

**OVERVIEW**

# Localizing resource insecurities: A biocultural perspective on water and wellbeing

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**Abstract**

A biocultural approach provides an emerging framework for clarifying the mechanisms that connect water security to human health and wellbeing. Five basic tenets of the biocultural approach are outlined: The focus on the local, the centrality of culture, the notion of embodied disadvantage, a concern with proximate mechanisms as a means to test theorized pathways, and recognition of intersecting and potentially amplified (syndemic) risks. From a review of both new and dispersed biocultural literature on household water, four key themes emerge: (a) individual vulnerabilities to the biological effects of water insecurity are shaped by cultural practices; (b) water insecurity is a powerful biocultural stressor on mental health; (c) water insecurity mediates between low power and worse health within communities, and through multiple mechanisms; (d) the household is a nexus for food–water interactions, each likely worsening each other and health through syndemic relationships. This sets an agenda for a biocultural approach to the household as a localizing nexus for manifesting the very human costs to mental and physical health of managing under conditions of extreme household resource insecurity.

This article is categorized under:

Engineering of Water > Planning Water

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**KEYWORDS**

health, households, stress, water insecurity, wellbeing

**1 | INTRODUCTION**

Some two-thirds of the global population—4 billion people—experience water insecurity at least 1 month of the year (Mekonnen & Hoekstra, 2016), meaning they do not have access to safe, sufficient water (Jepson, Wutich, Collins, Boateng, & Young, 2017). Two billion people are estimated to live with moderate or severe food insecurity (FAO (Food and Agriculture Organization of the United Nations), 2019). Given that both are highly associated with material poverty, these risks often overlap in low-resource communities (Brewis et al., 2020). Logically, this co-occurrence would be most likely to occur in zones characterized by poor physical access to adequate and safe water, whether because of infrastructure failures, institutional exclusions, and/or climate of other environmental challenges.

The implications of living with household food insecurity are well documented in a large and complex literature built over the last several decades. Generally, food insecurity is highly associated with low income and few assets, and it consistently worsens physical health through both infectious and chronic disease, delays or derails child growth and development, and undermines mental health (Cole & Tembo, 2011; Hadley & Patil, 2006, 2008; Jebena et al., 2016; Piperata, Salazar, Schmeer, & Herrera Rodríguez, 2019; Piperata, Schmeer, Rodrigues, & Torres, 2016). Living with inadequate safe water is widely understood to elevate risk of infectious disease because of its association with poor sanitation (Hunter, MacDonald, & Carter, 2010).

We know much less about other direct implications of living with household water insecurity because the topic is relatively new, and the relevant literature is much smaller. Here we provide a review and synthesis of current approaches to the contexts and implications of household water insecurity guided by what we refer to as a *biocultural approach*. Employing a biocultural approach allows us to (a) evaluate the current state of water insecurity literature as part of a wider set of unique understandings about how households and the people in them experience resource insecurities. As we will explain, it also (b) provides a framework for considering the dynamics between household water insecurity and household food insecurity in ways that provide an understanding of how the interaction of the two might additionally amplify damaging consequences for people living with both. Furthermore, (c) it provides an introduction to a novel theoretical approach that is little applied in water research to date but has great potential for developing a more sophisticated and integrated understanding of how people and their households manage with inadequate water. This includes improved means to identify possible mechanisms that proximately link household water security to human health and wellbeing.

## 2 | BIOCULTURAL APPROACHES: SOME BACKGROUND

In this section, we provide a background to biocultural approaches, including key terminology (Box 1). This provides a conceptual basis for the overview of biocultural studies of the household interconnections of food and water insecurities and their connections to stress and illness outcomes that follow in Section 3. Comparatively little of the published biocultural research to date has focused on water (Rosinger & Brewis, 2020). It is easiest to understand the set of literature we review below by beginning with a grounding in how the approach has managed the issues of resource insecurity more generally, most particularly in terms of other forms of material poverty or disadvantage and how such need relates to health and other stress-related outcomes. In this section, we highlight possible theorized implications of key features of a biocultural approach for the study of household water insecurity in particular.

### 2.1 | A brief history of the biocultural approach

While the term biocultural has no singular definition (Wiley & Cullin, 2016), the approach theorizes and tests the ways human interactions with local environmental challenges (i.e., physical, biological, and sociocultural) produce variation in health and biological function. The varied, dynamic, and often complex challenges that people and groups must adapt to are often referred to as stressors (Ice & James, 2007). Stressors include direct environmental exposures to contaminants (Schell, 1997), infectious disease (Livingstone, 1971), lack of material resources like food or water (Wutich & Brewis, 2014), or indebtedness (Sweet, Nandi, Adam, & McDade, 2013). Chronic forms of stress create the most damage, because they over-activate stress responses to the point of taxing and overwhelming them at costs to other physiological systems. For example, chronic stress severely erodes cardiovascular, immune, and metabolic function (McDade, Hoke, Borja, Adair, & Kuzawa, 2013; Thayer et al., 2017).

Biocultural approaches define a distinctive field of social science enquiry situated at the intersection of the fields of human biology and anthropology that emerged in the 1970s from population biology studies of human physiological adaptations to challenging environments (Zuckerman & Martin, 2016). Some of the most influential early biocultural studies considered population-specific physiological adaptations to living in high altitudes (Baker, 1969; Beall, 2003), arid ecologies (Baker, 1958; Leslie & Fry, 1989), and modernizing small island ecosystems (Baker, Hanna, & Baker, 1986). These studies collectively emphasized—often through inter-population comparisons—both the flexibility and limits of human physiological capacities to cope with environmental extremes, particularly how necessary adaptive trade-offs shaped human phenotypes during growth and development. The field continues to appreciate that human biology is both evolved and developmentally flexible, that we continue to adapt, and our phenotypes (e.g., disease, physical status, biomarkers) reflect this process.

**BOX 1 Key biocultural terms and their definitions**

Key term	Definition	Key references
Household resource security	Adequate material resources (food, water, energy) for an active and healthy life.	Wutich and Brewis (2014)
Household food security	Reliable access to a sufficient quantity of affordable, nutritious food for an active and healthy life.	World Summit on Food Insecurity (2009)
Household water security	Ability to access and benefit from adequate, reliable and safe water.	Jepson et al. (2017)
Biocultural approach	Analytic focus on the pervasiveness and dynamism of interactions between biological and cultural phenomena in their immediate environmental context, while recognizing broader historical and political-economic forces.	Dufour (2006); Zuckerman and Martin (2016); Leatherman and Goodman (2019)
Stress	A process by which a stimulus elicits an emotional, behavioral and/or physiological response. The response is conditioned by an individual's personal, biological, and cultural context.	Ice and James (2007)
Stressor	An event or condition that, in local context, elicits a stress response. Can include culture as a stressor.	Schell (1997); Ice and James (2007)
Embodiment	The process through which societal and ecological conditions, including (lack of) social, political, or economic power, are incorporated into human biology and are expressed as phenotypes, including illness. That is, how they "get under the skin."	Krieger (2005); Hertzman and Boyce (2010); Leatherman and Hoke (2016)
Local (or situated) Biologies	The population or group level manifestation of embodied exchanges between individual-level local conditions and physical and social worlds (i.e., the scaling of embodiment processes).	Lock (2001, 2017); Leatherman and Goodman (2019)
Biocultural mechanism	Causal factors that underpin and explain pathways between cultural variation and biological outcomes.	
Syndemic	Two or more simultaneously occurring conditions that amplify or worsen the health of individuals because of their <i>interaction</i> .	Singer (2011); Singer, Bullied, Ostrach, and Mendenhall (2017); Mendenhall (2017)

