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Improving water, sanitation, and hygiene (WASH), with a focus on hand hygiene, globally for community mitigation of COVID-19

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Abstract

Continuity of key water, sanitation, and hygiene (WASH) infrastructure and WASH practices—for example, hand hygiene—are among several critical community preventive and mitigation measures to reduce transmission of infectious diseases, including COVID-19 and other respiratory diseases. WASH guidance for COVID-19 prevention may combine existing WASH standards and new COVID-19 guidance. Many existing WASH tools can also be modified for targeted WASH assessments during the COVID-19 pandemic. We partnered with local organizations to develop and deploy tools to assess WASH conditions and practices and subsequently implement, monitor, and evaluate WASH interventions to mitigate COVID-19 in low- and middle-income countries in Latin America and the Caribbean and Africa, focusing on healthcare, community institution, and household settings and hand hygiene specifically. Employing mixed-methods assessments, we observed gaps in access to hand hygiene materials specifically despite most of those settings having access to improved, often onsite, water supplies. Across countries, adherence to hand hygiene among healthcare providers was about twice as high after patient contact compared to before patient contact. Poor or non-existent management of handwashing stations and alcohol-based hand rub (ABHR) was common, especially in community institutions. Markets and points of entry (internal or external border crossings) represent congregation spaces, critical for COVID-19 mitigation, where globally-recognized WASH standards are needed. Development, evaluation, deployment, and refinement of new and existing standards can help ensure WASH aspects of community mitigation efforts that remain accessible and functional to enable inclusive preventive behaviors.

Introduction

As of November 5, 2021, there have been more than 248 million confirmed cases of coronavirus disease 2019 (COVID-19), of which almost 60 million (a conservative estimate) were in Southeast Asia, Africa, and the Western Pacific regions (1). Multiple waves of COVID-19 cases continue to threaten low- and middle-income countries (LMICs) (2). As of the same date, almost 8 billion doses of COVID-19 vaccines have been administered globally, though comparatively few in LMICs; less than 6% of people in low-income

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Supporting Information:
S1: Inclusivity in Global Health Questionnaire (Checklist)
S2: Data for manuscript

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countries have received at least one dose of a COVID-19 vaccine (3). International collaborative vaccination efforts, such as the COVID-19 Vaccines Global Access (COVAX) project, have procured and shipped 236 million doses to date (4); however, goal levels for COVAX represent doses sufficient for only about 20% of those in LMICs. Reaching high vaccine coverage takes time in these populations: prevention and community mitigation measures to combat COVID-19—such as screening, isolation, quarantine, social distancing, masking, hand hygiene, and regular cleaning (with disinfection as-needed) of surfaces—remain critical to prevention and control offurther waves of COVID-19 in LMICs (5,6).

Functional water, sanitation, and hygiene (WASH) infrastructure and consistent practice of key WASH behaviors are critical for prevention of respiratory and enteric infections (6,7). Regular hand hygiene is a foundational, individually-actionable, and non-pharmaceutical strategy for combatting transmission of COVID-19 (8,9) , whether through handwashing with soap and water or using an alcohol-based hand rub (ABHR) with at least 60% alcohol content. Sources, treatment, and storage of water in quantities sufficient for basic needs (drinking, washing hands) is essential, especially if an individual must isolate or quarantine after infection or recent exposure. Similarly, isolation or quarantine may require functional, well-managed sanitation facilities, including enhanced cleaning and disinfection measures for shared facilities (10).

COVID-19-focused community mitigation guidance for LMICs that incorporates WASH can be developed from existing WASH standards (7). The Joint Monitoring Program (JMP) of the United Nations Children’s Fund (UNICEF) and the World Health Organization (WHO) have published normative criteria for water, sanitation, and hygiene ladders whose “basic” or “safely-managed” criteria can act as minimum standards for WASH access in households (11), schools (12), and healthcare facilities (HCFs) (13). In humanitarian emergencies, Sphere guidance includes minimum standards for core WASH services that may apply to the COVID-19 pandemic, including minimum water quantities for drinking and personal use (e.g., hygiene) and standards for hygiene promotion and hygiene items (14). For displaced populations, the United Nations High Commissioner for Refugees (UNHCR) has identified critical WASH practices to prevent the spread of COVID-19 in refugee locations with high population density and shared WASH services (15).

Before the pandemic, access to essential WASH services in LMICs was poor. Worldwide, 60% of households and 53% of schools had basic hygiene, defined as a handwashing station (HWS) with soap and water, but for United Nations-categorized least developed countries (LDCs), only 28% of households and 26% of schools had this infrastructure (11,16,17). About 74% of HCFs in LDCs had hand hygiene at points of care (18,19). Although water quantity is not directly measured, 74% of households globally—but only 37% in LDCs—had onsite water sources available when needed (11). Onsite water sources were present in 74% of HCFs and 69% of schools globally, but only 50% and 53%, respectively, in LDCs (12,13). Private (unshared) sanitation (categorized as at least basic sanitation) at households was 78% globally, but only 37% in LDCs (11). According to publicly-available data from UNHCR, in 119 sites that submitted data in March 2020, only 34% of refugee households had access to private sanitation; most sanitation facilities were shared (median: 14 people per facility) (20).

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The COVID-19 pandemic adds new considerations to deploying and managing WASH in LMICs (Table 1). For example, hand hygiene technologies—ABHR, handwashing with soap and water, soapy water, or use of chlorinated water—each present benefits but also challenges to ensuring quality control, use at appropriate times, user acceptability, and feasibility of maintenance under high-use conditions. Although there is no evidence to date that SARS-CoV-2 is transmitted through water or feces (21,22), public water sources and sanitation facilities may require additional COVID-19 mitigation measures to reduce crowding and ensure frequently-touched surfaces are cleaned regularly. Increased and competing demand for water for hygiene may also challenge water availability at public sources and storage capacity at households.

Combining existing WASH guidance with community mitigation guidance for COVID-19, we partnered with organizations and governments in LMICs in Latin America and the Caribbean (LAC) and Africa to assess WASH conditions and practices and deploy and manage WASH interventions to mitigate COVID-19. We focused assessments and interventions by setting (HCFs, community institutions, and households), primarily focused on hand hygiene initially. Results from these and other evaluations will strengthen the evidence base for WASH mitigation measures for COVID-19 in LMIC settings and identify new challenges or persisting gaps where further improvements are needed. By building partner capacity to conduct mixed-methods monitoring and evaluation, these projects may also improve sustainability of WASH services.

Methods

Selection of locations and assessment approach

Countries were prioritized based on existing partnerships, CDC country office collaboration, and anticipated risk of COVID-19 transmission and consequences based on existing country resources. Within countries, HCFs were selected by governmental and non-governmental partners based on risk for COVID-19 transmission, program viability, and in-country partner presence. Community institutions that were perceived to be high risk for COVID-19 transmission (e.g., had population mixing in densely-populated areas) were prioritized based on country partner or governmental guidance. In districts or regions with international borders or points of entry (POE), and therefore highly mobile populations, the CDC Population Connectivity Across Borders (PopCAB) toolkit (23) helped identify priority community settings associated with mobile populations, including additional POE and checkpoints, schools, markets, and other priority non-HCF community institutions. Household-level assessments were prioritized through partnerships with organizations that had existing health- or WASH-focused programs in low-resource locations of high-COVID-19 transmission risk, for example densely-populated informal settlements and internally displaced persons (IDP) camps. For all settings, priority locations selected and methods used varied slightly by the population served (e.g., refugee, IDP population, or general community). All settings (HCFs, community institutions, households) underwent WASH assessments and collection of qualitative data [focus group discussions (FGDs) or key informant interviews (KIIs)]; methods in HCF and community institutions were

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similar because new tools required for community institutions were generally derived from HCF-specific tools (Table 2).

