

PRIMER

Water and mental health

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Abstract

There is a well-established connection among water quality, sanitation, and physical health. The potentially important relationship between water and mental health is considerably less studied. Reviewing evidence from ethnography, geography, folklore, indigenous studies, rural medicine, drought research, and large-n statistical studies, we argue there is now good theoretical rationale and growing evidence of water insecurity as a possible driver of mental ill-health. Furthermore, some nascent evidence suggests that emotionally meaningful interactions with water might improve mental health outcomes. Leveraging these literatures, we address the many ways in which mental health outcomes are conceptualized and operationalized in water research, including as emotional distress, perceived stress, depressive symptoms, anxiety symptoms, somatic symptoms, and quality of life. We outline arguments supporting seven possible (and likely interlocking) mechanisms that could explain such a relationship: (a) material deprivation and related uncertainty, (b) shame of social failure, (c) worry about health threats, (d) loss of connections to people and places, (e) frustration around opportunity losses and restricted autonomy, (f) interpersonal conflict and intimate partner violence, and (g) institutional injustice or unfairness. However, we explain that as most existing studies are ethnographic, qualitative, or cross-sectional, a causal relationship between water and mental ill-health is yet to be confirmed empirically. More research on this topic is needed, particularly given that poorly understood connections may create barriers to achieving Sustainable Development Goals 3 (health) and 6 (water). We further suggest that tracking mental health indicators may provide unique and as-yet underappreciated insights into the efficacy of water projects and other development interventions.

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KEYWORDS

drought, emotional distress, mental health, psychosocial, water insecurity

1 | INTRODUCTION

In contrast to the well-established connection among water quality, sanitation, and infectious disease (Bartram & Cairncross, 2010), the relationship between water and mental health is relatively little-studied. However, as we will explain in this review, there is good theoretical rationale and growing evidence of such a link. Globally, 322 million people have depressive disorders and 264 million people have anxiety disorders, and these common mental disorders are linked with lost productivity, disability, and premature death (World Health Organization, 2017). Many of these people live in water-insecure settings. Common mental disorders represent a major barrier to achieving Sustainable Development Goal 3 (health and wellbeing) (Tsai & Tomlinson, 2015), and this challenge is connected in myriad ways to Sustainable Development Goal 6 (water and sanitation) (Adams, Stoler, & Adams, 2020; Bisung & Elliott, 2017b; Brewis, Piperata, Thompson, & Wutich, 2020; Rosinger & Brewis, 2020).

Global mental health scholars have long recognized that poverty and other forms of material deprivation can produce depressive and anxiety disorders (Patel & Kleinman, 2003). Water insecurity and scarcity, as forms of material deprivation, are acknowledged to play a role in this phenomenon (Kohrt & Mendenhall, 2016; Lund et al., 2010), but interventions have rarely focused on addressing water as a major driver of poverty-related common mental disorders (e.g., Lund et al., 2011; but see Stevenson, Ambelu, Caruso, Tesfaye, & Freeman, 2016 for a rare exception). Here, we refer to water insecurity as the inability “to access and benefit from affordable, adequate, reliable, and safe water” (Jepson, Wutich, Collins, Boateng, & Young, 2017), and water scarcity as the absolute lack of water. In the last 20 years, scholarship on water and mental health has grown quickly, revealing several lines of evidence that point to water insecurity as an important contributor to the global burden of common mental disorders.

In this paper, we review the evidence for a link between water and mental health. We explain common approaches in the water literature to conceptualizing and measuring emotional distress and symptoms of common mental disorders. We argue that there is a need for more nuanced and causal research on water and mental health, and discuss its possible applications to practical problems of water provision and mental health.

2 | BACKGROUND: LINES OF EVIDENCE

The field of scholarship on water and mental health is relatively new, but it has deep foundations. Throughout human history, prayers, rituals, and songs have been dedicated to calling for rain. Archeologists have documented the existence of rain rituals in societies as varied as the Mayans (Ishihara, 2008; Moyes, Awe, Brook, & Webster, 2009), ancient Greeks (Håland, 2005), and Torres Strait Islander people (McNiven, 2016). Anthropologists have long regarded rituals as a means to control anxieties (Homans, 1941; Malinowski, 1948; Radcliffe-Brown, 1939). Ethnographers argue that rain rituals can be used to reduce fears and anxieties about drought (Akong'a, 1987; Danfulani & Haruna, 1998; Kenyatta, 1938; Ombati, 2017). In Mozambique, for example, the Tsongan rain song that includes the refrain “We are longing for the rain; Wet rain, come” (Junod, 1927, p. 434) is interpreted as “an anxiety-reducing mechanism” for coping with environmental uncertainties (Johnston, 1979, p. 239). These literatures provide a foundation for recent scholarship that probes the possible causal mechanisms that could link water insecurity and mental ill-health.

