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Short Communication

Identifying ordinal categories for the Water Insecurity Experiences Scales

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ABSTRACT

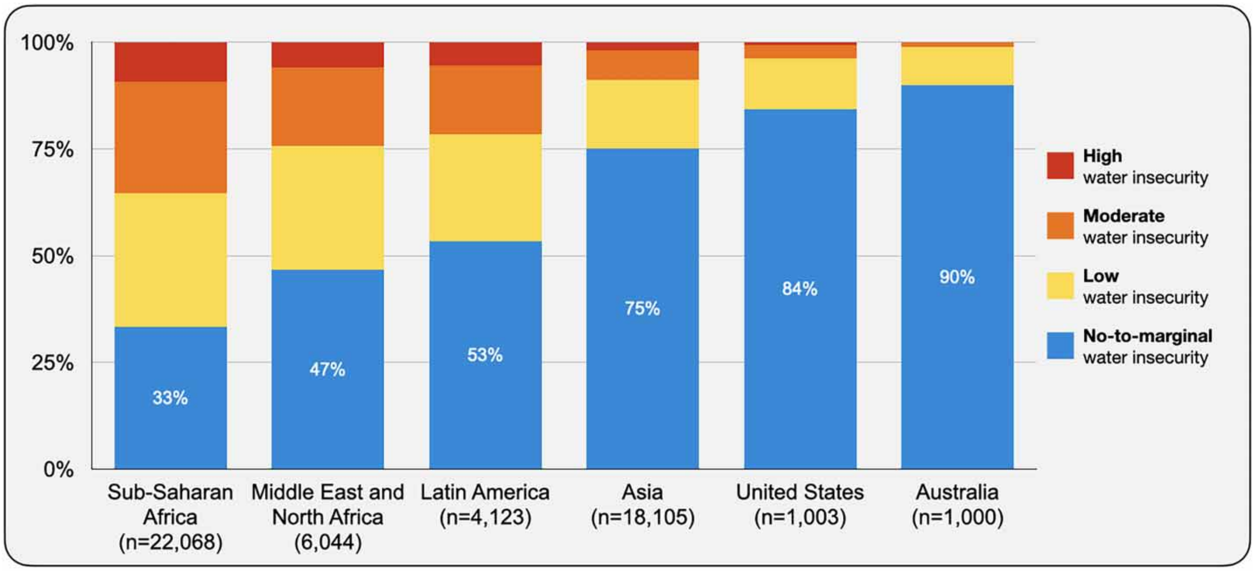
The Household Water Insecurity Experiences (HWISE) and Individual Water Insecurity Experiences (IWISE) Scales are globally suitable tools for comparably measuring water insecurity experiences among households and adults, respectively. The potential range for HWISE and IWISE scores is 0–36. When the WISE Scales were first published, scores of 12 and higher were considered indicative of water insecurity, but additional cut-points are needed to provide more nuanced insights. We therefore sought to develop a practical set of cut-points for the WISE Scales using HWISE data from 13 sites across 12 countries ($n = 3{,}293$) and nationally representative samples of IWISE data from 38 countries collected by the Gallup World Poll ($n = 52{,}343$). We selected cut-points in water insecurity scores to establish four ordinal categories: no-to-marginal (0–2), low (3–11), moderate (12–23), and high (24–36) water insecurity. These categories were monotonically associated with increasing odds of reporting water dissatisfaction and helped to differentiate the breadth of water insecurity across populations with heterogenous water insecurity experiences and frequencies. These four water insecurity categories can be used to better understand how water insecurity may be related to livelihoods, health, and well-being, both at low and high water insecurity.

Key words: indicators, scale development, validation, water security

HIGHLIGHTS

- The Water Insecurity Experiences (WISE) Scales have been used globally for research and policy.
- Water insecurity prevalence had been estimated dichotomously ($\geq$12, range 0–36).
- We established four ordinal categories that convey meaningful nuance in the range of WISE scores.
- Water insecurity categories are no-to-marginal (scores of 0–2), low (3–11), moderate (12–23), and high (24–36).

GRAPHICAL ABSTRACT



Cut-points for classifying ordinal categories of the Water Insecurity Experiences Scales can provide a greater understanding of water insecurity. Data from 52,343 individuals across 38 countries in Gallup World Poll 2020 and 2022.

INTRODUCTION

Issues with water scarcity, excess, and contamination are common globally (Mekonnen & Hoekstra 2016; Damania *et al.* 2019; Kulp & Strauss 2019). There has been growing interest in the quantification of lived experiences with water insecurity – the inability to stably access sufficient water for domestic uses (Jepson *et al.* 2017) – to better understand the scope and human consequences of these issues (e.g., Wutich 2009; Stevenson *et al.* 2012; Jepson 2014; Aihara *et al.* 2015; Tsai *et al.* 2016). The Household Water Insecurity Experiences Scales (HWISE) and Individual Water Insecurity Experiences (IWISE) Scales were developed in response to calls for globally suitable tools for comparably measuring water insecurity among households and adults, respectively (Young *et al.* 2019a, b; 2021).