Quantitative: WASH Assessments, Knowledge, Attitudes, and Practice Surveys, Hand Hygiene Observations

Where feasible, baseline assessments of WASH conditions used existing tools for assessing WASH in the given setting that were modified to focus on hand hygiene needs for COVID-19. In HCFs, tools included the water and sanitation for health facility improvement tool (WASH FIT), which identifies WASH gaps in HCFs and prioritizes interventions using national and international standards and can be used on a continuous cycle of improvement by facility staff (24). A second tool was the CDC assessment form for HCFs, which focuses on facility services and staff, water supply, sanitation, and hand hygiene resources (appropriate hand hygiene technologies present: ABHR or handwashing stations with soap and water for HCFs specifically (22)) at points-of-care (25). In community institutions, WASH assessments were adapted from HCF-specific tools to target water supply and hand hygiene resources (appropriate hand hygiene technologies present: ABHR, handwashing stations with soap and water, or chlorinated water solutions [only when the other technologies were not available) for community locations (22)) at location entrances and exits [prioritized for hand hygiene by WHO during COVID-19 pandemic (26)] and outside toilets. For households, WASH assessments were adapted from JMP questions to assess household hygiene and water ladders (11) and knowledge, attitudes, and practices (KAP) survey questions were adapted from existing CDC and partner WASH KAP tools with an increased emphasis on handwashing and water access. Questions were added to household WASH and KAP assessment tools on knowledge of COVID-19 prevention and perceptions of local response and mitigation measures. WASH assessments were conducted in all HCFs, community institutions, and households selected. KAP surveys were conducted in all households selected.

Hand hygiene observations were conducted in HCFs and community institutions. In HCFs, observers followed a single provider for three to five patient encounters and noted whether hand hygiene was performed (and the technology used, if performed) before and after patient contact as described for those moments in WHO hand hygiene observation guidance (27). To minimize bias, observers were introduced as observing quality of patient-provider care interactions (similar to structured observations using a mystery shopper method (28)) or as observing general hygiene practices (Guatemala). In community institutions, hand hygiene observations were conducted at locations where hand hygiene materials were present and expected to be used: location entrances and exits and outside latrines (26). Similar to HCFs, practicing/not practicing hand hygiene and the technology used were noted, along with the approximate age of the participant (child, adolescent, adult) to target future messaging. In HCFs, a goal of 3–5 patient contacts for each of 90 providers in HCFs per site (generally 3–5 providers at each HCF in a site). If the goal number of patient contacts could not be attained after 30 minutes following a given provider, the observer was instructed to move on to the next provider at that HCF. In community institutions, observers stood in an inconspicuous location, as far away from a given hand hygiene station as possible while still being able to observe it, and randomly observed someone

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entering/exiting the facility or a random latrine known to be in use and visually followed the individual until either they had performed hand hygiene or passed by the hand hygiene station, whichever came first. For these observations, approximately half of available locations (e.g. individual markets, POE) were selected for hand hygiene observations with a goal of observing a total of 20 hand hygiene events per location. Hand hygiene observations were in locations not serving IDPs or refugee populations.

Qualitative: Focus Group Discussions (FGDs), Key Informant Interviews (KIIs)

Qualitative data—whether collected by FGDs or KIIs—were collected in all settings with differing target participants (Table 2). In most HCFs, FGDs were originally planned, but due to social distancing concerns and limits on the number of individuals in a single space, KIIs usually replaced FGDs (though FGDs were successfully conducted in Belize). KIIs were conducted with healthcare providers, maintenance staff, and administrators to assess behavioral motivators and barriers to practicing hand hygiene before and after patient contact and challenges to managing hand hygiene at the facility. In community institutions, KIIs were conducted with staff and managers to understand barriers and motivators to hand hygiene in that setting and any existing management structures for hand hygiene, if they existed. FGDs were conducted separately with vendors and shoppers at markets to assess challenges to hand hygiene adherence. In households, FGDs were conducted with recipients of handwashing stations and hygiene kits and community volunteers to assess motivators and barriers to hand hygiene. Qualitative tools used in community institutions and households were designed from those used in HCFs. In general, KIIs were conducted at 50% of targeted HCFs and community locations. FGDs in markets were set at five for vendors and five for shoppers.

Schematics:

Schematics were a methodology used in community institutions, but not HCFs or households. Facilitators helped location managers to create drawings showing key locations where hand hygiene should be placed (e.g., entrances/exits, latrines, vendors, public gathering or eating locations), which was subsequently used to identify current hand hygiene resources and future needs.

Guidance for interventions:

Interventions were initiated after—and based on—baseline WASH assessments. Areas of intervention can be found in Table 3. The guidance used or developed for the specific interventions settings is listed below:

HCFs: JMP service ladders and concurrent normative WASH guidance exist for HCFs as of 2017 (13). Additionally, WHO guidance describes WASH-related practices that are important for mitigating the spread of SARS-CoV-2 in HCFs, including engaging in frequent and proper handwashing with soap and water or use of ABHR, implementing regular environmental cleaning and disinfection practices, managing excreta safely, and safely managing healthcare waste produced by COVID-19 cases (22).

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Community institutions: Schools are the only community institution where normative WASH assessments exist via JMP-established service ladders (12). In POE, although governments may provide guidance for national POE, there are no global recommendations for WASH at POE. In 2020, CDC, the WHO and other organizations developed operational considerations and recommendations for COVID-19 mitigation in community institutions in LMIC settings, including markets, schools, humanitarian settings, and high-density urban areas (10,29–36). These recommendations were based on existing CDC and partner guidance where available (e.g., USAID guidance for safe and functioning food markets; WHO guidance for disinfecting environmental surfaces) and emphasized the importance of increasing access to hand hygiene and enhancing environmental cleaning and other control measures in high-use areas such as shared toilets.

Household: Following existing normative WASH standards, ensuring access to at least basic hygiene infrastructure (handwashing materials on premise with both water and soap) is an important global hygiene standard (11,16). Guidance on behavioral messaging focused on key times to practice hand hygiene both generally (e.g., after the toilet, before eating, after coughing or sneezing or blowing one's nose) (9) and during the pandemic (e.g., after being in public spaces) (8,37).

Ethics

Broadly, the WASH assessments conducted and presented in this manuscript were exempt from formal institutional review board (IRB) approvals in Uganda, Kenya, Guatemala, Burkina Faso, and the Democratic Republic of the Congo because they were part of ongoing emergency public health response measures by CDC and local partners to the COVID-19 pandemic. Data collection in Belize and the Dominican Republic required IRB review given it was nested within ongoing data collection efforts. In Belize, protocols for data collection were approved by Baylor College of Medicine and the Belize Ministry of Health and Wellness. In the Dominican Republic, protocols for data collection were approved by the National Council of Bioethics in Health, Santo Domingo; the IRB of Pedro Henriquez Urena National University, Santo Domingo; and Mass General Brigham Human Research Committee, Boston, USA. No deviations to protocols occurred after approvals. Verbal or written informed consent (as suggested by the local partner or review board based on cultural acceptability and other factors) was obtained from healthcare workers prior to observations. Additional information regarding ethical, cultural, and scientific considerations to inclusivity in global research is included in Supporting Information (S1 Checklist).

