

Rethinking water insecurity's relationship to mental health: Evidence from Iran indicates positive emotions also matter

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ARTICLE INFO

Keywords:

Water insecurity
Emotion
Mental health
Stress
Distress
Embodiment
PANAS
Iran

ABSTRACT

This study examines how water-related emotions explain differences in mental health outcomes associated with household water insecurity, based on randomized sampling of 685 households in 2024 in a severely water-stressed region of Iran. This extends current water insecurity research by empirically testing both negative and positive emotional mediators of mental health outcomes. In response to recent calls for better means to capture water-related emotional valences we first develop and validate a novel adaptation of the PANAS scale. Using structural equation modeling, we then are able to confirm that negative water-related emotions (such as anger and shame) mediate the relationship between household water insecurity and mental health, with stronger negative emotional responses linked to heightened depression/anxiety. However, positive water-related emotions (such as gratitude and hope) also independently predict better mental health. This suggests a novel dual-pathway model. Contrary to expectations, gender does not significantly moderate these relationships, likely due to context-specific gender roles through which men and women share household water management responsibilities. Overall, our findings emphasize the need for more nuanced models that link the lived experience of water insecurity with emotion and mental health, including consideration of the potential role of positive emotions.

1. Introduction

Empirical studies consistently link experiences of water insecurity with higher levels of depression and anxiety (for reviews see Kimutai et al., 2023; Wutich et al., 2020a). Emotions shaped by the social meanings of water insecurity may help explain its close association with mental health symptoms. As Worthman (1999) explains, emotions intersubjectively connect social norms (like role expectations and definitions of success/failure) to sense of self in ways that become somatized or embodied as mental health. Our goal in this paper is to use the case of an extremely water-stressed region in Iran to test how emotional valences and mental health operate in relation to each other in the context of extreme water insecurity. We test what is often implicitly assumed in the current water insecurity literature but has rarely been examined empirically: that context-based emotional experiences around water

explain (i.e., mediate) the relationship between lived experience of water insecurity and mental health.

A range of ethnographic and qualitative studies have considered varied socially-embedded mechanisms through which water insecurity evokes strong emotional responses. These responses are reported to arise from experiences of social failure, frustrated aspirations, identity threats, and interpersonal conflicts that reflect deeply personal, culturally-situated experiences. For example, worry and frustration commonly reflect concerns with the consequences of failing to meet necessary household requirements in the contexts of restricted autonomy and lack of options, such as documented in Bolivia (Wutich, 2009), Uganda (Mushavi et al., 2020), and Kenya (de Jong and Butt, 2025; Ford et al., 2023). Worry can also result from concerns for health and safety due to use of unsafe water, such as recorded by Kangmennaang et al. (2020) in Ghana. Shame arises when individuals are unable to meet

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<https://doi.org/10.1016/j.ssmmh.2025.100563>

Received 12 June 2025; Received in revised form 30 October 2025; Accepted 5 November 2025

Available online 7 November 2025

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personal hygiene norms. In India, for instance, [Hirve et al. \(2015\)](#) and [Choudhary et al., \(2023\)](#) describe how inadequate access to clean water compromises self-presentation, social respectability, and hence dignity. Grief and sadness can be expressed when valued water sources are lost or when the landscapes and social ties connected to those waters are disrupted (e.g., [Ansloos \(2023\)](#) in Canada and [Rangecroft et al. \(2023\)](#) in Peru). Fear is reported where water acquisition entails threats of within-household violence or physical danger during collection, such as in Tanzania ([Kisliuk et al., 2024](#)) and Malawi ([Adams et al., 2022](#)). Anger is linked to perceptions that water scarcity or distribution is unjust, as shown in Bangladesh ([Sultana, 2015](#)), Uganda ([Mushavi et al., 2020](#)), and Ghana ([Achore and Bisung, 2022](#)). Finally, humiliation captures the loss of status or self-worth that occurs when individuals—often women—are unable to fulfill socially expected water-provisioning roles, as illustrated in [Sultana’s \(2015\)](#) research in Bangladesh, and [Savelli’s \(2023\)](#) study in South Africa. Both studies link queuing for water to diminished dignity and gendered power asymmetries.

Together, these studies illustrate that the emotional consequences of water insecurity extend beyond physical deprivation, reflecting deeply personal and socially embedded negative emotional experiences that relate to not just inadequate water in material terms but the meanings of water that extend to sense of unfairness, threats to personal identity, and conflicted relationships.

Notably, this literature is almost exclusively focused on *negative* emotional reactions to water security ([Wutich et al., 2020a](#)). This matters because negative emotions (like shame) are widely used to motivate behavior change in water, sanitation, and hygiene (WaSH) interventions, such as Community-led Total Sanitation (e.g., [Lawrence et al., 2016](#)). But such strategies of “triggering” behavior change through negative emotions raises complex and often unresolvable ethical issues, including the capacity to create unintended harms through creation and amplification of social stigma (with the greatest harm accruing to those with fewest resources and least power) ([Brewis and Wutich 2019](#)). Some WaSH interventions have begun to integrate positive emotions within their designs (e.g., [Czerniewska et al., 2019](#)). Yet, given the lack of research on how positive emotions relate to the lived experiences of water insecurity, such implementations are proceeding without the benefit of relevant basic research.

1.1. Theorizing a distinct role for positive emotions

As noted, the intersecting literatures around water insecurity, emotion, and mental health are strongly centered on negative emotions such as shame, anger, frustration, and humiliation. Looking to ethnographic and qualitative studies with those living with water insecurity, there are signals that positive emotions might also be generated even in the context of managing severe water challenges. [Sultana \(2015:643\)](#), for example, in an analysis of arsenic-related water challenges in rural Bangladesh, notes “... the joys and relief of having safe potable water

Table 1
Original PANAS (from [Watson et al., 1988](#)) and proposed adaptations for water emotions drawn from the ethnographic literature.

Positive affect		Negative affect	
Original PANAS	Adapted to Water	Original PANAS	Adapted to Water
Attentive	Grateful	Hostile	Angry
Active	Happy	Irritable	Disgusted
Alert	Satisfied	Ashamed	Ashamed
Excited	Hopeful	Guilty	Guilty
Enthusiastic	Enthusiastic	Distressed	Distressed
Determined	Determined	Upset	Sad
Inspired	Confident	Scared	Scared
Proud	Proud	Afraid	Afraid
Interested	Optimistic	Jittery	Powerless
Strong	Strong	Nervous	Worried

Table 2
Exploratory factor analysis for water emotions.

Dimensions	Items	Factor 1	Factor 2
Negative water emotions	Angry	.73	
	Disgusted	.75	
	Ashamed	.86	
	Guilty	.82	
	Distressed	.88	
	Upset	.89	
	Scared	.91	
	Afraid	.90	
	Powerless	.88	
	Worried	.80	
Positive water emotions	Grateful		.78
	Happy		.86
	Satisfied		.85
	Hopeful		.88
	Enthusiastic		.87
	Determined		.84
	Confident		.88
	Proud		.57
	Optimistic		.86
	Strong		.84
Eigenvalues		8.07	6.37
Percentage of the variance explained by each factor		36.94	35.36

coexist with the pain, fear, despair, conflicts and overall sufferings for and from water, where emotions saturate everyday water–society relations.” In their study of Ethiopian pastoralists, [Cooper et al. \(2019\)](#) identified some positive emotions as associated with relief from water insecurity (such as the arrival of the rainy season, and the resulting switch of attention to other less stressful tasks). [Savelli \(2023\)](#) considered how pride was expressed by elites around weathering the Cape Town water crisis better than others. In these cases, positive emotions are tied directly or indirectly to managing or coping when immediately facing water crises.

