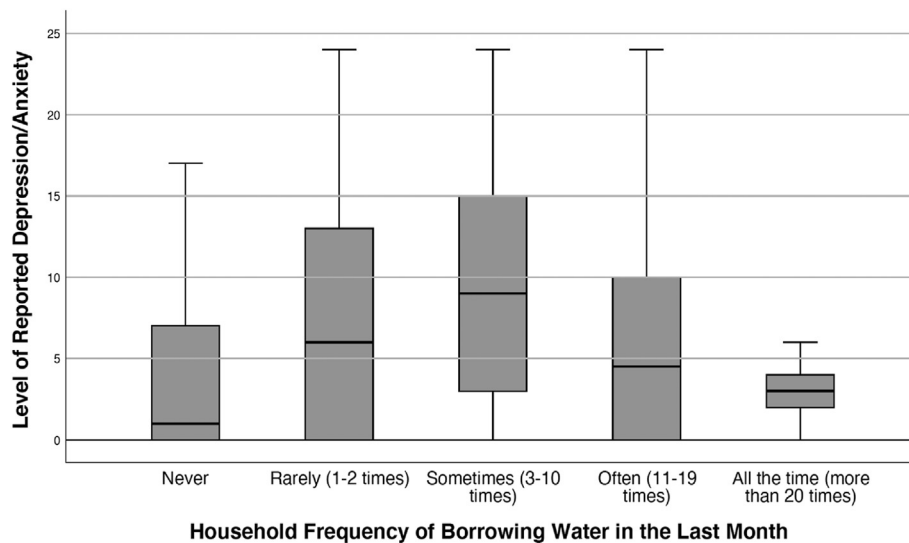


Fig. 1. Boxplots showing average (mid box), median (cross-line), and quartiles (whiskers) of distributions for reported depressive/anxious symptom level by intensity of water borrowing activity in the last 30 days.

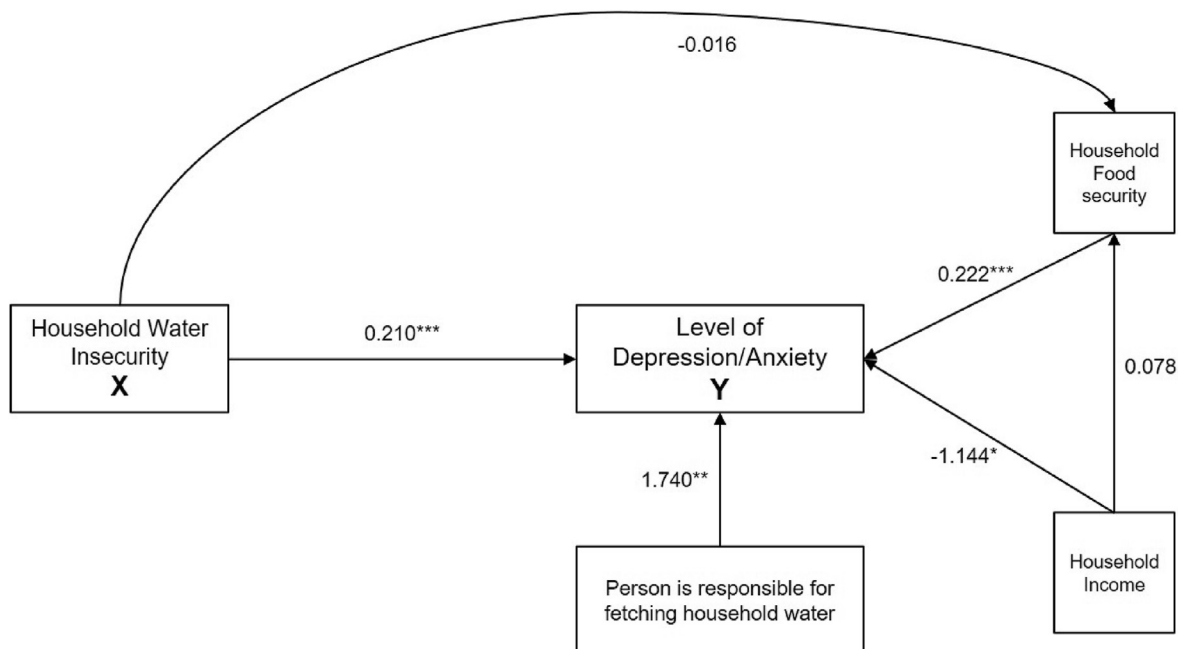


Fig. 2. Initial model predicting level of depression/anxiety symptoms from household water insecurity. The shown values reflect regression coefficients with significant relationships shown as * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

