

Water, Sanitation and Hygiene Research in Humanitarian Crises: A Project  
Supporting the Child Health & Nutrition Research Initiative (CHNRI)  
Prioritization Exercise

An Honors Thesis for the Department of Civil and Environmental Engineering  
Elsa Sager Rohm

Tufts University, 2022

## TABLE OF CONTENTS

<b>TABLE OF CONTENTS .....</b>	<b>ii</b>
<b>LIST OF TABLES AND FIGURES.....</b>	<b>v</b>
<b>CHAPTER 1: INTRODUCTION.....</b>	<b>1</b>
Section 1.1: Humanitarian Response .....	1
Section 1.2: WASH Response .....	2
Section 1.3: Research Gaps in WASH.....	3
Section 1.4: Goal Overall Project .....	5
Section 1.5: An Example CHNRI for WASH Interventions for Cholera.....	5
Section 1.6: Thesis Work as a Component of Overall Project .....	7
<b>CHAPTER 2: CHNRI METHODOLOGY .....</b>	<b>8</b>
Section 2.1: Selection of Process Managers .....	8
Section 2.2: Specifying the Context in Space, Impact of Interest, and Context in Time .....	9
Section 2.3: Choosing a Limited Set of the Most Useful and Important Criteria...	9
Section 2.4: Rapid Literature Review of WASH in Emergencies .....	12
Section 2.5: Key Informant Interviews with Key Stakeholders .....	13
Section 2.6: Systematic Listing of a Large Number of Proposed Options .....	13
Section 2.7: Selecting Technical Experts to Refine the Number of Research Options.....	20
Section 2.8: Scoring Research Options.....	21
Section 2.9: Calculating Scores for Each Research Option and Assigning Ranks	21
Section 2.10: Feedback and Revision .....	22
<b>CHAPTER 3: RESEARCH QUESTION EXTRACTION FROM THE RAPID LITERATURE REVIEW.....</b>	<b>23</b>
Section 3.1: CHNRI Methodology Step 4 .....	23
Section 3.2: Rapid Literature Review Methodology .....	24
<i>Section 3.2.1: Inclusion criteria.....</i>	<i>24</i>
<i>Section 3.2.2: Exclusion criteria.....</i>	<i>26</i>
Section 3.3: Resulting Extracted Research Questions .....	27
<i>Section 3.3.1: General WASH questions.....</i>	<i>27</i>
<i>Section 3.3.2: Behavior change intervention questions.....</i>	<i>28</i>
<i>Section 3.3.3: Cash and markets questions .....</i>	<i>29</i>

<i>Section 3.3.4: Distribution of hygiene materials and non-food items questions</i>	30
<i>Section 3.3.5: Sanitation questions</i>	31
<i>Section 3.3.6: Water access questions</i>	32
<i>Section 3.3.7: Water quality questions</i>	33
<i>Section 3.3.8: Disinfection materials questions</i>	35
<i>Section 3.3.9: Menstrual hygiene management questions</i>	35
<i>Section 3.3.10: Solid waste disposal question</i>	36
<i>Section 3.3.11: WASH policy questions</i>	37
<i>Section 3.3.12: WASH risk factors questions</i>	37
<b>Section 3.4: Conclusions</b>	<b>38</b>
<b>CHAPTER 4: RESEARCH QUESTION EXTRACTION FROM KEY INFORMANT INTERVIEWS</b>	<b>39</b>
<b>Section 4.1: Methodology for Key Informant Interviews</b>	<b>39</b>
<i>Section 4.1.1: The Importance of the key informant interviews</i>	39
<i>Section 4.1.2: Selection of key informants</i>	39
<i>Section 4.1.3: Key informant interview guide</i>	39
<i>Section 4.1.4: Key informant demographics</i>	40
<b>Section 4.2: Resulting Extracted Research Questions</b>	<b>40</b>
<i>Section 4.2.1: General WASH questions</i>	41
<i>Section 4.2.2: Behavior change intervention questions</i>	42
<i>Section 4.2.3: Cash and markets questions</i>	43
<i>Section 4.2.4: Climate change questions</i>	44
<i>Section 4.2.5: Distribution of hygiene materials and non-food items questions</i>	45
<i>Section 4.2.6: Dead body management questions</i>	47
<i>Section 4.2.7: Sanitation questions</i>	47
<i>Section 4.2.8: Water access questions</i>	48
<i>Section 4.2.9: Management of wastewater and fecal sludge questions</i>	49
<i>Section 4.2.10: Water quality questions</i>	50
<i>Section 4.2.11: Disinfection materials questions</i>	51
<i>Section 4.2.12: Menstrual hygiene management questions</i>	52
<i>Section 4.2.13 Solid waste disposal questions</i>	53