By the 1980s, the approach had expanded to consider an explicit role for cultural strategies in managing environmental challenges, including how the varied behavioral and physiological trade-offs of coping with stressors dynamically and variously manifested as disease or health (Armelaos, Leatherman, Ryan, & Sibley, 1992; Armelaos & McArdle, 1975). This included to idea that culture itself can be a stressor. Like other stressors, the effects of culture can be unevenly distributed within social groups, whether within a society (e.g., by ethnicity: Dressler, Oths, & Gravlee, 2005), community (e.g., by wealth or class: Leatherman, 2005), or even a household (e.g., by gender or age: Brewis et al., 2019). In the 1990s, political-economic theory was more explicitly integrated into biocultural models, as a means to consider how the already well-described localized effects of human-environmental interactions are shaped by broader political and economic structures that create and reinforces inequality through marginalization and discrimination. These are then understood as the upstream forces that create and reinforce localized suffering, such as illness (Goodman & Leatherman, 1998).

## 2.2 | Some key features of a biocultural approach

### 2.2.1 | The focus on the local

Biocultural approaches embrace the construct of local (or situated) biologies, taken from the work of medical anthropologists such as Margaret Lock (Lock & Kaufert, 2001). Local biologies in this sense represent the clustered concentration of embodied exchanges between individual-level local conditions, and physical and social worlds (i.e., the scaling

of embodiment processes). These can have many dimensions—related to shaping human reproduction, disease risk, child growth, adult weight, and mental health phenotypes in locally particular ways, to name just a few (Moffat & Galloway, 2007). This focus on the local is especially relevant to the study of both water and food since much of the impact of resource limitations on human health outcomes are centered within households. Indeed, households themselves are *defined* by their pooling of food resources for the benefit of all their members (Netting, Wilk, & Arnould, 1984). This definition of the household could be theoretically extended to a group of people who share and pool water resources also, although this is not an idea explored in the current literature (Wutich & Brewis, 2014).

## 2.2.2 | The centrality of detailed study of cultural practices in explaining health and human biological variation

In examining interactions between physical (e.g., climate, water), biological (e.g., food, infectious disease), and sociocultural (e.g., economic status, gender, or ethnicity) phenomena to understand variation in human health, biocultural studies thus require in-depth knowledge of the local context. Biocultural anthropology is consistently concerned with the key role for culture in the production of local biologies, both as a stressor and as a means to cope with stressors. “Culture” here refers to a host of shared understandings and expected practices, such as what foods people choose to eat, how they share (or do not share) resources like food and water, or gender differences in how work around food and water are allocated within the household. Some of the biological patterning often considered in relation to culture includes nutritional status and growth, reproductive function, chronic and infectious disease, and mental health. Knowledge of culture is gained through formative inductive data collection (i.e., anthropological fieldwork), combined with biological measurements. This approach is quite distinctive from, for example, the traditional approaches of social epidemiology that are directly concerned with generalizing to and from population-level patterns of disease; this provides to a very different (ground-up) way to study inter- and intra-population variation in health.

Importantly, as noted culture in biocultural analyses can act as a stressor. It can define cultural expectations that generate psychological distress when they are unobtainable or allow or encourage discrimination or other forms of social inequality that are health-damaging for those being excluded (Brewis, 2014; Dressler, Balieiro, Ribeiro, & Dos Santos, 2014; Schell, 1997). Relevant to understanding household water insecurity is that the cultural expectations around water can be highly gendered. For example, women are more often expected to be the household water managers (Graham, Hirai, & Kim, 2016), and women’s hygiene and dress standards can require more water than those for men (Brewis, Wutich, et al., 2019; Caruso, Sevilimedu, Fung, Patkar, & Baker, 2015; Geere & Cortobius, 2017).

## 2.2.3 | A focus on the embodiment of (dis)advantage

The process by which cultural practices and social and economic variation interact within local ecologies to create biological variation is sometimes termed embodiment (Krieger, 2005; Krieger, 2016; Mendenhall & Weaver, 2019). The concept of embodiment, however, can also accommodate the idea that lack of resources stems from low social, political, or economic power. Therefore, low power of groups is manifest in individual phenotypes, including their patterns of illness. One of the best documented examples from the literature is applying the notion of embodiment to explain health disparities in minoritized communities as the product of racism and other forms of institutionalized social inequality (Gravlee, 2009; Krieger, 2016; Kuzawa & Sweet, 2009). In the case of the utility of this idea for understanding household water insecurity, biocultural anthropologists would consider water insecurity as simultaneously a manifestation of broader inequality, a mechanism for embodying inequality, and a stressor that households need to manage. These ideas are better established in biocultural studies of social stress around such material domains as food insecurity and malnutrition (Leatherman, Hoke, & Goodman, 2016; Weaver, Worthman, DeCaro, & Madhu, 2015) and indebtedness (Sweet, 2018) but, as we discuss below, are also starting to emerge in the water insecurity literature.

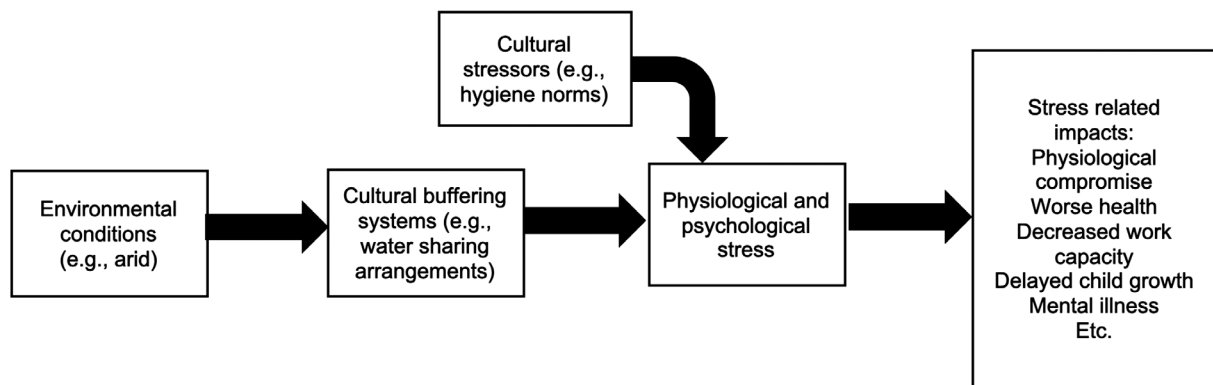
## 2.2.4 | A concern with proximate mechanisms