Results, Interventions, and Monitoring and Evaluation

Healthcare facilities:

WASH baseline assessments have been conducted at 114 HCFs across six countries (Table 4a) and observations of healthcare providers at 54 HCFs in five countries (Table 4b). HCF assessments have been completed in Belize (all government-supported hospitals and several priority outpatient clinics), Burkina Faso (Centre Nord and Est Regions, which served internally-displaced persons; HCFs prioritized by UNICEF and Ministry of Health), Dominican Republic (two large hospitals not in Santo Domingo: HCFs

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prioritized through participation in an acute febrile illness surveillance system to ensure geographic coverage and logistical feasibility of intervention delivery), Guatemala (five municipalities within Quetzaltenango Department: HCFs prioritized through participation in an acute febrile illness surveillance system to ensure geographic coverage and logistical feasibility of intervention delivery), Kenya (Nyando and Nyakach sub-counties in Kisumu County: all HCFs prioritized due to existing partner collaborations and displacement and concurrent flooding risks), and Uganda (community/non-refugee or IDP populations: Amuru and Tororo Districts: HCFs prioritized among non-refugee/IDP populations via PopCAB assessment; refugee/IDP populations: Adjumani, Arua, Madi-Okollo, and Terego Districts: HCFs prioritized by Ministry of Health, UNHCR, and local WASH partners).

HCF infrastructure: Most HCFs had access to an onsite, improved water supply (100% of HCFs in Belize, Dominican Republic, and Kenya program sites, 95% in Guatemala sites, 80% in Uganda sites, 66% in Burkina Faso sites, Table 4a). However, hand hygiene resources at points-of-care were less prevalent: two HCFs surveyed in Belize (18%), three HCFs in Uganda (25% of those surveyed in non-refugee/IDP populations), and two HCFs in Kenya (5%) had access to hand hygiene resources at all points-of-care. All HCFs assessed in Guatemala had hand hygiene resources at 75–99% of points-of-care; 47% in Burkina Faso, 46% in Belize, 33% in Uganda (non-refugee/IDP), 31% in Uganda (refugee/IDP), 5% in Kenya, and 0% in Dominican Republic met this criterion.

HCF hand hygiene adherence: Healthcare providers in participating HCFs had moderate to low levels of hand hygiene adherence around patient contact (49% in Belize, 38% in Uganda, 30% in Guatemala, <25% each in Dominican Republic and Kenya, Table 4b). In all sites, providers practiced hand hygiene more frequently after patient care (range: 25–62% by site) than they did before patient care (9–39%).

Interventions: In all HCFs, interventions included HWS or ABHR at points-of-care and entrances and exits (26), and HWS at toilets (Table 3), with an objective of 100% coverage per HCF. In HCFs serving refugee populations and IDPs, interventions also included distribution of environmental cleaning and hygiene kits (via antenatal clinics), as well as hygiene promotion sessions and trainings on COVID-19 prevention for health facility staff and patients. In HCFs serving general populations, partners implemented ABHR programs using the WHO Guide to Local Production of ABHR (38) to train local technicians in production and distribution models specific to their facility, district, or national needs. Findings from qualitative baseline assessments are also being used to develop behavior change interventions in HCFs.

Monitoring and evaluation: To measure the feasibility, acceptability, use, and sustainability of interventions, monitoring and evaluation tools were developed from baseline assessments. Tools focused on monitoring functionality, availability of soap and water, and water quality at HWS; quantity and quality of ABHR at production facilities; and functionality of dispensers and levels of ABHR consumption by HCFs. Hand hygiene observations will be repeated periodically, with data shared with HCF leadership to provide a feedback loop to inform further trainings and encourage improved hand hygiene

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adherence. Similarly, repeat assessments will be conducted for water storage capacity and environmental cleaning supply quantities.

Community Institutions:

To-date, WASH assessments of community institutions have been conducted in Uganda (10 markets, 15 POE, 7 schools) and DRC (27 schools, Table 5a). Hand hygiene observations have been conducted at all community institutions in Uganda, as well as five vendor- and five shopper-focused FGDs and 16 KIIs. Community institution assessments have been completed in Uganda (Amuru and Tororo Districts) and the DRC (North Kivu and Kasai-Central provinces). In Uganda, schools, POE, lodging locations, markets, and religious institutions were identified via the PopCAB assessment as priority locations with high population mixing in Amuru and Tororo Districts. In the DRC, schools were selected in Goma and Kananga to complement ongoing CDC work on cholera and in key areas identified for COVID-19 mitigation.

Markets: Markets in Uganda had poor access to water (44% had an improved water source onsite) and HWS (50% had any HWS, Table 5a). Observed hand hygiene at key times was moderate and better than other community settings observed: 58% of people entering/exiting markets were observed to clean their hands and 63% of people cleaned their hands after using the latrine (Table 5b).

KIIs with market managers in Uganda revealed support for both HWS (for vendors and visitors whose hands get heavily soiled) and ABHR (for speed and convenience) onsite and suggested that hand hygiene should be enforced by a monitor at market entrances. Managers felt staff and customers would need education on effective hand hygiene and suggested using posters with strong visual aids.

FGDs among vendors and shoppers found that hand hygiene stations at entrances/exits, though considered essential, were not easily accessible for vendors. Additional stations within the market were recommended to improve access. Additionally, most HWS installed in the early months of the pandemic were no longer functioning due to lack of management plans or identified responsibilities. Both vendors and shoppers believed that hand hygiene was effective for preventing COVID-19 and were motivated to practice hand hygiene to protect themselves, their children, and friends from disease, as well as to feel and appear clean.

POE: Many, but not all, POE had access to an improved water source onsite (71%) and HWS (60%), including at entrances and exits (71%, Table 5a). However, only 19% of people entering or exiting the POE cleaned their hands and only 42% of people cleaned hands after using the latrine (Table 5b).

Based on KIIs, ABHR was identified as a more convenient method for hand hygiene due to the high volume of travelers and number of contact events between POE staff and travelers. However, poor access to and high cost of ABHR, as well as the layout of some POE, challenged consistent access to hand hygiene for staff and travelers. Although some POE

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received ABHR from local HCF, increasing and sustaining ABHR access and improving access to HWS was viewed as a critical priority.

Schools: In Uganda, all schools had access to an improved water supply onsite (100%) and most had handwashing stations (86%), including at entrances/exits (71%, Table 5a). In DRC, although 67% of schools had either temporary or permanent HWS, only 30% had an improved water source available on the premises (Table 5a).

Observed hand hygiene adherence was poor in schools in Uganda: 17% of students or staff entering/exiting the school were observed to clean their hands and only 39% were observed to clean hands after using the latrine (Table 5b).

Based on data from KIIs in Uganda, head teachers felt that it would be best for students to use HWS but that ABHR would be good for visitors and teachers, and particularly for head teachers since they interact with many visitors. ABHR was prohibited from use by children in schools in Kenya by the Ministry of Education due to concerns over their ability to safely and appropriately use it (39).