In different literature concerned with emotions and climate threats more generally, there are also suggestions that distinct positive climate-related emotions may also be elicited and can exist simultaneously alongside negative ones. In a summary of literature on climate-related emotion terms by [Pihkala \(2022\)](#), positive responses emerge around the anticipated capacity to react prosocially with others to make change and ability to adapt well to a crisis, such as caring, optimism, pride, belonging, gratitude and love. [Schneider et al.’s \(2021\)](#) review of positive emotions in the context of climate change identifies two basic sets of literature that may be especially relevant to intervention design: studies showing positive emotions predict willingness to take action, and studies showing that taking action is associated with positive emotions (see also [Davidson and Kecinski, 2022](#)).

1.2. Distinguishing emotion from mental health

Overlap in core constructs likely impedes clear understanding of how emotions explain mental health outcomes in the contexts of water insecurity. In the relevant water insecurity literature, constructs like emotion, distress, stress, and depression are often considered proxies of each other and accordingly treated as interchangeable or conjoined elements of the same thing. Examples of this include “psycho-emotional distress” per [Achore and Bisung’s \(2022\)](#) study in and [Kimutai et al., 2025](#) ethnographic study of women in an informal settlement in Kenya that clumps negative emotions (shame, embarrassment, anger and hate) with depression and anxiety as outcomes of living with water insecurity. Some studies even consider level of emotional distress/wellbeing as a proxy measure for water insecurity itself ([Cooper et al., 2019](#); [Libey et al., 2022](#); [Hutchings et al., 2022](#)). But this overlap obscures the distinct role that emotion may play in *mediating* the relationship between water insecurity and mental health outcomes (like anxiety and depression).

1.3. Gender as a key factor

Many of the reported associations between both water insecurity and emotions and between water insecurity and mental health show differentiated results between women and men (e.g., Wutich et al., 2020a; Cooper-Vince et al., 2018; Kimutai et al., 2023). This is most often explained by the gendering of water-related household responsibilities, such as where women have primary responsibility for household water and this appears detrimental to their well-being relative to men (e.g., Sultana, 2015; Adams, 2024). For example, Brewis et al. (2019) demonstrated that household water insecurity strongly predicts physiological stress (blood pressure) in women but not their co-resident husbands, with this distinction was explained by a highly feminized responsibility for household water management in that context. Accordingly, we should expect the associations between water insecurity, emotions, and mental health might vary by gender if household water-related roles and responsibility are differentiated.

1.4. Research prediction

Putting these literatures and challenges together, we propose that negative emotions substantively mediate the negative mental health associations of living with water insecurity, considering that the patterns of association might be very different for women versus men. That is, contextually meaningful experiences of water insecurity elicit emotions that, in turn, affect mental health. Importantly, we also test for a possible, independent role for *positive* emotions as potentially *protective* of mental health.

2. Study setting: Southeastern Iran

Sistan and Baluchestan, the largest province in Iran, has been in the midst of an escalating and now dire water crisis for more than two decades. The combination of arid climate, erratic rainfall patterns, high evaporation rates, strong winds, limited vegetation cover, and overuse of groundwater have triggered frequent, severe, and escalating droughts that are adversely affecting agriculture, the economy, and the livelihoods of its inhabitants (Omidvar et al., 2024; Darroudi et al., 2022; Khosnoodi Far et al., 2022; Mahmoudi et al., 2015; Firoozi et al., 2020; Piri et al., 2013). This long-term water crisis was accelerated by the construction of the Kamal Khan Dam in neighboring Afghanistan, resulting in an almost complete loss of surface water by 2001 (Loodin, 2025). Subsequently, 25 percent of the population has left as forced environmental migrants due directly or indirectly to ongoing water issues (Minority Rights Group, 2023). The highly politicized and volatile situation around access to adequate and safe water across all of Iran is most acutely experienced in Sistan and Baluchistan, where the population includes many of the poorest, most minoritized and otherwise marginalized groups in Iran. Further worsening of conditions is likely, as rainfall continues to decline, temperatures are expected to rise, and no effective mitigation strategies have been implemented (Darroudi et al., 2022).

There are useful clues in the regional literature that we may also be able to meaningfully capture both negative and positive water-related emotions in southeastern Iran, even within this extremely stressful context. Certainly, negative emotions are well documented. Mohammedi et al. (2024) interviewed 25 farmers in Southern Iran and extracted themes of disappointment, despair, depression, anxiety, and hopelessness in relation to effects of drought. As one respondent put it: “I am 100 % sure that the despair and hopelessness [of people] in the regions is affecting their health ... the fact is that facilities do not solve the problem of water shortage ...” [section 3.3.2, no page number given]. Based on 96 interviews with farmers near hypersaline Lake Urmia, Zenko and Menga, 2019 found that they identified connections between water insecurity and local conflicts, and around these such emotions as sadness, hopelessness, and loneliness. Tahernejad et al. (2025) interviewed 35 farmers

and farming experts in affected regions with a focus on factors that provided resilience against drought in ways that hinted at emotional aspects of relief when they could successfully mitigate farmers as related to extreme situations discussed above. For example: “... I stopped worrying about the future and focused on adapting to the situation in any way possible. As a result, I feel much better now. I'm able to sleep more easily at night without needing sleeping pills, and I'm no longer preoccupied with anxious thoughts about the future ...” [p.9060]. In an analysis of 3850 rural residents, Khodarahimi et al. (2014) also reported that residents living with water shortages had much higher anxiety, depression, somatic complaints and also worse overall mental health. They also reported much more negative emotion on a standardized scale. However, their analysis did not mediate the effects of emotions on the relationship between water insecurity and mental health, which is our goal herein.

Sohrabi et al. (2024) correlated responses from 1379 residents in 10 Iranian provinces. Counter-intuitively, those living in zones with less impact from climate change expressed more negative emotions (anger, anxiety, sadness) when asked “What feelings do you have regarding climate change?” The authors were unable to readily explain the observations, but suggested that those in less affected areas felt more guilty or powerless in ways that made them sad and angry. They also collected responses on one positive emotion, enthusiasm, but found no difference across the two groups. Importantly for considering positive emotions in this specific context, using surveys with 1198 rural Iranian residents in Fars province, Khodarahimi and Deghani (2012) found that those living with water scarcity had higher levels of negative emotions, including less hope than those without. However, they also reported more instances of positive emotion.