The WISE Scales are composed of 12 similarly phrased questions that ask about life-disrupting water problems related to psychological well-being, daily living, food and water intake, and hygiene. Drawing on the work of Amartya Sen, water security was conceptualized as a capability similar to but distinct from food security (Wutich *et al.* 2017; Young *et al.* 2019a, b). The HWISE Scale queries experiences of household members (Supplementary material, Table S1), whereas the IWISE Scale is directed to adult respondents (Supplementary material, Table S2). The original validation studies used 4-week and 1-year recall periods, respectively, although some studies used alternative recall periods (e.g., Miller *et al.* 2023). For both scales, item responses – 'never' (scored 0), 'rarely' (1), 'sometimes' (2), and 'often' or 'always' (3) – are summed for a possible range of 0–36 (Young *et al.* 2019a, 2021). Scores of 12 and higher initially indicated water insecurity (Young *et al.* 2019a, 2021). This cut-point was sensitive to differences between groups known to have different water insecurity experiences and produced prevalence estimates of water insecurity that aligned with expert expectations for and understandings of each site.

Estimating the prevalence of water insecurity based on this cut-point has been useful for making comparisons across and within populations, and understanding the relationships between water insecurity and health outcomes (Miller *et al.* 2020; Rosinger *et al.* 2021; Ford *et al.* 2023; Young *et al.* 2023). Nevertheless, there is heterogeneity in experiences of water insecurity and their impacts on well-being among those below and above this cut-point. Additional cut-points may provide nuanced insights into the effects of low and high water insecurity. Some researchers have already created additional cut-points for this reason (Jepson *et al.* 2021; Ford *et al.* 2023); consistency in the selection and application of cut-points could facilitate comparability of findings. Consistency in cut-points has been useful for understanding and addressing food insecurity, a similar resource-based construct that is measured by asking people about their lived experiences.

As with food insecurity cut-points (Pérez-Escamilla 2012), ordinal categories that convey the range of the latent construct of water insecurity have potential to (1) clarify the *meaning* of the construct to the public (e.g., media, policymakers); (2) reveal *dose-response relationships* between water insecurity and outcomes like mental health, early childhood development, and physical health; (3) improve program *targeting*; and (4) improve program *evaluation*, all of which can lead to better governance. We sought to develop a practical set of cut-points for the WISE Scales to establish ordinal categories that convey the range of the latent construct of water insecurity and can be systematically used by researchers to enhance comparability of findings.

METHODS

Data collection

HWISE data were drawn from 13 sites across 12 countries in 2017–2018 (Table 1). Twelve sites were part of the original HWISE Scale development study that included all 12 items in the final HWISE Scale ($n = 3{,}490$). Data from Bangladesh,

Table 1 | Mean and median HWISE scores, percentage of households in water insecurity (WI) categories, and prevalence of dissatisfaction with one's household water situation, by site and in ascending order of mean HWISE score, among participants in the HWISE Scale development study

Site	N	Urbanicity	Sampling	Season	Mean HWISE score	Median HWISE score	No-to-marginal HWI: score 0–2 (%)	Low HWI: score 3–11 (%)	Moderate HWI: score 12–23 (%)	High HWI: score 24–36 (%)	Dissatisfied with water situation (%)
Pune, India	171	Urban	Non-random	Multiple	1.6	0	85.4	10.5	2.9	1.2	1.8
Morogoro, Tanzania	202	Urban, peri-urban	Cluster random	Rainy	3.7	3	46.0	49.0	3.5	1.5	39.6
Chiquimula, Guatemala	281	Rural	Systematic random	Dry	5.2	4	42.0	44.1	13.9	0.0	11.4
Sistan, Baluchestan, Iran	109	Urban, peri-urban, rural	Stratified random	Rainy	6.5	4	43.1	36.7	18.4	1.8	21.1
Dhaka, Chakaria, Bangladesh	473	Urban, rural	Cluster random	Rainy	6.9	4	36.6	45.5	11.2	6.8	42.1
Beirut, Lebanon	525	Urban	Cluster random	Rainy	7.2	6	31.6	43.8	22.1	2.5	65.9
Torreón, Mexico	239	Urban	Simple random	Dry	8.6	7	35.2	31.0	27.6	6.3	28.0
Gressier, Haiti	270	Peri-urban	Stratified random	Dry	9.8	8	31.5	30.0	29.3	9.3	52.2
Labuan Bajo, Indonesia	265	Urban	Cluster random	Dry	13.7	14	8.3	29.1	52.5	10.2	69.4
Rajasthan, India	182	Urban	Stratified random	Dry	14.0	15	5.0	36.8	46.7	11.5	48.4
San Borja, Bolivia	148	Rural	Simple random	Dry	17.9	19	2.7	21.0	52.0	24.3	81.0
Punjab, Pakistan	45	Rural, peri-urban	Cluster random	Dry	20.3	22	0.0	13.3	48.9	37.8	73.3
Cartagena, Colombia	214	Urban	Stratified random	Dry	20.8	21	2.3	8.4	51.9	37.4	78.9
Total	3,124				9.3	7	30.5	34.6	26.2	8.7	47.5

HWISE: Household Water Insecurity Experiences Scales; HWI: Household Water Insecurity.

collected in the Demographic and Health Surveys according to the scale development study protocol, were included ($n = 506$). Sites were selected through professional networks to maximize variation in climate, water infrastructure, and local water problems (Young *et al.* 2019a, b). Most sites recruited about 250 households and used simple random sampling, with two exceptions: purposive sampling in Singida, Tanzania and parallel assignment in Pune, India. Adults were eligible for participation if they reported being 'knowledgeable about their household's water situation.' Interviews were conducted in person by local study staff using paper- and tablet-based surveys. Surveys included information about sociodemographic characteristics and experiences with water problems in the prior 4 weeks. Households reported how satisfied they were with their water situation using a Likert scale, with 1 being not at all satisfied and 5 completely satisfied. Scores of 1 and 2 were considered to represent dissatisfaction.

