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Household water sources, drinking-water treatment and two-week diarrhoeal illness in Karangura Sub-County, Kabarole District, Uganda: a cross-sectional study with implications for safe water governance and public health

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Abstract

Background

Unsafe drinking water, inadequate sanitation and poor hygiene remain major drivers of preventable enteric disease. Rural households often use several water sources, so classification based on the presence of an improved source alone may conceal concurrent reliance on higher-risk sources and household-level water-safety gaps. We assessed household water-source portfolios, drinking-water treatment, sanitation and handwashing practices in Karangura Sub-County, western Uganda, and examined their association with recent household diarrhoeal illness.

Methods

We conducted a cross-sectional analysis of the 2025 Karangura Child Focused Community Transformation household baseline survey. Of 620 surveyed households, 618 had a valid response for the primary outcome, self-reported diarrhoea in any household member during the previous two weeks. Water-source categories were derived from the survey response options using WHO/UNICEF Joint Monitoring Programme source classifications. We distinguished households reporting any higher-risk source from those reporting improved-source categories only. Regular drinking-water treatment and regular handwashing were defined as “always” or “often”. Sanitation was conservatively classified as private/personal sanitation when households reported a flush toilet or personal pit latrine because the survey did not capture all Joint Monitoring Programme criteria for safely managed or improved sanitation. We estimated prevalence ratios using modified Poisson regression with village-clustered robust standard errors, adjusting for household size, presence of a child younger than five years, asset ownership and hill of residence.

Results

Among 618 households, 385 (62.3%) reported at least one improved-source category, but 450 (72.8%) also reported at least one higher-risk source; only 168 (27.2%) reported improved-source categories without a concurrent higher-risk source. Any drinking-water treatment was reported by 165 (26.7%) households and regular treatment by 147 (23.8%). Private/personal sanitation was reported by 533 (86.2%) households and regular handwashing with soap by 305 (49.4%). Eighty-six households (13.9%) reported diarrhoea in at least one member during the previous two weeks. Diarrhoea prevalence was 6.1% among households reporting regular water treatment compared with 16.3% among those without regular treatment. In the adjusted model, regular water treatment was associated with lower diarrhoea prevalence (adjusted prevalence ratio [aPR] 0.48, 95% CI 0.30–0.77; p = 0.002). The presence of a child younger than five years was associated with higher household diarrhoea prevalence (aPR 2.09, 95% CI 1.30–3.38; p = 0.003). Higher-risk source use, private/personal sanitation and regular handwashing were not independently associated with the outcome after adjustment.

Conclusions

Karangura households frequently combined improved-source categories with higher-risk water sources, while regular household water treatment and handwashing remained limited. Regular water treatment was associated with substantially lower two-week household diarrhoea prevalence. Local water governance should therefore move beyond infrastructure counts toward water-safety management across all sources households use, reliable access, household treatment, safe handling, hygiene promotion and routine water-quality surveillance. Longitudinal studies with microbial water testing are needed to assess causality and identify the highest-risk points in the household water chain.

Background

Diarrhoeal disease remains a substantial public-health problem, particularly in low- and middle-income countries. The World Health Organization (WHO) describes diarrhoea as a major cause of preventable morbidity and mortality and estimates nearly 1.7 billion childhood episodes each year. A large share of diarrhoeal disease is transmitted through faecally contaminated water and food or through person-to-person pathways that poor sanitation and hygiene amplify [1]. The global WASH burden also remains large. WHO estimates that microbiologically contaminated drinking water causes approximately 505,000 diarrhoeal deaths annually, while unsafe drinking water, sanitation and hygiene together account for a considerable avoidable disease burden [2, 3].

Progress in service coverage has not eliminated the problem. The WHO/UNICEF Joint Monitoring Programme (JMP) reports that 2.1 billion people still lacked safely managed drinking-water services in 2024, with inequalities increasingly concentrated in low-income countries and underserved population groups [4]. The distinction between an “improved” source and safe water is important. Improved source type is a service proxy, not a direct measurement of microbial safety. Contamination can occur at the source, during transport, in household storage, or during handling. WHO therefore frames drinking-water safety as a chain requiring safe sources, adequate treatment, protection during distribution and safe household storage and use [2].

Drinking-water interventions are relevant to diarrhoea prevention. Meta-analyses have consistently found protective effects for several household and point-of-use water-quality interventions, although effect sizes differ by intervention type, setting, adherence and study design [5–8]. In the 2022 systematic review by Wolf and colleagues, point-of-use filtration, solar disinfection and chlorination were associated with reductions in childhood diarrhoea in low- and middle-income settings [5]. Earlier systematic reviews also identified benefits from household water-quality improvement and handwashing with soap [6–9]. These findings support attention to behaviours that determine the microbiological quality of water at the point of consumption rather than relying solely on source category.

Uganda has made progress in WASH services, yet diarrhoeal illness remains important. The 2022 Uganda Demographic and Health Survey provides national evidence on drinking-water, sanitation,

hygiene and child health indicators [10]. Studies within Uganda show substantial geographical heterogeneity in diarrhoea and WASH conditions. Analysis of the 2011 Uganda Demographic and Health Survey found geographic clustering of high-risk WASH practices and child diarrhoea, with weak associations for individual WASH indicators but stronger associations for a composite WASH resource measure [11]. A later analysis of the 2016 Uganda Demographic and Health Survey also identified sociodemographic and environmental factors associated with diarrhoeal illness among children younger than five years [12]. In Lira City, a 2024 community study reported that lack of household water treatment was associated with childhood diarrhoea [13]. A large rural Ugandan household study further demonstrated that diarrhoea clusters within households and that cases in other household members strongly predict illness among young children, underlining the value of examining household-level transmission and household-wide prevention [14].