Section 4.2.14: WASH policy questions.....	54
Section 4.2.15: WASH risk factors questions.....	55
Section 4.3: Conclusions.....	<b>56</b>
<b>CHAPTER 5: FINDINGS FROM ADDITIONAL QUESTIONS ASKED DURING KEY INFORMANT INTERVIEWS .....</b>	<b>57</b>
Section 5.1: Methodology.....	<b>57</b>
Section 5.2: Results.....	<b>58</b>
Section 5.2.1: What is the research community doing right? .....	58
Section 5.2.2: What is the research community doing wrong?.....	59
Section 5.2.3: What is the most urgent WASH research gap?.....	60
Section 5.2.4: What WASH research should be stopped? .....	61
Section 5.2.5: What is the value of research?.....	62
Section 5.2.6: What do you look for in research you trust? .....	63
Section 5.2.7: What voices are not included in the research process that should be?.....	63
Section 5.2.8: Is research easily accessible and how could it be made more accessible? .....	64
Section 5.2.9: How will climate change impact research?.....	65
Section 5.2.10: How has COVID-19 revealed research gaps? .....	65
Section 5.3: Conclusions and Recommendations .....	<b>66</b>
<b>CHAPTER 6: SUMMARY AND CONCLUSIONS .....</b>	<b>67</b>
Section 6.1: Summary of Completed Work and Key Findings .....	<b>67</b>
Section 6.1.1: Summary of Completed Work .....	67
Section 6.1.2: Key Findings .....	67
Section 6.2: Value of Work .....	<b>69</b>
Section 6.3: Limitations .....	<b>70</b>
Section 6.4: Next Steps.....	<b>71</b>
Section 6.5 Personal Reflection .....	<b>71</b>
<b>REFERENCES.....</b>	<b>73</b>

## **LIST OF TABLES AND FIGURES**

Table 1. Potential criteria from the CHNRI method

Table 2: Criteria selected by the process managers with weights.

Table 3. The 4D framework

Table 4. Types and definitions of WASH interventions

Table 5: Search terms for rapid literature review

Figure 1: CHNRI methodology outline from Rudan et al., 2016

Figure 2: A PubMed image capture of the number of WASH articles published over time.

Figure 3: Extracted questions from rapid literature review.

Figure 4: Extracted questions from key informant interviews.

# CHAPTER 1: INTRODUCTION

## Section 1.1: Humanitarian Response

Humanitarian emergencies, which include natural disasters, conflicts, and disease outbreaks are occurring more frequently and affecting a larger number of people. During the past two decades, there has been an increase in the number of armed conflicts and natural disasters with the estimation that 235 million people needed the support of humanitarian aid workers in 2021 (Guisolan et al., 2022). Natural disasters (i.e. earthquakes, hurricanes, flooding events, or droughts) can affect more than 200 million people annually, and can cause human displacement (CRED, 2022). More than two billion people are currently potentially threatened by conflict and violence (Development Initiatives, 2020). Of a growing concern is the number of displaced persons as a result of humanitarian emergencies. By the end of 2019, the highest number ever of displaced persons was recorded, at 79 million people worldwide (Development Initiatives, 2020) (UNHCR, 2021). Disease outbreaks have also increased in number and diversity (Smith et al., 2014). 1980 to 2013 saw 12,102 outbreaks in 219 countries, which impacted more than 44 million people. The increase in outbreaks is attributed to adaption of pathogens, changing human susceptibility, climate change, changing human demographics and mobility, economic development, breakdowns in public health, poverty, social inequality, war, and famine.

Humanitarian response refers to the activities taken to provide for the needs of the affected population which often include water, food, sanitation, and

shelter, along with medical care (Leaning and Guha-Sapir, 2013). An essential component of humanitarian response is to improve and protect the health and dignity of the population. It has been recognized that there is an increasing need for humanitarian response as climate change increases the number of natural disasters, conflicts, and disease outbreaks (Guisolan et al., 2022). Climate change is expected to increase not only the scale and frequency of these disasters but also the rapidly expanding populations in disaster-prone regions mean a larger number of people may be impacted (Watts et al., 2017; Watts et al., 2021; Development Initiatives, 2020). Between 2000 and 2009 there were three times as many natural disasters than there were between 1980 and 1989 (Leaning and Guha-Sapir, 2013).

## **Section 1.2: WASH Response**

Water, sanitation, and hygiene (WASH) interventions aim to disrupt the transmission of bacteria, viruses, and parasites. The disruption of transmission is one method of preventing and controlling communicable diseases, which can be of specific concern following a disaster, conflict, or disease outbreak. Emergency WASH interventions should be implemented to provide access to safe water and sanitation and promote good hygiene practices with dignity, comfort, and security (Sphere, 2018). Two systematic reviews conducted in 2019 found that WASH interventions reduce the risk of disease and the risk of disease transmission in outbreak and short-term humanitarian contexts. Water interventions aim to increase water quantity available and/or improve the quality of the water. Sanitation interventions aim to isolate feces from the environment. Hand hygiene

interventions aim to promote awareness of disease risk among affected populations and motivate and equip people to prevent disease transmission via hands. Finally, environmental hygiene interventions reduce disease risks by disinfecting household objects and managing rubbish.