IWISE data were collected in 38 countries by the Gallup World Poll (GWP) in 2020 (31 countries) and 2022 (7 countries) (Table 2). GWP administers surveys to national probability-based samples of civilian, non-institutionalized individuals aged $\geq$15 years; additional details are published elsewhere (Gallup Poll 2020; Young *et al.* 2021, 2022). About 1,000 individuals were surveyed per country, except for China ($n = 3,503$) and India ($n = 12,650$). In 31 countries (and one-third of the India sample), surveys were conducted by telephone using random-digit dialing with stratification by landline or mobile phone; further stratification by region for landline and by provider for mobile phone ensured that individuals from all regions with different mobile phone providers had a non-zero chance of being selected. In eight countries (and two-thirds of the India sample), surveys were conducted in person, with participants randomly selected using a multi-stage sampling procedure that included stratification by region and urbanicity. Post-stratified sampling weights were constructed by GWP to adjust for non-response and ensure estimates were nationally representative, including urban and rural areas, for the prior year. GWP also collected data on sociodemographic characteristics and whether respondents were 'satisfied' or 'dissatisfied' with local water quality. Only GWP data from 2020 were used for IWISE scale development.

All participants provided verbal or written informed consent. Study activities were reviewed and approved by the appropriate ethical review boards (Young *et al.* 2019a, b, 2021).

Cut-point selection and evaluation criteria

When the WISE Scales were first published, scores of 12 and higher were considered to be indicative of water insecurity (Young *et al.* 2019a, 2021). To provide further nuance, we sought to identify additional cut-points. After preliminary analyses examining different numbers and combinations of cut-points in each site, two additional cut-points (one lower and one higher than 12), for a total of four categories of water security, were deemed practically meaningful (Coates *et al.* 2007; Gaynes *et al.* 2018; Rabbitt *et al.* 2023), whereas five or more would not contribute further information and would have diminishing utility for policymakers. We used raw scores when selecting cut-points, as opposed to also considering which experiences had been affirmed, because water insecurity experiences do not manifest consistently across the range of the latent construct (i.e., the relative proportion of affirmation of each experience varies across sites) (Young *et al.* 2021). This diverges from food insecurity, for which experiences progress similarly across most contexts (Cafiero *et al.* 2018). We proposed cut-points for water insecurity theoretically based on our understanding of experiences of water insecurity from prior literature and history of developing measures to reflect this construct, and then we used the empirical data to evaluate whether these cut-points were suitable.

First, we reasoned that affirming two questionnaire items as 'rarely' or one item as 'sometimes' (i.e., a score of 2) indicated no-to-marginal water insecurity and affirming all items as 'sometimes' or half of the items as 'often' or 'always' (i.e., a score of 24) indicated high water insecurity. Therefore, we proposed these categories of water insecurity: scores of 0–2 (no-to-marginal), 3–11 (low), 12–23 (moderate), and 24–36 (high), examining the percentages of the population in each category.

Second, we compared the percentage of respondents who affirmed each water insecurity experience by water insecurity category for both HWISE and IWISE. These comparisons were aggregated across sites.

Third, to evaluate the ability of these proposed categories to differentiate the range of water insecurity, we examined how the categories covaried (e.g., had inflections in trend) with alternative indicators of water problems for which data were available. Although these alternative indicators of water problems assess only one aspect of experiential water insecurity, the availability of these indicators in the datasets provided a means to compare their occurrence across the proposed categories of water insecurity. With HWISE data, we assessed how the odds of reporting dissatisfaction with one's water situation differed by the four water insecurity categories and if trends across the categories differed by plausible effect modifiers, including household primary drinking water service level (UNICEF JMP & WHO 2023), urbanicity, and season of interview. With IWISE data, we assessed whether respondents' dissatisfaction with local water quality differed by the four water insecurity

Table 2 | Mean and median IWISE score, percentage of water insecurity categories, and prevalence of dissatisfaction in water quality by country in ascending order of mean IWISE score in nationally representative samples of individuals in the 2020 & 2022 Gallup World Poll ($n = 52,343$)