3. Materials and methods

3.1. Data collection

Questionnaire-based surveys were the primary data collection method. We systematically sampled residents over 15 years of age resident in Sistan and Baluchestan provinces, with a total population in that age range of 1,875,128 distributed in 26 counties (Statistical Center Iran, 2024). Target sample size was determined by Cochran's (1977) formula and suggested a minimum of 384. The final sample was increased to 685 for better allocation of samples to key subgroups of the statistical population (i.e., gender and resident status in rural/urban areas). The data were gathered in the winter of 2024, when availability of drinking and other-use water is more accessible compared to summer (Darroudi et al., 2022). Given the overall severity of the water crisis in Sistan and Baluchistan, winter is still a time of households struggling to access both adequate and safe water to meet their most basic needs.

Multi-stage cluster random sampling began with random selection of 10 out of 26 counties, then selection for both rural and urban areas, then blocks, and then roads, streets, and alleys. Then, every third house was selected. Eligible members were identified and one respondent per household was randomly selected and then invited to participate. The agreement rate was 95.2 percent. Following informed consent, trained interviewers with familiarity with the targeted communities conducted the interviews in Persian.

3.2. Ethical oversight

This study has been registered in the Research Ethics Committee of Arak University of Medical Sciences with the code IR.Arakmu.rec.1404.021.

3.3. Variables

3.3.1. Predictor variable

A household water insecurity score was created using 9 items from the 12-item Household Water Insecurity Experiences (HWISE) scale

(Young et al., 2019). While the HWISE scale has 12 items, three of these are emotion-related (anger, worry, shame). So, we removed these from our household water insecurity variable calculation to manage potential conflation. All the remaining 9 items were assessed with a four week recall period using a Likert-like response categories (Never = 0, rarely = 1, sometimes = 2 often/always = 3). The resulting water insecurity score was developed by summing the scores, and the potential range of resulting scores was 0 (fully water secure) to 27 (maximally water insecure).

3.3.2. Mediating variables

Water-related Emotions were captured using an adapted PANAS (Positive and Negative Affect Schedule: Watson, Clark and Tellegen, 1988) scale with 20 items, 10 positive and 10 negative (see Table 1). We adapted the PANAS items slightly based on the body of ethnographic literatures that discuss emotion around water as described above. In particular, “worry” and “anger” are widely expressed around water cross-culturally, but neither are items in the original PANAS. We also substituted terms that have rarely been expressed in that same literature, such as hostility. In using the adapted PANAS items we asked respondents: “Thinking about your overall household water situation, to what extent do you generally feel: (emotion)?” Responses ranged on a Likert-type scale from 0 (not at all) to 5 (extremely). Thus, the possible range for both positive and negative water-related emotions from each scale was 0 (none) to 50 (all of them, and very strongly).

Given this is an adapted PANAS-Water scale, and the proposition that negative and positive emotions may operate distinctively in their effect on mental health, during variable development we tested the dimensionality of water emotions using exploratory factor analysis (EFA) and confirmatory factor analysis (CFA). That is, we wanted to check that we were not ignoring the possibility of latent mixed emotion sets (i.e., specific sets of related positive and negative emotions) that might confuse our observations. The results confirmed that these water emotions items have two distinct factors: (1) water positive emotions, and (2) water negative emotions. In particular, the EFA through Varimax rotation with Kaiser normalization obtained a two-factor solution which accounted for 77.26 % of the explained variance (Table 2), larger than the 60 % threshold recommended by Finch (2019). Also, all of the 20 items had factor loadings greater than .50 (.57–.91), as recommended by Kaiser (1996). The highest total explained variance occurred for the water negative emotions (36.94 %), compared with 35.31 % explained by the water positive emotions factor; (Kaiser–Meyer–Olkin [KMO] = .948, df = 190, Sig. = .000). CFA was applied to the two factors identified through EFA. The two-factor 20-item CFA model was estimated using SPSS AMOS, ver. 22 (Table 3). Results showed that all remaining items load highly on their corresponding factors, and the CFA results revealed that the factor loadings of all constructs were significant (sig. = .001) and above .50, the minimum threshold value. The 20 items showed an adequate overall model fit to the data (fit (χ^2 (df) = 3.66, $p < .001$; RMSEA = .070; CFI = .95; TLI = .94; SRMR = .079). Given this, we proceeded to use the adapted PANAS-Water scale items as the basis for two independent emotion variables, based in the assumption that these negative and positive emotions sets are distinct phenomena.

3.3.3. Dependent variable

The mental health variable was derived from the 4 items of the GAD-2 and PHQ-2 screening scales, designed to capture anxiety and depression respectively (see Table 4), using a standard response categories (never = 0, rarely = 1, sometimes = 2, often/always = 3) and a 4-week recall period to match the water insecurity variable. We combined these four items into a single summary “mental health measure” that could range from 0 (no anxiety/depression symptoms) to 12 (very high levels of anxiety/depression symptoms).

All the item-summation measures above were found to have high internal consistency ($\alpha > .70$; CR > .70) as recommended by Esposito Vinzi et al. (2010; see Table 3). We also tested their discriminant validity

Table 3

Validity and reliability of variables.

Variables	Items (Factor loadings)	AVE	CR	α
Water insecurity	In the last 4 weeks, how frequently has your main water source been interrupted or limited (e.g., water pressure, less water than expected, river dried up)? (.57). In the last 4 weeks, how frequently have problems with water meant that clothes could not be washed? (.71). In the last 4 weeks, how frequently have you or anyone in your household had to change schedules or plans due to problems with your water situation? (.68). In the last 4 weeks, how frequently have you or anyone in your household had to change what was being eaten because there were problems with water (e.g., for washing foods, cooking, etc.)? (.78). In the last 4 weeks, how frequently have you or anyone in your household had to go without washing hands after dirty activities (e.g., defecating or changing diapers, cleaning animal dung) because of problems with water? (.77). In the last 4 weeks, how frequently have you or anyone in your household had to go without washing their body because of problems with water (e.g., not enough water, dirty, unsafe)? (.78). In the last 4 weeks, how frequently has there not been as much water to drink as you would like for you or anyone in your household? (.78). In the last 4 weeks, how frequently have you or anyone in your household gone to sleep thirsty because there wasn't any water to drink? (.75). In the last 4 weeks, how frequently has there been no useable or drinkable water whatsoever in your household? (.79).	.51	.92	.93
Water positive emotions	Thinking about your overall household water situation, to what extent do you generally feel: Grateful (.71). Happy (.84). Satisfied (.85). Hopeful (.82). Enthusiastic (.87). Determined (.80). Confident (.82). Proud (.57). Optimistic (.76). Strong (.77).	.61	.91	.94
Water negative emotions	Thinking about your overall household water situation, to what extent do you generally feel: Angry (.67). Disgusted (.87). Ashamed (.84). Guilty (.87). Distressed (.86). Upset (.89). Scared (.91). Afraid (.88). Powerless (.85). Worried (.78).	.71	.93	.95
Mental health	In the last 4 weeks, how often have you been bothered by the following problems? Little interest or pleasure in doing things (.68). Feeling down, depressed or hopeless (.80). Feeling nervous, anxious, or on edge (.85). Not being able to stop or control worrying (.75).	.59	.80	.85

Note. AVE = average variance extracted; CR = composite reliability.

by exploring the average variance extracted (AVE) shared between a construct and its measures. AVE indices were found to be higher than .50 as recommend by Rodgers et al., (2006). Finally, we conducted a first order confirmatory factor analysis (CFA) for these scales. Factor loadings for all the items were significant (>.50). Moreover, the CFA revealed good fit indices for all (Byrne, 2016).