The contemporary origins of water and mental health scholarship are in Ennis-McMillan's (2001, 2006) ethnographic study of “suffering from water” in a Mexican town. The study found that people who lacked sufficient water experienced negative emotions including worry, anger, anguish, frustration, and bother. Importantly, this work found that social inequality was core to this phenomenon. Suffering from water was concentrated among people from lower and middle social strata, experienced collectively, and disproportionately affected women. Scholars have gone on to explore the negative emotional effects of water insecurity in a range of contexts, including India (Mehta, 2013; Sahoo et al., 2015), Kenya (Bisung & Elliott, 2016, 2017a; Collins et al., 2019), and among pregnant, postpartum, and breastfeeding women cross-culturally (Boateng et al., 2020; Collins et al., 2019; Schuster et al., 2020).

Bridging perspectives from emotional geography and feminist political ecology, Sultana (2007, 2009, 2011) examined women's experiences of “suffering for water” and “suffering from water” in rural Bangladesh where the water supply was contaminated by arsenic. Sultana documented a range of negative emotions—including shame, humiliation, sadness, anxiety, and depression—and traced how they emerged from complex social negotiations over water. Sultana (2015, p. 638) argues that research on emotions can help illuminate poorly understood dynamics of resource access and conflicts. Scholarship on the emotional dimensions of water politics is a growing field with significant

implications for water resource management (e.g., Bulled, 2017; Cole, 2017; Goldin, 2010; Morales & Harris, 2014; Tremblay & Harris, 2018; Truelove, 2019; Wilson, Harris, Joseph-Rear, Beaumont, & Satterfield, 2019).

In Cochabamba, Bolivia, Wutich (2006, 2009) first introduced systematic methods for measuring water insecurity (Hadley & Wutich, 2009) and water-related emotional distress (Wutich & Ragsdale, 2008). Building on these systematic efforts, scholars began to develop locally validated water insecurity scales (Jepson et al., 2017) and to incorporate them in studies alongside established measures of common mental disorders. Stevenson et al. (2012), the first to do so, found that Ethiopian women's experiences of water insecurity were associated with psychosocial distress, as measured by the Falk Self-Reporting Questionnaire (SRQ-F). Since then, a number of investigative teams have documented a robust relationship between water insecurity and systematically-assessed emotional distress (Cooper, Hutchings, et al., 2019; Harris, Kleiber, Goldin, Darkwah, & Morinville, 2017; Kangmennaang, Bisung, & Elliott, 2020; Thomas & Godfrey, 2018) or symptoms of stress, distress or common mental disorders (Aihara, Shrestha, Kazama, & Nishida, 2015; Aihara, Shrestha, & Sharma, 2016; Boateng et al., 2018; Boateng et al., 2020; Brewis, Choudhary, & Wutich, 2019a, 2019b; Chindarkar, Chen, & Gurung, 2019; Cooper-Vince et al., 2017, 2018; Espinosa-Montero et al., 2016; Maxfield, 2020; Mushavi et al., 2020; Shrestha et al., 2018; Slekiene & Mosler, 2019; Snodgrass, Upadhyay, Debnath, & Lacy, 2016; Subbaraman et al., 2012, 2014; Tallman, 2016, 2019; Tsai et al., 2016; Workman & Ureksoy, 2017; Young et al., 2019). Most of these studies have been conducted in lower-income economies, but scholarship based in the United States—in Texas *colonias* (Jepson, 2014; Jepson & Vandewalle, 2016) and Flint, Michigan (Cutbertson, Newkirk, Ilardo, Loveridge, & Skidmore, 2016; Fortenberry et al., 2018; Sneed, Dotson, Brewer, Pugh, & Johnson-Lawrence, 2020)—has documented similar associations between water insecurity, emotional distress, and mental ill-health. Together, these studies provide strong evidence of an association, but no clear evidence of causality, between water insecurity and mental ill-health.

Another line of evidence for the relationship between water and mental ill-health comes from studies of drought (Haile, Tang, Li, Liu, & Zhang, 2019). An important set of studies was conducted during the Australian droughts of the early 2000s. This work indicated there was a higher risk of mental ill-health and suicidality for certain populations (e.g., male farmers, adolescents, rural, and remote communities) during droughts (Dean & Stain, 2010; Hanigan, Butler, Kokic, & Hutchinson, 2012; Horton, Hanna, & Kelly, 2010; O'Brien, Berry, Coleman, & Hanigan, 2014; Sartore, Kelly, & Stain, 2007; Stain et al., 2011). Global, comprehensive reviews of the literature found that drought is linked to shame, anxiety, depression, hopelessness, and suicide (Stanke, Kerac, Prudhomme, Medlock, & Murray, 2013; Vins, Bell, Saha, & Hess, 2015; see also Yusa et al., 2015 in Canada and Sena, Barcellos, Freitas, & Corvalan, 2014 in Brazil). The intermediary mechanisms were generally related to crop failure, famine and food insecurity, unemployment, migration, and family disruption; there is little evidence that household experiences of water insecurity play a key direct role in these dynamics. However, one study in the city of Queimadas in Northeastern Brazil found that men and women experienced elevated anxiety and emotional distress during a drought (Coêlho, Adair, & Mocellin, 2004); water supply reductions were among the stressors the authors discussed to explain the findings.

