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Children's and stakeholders' perspectives and experiences with a multi-component hand hygiene program in Nigerian primary schools: a qualitative study

Yaman Maani-Abuzahra
yaman.abuzahra@swisstph.ch
Swiss Tropical and Public Health Institute
Mirko S. Winkler
Swiss Tropical and Public Health Institute
Ahamd Saleh
Terre des hommes
Halima Galtimari
Terre des hommes
Zainab Abdulkarim
Terre des hommes
Usman Modu Kolo
Terre des hommes
Muhammad Auwal Shuaibu
Terre des hommes
Andrea Tamas
Ranas Ltd
Maryna Peter
University of Applied Sciences and Arts, Northwestern Switzerland
Branwen N. Owen
Swiss Tropical and Public Health Institute
Anaïs Galli
Swiss Tropical and Public Health Institute
Nicole Probst-Hensch
Swiss Tropical and Public Health Institute
Olga Cambaco
Swiss Tropical and Public Health Institute

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Abstract

Background

Schools are high-transmission settings for infections. Handwashing with soap is an established preventive measure, yet millions of children in humanitarian contexts lack basic hygiene services at school. Evidence on school-based water, sanitation, and hygiene (WASH) interventions in these settings is mixed, with sustainability often constrained by unreliable availability of water and soap, weak WASH infrastructure and recurrent financing, and limited contextual fit.

Methods

We conducted a generic qualitative study to explore children's experiences of a multi-component hand hygiene intervention and teachers' and stakeholders' perspectives on barriers and opportunities for sustainability and upscaling. Data collection included focus group discussions (FGDs) with children and teachers, and key informant interviews (KIIs) with stakeholders, using semi-structured guides. Data were analysed thematically; codes were clustered into categories and refined into themes and sub-themes until saturation was reached.

Results

We conducted 15 FGDs (10 with children; 5 with teachers), and 10 KIIs with stakeholders. Children reported improved hygiene knowledge, more frequent handwashing, and described perceived health and well-being benefits, with some spillover of hygiene practices to homes. Teachers and stakeholders recognised the same improvements. Water-recycling handwashing stations and engaging behaviour change activities were viewed as drivers of improvements. Barriers to sustaining effects and upscaling to other schools included unreliable water availability at schools, inadequate toilets, inconsistent soap supply, gaps in routine operation and maintenance (O&M), occasional concerns about handwashing station water quality, and insufficient reinforcement of behaviour change activities; wider constraints such as vandalism, insecurity and limited WASH resources at home were also noted. Government leadership and community engagement were emphasised as opportunities to secure funding for consumables and O&M so infrastructure and handwashing habits are maintained.

Conclusion

In a protracted humanitarian setting, addressing context-specific barriers through tailored hardware and theory-informed behaviour change appears helpful for improving handwashing and hygiene at school. However, sustaining improvements and expanding to other schools will depend on recurrent budgets for consumables and day-to-day upkeep of infrastructure. Governments should have a clear plan to

institutionalise school hand hygiene, incorporate dedicated WASH budgets, and enable active community participation with clear roles for education authorities and community committees.

Background

Schools are dense environments where infectious diseases readily spread, posing transmission risks for children and their households [1, 2]. At the same time, schools hold strong potential to improve behaviour in both settings, schools and households, as children can act as agents of change [3]. Promoting hygienic behaviour and ensuring reliable access to handwashing facilities with soap are cost-effective measures to interrupt faeco-oral and indirect respiratory transmission; studies report reductions in diarrhoeal and acute respiratory infections [4, 5], which may, in turn, reduce absenteeism and healthcare costs, and improve child well-being [6].

Despite clear evidence and broad awareness of the benefits of hand hygiene, one in three schools globally still lack a basic hygiene service, defined as a handwashing facility with soap and water, leaving an estimated 646 million children without access to basic hygiene at school [7]. It is worth emphasising that more than half of these children live in humanitarian settings [7], where poor access to water and hygiene drives preventable diseases and death, especially among children and other vulnerable groups [8]. Over the last decade, water, sanitation, and hygiene (WASH) programmes have been implemented in humanitarian schools, and were incorporating different components, and targeting a range of outcomes [9, 10]. However, evidence for their effectiveness and sustainability remains limited and inconsistent [11, 12]. Key challenges include inconsistent access to hygiene materials, cultural and behavioural barriers, insufficient infrastructure, and the need for interventions tailored to local contexts and behavioural determinants of hand hygiene [13, 14].

The Hands4Health (H4H) project was designed to address these challenges in protracted humanitarian contexts [15]. In overcrowded, under-resourced primary schools in Maiduguri, Borno State, Nigeria; an area affected by conflict, displacement and climate pressures that strain already fragile systems [16–18], H4H introduced a multi-component intervention that combined novel handwashing stations with theory-informed behaviour-change activities and explicit operation and maintenance (O&M) support [15].

As part of the H4H project, we conducted a comprehensive assessment of the intervention. While the intervention effects on children's handwashing behaviour were evaluated in a cluster randomised controlled trial (cRCT) and are reported elsewhere (Maani-Abuzahra et al., under review). This paper examines how the intervention was implemented and experienced by children, and explores teachers' and stakeholders' perceived opportunities and barriers to sustainability, and upscaling.

Methods

Hand hygiene multi-component intervention

A detailed description of the framing of the H4H project and the multi-component intervention is provided elsewhere [15]. In short, the H4H project implemented a multi-component hand hygiene intervention in primary schools in Borno state, Nigeria, to improve schoolchildren hand hygiene practices. The intervention comprised three key components: (i) two locally built *Gravit'eau* water-recycling handwashing stations, sized for primary schoolchildren and supplied with soapy water (Fig. 1); the stations were delivered to schools in Sep 2023 and installed in the school yard: one near some classroom blocks serving a cohort of 50 children participating in a study to evaluate the intervention, and the other near the toilet areas; (ii) theory-informed behaviour change programme based on the Risks, Attitudes, Norms, Abilities, and Self-regulation (RANAS) model [19], delivered in Sep 2023 with a refresher in January 2024 by implementation partners trained to be RANAS experts; (iii) O&M support, including routine chlorination, monitoring of drinking water and preventive maintenance of WASH infrastructure (water storage and distribution, handwashing facilities, and sanitation).

Study settings

The study took place in primary schools across peri-urban and rural communities of Jere and Maiduguri Metropolitan Council (MMC) in Borno State, north-eastern Nigeria. Jere (≈ 868 km²; ≈ 306,400 people) [20, 21] surrounds the urban centre of MMC (≈ 543 km²; ≈ 791,200 people) [22, 23], and together they host more than 490 primary schools (≈ 166 in Jere; >324 in MMC) [24], reflecting rapid urbanisation around Maiduguri and agrarian settlements in Jere [25]. The area has a semi-arid Sahelian climate with distinct wet and dry seasons and increasing climate stressors, including desertification and severe flooding [26]. Children aged 0–14 years make up almost half of the population in Jere (45%) and MMC (46%) [21, 23]. Schools report very high pupil-teacher ratios and periodic school disruption from flood-related facility damage and temporary classroom use to shelter displaced people [27]. Against this backdrop, a protracted crisis linked to insurgent armed groups has displaced millions nationally, with around 1.7 million internally displaced persons (IDPs) across Borno state [28], intensifying pressure on already strained infrastructure, including the WASH sector [29, 30]. Schools in the region remain overcrowded, understaffed, and under-resourced for adequate WASH infrastructure and maintenance [31].

Study design

This generic qualitative study was conducted in schools that received the multi-component hand-hygiene intervention as part of the H4H project [32]. We conducted 10 focus group discussions (FGDs) with children and 5 FGDs with teachers across 10 randomly selected intervention schools. Additionally, we conducted 10 key informant interviews (KIIs) with stakeholders. Each of the 10 schools hosted one FGD with children: five with boys and five with girls. As shown in Fig. 2, FGDs with children and teachers were carried out six months after implementation of the intervention (March-April 2024), and KIIs were conducted in the subsequent period (July-August 2024).

Study participants

Children were selected by teachers in the participating classes and were eligible if they had received the intervention and had been continuously enrolled since the trial baseline of the study. Teachers were eligible if they were aged ≥ 18 years, permanently employed at the school, and either taught a participating class or were involved in intervention delivery or maintenance activities. Stakeholders for KIIs were purposively identified by the research team in collaboration with the implementing partner and were involved in the planning, implementation, oversight, or evaluation of the intervention in the study area. They included individuals from the education and WASH sectors, as well as community and Non-governmental association (NGO) representatives (Table 1).