One effort that is central to biocultural studies is the constant questioning around the implied mechanisms that explain observed variation in health and human biology resulting from human–environmental interactions. That is, theorizing

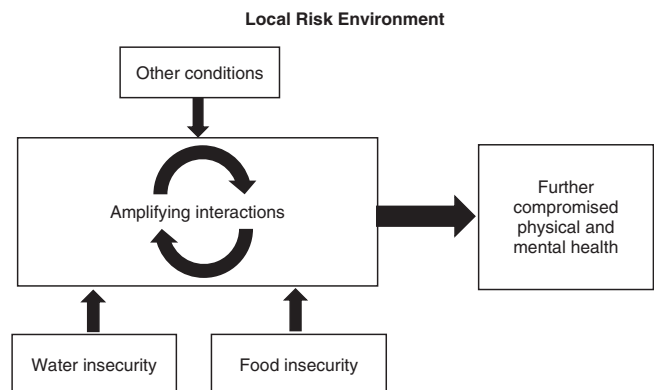
pathways is considered inadequate to theory building; the causative factors underpinning those pathways should be tested. Two examples that employ this basic model and consider cultural stressors as well as buffering come from the food insecurity literature. Hadley, Stevenson, Tadesse, and Belachew (2012) showed, through their inductive research with members of very low-income Ethiopian households during the 2008 global food crisis, that people's abilities to participate in socially important activities such as funerals where food sharing is a critical component explained why food insecurity was highly associated with symptoms of mental distress. The detailed observational work of Gittelsohn (1991) on intra-household food distribution patterns in Nepal described how the cultural prioritization of young children and adult men over adult women in intra-household food distribution placed women at heightened nutritional risk. Here the localization of nutrition risks of women reflects their broader social devaluation relative to others in the family within Nepali society. This concern for identifying relevant mechanisms, concerned primarily with describing and explaining associations at the population level, can be easily applied to conceptualized mechanisms around household water (as shown in Figure 1).

### 2.2.5 | Recognition of amplification through intersecting risks

Recognizing the complexities of trade-offs, biocultural anthropologists are increasingly incorporating a *syndemic* framework and approach in their work to address the multiple, interacting factors that influence local biologies (Figure 2). Originally developed in medical anthropology and public health, a syndemic framework argues that a dynamic interaction exists among two or more co-occurring diseases in a given population or location with each shaping and reinforcing the other and exacerbating their detrimental effects (Mendenhall & Weaver, 2019; Singer, 2009). This also fits with earlier biocultural research that highlighted the dialectical nature of human interactions with their environments: Humans respond to varied stressors from these domains and in doing so then alter the environment (Livingstone, 1958). This then can exert new stressors to which people must then respond.



**FIGURE 1** A basic biocultural model that identifies pathways linking environments, cultural and biological domains, using water insecurity examples (Adapted from Zuckerman and Martin (2016))

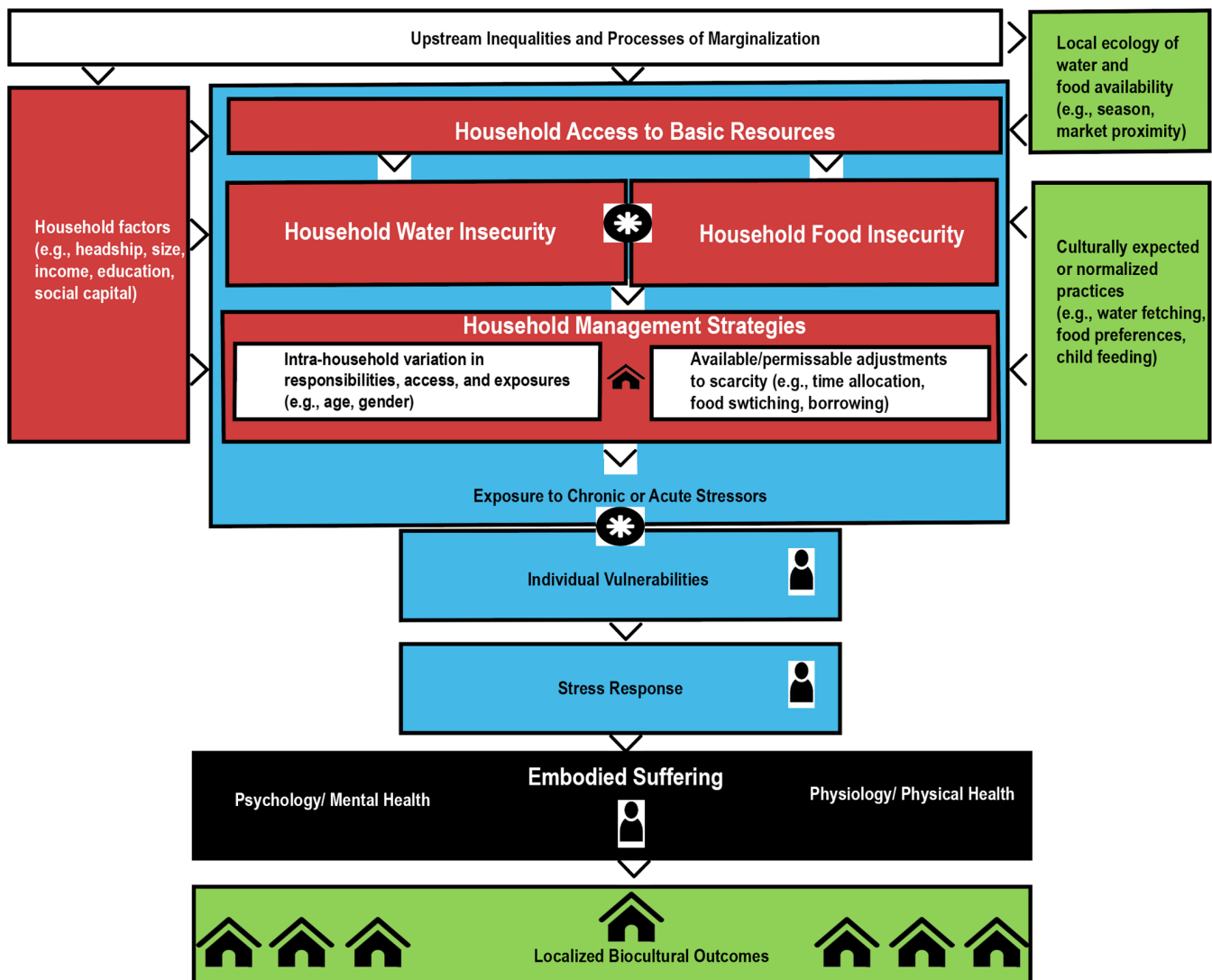


**FIGURE 2** A basic syndemic model relevant to household food and water insecurity interactions (Adapted from Singer et al. (2017))