given the theory discussed in the introduction above). So, we refined the model to differentiate the effect between low intensity and high-intensity levels of household water borrowing on depressive/anxious symptom levels. This was done via a first dummy coded indicator as 1 if the household borrowed water 1–10 times in a 4-week time span (rarely/sometimes) and 0 if anything else. The second indicator variable was coded similarly such that value of 1 signified the household borrowed water 11–20 times in a 4-week time span (often/always) and 0 if anything else. So, these indicators allowed us to observe the effect low intensity and high-intensity water borrowing has on depressive/anxious symptom levels compared to the baseline of never borrowing water. In addition to observing the direct effect, water borrowing has on depressive/anxious symptom level, model 3 also looked at the effect water borrowing has on perceived unfairness. As predecessor models, Model 3

fit the data well ($\chi^2 = 43.696$, $df = 5$; CFI = 0.955; RMSEA = 0.071; SRMR = 0.035).

Model 3 showed that, compared to individuals in households that never received borrowed water, water borrowing rarely/sometimes raised individuals' level of depressive/anxious symptoms by 2.75 points. Although this effect is substantial, it pales in comparison and is opposite in direction to the effect of borrowing water often/always. Higher frequencies of borrowing reduced the level of depression/anxiety by 4.87 points compared to those in households that never borrow water. Though the effect of low-intensity vs high-intensity water borrowing was highly nonlinear when predicting depressive/anxious symptom levels, the effects of each on predicting perceived unfairness was the same (borrowing levels having a regression coefficient of 0.4) as can be seen in Fig. 4. That is, people who share sometimes or those who share a lot also perceive the