Water governance adds a service-delivery dimension to these epidemiological relationships. Governance concerns who plans, finances, manages, monitors and maintains water services, how communities participate in decisions, how quality and continuity are regulated, and whether services remain equitable and reliable. In Uganda, research on sustainable sanitation has highlighted links between governance deficits, service delivery, affordability, infrastructure and sanitation outcomes [15]. Recent work published within the BMC Public Health collection on water governance and sanitation also illustrates the value of combining WASH infrastructure information with water-quality evidence rather than treating service categories as direct measures of exposure [16].

Karangura Sub-County in Kabarole District is a rural setting in western Uganda. The Child Focused Community Transformation (CFCT) baseline survey was designed to assess household socioeconomic conditions, health-care access, disaster resilience and related community needs to guide a five-year development programme. The household instrument included detailed information on available water sources, drinking-water treatment, sanitation, handwashing and recent illness. This created an opportunity to examine the coexistence of different water-source types and household WASH practices in relation to recent diarrhoeal illness.

This study had four objectives: (1) to describe household water-source portfolios, drinking-water treatment, sanitation and handwashing practices; (2) to estimate the prevalence of self-reported household diarrhoeal illness during the previous two weeks; (3) to assess associations between selected household WASH conditions and recent diarrhoeal illness; and (4) to identify implications for safe water governance and public-health action in rural Karangura.

Methods

Study design and reporting

This study is a cross-sectional secondary analysis of household data collected during the 2025 Karangura Child Focused Community Transformation (CFCT) project baseline survey. Household

interviews in the analytical dataset were conducted from 31 March to 22 April 2025. The present analysis used existing de-identified baseline data and involved no new participant recruitment, contact or data collection. The study is reported in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) recommendations [17].

Study setting

Karangura Sub-County is located in Kabarole District in western Uganda. The baseline sampling frame covered five local hills: Buhamia, Mahyoro, Kibagha, Nyarukamba and Karangura. The parent survey estimated approximately 3,492 households across these areas and allocated the household sample proportionally across the five hills. Household interviews in the analytic dataset were recorded from 31 March through 22 April 2025.

Study population, sampling and sample size

The parent baseline protocol specified a multistage household sampling approach with geographic clustering and proportional allocation. The planned household sample was 620, incorporating finite-population correction and a non-response allowance. The household workbook contained 620 completed household records. The primary outcome had 618 valid yes/no responses; two responses coded “prefer not to say” were excluded from outcome analyses. Therefore, the descriptive and bivariate analytic denominator was 618 households. The multivariable model included 616 households because two records lacked usable geographic cluster information.

Data collection and quality assurance

Trained research assistants administered a structured digital household questionnaire developed specifically for the 2025 Karangura Child Focused Community Transformation (CFCT) baseline survey. The questionnaire was developed to capture the information required for programme planning, monitoring and evaluation, including household demographics, socioeconomic conditions, health outcomes, water and sanitation conditions, hygiene behaviours and other CFCT thematic indicators. During the baseline inception process, the instrument was reviewed and finalised, digitised using Open Data Kit (ODK), and tested for clarity, question flow, skip logic and language before field deployment. An English-language version of the household questionnaire is provided as Additional file 1.

The baseline protocol specified ODK-based mobile data collection, programmed skip logic and validation checks, daily upload where connectivity allowed, and supervisor review of submitted records. The present analysis used only de-identified household-level fields and linked household-roster counts required for the prespecified covariates.

Primary outcome

The primary outcome was recent household diarrhoeal illness. Respondents were asked whether any member of the household had experienced diarrhoea during the previous two weeks. Responses were coded yes or no. This outcome measures whether a household had at least one recent case, rather than individual-level incidence. The two-week recall period is consistent with common household survey approaches for recent diarrhoeal morbidity, but the outcome was based on respondent report and was not microbiologically confirmed.

Water, sanitation and hygiene exposures

Households selected all primary water sources available to them from a list that included household connections, yard taps, public standposts, boreholes, protected springs or wells, unprotected springs or wells, public hand-dug wells, rainwater harvesting, rivers/lakes/streams/swamps, valley dams or tanks, gravity-fed supplies and vendors. We classified house connections, yard taps, public standposts, boreholes, protected springs/wells, rainwater harvesting and gravity-fed supplies as improved-source categories, broadly following JMP source-type definitions [4]. Unprotected springs/wells, public hand-dug wells, surface water, valley dams/tanks and vendor-supplied water were classified as higher-risk categories for this analysis. Because households selected multiple sources, “any improved source” and “any higher-risk source” were not mutually exclusive. We therefore also derived “improved-source category only”, meaning that the household reported at least one improved-source category and no higher-risk source.

Drinking-water treatment was measured in two ways. “Any treatment” indicated that the household reported treating drinking water to make it safe. Among those reporting treatment, frequency options were always, often, sometimes or rarely. “Regular treatment” was defined as always or often. The questionnaire did not capture the specific treatment technology, such as boiling, chlorination or filtration, so the analysis did not distinguish between treatment methods.