Table 1
Overview of participants and data-collection summary. (Primary schools in Jere and Maiduguri Metropolitan Council, Nigeria, 2024)

Data-collection method	Schools (n)	Groups / interviews (n)	Notes
FGDs - Schoolchildren	**10**	**10**	
Boys	5	5	1 FGD with boys per school
Girls	5	5	1 FGD with girls per school
FGDs - Teachers	**5**	**5**	
Gender mixed group	5	5	1 FGD per school (female and male teachers)
KII	**5**	**10**	
Community representatives	2	2	1 parent per 2 participating schools
Education and WASH public sector representatives	2	6	Headteachers, school security/maintenance, Government representatives
WASH-related NGO representatives	-	2	Implementing partners
Total (FGDs + KIIs)	10	25	FGDs: 10 children + 5 teachers KII: 10 stakeholders

*Abbreviations: FGDs: Focus Group Discussion, KII: Key Informant Interviews, WASH: Water, Sanitation and Hygiene, NGO: Non-governmental association.

Data collection

FGDs and KIIs followed semi-structured guides (Appendix 1) organised around three domains: (i) implementation and influence on children; (ii) opportunities for sustainability and upscaling; and (iii) barriers for sustainability and upscaling. Guides were tailored to each participant group. With children, we explored their perspectives and experiences with the intervention. With teachers and stakeholders, we focused on barriers and opportunities for sustaining the intervention and scaling it up to other schools. All FGDs and KIIs were conducted in person and audio-recorded with the permission of the participants. Given the cultural context and linguistic diversity in the study area, the discussions were conducted in participants' preferred languages, including English, Kanuri, and Hausa. FGDs with children lasted, on average, 45–50 minutes; FGDs with teachers, 60–70 minutes; and KIIs, 50–60 minutes.

The field research team consisted of two researchers: AS served as the main moderator, leading and coordinating the discussions, while HG acted as a note-taker, assisting the moderator and recording notes and observations. Both had prior experience facilitating discussions with children of this age group and adults and had previously worked on related projects in the same communities in the selected study settings. Having the field research team comprised of a male (AS) and a female (HG) was to ensure gender balance and readiness to address age and gender-sensitive dynamics with participants. Additionally, they were not involved in the activities related to the implementation of the intervention. This independence helped minimise identification of implementers or cRCT data-collection teams by children, teachers, and other stakeholders, thereby reducing potential response bias. However, the team received training on Child Protection Policy (CPP) & safeguarding, the code of conduct, and the H4H project including an overview of the objectives of this qualitative assessment.

Data management and quality

The guides were prepared in English and thoroughly reviewed by the research and implementation teams and translated into the two most common local languages; Kauri and Hausa, by AS and then back translated by HG. Subsequently, the guides were piloted with children and teachers in two schools that were designated for piloting both project activities and data-collection procedures. The guides were then refined based on pilot feedback to ensure they are culturally sensitive, friendly and simplified for children's ages, teachers' roles, and stakeholders' positions.

Early in the data collection process, the authors YMA and OC regularly reviewed transcripts to ensure clarity, identify categories and terms requiring cultural interpretation, and flag any emerging issues that might require adaptation. Any adaptations deemed necessary (e.g., rephrasing and follow-up questions and/or adding probes) were discussed among the research team to enhance the elicitation of information on emerging topics. These adjustments occurred during the early FGDs with children; thereafter, no further changes were required.

During data collection across FGDs and KIIs, all participants were assigned unique identifiers, and transcript were pseudonymised (i.e., names and direct identifiers were replaced with participant codes). Full anonymisation was not feasible because FGDs and KIIs were audio-recorded and some KIIs involved

participants in identifiable professional roles. Identifying details were removed from transcripts, and stakeholders are reported by role category rather than name. Children's FGDs were gender-separated and conducted by grade, with either Grade 5 or Grade 6 children per group (typically aged 10–12 years). Homogeneous groups for boys and girls were used to facilitate meaningful feedback, recognising that children around age 10 may feel shy speaking in front of peers and that teasing can increase at this age [33]. In this study, it was crucial that they felt comfortable speaking freely without fear of any embarrassment or teasing [33]. The discussions were held in private and closed classrooms. With permission from school administrators, no teachers were present during FGDs with children to support candid discussion of their perspectives and experiences with the intervention. Teachers participated in separate FGDs without headteachers to minimise hierarchical and power dynamic influence. School headteachers were interviewed individually, along with other stakeholders from different administrative hierarchies and with WASH relevance. Before the KIIs, stakeholders received a brief refresher of the intervention components that had been implemented, to ensure shared knowledge of what had occurred at the schools. Insights from stakeholders provided depth to the group discussions, given that group dynamics can limit probing and in-depth individual questioning and openness [34, 35].

Data analysis

Audio-recorded FGDs and interviews were transcribed in the original languages in which they were conducted by AS. HG checked transcripts for completeness and incorporated field notes. AS then translated them into English, and ZA back-translated. Transcripts then were coded by YMA and OC using MAXQDA 24 (VERBI Software, Berlin, Germany). Coders were not aware of participants' identities; however, for some stakeholders, the interviewee's role was apparent from the content of the transcript.

Code development began deductively, based on the research questions, and became inductive through multiple iterations. Initially, OC and YMA independently coded approximately 10% of transcripts and subsequently met to compare and refine the coding framework. Thereafter, the two encoders met regularly to review and discuss emerging codes, iteratively refining until no further modifications were required. All transcripts were then coded by the two authors (OC and YMA). For data analysis, we followed thematic analysis approach [36]. Codes were organised into clusters of related ideas, which were then developed into categories. Guided by the research questions, these categories were interrogated and inductively refined into themes and sub-themes. The final coding tree, showing the organisation of codes into categories, subthemes and themes, with illustrative quotations, is provided in Appendix 2. Analysis proceeded until thematic saturation was reached, meaning that additional data no longer generated new themes or added depth to existing ones. Relevant quotations were selected to illustrate each theme and sub-theme. Presentation of the qualitative data complied with COREQ guidelines for reporting qualitative research (Appendix 3) [37]. The analyses were structured so that specific research questions were addressed by themes emerging from particular FGDs or KIIs. FGDs with children primarily informed themes related to "perspectives and experiences with the intervention", while FGDs with teachers and KIIs with stakeholders contributed themes on "barriers and opportunities related to the sustainability and scalability of the multi-component hand-hygiene intervention" (Fig. 3).

Ethical considerations

The protocol for the whole assessment of the intervention, including this qualitative study, is published and registered on ClinicalTrials.gov (NCT05964478) [15]; baseline findings are reported elsewhere [38]. Ethical approval was obtained from the National Health Research Ethics Committee in Nigeria (21/2023) and the Ethics Committee for Northwestern and Central Switzerland (Ethikkommission Nordwest- und Zentralschweiz; AO_2023-00047).

Guardians of the children provided written consents at the beginning of the trial, consenting to their children's participation in the trial, including the qualitative assessment. Children provided oral assent, which was recorded at the beginning of the discussions. Teachers and stakeholders provided written consent prior to participating in the study.

Results

A total of 74 children participated in 10 FGDs across 10 intervention schools: five groups of boys (n = 36; 49%) and five groups of girls (n = 38; 51%). Most children were aged 10–12 years old and had been enrolled in the intervention schools for 1–5 years (Table 2). Five FGDs were conducted with 30 teachers from five intervention schools; approximately 70% were women. Most teachers were aged 41–50 years and had 1–5 or 16–20 years of service at their schools. Nearly half held Nigeria Certificate in Education (NCE), and the remainder held a bachelor's degree (Table 3). Ten KIIs were conducted with stakeholders representing the education and WASH sectors and the community, including parents, school-level actors (headteachers, a school guard) and senior public WASH and education representatives; namely the Manager of the Borno State Rural Water Supply and Sanitation Agency (RUWASSA), the Education Secretary of Maiduguri Metropolitan Council, and the Chair of the School-Based Management Committee, as well as implementing partners from the WASH-related NGOs (International Organization for Migration (IOM) and Youth Integrated For Positive Development Initiative (YIPDI). About two-thirds of the 10 stakeholders interviewed were men. Educational attainment ranged from secondary school to PhD, with almost half having completed a bachelor's degree (Table 4).

Table 2
Characteristics of children who participated in 10 focus group discussions (FGDs) (5-boy and 5-girl FGDs) from 10 intervention schools. (Primary schools in Jere and Maiduguri Metropolitan Council, Nigeria, 2024).