A final line of evidence examines the relationship between mental wellbeing and emotionally meaningful interactions with water. Indigenous scholars have shown, in a variety of contexts, that emotionally meaningful relationships with water—including water as sacred spaces and as part of ceremonies—are essential for mental health and wellbeing (Cooper, Hutchings, et al., 2019; McGregor, 2015; Wilson et al., 2019). Some recent research suggests these findings may be generally applicable. For example, a study in urban New Zealand found that people who lived closer to “blue spaces” (e.g., oceans, lakes, rivers) reported less psychological distress (Nutsford, Pearson, Kingham, & Reitsma, 2016). The authors suggested that greater visibility of blue spaces might decrease distress and promote mental wellbeing. Such a finding would be generally consistent with prior work linking green spaces to mental wellbeing (Alcock, White, Wheeler, Fleming, & Depledge, 2014; De Vries, Verheij, Groenewegen, & Spreeuwenberg, 2003; van den Berg, Maas, Verheij, & Groenewegen, 2010). However, a review of the literature found only limited support for the proposition that blue spaces are associated with mental health; more research is needed to clarify any potential relationship (Gascon, Zijlema, Vert, White, & Nieuwenhuijsen, 2017).

In Table 1, we summarize these lines of evidence.

3 | ASSESSING MENTAL ILL-HEALTH

The “common mental disorders” construct has traditionally been defined as a heterogeneous group of non-psychotic syndromes presenting with depressive, anxiety, and somatic symptoms that are commonly encountered in primary care

TABLE 1 Summary of lines of evidence in water and mental health research

Contribution, in brief	Exemplar scholarship
Rituals, songs, and prayers show distress over rainfall and drought is common cross-culturally; evidence from archeology, ethnography, folklore, and other humanities	Ethnography: Danfulani & Haruna, 1998 (Nigeria); Ombati, 2017 (Africa, multiple cases); Archeology: Moyes et al., 2009, Ishihara, 2008 (Mayans)
Exploratory work discovered link between water insecurity and emotional distress; ongoing research points to possible causal mechanisms	Ennis-McMillan, 2001, 2006 (Mexico); Bisung & Elliott, 2016, 2017a (Kenya); Mushavi et al., 2020 (Uganda)
Qualitative scholarship shows the centrality of emotions to water management and politics; strong emphasis on intersectionality and embodiment	Sultana, 2011, 2015 (Bangladesh); Goldin, 2010 (South Africa)
Uses larger-n and random samples; developed systematic methods to assess water insecurity; demonstrated association between water insecurity and systematic measures of emotional distress and mental health	Wutich & Ragsdale, 2008 (Bolivia); Stevenson et al., 2012 (Ethiopia); Aihara et al., 2016 (Nepal); Mushavi et al., 2020 (Uganda)
Emerges from medical practitioner literature; indicates many populations, especially in rural areas, experience mental ill-health and suicidality during drought; role of water unclear	Sartore et al., 2007, Stain et al., 2011 (Australia); Coêlho et al., 2004 (Brazil)
Indigenous scholars establish that emotionally-meaningful relationships with water—including water as sacred spaces and as part of healing ceremonies—are essential for mental health and wellbeing	Cooper, Hutchings, et al., 2019 (Hopi, Kanaka Maoli, and Kanien'kehá:ka); McGregor, 2015 (Anishinaabek)
Part of larger literature indicating outdoor environments (e.g., “green spaces”) can improve mental health; literature on “blue spaces” is in its infancy	Nutsford et al., 2016 (New Zealand)

(Goldberg & Huxley, 1992). These symptoms lie on a continuum of ill health ranging from absence of any symptoms, to subthreshold symptoms causing moderate degrees of functional impairment, to frank disorder (Frank et al., 1991; Judd et al., 1998; Mirowsky & Ross, 1989; Wells, Burnam, Rogers, Hays, & Camp, 1992). Screening and measurement, accordingly, have focused on eliciting these symptoms systematically through the use of interviewer-administered scales that have been validated against the criterion standard of structural clinical diagnoses. In Table 2, we list mental health measures that are commonly used in water research, along with exemplar studies from recent water insecurity scholarship.