Sanitation response options were flush toilet, personal pit latrine, shared pit latrine, digging and burying faeces, casting/dumping, other, or no facility. We deliberately avoided labelling flush toilets and personal pit latrines as “improved sanitation” because the questionnaire did not document all JMP requirements, such as slab type, safe containment or excreta management. Instead, the analysis used the descriptive category “private/personal sanitation facility”, defined as a flush toilet or personal pit latrine. All remaining responses formed the comparison category.

Handwashing was assessed by reported frequency of handwashing with soap and water. “Regular handwashing” was defined as always or often, while sometimes, rarely and never were grouped as non-regular. This measure reflects reported behaviour rather than direct observation of a handwashing station, water and soap at the time of interview.

Covariates

Potential confounders and precision variables were selected on substantive grounds and data availability. Household size came from the linked household roster. Presence of a child younger than five years was included because young children experience a high burden of diarrhoeal disease and their presence changes the probability that a household reports any case. A simple household asset count summed ownership of 11 quality-of-life assets recorded in the questionnaire. Hill of residence was included as a fixed geographic adjustment. The regression variance estimator was clustered by village to account for within-village correlation arising from the geographic sampling structure.

Statistical analysis

We summarized binary indicators using counts and percentages and continuous variables using means and standard deviations. We calculated recent diarrhoea prevalence within categories of each WASH exposure. Fisher exact tests were used for two-by-two comparisons because some cells were small. Crude prevalence ratios (PRs) were estimated with separate Poisson regression models using a log link and robust variance estimation. The multivariable model used modified Poisson regression to estimate adjusted prevalence ratios directly [18], with sandwich standard errors clustered at village level, an approach suitable for correlated binary observations [19]. The adjusted model included any higher-risk water source, regular drinking-water treatment, private/personal sanitation, regular handwashing with soap, household size, presence of a child younger than five years, asset count and hill of residence. Results are presented as PRs or aPRs with 95% confidence intervals (CIs) and two-sided p values. Statistical significance was assessed at $p < 0.05$. Complete-case analysis was used; outcome missingness was 0.3% (2/620).

Use of generative artificial intelligence during manuscript preparation

During manuscript preparation, artificial intelligence was not used. The analytical definitions and statistical outputs were derived from the study data, and the authors remain responsible for verifying the analysis, interpretation, citations and final manuscript.

Results

Household characteristics and analytic sample

Of 620 household records, 618 (99.7%) had a valid response to the two-week household diarrhoea question. Respondents had a mean age of 39.2 years (SD 15.0), and 368 (59.5%) were female. Mean household size was 4.0 members (SD 1.8). A child younger than five years was present in 387 households (62.6%). The average asset count was 2.6 of 11 recorded assets. The analytic households were distributed across Karangura, Mahyoro, Buhamia, Nyarukamba and Kibagha hills.

Water-source portfolios and household WASH conditions

Water-source use was heterogeneous and frequently involved more than one source category. Among the 618 analytic households, 385 (62.3%) reported at least one improved-source category and 450 (72.8%) reported at least one higher-risk source. Only 168 (27.2%) reported improved-source categories without a concurrent higher-risk source. These overlapping percentages are important: the presence of an improved-source category did not mean that a household relied exclusively on it.

Household water treatment was uncommon. One hundred sixty-five households (26.7%) reported treating their drinking water at all, while 147 (23.8%) reported doing so always or often. Most households, 533 (86.2%), reported either a flush toilet or personal pit latrine, which we classified as a private/personal sanitation facility. Regular handwashing with soap and water was reported by 305 households (49.4%). Figure 1 summarizes these WASH conditions.

Prevalence of recent household diarrhoeal illness

Eighty-six of 618 households reported diarrhoea in at least one member during the previous two weeks, giving a household-level period prevalence of 13.9% (95% CI not survey-weighted), with diarrhoea prevalence by regular water treatment and handwashing shown in Fig. 2. Because the outcome refers to any member of the household, it should not be interpreted as an individual diarrhoea prevalence. Households with a child younger than five years had higher prevalence in adjusted analysis, supporting the importance of household composition when interpreting this outcome.

Bivariate associations between WASH practices and diarrhoea

Recent diarrhoea prevalence was similar in households reporting any higher-risk water source (14.0%) and those without one (13.7%; crude PR 1.02, 95% CI 0.66–1.59). In contrast, households reporting any drinking-water treatment had a lower prevalence than households reporting no treatment (7.9% versus 16.1%; crude PR 0.49, 95% CI 0.28–0.86). The association was stronger for regular treatment: 6.1% versus 16.3% (crude PR 0.37, 95% CI 0.19–0.73).

Regular handwashing with soap was also associated with lower diarrhoea prevalence in the unadjusted analysis: 10.5% among regular handwashing households compared with 17.3% among households reporting sometimes, rarely or never (crude PR 0.61, 95% CI 0.40–0.91). Private/personal sanitation was not associated with lower diarrhoea prevalence in the crude analysis. This unexpected direction should be interpreted in light of the limited sanitation detail in the questionnaire, residual confounding and the possibility that source or facility category does not capture actual condition, cleanliness, sharing patterns, containment or environmental contamination.

Multivariable modified Poisson regression

The adjusted model included 616 households and used village-clustered standard errors. Regular drinking-water treatment remained associated with lower two-week household diarrhoea prevalence after adjustment (aPR 0.48, 95% CI 0.30–0.77; p = 0.002). This estimate corresponds to approximately 52% lower prevalence among households reporting treatment always or often, conditional on the covariates in the model. Presence of at least one child younger than five years was associated with higher household diarrhoea prevalence (aPR 2.09, 95% CI 1.30–3.38; p = 0.003).