Country	N	Mean IWISE score	Median IWISE score	No-to-marginal IWI: score 0–2 (%)	Low IWI: score 3–11(%)	Moderate IWI: score 12–23(%)	High IWI: score 24–36(%)	Dissatisfied with water quality(%)
Countries with mean IWISE score <3								
Australia	1,000	0.8	0	90.0	9.0	1.0	0	10.7
United States	1,003	1.5	0	84.3	12.0	3.0	0.7	17.9
China	3,498	1.6	0	82.5	13.9	3.0	0.5	21.3
Indonesia	999	1.9	0	80.1	14.7	4.2	1.1	12.5
Bangladesh	1,009	2.5	0	85.9	4.7	5.2	4.2	14.0
Countries with mean IWISE score ≥ 3 and <6								
India	1,2599	4.3	0	64.5	20.2	11.7	3.5	16.6
Morocco	1,005	4.6	0	66.8	18.7	7.8	6.7	31.5
Brazil	1,003	4.6	2	58.8	25.1	12.8	3.3	22.5
Mauritius	998	4.9	2	50.7	33.0	14.8	1.5	16.4
Senegal	998	5.8	2	52.0	29.7	13.3	5.1	44.4
Countries with mean IWISE score ≥ 6 and <10								
Mali	981	6.0	3	47.5	30.0	19.6	3.0	39.7
Ghana	997	6.4	3	44.4	31.6	21.4	2.7	25.4
Palestine	999	6.4	3	45.4	30.9	19.4	4.3	32.1
Tunisia	1,004	6.7	4	42.7	34.4	18.2	4.7	61.4
Guatemala	1,145	7.1	4	43.4	32.4	17.3	6.9	23.8
Benin	1,013	7.1	5	39.8	34.7	21.0	4.5	36.0
South Africa	1,001	7.1	4	46.9	24.4	23.2	5.5	9.3
Guinea	1,002	7.2	5	39.1	33.1	23.8	4.0	41.9
Côte d'Ivoire	1,007	7.3	6	33.4	43.3	18.9	4.4	42.0
Egypt	1,001	7.6	4	42.4	30.3	20.9	6.4	36.5
Congo Brazzaville	1,000	7.9	6	36.4	33.3	25.0	5.2	49.3
Algeria	1,037	7.9	6	34.4	36.6	24.1	4.9	43.6
Nigeria	1,019	8.5	6	35.8	31.7	25.0	7.5	46.0
Togo	998	8.6	6	33.6	35.7	23.4	7.3	51.9
Uganda	992	8.7	7	29.8	37.7	26.2	6.2	38.4
Madagascar	990	8.9	5	38.1	30.2	20.1	11.7	48.6
Tanzania	1,000	9.8	6	38.1	24.3	23.8	13.8	35.2
Countries with mean IWISE score ≥ 10								
Burkina Faso	1,002	10.6	9	27.5	28.1	33.1	11.3	41.4
Gabon	1,023	10.9	9	27.1	30.5	29.8	12.6	70.1
Namibia	992	11.2	8	31.1	26.8	26.0	16.0	41.3
Ethiopia	1,022	11.2	10	20.5	34.5	34.0	10.9	46.9
Zimbabwe	1,003	11.6	10	23.9	31.4	30.4	14.2	53.6
Peru	989	11.6	10	27.6	24.2	32.1	16.1	36.7
Zambia	1,008	11.8	11	20.3	31.5	36.8	11.4	58.4
Afghanistan	998	12.0	10	17.5	36.2	31.8	14.4	58.9

(*Continued.*)

Table 2 | Continued

Country	N	Mean IWISE score	Median IWISE score	No-to-marginal IWI: score 0–2 (%)	Low IWI: score 3–11(%)	Moderate IWI: score 12–23(%)	High IWI: score 24–36(%)	Dissatisfied with water quality(%)
Honduras	986	12.0	11	20.8	32.0	31.2	16.1	29.4
Kenya	1,000	12.2	10	20.8	32.6	30.3	16.3	45.8
Cameroon	1,022	15.3	15	13.2	22.9	41.6	22.3	67.3

IWISE: Individual Water Insecurity Experiences Scales; IWI: Individual Water Insecurity.

categories within each country. We also did this within countries grouped in relation to their national burden of water insecurity, assessed with weighted national mean IWISE scores and prevalence of IWISE scores $\geq$12: (1) mean scores of $<$3 and $<$10% prevalence; (2) mean scores $\geq$3 to $<$6 and $\geq$10 to $<$20% prevalence; (3) mean scores $\geq$6 to $<$10 and $\geq$20 to $<$40% prevalence; and (4) mean scores $\geq$10 and $\geq$40% prevalence.

Household water insecurity analyses

Of the 3,996 respondents across 13 sites, 3,293 had complete HWISE data. Households with insufficient data to compute HWISE scores ($n = 703$) were excluded. We estimated the percentage of the population in each of the four water insecurity categories in each site. We then used logistic regression to estimate the predicted probability of reporting dissatisfaction with one's water situation by the four water insecurity categories, adjusting for site, specifying indicator variables for each of the three low, moderate, and high categories of water insecurity (compared with the reference category of no-to-marginal) and indicator variables for site. We tested for linear and quadratic trends (using orthogonal polynomials) in the relationship between categories and the predicted probability of dissatisfaction. Additionally, we stratified analyses by the Joint Monitoring Programme's drinking water service level (less than basic vs. at least basic) (24), urbanicity (urban vs. rural), and season of interview (dry, rainy, dry and rainy), to assess whether trends differed by plausible effect measure modifiers. Analyses were conducted using Stata (College Station, TX, v17 & v18).