WASH interventions are among the main challenges during a humanitarian response, especially during the acute and recovery phases. The acute phase refers to the responses immediately following an event, usually occurring within the first few weeks. During the recovery phase, the pre-emergency conditions of the affected populations are attempted to be improved upon. WASH interventions are used in a variety of ways including but not limited to, water supply, water treatment, sanitation, hygiene promotion, handwashing promotion, distribution of hygiene materials and other non-food items, menstrual hygiene management, wastewater management, fecal sludge management, solid waste management, and combined WASH programs.

### **Section 1.3: Research Gaps in WASH**

Two systematic reviews, conducted in 2015, concluded that there is a lack of data and evidence on cholera-response and health impact in humanitarian emergencies (Taylor et al., 2015; Ramesh et al., 2015). This weak evidence base was attributed to the prioritization of response activities, the difficulty of conducting research, the lack of technical knowledge and personnel for data collection, and the lack of clear goals for the use of collected data (Spiegel et al., 2007; Ager et al., 2014; Kohrt et al., 2019). Two 2019 broader reviews found that WASH interventions consistently reduced both the risk of disease and the risk of disease transmission

in outbreak and short-term humanitarian contexts. This conclusion was based on an evaluation of quantitative and qualitative outcomes, impact, and influencing contextual factors that contributed to program effectiveness from both published and gray literature (Yates et al., 2018; Yates et al., 2018).

The launch of the WASH sector roadmap in 2020, designed to lead the sector until 2050, led to the Research and Innovation initiative which is co-led by the London School of Hygiene and Tropical Medicine and Tufts University. This initiative is focused on fostering a collaborative environment for research and increasing the ways of working between WASH actors and academic institutions. The operational and academic research community plays an important role in addressing the evidence gap in humanitarian WASH, particularly because there are important research questions that can only be answered within humanitarian contexts and settings (Kohrt et al., 2019; Farrar 2019; Abdelmagid et al., 2019; Blundell et al., 2019; Waldman and Toole, 2017; Samarasekera and Horton, 2017; Duffield et al., 2017; Blanchet et al., 2017). By setting a consensus-based agenda for WASH research in humanitarian crisis, WASH programming will be better informed which is an integral component to global health progress. Further, the consensus-based agenda will ensure WASH responses meet recognized needs and gaps by the sector and ensure fair and direct benefits to participants and include planned dissemination of research to participants, collaborators, and funders (Kohrt et al., 2019).

## **Section 1.4: Goal Overall Project**

The goal of the overall project is to generate a consensus-based research agenda that can steer the WASH in humanitarian crisis field for the next ten years. This thesis served as a component of the overall CHNRI project. The objective of the overall project was to identify priority areas of research that are rigorous and respond to WASH policy and practice questions.

It was decided that the Child Health and Nutrition Research Initiative (CHNRI) method would be used for the identification of the WASH research priorities in a transparent, consultative, comprehensive, and replicable way (Rudan et al., 2008; Yoshida et al., 2016; Rudan et al., 2016; Rudan et al., 2016). The CHNRI method was chosen specifically for the way it can generate a prioritization in a consensus-based manner.

## **Section 1.5: An Example CHNRI for WASH Interventions for Cholera**

An example of a successful CHNRI methodology was completed in 2019 to identify research gaps for WASH interventions for cholera prevention and control. The literature review found 42 knowledge gaps and the key informant interviews found 59 knowledge gaps. Once the knowledge gaps were screened for duplication and merged based on similar topics, there were 41 total gaps for distribution. After distribution and scoring, four questions received the highest priority score. These questions were as follows:

1. What WASH products (kits) should be distributed to people affected by cholera to enable them breaking household transmission routes? How does this vary by context?
2. What method of delivery works best for household intervention (including household decontamination and household water treatment)?
3. How can oral cholera vaccine campaigns leverage existing WASH?
4. Which WASH interventions are the most effective at reducing within household and community-level transmission of cholera?

Four questions were also grouped into the next highest priority. These questions are as follows.

1. What would be the methodology to prioritize cholera hotspot for WASH and Oral Cholera Vaccine intervention?
2. Which WASH rapid response teams' intervention modalities are the most effective during cholera outbreak?
3. When and where is it effective to combine WASH package and oral cholera vaccine, and oral cholera vaccine plus chemoprophylaxis?
4. Which targeted approaches are the most effective depending on the stage of the cholera outbreak and on the transmission routes and contexts?

The success of the CHNRI methodology for WASH cholera responses encouraged the selection of this method for the WASH in humanitarian crises research prioritization exercise.

## **Section 1.6: Thesis Work as a Component of Overall Project**

This thesis represents work starting in June 2021 that was done as a component of the CHNRI prioritization for WASH interventions during humanitarian crises.

This thesis comprises a rapid literature review and key informant interviews for the development of research gaps. Analysis was also completed for key informant interview findings for characterization of the humanitarian WASH research sector.