Any higher-risk water-source use was not independently associated with the outcome (aPR 1.04, 95% CI 0.58–1.87; p = 0.900). The adjusted estimate for regular handwashing was protective in direction but imprecise (aPR 0.71, 95% CI 0.42–1.18; p = 0.184). Private/personal sanitation showed an aPR of 1.98 (95% CI 0.99–3.98; p = 0.054), a result that should not be interpreted as evidence that sanitation increases diarrhoea risk because the exposure definition was coarse and likely subject to uncontrolled differences in facility quality, environment and household characteristics. Household size, asset count and hill were not independently associated with the outcome at $p < 0.05$. Figure 3 presents the principal adjusted estimates.

Discussion

Principal findings

This rural household study identified three findings with direct relevance to water safety and public health. First, source portfolios were mixed: almost three quarters of households reported at least one higher-risk source even though more than three fifths also reported an improved-source category. Second, routine protective behaviours were limited, with fewer than one quarter of households reporting regular drinking-water treatment and about half reporting regular handwashing with soap. Third, regular drinking-water treatment was associated with substantially lower recent household diarrhoea prevalence after adjustment for household composition, assets, geography and other WASH indicators.

The overlap between improved and higher-risk sources is important for interpreting infrastructure-based coverage indicators. A household with access to a borehole, protected spring or piped source might still collect water from an unprotected spring, surface source, valley tank or vendor depending on distance, reliability, queue time, cost, season, taste or household demand. A binary “improved source” indicator therefore risks overstating the protection a household receives when the household alternates among sources. The JMP service ladders remain essential for population monitoring [4], but local governance requires information on all sources actually used, their reliability and their measured water quality.

Drinking-water treatment and diarrhoeal illness

The protective association observed for regular treatment is consistent with a substantial body of intervention evidence. Wolf and colleagues’ 2022 systematic review found reductions in childhood diarrhoea across several point-of-use water treatment approaches, including filtration, solar treatment and chlorination, although effectiveness varied by technology, intervention delivery and setting [5]. The

2018 meta-analysis similarly reported protective effects for water-quality interventions and emphasized the stronger performance of higher-quality, continuously available water services [6]. Earlier systematic reviews by Clasen and colleagues and Fewtrell and colleagues also support the role of drinking-water quality improvement in diarrhoea prevention [7, 8].

Ugandan evidence points in the same direction in some settings. In Lira City, Auma and colleagues reported that not treating household water was associated with higher odds of diarrhoea among children younger than five years [13]. Our outcome differs because it captures any household member, yet the direction of association is concordant. The result also has biological plausibility because water contaminated with faecal pathogens transmits bacterial, viral and parasitic enteric infections [1, 2].

The association should still be interpreted cautiously. The study is cross-sectional, so temporal ordering between routine treatment behaviour and the two-week illness outcome is not guaranteed. Treatment was self-reported, and the survey did not identify the treatment method, dose, contact time, filter performance or consistency for each drinking event. Households with stronger health awareness or other unmeasured protective behaviours may have been more likely to treat water. For these reasons, the aPR should not be presented as a causal effect estimate. It is best interpreted as evidence that regular treatment behaviour identifies a lower-risk household water-safety pattern worthy of prospective evaluation.

Water-source classification and the absence of an independent source association

Any higher-risk source use was not associated with diarrhoea after adjustment. This does not establish equivalence between sources. Similar complexity has been reported in Uganda. Hirai and colleagues found that individual high-risk WASH practices were not consistently associated with child diarrhoea in national survey data, although broader WASH resource patterns were associated with risk [11]. Shaaban and colleagues found that within-household diarrhoeal cases strongly predicted diarrhoea among young children and that these transmission dynamics changed the apparent contribution of WASH variables [14]. These studies show why a single source-type indicator often fails to represent the full faecal-oral transmission system.

Several measurement issues also matter. Source classifications describe infrastructure but not microbial quality at the time of use. Protected sources may become contaminated through poor maintenance, damaged drainage, animal access, flooding or unsafe collection and storage. Conversely, some nominally higher-risk sources might have lower measured contamination at a specific time. The current BMC Public Health Collection already includes work linking infrastructure information with groundwater quality, illustrating the added value of direct environmental measurement [16]. A future Karangura study should therefore pair household source histories with E. coli or thermotolerant coliform testing at source and point of consumption.

Handwashing and sanitation

Regular handwashing was associated with lower diarrhoea prevalence before adjustment, but the adjusted CI included the null. The direction is compatible with established evidence. The classic systematic review by Curtis and Cairncross estimated a substantial reduction in diarrhoeal risk associated with handwashing with soap [9], and later meta-analyses also support handwashing interventions [5, 6]. The attenuation in our adjusted model might reflect confounding, exposure misclassification, limited statistical power, or the difference between reported frequency and observed access to a functioning handwashing station with soap and water.

The sanitation result deserves particular caution. The survey recorded broad facility types but did not capture slab characteristics, excreta containment, emptying practices, environmental leakage or all conditions needed to assign JMP improved or safely managed service categories. We therefore used the narrower label private/personal sanitation rather than “improved sanitation”. The adjusted association pointed toward higher diarrhoea prevalence among households in this category but did not meet the conventional $p < 0.05$ threshold. This finding should not drive policy and does not contradict the wider evidence that safe sanitation reduces enteric-disease transmission [5, 6]. It instead highlights the limits of facility labels when sanitation quality and environmental contamination are not measured.