Individual water insecurity analyses

Of the 52,560 respondents in 38 countries, 50,768 had complete IWISE Scale data. For those missing $\leq$3 IWISE responses ($n = 1,575$), we imputed missing IWISE responses from non-missing IWISE items using linear regression for each item within each country separately, yielding an analytical sample of 52,343, reasoning that individuals who had responded to $\geq$9 of the 12 items provided sufficient information to confidently and accurately impute the 1–3 missing items (Young *et al.* 2022). We examined the percentage of the population in each of the four water insecurity categories in each country and global region, accounting for design effects and using projection weights (post-stratified sampling weights multiplied by the average projected $>$15-year-old population size of each country across 2020–2022 determined by World Bank n.d.) to identify which countries and regions had sufficient numbers of individuals in the high category to warrant that additional category.

We tested how the odds of water quality dissatisfaction related to each category within each country using logistic regression models with post-stratified sampling weights. We used Stata's postestimation contrast command to test linear and quadratic trends between categories and the odds of dissatisfaction. We then used Stata's margins command to estimate predicted probabilities of water quality dissatisfaction in each category.

To test if the categories predicted different odds of water quality dissatisfaction across countries with varying water insecurity burdens, we grouped countries according to their mean IWISE scores and prevalence of IWISE scores $\geq$12. For each of these country groups (mean weighted IWISE scores of 3, $\geq$3 to $<$6, $\geq$6 to $<$10, and $\geq$10), we estimated the percentage of the population in each water insecurity category using projection weights. We then tested how the odds of water quality dissatisfaction related to each category in these country groups using logistic regression models with normalized sampling weights (post-stratified weights divided by the country's sample size so that each country was weighted equally regardless of population size), adjusting for country fixed effects, testing for linear and quadratic trends, and estimating marginal probabilities of water quality dissatisfaction in each water insecurity category.

RESULTS

Household water insecurity experiences

A greater percentage of households experienced no-to-marginal water insecurity (30.5%) or low water insecurity (34.6%) compared to the 26.2% and 8.7% that experienced moderate and high water insecurity, respectively (Table 1). The percentage affirming each household water insecurity experience in aggregate had a monotonic trend across the four water insecurity categories, with the median number of distinct experiences affirmed being 0, 4, 9, and 11, respectively (Supplementary material, Table S3). In aggregate, the predicted probability of being dissatisfied with one's water situation differed across each category of water insecurity, except between moderate and high water insecurity ($p = 0.467$; Supplementary material, Table S4). Furthermore, there was a positive linear trend between the predicted probability of being dissatisfied with one's water situation and each higher category of water insecurity ($p < 0.001$). Linear trends were similarly observed when disaggregating the data by drinking water service level (Figure 1). That is, the different water insecurity categories distinguished between odds of being dissatisfied with one's water situation by primary drinking water service level. The four water insecurity categories showed similar trends by household urbanicity (Supplementary material, Figure S1) and season of interview (Supplementary material, Figure S2).

Individual water insecurity experiences

Having all four water insecurity categories was important in countries with higher overall burdens of water insecurity (country mean IWISE scores $\geq$6), with an estimated 22.3% of adults (in Cameroon) having high water insecurity (Table 2; Figure 2). In contrast, in countries with lower mean IWISE scores (<3), few adults (and no one in Australia) were estimated to be in the high category. The addition of the low water insecurity category revealed that many adults in those countries affirmed multiple items or at least one item at the highest frequency (i.e., often or always), e.g., 12% of individuals in the US were categorized as having low water insecurity. The percentage affirming each individual water insecurity experience in aggregate showed a monotonic trend across the four water insecurity categories, with the median number of distinct experiences affirmed being 0, 4, 9, and 12, respectively (Supplementary material, Table S5).

There was a positive linear trend between the odds of water quality dissatisfaction and each higher category of water insecurity when examining trends within individual countries, except for the United States (Supplementary material, Figure S3). In Australia, there was a linear trend with the first three water insecurity categories (and no one in the high category). In five countries (Benin, Ethiopia, Madagascar, Uganda, and Egypt), there was no difference between those in the no-to-marginal and low water insecurity categories in the odds of water quality dissatisfaction. In 11 countries (Burkina Faso, Ghana, Guinea, Kenya, Namibia, Zambia, Afghanistan, India, Guatemala, Honduras, and Peru), there was a difference in the odds of water quality dissatisfaction between those with moderate versus high water insecurity.

When examining trends by the overall mean IWISE score in each country, the odds of water quality dissatisfaction differed between each water insecurity category in the countries with mean IWISE scores $\geq$6 (Figure 3). In the countries with mean IWISE scores <6, there was not a difference between those with moderate versus high water insecurity.

DISCUSSION

Four categories of experiential water insecurity performed well in conveying the range of water insecurity when compared with alternative indicators of water problems. In most countries and study sites, those in the low (3–11 score) water insecurity category had a higher odds of water quality dissatisfaction than those in the no-to-marginal (0–2 score) category, justifying the value of a low water insecurity category. In most countries and study sites, having four categories provided differentiation between moderate and high categories of water insecurity. The four categories performed well with both HWISE data and nationally representative IWISE data that were collected from sites that were geographically and hydrologically heterogeneous.