Calling for an examination of the social inequities and inadequate structures that underlie disease co-occurrence, the syndemic approach highlights the critical need to understand the complexities of mechanisms (Mendenhall, 2017; Mendenhall, Kohrt, Norris, Ndeti, & Prabhakaran, 2017). After all, a single pathway may be underpinned by multiple—potentially counter-acting or amplifying—mechanisms. This is useful to understanding proximate impacts of household water, because it highlights that diseases and conditions that tend to co-occur with water insecurity (e.g., diarrheal disease, mental ill-health, undernutrition) likely worsen each other, even as they also are being amplified by many coalescing stressors beyond illness or water (e.g., food insecurity or financial strain and indebtedness). Also, an additional way that syndemic frameworks are important is they are necessarily localized (Mendenhall & Singer, 2019), meaning they cannot be divorced from local community practices, norms, and circumstances.

Most management (coping) processes to deal with resource shortages involve trade-offs. This approach is particularly helpful for considering household water insecurity because it would suggest that meeting water needs might come at costs to other aspects of health or wellbeing. For example, resources like time, money, or labor expended on accessing food or health care might undermine the ability to secure food or healthcare—or vice versa (e.g., Brewis, Choudhary, & Wutich, 2019b).

A summary conceptual model that reflects the basic points of the following overview as relevant to theorizing the connections between and implications of household water insecurity, including in interaction with food insecurity, is presented in Figure 3.



**FIGURE 3** A biocultural model of the household water insecurity, including in interaction with food insecurity



### 3 | WHAT HAVE WE LEARNED ABOUT HOUSEHOLD WATER INSECURITY FROM A BIOCULTURAL PERSPECTIVE?

The last section outlined some basic theoretical starting points on how to consider household water from a biocultural approach. Some, but not all, of these ideas are evident in the current nascent biocultural literature. In this section, we start from this literature rather than general theoretical propositions, to identify if the approach is identifying other possible novel primary findings on household water insecurity. We have organized this overview around four themes that emerged in our review, some of which map onto the above better than others: (a) Individual vulnerabilities to the effects of water insecurity; (b) Water insecurity distress as a particularly powerful biocultural stressor; (c) Water insecurity as a mechanism to embody structural inequalities as local biologies; (d) How the household acts as a nexus for food–water interactions that elevate or amplify health risks and suffering. Of course, many of the studies cross these thematic domains; In some cases, the organization should be considered arbitrary as a single study may illustrate multiple points. The intersecting points, alongside study details, are identified in Table 1.

#### 3.1 | Theme 1: Individual vulnerabilities to the effects of household water insecurity

Several recent biocultural studies have established an empirical relationship between household water insecurity in ecological context and individual-level physical health outcomes. Two such studies were conducted among the Tsimané, an indigenous group living in the Bolivian Amazon (Rosinger, 2018; Rosinger & Tanner, 2015). Despite living in a water-rich zone, the Tsimané experience water insecurity due to issues of water quality and periodic flooding. In this context, Rosinger and Tanner (2015) explored hydration strategies among adults and found that a greater reliance on foods (e.g., local fruits and tubers) as a source of water was associated with reduced risk of gastrointestinal illness. In the second study, Rosinger (2018) considered the relationship between perceived water security, prevalence of diarrhea, and hydration status among adults and children and found a positive association between the level of household water insecurity and child dehydration – severely undermining child health. Based on grounded, ethnographic research in the community Rosinger (2018) suggests that concerns over the safety of drinking water may have led to reductions in water consumption, resulting in child dehydration. Also, consumption of water contaminated with fecal coliforms can cause diarrhea, which can also result in dehydration. Thus, reliance on water-rich foods may be an adaptive strategy for coping with unsafe water (Rosinger & Tanner, 2015).

A further example comes from a study conducted in a rural, water-rich zone in Nicaragua (Piperata et al., 2019, 2020). Unlike the Tsimané, these rural Nicaraguans received their water from a treatment plant and testing of that water indicated it was free of fecal coliforms (a primary indicator of potability). Most accessed this water via a spigot located on their property, which they were required to pay for. The location of a spigot far from the point of use, low flow rates, and periodic cut-offs led households to store water. Direct observations of water collection, storage, and usage revealed opportunities for contamination; 85% of households had drinking water contaminated with fecal coliforms. A novel finding was that across age groups, children from homes with higher coliform concentration drinking water had a less diverse gut microbiota. Less diverse gut microbiota is generally considered a biomarker signaling poor health and a risk factor for developing subsequent illnesses.

The cases cited above to consider how cultural practices (food choice, water consumption patterns, and water storage decisions) influences the ways household water insecurity can shape health. In the case of the Nicaraguan study, attention is also drawn to how local strategies for coping with water insecurity, which may place people at risk of pathogen exposure, are ultimately related to the failure of the State to meet citizens' most basic needs.

#### 3.2 | Theme 2: Water insecurity as a powerful biocultural stressor

The largest number of published biocultural studies on water insecurity as a stressor are focused on its proposed significant impacts on mental health, particularly on symptoms of anxiety and depression. As a set, this research suggests that water insecurity in itself is not what is most distressing for people. Rather, it is failures to meet social norms, expectations, and responsibilities because of water insecurity that is associated with poor mental health. Much of the early work in this field focused on embodied emotions. Ennis-McMillan (2001, 2006), in his study in a town in the Valley of Mexico, was the first to draw an explicit link between water insecurity and emotional distress. He documented a