## CHAPTER 2: CHNRI METHODOLOGY

### Section 2.1: Selection of Process Managers

The CHNRI methodology, which has been refined over many years and has been used in several other sectors to assist stakeholders in prioritizing health research investments, consists of ten steps. Figure 1 presents the three main stages of the CHNRI methodology. The work of this thesis focused on the first stage of collecting research gaps.

The first step is the selection of the process managers, which are a small team of people that represent investors in health research, their interests, and their visions. The process managers are comprised of the research team and other individuals based at the London School of Hygiene and Tropical Medicine and Tufts University and representatives from the technical working groups of the Global WASH cluster. The process managers are selected to represent a diversity of research areas and interests.

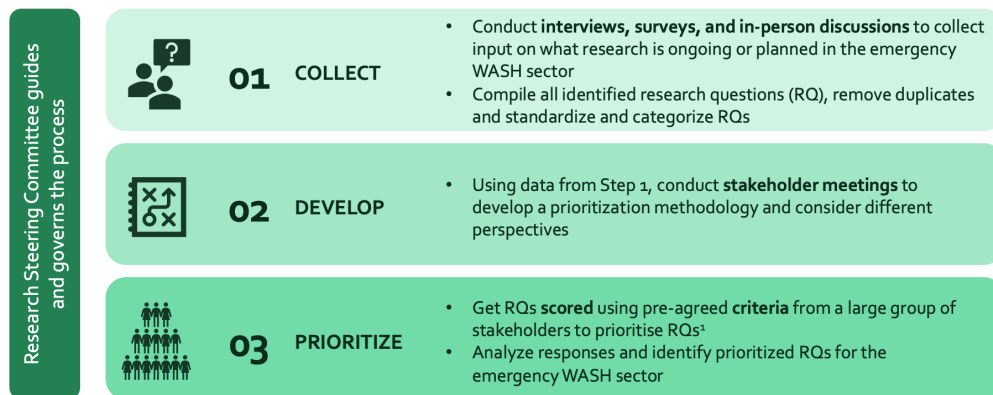


Figure 1: CHNRI methodology outline from Rudan et al., 2016

## **Section 2.2: Specifying the Context in Space, Impact of Interest, and Context in Time**

The second step occurred when the process managers selected the context in space, health and social outcomes, and context in time for the research. Context in space refers to the target population in which investments in research would contribute to a reduction in the burden of disease or social outcomes. The context of interest is all countries and communities affected by or at-risk of humanitarian crises at global, regional, country, and local levels. The impact of interest refers to the health or social outcomes that would be addressed by the research. Context in time refers to the period of time in which research results would be produced. The context in time is the present day to 2030.

## **Section 2.3: Choosing a Limited Set of the Most Useful and Important Criteria**

The process managers were also tasked with selecting five criteria from a set recommended by the CHNRI method against which the research questions will be judged (Table 1). The process managers distributed 100 points across the four criteria based on the perceived level of importance. The selected criteria are impact, answerability, relevancy, potential for translation, and implementability (Table 2). The proposed weights were then determined by dividing the mean value allocated to each criterion by 25. The final list of criteria is built into how the research questions are critiqued (Table 2).

*Table 1. Potential criteria from the CHNRI method*

<b>Criteria</b>	<b>Definition</b>
Answerability	Some health research options will be more likely to be answerable than the others
Attractiveness	Some health research options will be more likely to lead to publications in high-impact journals
Novelty	Some health research options will be more likely to generate truly novel and non-existing knowledge
Potential for translation	Some health research options will be more likely to generate knowledge that will be translated into health intervention
Effectiveness/ Impact	Some health research options will be more likely to generate/improve truly effective health interventions
Affordability	The translation or implementation of knowledge generated through some health research options will not be affordable within the context
Deliverability/ Implementability	Some health research options will lead to/impact health interventions that will not be deliverable within the context
Sustainability	Some health research options will lead to/impact health interventions that will not be sustainable within the context
Ethical aspects	Some health research options will seem more justified and acceptable to general public than the others

Maximum potential impact	Some health research options will have a theoretical potential to reduce much larger portions of the existing disease burden than the others
Equity	Some health research options will lead to health interventions that will only be accessible to the privileged in the society/ context, thus increasing inequity
Community involvement	Some health research options will have more additional positive side-effects through community involvement
Cost and feasibility	All other criteria being equal, some research options will still require more funding than the others and thus be less feasible investments
Likelihood of generating patents/lucrative products	Some research options will have greater likelihood of generating patents or other potentially lucrative products, thus promising greater financial return on investments, regardless of their impact on disease burden

*Table 2: Criteria selected by the process managers with weights.*

<b>Criteria</b>	<b>Definition</b>	<b>Weight</b>
Impact	Some health research options will be more likely to generate/improve truly effective health interventions	0.96
Answerability	Some health research options will be more likely to be answerable than the others	0.92
Relevancy	Some health research options will be more relevant than others	0.92
Potential for translation	Some health research options will be more likely to generate knowledge that will be translated into health intervention	0.88
Implementability	Some health research options will lead to/impact health interventions that will not be deliverable within the context	0.83

## **Section 2.4: Rapid Literature Review of WASH in Emergencies**

A rapid scoping review of WASH in humanitarian crises was conducted to inform the listing of potential research questions. A systematic review was not possible due to the timing and resources available. The rapid literature review was structured in line with PRISMA guidelines for scoping reviews (Tricco et al., 2018) (PRISMA-ScR, 2018), including defined inclusion and exclusion criteria.