Household composition and transmission

Households containing a child younger than five years had approximately twice the prevalence of reporting at least one diarrhoeal case. This association is expected because young children carry a high burden of diarrhoeal morbidity and because the household-level outcome becomes more likely as susceptible members are present. It also aligns with evidence of household clustering of diarrhoea in rural Uganda [14]. Future analyses should distinguish individual child outcomes from household occurrence and should account for transmission among household members. The linked Karangura roster and child-health modules provide a basis for a separate child-focused analysis after resolving inconsistencies in the six-month child diarrhoea module.

Implications for water governance and public-health action

The findings support a practical shift from counting infrastructure toward managing household water safety across the full service chain. For Karangura, this means mapping every routinely used source, recording seasonal switching, monitoring functionality and downtime, testing microbial quality, and linking household reports to source-level identifiers. Such an approach would show whether households turn to higher-risk alternatives because the preferred source fails, becomes congested, dries up or is unaffordable. These are governance questions because they concern maintenance, accountability, financing, service continuity and community participation, not only household behaviour.

Household water treatment also needs a service system around it. Health and WASH teams should identify treatment methods acceptable to households, verify correct use, address recurring costs and supply availability, and integrate safe storage and handling messages. Behaviour-change activities should emphasize treatment continuity rather than occasional treatment, because the analysis found the

strongest association for households reporting treatment always or often. Community health workers, water-user structures, local leaders and health facilities offer channels for reinforcement, while district surveillance can track treatment uptake and diarrhoeal trends.

Handwashing promotion should combine messages with reliable access to water and soap at critical times. Sanitation programming should assess facility quality, sharing, containment and faecal-sludge management rather than relying on ownership alone. These actions align with the broader SDG 6 objective of safe and equitable water and sanitation services and with the Collection's focus on public-health impacts, community initiatives and sustainable water-resource management [4, 15].

Strengths and limitations

The study has several strengths. It analyzed a large rural household sample with broad geographic coverage across five hills. The instrument captured multiple water sources rather than forcing a single source response, which exposed the coexistence of improved and higher-risk sources. The primary outcome used a short two-week recall window. The regression estimated prevalence ratios, which are easier to interpret than odds ratios when outcomes are not rare, and accounted for geographic clustering at village level.

Several limitations constrain interpretation. First, the cross-sectional design prevents causal inference and establishes association only. Second, both WASH practices and diarrhoeal illness were self-reported and therefore vulnerable to recall, reporting and social-desirability bias. Third, the household outcome did not record which member experienced the two-week episode, severity, pathogen or clinical confirmation. Fourth, source categories were not supported by microbial water testing, source functionality or measures of household storage and handling. Fifth, the sanitation item lacked enough technical detail for strict JMP improved/safely managed classification. Sixth, reported treatment frequency did not identify the treatment method or verify correct implementation. Seventh, residual confounding is possible despite adjustment. Finally, the survey was conducted over a short period from late March to late April, so the findings do not capture seasonal changes in source availability, contamination or diarrhoeal risk.

Conclusions

Household water safety in Karangura cannot be understood from access to an improved-source category alone. Many households reported both improved and higher-risk sources, suggesting routine source switching or mixed-source use. Regular drinking-water treatment was uncommon but was associated with lower prevalence of household diarrhoeal illness during the previous two weeks. Regular handwashing was also protective in unadjusted analysis, while source category and broad sanitation type did not show independent protective associations after adjustment.

Local WASH planning should combine reliable safe-source access with household treatment, safe handling, handwashing, sanitation-quality assessment and source-level water-quality surveillance.

Longitudinal monitoring linked to permanent water-point identifiers would help determine when and why households shift to riskier sources and whether improvements in source reliability and household water safety reduce diarrhoeal illness over time.

Abbreviations

aPR
adjusted prevalence ratio
CFCT
Child Focused Community Transformation
CI
confidence interval
IDI
International Development Institute
JMP
WHO/UNICEF Joint Monitoring Programme for Water Supply, Sanitation and Hygiene
ODK
Open Data Kit
PR
prevalence ratio
SDG
Sustainable Development Goal
STROBE
Strengthening the Reporting of Observational Studies in Epidemiology
WASH
water, sanitation and hygiene
WHO
World Health Organization

Declarations

Ethics approval and consent to participate

This manuscript reports a secondary analysis of de-identified household data collected from 31 March to 22 April 2025 during the Karangura Child Focused Community Transformation project baseline. The baseline survey involved household-level human participant data and was conducted as a project monitoring and evaluation activity under an established protocol. The requirement for formal ethical approval for the present secondary analysis was waived by the Makerere University School of Public Health Research and Ethics Committee (MakSPH-REC), reference number SPH-2025-907. All participating households provided voluntary informed consent before the baseline interviews. No new data were collected, and there was no participant contact for the present secondary analysis. The

baseline procedures and the present secondary analysis were conducted in accordance with relevant ethical guidelines and regulations, including the ethical principles of the Declaration of Helsinki.

Consent for publication

Not applicable. This manuscript reports aggregate, de-identified household data and contains no identifiable individual information, images or case details.

Competing interests

The authors declare that they have no competing interests.

Authors' information

The team comprises professionals with expertise in public health, epidemiology, child health, monitoring and evaluation, district health services, programme implementation and community-based health programming in Uganda. This multidisciplinary expertise informed the interpretation of the findings from epidemiological, WASH, health-system and public-health perspectives.