Interventions: Market and POE interventions focus on improving access to HWS and locally-produced ABHR, as well as hygiene education materials, at key locations (entrances and exits and outside latrines) for staff or visitors (Table 3). Amount of hand hygiene resources required for staff and travelers will vary based on the location size, existing infrastructure or layout, and local regulations. School interventions will focus on ensuring access to hand hygiene at entrances, exits, within classrooms, and within 5 meters of toilets/latrines; hand hygiene promotion; and ensuring sufficient water supply for increased hand hygiene and cleaning needs.

Monitoring and evaluation: Monitoring will focus on functionality of hand hygiene stations (including resources available, usability, and water quality) and ABHR quality and use (where present; Table 3). Periodic evaluations will include intercept interviews with users to assess acceptability of hand hygiene, KIIs and FGDs with staff or managers to assess feasibility of management, observations to assess use, water quality testing of free chlorine residual, and targeted evaluations assessing appropriateness of use cases for ABHR in communities. Tools used will be adapted from baseline assessments.

Households:

To-date, household WASH assessments and KAP surveys have been conducted at 405 households in Burkina Faso (Table 5a). Assessments have been completed in households in areas prioritized by the Ministry of Health in Burkina Faso (Diabo Commune, Est Region; Boroum Commune, Centre Nord Region).

Access to WASH at household level: Almost all households (96%) in sites in Burkina Faso used water from an improved source; however, few (2%) had a handwashing station present (Table 5a).

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Household reported hygiene knowledge, motivators, and barriers: In sites in Burkina Faso, 49% (199/405 household surveyed) reported using water only (no soap) during regular handwashing. In Kenyan informal settlements, FGD participants highlighted that placement of HWS near a doorway served as a reminder to wash hands, but this benefit may not exist where HWS are shared among several households. In such cases, disrepair or abandonment might occur due to perceptions of diminished responsibility. FGD participants discussed the need for inter-household agreements to rotate costs of supplying water and soap.

Interventions: Initial interventions—freestanding, temporary HWS in high traffic areas to maximize the number of households reached per HWS—quickly broke down due to misuse, damage, or theft because resources for full-time operators were not available. Interventions subsequently shifted to household- or compound (groups of households sharing a space)-level HWS. Objectives were to achieve access to at least basic hygiene in households or compounds; to identify barriers, motivators, and gaps to hand hygiene adherence in communities for message development and dissemination; and to monitor utilization and sustainability of approaches to hand hygiene access and messaging. Households received hand hygiene kits (e.g., HWS, 20-L water storage containers, and bars of soap) complemented by awareness campaigns organized with local community health workers to improve knowledge of COVID-19 mitigation measures. In some contexts, hygiene kits were distributed through maternal, newborn and child health activities in HCFs: expectant mothers received a hygiene kit plus face masks, ABHR, and communications materials at their first prenatal visit. Community health workers subsequently provided hygiene promotion messages during prenatal household visits.

Monitoring and Evaluation: To sustain interventions, periodic monitoring and evaluation will be conducted via repeat visits or text/phone-based assessments of functionality of HWS and interviews about acceptability and feasibility of HWS designs and maintenance (Table 3). Tools were adapted from baseline assessments with additional questions focusing on barriers to maintaining hand hygiene stations and adherence.

Discussion, Future Directions, Challenges and Limitations, and Conclusions

The need for at least basic levels of WASH in HCFs, community institutions, and households has only increased during the COVID-19 pandemic. The focus on WASH in HCF just before 2020, accompanied by existing guidance and standards for WASH in schools and households, provided multiple appropriate WASH assessment tools that could be readily adapted for COVID-19-focused assessments. However, in other community institutions such as markets or POE, CDC and WHO created new operational guidance based on existing WASH guidance for other settings and added COVID-19-specific considerations.

Data from baseline assessments conducted to-date demonstrate poor access to hand hygiene resources at key public locations—points-of-care in HCFs, entrances/exits and at toilets

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in community institutions—despite most, except schools in DRC and markets in Uganda, having access to an improved, onsite water supply. Other enabling factors for hand hygiene, such as sufficient water quantity and management plans for restocking supplies and repairing HWS, may need to be prioritized. Local ABHR production may be a cost-effective complement to HWS in appropriate settings and projects are currently scaling the WHO protocol (38) to district, regional, and national levels in five countries.

Where hand hygiene resources were available, healthcare providers and community members had low adherence overall. Healthcare providers were more likely to clean hands after than before patient contact, suggesting that behavioral interventions to improve compliance should increase emphasis on protecting the patient in addition to protecting oneself. Hand hygiene in healthcare contexts requires a multimodal approach, including systems-level change to improve access to hand hygiene materials but also training and education, monitoring of practices, reminders and nudges, and establishment of a culture to reinforce practices (40–42). Community members were more likely to clean hands after the toilet than at entrances/exits, suggesting a need for greater communication of other key times to wash hands, especially during the pandemic (22,26,37). However, models such as the Integrated Behavioral Model for WASH (IBM-WASH) suggest that multiple levels, beyond the individual, should be considered in uptake of WASH behaviors: these include societal, community, interpersonal, and habitual levels (43,44). For example, the context of the pandemic itself may factor into the drivers of hand hygiene uptake, but these behaviors need to be matched to the appropriate technology as well. Further research into methods to prolong outbreak-associated (short-term) behavior change is needed, though evidence suggests that awareness/knowledge-based methods may have limited effect if not addressing multiple societal levels (43–47).

Similar to community and HCF locations, household use of improved water sources was high but access to HWS was poor. HWS targeted to multiple households—via shared or otherwise freestanding community infrastructure—suggest cost-efficient ways to temporarily increase community coverage; however, the absence of management considerations may cause infrastructure to become unusable. Community HWS attached to retail points, schools, and other community institutions can help improve responsible management; however, household- or compound-focused interventions may be more feasible, manageable, and help achieve basic hygiene access for longer term prevention capacity (16).

Future directions:

The new WASH-focused guidance necessitated by the COVID-19 pandemic—including guidance for public places: placement, management, and behavior change communication about hand hygiene in markets, POE, and other community institutions, and who is responsible for these aspects—must be implemented, monitored, evaluated, and improved to maximize feasibility and acceptability while maintaining effectiveness. Though human rights to accessing WASH services in public places has been emphasized by the United Nations General Council (48) and individual nations may have guidance, systematic, global guidance for WASH standards in public places is a gap. The microbiological quality of water

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for handwashing is not currently incorporated into the hygiene ladder (16) and thus is an area of new guidance. Although limited evidence suggests that non-potable water with low-to-moderate *E. coli* contamination still may be effective when used for handwashing (49), the potential for dual-use of water from handwashing stations being consumed because of limited access to basic and safely-managed water services (11) suggests that potable levels of water quality may be necessary in many areas. Within our sites, water for handwashing will be tested at the source and at the handwashing station for free residual chlorine (except if only soapy water for handwashing is present, as this may affect accuracy of chlorine residual measurements). If free residual chlorine levels are <0.2mg/L, an additional sample will be collected for assessment of presence or absence of fecal indicator bacteria.