Characteristics	**n (%)**
Sex	74
Male	36 (49)
Female	38 (51)
Age range	74
9–10	42 (57)
11–12	32 (43)
Duration in schools (years)	74
1–5	38 (51)
6–10	36 (49)

Table 3
Characteristics of teachers who participated in 5 focus group discussions (FGDs) from 5 intervention schools. (Primary schools in Jere and Maiduguri Metropolitan Council, Nigeria, 2024).

Characteristics	**n (%)**
Sex	30
Male	10 (33)
Female	20 (67)
Age range	30
21–30	3 (10)
31–40	9 (30)
41–50	13 (43)
51–60	5 (17)
Education (Highest degree)	
Nigeria Certificate in Education (NCE)	16 (53)
Bachelor's degree	14 (47)
Duration in schools (years)	30
< 1	1 (3)
1–5	8 (27)
6–10	3 (10)
11–15	5 (17)
16–20	8 (27)
> 20	5 (17)

Table 4
Characteristics of stakeholders who participated in 10 key informant interviews (KIIs). (Jere and Maiduguri Metropolitan Council, Nigeria, 2024).

Characteristic	n (%)
Sex	10
Male	7 (70)
Female	3 (30)
Age range	10
31–40	2 (20)
41–50	4 (40)
51–60	4 (40)
Education (Highest degree)	10
PhD	2 (20)
MSc	1 (10)
BSc	5 (50)
Basic	1 (10)
High school	1 (10)
Sector/role	10
Parents	2 (20)
Headteachers	2 (20)
School guards	1 (10)
MoE representatives	2 (20)
Public WASH sector representative	1 (10)
WASH-related NGO representatives	2 (20)

*Abbreviations: MoE: Ministry of Education, WASH: Water, Sanitation and Hygiene, NGO: Non-governmental association.

Perspectives and experiences with the intervention (children's FGDs)

Children described their perspectives and experiences with the intervention components and the available WASH infrastructure in their schools. We classified their responses as positive or negative experiences.

Perceived positive experiences

Improved hygiene knowledge and health awareness

Children demonstrated a good understanding of the hygiene knowledge they received by describing in detail the knowledge and skills they learnt. They recalled being taught specific handwashing moments and techniques for effective washing. Some children described learning for the first time how to wash their hands correctly, including rubbing between fingers, under their nails, and the backs of their hands, using soap and water from the newly installed stations. According to them, demonstrations by teachers and NGO staff were seen as essential in making the practices clear and easy to remember.

“We didn’t know how to wash our hands that way before (as per the way they were taught) until they taught us and we learn, we are feeling happy when we are washing our hands. Like now that mango is in season, whenever you want to eat mango, or when you are on break you will wash your mango and your hands before eating.” (Boy, Gwange)

Children also reported a transformation in their understanding of the importance of handwashing in preventing disease transmission. Handwashing was described as essential to staying healthy and something to be practised consistently. They linked their knowledge of hygiene and the availability of the handwashing stations with protection against disease.

“*I was impressed by learning the steps of washing our hands properly because it prevents us from diseases. We also like the hand wash machine because you will not easily be infected by any disease if you wash your hands very well with the water from the machine.*” (Girl, Abbaganaram)

Improved hygiene behaviour

Children described a transformation in hygiene practices at both personal and environmental levels. Previously, handwashing at key moments (before eating and after toilet use) was irregular or absent; now it is reported to be more regular, routine, and self-driven. Additionally, many children mentioned that they wash their hands without teacher prompts. They also reported learning that led to improvements in other personal hygiene behaviours, including more frequent toothbrushing, bathing, and hair washing. In addition, they observed cleaner school environments, as children were more regularly involved in cleaning school facilities, resulting in cleaner classrooms and toilets.

“Before they started teaching us on proper hygiene, some of us don't use to wash hands even after using the restroom that is how we will come out of the toilet and go ahead and buy something and eat with unclean hands. But now that we have learned about hygiene, we will wash your hands before eating and after using the restroom.” (Girl, Mala Kachalla)

Intervention components

Children explained what each of the intervention components meant to them and why they preferred it. First, they perceived the handwashing stations as a key protective measure against disease and could accurately describe its operation, demonstrating that training and demonstrations, often led by teachers, effectively promoted correct and independent use. Importantly, children also recalled being explicitly taught not to drink water from the handwashing stations.

"They taught us how to press on the machine (pedal) so water will gush out. They also taught us never to drink the water from the machine." (Girl, Mala Kachalla)

Also, many of them expressed clear admiration for how the stations operated, particularly the foot-operated mechanism, the flow of water, soap dispensing, and the idea that the machine could "wash itself" through recycling. For many, using the station was not only practical but also enjoyable, with some describing it as "fun", which appeared to encourage more frequent handwashing.

"What I like about the handwashing machine is the way it is being operated, you just have to press it with your foot and the water in will start coming out to wash our hands clean. After press it with your foot, you will then apply some liquid on your hand before washing your hands. That's surprising (amazing)." (Girl, Mala Kachalla)

Children also demonstrated awareness of the importance of maintaining the stations and recognising them as a long-term asset that should benefit future students. Many understood that the stations require regular cleaning, water renewal, and occasional repairs, and clearly linked these tasks to external actors, particularly the NGO. While some children noted that individual teachers or a school guard were involved in protecting or occasionally fixing the station, a common understanding that the NGO's continued presence was critical for keeping the stations functional was present in children's reflections.

"When they brought the handwashing machine, they said children are not allowed to climb on top of it because they will spoil it and it will no longer be useful. There is a person who comes around to check the machine, change the water in it and keep the machine in a useful form (functional)." (Girl, Mala Kachalla)

Second, many children shared that they were impressed by the behaviour change activities. They found activities like songs and visual aids engaging, and soap-making and hygiene diaries to be practical skills that encouraged consistent handwashing practices both at school and at home.

"We were trained on how to make soap, they taught us a song about hygiene and gave us a booklet with pictures of children washing their hands on it, so we go and practice proper hygiene culture at home. We wash our hands every time we eat or after we come out of the toilet like we see in the pictures and mark (check mark) the book after every circle of hand washing per day and throughout the week and bring the book back to school." (Girl, Mala Kachalla)

Third, children described infrastructure improvements, including maintenance and the provision of hygiene supplies, as one of the most significant benefits from the intervention. They reported repairs and rehabilitation, such as installing new water taps, overhead tanks, and boreholes, which increased water availability, reducing previous shortages and the need to fetch water from other sections of the school. The provision of cleaning tools, detergents, and liquid soap was also appreciated; the consistent availability of these supplies was seen as crucial to maintaining an improved hygiene environment and supporting the use of the new infrastructure. Toilet renovations were also highlighted and linked to increased access and use in the school.

"We don't use to have detergents before but now we are getting them provided. They bring soap, the liquid soap was also brought and detergents for washing the toilet (Izal antiseptic)." (Girl, Abbaganaram)

Bridging school and home with knowledge transfer

Children's narratives demonstrated how the intervention effectively bridged school and home by equipping them with practical tools and skills to sustain hygiene behaviours beyond the classroom, even when resources were limited. They particularly valued activities such as soap-making workshops, which enabled them to produce soap using low-cost materials, and they anticipated it would last for weeks.

"The reason why they asked us to make soap, is because we should continue practising it at home and use it in maintaining our personal hygiene. If we don't have money to buy expensive soap, we can buy the materials with small money and make big soap that will last up to two weeks or one month." (Girl, Wulari)

Children reported being encouraged to share their hygiene knowledge with family and friends. Most children (82%) described becoming hygiene advocates within their households and social circles, teaching friends, siblings, and peers, and even influencing parental practices. They expressed pride in these roles, noted improvements in others' hygiene behaviours, and felt they were helping to protect others against diseases. They also reported their families were happy and satisfied with their efforts.

"My family are happy because they see me wash my hands frequently and even teaching my younger ones in our school and different schools how to wash their hands properly in order to remain healthy." (Boy, State Low cost)

Health and well-being

Children described feeling healthier since the intervention, noting fewer episodes of "falling sick", headaches, stomach upsets and general weakness compared to the past. They linked these perceived changes to regular handwashing, use of hygiene materials, and improved access to hygiene and sanitation facilities. Beyond fewer reported ailments, many said they personally felt cleaner and happier with new hygiene activities.

"When we are not used to washing our hands regularly, we often fall sick, feel headache and our body is weak sometimes, but now we are healthier and very happy about that." (Girl, Abbaganaram)

Commitment to hygiene

Children expressed a strong commitment to sustaining hygiene at three levels. First, at the individual level, by expressing their willingness to practise handwashing everywhere consistently; second, at the community level, by committing to keep teaching younger siblings and encouraging others; and third, at the school level, through a commitment not to misuse supplies, to maintain the stations, and to help keep toilets and classrooms clean.