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Author Contribution

SCO conceptualized the manuscript, led the parent baseline methodology and project coordination, curated the analytic data, led the statistical analysis and visualization, and prepared the original manuscript draft. IRO contributed to methodological refinement, interpretation of the findings, and critical review and editing of the manuscript. HS , GN and RA contributed to epidemiological methodology, interpretation of public-health findings and critical manuscript revision. RJO contributed child-health and diarrhoeal-disease interpretation and critical revision. CKa contributed literature synthesis, public-health interpretation and critical revision. ML contributed contextual interpretation and critical revision. DB contributed parent-study implementation, data-quality oversight and critical revision. MM contributed local health-system context, field implementation interpretation and critical revision. MH contributed methodological and health-system interpretation, supervision and critical revision. BK, CKe, AT and SK contributed local programme and district-health interpretation, field-context validation and critical revision. All authors are expected to review and approve the final submitted manuscript and accept accountability for their contributions. Initials: SCO, Stephen Charles Olet; IRO, Ivan Ronald Omara; HS, Henry Sendikadiwa; GN, George Ndagijimana; RJO, Richard Justin Odong; CKa, Cynthia Katusiime;

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Data Availability

The de-identified analytic data and analysis code underlying this manuscript are available from the corresponding author on reasonable request, subject to approval by the data custodian and applicable ethical, confidentiality and institutional data-sharing requirements.

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Tables

Table 1. Household characteristics and WASH conditions among households with valid recent diarrhoea data (N=618)

Characteristic	n	%
Female respondent	368	59.5
Respondent age, mean (SD), years	39.2 (15.0)	
Household size, mean (SD)	4.0 (1.8)	
Household with child aged <5 years	387	62.6
Any improved-source category	385	62.3
Any higher-risk water source	450	72.8
Improved-source category only	168	27.2
Any drinking-water treatment	165	26.7
Regular drinking-water treatment	147	23.8
Private/personal sanitation facility	533	86.2
Regular handwashing with soap	305	49.4

Note: Water-source indicators are not mutually exclusive because households selected multiple sources. “Improved-source category only” means at least one improved-source category and no higher-risk source. Private/personal sanitation includes flush toilet or personal pit latrine and is not equivalent to the full JMP definition of improved or safely managed sanitation.

Table 2. Two-week household diarrhoea prevalence by selected WASH conditions

Exposure	Category	Cases/N	Prevalence (%)	Crude PR (95% CI), p value
Any higher-risk source	No	23/168	13.7	1.00
	Yes	63/450	14.0	1.02 (0.66-1.59); p=0.921
Any drinking-water treatment	No	73/453	16.1	1.00
	Yes	13/165	7.9	0.49 (0.28-0.86); p=0.013
Regular drinking-water treatment	No	77/471	16.3	1.00
	Yes	9/147	6.1	0.37 (0.19-0.73); p=0.004
Private/personal sanitation	No	8/85	9.4	1.00
	Yes	78/533	14.6	1.55 (0.78-3.10); p=0.210
Regular handwashing with soap	No	54/313	17.3	1.00
	Yes	32/305	10.5	0.61 (0.40-0.91); p=0.017

PRs were estimated using separate modified Poisson models with robust variance. Percentages refer to households reporting at least one diarrhoeal case in the preceding two weeks.

Table 3. Adjusted modified Poisson model for two-week household diarrhoeal illness (N=616)

Variable	aPR	95% CI	p value
Any higher-risk water source	1.04	0.58-1.87	0.900
Regular drinking-water treatment	0.48	0.30-0.77	0.002
Private/personal sanitation facility	1.98	0.99-3.98	0.054
Regular handwashing with soap	0.71	0.42-1.18	0.184
Household size, per additional member	1.09	0.97-1.22	0.165
At least one child aged <5 years	2.09	1.30-3.38	0.003
Asset count, per additional item	0.82	0.58-1.16	0.250

Model additionally adjusted for hill of residence. Standard errors were clustered by village. The reference categories for binary variables are absence of the stated characteristic.