**TABLE 1** Key biocultural studies of household water insecurity

References	Study site	Sample/approach	Key findings	Key themes
Rosinger (2018)	Two rural indigenous Tsimané communities in the Bolivian Amazon that experienced massive flooding.	Pre-flood interviews with 36 household heads; 50% women. Post-flood data interviews, diarrhea events, and anthropometrics with 118 adults, 115 children.	Household water insecurity score was associated with dehydration among children, but not child diarrhea risk.	1
Piperata et al. (2019, 2020)	Rural, coffee-producing community with access to water from nearby treatment facility.	Tested diversity and composition of gut microbiota of 41 children in 39 households with lower and higher coliform concentrations in drinking water.	Children from homes with higher coliform concentrations in their drinking water had a less diverse and compositionally different gut microbiota compared to those from homes with lower coliform concentrations in their drinking water.	1
Rosinger and Tanner (2015)	Rural indigenous Tsimané community in Bolivian Amazon with horticulture and foraging subsistence.	Interviews, dietary recall, thirst assessment, illness event reports with 45 adults in dry season and 22 follow-up interviews.	Each percentage increase in water obtained from foods rather than water sources was associated with 6% lower odds of GI illness. For every 100 ml of raw water consumed, there was a 12% higher odds of GI illness.	1, 4
Stevenson, Ambelu, Caruso, Tesfaye, and Freeman (2016)	Female household heads or wives in rain-dependent rural villages in South Gondar, Amhara, Ethiopia.	Intervention design with surveys before and after community water supply improvement projects: $n = 247$ in Round 1; $n = 223$ in Round 2; $n = 123$ households in both rounds.	Women's scores on a local water insecurity scale were associated with their psychological distress as measured by the WHO Self-Reporting Questionnaire (SRQ-20). The water intervention did not improve women's psychological distress.	2
Cooper-Vince et al. (2017)	Women of reproductive age caring for a child <5 years old in rural areas near Mbarara, Uganda.	Cross-sectional population-based study in which 257 female household heads reported on behalf of children ( $n = 551$ ) in their care.	Water insecurity was associated with caregiver depression as measured by the Hopkins Symptom Checklist-Depression Subscale (HSCL-D); caregiver depression mediates the relationship between water insecurity and missed school (but only for girls).	2
Tallman (2019)	Four indigenous communities in Amazonia province, Peru.	Interviews with a convenience sample of 225 adult men and women.	Higher water insecurity scores were associated with higher levels of perceived stress, depressive symptoms, and somatic symptoms; women were most affected.	2
Mushavi et al. (2019)	Rural surrounds of a town in southwestern Uganda.	Interviews with 257 women in households with a child under 5 years of age and woman of reproductive age.	Household water insecurity predicted children's missed school days and female depression symptoms; depression symptoms were partially mediated by water insecurity and missed school.	2
Geere, Hunter, and Jagals (2010)	Six rural villages in Limpopo province, South Africa.	Exploratory study using mixed methods approach, 76 observations of water carrying events.	Head loading of water was associated with head and neck pain; men often refused to carry water so women were much more affected.	2
Asaba, Fagan, Kabonesa, and Mugumya (2013)	15 rural villages South-Central Uganda.	Mixed-methods including 602 surveys with household heads on water fetching, focus groups.	Water collecting considered "unmanly"; women and children did most of it. Water fetching was associated with frequent chest pain, fatigue, and headaches. Effects were more commonly reported by women.	2



**TABLE 1** (Continued)

References	Study site	Sample/approach	Key findings	Key themes
Brewis, Wutich, et al. (2019)	Nepal (all areas).	Population-representative study of men and women age 18–45 in 8,633 randomly selected households in Nepal, surveys and blood pressure measurements.	Women in households with poor water access had elevated rates of systolic and diastolic blood pressure compared to those in households with more optimal access. Women in households in the lowest socioeconomic strata had the highest blood pressure values. By contrast, men's blood pressure showed no association with household water status.	2, 3
Ennis-McMillan (2001, 2006)	La Purificacion, Mexico, a highly water insecure foothill community in the Valley of Mexico.	Ethnographic interviews with 15 women and 26 men.	“Suffering from water” emerged as a local idiom for frustration, anguish, bother, worry, anger, which was experienced when water shortages re seen as unjust (especially by women and people with lower SES).	2, 3
Wutich and Ragsdale (2008); Hadley and Wutich (2009)	An informal settlement in urban Cochabamba, Bolivia	Mixed-methods longitudinal design with participant-observation and five interviews with a random sample of 72 household heads.	Scores on a locally developed water insecurity scale were associated with emotional distress. Emotional distress over water was significantly associated with having more interaction with unpredictable water sources (markets and reciprocity), having fewer social and economic assets, and female gender—but not water use, seasonality, and access to a water commons. Distress was also associated with perceptions of injustice in how water was allocated in the community.	2, 3
Wutich (2009)	An informal settlement in urban Cochabamba, Bolivia.	Mixed-methods longitudinal design with participant-observation and 24 matched pairs of men and women living in the same household	Women are more likely to experience fear and anger over water, but men and women were equally likely to feel worry, annoyance, and anger with family. Distress around water among women was related to their key roles in household water management.	2, 3
Stevenson et al. (2012)	Women living in rain-dependent rural villages in South Gondar, Amhara, Ethiopia.	Mixed-methods design with formative qualitative and quantitative survey phases; 104 free lists; three focus groups; surveys for 324 households.	Women's scores on a locally developed water insecurity scale—but not water collection times or access to a protected water source—were significantly associated with their psychosocial distress scores on the Falk Self-Reporting Questionnaire (SRQ-F).	2, 3
Bisung and Elliott (2016, 2017)	Residents of a community next to Lake Victoria, western Kenya, with no safe water access.	Two-phase qualitative design with 10 focus groups (stratified and mixed based on age and gender) and nine key informant interviews.	Feelings of anxiety, frustration, embarrassment, and marginalization resulted from cost and time to get water, poor water quality, shame in front of visitors, and sense of political abandonment.	2, 3
Brewis, Choudhary, and Wutich (2019b)	Three very low SES sites (urban, town, rural) in Haiti.	Multi-site, mixed-method cross-sectional design; surveys with 4,055 household heads.	Water insecurity was directly associated with anxiety and depression (measured with the Beck Anxiety & Depression Inventories), and indirectly associated with food insecurity, in all three sites. In the rural site only, water insecurity was indirectly associated with anxiety through sanitation insecurity.	2, 4

(Continues)

TABLE 1 (Continued)

References	Study site	Sample/approach	Key findings	Key themes
Maxfield (2019)	Households in very low-income sections of Jaipur, India.	Survey with 650 mothers, fathers, boys and girls, selected through multistage cluster design.	The relationship between water insecurity and psychosocial stress was no longer significant once food insecurity was considered. The effect of mild food insecurity on mental health was stronger in mothers compared to fathers while an independent association between water insecurity and anxiety and depression was significant only for fathers.	2,4
Workman and Ureksoy (2017)	Three rural villages in the Maseru District of Lesotho.	Mixed-method study with convenience sampling, interviewing 75 adults (56 women, 19 men).	Poor water availability, low access, usage amount, and perceived unclean water were stressful. Water insecurity, food insecurity and changing household demographics, likely resulting from the HIV/AIDS epidemic, are all associated with increased anxiety and depression based on the Hopkins Symptom Checklist-25. These appeared to worsen stress when co-occurring.	2, 4
Brewis et al. (2020)	27 sites in 21 low-middle income countries.	Survey interviews with 6,691 randomly selected household heads.	Water insecurity was positively associated with household food insecurity in 26 of the 27 sites. Household water insecurity and its sub-domains (lower water quantity, worse quality, and more time/labor impacts) were all independently associated with greater food insecurity. While there were no urban and rural differences in the overall relationship between water and food insecurity, rural households were better buffered against water insecurity's effects on food quantity and urban ones for food quality.	4
Thompson, Nicholas, Watson, Terán, and Bentley (2019)	Galapagos Islands, Ecuador, where both under and over-nutrition co-occur.	Surveys with 693 randomly selected households from a nationally representative survey, with 1,119 children (0–18) and 1,582 adults.	Individuals and households suffering from both water and food limitations were more likely to exhibit signs of under- and over-nutrition, sometimes simultaneously.	4

phenomenon called *sufriendo del agua* (suffering from water), a local idiom of distress that describes negative emotions (frustration, anguish, bother, worry, and anger) related to water insecurity.