Sanitation management—for example, development of standard operating procedures (SOPs) to clean and manage public toilets in densely-populated locations and improvement of personal protective equipment (PPE) use by manual pit emptiers to protect themselves and their customers while entering households—should be prioritized as essential services (7). Access to public toilets may be the only means of sanitation access for many globally, and should be managed so as to avoid added risk from communal spaces (7), with similar arguments for improving the hygienic practices of pit emptiers. SOPs for public facilities have often focused on managing fecal waste, but improvements to cleaning and disinfection guidance, social distancing while queuing, and other changes may be necessitated.

ABHR is an effective complement to HWS in HCFs and has logistical and financial savings if produced locally; however, appropriate supply chains for and appropriate use in community settings must be evaluated. In community settings, CDC recommends ABHR when handwashing with water and soap are not practically available (9) because soap and water may be more effective at removing a broader array of microbes, as well as other unknown chemical or organic materials, that may be present on hands (50). Furthermore, ABHR is effective against microbes specifically, but is less likely to effectively inactivate them if hands are visibly dirty (51). Before expanding ABHR in these settings in the short to medium term, evaluations should ensure targeted community settings are appropriate for use of ABHR, with concurrent messaging if necessary to guide users on when to use soap and water vs. ABHR.

In our program sites, access to ABHR in community institutions does not have clear supply chains. In previous work in Uganda, locally-produced ABHR at POE followed HCF supply chains because of Ebola preparedness efforts, but markets, schools, or other key community locations were not included. To ensure sustainable access to ABHR in LMICs, there is a need to evaluate whether HCF-based local production and distribution to non-HCF locations is feasible or if non-HCF-based production and distribution models are needed.

Challenges and limitations:

Sustaining hand hygiene behavior change remains the largest challenge to-date, requiring consistent access to functional hand hygiene stations at key locations, behavioral nudges or reminders to perform hand hygiene at key moments, and local, regional, and national support for hand hygiene integrated across programs (16). Installation of hand hygiene facilities must include plans for their management and repair, including identifying supplies

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and repair parts and personnel responsibilities for restocking, cleaning, maintenance, and repair (52). As in many outbreak situations, rapid deployment of HWS in project sites without concurrent maintenance plans led those stations to quickly deteriorate or become unusable within a year despite longer advertised lifespans (53), which wastes resources and reduces access to hand hygiene. Lack of consistent access to hand hygiene resources may inhibit changes to behavior and development of hand hygiene as a habit (47,54). To ensure sustained hand hygiene access and behavior change, support must come from multiple disciplines (e.g., healthcare, education, WASH partners, community) integrating hand hygiene into new and existing work plans, rather than isolated or temporary initiatives (16).

There are several limitations to consider within the context of these assessments and guidance. Notably, data are site- and context-specific and may not be generalizable to other settings. Although inclusiveness of WASH services by persons with disabilities are priorities for the WASH SDGs, including design of HWS (16), and are being accounted for in design of interventions, they were consistently not enumerated in baseline assessments. Additionally, WASH interventions are one of many tools, including masking, social distancing, and vaccination, that should be implemented for comprehensive community mitigation of COVID-19.

Conclusions:

Within the COVID-19 pandemic, hand hygiene, water supply, and sanitation—all core components of WASH—have greater importance. In LMICs, we adapted common WASH tools for COVID-19 mitigation via rapid, mixed-methods assessments and adapted WASH guidance for settings without existing WASH standards (e.g., community markets, POE), with a focus on hand hygiene initially. We found inadequate hand hygiene access and behavioral adherence across LMIC contexts and settings—HCFs, community institutions, and households— and a need to improve personal and community capacity to follow guidelines for COVID-19 mitigation. These changes may include a need for greater water supply (for handwashing) and improved management of public sanitation facilities. Management of hand hygiene stations represents an area of elevated importance within the ongoing pandemic, for example, keeping HWS functional and well-stocked and ensuring continuous access to ABHR where available. New evaluation of these areas, and subsequent development and refinement of standards and assessment tools, will help ensure that WASH aspects of community mitigation of COVID-19 are accessible, functional, and usable for all.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Data availability:

All data can be found in Supporting Information S2: Dataset.

References:

1. World Health Organization (WHO). World Health Organization Coronavirus (COVID-19) Dashboard [Internet] 2021. Available from: covid19.who.int
2. Salyer SJ, Maeda J, Sembuche S, Kebede Y, Tshangela A, Moussif M, et al. The first and second waves of the COVID-19 pandemic in Africa: a cross-sectional study. Lancet [Internet] 2021;397(10281):1265–75. Available from: 10.1016/S0140-6736(21)00632-2 [PubMed: 33773118]
3. University of Oxford. Our World in Data: Statistics and Research: Coronavirus (COVID-19) Vaccinations [Internet] 2021. Available from: https://ourworldindata.org/covid-vaccinations?country=USA~KEN~UGA~GTM~COD~HND~DOM
4. Gavi. COVAX vaccine roll-out [Internet] 2021. Available from: https://www.gavi.org/covax-vaccine-roll-out
5. Zhang Y, Quigley A, Wang Q, MacIntyre CR. Non-pharmaceutical interventions during the roll out of covid-19 vaccines. BMJ 2021;375(n2314):1–4.
6. Donde OO, Atoni E, Muia AW, Yillia PT. COVID-19 pandemic: Water, sanitation and hygiene (WASH) as a critical control measure remains a major challenge in low-income countries. Water Res 2021;191:2016–21.
7. Howard G, Bartram J, Brocklehurst C, Colford JM, Costa F, Cunliffe D, et al. COVID-19: Urgent actions, critical reflections and future relevance of “WaSH”: Lessons for the current and future pandemics. J Water Health 2020;18(5):613–30. [PubMed: 33095188]
8. Centers for Disease Control and Prevention. COVID-19: How to Protect Yourself and Others [Internet] 2021. Available from: https://www.cdc.gov/coronavirus/2019-ncov/prevent-getting-sick/prevention.html