3.3.4. Key Covariates

Key Covariates included respondent gender and residence status as potentially important explanatory factors in interpreting data patterns. Gender was specified as (1) male, (2) female. Residence status was

Table 4
Descriptives related to key water variables.

What is your water source at home?	Source of drinking water	Source of water for other uses
Piped water into dwelling	46.1 %	45.7 %
Piped water to yard/plot	13.4 %	17.7 %
Public tap/standpipe	6.1 %	5 %
Tubewell/borehole	10.7 %	12.6 %
Protected dug well	3 %	3.8 %
Unprotected dug well	2 %	1.7 %
Protected spring	1.5 %	1 %
Unprotected spring	–	1.2 %
Rainwater collection	1 %	1.2 %
Cart with small tank/drum	2 %	1 %
Tanker-truck	4.8 %	4 %
Surface water (river, dam, lake, pond, stream, canal, irrigation channels)	1.7 %	1.2 %
Purchased, borrowed, or gifted from other households	1.5 %	.5 %
Other	6.3 %	3.6 %
Sum	100 %	100 %

Who in your household is most responsible for ensuring the household has water?	All respondents	Men	Women
Self	40.7 %	47.6 %	30 %
Another female adult	5.4 %	3.3 %	8 %
Another male adult	17.6 %	14.3 %	23.2 %
All adults equally	23.8 %	22.6 %	24.9 %
Male child or children	11.1 %	10.4 %	12.7 %
Female child or children	1.5 %	1.8 %	1.3 %
Sum	100 %	100 %	100 %

Average time spent by the respondent collecting water per week	4.4 h (SD = ±15.1)
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specified as (1) residence in an urban area, (2) for residence in rural area.

3.3.5. Additional Variables

Additional Variables in the model included respondent's age, time they spent each week fetching water (in minutes per week, including travel and waiting time), marital status, and their education, as well as household size, water source, household income, and who is most responsible for household water fetching. Marital status was specified as (1) standing for single, (2) for married, (3) divorced or widowed. Monthly total household income (as an index of wealth), time to fetch household water, and household size were entered into the models as continuous variables. Education was measured by the number of years of formal education. We also created a collapsed "education level" variable

differentiating 1–11 years, 12 years with a diploma, and more than 12 years in three locally-relevant categories no diploma, diploma, and more than diploma, respectively.

3.4. Analytic approach

Responses from close-ended questions were analyzed using the basic Statistical Package for the Social Sciences (SPSS, version 23). The independent and dependent variables were described and presented by mean, and standard error. To achieve the main goals of the study, we used visually-based structural equation models (SEM) via AMOS software (SPSS, version 23) as shown in Fig. 1. This approach yielded estimates of the degree of impact of the independent variables (household water insecurity, water-related positive and negative emotions) on mental health. SEM was selected because it allowed simultaneous testing of both the direct and indirect effects of independent variables on dependent variable. The results from the model were reported as standardized coefficients (beta coefficients).

4. Results

4.1. Descriptive results and correlations

With regards to gender, 58 % of respondents were male and 42 % were female. 57 % of respondents lived in rural areas and 43 % in urban areas. 59.4 % of respondents were married, 37.7 % were single, and 2.9 % were divorced or widowed. On average, the income of the respondent's households was the equivalent of USD117.4 (SD = 8.74) per month. The mean household size was 5.5 (SD = 2.41). The mean age of respondents was 29.7 years (SD = 2.30) and the mean education of the respondents was 13.1 years (SD = 1.44).

The most common sources of drinking water and other water uses are piped water into dwelling and piped water to yard/plot, respectively (Table 4). Regarding the question of who is responsible for accessing household water, more people identified themselves as the primary individual (40.7 %) versus one shared with another (23.8 %). Respondents reported they spend an average of about 4.4 h per week accessing water on behalf of their households (also Table 4).

Table 5 shows that the means and standard deviations for household water insecurity and emotion scale measures. The water insecurity score we use herein analytically, as noted, does not include the "emotions" items in the original HWISE scale. If we add those in for comparison to other studies, the HWISE 12-item scale yields a mean household water insecurity score of 21.79, exceeding any collected across 27 water-insecure community sites in 22 countries during initial scale testing

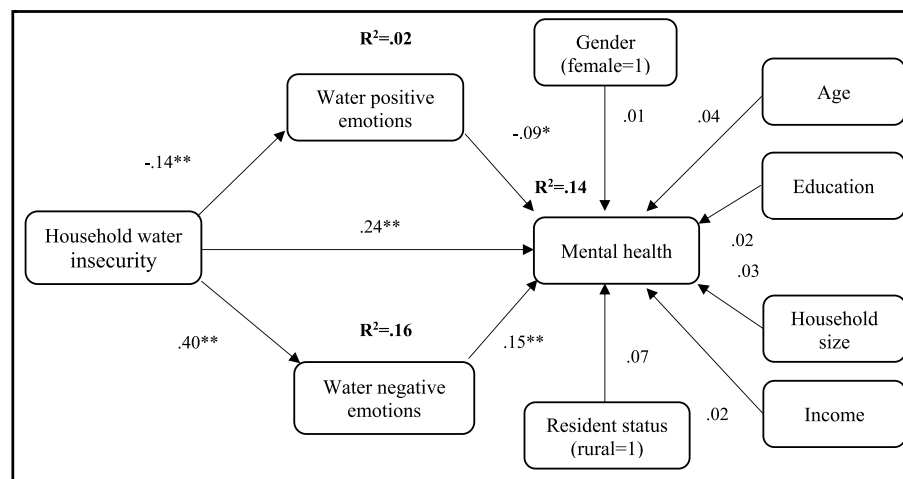


Fig. 1. SEM model of independent variable effects on mental health in all respondents [N = 685].

Table 5
Descriptives for scale measures.

Variables	Mean	Standard deviation	Range
Household water insecurity (9-item, emotion items excluded)	15.94	6.6	0–27
Household water insecurity (12-item, all items included)	21.79	8.55	0–36
Water positive emotions	32.70	10.1	0–50
Water negative emotions	26.51	11.64	0–50
Mental health	5.72	3.16	0–12

(Stoler et al., 2021). Only .5 percent of households reported being fully water insecure (that is, an HWISE score of zero).

Results of bivariate correlations in Table 6 show that household water insecurity has a positive and significant relationship with variables of water negative emotions, mental health, and weekly time accessing water, and has a negative and significant relationship with variable of water positive emotions. The measures of water-related positive emotions have a negative and significant relationship with variables of household water insecurity, water negative emotions, mental health and time spent accessing water. Water-related negative emotions have a positive and significant relationship with variables of household water insecurity, and mental health, and has a negative and significant relationship with water-related positive emotions. Mental health has a positive and significant relationship with variables of household water insecurity, water-related negative emotions and time spent accessing water, and has a negative and significant relationship with water-related positive emotions.