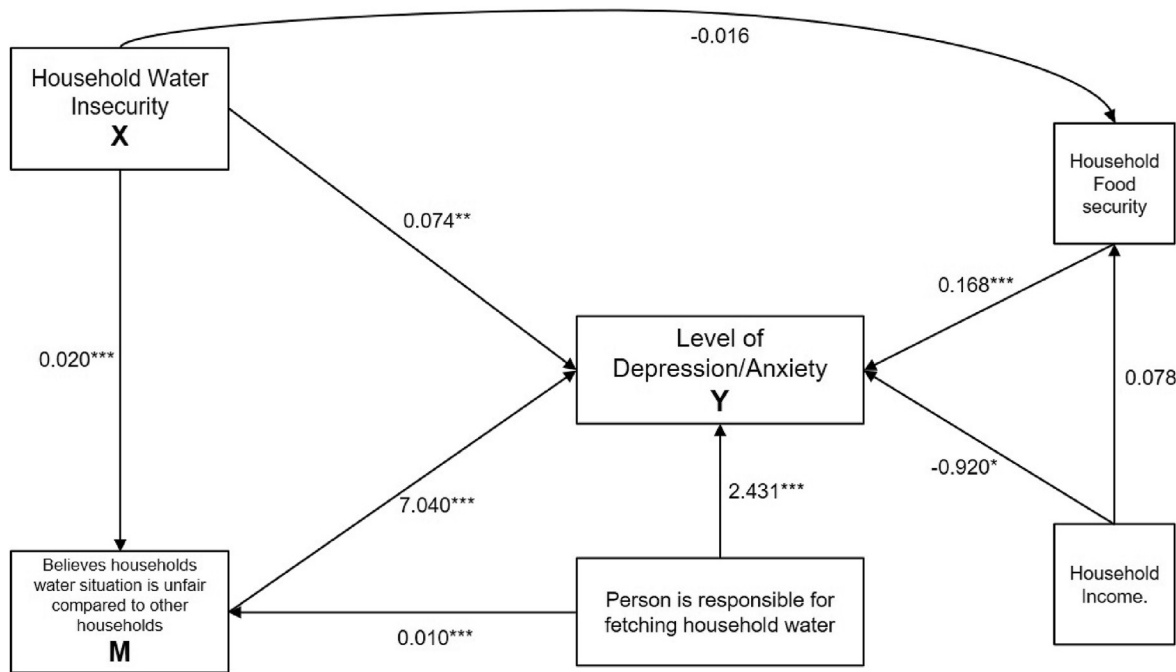


Fig. 3. Model 2 predicting level of depressive/anxiety symptoms where household water insecurity is mediated (M) by perceived unfairness. The shown values reflect regression coefficients with significant relationships shown as * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

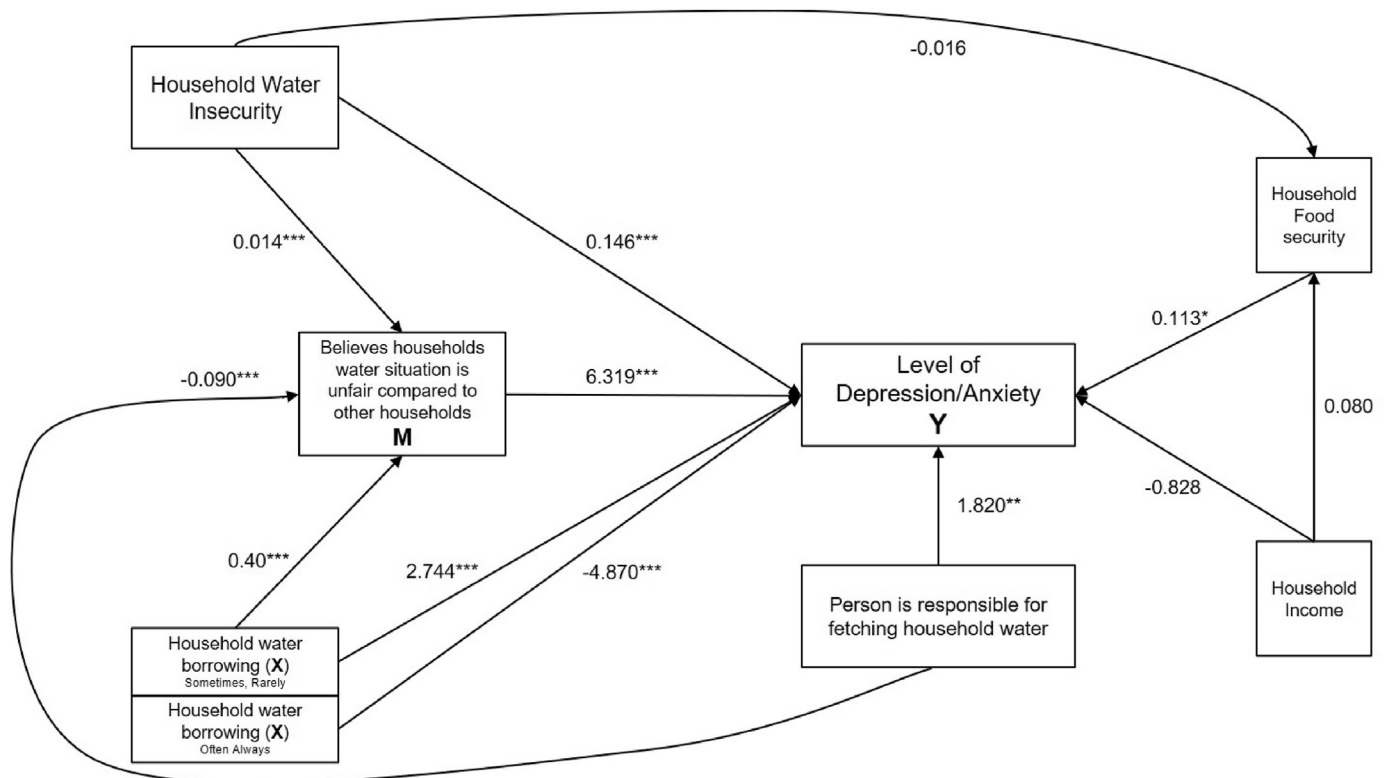


Fig. 4. Model 3 predicting level of depressive/anxiety symptoms where household water insecurity and water borrowing are mediated by perceived unfairness. The shown values reflect regression coefficients modeled with significant relationships shown as * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

situation to be less fair compared to those who never share (once other factors are taken into account). This indirect effect of water borrowing on depressive/anxiety symptom levels through perceived unfairness was confirmed as statistically significant using a bootstrap procedure (95% CI = 1.80, 3.32, excluding zero).