Figures

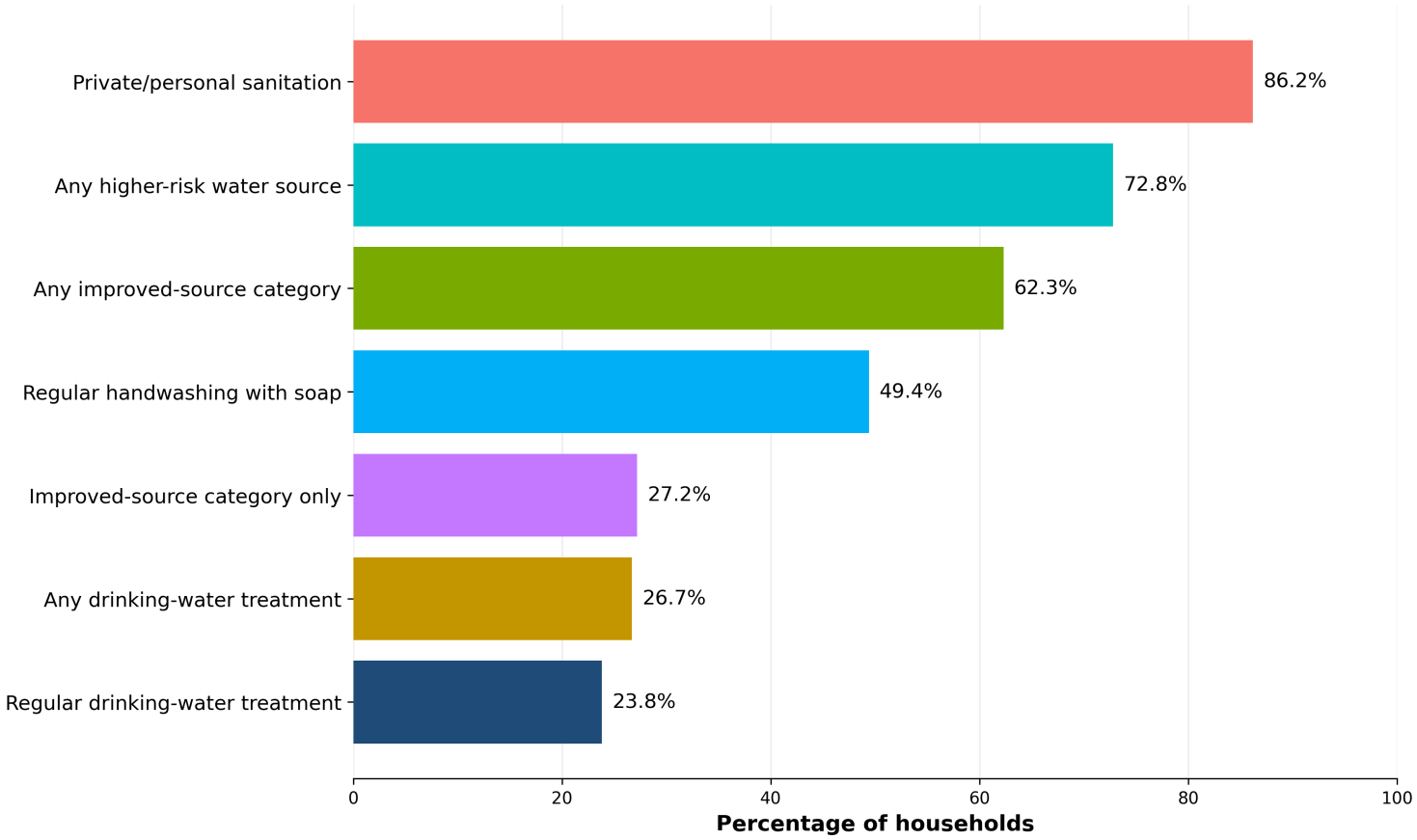

Figure 1

Household WASH conditions in Karangura. Water-source indicators overlap because households reported multiple sources; private/personal sanitation is not a full JMP service-level classification.