The effect size results of Table 7 show that residence status has a moderate and significant effect on household water insecurity ($d = .36$, $p < .01$) and a small and significant effect on level of positive water-related emotions ($d = .20$, $p < .05$) and worse mental health ($d = .23$, $p < .05$). Household water insecurity, level of positive water-related emotions, and worse mental health were more highly correlated in rural areas. Education level shows a small and significant effect on water insecurity ($\eta^2 = -.02$, $p < .05$) and worsening mental health ($\eta^2 = -.02$, $p < .05$). More education is associated with greater water security and better mental health. Drinking water sources have a moderate and significant effect on water insecurity ($\eta^2 = .08$, $p < .01$) and a small and significant effect on negative emotions ($\eta^2 = .05$, $p < .01$) and mental health ($\eta^2 = .04$, $p < .05$), while non-drinking water sources have a moderate and significant effect on water insecurity ($\eta^2 = .11$, $p < .01$) and a small and significant effect on negative emotions ($\eta^2 = .05$, $p < .05$) and worsening mental health ($\eta^2 = .06$, $p < .05$). Less reliable water sources (e.g. rain harvesting, tankers) are associated with more water insecurity, more negative emotions, and worse mental health scores. Who has household responsibility for providing water had a small and significant effect on positive emotions ($\eta^2 = -.04$, $p < .01$), and if the respondent reported that household water was collected by all adults equally, they also reported higher levels of positive water-related emotion.

Table 6
Bivariate correlations.

Variables	1	2	3	4	5	6	7	8
1-Household water insecurity (9-item)	1							
2-Water positive emotions	-.15**	1						
3-Water negative emotions	.43**	-.10*	1					
4-Mental health	.34**	-.15**	.28**	1				
5- Time to fetch water	.18**	-.10**	.03	.11**	1			
6-Age	.03	-.05	.04	.03	.01	1		
7-Household size	.03	.08	.02	.04	.05	.02	1	
8-Income	.07	-.08	.03	.01	.07	.06	-.15**	1

Note: * $p < .05$, ** $p < .01$.

4.2. Data modeling results

4.2.1. Modeling the total sample

Fig. 1 depicts the results of the structural equation model of mental health with all respondents included ($N = 685$). This analysis produced good overall model fit, with indices indicating acceptable fit to the data ($\chi^2(df) = 1.30$, $p < .001$; RMSEA = .012; CFI = .99; TLI = .98; SRMR = .061). Household water insecurity significantly predicted both positive and negative water-related emotions. Greater water insecurity was associated with lower levels of positive water-related emotions ($\beta = .14$, $p < .05$) and higher levels of negative water-related emotions ($\beta = .40$, $p < .05$). The household water insecurity explained approximately 16 % and 2 % of the variance in water negative and positive emotion scores.

In turn, both levels of negative and positive water-related emotions were significantly associated with mental health. Positive emotions were related to better mental health ($\beta = .09$, $p < .01$), whereas negative emotions were associated with poorer mental health ($\beta = -.15$, $p < .01$). That is, both positive and negative water-related emotions mediate the relationship between household water insecurity and mental health, with stronger negative emotional valence associated with worse outcomes. None of the sociodemographic variables included in the model contributed to variation in mental health outcomes, once the other factors were taken into account.

The proportion of variance explained by our models ($R^2 = .11-.21$ across subgroups) is consistent with expectations for psychosocial and behavioral models involving mental health outcomes (Byrne, 2016), whereby R^2 values of this magnitude are considered adequate for models addressing complex, multidimensional phenomena with the assumption that there are additional unobserved influences that are beyond the scope of our study to identify.

4.2.2. Gender-specific models

4.2.2.1. *The men-only model.* ($N = 397$), as shown in Fig. 2, showed acceptable fit ($\chi^2(df) = 1.25$, $p < .001$; RMSEA = .038; CFI = .97; TLI = .95; SRMR = .069). As in the overall model, level of household water insecurity predicted both positive and negative emotions ($\beta = .13$ and $\beta = -.40$, respectively, both $p < .05$). For men, however, the emotional pathways were particularly strong. Positive water-related emotions were strongly associated with better mental health ($\beta = .12$, $p < .01$), whereas negative water-related emotions were strongly associated with worse outcomes ($\beta = -.20$, $p < .01$). None of the sociodemographic variables included in the model contributed to variation in mental health outcomes, once the other factors were taken into account.

4.2.2.2. *The women-only model.* ($N = 288$), as shown in Fig. 3, also fit the data well ($\chi^2(df) = 2.78$, $p < .001$; RMSEA = .071; CFI = .94; TLI = .92; SRMR = .078). Household water access significantly predicted positive ($\beta = .16$, $p < .05$) and negative water-related emotions ($\beta = -.40$, $p < .05$). Just one type of emotional responses was significantly related to women's mental health: positive emotions enhanced well-being ($\beta = .08$, $p < .05$). Household size ($\beta = -.12$, $p < .05$), resident status [rural = 1] ($\beta = .12$, $p < .05$), and education ($\beta = .11$, $p < .05$) also

Table 7
Demographic variables.