One of the primary challenges in eliciting and measuring mental health symptoms in a standardized fashion is the fact that the measurement scales that currently dominate the field were developed in native English-speaking populations (Bagby, Ryder, Schuller, & Marshall, 2004; Beck et al., 1988, 1996; Goldberg, 1972a, 1972b; Goldberg & Williams, 1988). Straightforward translation of scale items from English to a non-English language, even where care is taken to avoid literal translation of western idioms (e.g., “shake the blues”), may obscure some items' intended meanings (Miller, Kintu, & Kiene, 2020). Translation can be challenging because the vocabulary of emotional distress and mental ill-health can vary greatly due to cultural and language differences (Kleinman, 1977). In some settings, a parallel vocabulary may not exist or there may be different idioms of distress not accounted for in translation (Kaiser et al., 2015; Mushavi et al., 2020; Patel, Gwanzura, Simunyu, Lloyd, & Mann, 1995; Patel, Simunyu, & Gwanzura, 1995).

Investigators have used different methods to address this limitation, but generally these involve the use of qualitative and psychometric methods. In a study of water insecurity in urban Bolivia, Wutich (2006, 2009) conducted 5 months of participant observation and ethnographic interviews to identify five different single-item local expressions of water-related emotional distress. To measure a Shona construct locally understood as being both a cause and a symptom of poor mental health (*kufungisisa*), Patel, Gwanzura, et al. (1995) and Patel, Simunyu, et al. (1995) derived an initial pool of scale items, supplementing items from the SRQ (Beusenberg & Orley, 1994; Harding et al., 1980) with additional items derived from qualitative interviews with patients with symptoms of mental illness (Patel, Gwanzura, et al., 1995; Patel, Simunyu, et al., 1995). This approach, which combines items from English/western-derived instruments with locally validated concepts, is frequently used in the literature (Ashaba et al., 2018). A third approach derives scale items principally from qualitative interviews. Betancourt, Speelman, Onyango, and Bolton (2009) and Betancourt,

TABLE 2 Systematic measures spanning the continuum of mental health in recent scholarship on water insecurity

Construct	Scale ^a	Exemplar scholarship
Nonspecific psychological distress	Water-related Emotional Distress Scale (Wutich & Ragsdale, 2008)	Wutich & Ragsdale, 2008, Hadley & Wutich, 2009 (Bolivia); Jepson, 2014, Jepson & Vandewalle, 2016 (<i>colonias</i> in Texas); Thomas & Godfrey, 2018 (Ethiopia), Kangmennaang et al., 2020 (Ghana)
	Self-Reporting Questionnaire (Beusenbergh & Orley, 1994; Harding et al., 1980)	Stevenson et al., 2012, 2016 (Ethiopia); Slekiene & Mosler, 2019 (Malawi)
	General Health Questionnaire (Goldberg, 1972a, 1972b; Goldberg & Williams, 1988)	Subbaraman et al., 2014 (India)
	K6 Screening Scale for Psychological Distress (Kessler et al., 2003)	Gaber, 2019 (Detroit, MI)
Perceived stress	Perceived Stress Scale (Cohen, Kamarck, & Mermelstein, 1983)	Aihara et al., 2015 (Nepal), Tallman, 2016, 2019 (Peru), Boateng et al., 2018 (Kenya), Young et al., 2019 (28 sites in 23 low and middle income countries); Maxfield, 2020 (India)
Depressive symptoms	Edinburgh Postnatal Depression Scale (Cox, Holden, & Sagovsky, 1987)	Aihara et al., 2016 (Nepal)
	Beck Depression Inventory-II (Beck, Steer, Ball, & Ranieri, 1996)	Brewis, Choudhary, & Wutich, 2019a (Haiti)
	Hopkins Symptom Checklist depression subscale (Derogatis, Lipman, Rickels, Uhlenhuth, & Covi, 1974)	Snodgrass et al., 2016 (India); Workman & Ureksoy, 2017 (Lesotho); Cooper-Vince et al., 2018, Mushavi et al., 2020 (Uganda); Maxfield, 2020 (India)
	Patient Health Questionnaire-9 (Kroenke, Spitzer, & Williams, 2001)	Tallman, 2016, 2019 (Peru)
Anxiety symptoms	Beck Anxiety Inventory (Beck, Epstein, Brown, & Steer, 1988)	Brewis, Choudhary, & Wutich, 2019a (Haiti)
	Hopkins symptom checklist anxiety subscale	Workman & Ureksoy, 2017 (Lesotho)
Quality of life	WHO Quality of Life Assessment (The WHOQOL Group, 1998)	Shrestha et al., 2018 (Nepal)
Somatic symptoms	Patient Health Questionnaire-15 (Kroenke, Spitzer, & Williams, 2002)	Tallman, 2016, 2019 (Peru)

^aCitation refers to publication describing original scale development activities; many of the exemplar publications use locally adapted versions of these scales.

