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SHORT REPORT

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Water insecurity, self-reported physical health, and objective measures of biological health in the Peruvian Amazon

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Abstract

Objectives: This study examines the associations between water insecurity, self-reported physical health, and objective measures of biological health among 225 Awajún adults (107 women; 118 men) living in the Peruvian Amazon, a "water-abundant" region.

Methods: A survey, which included multiple measures of self-reported physical health, and objective measures of biological health such as blood pressure and nutritional and immune biomarkers.

Results: Greater water insecurity was associated with multiple measures of self-reported physical health, including higher incidence of reported diarrhea, nausea, back pain, headaches, chest pain, fatigue, dizziness, overall poor perceived health, and "being sick." These symptoms align with the physical strain associated with water acquisition and with drinking contaminated water. A significant association between higher water insecurity and lower systolic blood pressure emerged, which may be linked to dehydration. None of the other biomarkers, including those for nutrition, infection, and stress were significantly associated with water insecurity scores.

Conclusions: These analyses add to the growing body of research examining the associations between water insecurity and health. Biocultural anthropologists are well-positioned to continue probing these connections. Future research will investigate relationships between measures of water insecurity and biomarkers for gastrointestinal infection and inflammation in water-scarce and water-abundant contexts.

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Practitioner Points

1. Water insecurity exists in "water-abundant" areas such as the Amazon rainforest.
2. Higher water insecurity scores were associated with measures of self-reported physical health, including reported diarrhea, nausea, back pain, headaches, chest pain, fatigue, dizziness, overall poor perceived health, and "being sick".
3. In terms of objective measures of biological health, higher water insecurity scores were associated with lower systolic blood pressure, which may be associated with dehydration.

1 | INTRODUCTION

Water insecurity – the inability to access and benefit from affordable, adequate, reliable, and safe water – is one of the greatest contemporary threats facing humans (Jepson et al., 2017). While there are strong conceptual reviews of the relationship between water insecurity, human biology, and reported physical health (Rosinger & Young, 2020), the empirical literature remains limited (Wutich et al., 2022).

Existing studies, primarily conducted by biocultural anthropologists, indicate that water insecurity is associated with elevated blood pressure (Brewis et al., 2019), dehydration (Rosinger, 2018), diarrhea (Jepson et al., 2021; Rosinger, 2018), physical trauma/injuries (Geere et al., 2018; Rosinger et al., 2021), mental health (reviewed in Wutich et al., 2020), and gender-based violence (reviewed in Tallman et al., in press).

Emerging within the broader water insecurity literature is the focus on water insecurity in "water-abundant" areas, such as the Amazon rainforest (Rosinger, 2018; Tallman, 2019; Torres-Slimming et al., 2020). This study extends this line of inquiry by examining the relationship between water insecurity, self-reported physical health, and objective measures of biological health among the Awajún of the Peruvian Amazon.

2 | MATERIALS AND METHODS

The Awajún are an indigenous population living in the northern Peruvian Amazon, primarily in an area spanning the *selva alta* (upper jungle), which is covered in dense vegetation with rainfall >100 inches annually. The importance of water in Awajún livelihoods and culture cannot be overstated. Historically, rivers have served as a source of food, water, transport, and spiritual practice. Yet recent political-economic and ecological changes have led to problems with water access, contamination, and use among the Awajún (Tallman, 2019).

Study data are from a convenience sample of 118 Awajún men and 107 women, 18–65 years old in four communities in the province of Amazonas (see Appendix Figure S1 for a map of the field sites). Water insecurity was initially measured using seven questions drawn from Stevenson et al.'s (2012) work, which assessed water access, quality, and consumption. Pearson's Correlations (Coeff > 0.3) were used to evaluate the relationship between these questions and principal component analysis (Cronbach's alpha > 0.7) was used to assess internal consistency. Three items emerged that were statistically the best fit for measuring water insecurity in this context and captured domains of water access, availability, use, and quality. Binary responses to these questions (cf. footnote Table 1) were summed to create a composite water insecurity score (range 0–3).

Self-reported physical health was measured by asking participants (1) whether they were currently sick (yes/no), (2) if they had experienced physical health problems such as pain, dizziness etc. in the last month (not bothered, a little bothered, and very bothered), and (3) how they ranked their perceived physical health (poor to excellent). Objective measures of biological health included blood pressure, body mass index, and blood spot biomarkers including high-density lipoprotein cholesterol, triglycerides, hemoglobin, glucose, Epstein–Barr virus antibodies, and C-reactive protein. All study activities were approved by the Northwestern University Institutional Review Board (STU00074297). Participants were verbally consented and biomarker analyses were conducted by PST in the Laboratory for Human Biology at Northwestern University.