Demographic variables		Variables			
		Household water insecurity (SD)	Water positive emotions (SD)	Water negative emotions (SD)	Mental health (SD)
Gender	Men	16 (6.5)	32.87 (9.8)	26.43 (11.7)	5.65 (3.1)
	Women	16.11 (6.55)	31.65 (10.5)	26.71 (11.4)	5.74 (3.2)
	T-value	.064	1.34	.258	.324
	Effect size (Cohen's d)	-.01	.08	-.02	-.02
Resident status	Urban	14.66 (6.6)	31.25 (10.7)	25.85 (11.5)	5.28 (3.01)
	Rural	16.97 (6.3)	33.24 (9.4)	27.1 (11.8)	6.01 (3.2)
	T-value	4.23**	2.20*	1.42	2.72*
	Effect size (Cohen's d)	.36**	.20*	.09	.23*
Education levels	No diploma	18.1 (6.2)	31.61 (9.7)	28.82 (12.5)	6.37 (3.1)
	Diploma	16.08 (6.6)	31.5 (9.8)	26.17 (11.5)	5.72 (3.2)
	Advanced diploma	15.32 (6.4)	33.13 (10.2)	25.58 (11.4)	5.47 (3)
	F-value	6.31**	1.62	1.45	2.99*
Effect size (Eta squared)		-.02*	.01	-.01	-.02*
Source of drinking water at home	Piped water into dwelling	14.1 (6.3)	32.7 (10.6)	24.1 (11.5)	5.16 (3.1)
	Piped water to yard/plot	16.4 (5.8)	31.4 (8.7)	25.9 (10.6)	6.11 (3.3)
	Public tap/standpipe	18.3 (6.2)	32.9 (6.3)	26.9 (11.9)	5.65 (3.1)
	Tubewell/borehole	18.8 (6.4)	33.2 (10.1)	29.9 (10.5)	5.84 (3.2)
	Protected dug well	18.9 (6.9)	33.8 (5.6)	29.4 (11.7)	6.46 (2.2)
	Unprotected dug well	17.4 (7.4)	37.6 (8.8)	33.5 (7.6)	6.91 (2.5)
	Protected spring	17.2 (5.2)	38 (8.4)	32.4 (8.6)	6.11 (2.9)
	Rainwater collection	20.3 (3.5)	30.6 (12.2)	31.5 (7.8)	7 (2.2)
	Cart with small tank/drum	16.1 (5.9)	32.5 (7.7)	33.6 (4.6)	6.1 (3.1)
	Tanker-truck	17.6 (7.1)	27.6 (13.1)	30.4 (12.1)	7.57 (2.4)
	Surface water	17.7 (4.6)	36.8 (5.2)	24.7 (4.1)	5.44 (4.6)
	Purchased, borrowed, or gifted from other households	19.2 (5.5)	31.4 (7.8)	27.6 (8.1)	5.88 (1.7)
	Other	16.9 (6.7)	31.7 (8.5)	28.9 (15.2)	6.52 (3.2)
	F-value	4.40**	1.32	2.73**	2.12*
Effect size (Eta squared)		.08**	.01	.05**	.04*
Source of water for uses water at home	Piped water into dwelling	13.9 (6.1)	31.8 (10.8)	24.5 (11.2)	5.17 (3)
	Piped water to yard/plot	16.2 (6)	33.5 (8.3)	26.2 (11.1)	5.76 (3.1)
	Public tap/standpipe	18.6 (6.6)	35.1 (7.3)	30.4 (10.7)	6.63 (3.5)
	Tubewell/borehole	17.4 (6.5)	33.1 (.)	26.1 (12.2)	5.75 (3.1)
	Protected dug well	18.6 (6.7)	33.8 (10.1)	29.7 (9.7)	5.9 (2.5)
	Unprotected dug well	20.4 (4.5)	32.5 (6)	32.6 (7.9)	6.5 (3)
	Protected spring	18.6 (5.1)	34 (9.7)	33.3 (6.2)	7.16 (2.9)
	Unprotected spring	16.1 (5.3)	36.8 (10.3)	33 (4.4)	7.2 (1.3)

Table 7 (continued)

Demographic variables		Variables			
		Household water insecurity (SD)	Water positive emotions (SD)	Water negative emotions (SD)	Mental health (SD)
	Rainwater collection	21.4 (4.5)	28.1 (7.3)	28 (11.2)	6.85 (2.8)
	Cart with small tank/drum	16 (5.3)	33.2 (12.4)	29 (2.5)	6.66 (2.7)
	Tanker-truck	19.5 (5.7)	29.8 (7.3)	30.4 (13.4)	7.4 (2.8)
	Surface water	16.7 (5)	38.8 (11.6)	23.8 (3.7)	5 (4.2)
	Purchased, borrowed, or gifted from other households	24.4 (4.6)	41.5 (7.7)	28.3 (7.6)	8 (4)
	Other	19.2 (7.9)	29.9 (9.8)	31.1 (16.8)	7.2 (3.9)
	F-value	5.42**	1.10	2.11*	2.20*
Effect size (Eta squared)		.11**	.01	.05**	.06**
Responsible for household water	Self	15.9 (6.6)	32.4 (10.1)	26.6 (12.4)	5.79 (3.)
	Another female adult	18.6 (5.6)	31 (9.5)	30.8 (7.8)	6.75 (3.5)
	Another male adult	15.7 (7.1)	33.4 (8.4)	27 (11.6)	5.68 (3.1)
	All adults equally	15.8 (6.4)	34.6 (9.1)	26 (12.2)	5.35 (3.3)
	Male child or children	16.4 (5.6)	27.2 (11.3)	24.8 (8.4)	6.1 (2.5)
	Female child or children	12.4 (4.7)	28.4 (7.1)	26.7 (5.4)	4.44 (1.9)
	F-value	1.69	5.32**	1.04	1.50
Effect size (Eta squared)		.01	-.04**	.01	-.02

Note: * $p < .05$, ** $p < .01$.

exerted effects of mental health, even once the other variables in the model are considered.

The tested models explain more variance in men's mental health (21 %) than women's mental health (11 %). To examine the path differences between groups, multi-group analysis and chi-square difference test ($\Delta\chi^2$) were used in the Nested Model Comparisons section of AMOS software (Table 8). The significance of the constrained models shows that the difference in standardized coefficients of different models by gender is significant compared to the unconstrained models. Therefore, with the results of this statistical test, it can be said that model of the effect of insecurity on mental health through the mediation of positive and negative emotions is stronger in men than in women. The results of bias-corrected bootstrapping method in Table 8 show that value of the indirect effect of household water insecurity on mental health through negative and positive water emotions is also slightly clearer in men (.10) than in women (.03).

4.2.3. Models by residence

4.2.3.1. The rural residents'. The **rural residents** model ($N = 390$), as shown in Fig. 4, fit the data acceptably ($\chi^2(df) = 2.51$, $p < .001$; RMSEA = .041; CFI = .96; TLI = .94; SRMR = .069). Household water access predicted both positive ($\beta = .18$, $p < .01$) and negative ($\beta = -.37$, $p < .01$) emotions. Positive emotions improved mental health ($\beta = .16$, $p < .01$), while negative emotions worsened it ($\beta = -.16$, $p < .01$). None of the sociodemographic contributed to variation in mental health outcomes, once the other factors were taken into account, except for age ($\beta = -.12$, $p < .05$).

4.2.3.2. The urban residents'. The **urban residents** model ($N = 295$), as

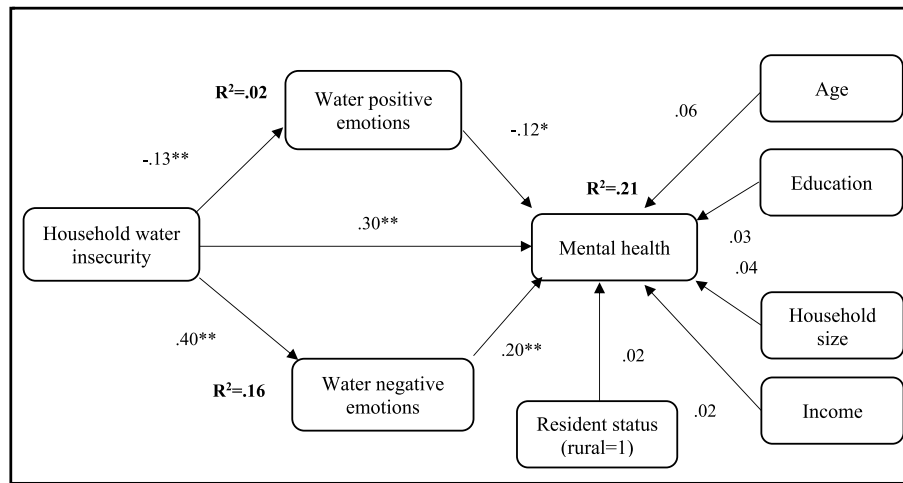


Fig. 2. SEM model of independent variable effects on mental health in men [N = 397].