"Even if the machine is faulty or there is no soap, we can always cut some soap from home and bring it so we can wash our hands with. And for me again, I will continue to wash my hands till I die." (Boy, State low cost)

Perceived negative experiences

Limited hygiene supplies

Despite expressing a general positive feeling about the intervention and acknowledging the existence of supplies, children also reported that there were times with inconsistencies in the provision of these supplies. Lack of basic supplies, such as soap, detergents, brushes, rakes, kettles, and tissue paper was perceived as barrier to maintaining hygiene in schools, particularly when supplies were insufficient, irregularly replenished, or not suited to tasks. Some children suggested additional tools to manage waste and vegetation during the rainy season, such as hoes and wheelbarrows. They consistently linked the reliable availability of supplies to their ability to contribute to hygiene activities.

"...some of them (cleaning tools) are not good, some of the buckets are broken. We don't have wheelbarrow." (Girl, Abbaganaram)

Toilets' conditions and access

Although improving toilet conditions was not explicitly mentioned as a core component of the intervention, children consistently raised general concerns about poor toilet conditions and access at school. They expressed significant concerns about inconsistent cleanliness, citing inadequate cleaning supplies, limited water availability, insufficient staffing, and limited student involvement in upkeep due to age and gender norms. Despite learning about proper hygiene and recognising the risks of dirty facilities, they reported that irregular cleaning, inconsistent supplies of disinfectants, and misuse by some children often led them to avoid using school toilets or engage in open defecation, which they associated with infections, and consequently made it difficult to comply in practice with the good hygiene practices.

"In some toilets we have them (cleaning substances) while in others to be candid we don't have them. For example, it is not everyday that they clean the toilets and the toilet don't look good whenever they're dirty. You might enter today and see a mess on the floor and tomorrow you might see it clean and so on and vice versa. Even the water to wash the toilets may not be available everyday. The teacher that is in charge of the

toilets is just one person and whenever he is not around, it means nobody is going to ensure that the toilets are clean." (Boy, State Low Cost)

Lack of maintenance

Children frequently pointed to the general poor maintenance of WASH infrastructure at school. They reported broken or non-functional water reservoirs, taps, water containers, toilets and handwashing stations. Some cited long delays before repairs were made. Contaminated reservoirs, for example, with insects or plant roots, were perceived as a health risk and were avoided for drinking, while damage to buckets, kettles, and sanitation tools limited day-to-day hygiene efforts. Despite recognising the importance of cleanliness, students described feeling unable to fully practise what they had learned due to broken or poorly maintained systems.

"Sometime when the taps stops functioning, we have to wait till we resume school for another term before they fix it." (Girl, Bolori)

Water in the handwashing stations

A recurring concern was the water's texture and odour after the stations had been in use for some time. In 8 of 10 schools, children reported that the water sometimes felt slippery or had an odour, particularly when it had not been changed for several days. Some judged acceptability by whether they would be willing to drink it; when it failed that "drinkability" test, they took it as a sign of contamination and avoided the hand stations. As a result, several children said they stopped using the stations when the water seemed "bad" (in their words), and a few explicitly stated they would not drink it, despite the water not being intended for drinking. Children also noted several occasions when the stations ran out of water, interrupting handwashing during the school day.

"Sometimes when you wash your hands the water is slippery; it is a kind of water that you won't even like to drink it." (Boy, Gamboru)

Sustainability and upscaling (teachers' FGDs and stakeholders' KII)

Teachers and stakeholders reflected on sustaining the intervention beyond the implementation period and scaling it to other schools. Findings are presented as barriers and opportunities for sustainability and upscaling.

Opportunities for sustainability and upscaling

Perceived benefits supporting sustainability and upscaling

Stakeholders linked the intervention to tangible improvements. They believed these benefits strengthened the community's motivation and acceptance, making a strong case for sustaining the

programme and expanding it to additional schools. They pointed to several benefits. First, improved water quality through chlorination. Teachers and headteachers highlighted that simple chlorination training improved the taste and acceptability of borehole water and was even linked to fewer stomach aches in children. Learning how to chlorinate on site was seen as a practical skill that schools can apply to keep drinking water safer.

"Honestly the water we were drinking from our borehole is not sweet… When TdH came they taught us about the chlorination of water and since then, water has become sweet and the children are enjoying it." (Headteacher, Mala Kachala)

Second, children's hygiene practices were improved. Teachers and headteachers reported that children were increasingly washing their hands at key moments (after using the toilet, after play, before eating), cleaning classrooms and toilets more routinely, and arriving with cleaner bodies and uniforms. Teachers thought that stations motivated independent handwashing. They also observed fewer unpleasant odours in class, reduced soiling around toilets, and smoother daily routines, as water and supplies were available at school.

"Honestly all the activities are very successful. The most successful… is the handwashing activity with the Gravit'eau machine… the children were able to understand that eating with dirty hands… was the cause of the illness and the stomach ache… Whenever they finish playing they will head to the Gravit'eau machine and wash their hands… when they are to eat… [and] after using the restroom… because they understand the benefits attached to regular handwashing practice." (Headteacher, Mala Kachala)

Third, children were seen as WASH advocates. Teachers, headteachers and parents observed that trained children actively promoted hygiene among peers and at home. They said that children were reminding classmates to wash their hands, teaching siblings and neighbourhood friends (including out-of-school children) about hygiene, and challenging non-washing norms. They thought that peer-to-peer spillover suggested the intervention's effects had extended beyond school into households and the wider community.

"There are a lot of changes… they interact with other students from different schools and children that don't go to school at all… they enlighten them on the importance of washing their hands before eating… The knowledge hasn't stopped with them in school; they have extended it to their siblings and friends… They automatically became advocates of hygiene and warn others that not washing their hands… can cause stomach upsets and diseases… The impact has manifested on the community beyond our imagination." (Teacher, Yerwa Practice)

Fourth, teachers linked the intervention to better child health and attendance at school. They thought that events like stomach aches and sickness-related absences were less frequent than before. They framed handwashing and cleaner WASH facilities as preventive, making children "happier to come to school" because water, toilets, and stations help addressing everyday problems.

"Their punctuality has significantly improved, previously, a student comes today and absent the next day because he/she is sick, but due to this development about having water, better toilets and hand washing machine, children come to school regularly, they're more happier now, they are very happy to come to school because they don't suffer like before to get things as basic as water." (Teacher, Yerwa Practice)

Fifth, teachers and headteachers highlighted the acquisition of important skills through the behaviour change activities, emphasising soap-making as a life skill. They felt it supported maintaining personal and environmental hygiene, could generate a small household income, and might offset school costs by supplying soap. They framed it as a practical, sustainable skill that strengthened programme continuity beyond the classroom.

"This life skill can help them in maintaining their personal and environmental hygiene and as well as having some money to sustain themselves… they can produce soap which can be used for washing the school toilets." (Headteacher, State Lowcost)

Sixth, improvements in menstrual hygiene awareness. One of the headteachers observed positive impacts of the intervention on girls' awareness of personal dignity and self-care. She also noted that cultural norms and taboos around menstruation and female hygiene could limit open discussion and uptake. These challenges, however, were seen as addressable through expanded sensitisation efforts, potentially involving school-based management committees and parents. Teachers recommended extending these programmes to older girls in junior secondary school, suggesting that gender-sensitive programming is both a challenge and an opportunity for upscaling.

"Since the introduction of this activity, it has raised the level of their awareness… If it's possible, I would like TdH to extend the program to include the junior secondary school students… The only barriers I foresee… are cultural attachments to female-related issues… but addressing those barriers is not beyond tackling it with proper sensitisation… This is a responsibility for the PTA and the SBMC… when they are well informed… those barriers will be broken." (Headteacher, Mala Kachala)

Child friendly design

Participants highlighted features that made the stations suitable for children including hands-free use (pedal operation), which was seen as reducing cross-contamination compared with kettles; and an engaging design that encouraged use. One WASH-related NGO participant noted that station materials should be safe for children (e.g., no sharp edges or splinters), particularly given earlier wooden versions. Overall, a design that is both hygienic and appealing supports correct and independent use.