3.2.4. Model 4. Testing an additional role for water sharing network size

Finally, in Model 4 (no figure shown) we tested the role of network size (number of possible households people reported they could borrow from). This was not a significant predictor of depressive/anxiety symptom level in itself once all the other variables were considered, and had

no perceptible effect on any of the direct or indirect outcomes (model is not shown). Additionally, this model did not fit the data well ($\chi^2 = 66.600$, $df = 11$, $p < 0.001$; CFI = 0.938; RMSEA = 0.057; SRMR = 0.038). Hence this was a null result.

4. Discussion

An array of social science studies has established that living with water problems is associated with elevated depression/anxiety markers. While empirically established, samples are generally small and explanations of the theorized underlying mechanisms have been little tested. In this study, we interviewed reproductive-age women (all with at least one young child) in randomly-selected households in a primarily agricultural zone in Eastern Ethiopia regarding their household water situation (status, perceptions, activities) and related these to their reported depressive/anxious symptom levels. As expected, increases in household water insecurity – alongside food insecurity – predicted women's worsening mental health outcomes. Also as expected, increasing levels of household wealth reduced both water insecurity and risk of depression/anxiety symptom reporting. In terms of our primary research questions, we could establish a number of additional factors that exaggerated effects, including (also as expected) personal responsibility for acquiring household water.

In terms of our key research questions, increasing levels of household water insecurity was associated with more perceived unfairness, and unfairness was associated with more depression/anxiety. This pathway was particularly important in mediating between household water insecurity and depression/anxiety symptom levels; it accounted for some two-thirds of the direct effect. This is an important empirical observation that builds on and helps explain Stevenson and colleagues' (Stevenson, 2019) findings that interventions that improve water quality did not necessarily improve psychosocial distress outcomes. This observation of the pivotal role of perceived unfairness has enormous implications, both theoretically and practically, for scholarship aimed at breaking the cycle between water insecurity and mental ill-health. It means that creating fair water institutions *may be much more important* than merely providing better quality or more water if improving overall wellbeing is a goal of water projects. Moving forward, we need much more locally-embedded, ethnographic, and mixed-methods research to advance our understanding of perceived unfairness and injustice in specific social, cultural, and ecological contexts. Our own work here focused on women's perceptions, but experiences of unfairness and injustice are embedded in broader gender, class, race, ethnic, and other systems of social inequality. Future work should be sensitive to local understandings and experiences in order to implement just water interventions.

The model results also revealed water borrowing as a complex mechanism connecting household water insecurity to different likely effects on mental health. People in households that borrowed a little (1–10 times in the last month) have the worst mental health associations, even once such other explanatory factors as level of household water insecurity, responsibility for water, and perceived injustice around water are taken into account. People who never borrow water do better than those who borrow rarely/sometimes. However, *those who borrow water most intensely ≥ 11 times in the last month do significantly better than both groups*, at least as reflected in their reported depression/anxiety symptom levels (and while taking into account their level of household water insecurity and their responsibility for it). (Note that this is not apparent in the data as shown in Fig. 1, but is revealed when the relevant covariates and their relationships are taken into account (Model 4, Fig. 3)). Also, any borrowing activity then additionally appears to worsen the perception of fairness, meaning unfairness again may be partially mitigating this effect. However, even taking this into account, the complex relationship (between some sharing and more depression/anxiety and more sharing and less depression/anxiety) remains and is substantial.