The rapid literature review aimed to present a thematically comprehensive synthesis of relevant papers published after 2016 to supplement the previously conducted systematic review. The rapid literature review was one of the key components of the thesis.

## **Section 2.5: Key Informant Interviews with Key Stakeholders**

23 key informant interviews were conducted with WASH researchers, technical working group leads, and the member agencies of the Global WASH cluster. Interviewees were purposefully selected to reflect various professional, geographical, and gender configurations. The interviews were semi-structured and asked respondents to detail published, existing, or upcoming research within their agency or working group. A topic guide was developed for the interviews to aid the consistent reporting of research projects and research options within agencies or technical working groups. Participants were also asked about perceived WASH research gaps. Research questions from the rapid scoping review and the key informant interviews was combined into one central dataset. The key informant interviews were one of the main components of the thesis.

## **Section 2.6: Systematic Listing of a Large Number of Proposed Options**

The CHNRI method recommends listing the large number of proposed research options using the 4D framework in which research options are grouped around four themes: description, delivery, development, and discovery (Table 3).

“Description” refers to research to assess the burden of WASH-related health and social outcomes and their determinants in humanitarian crises. “Delivery” refers to research that prevents poor health and social outcomes using already available interventions. “Development” refers to research to improve existing interventions to better improve health and social outcomes. “Discovery” refers to research that may lead to innovations or completely new interventions.

<i>Table 3. The 4D framework</i>	
Description	Measuring the burden of WASH related health and social outcomes
	Understanding the risk factors of WASH-related health and social outcomes
	Measuring prevalence of exposure to risk factors of WASH-related health and social outcomes
Delivery	Evaluating the efficacy of WASH interventions in a laboratory setting
	Evaluating the efficacy and effectiveness of WASH interventions in place
	Evaluating the financial / cost analysis of WASH interventions in place
	Evaluating the provision of WASH infrastructure or WASH system strengthening
	Evaluating the human resources/ coordination constraints or requirements
	Evaluating responsiveness and operational feasibility of WASH interventions in place
Development	Improving existing interventions (affordability)
	Improving existing interventions (deliverability)
	Improving existing interventions (effectiveness)

	Improving the responsiveness and operational feasibility of WASH interventions in place
Discovery	Basic, clinical, and public health research to advance on existing knowledge to develop new capacities
	Basic, clinical, and public health research to explore entirely novel ideas to develop new capacities
	Basic, clinical, and public health research to explore entirely novel ideas to develop new interventions

Each of the research questions were also assigned a type of WASH intervention to which they pertain based on definitions used in other systematic reviews (Yates et al., 2018; Dangour et al., 2013; D’Mello-Guyett et al., 2020) and indicators from the WHO/UNICEF Joint Monitoring Program (JMP) (Table 4).

**Table 4. Types and definitions of WASH interventions**

<b>Category of WASH</b>	<b>Definition</b>
Improving the access to water sources and/or quantity of water	Any intervention to provide a new and/or improved water supply or distribution system, or both, i.e., to reduce direct and indirect exposure with contaminated water (e.g., installation of piped water supply, hand pumps, boreholes; installation or extension of distribution networks; water trucking or tankers; and, protection of water sources)
Improving the quality of water: water treatment at source	Any intervention to improve the microbiological quality of drinking water at the source, including: assessment and monitoring of water quality i.e., microbiological, chemical and physical quality removing or inactivating microbiological pathogens (e.g., water source level water treatment systems, filtration, sedimentation, chemical treatment, heat treatment, ultraviolet (UV) radiation or flocculation)
Improving the quality of water: point of use (POU) and safe storage	Any intervention to expand use of or improve the microbiological quality of drinking water at the point of use (POU), including: assessment and monitoring of water quality i.e., microbiological, chemical and physical quality