Our hypothesis is that higher water insecurity scores will be associated with worse self-reported physical health and objective measures of biological health. To test this, associations were evaluated using multivariable ordered logit regression (ordinal variables) and linear regression (continuous variables) in Stata17, controlling for age, sex, community, and socioeconomic status.

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TABLE 1 Multivariable logistic and linear regression results for reported health outcomes and the biomarker significantly associated with water insecurity among Awajún adults ($n = 225$).

	Biomarker		Overall health and perceptions of illness				Gastrointestinal Distress				Water Acquisition Related									
	Systolic blood pressure (mm Hg)		Perceived health		Sickness		Diarrhea		Nausea		Back pain		Headache		Dizziness		Chest pain		Fatigue	
	β	p=	OR	p=	OR	p=	OR	p=	OR	p=	OR	p=	OR	p=	OR	p=	OR	p=	OR	p=
Water insecurity score	−2.3	**0.009**	0.6	**<0.001**	1.9	**0.001**	1.4	**0.01**	1.5	**0.007**	1.6	**0.002**	1.6	**0.002**	1.6	**0.001**	1.5	**0.01**	1.8	**<0.001**
SES	−2.3	0.10	1.8	**0.002**	0.5	**0.02**	0.9	0.66	1.3	0.35	0.6	0.06	0.8	0.23	1.1	0.82	0.8	0.47	0.9	0.94
Age (y)	0.6	**<0.001**	0.9	**0.007**	1.0	**0.03**	1.0	0.09	1.0	0.95	1.0	**0.006**	1.0	0.15	1.0	0.18	1.0	0.93	1.0	0.19
Community 1																				
Community 2	7.1	**0.01**	3.8	**0.01**	0.2	**0.00**	1.1	0.76	1.5	0.42	0.4	0.07	0.4	**0.04**	0.9	0.83	0.7	0.53	0.5	0.19
Community 3	9.1	**<0.001**	1.7	0.13	0.4	0.08	0.6	0.31	1.0	0.97	0.4	0.05	0.5	0.09	0.7	0.47	1.0	0.92	0.5	0.06
Community 4	10.5	**0.01**	0.8	0.75	1.2	0.83	0.6	0.46	1.4	0.62	0.5	0.25	1.0	0.99	0.7	0.52	0.3	0.22	0.4	0.14
Sex	7.5	**<0.001**	1.3	0.28	0.4	0.11	0.5	**0.02**	0.7	0.29	0.7	0.31	0.5	**0.01**	0.4	**0.01**	0.4	**0.03**	0.5	0.05

Note: Water insecurity scores ranged from 0 to 3 and were based on the following three questions:
"In the last month were there times you could not collect water because it was too far away?"
"Have you gone to bed thirsty because there is no clean water available?"
"Have you gone a long time without drinking because there was no clean water available?"

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3 | RESULTS

Descriptive characteristics can be found in Table 2. Multivariable models indicated that higher water insecurity scores were associated with worse self-reported physical health, including poorer perceived health and greater odds of reporting diarrhea, nausea, back pain, headache, chest pain, fatigue, dizziness, and "being sick" (Table 1). Water insecurity was not associated with body pain, limb pain, menstrual pain, nor sexual problems (Supplemental Table S1). For objective measures of biological health, higher water insecurity scores were associated with lower systolic blood pressure (β −2.3; $p = 0.009$), even when controlling for perceived stress scores (Table 1). Water insecurity was not significantly associated with any other objective measures of biological health (Supplemental Table S2).

4 | DISCUSSION

Water insecurity was associated with self-reported physical health and one objective measure of biological health, systolic blood pressure, among Awajún adults. Self-reported symptoms, such as back pain, headaches, chest pain, fatigue, and dizziness align with the physical strain associated with water acquisition (Geere et al., 2018; Rosinger et al., 2021). Others, such as diarrhea, nausea, overall poor health, and the feeling of "being sick," may be associated with drinking contaminated water (Jepson et al., 2021) or the psychoemotional distress associated with water insecurity (Wutich et al., 2020).

These quantitative findings fit with qualitative findings reported previously (Tallman, 2019). Specifically, Awajún community members expressed concern that local rivers were contaminated with sewage, garbage, and contaminants from mining operations. Additionally, study participants reported that they went "without drinking," particularly while working in *chacras* (agricultural fields), which could be up to from communities and primary water sources. Therefore, despite an abundance of water in this region, sub-optimal water access and quality precluded individuals from being water secure.