Ordinal categories conveying the range of water insecurity can help demonstrate how low water insecurity may be related to disruptions in life and health, as well as to understand where high water insecurity may have an even greater impact on well-being (Jepson *et al.* 2021; e.g., Bethancourt *et al.* 2022). Such categories can provide 'important specificity that can assist with improvements in the design, targeting, and evaluation of policies and programs' as was seen with additional categories of food insecurity (Pérez-Escamilla *et al.* 2020). Given the increasing attention paid to WISE data by policymakers (La Razón 2023; Marlan & Kennedy 2023; Melgar-Quiñonez *et al.* 2023; Nature Editorial Board 2023; Osorio 2023; Shamah-Levy *et al.*

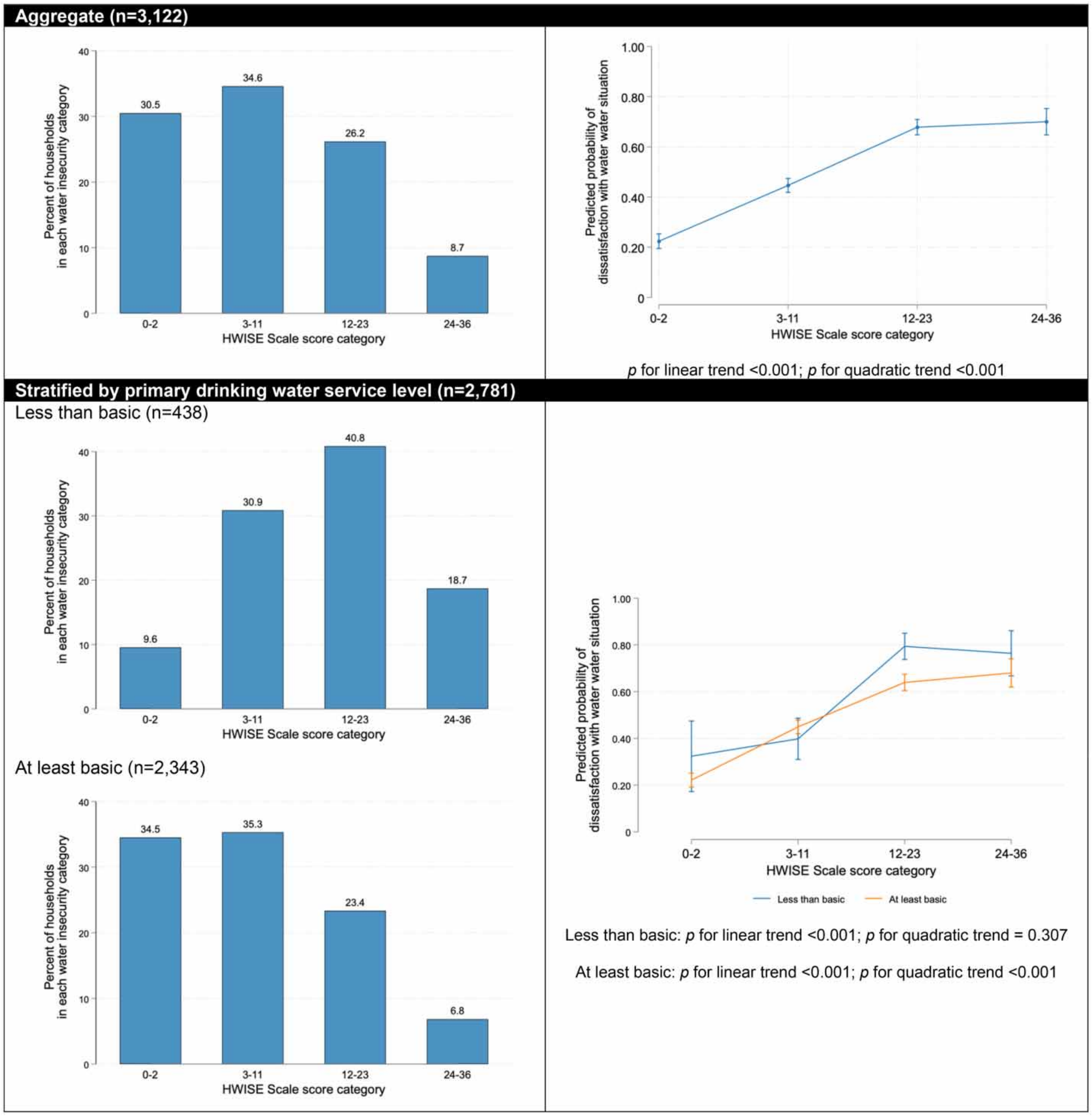


Figure 1 | Percentage of households within each HWISE water insecurity category and predicted probability of dissatisfaction with one's household water situation in relationship to each water insecurity category, in aggregate and by drinking water service level. Results from a logistic regression model adjusting for site.