Following Ennis-McMillan, Wutich's (2009) work in Cochabamba, Bolivia introduced a mixed-methods approach with locally validated scales measuring water insecurity and emotional distress. Surprisingly, however, water availability (measured by use and two seasonality measures) was not associated with emotional distress. Building on this approach, Bisung and Elliott (2016, 2017) used a qualitative approach in a very different context—a Kenyan town—to confirm in a different context that experiences of water insecurity produced feelings of anxiety, frustration, embarrassment, and marginalization.

Using a mixed-methods approach with locally validated water insecurity scales, Stevenson et al. (2012, 2016) work in Ethiopia made a major contribution by introducing the use of validated mental health scales into research on water insecurity. Stevenson et al. (2012) showed that women's experiences of water insecurity were associated with their psychosocial distress scores. Significantly, they found, like Wutich and Ragsdale (2008), that measures of water availability (time to collect and access to an improved source) were not associated with distress outcomes. In later work in three Ethiopian villages, Stevenson et al. (2016) found that women's scores on the water insecurity scale were associated with psychological distress, though this work also indicated that a water intervention did not improve it. Stevenson

et al.'s (2012, 2016) work is important because it moved the literature significantly beyond the earlier approach of studying emotional distress and showed definitively that water insecurity was associated with psychological ill-health.

Tallman (2019) used a biocultural approach that explicitly focuses on political–economic factors to understand how exposures to modernization and water insecurity were associated with both mental and physical ill-health. Using data from 225 adults in four indigenous communities in Amazonas province, Peru she showed strong associations between water insecurity and depression and distress symptoms. Water was not necessarily scarce in the area, but often contaminated and otherwise unsafe. Based on qualitative interviews, Tallman's analysis of the association between water insecurity and depression/distress identified three culturally embedded mechanisms that may explain the association: Uncertainty and unpredictability, social stigma and shame, and perceptions of unfairness or injustice.

Some recent biocultural work applied larger samples in cross-sectional designs with sophisticated quantitative models to test hypotheses regarding the processes by which water insecurity produces mental ill-health. Cooper-Vince et al. (2017), examined the relationship between water insecurity, caregiver mental health, and children's missed school in rural areas of Uganda. Water insecurity was associated with heightened expressions of depression in the female caregivers. Furthermore, caregiver depression mediated the relationship between water insecurity and children's missed schools. This study is significant because it shows that the previously under-recognized relationship between water insecurity and depression is, at least in part, driving a well-established phenomenon that water scholars believed to be well understood. That is, education suffers among children across Africa who must fetch water (Burke & Beegle, 2004; Dreibelbis et al., 2013; Stevenson et al., 2012).

Most recently, Brewis, Choudhary, and Wutich (2019b) studied the direct influence of water insecurity on depression and anxiety while considering the additional indirect role of water insecurity on mental health via its additional effects of food insecurity and sanitation insecurity. They collected survey data from 4,055 respondents in rural, town, and urban Haitian communities, and found that higher water insecurity (access and quality/quantity) was associated with anxiety and depression. Importantly, this study was the first to show that food insecurity and sanitation insecurity can be theorized as indirect pathways in which water insecurity impacts anxiety and depression (though the sanitation pathway was only found in the rural site). This work demonstrates that scholarship on the relationship between water insecurity and common mental disorders, now nearly 20 years old, has reached a more advanced state with well-operationalized measures, clearly derived hypotheses, and progressive contributions to theory-building.

One study has revealed how water-related task assignments might pattern stress in ways that affect chronic disease, not just mental ill-health. In a study of adult women and men in a nationally representative sample of households in Nepal, Brewis, Choudhary, and Wutich (2019a) found that women in households with poor water access had elevated measures of systolic and diastolic blood pressure compared to those in households with more optimal access. Nepal is a key case, because almost all responsibility for household water tasks falls to women. Heightened blood pressure is often treated as a biocultural marker of stress, in addition to its association with chronic disease risk. Women in households in the lowest socioeconomic strata had the highest blood pressure values. Together, this literature shows how water insecurity “gets under the skin” to lead to poor mental health, particularly in contexts where individuals are not able to fulfill social expectations.

### **3.3 | Theme 3: Water insecurity as a mechanism to embody structural inequalities as local biologies**

These same studies also show how water insecurity manifests in local biologies in ways that reflect broader social and political inequalities. Ennis-McMillan's study in Mexico (Ennis-McMillan, 2001, 2006) prioritized understanding the social origins of this distress, designing his inductive ethnographic research to explore how social structures (gender and socio-economic status) shaped suffering from water. He found that women and people with lower social status were more likely to suffer distress associated with water.

Drawing on long-term fieldwork, Wutich (2009) identified that it was gender-based differences in the mechanisms by which limited access to water caused stress in Cochabamba communities neglected by the Bolivian state. In communities that were excluded from municipal water service, the risk of mental distress was related to the specific responsibilities people had within households around getting and managing water—where women were more likely to recognize water shortages and were more sensitive to emotional distress. Importantly, the mechanisms relating resource insecurity and health in the Cochabamba study, while localized, also draw attention to the role of broader social–political–economic processes (e.g., food crises, State failures to provide services).

Wutich (2009) also showed, with matched pairs of men and women within water-insecure households, that the gap between men and women's experiences of water insecurity and emotional distress narrowed when the house was in a particularly severe water crisis, because men were helping more with the management of extremely limited resources. Also attentive to social structure, Wutich and Ragsdale's (2008) work in Cochabamba, Bolivia asked how people's entitlements, assets, gender, and water availability were associated with emotional distress in an informal settlement. They found, surprisingly, that the more people reported accessing institutions like water markets and water sharing, the more likely they were to experience emotional distress. This was because these institutions were experienced as unjust and unpredictable. As expected, female gender and having fewer social and economic assets were associated with greater emotional distress.

Brewis, Choudhary, and Wutich (2019a) study of gender differences in the effects of water access on physiological stress in Nepal provides one of the clearer examples of how gender inequality is manifest in biology through the mechanism of water insecurity. While women's blood pressure was highly influenced by water sources, men's blood pressure showed no association with household water status. This is because women do almost all the work of water fetching and water management in Nepal. Such gendered water fetching practices, based in patriarchal social structures, also affect women disproportionately in terms of risks of physical injuries. In a small study that observed and then talked to water fetchers in Limpopo province in South Africa, Geere et al. (2010) noted that water fetching was associated with skeletal pain and trauma; because women were expected to do the fetching, they were much more at risk. Asaba et al. (2013) similarly report, based on a mixed-methods study from Uganda, that local ideas about water collecting as "unmanly" mean most fetching is done by women and children. Accordingly, women reported higher levels of pain and fatigue related to water work than did young men or adult males.