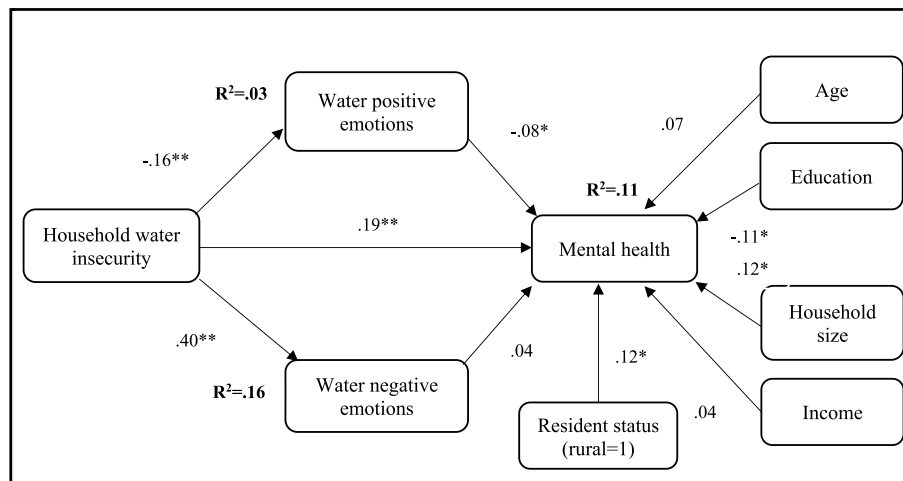


Fig. 3. SEM model of independent variable effects on mental health in women [N = 288].

Table 8

Direct and indirect effects on mental health.

Paths	Group	Standardized Direct Effects			Standardized Indirect Effects	
		Water Insecurity → Mediator	Mediator → Mental Health	$\Delta\chi^2$	Estimates	Bootstrap 95 % CI (Lower-Upper)
Water Insecurity → Positive Emotions → Mental Health	Overall	-.14**	-.09*	–	.01*	(-.01)–.03
	Men	-.13**	-.12*	Model 1 = 19.39	.02*	.0–.04
	Women	-.16**	-.08*	Model 2 = 17.56**	.01*	(-.02)–.04
	Urban	-.13**	-.10*	Model 1 = 10.84	.01*	(-.01)–.03
	Rural	-.18**	-.16*	Model 2 = 21.85**	.03**	.01–.05
Water Insecurity → Negative Emotions → Mental Health	Overall	.40**	.15**	–	.06**	.03–.09
	Men	.40**	.20**	Model 1 = 19.39	.08**	.06–.10
	Women	.40**	.04	Model 2 = 17.56**	.02*	(-.01)–.05
	Urban	.45**	.13**	Model 1 = 10.84	.06**	.03–.09
	Rural	.37**	.16**	Model 2 = 21.85**	.06**	.03–.09

Note: Model 1 = Unconstrained Model, Model 2 = Constrained Model, * $p < .05$; ** $p < .01$.

shown in Fig. 5, also demonstrated acceptable fit ($\chi^2(df) = 2.65$, $p < .001$; RMSEA = .055; CFI = .96; TLI = .94; SRMR = .073). Similar to the rural sample, household water access predicted both positive ($\beta = .13$, p

$< .01$) and negative ($\beta = -.45$, $p < .01$) emotions, which in turn predicted mental health outcomes ($\beta = .10$ and $\beta = -.13$, respectively, both $p < .01$). None of the sociodemographic contributed to variation in

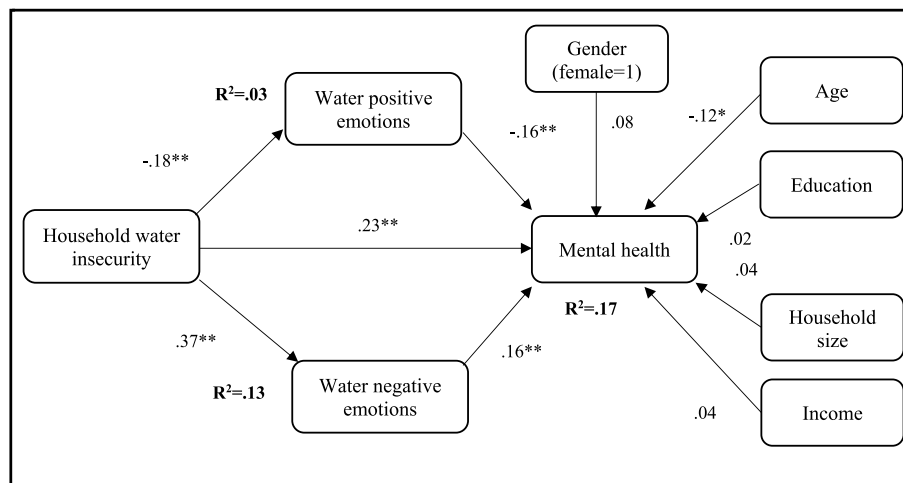


Fig. 4. SEM model of independent variable effects on mental health in rural [N = 390].

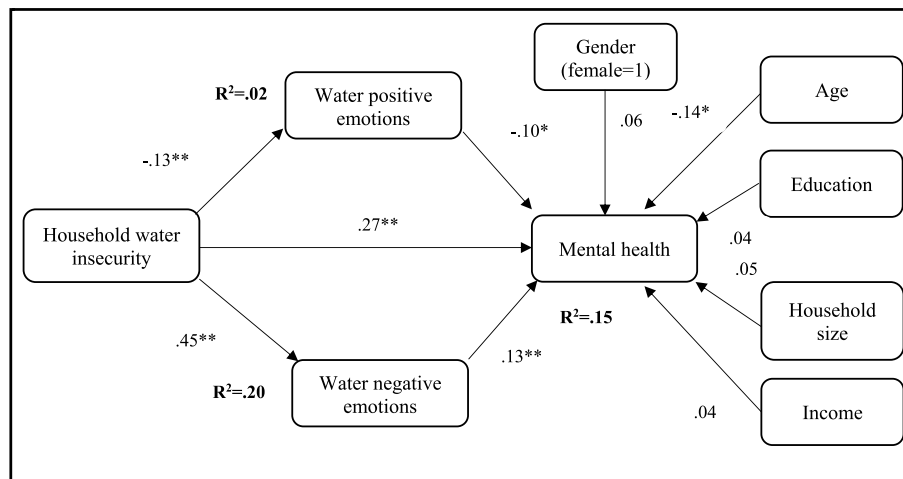


Fig. 5. SEM model of independent variable effects on mental health in urban [N = 295].

mental health outcomes, once the other factors were taken into account, again except for age ($\beta = -.14$, $p < .05$).

That is, both rural and urban models showed consistent mediating roles of water-related emotions in expected directions. The tested models explained slightly more variance in rural residents' mental health (17 %) than urban residents mental health (15 %). The significance of the constrained models shows that the difference in standardized coefficients of different models by residents' status is significant compared to the unconstrained models. Therefore, with the results of this statistical test, it can be said that model of the effect of insecurity on mental health through the mediation of positive and negative emotions is stronger in rural residents than in urban residents. The results of bias-corrected bootstrapping method show that value of the indirect effect of household water insecurity on mental health through negative and positive water emotions is slightly clearer in rural residents (.09) than in urban residents (.07).