In terms of human biology, the only significant finding that emerged was an unexpected relationship between higher water insecurity and lower systolic blood pressure. Blood pressure is a well-known correlate of psychological stress. Brewis et al. (2019) found a positive association between water insecurity and blood pressure among women in Nepal. A potential explanation for the inverse association found in this study is that water insecurity can cause dehydration, resulting in lower blood volume and thus lower blood pressure (Coyle, 1998).

Nutritional biomarkers were not associated with water insecurity in this study. This fits with the "water-abundant" ecology of the region, as agricultural production is sustained by natural hydrological cycles. Additionally, Amazonian households do not typically face limitations of water adequacy for cooking. Relationships between water insecurity and nutritional biomarkers may be more relevant in water-scarce areas.

Water insecurity was not significantly associated with C-reactive protein. C-reactive protein (CRP) spikes with active infections and can be chronically elevated in inflammatory conditions. Elevated CRP was low in this sample and water-related infections may be chronic, in contrast to the acute infections commonly associated with significant increases in CRP. Water insecurity was also not significantly associated with Epstein–Barr virus (EBV) antibodies. EBV antibodies are a well-known correlate of psychological stress. One potential explanation for the null findings is that Tallman (2018) previously found that worries over socioeconomic status (SES) were salient among Awajún community members and associated with Epstein–Barr virus antibodies. SES concerns may overshadow stress over water insecurity in this context.

TABLE 2 Demographics of Awajún participants ($n = 225$), stratified by water insecurity scores.

Water insecurity score	Low/none ($n = 161$) (0 = 1)	Moderate ($n = 38$) (2)	High ($n = 25$) (3)
Females, %	68.2	17.8	14.0
Socioeconomic status, mean (SD) (0–3.5)	1.2 (0.7)	1.3 (0.7)	1.0 (0.8)
Age (y), mean (SD)	33.7 (12.1)	30.1 (8.6)	36.7 (13.5)
Community, %			
Comm	72.6	17.3	10.1
Commun	68.9	27.6	3.5
Co	68.3	14.6	17.1
Community 4	80.0	0.0	20.0

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Future research should investigate whether measures of water insecurity are associated with *Helicobacter pylori* infection, a common bacteria spread through contaminated water, and with endotoxin-core antibodies, a proxy of intestinal permeability (Hoke et al., 2018). Analysis of these biomarkers could yield insight into the biological correlates of water insecurity, particularly in "water-abundant" areas with poor sanitation infrastructure, such as the Amazon rainforest.

Limitations of this study include its cross-sectional design, limiting discussions of directionality of associations. Additionally, the measure of water insecurity used was a modified version of Stevenson et al.'s (2012) survey, which was developed in a water-scarce setting, reducing the power of comparisons across studies. Recent advances in the measurement of household water insecurity have facilitated important, international comparisons (Jepson et al., 2017). This study included a wide range of measures of self-reported physical health and human biological functioning. However, other important biomarkers such as *H. pylori* and endotoxin-core antibodies have not yet been analyzed. Finally, we did not assess water access or quality, which could yield insight into the most relevant stressors, infectious exposures, and environmental contaminants in this area. Future research will address these gaps.

5 | CONCLUSION

In conclusion, this analysis adds to the small but growing body of research examining the associations between water insecurity, perceived health, and objective measures of biological health in "water-abundant" areas. Biocultural anthropologists are well-positioned to continue probing these connections, and importantly, to connect their research to interventions to address this escalating problem in water-scarce and water-abundant areas.

AUTHOR CONTRIBUTIONS

Paula Skye Tallman: Conceptualization, Funding Acquisition, Project Administration, Methodology, Investigation, Resources, Writing, Supervision. Shalean Collins: Conceptualization, Formal Analysis, Writing, Visualization. M. Pia Chaparro: Writing, Visualization. Gabriela Salmon-Mulanovich: Conceptualization, Formal Analysis, Writing, Visualization.

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CONFLICT OF INTEREST

The authors have no conflicts of interest.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request. Data is accessible to any interested scholars by contacting Paula Tallman (paulaskyetallman@gmail.com).