"Everyone tries to wash their hands first… it is like a competition… we sometimes have to send them away from the place, otherwise they can destroy the machine out of excitement." (Teacher, Gamboru)

"You cannot touch anything… with this machine you will just go and wash your hands and leave… even if a child is infected… he cannot transmit to others-which is one advantage of this machine." (Education Secretary, MMC)

Stakeholders' engagement

Participants emphasised that active, early, and continuous engagement with the government, the teachers, and community actors is essential for sustainability and upscaling of the intervention to other schools. For each stakeholder group, they identified specific priorities. First, for the government engagement, participants with decision-making roles called for: (i) inception-stage partnership (planning, school selection, clear roles); (ii) timely information and supervision throughout the implementation; (iii) capacity transfer so local stakeholders can manage WASH assets after the project; and (iv) broader partner participation to share workload and resources. Without this, they warned, investments can be wasted.

"The partnership should be right from the inception and right from the planning stage… Inform them of what activities are involved and how the project is going to be monitored… and at the end, the organisation should properly hand over to the relevant stakeholders and the community. So, this is how the project will be sustained." (General Manager, RUWASSA)

Second, teachers were seen as central to sustaining the intervention. Headteachers and MoE stakeholders called for ongoing training and refresher sessions on hygiene education and basic technical skills (minor fixes to stations) for the teachers. Headteachers described the need for actively coordinating campaigns, integrating hygiene across subjects, and planning for continuity after NGO exit. The message was clear: with equipped and engaged teachers, behaviour change and asset care are more likely to persist.

"That is why I am insisting on re-training both the teachers and the students, so that even when the project comes to an end they might have developed the skills and the expertise required to handle every situation that may come up." (Headteacher, State Lowcost)

Third, participants emphasised community engagement. They shared that parents and community actors play an important supporting role in sustaining handwashing behaviours and protecting assets in schools. They also stressed the need for regular sensitisation (not one-off talks) to build habits over time. They proposed including parents and SBMC members in activities and training, utilising PTA meetings and local media (e.g., radio) for ongoing messages and engaging wider community groups so that everyone feels a sense of ownership. Importantly, stakeholders also saw community engagement as a pathway to mobilise resources despite difficult living conditions: small local contributions can contribute to the school's WASH budget to help address some gaps, volunteer time for routine tasks, and community monitoring to reduce misuse and vandalism.

"Wherever this program is replicated, please carry all the stakeholders along… If all the stakeholders are aware… they will not allow [assets] to be carted away. They will protest through the PTA… they indirectly own the school because their children are studying in the school, so they won't let anything happen." (Teacher, Gwange4)

Community interest and demand for upscaling

Participants described strong community interest in scaling the project up to other schools. They reported that children told their families about the new facilities, prompting parents to visit the schools and broadening community awareness of the newly installed stations, with many expressing a desire for installation in additional schools. Stakeholders demanded expansion to additional schools and recommended tailoring coverage by school size (more stations in larger schools). They also suggested partnering with local organisations and government to extend their reach and share responsibilities.

"It's obvious that we and our students greatly benefit… other schools have children too and they should have it and benefit from it like we do… Many students in other schools are aware of this project and are longing for it already… it is very useful for hygiene and it affects the health of all the children in our community." (Teacher, Gwange 4)

Barriers for sustainability and upscaling

Teachers and stakeholders reflected on factors influencing whether the intervention could be maintained over time and expanded to other schools. In doing so, they discussed both intervention-specific barriers and broader school WASH system constraints (e.g., water and toilet conditions) that shape day-to-day use, sustainability, and the feasibility of scale-up.

Issue related to water at schools

Participants identified water access as the main constraint to sustaining the intervention, highlighting several related issues. First, several schools lacked functional boreholes or had systems that depended on unreliable power; when there was "no light", there was no water. According to them, generators were costly to fuel, and existing solar systems were often insufficient to power pumps. They called for new or rehabilitated boreholes and reliable power solutions (especially solar) to ensure a consistent water supply at schools.

"There are some of our schools which are lacking boreholes… if you are going to bring water you must bring electricity and most of our schools are not connected to the national grid… The source of power could be solar energy… if they can assist schools with boreholes and alternative source of power… this is what I am suggesting." (Education Secretary, MMC)

Second, the parents in our study reported that where borehole or piped water was unavailable, children often resorted to using water from the school reservoir, which was widely perceived as contaminated. Washing near the water reservoir led to recontamination, and children reportedly threw objects into the water. Among parents, these conditions raise concerns about disease risk and highlight the need for safe, protected water sources.

"When they fetch it from the dam, they use to wash themselves close by which make the water to go back into the dam. Someone can even bring something and throw it into the dam… this can cause problems."

(Male parent, Gamboru)

Third, similarly to the children's concern, the lack of water inside school toilets was spotted as a barrier for effective hygiene practices. Teachers shared that this issue was preventing self-cleaning and flushing toilets after use. They also noted that fetching water from outside the toilet could not be practical or feasible, especially for young children who may lack the strength or maturity to fetch water or properly manage toilet hygiene, leading to issues with cleanliness and discomfort.

"Some don't even have the age and strength to fetch and carry water enough to flush his mess… But if there is water in the toilet, they will benefit from it and leave the toilet in a re-usable condition almost immediately." (Teacher, Gamboru)

Intervention components

Participants shared some concerns regarding specific intervention components that were directly related to their day-to-day observations. First, for the handwashing stations; teachers and headteachers stressed that the number and placement of stations are insufficient for the children's population. Within schools, too few stations and distant locations (e.g. not immediately at the toile exit) lead to crowding, queues, and "overstretching," which in turn increases maintenance needs.

"I think is not what is missing but is about shortage. Considering the population of the students, two hand washing machines are not enough and that's why we often experience maintenance issues because of how the machines were overstretched" (Teacher, Yerwa Practice)

Ministry of education (MoE) stakeholders expressed concerns about the misuse of the stations and said that it sometimes occurs due to limited awareness among children and a lack of supervision by teachers. They noted that in some schools, the stations were underused or misused as play objects which could damage them.

"Only that sometimes, the machine to be installed just closer to maybe the buildings. It is far away from the buildings. So, it may be in an open or a free space and children may climb on it, and they may fall. This is some of the risk I am talking about." (Education Secretary of MMC)

"The children are not even aware of the importance and the use of the machine. In some case it has even become a toy that the children play with because they see water is coming out from the machine." (Teacher, Mala Kachalla)

One particular concern shared only by a stakeholder from a WASH-related NGO, centred on the religious acceptability of using recycled water, particularly for ablution. While the stations are intended for handwashing only, some community members may consider using this water for religious purposes and question its sanctity (purity) because it is recycled.

“From my own view, the only challenge… is about the water that is being recycled… from the religious perspective… people may likely want to use the water for performing their ablution… there are some questions in regard to its sanctity…” (WASH programme manager, YIPDI)

Second, headteachers and MoE stakeholders felt that the behaviour change activities were not frequent enough to achieve durable impact. They noted that delivering the activities only once or twice left some teachers and children unclear about the key messages. They stressed that behaviour change is gradual, varies by individual, and requires consistent, repeated exposure. They shared this point by warning that home environments can limit uptake and schools might need ongoing refreshers to reinforce hygiene habits.

“When such things are done only once or twice there may be some people who don't even understand what was done. It needs to be done for like three or more times before some of them will catch up, even the children, they cannot understand the behavioural change at once, it should be a gradual process because of individual differences, but when it becomes consistent everybody will learn.” (Headteacher, State Lowcost)

Financing and resourcing constraints

When questioned about the future, participants identified lack of resources and funding as a central issue. While the intervention supplied cleaning materials and carried out preventive maintenance during implementation, participants emphasised that these inputs were time-bound; sustaining them would require resources beyond the current means of the school and the community. Budgets fall short of covering infrastructure, consumables, and maintenance costs. They clarified that these expenses far exceed what schools or other sources, such as Parent-Teacher Associations (PTAs) or School-Based Management Committees (SBMCs) can cover, especially given the prevalence of poverty and irregular levy payments. Government support was perceived as slow or insufficient. Budget constraints were centred on two key areas: First, infrastructure and consumables shortfalls. Teachers, headteachers and MoE stakeholders expressed their appreciation for the materials supplied through the intervention; however, the routine replenishment after project support ends was viewed as the primary constraint. They described shortfalls in infrastructure (e.g., water pumps and taps; water-storage containers; cleaning tools; buckets and kettles; and waste-management infrastructure such as an incinerator) and ongoing needs for consumables (routine cleaning supplies). They emphasised that such supplies motivate children and teachers to keep facilities, especially toilets, clean.