This finding provides us with sufficient results to begin to better theorize how reciprocal systems like water sharing may help explain the

complex associations between water insecurity and mental health, like why some groups, in some places, or some households are more at risk of stress/distress and its mental health effects than others in ways that are not based in material access to water in itself. Rather, these are rooted in the socially-embedded ways that households are *managing* their water insecurity. We conceptualize the water borrowing variable as capturing the reliability and effectiveness of water sharing arrangements in providing water in times of need. For households that borrow infrequently, the best explanation is that this experience is less predictable, more stressful, and sometimes humiliating because the exchanges are not embedded in well-established and robust socially-supportive reciprocal relationships. This aligns with the dynamics described in Wutich's research on water sharing as emotionally distressing in Bolivia (Wutich, 2011; Wutich & Ragsdale, 2008). Indeed, our findings indicate that it may be better not to borrow water at all—in terms of mental health outcomes—than to borrow water in the context of infrequently-activated reciprocal ties. In contrast, the finding for households that borrowed intensely (≥ 11 times in the last month) aligns well with the large literature on the positive mental health effects of social support (Kessler et al., 1985; Taylor and Friedman, 2011; Uchino, 2006), as well as findings indicating water sharing works best when integrated fully into broader sharing networks (Schnegg & Linke, 2015; Wiessner, 2002; Wutich, 2011).

Our findings that water network size had no apparent role in mediating any of these relationships requires some explanation. We conceptualized network size as one way of measuring the potential reach of networks in mobilizing resources for effective water redistribution. It may be that we did not assess the characteristics of networks that really mattered. For example, Wutich's (2011) qualitative research in Bolivia documented how a household network of just two sharing partners—their in-laws and neighbors—had a water sharing arrangement that was reliable, robust, embedded in rich in food and labor exchanges, and emotionally-meaningful for participants. This suggests that the quality of the relationship, including the importance of kin-based reciprocity, was more important than the number of possible contacts. This might mean that future research should explore more deeply the affective, material, and instrumental value of water sharing network ties. It may also be that respondents were not thinking concretely about who they really would go to for water if needed, but rather more abstractly about who they could possibly go to. If we were not definitive enough in how we posed the question to get into these subtleties, we may have missed what mattered most (meaning: more detailed ethnographic work on this point is now needed). Or it may be that network size really does not matter, because only those relations who are engaged in large numbers or volumes of water exchanges really matter. We hope future studies can build on this finding to identify which of these is the best explanation.

4.1. Study strengths and limitations

A strength of the study is the random selection strategy using a very large sampling frame and the large size of the sample in comparison to prior studies, allowing inclusion of known covariates in the model and enhanced capacity to generalize from the results. The constitution of the sample (all reproductive-age mothers) likely added to the capacity to focus on testing how proposed mechanisms mattered in explaining variation in mental health outcomes. As the study is cross-sectional, however, causation cannot be established. As noted, the question related to the size of potential water sharing networks may have been insufficiently precise as posed (but we cannot know). Additionally, the responses regarding the causes of perceived unfairness in household water did not identify the issues in local water institutions but rather were universally explained as systemic discrimination (especially being Oromo). This is more difficult to align with the theoretical literature, which has been focused more on inequities in water institutions (such as unfair community systems); unfortunately, follow-up on this point proved unfeasible due to COVID-19. Many of the households in this study

grow *khat* on their land for market sale, a potentially lucrative cash crop. *Khat* grows much better if irrigated. There may be issues of unfairness related to crop irrigation (i.e., water issues outside of the household) that we are not able to discern in the context of a study focused on household water.

5. Conclusion

A growing number of studies have shown cross-sectional associations between greater household water insecurity and elevated risks of depression/anxiety in household members – most especially when respondents are women. Our results help move the needle beyond the basic observation that water insecurity instrumentally erodes mental health. It reveals some underpinning perceptual/cultural and social mechanisms that can help explain how water distress is constituted within water-insecure communities, and how those arrangements constitute or reduce risk and why. We find that perceived unfairness matters greatly in how water is distributed and accessed – in this case accounting for the majority (2/3) of the observed effect of water insecurity on mental health outcomes once other factors like food insecurity, income, actual level of water insecurity, and water responsibilities are taken into effect. Additionally, we show that social arrangements around water (borrowing) interact to both elevate and buffer risk in complex ways. Together, these findings highlight the theoretical necessity and benefits of testing implied mechanisms rather than just observing that water distress happens.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.ssmmh.2021.100008>.

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