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REFERENCES

Brewis, A., Choudhary, N., & Wutich, A. (2019). Low water access as a gendered physiological stressor: Blood pressure evidence from Nepal. *American Journal of Human Biology*, *31*(3), e23234. https://doi.org/10.1002/ajhb.23234

Coyle, E. (1998). Cardiovascular drift during prolonged exercise and the effects of dehydration. *International Journal of Sports Medicine*, *19*(2), S121–S124. https://doi.org/10.1055/s-2007-971975

Geere, J.-A. L., Cortobius, M., Geere, J. H., Hammer, C. C., & Hunter, P. R. (2018). Is water carriage associated with the water carrier's health? A systematic review of quantitative and qualitative evidence. *BMJ Global Health*, *3*(3), e000764. https://doi.org/10.1136/bmjgh-2018-000764

Hoke, M. K., McCabe, K. A., Miller, A. A., & McDade, T. W. (2018). Validation of endotoxin-core antibodies in dried blood spots as a measure of environmental enteropathy and intestinal permeability. *American Journal of Human Biology*, *30*(4), e23120. https://doi.org/10.1002/ajhb.23120

Jepson, W. E., Stoler, J., Baek, J., Morán Martínez, J., Uribe Salas, F. J., & Carrillo, G. (2021). Cross-sectional study to measure household water insecurity and its health outcomes in urban Mexico. *BMJ Open*, *11*(3), e040825. https://doi.org/10.1136/bmjopen-2020-040825

Jepson, W. E., Wutich, A., Colllins, S. M., Boateng, G. O., & Young, S. L. (2017). Progress in household water insecurity metrics: A cross-disciplinary approach. WIREs. *Water*, *4*(3), 1-21. https://doi.org/10.1002/wat2.1214

Rosinger, A. Y. (2018). Household water insecurity after a historic flood: Diarrhea and dehydration in the Bolivian Amazon. *Social Science & Medicine*, *197*, 192–202. https://doi.org/10.1016/j.socscimed.2017.12.016

Rosinger, A. Y., Bethancourt, H. J., Young, S. L., & Schultz, A. F. (2021). The embodiment of water insecurity: Injuries and chronic stress in lowland Bolivia. *Social Science & Medicine*, *291*, 114490. https://doi.org/10.1016/j.socscimed.2021.114490

15206300, 0, Downloaded from https://onlinelibrary.wiley.com/doi/10.1002/ajhb.23805 by Loyola University Chicago, Wiley Online Library on [17/11/2022]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

Rosinger, A. Y., & Young, S. L. (2020). The toll of household water insecurity on health and human biology: Current understandings and future directions. *WIREs Water*, *7*(6) 1-22. https://doi.org/10.1002/wat2.1468

Stevenson, E. G. J., Greene, L. E., Maes, K. C., Ambelu, A., Tesfaye, Y. A., Rheingans, R., & Hadley, C. (2012). Water insecurity in 3 dimensions: An anthropological perspective on water and women's psychosocial distress in Ethiopia. *Social Science & Medicine*, *75*(2), 392–400. https://doi.org/10.1016/j.socscimed.2012.03.022

Tallman, P. (2018). "Now we live for the money": Shifting markers of status, stress, and immune function in the Peruvian Amazon: STATUS, STRESS, AND IMMUNE FUNCTION IN THE AMAZON. *Ethos*, *46*(1), 134–157. https://doi.org/10.1111/etho.12189

Tallman, P. S. (2019). Water insecurity and mental health in the Amazon: Economic and ecological drivers of distress: Water insecurity and mental health in the Amazon. *Economic Anthropology*, *6*(2), 304–316. https://doi.org/10.1002/sea2.12144

Tallman, P.S., Collins, S., Salmon-Mulanovich, G., Rusyidi, B., Kothadia, A., Cole, S. (in press). Water Insecurity and Gender-based Violence: A Global Review of the Evidence. WIREs Water.

Torres-Slimming, P. A., Wright, C. J., Lancha, G., Carcamo, C. P., Garcia, P. J., Ford, J. D., IHACC Research Team IHACC Research Team, & Harper, S. L. (2020). Climatic changes, water systems, and adaptation challenges in Shawi communities in the Peruvian Amazon. *Sustainability*, *12*(8), 3422. https://doi.org/10.3390/su12083422

Wutich, A., Beresford, M., Montoya, T., Radonic, L., & Workman, C. (2022). Water security and scarcity. In E. A. Wutich, M. Beresford, T. Montoya, L. Radonic, & C. Workman (Eds.), *Oxford research encyclopedia of anthropology*. Oxford University Press. https://doi.org/10.1093/acrefore/9780190854584.013.475

Wutich, A., Brewis, A., & Tsai, A. (2020). Water and mental health. *WIREs Water*, *7*(5). https://doi.org/10.1002/wat2.1461

SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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