“Well, it (the intervention) has partially met the school needs...not only water station...You know cleaning the environment is also part of it...cleaning the toilet is also part of it and then the materials that could be used to clean the toilet and environment is also very important…There is need for us to have things like detergent, Izal (antiseptic detergent), and dust bin. So, all those things we are lacking in our schools.” (Education Secretary of MMC)

Second, O&M gaps. Preventive maintenance during the intervention period was welcomed, yet participants noted that without a recurrent O&M budget and clear responsibility for repairs, functionality

would decline over time. Reported gaps included routine repairs to taps, pumps and stations, fragile fixtures such as plastic taps breaking under routine use, poor drainage, overhead tanks without secure covers that risk contamination despite chlorination, and multiple toilets out of service due to disrepair. These issues reduce access to and trust in facilities even when infrastructure is in place. Without regular school WASH budgets, participants feared that facilities, including the intervention hardware, would deteriorate, leading to more breakdowns, unsafe conditions, and decline of hygiene behaviours.

"Honestly speaking… the cost of maintenance and purchasing the sanitary materials… the government will not provide those things. Even if they are going to do it, it won't be sufficient enough to meet with the demand. And the school is not financially strong enough to shoulder this responsibility… when we cannot meet up with the standard, there might be possibility of those diseases to resurface. Imagine when they no longer have the means of washing their hands after all this? … then everything will just look like a white Elephant project." (Headteacher, State Lowcost)

Vandalism

Participants noted risks of theft and vandalism of WASH assets (e.g. *Gravit'eau* stations, water taps, water containers). Vulnerability varied by school and neighbourhood security; some assets, e.g., the filter of *Gravit'eau* station, were seen as particularly at risk due to their resale value. Concerns included both external theft and occasional insider misuse. Schools with stronger oversight (active head teachers and guards) reported fewer problems; others emphasised the need for tighter security and community checks before upscaling.

"We have been reporting… risks of vandalization, theft of materially valuable assets like the machine, taps, water containers… This filter is one key asset… it can be stolen for sale… you need to make security checks of the community to understand the level of criminality in schools based on their recent history." (Gamboru Teachers)

Insecurity

Participants shared that sustainability and upscaling were constrained by insecurity. Some schools were in remote, security-affected areas where travel restrictions or state directives limited reach, supervision, and timely maintenance.

"Accessibility Barriers to the school locations… some schools are located in very remote and security-threatened areas… security threats can cause the barriers to reach out to such locations." (WASH Sector, IMO)

Household barriers

Participants highlighted household-level constraints that undermined children's hygiene practices, including limited household water access and financial constraints that restricted supplies. Even when children were motivated, inconsistent support and inadequate infrastructure at home made daily routines (handwashing, bathing, toothbrushing, cleaning uniforms) hard to sustain.

"Since we teach the students to clean this and that part of their body, at times a child is doing his/her best but the parents' capacity may hinder the progress of the lessons learnt about hygiene—we contribute our best but their financial means may not support that." (Teacher, Yerwa Practice)

Discussion

Our study aimed to describe children's experiences of a multi-component hand hygiene intervention in primary schools located in a humanitarian setting in Nigeria, and to document teachers' and WASH stakeholders' views on opportunities and barriers for sustaining and upscaling the intervention to other schools. Our results show that children reported better hygiene knowledge and more frequent handwashing, and described perceived health and well-being benefits, including fewer minor illnesses and feeling cleaner, with apparent spillover of hygiene practices from school to home. They linked these improvements to child-friendly handwashing stations, engaging behaviour change activities, and improvements to WASH infrastructure and supplies, including soap and basic cleaning materials. Teachers and stakeholders recognised the improvements described by children and emphasised that sustaining effects and enabling upscaling depend on early initiation and steady, participatory stakeholder engagement to secure budgets, promote ownership, and share responsibilities so that infrastructure and handwashing habits are maintained. Teachers and stakeholders also identified barriers for sustainability and upscaling of the intervention. Several of these barriers reflect broader constraints in the existing school WASH environment that influenced day-to-day use and sustainability. These constraints were also evident in children's negative experiences, such as limited water access at schools, constrained resources for operation and maintenance (especially for toilets), and occasional issues with water inside the stations. Additional barriers included insufficient frequency of behaviour change activities, and wider constraints included vandalism, insecurity, and limited WASH resources at home.

Reported handwashing behaviour improved, echoing the cRCT findings of significant improvement in handwashing at school. Children and teachers largely attributed this to the newly installed handwashing stations. Besides being fun to use, the stations recycle water without the need for energy, which participants highly appreciated. This helps address one of the most pressing WASH issues in such settings: access to water. Previously, schools relied on pipe-and-tap points or buckets/containers with taps or scoops, which require water to be available on site and sometimes electricity to pump borehole water. In contrast, the new stations made handwashing more visible and convenient and were usable even when electricity or piped water was unavailable. This aligns with other school-based interventions showing that visible, convenient infrastructure improved handwashing [9, 39, 40]. Taken together, these

accounts suggest that context-appropriate, practical infrastructure that addresses real constraints and improves convenience contributed to the observed improvements in handwashing.

Although the stations helped mitigate constraints on water access, children's accounts highlighted technical and operational issues that could limit trust and use over time. Consistent with prior process and sustainability studies, which show that day-to-day O&M strongly conditions the use of school handwashing facilities [41, 42], our findings indicate that high-load contexts amplify minor technical issues (e.g., leaks, clogging, water quality changes) and undermine trust. Beyond hardware, perception matters: unfamiliar sensory cues of recycled water can trigger avoidance, echoing literature on the role of norms and beliefs in shaping WASH behaviours and the importance of community engagement for acceptability [43, 44]. Accordingly, our findings suggest that routine O&M of handwashing stations, at a frequency and intensity matched to the level of use, together with communication and engagement to normalise recycled water, will be necessary to maintain use; otherwise, trust and use are likely to decline.

Children also raised inconsistent soap availability on handwashing stations as a concern. This aligns with studies from schools in LMICs that document irregular soap supply and weak follow-up routines [39, 41]. This pattern may help explain our cRCT finding of smaller improvements for handwashing with soap (HWWS) compared with water only. When soap is not reliably available, children are less likely to use it [45, 46]. Reasons for inconsistency are well-described across school WASH evaluations. They include resource constraints [41, 42, 47] and limited routine checks [40, 42, 48]. Prevailing norms also matter: in many settings soap is not expected at water points, and many households may not practise HWWS regularly [49, 50]. These norms were mirrored at baseline in our setting; none of the schools had soap at water points [38]. Thus, while providing soap is essential, sustaining HWWS will require regular replenishment routines, and addressing norms and preferences so that children value and expect soap at every wash.

Given the inconsistent availability of soap, one behaviour change activity widely welcomed by children and stakeholders was the school-based soap-making workshop. During this activity, children softened soap flakes/scraps with warm water, kneaded the mixture, and moulded it into shapes (with optional colour). This positive reception aligns with handwashing intervention studies that incorporate behaviour change approaches, showing that strategies tailored to local needs and values can improve acceptability and uptake [51, 52]. However, such activities complement rather than replace the need for routine soap replenishment and modest recurrent budgets for consumables [39, 42]. Consequently, effective handwashing intervention design would pair behaviour change techniques that target context-specific barriers with simple systems for regular supply and follow-up, ensuring the behaviour remains feasible in everyday school routines [9].

Beyond addressing soap availability, children described behaviour change activities as engaging and said they helped them practise handwashing more regularly. The behaviour change approach was theory-informed, since it was developed based on the analysis of psychological determinants of handwashing. However, teachers and stakeholders felt that the frequency of activities was insufficient to

embed habits; consistent with evidence that behaviour change takes time and fades without reinforcement [53, 54]. Thus, while theory-based approaches can initiate change, sustained routines require planned reinforcement, including teacher training, integration into the timetable and curriculum, as well as parental involvement, so that messages are echoed at home, where children often model their parents' behaviour [40, 48, 55].

Behaviour change activities also travelled home. Tools such as hygiene calendars and "role-model" assignments encouraged children to practise, and prompt others to practise handwashing outside school. In community settings, where programmes often focus on schools [9], these home-directed elements in the programmes are reported to help bridge the school and household environments, extending impact to families and communities [56, 57]. However, their impact still depends on household WASH conditions and local norms [57, 58]. Hence, it is recommended to design for spillover intentionally so that improvements in routine handwashing are reinforced where children live as well as where they learn, which can also broaden benefits to the wider community.

Alongside these homeward effects, children and stakeholders repeatedly identified toilet conditions as a key factor for handwashing. They reported that when toilets were dirty or dry, children avoided them and handwashing rates dropped, even if stations were available elsewhere. This observation is consistent with our cRCT findings: handwashing after toilet use improved less than handwashing before eating, and microbial contamination of hands was high. While social norms in sub-Saharan Africa may emphasise pre-eating handwashing more than post-toilet use [59], participant narratives and the broader literature likewise underscore the central importance of toilet conditions for handwashing after toilet use [60, 61]. This suggests that inadequate toilet conditions reduce uptake of handwashing after toilet use because children avoid the toilets and the handwashing opportunity is lost. Thus, in order to sustain improvements in handwashing, usable toilets need to be ensured [61, 62]. In addition, culturally appropriate messaging may help further reinforce handwashing after toilet use by linking it to practical, locally meaningful cues and routines.