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

9. Centers for Disease Control and Prevention. Handwashing: Clean Hands Save Lives [Internet] 2021. Available from: https://www.cdc.gov/handwashing/index.html
10. Centers for Disease Control and Prevention. Cleaning and Disinfecting Your Home [Internet] 2021. Available from: https://www.cdc.gov/coronavirus/2019-ncov/prevent-getting-sick/disinfecting-your-home.html#DisinfectHome
11. UNICEF and World Health Organization. Progress on Household Drinking Water, Sanitation, and Hygiene 2000–2020 2021;
12. WHO/, UNICEF. Special Focus on Covid-19 Who/Unicef Joint Monitoring Programme for Water Supply, Sanitation and Hygiene Progress on Drinking Water, Sanitation and Hygiene in Schools [Internet] 2020. 7–9 p. Available from: https://washdata.org
13. World Health Organization (WHO), UNICEF. WASH in Healthcare Facilities: Global Baseline Report [Internet] 2019. Available from: http://apps.who.int/bookorders.
14. Sphere. The Sphere Handbook: Humanitarian Charter and Minimum Standards in Humanitarian Response [Internet] Vol. 1, CHS Alliance, Sphere Association and Groupe URD. 2018. 402 p. Available from: www.practicalactionpublishing.org/sphere
15. UNHCR. Emerging Practices: Wash and Covid 19 field practices 2020; Available from: https://reporting.unhcr.org/sites/default/files/WASH Emerging Practices COVID-19_v5.pdf
16. UNICEF. State of the World's Hand Hygiene: A global call to action to make hand hygiene a priority in policy and practice New York; 2021.
17. WHO, UNICEF. Drinking water, sanitation and hygiene in schools: global baseline report 2018. WHO/UNICEF Joint Monitoring Programme for Water Supply SAH, editor. https://data.unicef.org/wp-content/uploads/2018/08/JMP-WASH-in-Schools-WEB.pdf; 2018.
18. WHO/UNICEF. Hygiene Baselines pre-COVID-19 Global Snapshot Source: WHO/UNICEF Joint Monitoring Programme for Water Supply, Sanitation and Hygiene 2020;1–7. Available from: https://www.wsp.org/sites/wsp/files/publications/WSP-Practical-Guidance-Measuring-Handwashing-Behavior-2013-Update.pdf
19. World Health Organization. Global progress report on wash in health care facilities 2020.
20. UNHCR. WASH Dashboard Overview [Internet] 2021. Available from: https://wash.unhcr.org/wash-dashboard-for-refugee-settings/
21. Centers for Disease Control and Prevention. Healthy Water [Internet] 2021. Available from: https://www.cdc.gov/healthywater/
22. WHO. Water, sanitation, hygiene, and waste management for SARS-CoV-2, the virus that causes COVID-19. Interim Guid [Internet] 2020;(29 July):1–11. Available from: https://www.who.int/publications/i/item/water-sanitation-hygiene-and-waste-management-for-the-covid-19-virus-interim-guidance
23. Centers for Disease Control and Prevention. Population Connectivity Across Borders (PopCAB) Toolkit [Internet] 2021. Available from: https://www.cdc.gov/coronavirus/2019-ncov/global-covid-19/popcab-toolkit.html
24. World Health Organization. Water and sanitation for health facility improvement tool (WASH FIT) [Internet] 2021. Available from: https://www.who.int/publications/i/item/9789241511698
25. Centers for Disease Control and Prevention. Global Water, Sanitation, and Hygiene (WASH): Data Collection Tools and Communication [Internet] 2020. Available from: https://www.cdc.gov/healthywater/global/healthcare-facilities/tools.html
26. World Health Organization. WHO: Interim Recommendation on Obligatory Hand Hygiene against transmission of COVID-19 2020;2–4.
27. Sax H, Allegranzi B, Chraïti MN, Boyce J, Larson E, Pittet D. The World Health Organization hand hygiene observation method. Am J Infect Control 2009;37(10):827–34. [PubMed: 20004812]
28. Douglas J Mystery shoppers: An evaluation of their use in monitoring performance. TQM J 2015;27(6):705–15.
29. Centers for Disease Control and Prevention. Framework for Implementation of COVID-19 Community Mitigation Measures for Lower-Resource Countries [Internet] 2020. Available from: https://www.cdc.gov/coronavirus/2019-ncov/global-covid-19/community-mitigation-measures.html

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

30. Centers for Disease Control and Prevention. How to mitigate COVID-19 transmission in densely populated areas globally 2021.
31. Centers for Disease Control and Prevention. Operational Considerations for Preventing COVID-19 Transmission in Schools in non-U.S. Settings [Internet] 2021. Available from: https://www.cdc.gov/coronavirus/2019-ncov/global-covid-19/schools.html
32. UNICEF, UNESCO, WHO. Considerations for school-related public health measures in the context of COVID-19 and social measures in the context of COVID-19 2020;(September):1–10. Available from: https://www.who.int/publications/i/item/considerations-for-school-related-public-health-measures-in-the-context-of-covid-19
33. Centers for Disease Control and Prevention. Mitigation measures for COVID-19 in households and markets in non-US low-resource settings [Internet] 2020. Available from: https://www.cdc.gov/coronavirus/2019-ncov/global-covid-19/global-urban-areas.html?CDC_AA_refVal=https%3A%2F%2Fwww.cdc.gov%2Fcoronavirus%2F2019-ncov%2Fglobal-covid-19%2Fmarkets.html
34. Centers for Disease Control and Prevention. Considerations for Outdoor Farmers Markets (archived) [Internet] 2020. Available from: https://www.cdc.gov/coronavirus/2019-ncov/community/outdoor-farmers-markets.html
35. USAID. Responding to COVID-19's Impact on Resilience and Food Security [Internet] 2020. Available from: https://www.usaid.gov/who-we-are/organization/bureaus/bureau-resilience-and-food-security/responding-to-covid-19-impact-on-resilience-and-food-security
36. World Health Organization. Cleaning and disinfection of environmental surfaces in the context of COVID-19 [Internet] 2020. Available from: https://www.who.int/publications/i/item/cleaning-and-disinfection-of-environmental-surfaces-inthe-context-of-covid-19
37. Centers for Disease Control and Prevention. COVID-19: Handwashing [Internet] COVID-19. 2021. Available from: https://www.cdc.gov/coronavirus/2019-ncov/global-covid-19/handwashing.html
38. World Health Organization (WHO). Guide to Local Production: WHO-recommended Handrub Formulations Introduction: Who [Internet] 2010;(April):9. Available from: https://www.who.int/gpsc/5may/Guide_to_Local_Production.pdf
39. Waithera A Students will not be allowed to handle hand sanitisers: Magoha. The Star [Internet] 2021; Available from: https://www.the-star.co.ke/news/2021-01-02-students-will-not-be-allowed-to-handle-sanitisers-magoha/
40. Bert F, Giacomelli S, Ceresetti D, Zotti CM. World Health Organization Framework: Multimodal Hand Hygiene Strategy in Piedmont (Italy) Health Care Facilities. J Patient Saf [Internet] 2019;15(4):317–21. Available from: http://search.ebscohost.com/login.aspx?direct=true&db=cin20&AN=140082277&site=ehost-live [PubMed: 28079641]
41. World Health Organization. WHO Guidelines on Hand Hygiene in Health Care [Internet] Geneva; 2009. Available from: https://www.ncbi.nlm.nih.gov/books/NBK144013/pdf/Bookshelf_NBK144013.pdf
42. Pittet D Improving Adherence to Hand Hygiene Practice : A Multidisciplinary Approach 2001;7(2):234–40.
43. Dreibelbis R, Winch P, Leontsini E, Hulland KR, Ram PK, Unicomb L, et al. The integrated behavioural model for water, sanitation, and hygiene: a systematic review of behavioural models and a framework for designing and evaluating. BMC Public Health 2013;13(1015):1–13. [PubMed: 23280303]
44. Hulland KRS, Leontsini E, Dreibelbis R, Unicomb L, Afroz A, Dutta NC, et al. Designing a handwashing station for infrastructure-restricted communities in Bangladesh using the integrated behavioural model for water, sanitation and hygiene interventions (IBM-WASH). BMC Public Health 2013;13(1).
45. Caris MG, Labuschagne HA, Dekker M, Kramer MHH, van Agtmael MA, Vandenbroucke-Grauls CMJE. Nudging to improve hand hygiene. J Hosp Infect [Internet] 2018;98(4):352–8. Available from: 10.1016/j.jhin.2017.09.023 [PubMed: 28974467]
46. Lawson A, Vaganay-Miller M. The effectiveness of a poster intervention on hand hygiene practice and compliance when using public restrooms in a university setting. Int J Environ Res Public Health 2019;16(24).