	<p>protecting the microbiological quality of water prior to consumption (e.g., chemical treatment, filtration, heat treatment, flocculation, UV radiation, residual disinfection, protected distribution, improved storage)</p>
<p>Improving the access to and use of sanitation facilities and reducing exposure to faeces</p>	<p>Any intervention to introduce, improve or expand the coverage of facilities for the safe management, disposal and treatment of excreta, i.e., to reduce direct and indirect contact with human faeces (e.g. latrine construction, pour flush, composting or water sealed flush toilet, piped sewer system, septic tank, simple pit latrines, VIP latrine, defecation trenches or use of a potty or scoop for the disposal of child faeces)</p>
<p>Behaviour change interventions to improve hand, domestic and food hygiene practices</p>	<p>Any intervention to improve hygiene, including: promotion of hygiene behaviours, norms or practices surrounding personal, food and hand hygiene assessment and monitoring of hygiene behaviours, norms or practices, including adaptation of activities any named method of delivery of hygiene promotion (e.g., interpersonal channels, house-to-house visits, community meetings, mass and social media, targeted areas or information, education and communication (IEC) materials, or other hygiene promotion activities)</p>

	any named theory, framework or technique for hygiene promotion (e.g., behaviour change communication (BCC), community engagement, social marketing and demand creation, integrated hardware)
Distribution of hygiene materials or non-food items (NFIs)	Any intervention that provides hygiene materials or use of hygiene materials (e.g., soap, hygiene kits, handwashing stands, sinks and other facilities)
Promotion or distribution of safe menstrual hygiene management (MHM) practices or materials	Any intervention that provides hygiene promotion or hygiene materials for MHM (e.g., MHM kits, pads, underwear, etc.)
Promotion or distribution of disinfection and cleaning of households and community spaces and/or materials	Any intervention that provides or distributes disinfection materials (e.g., chlorine spraying, disinfection of clothes, disinfectants, disinfection of bedding or vehicles) or promotes household cleaning (e.g., safe laundry practices, cleaning of floors and furniture)
Improving dead body management and safe funeral practices	Any intervention to improve safe funeral practices, funeral gatherings and management of corpses in the community

Improving the management of wastewater and faecal sludge	Any intervention to improve management of wastewater and faecal sludge
Provision of interventions that improve solid waste disposal	Any intervention to improve solid waste disposal, particularly in public places
Use of vector control interventions	Any intervention to improve vector control e.g., fly, mosquito, rat, snake, etc.
Other WASH interventions	As applicable

## **Section 2.7: Selecting Technical Experts to Refine the Number of Research Options**

Technical experts, chosen to represent a broad spread of geography, types of organizations, and areas of expertise, were asked to review, refine, and reduce the number of research questions ready for wider dissemination and scoring. This process removes duplicates, refines the language, and identifies questions where sufficient evidence is already available.

## Section 2.8: Scoring Research Options

An online survey will be developed with question order randomized to ensure a similar response rate for each section of questions. The survey will be circulated via existing networks and the selected list of technical experts.

For each research questions, survey participants will be asked to judge how each question may meet each of the four criteria, selected in step 3, by indicating “Yes” (allocated 1 point), “Undecided” (0.5 points), “No” (0 points), or “Insufficiently Informed” (no input). The score weighted research priority score based on the following formula:

**Weighted research priority score:** the following formula was used, where “W” is the weight for each criterion and “c” is the four criteria evaluating the research question. Weights will be applied based on weights and criterion previously selected by the process managers, respectively.

$$\text{Weighted RPS} = \frac{1}{4} \times \sum_{c=1}^4 W_c \times \frac{(N_{\text{Yes}} \times 1) + (N_{\text{Maybe}} \times 0.5)}{N_{\text{Yes}} + N_{\text{No}} + N_{\text{Maybe}}}$$

## Section 2.9: Calculating Scores for Each Research Option and Assigning Ranks

A research prioritization score of 0 to 100 percent will be calculated for each criterion for each research questions, and from this, an overall research prioritization score for each question will be computed (based on the mean of the scores for each criterion). Based on the weighted research priority scores, a rank

will be assigned to the research questions, where the highest research priority score will receive a rank of 1, and the lowest research priority score will receive a rank of X (depending on the number of research options available).

Further stratified analyses considering certain perspectives may also be conducted to evaluate potential biases in the results. This may include stratification by location, gender, or type of agency. This will be assessed using the average expert agreement formula. The formula is as follows:

$$AEA = \frac{1}{4} \times \sum_{c=1}^4 \frac{N_{\text{scorers who provided most frequent response}}}{N_{\text{scorers who provided any response}}}$$

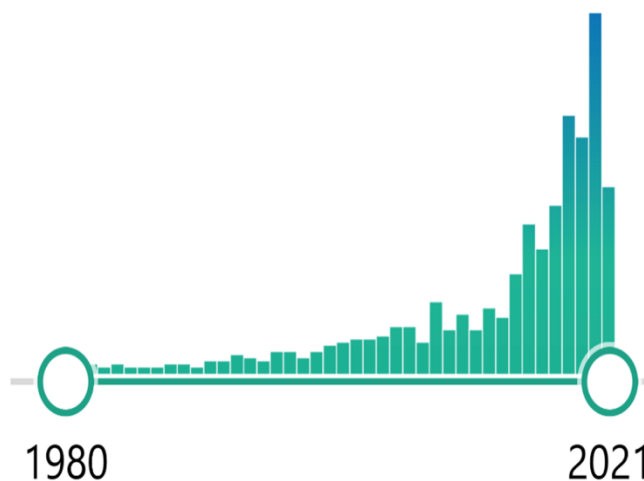
## **Section 2.10: Feedback and Revision**

During these steps, which complete the CHNRI methodology, further input and revisions are made through engagement with technical experts. This may lead to the reassessment of overall priority scores and ranks. The CHNRI methodology expects changes in research priorities over time including adding further research options, adding additional criteria, monitoring progress towards reducing the health and social outcomes, and monitoring research uptake and use.