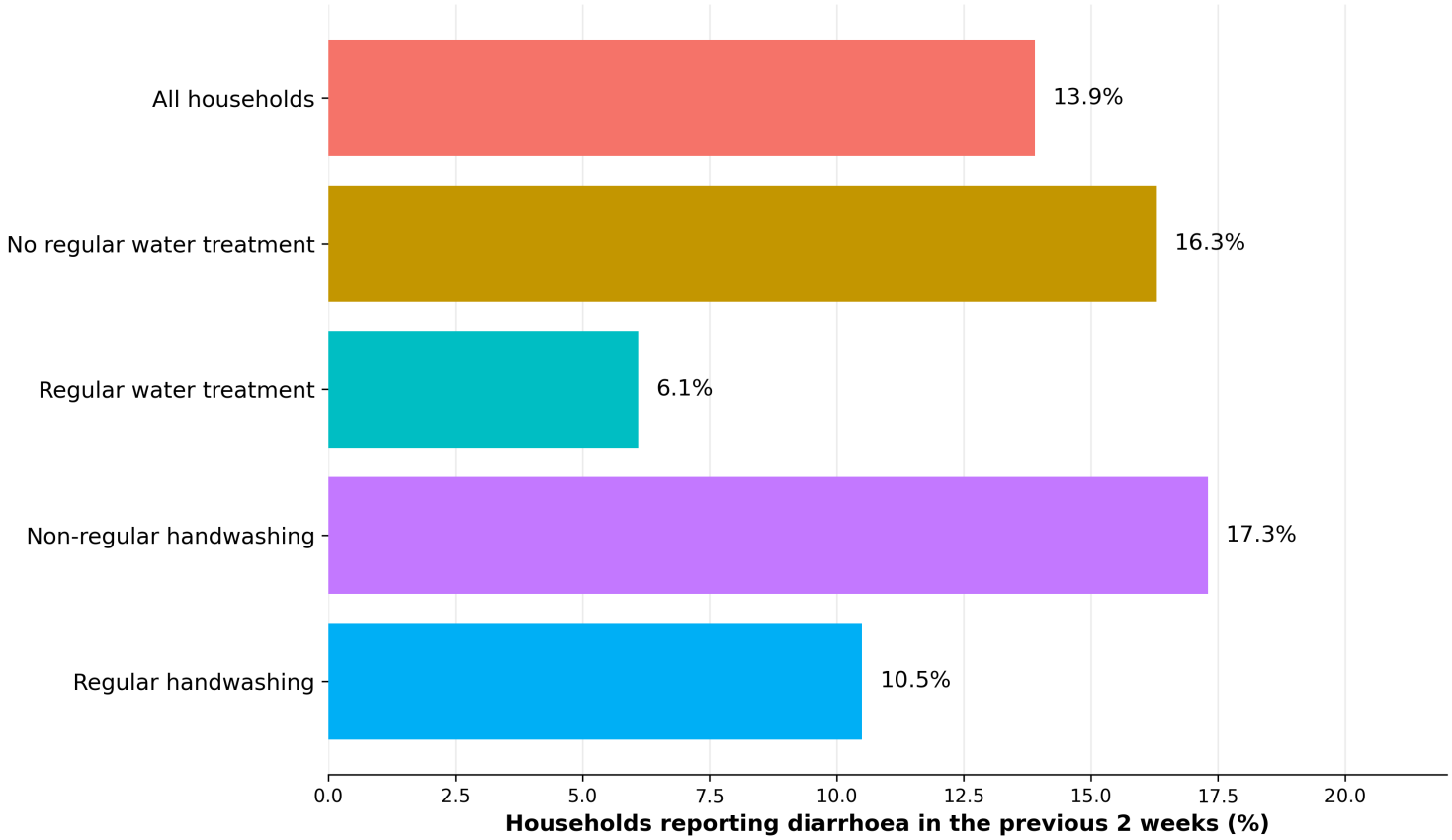

Figure 2

Two-week household diarrhoea prevalence overall and by regular drinking-water treatment and handwashing practices.

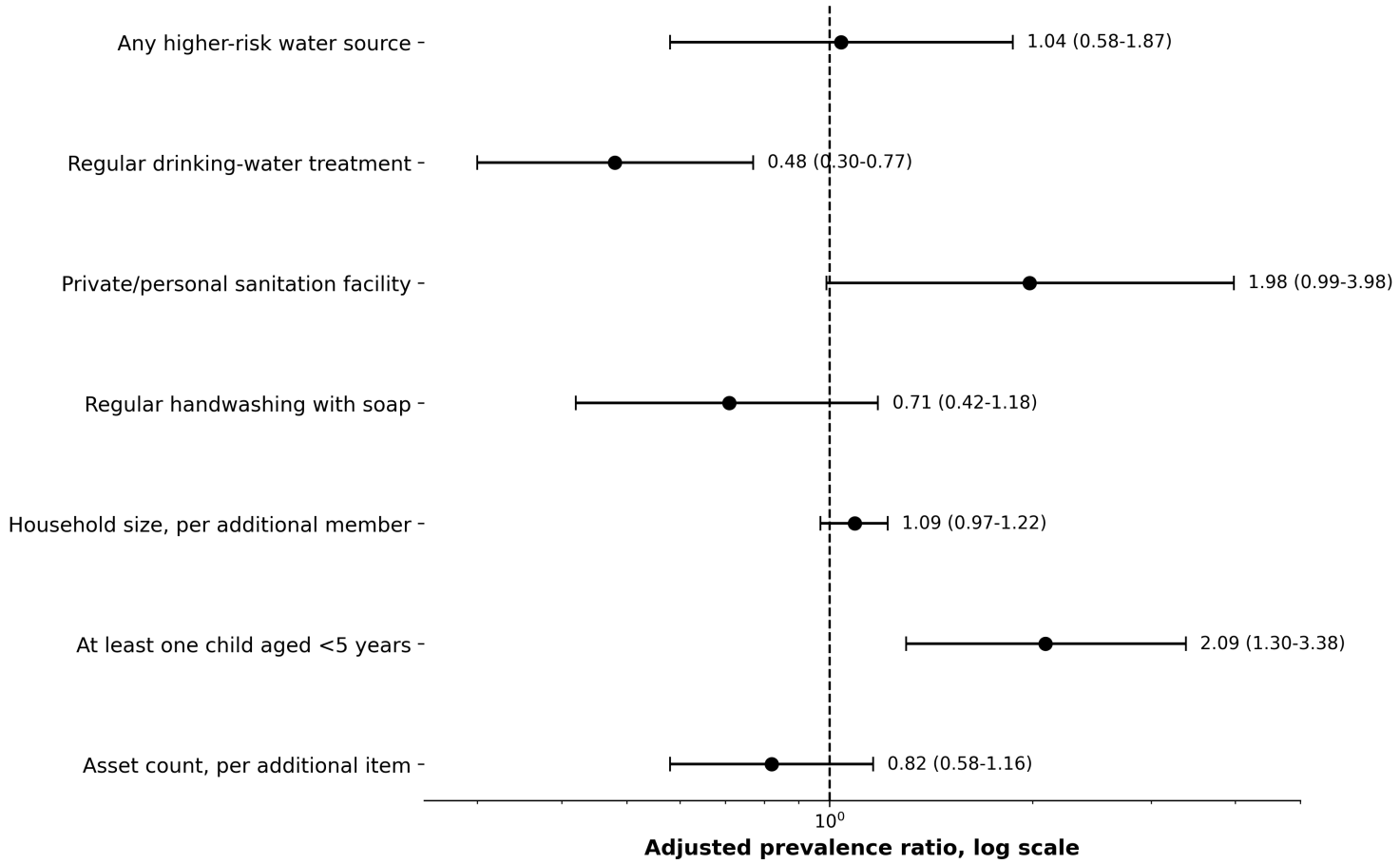

Figure 3

Adjusted prevalence ratios for two-week household diarrhoeal illness. Modified Poisson estimates use village-clustered robust standard errors and adjust for hill of residence.

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- AdditionalFile1KaranguraCFCTHouseholdQuestionnaireEnglish.docx
- Table2WASHHHdiarrhoea.docx
- KaranguraWaterTreatmentDiarrhoeaAnalysisScript.r
- Table6Parishprofile.docx
- Table3WASHU5diarrhoea.docx
- Table1Baselinebydiarrhoea.docx
- Table7Prevention.docx
- Table5Adjustedmodels.docx
- Table4Crudemodels.docx