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

47. Mbakaya BC, Lee PH, Lee RL. Hand Hygiene Intervention Strategies to Reduce Diarrhoea and Respiratory Infections among Schoolchildren in Developing Countries: A Systematic Review. Int J Environ Res Public Heal [Electronic Resour [Internet] 2017;14(4):1. Available from: http://ovidsp.ovid.com/ovidweb.cgi?T=JS&CSC=Y&NEWS=N&PAGE=fulltext&D=med13&AN=28368323

48. General Assembly of the United Nations. Human rights to water and sanitation in spheres of life beyond the household with an emphasis on public spaces. Human Rights Council, Forty-second session 2019.

49. Verbyla ME, Pitol AK, Navab-Daneshmand T, Marks SJ, Julian TR. Non-Potable Water for Hygiene: A Risk-Based Assessment of Handwashing Water Quality. Environ Sci Technol 2019;

50. Centers for Disease Control and Prevention. Show Me the Science -- When & How to Use Hand Sanitizer in Community Settings [Internet]. Handwashing: Clean Hands Save Lives 2020. Available from: https://www.cdc.gov/handwashing/show-me-the-science-hand-sanitizer.html

51. Todd ECD, Michaels BS, Holah J, Smith D, Greig JD, Bartleson CA. Outbreaks where food workers have been implicated in the spread of foodborne disease. Part 10. Alcohol-based antiseptics for hand disinfection and a comparison of their effectiveness with soaps. J Food Prot 2010 Nov;73(11):2128–40. [PubMed: 21219730]

52. Knight J, Kontos L, Forte JDC, Muktadir G, Gautam OP. Technical Guide for handwashing facilities in public places and buildings. Wateraid [Internet] 2020;(August). Available from: https://washmatters.wateraid.org/sites/g/files/jkxoof256/files/technical-guide-for-handwashing-facilities-in-public-places-and-buildings.pdf

53. UNICEF. Handwashing Stations and Supplies for the COVID-19 response. UNICEF Fact Sheet 2020;(May):1–14.

54. Jacqueline D Beyond tippy-taps: The role of enabling products in scaling up and sustaining handwashing. Waterlines 2010;29(4):304–14.

55. Kratzel A, Kratzel A, Todt D, V'kovski P, Steiner S, Steiner S, et al. Inactivation of Severe Acute Respiratory Syndrome Coronavirus 2 by WHO-Recommended Hand Rub Formulations and Alcohols. Emerg Infect Dis 2020;26(7):1592–5. [PubMed: 32284092]

56. Wolfe MK, Wells E, Mitro B, Desmarais AM, Scheinman P, Lantagne D. Seeking clearer recommendations for hand hygiene in communities facing Ebola: A randomized trial investigating the impact of six handwashing methods on skin irritation and dermatitis. PLoS One 2016;11(12):1–17.

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Table 1:

Considerations for WASH systems and interventions with a focus on COVID-19 in LMICs

Sub-topic	Setting			COVID-19 considerations
Water	**Healthcare**	**Household**	**Community Institution**	
Water source	X	X	X	● Shared sources present additional public space-associated exposure risks ● Increased water demand for hygiene purposes ● Need for enhanced cleaning and disinfection protocol ● Access to improved water sources suggested for handwashing (9,22,37)
Water storage	X	X	X	● Increased storage required for high quantities of water needed for hygiene to combat COVID-19 (to avoid additional need for water collection)
Water treatment	X	X	X	● If excess demand for water for handwashing leads to use of unimproved or otherwise highly contaminated sources, demand for and use of water treatment products may increase (9,22,37)
Sanitation				
Private sanitation		X		● Use of onsite systems requires emptying ● If one facility per household, need for messaging to guide cleaning and disinfection between users when one or more household members may be quarantining (10) ● Individuals without private sanitation at their household cannot effectively isolate or quarantine
Public/shared sanitation	X	X	X	● Sharing of spaces/queueing in line could present additional exposure risks ● Need for enhanced cleaning and disinfection protocol
Hygiene				
Access to hand hygiene	X		X	● Hand hygiene stations must be placed in key public locations (26) and maintained by staff to ensure consistent functionality ● Hand hygiene stations should be sized/adjusted to ensure access for children and those with disabilities ● Hand hygiene stations may require enhanced cleaning and disinfection protocols, adding to maintenance requirements
Hand hygiene technologies	X	X	X	● Effective by inactivating (ABHR) (55) or physically removing (soap and water) SARS-CoV-2 ● Risk of theft exists for all technologies (e.g., theft of ABHR, soap)
ABHR	X	X	X	● Expensive if not locally produced ● Local production guides exist for single healthcare facilities only (38), adaptations to production and distribution needed for expansion to whole districts or outside of healthcare facilities ● Drying materials not required ● Potential for variable quality control/regulation of alcohol content
		X	X	● Limited exposure to ABHR in non-healthcare populations: potential for misuse/ineffective use (e.g., use on visibly soiled hands), may incur low acceptability generally and amongst specific populations (e.g., religious groups that do not use alcohol) ● Not a substitute for handwashing with soap and water in all situations (e.g., visibly dirty hands)
HWS	X	X	X	● Works primarily by removing, rather than inactivating, SARS-CoV-2 regardless of presence of dirt/other chemicals on hands ● Requires drying materials that are generally not available; drying hands in air can be time-consuming and difficult to adhere to ● *Liquid soap*: reduced risk of theft compared with bar soap, more expensive and requires more refills; may be more acceptable ● *Soapy water*: requires staff/household members to mix soap concentration appropriately; soap alters measurements of chlorine residual in final solution (monitoring of water quality for handwashing is more difficult); may require additional water to rinse with ● *(0.05% solution) chlorinated water*: requires staff/household members to mix bleach concentrations; consistent source of

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Sub-topic	Setting			COVID-19 considerations
Water	Healthcare	Household	Community Institution	
				chlorine can be difficult[3]; risk of children drinking; can be harsh on skin/issues with broken skin (56); may be religious/cultural barriers to using chlorine; should only be used if soap and water or ABHR are not available (26)

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Table 2:

Methods Table

Setting	Method (target group, location, and/or time)							
	WASH assessment[1]	**FGDs[2]**	**KIIs[3]**	**KAP surveys[4]**	**Hand hygiene observations[5]**	**PopCAB[6]**	**Schematics[7]**	**Water quality testing[8]**
Healthcare	Yes (points of care)	Yes	Yes	Yes	Yes (before/after patient contact)	No	No	Yes
Household	Yes	Yes (household heads, community health volunteers)	No	Yes (household members)	No	No	No	No
Community Settings and Institutions	Yes (entrances/exits, outside latrines, and other gathering spots)	Yes (market staff and patrons, manual pit emptiers)	Yes	Yes (manual pit emptiers)	Yes (entrances/exits, after latrine use)	Yes	Yes	Yes

[1] Water, sanitation, and hygiene assessment including interviews and observations about hand hygiene materials; CDC assessment or WASH FIT used for healthcare settings.

[2] Focus group discussions focused on hand hygiene barriers/motivators, beliefs, and acceptability of materials. FGDs with HCF providers planned but shifted to KIIs due to COVID-19 restrictions

[3] Key informant interviews with HCF providers, managers or supervisors of locations; focused on hand hygiene needs and preferences for hand hygiene technology and maintenance.

[4] Knowledge, attitudes, and practices surveys focused on hygiene.

[5] Observations of hand hygiene (use of a handwashing technology) at key locations/times dependent on setting; documented if hand hygiene was present but unused or completely absent.