Bass, et al. (2009) conducted free listing interviews with Ugandan youth and adults to identify five common local mental health syndromes that share some similarities with Western understandings of mood disorder, generalized anxiety disorder, and conduct disorder but also contain culturally specific concepts of distress. They then used these qualitative data to generate scale items to measure these local mental health syndromes (Betancourt, Bass, et al., 2009; Betancourt, Spielman, et al., 2009) and also applied item response theory to reduce and refine the scale and cross-reference the scale items to qualitative data on local mental health syndromes in Rwanda and Sierra Leone (Betancourt, Yang, Bolton, & Normand, 2014). No single approach is considered dominant, and the most appropriate approach for individual investigators is likely to be conditioned on the purposes of the study, ethnographic understandings of local constructs, and available research.

4 | MECHANISMS

The previously discussed ethnographic research leans on people's understanding that water insecurity leads to distress; the empirical literatures discussed above rest, for the most part, on identifying cross-sectional associations—assuming a

causative relationship in the same direction. So, theoretically, mental ill-health follows from living with water insecurity. The first longitudinal study to test this connection causally is Devoto, Duflo, Dupas, Pariente, and Pons' (2012) study of a private utility company that launched a social program to increase household direct access to piped water in Tangiers, Morocco. Using a randomized encouragement design, they showed that connection to the water grid yielded significant increases in time gains, social integration, and quality of life while reducing conflicts about water-related problems within families and with neighbors.

The second longitudinal study followed 223 rural Ethiopian women's psychological distress (on the SRQ-20) before and after a community water supply improvement project (Stevenson, 2019; Stevenson et al., 2016). Stevenson's team found that SRQ-20 scores showed no change before and after the intervention, even though water security measurably increased by more than half baseline standard deviation. That is, water security in itself did not seem to be the most relevant factor. Stevenson et al. (2016) initially could not offer specific reasons, but suggested that the water improvements might not have solved stressors of water governance (i.e., the stressor was not water itself, but how water was managed). Later work clarified that the water governance was indeed a stressor in this case, as a flat fee structure penalized poorer households and new opening/closing hours heightened the opportunity costs of using the water system (Stevenson, 2019).

The previously discussed lines of inquiry are also consistent with standard psychosocial theories of stress and psychological disorder (Abramson, Metalsky, & Alloy, 1989; Kanner, Coyne, Schaefer, & Lazarus, 1981; Pearlin, Menaghan, Lieberman, & Mullan, 1981). Water insecurity is probably most usefully conceptualized as a "daily hassle" (Kanner et al., 1981) or chronic life strain (Pearlin et al., 1981), although acute changes in water insecurity might also be considered stressful life events (Brown & Harris, 1978; Brown, Harris, & Peto, 1973). However, in this literature the key mechanisms have been heretofore underexplored: what is needed to explain how water and mental health are connected is improved testing for the influence of potential *mechanisms* that can connect these causally (Bisung & Elliott, 2017b; Brewis, Piperata, et al., 2020; Mushavi et al., 2020; Wutich, 2020). A reading of the broader water insecurity literature identifies an array of possibilities, outlined in Figure 1. These mechanisms consider anger, worry, distress, shame, humiliation, grief—and so, risk of common mental illness—as embedded in the cultural meanings and social relations of water, more so and well beyond water scarcity.

4.1 | Candidate mechanism 1: material deprivation, especially uncertainty

Water insecurity can trigger worries and uncertainties about material deprivation. Many studies, as we discussed above, document worries about whether there is enough water for the day's needs, how water will be acquired, or how to pay