These observations point directly to the next binding constraint: securing resources for routine O&M and consumables. Inconsistent cleaning supplies (especially for toilets) and gaps in O&M were widely reported, with costs exceeding what schools, PTAs, SBMCs, or irregular levies can support. Evidence from other school-based WASH interventions suggests that without predictable, government-funded recurrent budgets and clear lines of responsibility, both existing infrastructure and newly introduced hardware risk falling into disrepair once project support ends [63]. Given that the intervention was accepted by authorities and welcomed by beneficiaries, sustaining its effects depends on government planning and the allocation of ongoing WASH funds within the education system; otherwise, hygiene improvements will diminish over time, even when the technology and behaviour change package are acceptable [1, 63].

Against this backdrop, stakeholders emphasised the importance of government engagement from project inception through to handover, consistent with international guidelines promoting the adoption of

handwashing in schools, which frame government leadership and ownership as the basis for a true partnership [64, 65]. An important aspect of that leadership is the government's role in institutionalising handwashing interventions [65, 66]. For example, by embedding behaviour change activities in the formal curriculum, establishing regular teacher training, and setting routines for handing over skills and responsibilities when staff rotate or are newly posted, so practices outlast turnover and NGO exit [1, 66]. Alongside these measures, involving parents and community representatives from the outset; through joint training on station use and routine maintenance, can help ensure responsibilities are established before handover and sustained beyond staff turnover.

Parents and community actors were viewed as potential supporting partners with roles including maintaining the newly installed stations, protecting against vandalism, and providing financial support for consumables and minor infrastructure repairs. Stakeholders were clear that large financial contributions were not expected from this engagement. Some also described this engagement as the only alternative when government provision is insufficient; a critical framing because it risks normalising the replacement of system functions by communities. Community engagement should reinforce, rather than substitute for, government commitments [64]. Guidance on WASH systems strengthening indicates that such engagement is crucial for supporting facility maintenance, helping with cost recovery for consumables, and strengthening sustainability when roles are clearly defined with responsibilities and limits and when government provides leadership [63, 64]. For instance, integrating women into leadership roles in community water management has been linked to more sustainable and effective projects. In Cameroon and Mali, active community participation throughout system development has improved access, reduced costs, and enhanced financial management [67]. Accordingly, participants viewed community engagement as essential to sustaining the changes achieved by the intervention; at the same time, this engagement needs to be organised by government, which should lead and set parameters so that community roles complement school WASH provision, rather than funding capital works or covering systemic gaps [63, 64].

Lastly, reports of parents visiting schools after children described the new facilities, and stakeholders calling for extension to additional schools, indicate strong acceptability and perceived value. However, evidence from LMIC school settings shows that successful upscaling depends on contextual fit, delivery capacity and governance arrangements, not just user enthusiasm [68]. Scalability guidance emphasises the need for a structured appraisal of system requirements and adaptation requirements before expansion [69]. A scale-up framework for health interventions in Africa highlights the prerequisites of resourcing, management routines, and continuous improvement to sustain performance at larger coverage [70]. In our setting, participants also pointed to specific opportunities for upscaling: routine O&M and consumables, usable toilets, reliable water soap, and clear government leadership with defined community roles. Accordingly, any decision to expand should ensure these conditions are in place and adapt handwashing station coverage to school context and size; otherwise, upscaling risks spreading fragile services and eroding the improvements observed.

Strengths and limitation

Our study has several strengths. First, we sampled participants across most intervention schools and conducted gender-balanced child FGDs, supporting breadth of perspectives within the intervention arm.. Second, discussions with children were held in private, closed classrooms and, with school permission, without teachers present, to support candid accounts. Third, we captured multiple perspectives from direct beneficiaries (children), their teachers, and system stakeholders, allowing us to synthesise all different views and enabling a more comprehensive understanding of how the intervention operated in practice in humanitarian settings. Fourth, the qualitative team worked independently of the implementors, reducing recognition and desirability bias. Fifth, our qualitative findings can be triangulated with the results from the accompanying cRCT, strengthening credibility.

The study, however, has limitations that are worth discussing. First, FGDs and interviews were conducted in Hausa/Kanuri and then translated into English with back-translation; some nuances may have been lost in the process. Second, social desirability bias is possible because participants were aware of our affiliation with the wider project. Hence, reported behaviour change needs to be interpreted cautiously. Third, because teachers and school administration selected participants for FGDs, it is possible that more adherent or more engaged children and teachers were invited, which may have biased discussions towards more favourable experiences. Fourth, interviews with stakeholders were conducted almost one year after the intervention. As a result, some details may have been affected by recall bias, and participants' accounts might not fully capture all aspects of their experiences. Finally, the study was conducted in one state within a humanitarian context, which may limit transferability to other settings.

Conclusion

Children, teachers and other stakeholders perceived the H4H multi-component hand hygiene intervention to be highly acceptable, with positive experiences attributed to *Gravit'eau* water-recycling handwashing stations, engaging behaviour-change activities and the provision of basic cleaning materials. The practical, context-appropriate stations seemed to mitigate key constraints, including limited access to water at schools, and appeared to improve convenience, which contributed to observed improvements in handwashing. Children also described perceived health and well-being benefits. Behaviour change approaches were most useful when tailored to local barriers, with spillover effects attributed to activities that bridged school and home and motivated handwashing across both settings. Toilet conditions were of central importance and closely linked to handwashing after toilet use. When toilets were dirty or dry, children avoided them, and the handwashing opportunity was lost.

Sustaining these improvements depends on routine O&M at a frequency and intensity that keeps pace with use of the stations, together with communication and engagement to normalise the recycled water used in the stations, and with soap reliably available at handwashing points. The sustainability of the intervention's provisions, including stations, behaviour change activities, soap and cleaning consumables, depend on government funding for day-to-day upkeep. Community engagement is essential to sustaining change, given its role in providing modest financial support, assisting with

maintenance and protecting against vandalism. Planned reinforcement of behaviour change activities, including continuous teacher training, is crucial to embed the habit of handwashing.

Finally, while interest in expansion was strong, several basics should be ensured when upscaling: ongoing O&M and supply of consumables, adequate toilets, consistent water and soap availability, and clear, active government leadership supported by community engagement. Number of stations need to be adjusted to school size and context. In humanitarian settings, where resources are constrained, priorities shift, staff turnover is common and services are intermittent, putting these basics in place and planning for supply-chain and service disruptions is especially critical. Additionally, using theory-informed behaviour change approaches can address context-specific barriers and may strengthen effects when activities bridge school and household settings to enable spillover. Future research in humanitarian settings is recommended to intentionally design for spillover and measure its effects across home and school, alongside assessing implementation fidelity across all intervention components, including how delivery adapts under shocks, and assess longer-term effects.

Abbreviations

COREQ Consolidated criteria for reporting qualitative research

cRCT	Cluster randomised controlled trial
FGD	Focus group discussion
HWWS	Handwashing with soap
IOM	International Organization for Migration
KII	Key informant interview
LMICs	Low- and middle-income countries
MMC	Maiduguri Metropolitan Council
NCE	Nigeria Certificate in Education
O&M	Operation and maintenance
PTA	Parent-Teacher Associations
RANAS	Risks, attitudes, norms, abilities and self-regulation
RUWASSA	Rural Water Supply and Sanitation Agency
SBMC	School-Based Management Committees

SDC	Swiss Agency for Development and Cooperation
WASH	Water, sanitation and hygiene
YIPDI	Youth Integrated For Positive Development Initiative

Declarations

Ethics approval and consent to participate

Details are provided in the main text under “Ethical consideration”.

Availability of data and materials

Anonymised participant data and a data dictionary will be made available 6 months after publication upon request and sent via secure data transfer to the applicant. Data will be shared following a reasonable request and approval by the corresponding author

Competing interests

Author MP is a co-founder of the non-profit organisation *Gravit’eau*. Their handwashing stations are for humanitarian purposes and not marketed. Author AT was employed by the company RANAS Ltd. However, no patents, marketed products, or products in development of RANAS are associated with this research. The remaining authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Authors' contributions

MSW was the principal scientific lead, overseeing the study design and implementation, and served as the principal investigator for all impact evaluation research within this project. YMA and MSW conceptualised the research project and managed its administration. MP and MSW secured funding. AT and MP coordinated the project’s activities among the partners; MP also oversaw the overall methodology development for the project.