These findings, identifying mechanisms around gender and low social status, are increasingly being replicated (e.g., see review in Wutich, 2020). Together, these studies suggest that structural inequalities produce water insecurity, which then manifests as local biologies. The evidence for this is strongest for gender, though the ways in which gender structures water insecurity varies across cultural and social contexts. The evidence for socio-economic status is also strong, but less studied. Other important aspects of social structural inequality are still too little studied to draw any clear conclusions regarding their broader role(s) in the embodiment of water insecurity.

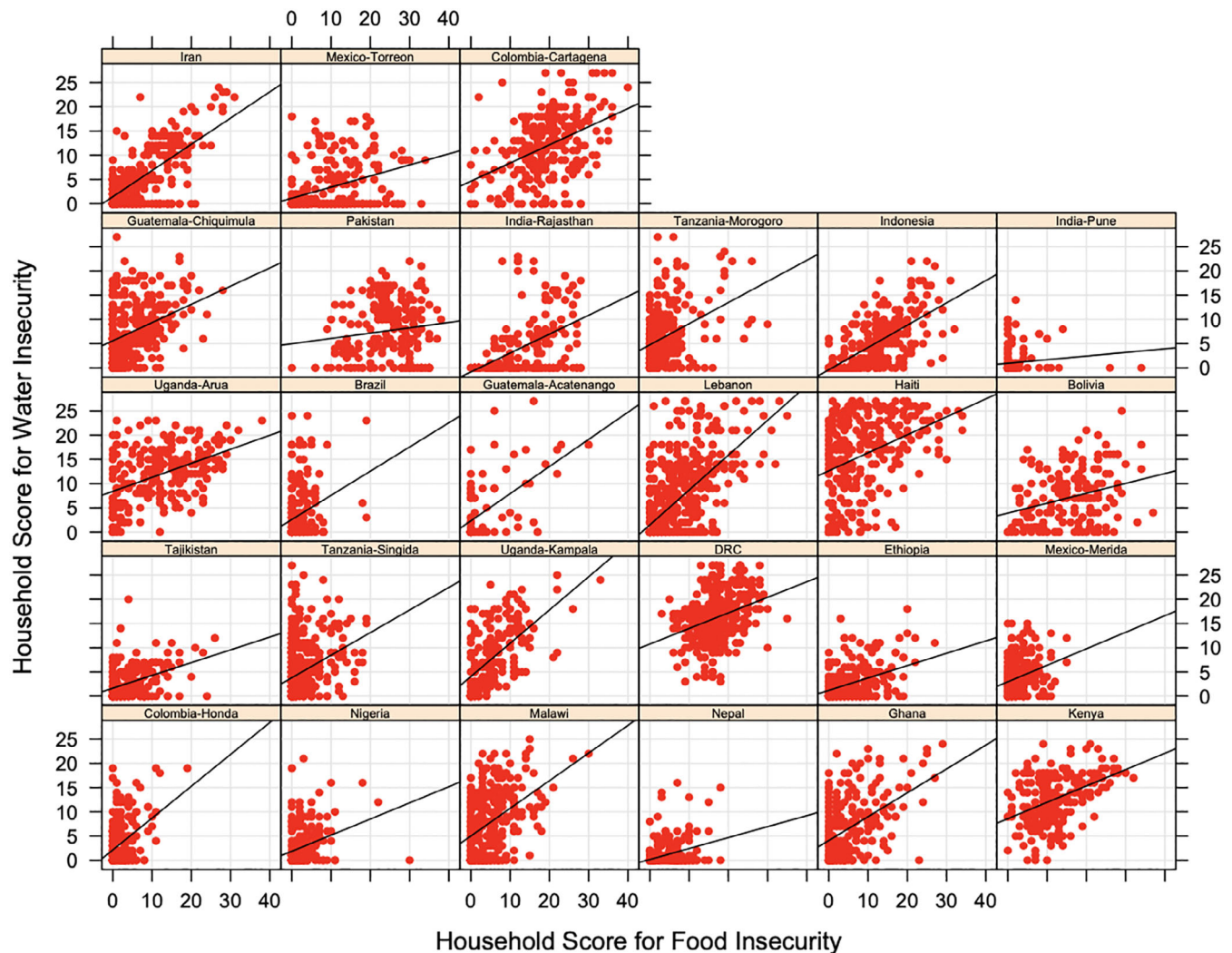
### 3.4 | Theme 4: The household as nexus for food–water suffering

At the household level, water insecurity acts directly to impact physical and mental health of household members and, at the same time, likely amplifies the effects of food insecurity. For example, in the Nepal study by Brewis, Choudhary, and Wutich (2019a), water insecurity had a direct effect on women's heightened blood pressure; however, women in households also affected by food insecurity had additional negative effects. Similarly, households in Galapagos, Ecuador that were experiencing limitations in both water and food access and quality were significantly more likely to experience the dual burden of undernutrition/infectious disease and overweight/cardiometabolic disease than those with neither concern or those with water concerns alone (Thompson et al., 2019). These studies provide solid if preliminary evidence that the household serves as a nexus through which water and food interact to contribute to health.

The experience of combined household water and food insecurity likely additionally worsens mental health outcomes because of worry involved in coping simultaneously with both. We have extremely limited understanding of the scale of this combined challenge or how living in households at the nexus of food and water insecurity are differently affected than those living with just one or the other. A recent study by Brewis et al. (2019) tested for the simultaneous occurrence of household water and food insecurity in cross-sectional samples from 27 diverse global sites. This study showed a significant positive correlation between household water and food insecurity in 26 of the 27 sites. However, perhaps more importantly, showed that people in many households also worry greatly about *both* (Figure 4).

Brewis, Choudhary, and Wutich (2019b) found that men and women from three vulnerable areas in Haiti had worse anxiety and depression scores when faced with water and food insecurity compared to those who suffered food or water insecurity alone. Workman and Ureksoy (2017) document a similar (potentially syndemic) situation in a water and food insecure area of rural Lesotho, where water insecurity predicts increased self-reported depression and anxiety even when accounting for food insecurity and material assets. In contrast, Maxfield (2019) found that among households in very low-income informal communities in India, water insecurity remained an independent predictor of poorer mental health only among fathers when food insecurity was controlled for in the models. These results suggest that lived experiences of water and food insecurity may overlap differently within households as family members face different decisions about resource allocation.





**FIGURE 4** Reported worry about water and food in 6,691 households in 27 local community sites (Adapted from Brewis et al. (2020)) [Correction added on 03 May 2020, after first online publication: Figure 4 image has been updated.]