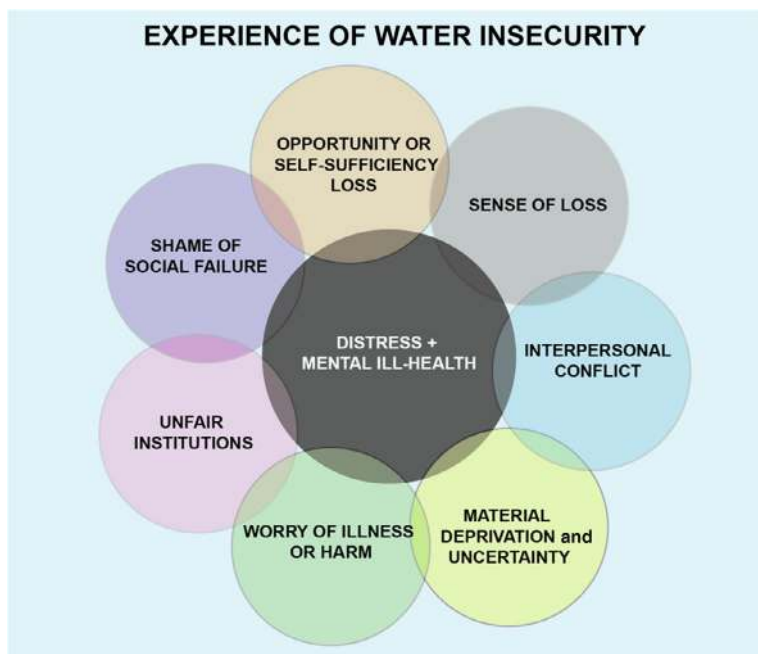


FIGURE 1 Candidate mechanisms connecting water insecurity to distress and mental ill-health

for water as one of many competing household needs. Water-related financial worries are particularly salient in urban communities with high rates of shut-offs or without safe piped water (e.g., Gaber, 2019; Stoler et al., 2020). In rural areas, long-term worries around debt with water-related loss of income, such as with farming, appear to be common (e.g., Yusa et al., 2015). What seems to be especially stressful here is not just material deprivation, but uncertainty.

Water insecurity is highly correlated with other forms of material deprivation that independently predict heightened levels of anxiety and depression. These include very low income, debt, and insecure employment, housing, or food access (Lund et al., 2010; Patel & Kleinman, 2003). Recent research has sought to unravel the complex relationship between water insecurity and food insecurity as each might independently predict or together compound mental ill-health, and these early results suggest both matter (Boateng et al., 2020; Brewis, Workman, et al., 2020; Brewis, Choudhary, & Wutich, 2019b; Maxfield, 2020; Workman & Ureksoy, 2017; Wutich & Brewis, 2014). More research will be needed to determine the role water plays in exacerbating the negative mental health effects of other poverty-related risks like insecure household housing, energy, and/or employment. For instance, water shut-offs in the United States can reportedly be used as a pretext for removing people from their housing—through evictions, foreclosures, and child removal (Price, 2010; Wahowiak, 2014), and the combined effect likely triggers mental ill-health in many. But such connections have not yet been tested.

4.2 | Candidate mechanism 2: shame of social failure

Water insecurity is not only material, it is also laden with social meaning, because it intersects with valued social roles and the capacity to adhere to cultural norms. Experiences of social stigma—a well-known trigger for common mental illness—can stem from incapacities to meet adequately expected productive roles (such as cleaning house, earning money). Stigma is closely tied to shame, a psychologically distressing emotional state. Several studies have identified that humiliations and shame around mistreatment while water purchasing, such as from vendors, can generate feelings of anger and shame (e.g., Kangmennaang et al., 2020; Mushavi et al., 2020). For example, in Bolivia, women in informal settlements reported the abject humiliation of having to run after and beg water truck vendors to sell them water (Wutich, 2020; Wutich, Beresford, & Carvajal, 2016; Wutich, Brewis, Chavez, & Jaiswal, 2016; Wutich & Ragsdale, 2008). Similarly, begging neighbors to borrow or buy water is also reported to be highly stressful and often humiliating (Wutich, 2011, 2020; Wutich & Ragsdale, 2008).

Other distressing social failures might be linked to sanitation and hygiene norms. Inability to be adequately clean (such as in laundry or menstrual hygiene) under conditions of household water insecurity can be intensely humiliating and associated with increased anxiety and depression (Caruso et al., 2018; Mushavi et al., 2020). Similarly, the literature on droughts points to unemployment or income reductions as loss of both social as much as economic status, suggesting a further mechanism by which extreme water shortages like droughts can trigger emotional distress (Yusa et al., 2015) and, potentially, suicidal thoughts (Stanke et al., 2013).

4.3 | Candidate mechanism 3: worry about threats to health

Unsafe water and the challenges of fetching water can raise worries around becoming ill or getting hurt. A recent study in informal settlements in Ghana, Kangmennaang et al. (2020) reported that participants described distress around perceived contaminants in vended water as “drinking diseases.” Much of this unease was focused on how their children’s exposure to unclean water could make them sick. Water fetching and queueing itself can be associated with physical threats to health, such as chronic pain and fatigue (Geere, Bartram, et al., 2018; Geere, Cortobius, Geere, Hammer, & Hunter, 2018; Geere, Hunter, & Jagals, 2010). Moreover, because the burden of water fetching is typically borne by women and girls (Crow & McPike, 2009; Geere & Cortobius, 2017; Graham, Hirai, & Kim, 2016), these activities can be physically dangerous given the risk of falls or sexual assault (Bisung & Elliott, 2017a, 2017b; Collins et al., 2017, 2019, Pommells, Schuster-Wallace, Watt, & Mulawa, 2018). For example, in a study of women in Pune, India, Hirve et al. (2015) pointed to women’s fears of attacks from people, animals, or insects when openly defecating (see also Caruso et al., 2017, 2018; Corburn & Hildebrand, 2015; O’Reilly, 2016; Sahoo et al., 2015; Sommer et al., 2015; Winter & Barchi, 2016). In another study in Zimbabwe, women reported worries around sexual assault while queueing at boreholes (Mukuhlani & Nyamupingidza, 2014).