YMA led the study design, obtained ethics approval, coordinated and supervised fieldwork. YMA developed data collection methods, conducted the formal data analysis with support from OC. OC oversaw data analysis and interpretation and provided guidance and support.

AS translated the discussions' and interviews' guides supported by HG and ZA. AS conducted the discussions and interviews supported by HG. AS transcribed the discussions and translated the discussions into English. Back translation was supported by ZA.

NPH contributed to the study design and tools and, along with MSW, supervised YMA throughout the research process. AG contributed to the overall development of the study design, supported the ethics approval process and development of data collection tools. BNO supported data analysis.

ZA, UMK, and MSA, as focal points of the implementation partner, contributed to protocol development and coordinated all implementation activities. They supported the process of obtaining ethical clearance from the relevant ethics board and facilitated formal approval from the Ministry of Education (MoE). They also coordinated school access and fieldwork logistics.

YMA and OC drafted the manuscript. MSW critically reviewed and revised the manuscript. All authors read and approved the final manuscript.

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Figures



Figure 1

Handwashing station Gravit'eau installed in intervention schools (Primary schools in Jere and Maiduguri Metropolitan Council, Nigeria, 2024)

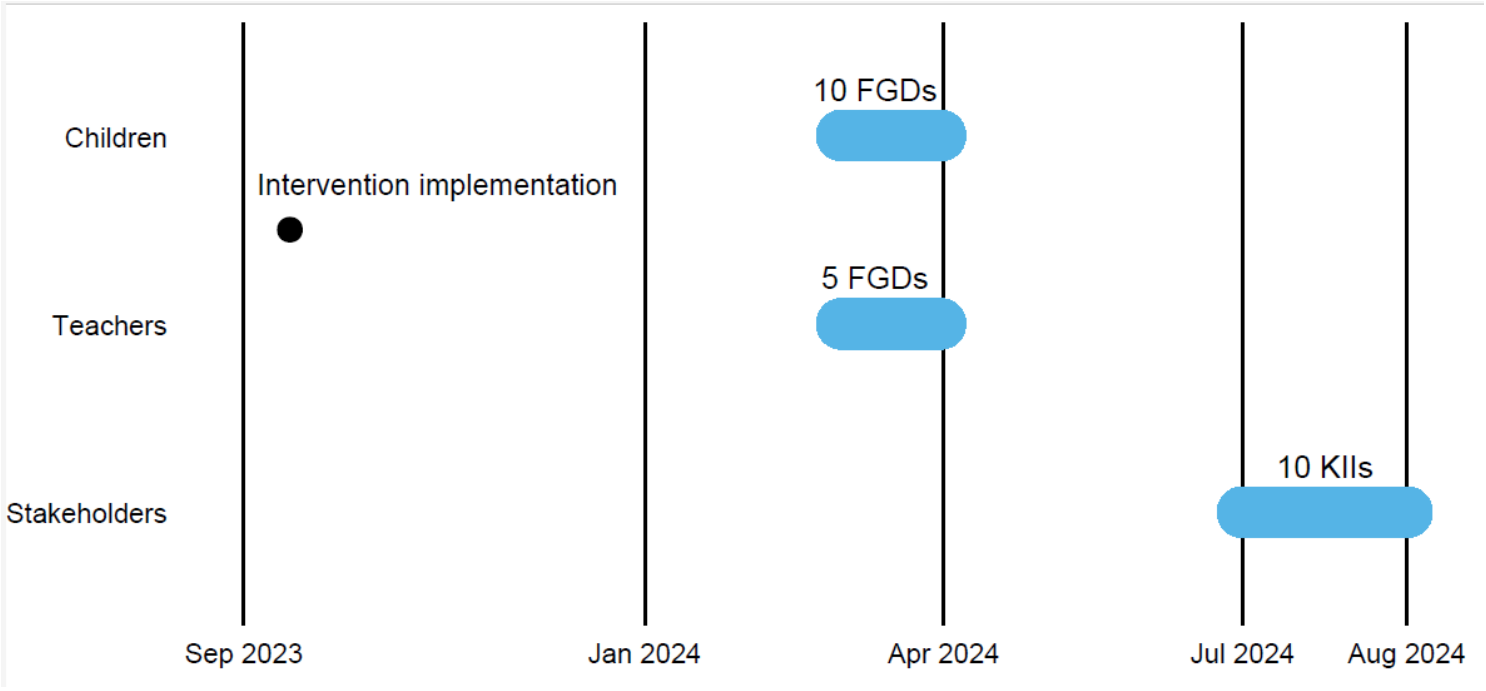


Figure 2

Timeline of qualitative activities relative to intervention implementation: 10 FGDs with children in March-April 2024; 5 FGDs with teachers in March-April 2024; and 10 KIIs with stakeholders in July-August 2024. (Jere and Maiduguri Metropolitan Council, Nigeria, 2024). (Abbreviations: FGDs: Focus Group Discussion, KII: Key Informant Interviews)

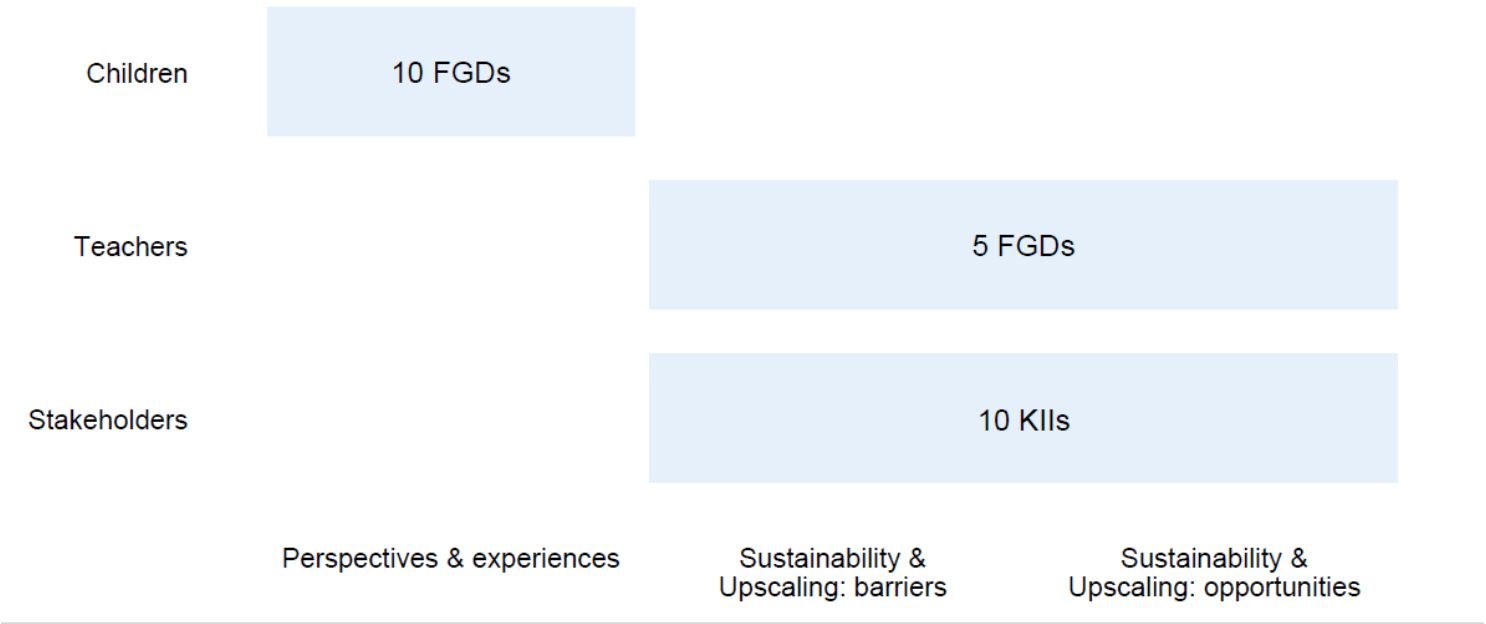


Figure 3

Mapping of participant groups to analytic domains used to structure the results: children contributed perspectives and experiences with the multi-component hand hygiene intervention; teachers and stakeholders contributed views on barriers and opportunities for sustainability and scalability. (Jere and Maiduguri Metropolitan Council, Nigeria, 2024).

Supplementary Files

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- Appendiceslegends.docx
- Supplementarymaterial.zip