2023), the ability to differentiate households or individuals across the range of water insecurity will be valuable, as has been for experiential measures of water insecurity (Jepson *et al.* 2021; Ford *et al.* 2023) and food insecurity (Pérez-Escamilla *et al.* 2020). Binary indicators such as being dissatisfied or satisfied with water quality are less suited to policy evaluation because they are insufficiently granular both in the measuring scale and in the sub-constructs of water insecurity.

This study made use of rigorously collected water insecurity data from large numbers of households and individuals across many sites and countries, and included data not used for scale development (HWISE data from Bangladesh, GWP 2022 data from seven countries). The cut-points chosen to establish the categories of water insecurity were based on judgment and empirical analyses comparing occurrence of alternative indicators of water problems across the categories. These alternative

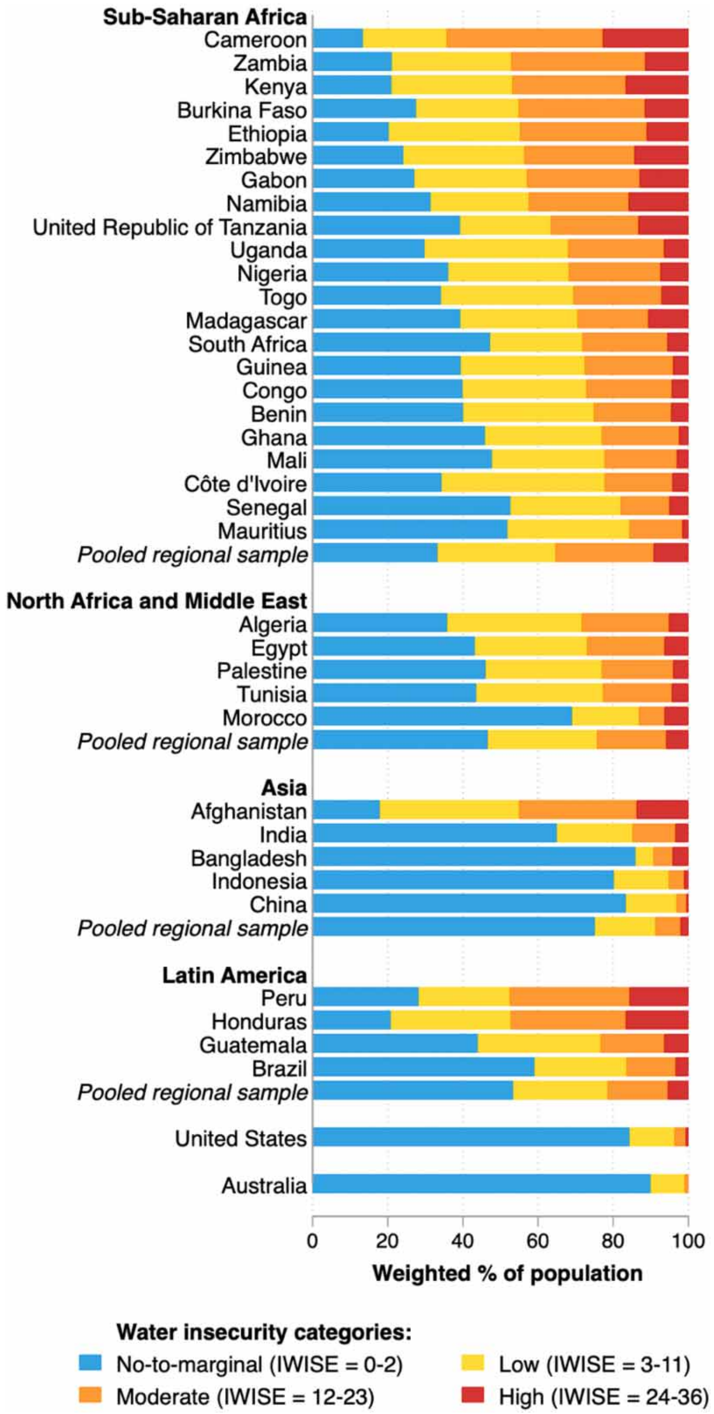


Figure 2 | Weighted prevalence of adults with IWISE scores in the 0–2, 3–11, 12–23, and 24–36 categories by country (in descending order by prevalence of IWISE scores $\geq$12) and region ($n = 38$ countries). Estimates obtained using projection weights so that they are representative of the average adult ($\geq$15 years) population in 2020–2022.

indicators were useful comparators despite reflecting only part of the construct of water insecurity. Further research assessing the relationship of measures or indicators such as dissatisfaction with water quality or the JMP Service Ladder to WISE sub-constructs would be useful; initial work supports that WISE Scales capture additional sub-constructs of water insecurity (Miller *et al.* 2020).