4.4 | Candidate mechanism 4: loss of meaningful connections to spaces, places and people

Losses of valued connections to people, communities, or places, such as in the wake of landscape degradation or because of water-forced migration, have also been suggested as possibilities for why droughts are emotionally distressing (Stanke et al., 2013; Yusa et al., 2015). Such grief could be connected in some manner to the value placed on “blue spaces” to improve mental health (Nutsford et al., 2016). This mechanism may link into the broader emerging literature on solastalgia, a term that describes distress produced by drought and other forms of unwanted environmental change (Albrecht et al., 2007).

Especially significant are ways that the mental health of Indigenous/Aboriginal peoples is harmed by colonization-related losses of connections to spaces and people. Relationships with water—both in terms of water as sacred places (e.g., rivers, springs) and water as a source of healing—are spiritually important for many Indigenous/Aboriginal peoples (Cooper, Delormier, et al., 2019; McGregor, 2015; Mitchell, 2019; Montoya, 2017; Rigby, Rosen, Berry, & Hart, 2011; Wilson et al., 2019). Research indicates that colonization-related losses of access to sacred waters, harm to relationships structured around and with water, and degradation of water may be linked to historical trauma (Brave Heart, 1998; Brave Heart, 2003), psychoteric illness (Albrecht et al., 2007), and PTSD (Manson et al., 1996) for Indigenous/Aboriginal peoples (Cooper, Delormier, et al., 2019). McGregor (2015) suggests that re-establishing reciprocal and caring relations between people and waters can help to address these harms.

4.5 | Candidate mechanism 5: frustration around lost opportunities and lack of autonomy

Fetching and queueing for water in water-insecure communities can take hours each day (Geere & Cortobius, 2017; Kremer, Leino, Miguel, & Zwane, 2011). More often this is the work of girls and women, interrupting or forestalling other possible ways they could use their time—such as for earning or education (Mukuhlani & Nyamupingidza, 2014; Nauges & Strand, 2017; Stevenson et al., 2016; Wutich & Ragsdale, 2008). Some scholars suggest frustrations around lack of autonomy and self-sufficiency matter for water-related distress (Bisung & Elliott, 2016), implicated here also.

4.6 | Candidate mechanism 6: inter-personal conflict including intimate partner violence

Water insecure households appear often to have heightened disagreements and arguments, creating and reflecting additional stress. This might be triggered by shared anxieties around getting enough water, such as arguments at the tap, in families, or within couples (Devoto et al., 2012; Sultana, 2011; Wutich, 2009; Wutich & Ragsdale, 2008). It may also be verbal harassment directed at those failures to meet expected responsibilities, such as not cleaning house or cooking meals due to lack of water, by family members (Aihara et al., 2015; Mushavi et al., 2020; Stevenson et al., 2012; Subbaraman et al., 2014; Sultana, 2011). For example, in Lesotho, women identified water-based development projects as a priority for helping them maintain peace with their spouses, because it meant being able to complete expected household chores (Cairns, Workman, & Tandon, 2017). Studies are starting to observe associations between household water insecurity and risk of intimate partner and other domestic violence (e.g., Choudhary, Brewis, Wutich, & Bhushan, 2020; Stevenson et al., 2012)—itself a well-known risk factor for depression and other common mental illness.

4.7 | Candidate mechanism 7: institutional injustice or unfairness

Where the rules for water access are enacted in unclear, individualized, or discriminatory ways, this can be very distressing (Wutich, 2020). Institutional injustices can lead to constant negotiations and arguments about rights to water. For example, trouble accessing reasonable shares at a community tap (Ennis-McMillan, 2001, 2006; Wutich &

Ragsdale, 2008) or dysfunctional household-to-household water-sharing arrangements (Krumdieck et al., 2016; Sultana, 2011; Wutich et al., 2018) can lead to forms of frustrating and distressing conflict with neighbors (Devoto et al., 2012). People's experiences of inequitable water fee structures can also be source of distress (Stevenson, 2019). The sense of unfairness or injustice itself seems to matter, so the distress is possible even in the absence of outright conflicts (Ennis-McMillan, 2006; Stevenson, 2019; Sultana, 2011; Wutich, 2020; Wutich & Brewis, 2014; Wutich, Brewis, et al., 2016).