5. Discussion

In this Iranian sample of households in an extremely water-stressed region: a) negative water-related emotions mediate the relationship between household water insecurity, whereby stronger emotional valence is associated with worse mental health; b) positive water-emotions have a distinct and separate relationship and predict better mental health; and, contrary to predictions, c) gender is not a significant

factor in explaining within-sample variation in these relationships. Men and women showed similar pathways, but notable is that the magnitude of emotional effects was stronger among men in their relationship to their mental health. By contrast, sociodemographic variables exerted more influence in the women's model, suggesting gendered differences in the relative weight of structural versus psychosocial determinants of mental health.

We also observe that levels of water-related emotions explain only part of the relationship between household water insecurity and mental health outcomes, suggesting that water insecurity itself—and possibly other unmeasured factors—also influence symptoms of depression and anxiety. Also notable is that household income did not add additional explanation for mental health measures once water insecurity is taken into account. This may be explained by the severity and chronicity of water insecurity across this region of Iran, alongside incomes being consistently low. The lack of a relationship between income and water insecurity can be attributed to the specific conditions of the region, as in this province, access to water is more influenced by climatic factors, infrastructure, and distribution policies than by household income levels. On the other hand, the relative uniformity of income and widespread poverty mean that there are not many income differences that can affect access to water. Also, in many areas, water supply is provided publicly or through social and kinship networks, not based on household financial capacity. Therefore, even higher-income households face water insecurity in the event of poor infrastructure and shortages of

water resources, and the role of income in this regard is limited.

The finding that negative water-related emotions are associated with worse mental health is confirmatory evidence, in that it is consistent with what is already expected based on prior studies. However, the observation that positive emotions have a distinct effect provides encouragement to consider a wider range of emotional valences – positive as well as negative – in testing why and how water security associates with better mental health. This is relevant to the ethical design and monitoring of water-related interventions.

The findings also confirm that while the literature often considers emotions and mental health are inter-related outcomes of living with the stress of water insecurity, so that a measure of one is often taken as a proxy for others. Here we have identified benefits to distinguishing emotions and mental health clearly from each other in understanding how water insecurity creates suffering, allowing testing of additional potential key explanatory mechanisms in imputed causal relationships.

One interesting finding in terms of the existing literature is the lack of influence of respondent gender on these relationships. This may be best explained by how gender roles and water intersect in these households; particularly men are also often directly engaged in and responsible for household water fetching at least as much as women in this highly stressed context, as shown in Table 4.

Further, recent analyses of the literature connecting chronic, slow-onset climate disasters to mental health have identified a pressing need for novel measures to assess the negative emotional impacts previously identified in ethnographic and qualitative studies. Our adapted PANAS-Water scale (Tables 1 and 2) – developed specifically using insights from that literature – now provides one such option, with the added benefit of also including positive emotional valences and demonstrating adequate reliability/validity. While we did not capture any temporal dynamics in this cross-sectional study, using this or a similar scale provides a new strategy for pre-post testing in water insecurity interventions that might reveal important positive mental health effects not captured otherwise (see Stevenson et al., 2016 for an example where this approach might have captured effects in the context of a null finding of mental health improvements following a water insecurity intervention in Ethiopia).

5.1. Application to the Iranian context

The relationship between water insecurity and emotions in Sistan and Baluchestan province is not just a statistical, psychological, or practical issue. It also has complex political and ethical dimensions. Water insecurity in Iran is severely undermining public trust in many institutions, in ways that are complicating and worsening an array of civil conflicts (Astaneh et al., 2019; Asghari Niari, 2017). From an ethical perspective, the burdens and patterning of water insecurity is also in tension with the principles of social justice and the fundamental right of humans to access safe and sustainable water resources (Hassaniyan, 2024). In this context, showing connections between water insecurity and strong negative emotions, with consequential negative health effects, is a means to demonstrate why investments in improving household water security through supportive policies and upgrading water infrastructure can have broad and extremely positive societal effects, including in enhancing institutional trust more generally and reducing civil conflicts.

6. Study limitations

As a cross-sectional study we are unable to test causative relationships. We did not consider food insecurity as a possible confounder. Often food insecurity and water coexist, and they can have both independent and interacting effects on mental health, although food insecurity is theoretically driven by water insecurity rather than the other way around (Brewis et al., 2025). Use of self-reports to estimate water collection times are subject to truncation and other possible recall bias.

More time- and cost-intensive diary methods or GPS tracking would likely be more accurate (Wutich et al., 2020b), but were beyond the capacity of this study. Results should be considered with this in mind. We also applied one conceptual model of emotions as intersubjectively connecting material/environmental contexts and social norms to mental health that aligns with what has been identified through qualitative water insecurity research. We recognize there are alternative social science theories of emotions, especially in cross-cultural perspective, that might configure these relationships differently. Also, the measurement of mental health such as on GAD-2 and PHQ-2 themselves might overlap conceptually with emotional states, such as “feeling down.” We attempted to mitigate this with a distinct approach to capturing emotional valence directly related to just water across a wide array of emotion types by asking this directly, but this limitation should be kept in mind when evaluating our study. Further, simply coping with water insecurity cannot be assumed to always result in positive emotions because the physical and behavioral responses that lead to coping are themselves very stressful (e.g., Achore and Bisung, 2023). Thus, coping strategies in themselves likely shape both positive and emotional pathways. This suggests an important area for future research that will require a more nuanced research design than we deployed here.

7. Conclusion

Living with water insecurity has been observed in many global contexts as chronically stressful, associated with expressions of strongly negative emotions and worse mental health measures. Our analysis introduces an additional pathway through which positive water-related emotions might mitigate poor mental health under conditions of severe water insecurity. This extends current water insecurity research by empirically testing both negative and positive emotional mediators of mental health.

To this end, we offer three relevant concluding points. First, based on our analysis of highly water-stressed households in southeastern Iran, we demonstrate the value of more precisely defining and distinguishing the varied aspects of water-related distress. Second, we suggest that while a research focus on water-related psychosocial distress has proceeded apace, we should also be integrating into our models a role for positive emotions that are also potentially generated through the lived experience of water insecurity even under extreme conditions. Third, we note that the implications of this integration of positive emotions are both theoretically and ethically complex, and more research across water-insecure communities is needed. But addressing these interlinked dimensions of the mental health associations with lived experiences of the material and social challenges of slow disasters such as water insecurity will be essential to identifying effective and ethical infrastructural, social, and mental health interventions.

CRedit authorship contribution statement

Seyed Ahmad Mir Mohamad Tabar: Writing – review & editing, Writing – original draft, Supervision, Project administration, Methodology, Investigation, Formal analysis. **Alexandra Brewis:** Writing – review & editing, Writing – original draft, Validation, Supervision, Methodology, Formal analysis. **Mahmod Teimouri:** Writing – original draft, Data curation. **Maryam Sohrabi:** Writing – original draft, Formal analysis, Data curation.

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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