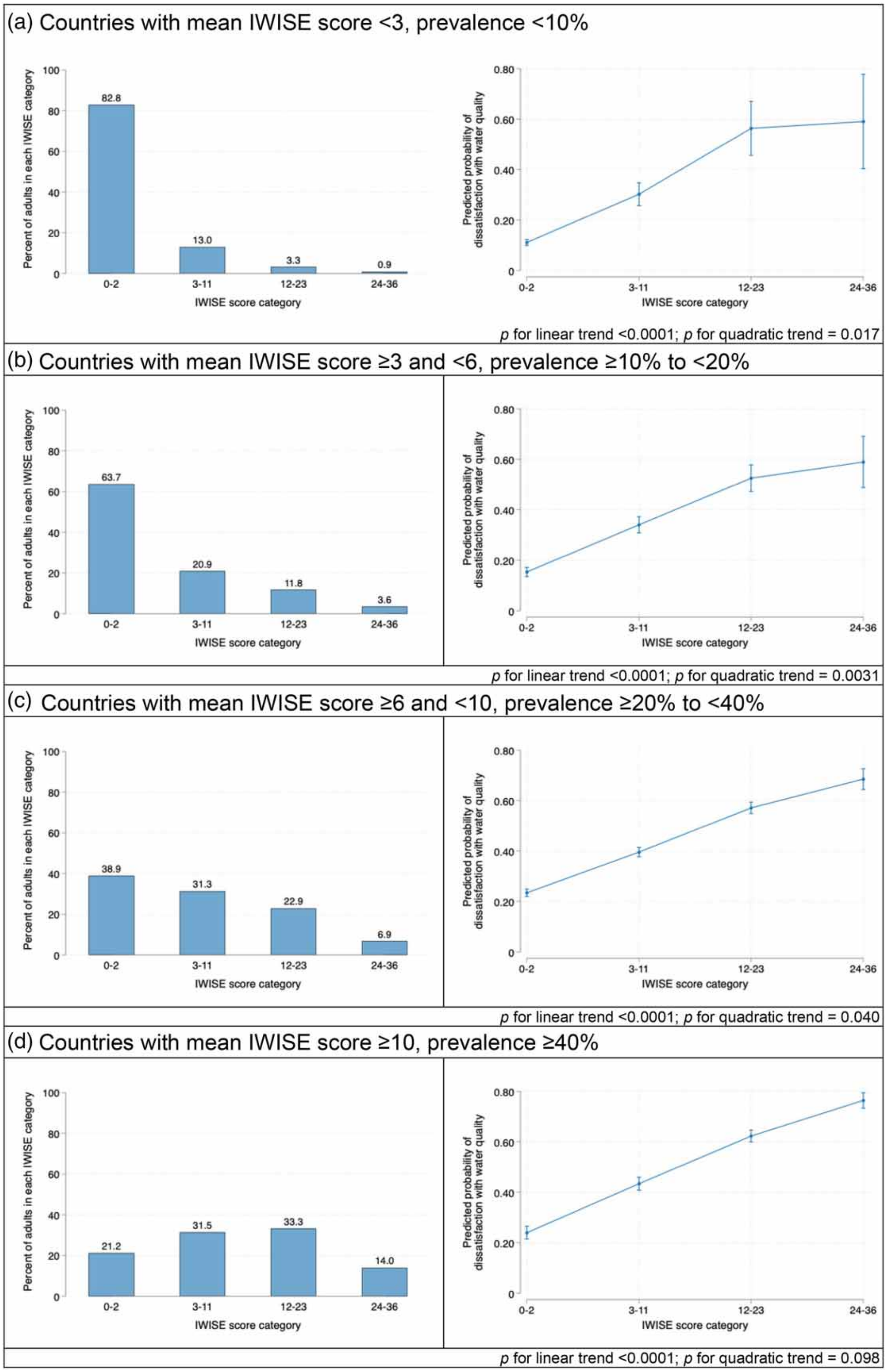


Figure 3 | Weighted distribution of individuals within each IWISE score category and predicted probability of water quality dissatisfaction in relationship to each IWISE score category for countries grouped in relation to mean IWISE scores and prevalence of IWISE score $\geq$12. (a) Countries with a mean IWISE score $<$3 were Australia, the United States, China, Indonesia, and Bangladesh. (b) Countries with a mean IWISE score $\geq$3 and $<$6 were India, Morocco, Brazil, Mauritius, and Senegal. (c) Countries with a mean IWISE score $\geq$6 and $<$10 were Mali, Ghana, Palestine, Tunisia, Guatemala, Benin, South Africa, Guinea, Côte d'Ivoire, Egypt, Congo Brazzaville, Algeria, Nigeria, Togo, Uganda, Madagascar, and Tanzania. (d) Countries with a mean IWISE score $\geq$10 were Burkina Faso, Gabon, Namibia, Ethiopia, Zimbabwe, Peru, Zambia, Afghanistan, Honduras, Kenya, and Cameroon.

There is no definitive method to establish cut-points; multiple alternative methods can be used depending on the characteristics of a scale and the purpose for its use (Frongillo *et al.* 2004). One potential alternative method involves selecting items that reflect different sub-constructs of the main construct. Future research on water insecurity should explore the potential of developing categories based on such theoretical constructions, as has been proposed for assessing energy access (Bhatia & Angelou 2015).

In summary, the selected cut-points for the 12-item WISE Scales establish ordinal levels that meaningfully convey the range of water insecurity. These four ordinal categories will be useful for describing the burden of household and individual water insecurity within populations and across time, helping to advance our understanding of water insecurity and its consequences.

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DATA AVAILABILITY STATEMENT

Data cannot be made publicly available; readers should contact the corresponding author for details.

CONFLICT OF INTEREST

The authors declare there is no conflict.

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