4.8 | Interlocking mechanisms

Of course, these mechanisms likely rarely operate fully independently. More likely, they contribute to iterative, layering and compounding risks for distress and mental ill-health (Bisung & Elliott, 2017b; Brewis, Piperata, et al., 2020; Workman & Ureksoy, 2017). For example, social humiliation, perceived role inadequacies, frustrated autonomy, and material uncertainty could all coincide to elevate the distressing family conflicts, including triggering of intimate partner violence. And gender also seems to have an important interactional effect. The core role women and girls play in responsibility for managing household water is the key reason theorized for why water-related distress and mental ill-health is consistently observed to affect them more than boys and men (e.g., Cooper-Vince et al., 2018; Stevenson et al., 2012, cf. Geere & Cortobius, 2017; Wutich, 2009, 2012). Another related reason may be different hygiene standards applied to women versus men (Brewis, Wutich, et al., 2019). And men have been identified as perhaps more at risk than women in farming communities facing drought, because of the association between farming productivity and masculinity (Vins et al., 2015).

5 | DISCUSSION: RESEARCH APPLICATIONS

The relationship between water and mental health is of increasing interest as a basic science question, but the mental health impacts of water insecurity also have broad applied relevance (e.g., Cooper, Hutchings, Butterworth, Parker, & Terefe, 2018). Most directly, monitoring mental health outcomes can provide important insights into the efficacy of water delivery interventions and other international development efforts (Bisung & Elliott, 2017b).

Water projects typically monitor the quality and quantity of water delivered and, potentially, physical health outcomes. Yet mental health outcomes provide a very different—and likely highly sensitive—window into the efficacy of water projects in improving people's lives, as in Stevenson et al.'s (2016) finding that water interventions in Ethiopia improved women's reported water security, but not their psychosocial health. Similarly, Devoto et al. (2012) found that piped water access did not reduce the incidence of diarrheal disease but improved social integration and quality of life. Thus, monitoring of psychosocial health outcomes in water projects is likely to provide an important assessment of outcomes that matter to many people. Furthermore, the evidence we reviewed here indicates that emotional distress and mental health indicators are likely quite sensitive to perceptions of injustice and unfairness in water distribution and other nonmaterial dimensions of water insecurity.

We recommend that more projects consider incorporating emotional distress and mental health indicators as general monitoring tools to assess the efficacy of water projects. Tracking mental health outcomes could help enormously in understanding (and improving) the overall efficacy of water interventions. Beyond this, mental health monitoring may have utility in a wider range of development projects in which water plays a key role. Possible applications include poverty alleviation, economic development, and climate change mitigation.

Finally, we believe there is a need to test the efficacy of mental health interventions designed to improve water security. In many cases, we believe, water insecurity may be part of a cluster of stressors related to poverty (e.g., Brewis, Workman, et al., 2020; Maxfield, 2020; Workman & Ureksoy, 2017) or colonization (Cooper, Delormier, et al., 2019; McGregor, 2015)—if so, improving water security in isolation may have a minimal effect on people's emotional distress or mental ill-health. In other cases, however, water insecurity may be the most severe stressor people experience or may occur in the absence of other major poverty-related stressors (e.g., Brewis, Choudhary, & Wutich, 2019a; Wutich & Brewis, 2014). Water insecurity may also be a primary determinant of food insecurity (and other poverty-related stressors), given that an adequate water supply is a necessary precondition in many cases for subsistence agriculture or animal husbandry. In these situations, we hypothesize that alleviating water insecurity could be a viable way to improve mental health outcomes.

6 | CONCLUSION

There is now abundant evidence, from a wide range of sources, of a relationship between water and mental health. Much of this evidence is ethnographic or cross-sectional, and cannot establish definitively a causal relationship. We have outlined the arguments supporting seven possible (and likely interlocking) mechanisms that could explain such a relationship. We argue that more research on this topic is needed, particularly given that poorly understood connections may create barriers to achieving Sustainable Development Goals 3 (health) and 6 (water and sanitation). We further suggest that tracking mental health indicators may provide unique and as-yet underappreciated insights into the efficacy of water projects and other development interventions.

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CONFLICT OF INTEREST

The authors have declared no conflicts of interest for this article.

AUTHOR CONTRIBUTIONS

Amber Wutich: Conceptualization; data curation; formal analysis; writing-original draft; writing-review and editing. **Alexandra Brewis:** Conceptualization; data curation; formal analysis; writing-original draft; writing-review and editing. **Alexander Tsai:** Conceptualization; data curation; formal analysis; writing-original draft; writing-review and editing.

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