Beyond their co-occurrence due to poverty, a number of mechanisms link water and food insecurity within households, compounding their individual impacts on health. Data from multi-sited comparisons across a number of low- and middle-income settings provide evidence that water insecurity is positively associated with food insecurity within households, with both overall water insecurity and components of water insecurity (low quantity, low quality, and greater time/labor cost) associated with worsening food insecurity (Brewis et al., 2020). This strong association likely lies in the importance of water for nearly all aspects of food production and preparation. As Workman and Ureksoy (2017) describe, in qualitative interviews participants relayed that they could not cook food or grow sufficient crops without water. Similarly, Maxfield's (2019) findings that water insecurity had independent effects in Jaipur fathers when controlling for food insecurity, but not mothers, may be due to the interconnected nature of water and food for women, who are responsible for food preparation, cooking, and cleaning, all tasks that link food and water resources. Men, conversely, may experience water insecurity distinctly as they suffer from inadequate water for drinking or personal hygiene.

Along with these close connections between water and food preparation, the need to purchase and treat water also puts an additional strain on household resources, exacerbating food insecurity. Money or time spent to procure and/or treat water may limit families' budget for food or time to invest in agriculture, leading to food insecurity (Stoler et al., 2020). The dual burden of water and food insecurity appears to result in more adverse outcomes in lower-income households, likely due to their more limited ability to cope with stressors overall (Brewis et al., 2020; Thompson et al., 2019; Workman & Ureksoy, 2017). Together, this research highlights the importance of the household as analytic site, because it seems to be where water and food insecurity interact to undermine health and well-being. While studies

are few to date, a reasonable assumption based on current evidence is that the effects of food and water insecurity are not just additive, but also likely syndemically to undermine human health and biology.

## 4 | CONCLUSION

Similar to the larger existing literature on food insecurity, household water insecurity consistently emerges as a source of both physical illness and mental ill-health, and through several different pathways. While limited to relatively small samples and mostly cross-sectional studies, the consistency of findings across an array of highly diverse ecologies and societies is startling. The household emerges as a key nexus for the interactions, as an important site for organizing responses to stressors associated with scarcity, including water shortages, intermittent water availability, high water costs, and water contamination. Thus, the household is an appropriate level for testing how water insecurity interacts with other forms of material need and testing what forms or foci of interventions might be most effective at reducing illness and suffering. The available literature also identifies water insecurity—and as it co-occurs with food insecurity, and perhaps also syndemically is worsened by it—as reflecting wider inequalities. It also theorizes at least three basic ways that social structures seem to shape the embodiment of water insecurity: Through gender roles, systemic forms of economic disadvantage, and through people's recognition of systems as unfair.

Our overview also reveals some other key gaps in the literature that suggest priorities for future research. We have some limited associational studies that suggest that household water status probably complicates and worsens the effects of food insecurity. Studies that identify with precision how food and water insecurities drive each other and health outcomes within the household are currently missing, because there are no relevant longitudinal studies. These are needed to understand the mechanisms by which risk is differentially distributed within households, the local conditions in which their intersection is most harmful to households and individuals, and why. Gendered inequalities, in mental health, stress-related physiological markers (like blood pressure), and physical trauma, reflect ideas that onerous tasks associated with water acquisition and management should be done by women. Yet, we are far from attaining a comprehensive understanding of the processes by which gender shapes water-related embodiments of stress and suffering. Some studies suggest that men may become much more involved in water responsibilities—and suffer associated health impacts—during household water crises. We also do not understand how that relates to parallel and related gendered roles in household food production and preparation. For example, allocations of tasks and trade-offs between water and food management might elevate risk for some more than others. Other work suggests that gender norms around water fetching involve men much more frequently than previously thought. However, the extent to which this may be an indicator of increasing gender equity or perhaps long-standing patterning is not yet well understood. And shifting global gender norms—with widespread recognition of and growing social roles for people who are transgender or non-binary—open whole new fields of scholarship that have barely been considered (Grant, Huggett, Willetts, & Wilbur, 2017).

There is a clear association between socio-economic disadvantage, across all kinds of social systems, and the embodiment of water insecurity. Yet, we have little empirical understanding of what kinds of social structural inequalities seem to be most damaging. Systems of social inequality differ widely—across caste systems, racial capitalism, and other political-economic formations—and more research is needed to develop a synergistic theory of socio-economic disadvantage and its role in shaping the embodiment of water insecurity. Some studies suggest that a sense of unfairness, injustice, or unpredictability around water may have particularly harmful mental health impacts. There is strong theoretical justification for such a relationship, but there has been very little focused investigation into this; More investigation is needed to identify and unravel possible causal mechanisms. This overview also highlights that much of the current limited literature relating water security and health has focused on physical access to water and its relationship with mental wellbeing. Good progress has been made here, with a number of middle-range theories being tested using biocultural approaches. We need to expand this approach to consider other forms of embodied water insecurity, such as dehydration and musculoskeletal trauma. Testing the mechanisms that connect water to household food could focus on breastfeeding and infant feeding, effects on the microbiome, and the possible effects of consuming food that has been contaminated by water provide additional avenues for study (see Schell & Tarbell, 1998).

This brings us to a further important question: What sorts of structural or other interventions around water insecurity might this current biocultural literature suggest? Our review of the literature indicates that household water insecurity contributes to food insecurity and together these interact to worsen mental health outcomes. Thus, improving household access to water through community-level interventions, such as protecting water sources from



contamination (Stevenson et al., 2016) or extending municipal delivery of water (Bisung & Elliott, 2018), may alleviate food insecurity and have downstream effects on mental health, particularly for women. This literature review also suggests the water interventions must recognize that affected households are composed of people of different ages, genders, and other social roles, and not everyone in that household shares the same risks and responsibilities related to water. This means that the burdens of “successful” water interventions may be carried by some more than others. For example, consider an intervention that brings more water to a community and improves food security of households or reduces diarrheal disease of household children. If women end up hauling more water or experience those new water systems as unfair, the biocultural approach suggests they may suffer worse health even as that of others improves.

Finally, here we have considered current evidence on the household interactions of water with food insecurity, and how this affects health and wellbeing. However, household energy is an additional potential dimension of localized resource insecurity, and barely considered in current biocultural current research. For example, in lower- and middle-income countries, a large percentage of household energy expenditures can be for pumping or heating water (e.g., see Hussien, Memon, and Savic (2017) for a review). Future biocultural studies on household food–water nexus should benefit from greater consideration of how these additionally relate to household energy insecurity.

## CONFLICT OF INTEREST

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

## AUTHOR CONTRIBUTIONS

**Alexandra Brewis:** Conceptualization; investigation; methodology; writing-original draft; writing-review and editing.

**Barbara Piperata:** Conceptualization; investigation; methodology; writing-original draft; writing-review and editing.

**Amanda Thompson:** Conceptualization; investigation; methodology; writing-original draft; writing-review and editing.

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