## CHAPTER 3: RESEARCH QUESTION EXTRACTION FROM THE RAPID LITERATURE REVIEW

### Section 3.1: CHNRI Methodology Step 4

Published WASH literature has expanded significantly in the past decade. As demonstrated in Figure 1, the number of research articles available on PubMed related to “WASH” has expanded significantly since 1980, when the first articles are listed. This explosion in literature demonstrates the amount of interest and demand for WASH research, further increasing the importance of this prioritization exercise.



*Figure 2: A PubMed image capture of the number of WASH articles published over time.*

The fourth step of the CHNRI methodology is the completion of a literature review. Because of time and resource constraints this literature review was completed as a rapid review as opposed to a systematic review. Further, the

2015 systematic review (Yates et al., 2015) was comprehensive, so the rapid literature review served as an update to the previous systematic review. The rapid review was done largely in the summer of 2021. The literature reviews allow research gaps to be gathered from published and gray literature. The research gaps may be discussed by authors as areas of further research, or they may be an unanswered research questions from the work itself. Regardless, the literature review provides a method of extracting research questions in an effective and systemized manner.

### **Section 3.2: Rapid Literature Review Methodology**

The rapid literature review was structured in line with PRISMA guidelines for scoping reviews, including defined inclusion and exclusion criteria. Overall, 404 articles were reviewed for research question extraction through a PubMed search, review by a librarian from the London School of Hygiene and Tropical Medicine, and review of previously conducted systematic reviews. With the benefit of more time, additional databases would have been explored. Further, the grey literature would have been researched for inclusion in the rapid review.

#### **Section 3.2.1: Inclusion criteria**

Inclusion criteria for the PubMed search were referenced from the protocol for the humanitarian WASH CHNRI project, written by Lauren D'Mello-Guyett and Daniele Lantagne (Table 5). The search terms presented in Table 5 were searched within PubMed. Results were filtered for publication date, starting with 2016. Results were title-screened based on relevance to the

humanitarian WASH CHNRI project. Applicable results were saved to Zotero. An academic librarian at the London School of Hygiene and Tropical Medicine also drew sources for review and extraction. The full papers were read, and research gaps were extracted into an Excel spreadsheet. The primary research question of the paper was also extracted.

<i>Table 5: Search terms for rapid literature review</i>	
<b>Search concept</b>	<b>Search terms</b>
Population / Setting	e.g., Humanitarian; Crisis; War; Conflict; Emergency; Epidemic; Genocide; Earthquake; Flood; Famine; Drought; Tsunami; Terror; Trauma; Violence; Accident; Refugee; Migrant; Displaced; Disaster;
Intervention/s	WASH related intervention intended to improve health or social outcomes
Health Outcomes	e.g., Morbidity; Mortality; Disease; Diarrhoea; Cholera; Ebola; Malnutrition; Psychosocial health;
Social Outcomes	e.g., Dignity; Satisfaction;
WASH Outputs	e.g., WASH intervention use; uptake; use; practices
Gaps	e.g. gap, research gap, under-researched, research agenda

### **Section 3.2.2: Exclusion criteria**

Exclusion criteria were also referenced from the protocol for the humanitarian WASH CHNRI project. Due to the publication of recent reviews of WASH in humanitarian crises, any results published earlier than 2016 were excluded. Also excluded were studies in languages other than English due to limitations of the study team. Studies from non-humanitarian crises settings and from high-income countries or middle-income countries, as defined by the World Bank 2017 list, were also excluded because of a lack of relevance to the study.

### Section 3.3: Resulting Extracted Research Questions

480 questions were originally extracted from the rapid literature review. After removal of duplicates and condensing similar questions, 62 total research questions were extracted from the literature. These questions can be organized into themes based on their applicable WASH intervention category. The extracted questions are presented below, organized by their WASH intervention theme. Figure 3 presents an overview of the number of extracted questions in each WASH intervention category.



Figure 3: Extracted questions from rapid literature review.

#### Section 3.3.1: General WASH questions

The six general WASH questions refer to general WASH interventions. These questions generally ask about the effect of and contexts surrounding the implementation of WASH interventions. They are as follows:

- Do single WASH and nutrition interventions reduce respiratory illness in young children when delivered alone or in combination?
- What WASH interventions are most appropriate during typhoid outbreaks in crises contexts, and can WASH interventions be integrated with typhoid vaccination in emergencies?
- What are the reductions in hookworm and soil-transmitted helminths (STH) prevalence from water treatment, sanitation, hygiene, and combined WASH interventions in crisis contexts?
- What are the gender violence risks in crises contexts where poor water, sanitation, and hygiene access is a known problem?
- What methods can be used to assess access and coverage of WASH in refugee and internally displaced persons (IDP) camps?
- What is the exhaustiveness, intensity, and quality of case area targeted interventions (CATI), involving vaccination, case management and WASH actors, in response to cholera alerts?