[6] Population Connectivity Across Borders Toolkit: used in districts/locations with points of entry to prioritize community settings and healthcare facilities for intervention (hand hygiene) based on amount of population movement; includes FGDs and KIIs with participatory mapping.

[7] Following PopCAB, location managers drew schematic diagrams indicating key areas of locations where hand hygiene is present or would be needed (outside latrines) or wanted.

[8] Planned but not yet begun. Water for handwashing testing for free chlorine residual at source or HW station via color wheel test; additional *E. coli* testing via IDEXX Quantitray (IDEXX, Westbrook, Maine, US) completed if free chlorine residual <0.2mg/L.

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Table 3:

Interventions, monitoring, and evaluation

Setting	Intervention	Countries (Reach)	Monitoring and Evaluation
Healthcare	- Increase access to hand hygiene at points of care, entrances/exits, and toilets via handwashing stations or ABHR	10 (177 HCF)	- Monitor ABHR use, alcohol content, functionality of hand hygiene materials (handwashing stations, ABHR stations) - Observe hand hygiene practices of staff - Conduct KIIs/FGDs and intercept interviews with staff and patients - Conduct onsite HWS water quality testing (free chlorine and *E. coli*)
	- Distribute information, education, and communication (IEC) materials focusing on hygiene education		
	- Supplement existing or establish new local ABHR production units and distribution plans	7 (100 HCF)	
	- Increase capacity for water storage onsite	3 (48 HCF)	
	- Improve access to environmental cleaning supplies	2 (35 HCF)	
	- Provide hygiene kits for expectant mothers at prenatal clinics	1 (13 HCF)	
	- Promote chlorination of water supplies	1 (10 HCF)	
	- Provide refresher training on appropriate hand hygiene practices, addressing knowledge gaps	1 (11 HCF)	
Households	- Increase household access to handwashing stations and/or hygiene materials	6 (4,830 households)	- Observe functionality of HWS - Conduct interviews with users/household heads
Community (general)	- Expansion of water supply - Where households are connected to municipal water supplies, minimize service disruptions to ensure adequate water supply for handwashing and cleaning	1 (2 districts)	- Monitor functionality of HWS - Conduct KIIs/FGDs and intercept interviews with vendors/managers and visitors
	- Hand hygiene stations at transit hubs, key community congregation points	1 (25 locations)	
Schools	- Expansion of water supply	1 (27 schools)	- Monitor functionality of HWS - Conduct KIIs/FGDs and intercept interviews with teachers and students - Conduct onsite HWS water quality testing (free chlorine and *E. coli*)
	- Increased access to hand hygiene stations for staff and students, including at entrances, exits, within classrooms, and within 5 meters of toilets/latrines - Hand hygiene promotion/education - Increased frequency of hand hygiene, particularly for small children and at key moments (at school arrival, before snacks and lunch, and before school exit)	6 (64 schools)	
	- Staggering bathroom breaks - Frequent cleaning of school toilets	2 (13 schools)	
Markets	- Increased access to functional hand washing stations for staff	2 (13 markets)	- Monitor ABHR use, alcohol content, functionality of hand hygiene materials - Observe hand hygiene practices among visitors and vendors

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Setting	Intervention	Countries (Reach)	Monitoring and Evaluation
	- Increased access to ABHR for staff and patrons - Improved hand hygiene education materials		- Conduct KIIs/FGDs and intercept interviews with vendors/managers and visitors - Conduct onsite HWS water quality testing (free chlorine and *E. coli*) - Conduct assessments of hand dirtiness before ABHR use to evaluate appropriateness of ABHR in community settings
Points of entry	- Increased access to functional hand washing stations for staff - Increased access to ABHR for staff and travelers, which may require modifying the flow of travelers through the POE - Improved hand hygiene education materials	1 (15 POE)	- Monitor ABHR use, alcohol content, functionality of hand hygiene materials - Observe hand hygiene practices among visitors and vendors - Conduct KIIs/FGDs and intercept interviews with vendors/managers and visitors - Conduct onsite HWS water quality testing (free chlorine and *E. coli*) - Conduct assessments of hand dirtiness before ABHR use to evaluate appropriateness of ABHR in community settings

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Table 4a:

Healthcare infrastructure

Country	# HCFs	# HCFs with improved onsite water supply (%)	# HCFs with hand hygiene resources at 100% of points-of-care (%)	# HCFs with hand hygiene resources at <75–99% of points-of-care (%)	# HCFs with hand hygiene resources at <75% of points-of-care (%)
Belize	11	11 (100%)	2 (18%)	5 (46%)	4 (36%)
Burkina Faso	15	10 (66%)	0 (0%)	7 (47%)	8 (53%)
Dominican Republic	2	2 (100%)	0 (0%)	0 (0%)	2 (100%)
Guatemala	19	18 (95%)	0 (0%)	19 (100%)	0 (0%)
Kenya	42	42 (100%)	2 (5%)	2 (5%)	38 (90%)
Uganda	12[1]	10 (83%)	3 (25%)	4 (33%)	5 (42%)
	13[2]	10 (77%)	0 (0%)	4 (31%)	9 (69%)

Table 4b: Healthcare hand hygiene observations

Country	# HCFs	Observations where provider practiced hand hygiene (%)[1]	Observations where provider practiced hand hygiene before patient contact	Observations where provider practiced hand hygiene after patient contact
Belize	11	363 (49%)	144 (39%)	219 (59%)
Dominican Republic	2	322 (23%)	62 (9%)	260 (37%)
Guatemala	19	150 (30%)	47 (19%)	109 (44%)
Kenya	10[2]	70 (22%)	31 (20%)	39 (25%)
Uganda	12	167 (38%)	57 (26%)	110 (50%)

[1]Amuru and Tororo Districts, non-refugee/IDP populations, Uganda

[2]Adjumani, Arua, Madi-Okollo, and Terego Districts, refugee/IDP populations, Uganda.

[1]Before patient contact, after patient contact, or both

[2]Enumerators selected a random sample of 10 of the 42 HCFs for observation

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Table 5a:

Household and Community infrastructure

Country	Setting	# locations	# locations with improved water source [1]	# locations with at least one HW station present	# entrances/exits typically have at least one HW station[2]
Burkina Faso	Household	405	388 (96%)	8 (2.0%)[3]	NA
Democratic Republic of the Congo	Schools	27	8 (30%)	18 (67%)	NA
Uganda	Markets	10	4 (44%)[4]	5 (50%)	4 (40%)
	Schools	7	6 (100%)[5]	6 (86%)	5 (71%)
	Points of entry	15	10 (71%)[6]	9 (60%)	10 (71%)[7]

Table 5b: Community hand hygiene observations

Country	Setting	# locations	Observations where hand hygiene was practiced upon entrance/exit to location (%)	Observations where hand hygiene was practiced after latrine use (%)
Uganda	Markets	10	7 (58%)	35 (63%)
	Schools	7	4 (17%)	29 (39%)
	Points of entry	15	20 (19%)	5 (42%)

[1] For households, principal water source accessed is improved; for community infrastructure, locations have an improved water source onsite

[2] Assessed at community institutions only, doesn't assess functionality

[3] 7 households with a handwashing station (88%) had both water and soap present at stations at time of survey

[4] 4/9 because of missing data

[5] 6/6 because of missing data

[6] 10/14 because of missing data

[7] 10/14 because of missing data