### **Section 3.3.2: Behavior change intervention questions**

The seven behavior change intervention questions refer to behavior change interventions to improve hand, domestic, and food hygiene practices. These questions generally ask about the best methods of behavior change and the impacts they have on both health and non-health outcomes, with many referencing disease outbreaks. They are as follows:

- What response activities are required during Typhoid outbreaks to convey information safe practices surrounding typhoid fever, safe water, and hygiene?
- How can we improve and sustain hygiene practices during outbreaks of cholera, typhoid, Hepatitis E, Ebola Virus Disease, and COVID-19?
- What are the psychosocial motivators for improved hand hygiene during disease outbreaks such as cholera, Ebola Virus Disease, typhoid, and Hepatitis E?
- What is the effectiveness and cost-effectiveness of handwashing and hygiene promotion campaigns on non-health outcomes among populations affected by crises?
- What types and how effective are health-related or psychosocial motivations and educational messages at changing the hygiene behaviors of crises affected populations?
- What is the effect of hand washing with soap and water, sanitation, and hygiene education intervention on the incidence of diarrhea among children under five in crises contexts?
- What is the effect of handwashing promotion in interventions targeting children, on diarrhea, STH infection, and handwashing behavior in crises-contexts?

### **Section 3.3.3: Cash and markets questions**

The two cash and markets questions refer to the provision of cash or use of markets to provide WASH interventions. These questions are about the best

practice for distribution and the resulting impacts of cash and market interventions. They are as follows:

- Can cash-based interventions for WASH be improved to have an impact on acute malnutrition and its risk factors?
- Should hygiene kits be distributed as gifts in kind in contexts where hygiene products are widely available in markets? And how can local markets provide hygiene supplies during emergencies?

#### **Section 3.3.4: Distribution of hygiene materials and non-food items questions**

The four distribution of hygiene materials and non-food items questions refer to providing WASH materials to a population facing crisis. These questions refer to the best methods for distribution, engagement with populations, and effectiveness of distribution interventions. They are as follows:

- Can households be encouraged to develop their own handwashing station with soap and water to place at a food preparation, child feeding location, or latrine in crises contexts? What can make these handwashing stations usable for sustained periods of time?
- How can women and girls be more involved in the design and construction of hygiene facilities in refugee and internally displaced persons camps?
- What is required to ensure timely, appropriate, and high coverage delivery of hygiene kits to cholera affected populations in emergency contexts?

- What is the effectiveness and cost-effectiveness of hygiene kit distribution on health and non-health outcomes among populations affected by crises?

### **Section 3.3.5: Sanitation questions**

The six sanitation questions refer to improving access to and use of sanitation facilities and reducing exposure to feces. These questions cover the effectiveness of sanitation interventions and how sanitation interventions can be improved to better serve populations. They are as follows:

- How can women and girls be more involved in the designs and construction of sanitation facilities in refugee and internally displaced persons camps?
- How does sanitation coverage affect incidence of Ebola Virus Disease?
- What factors affect sustainable sanitation uptake in climate-vulnerable populations?
- What is the effectiveness and cost-effectiveness of sanitation construction and repairs to sanitation facilities on health and non-health outcomes among populations affected by crises?
- What novel sanitation technologies, and what can we design, for use in the acute phase of humanitarian crises?
- How effective are existing approaches, and what are novel technologies and approaches to improve sanitation uptake among

vulnerable populations including people with disabilities and young children in humanitarian crises?

### **Section 3.3.6: Water access questions**

The six water access questions refer to improving access to water sources or quantity of water. These questions examine effectiveness of water supply interventions and describing the experiences of those who do not have access to water. They are as follows:

- How can women and girls be more involved in the design and construction of water facilities in refugee and internally displaced persons camps?
- What are the experiences of water insecurity of populations living in crises contexts and what affects the availability, accessibility, and quality of water they use during disease outbreaks, natural disasters, or climate change induced shocks? And what options are available for water conservation and reuse?
- What is the effectiveness and cost-effectiveness of repairing damaged water points on health and non-health outcomes among populations affected by crises?
- What is the effectiveness and cost-effectiveness of water trucking on health and non-health outcomes among populations affected by crises?
- How can organizations support affected populations in accessing safe, sufficient, and reliable drinking water supplies at reasonable cost in crises contexts?

- Can the Household Water Insecurity Experience (HWISE) Scale be used as a household water insecurity measure across crises in low- and middle-income countries?

### **Section 3.3.7: Water quality questions**

The thirteen water quality questions focus on improving the quality of water, point of use, and safe storage. These questions look at the effectiveness of interventions as well as the impacts of interventions on antimicrobial resistance and the production of by-products. They are as follows:

- What is the efficacy, effectiveness, and cost-effectiveness of different types of household water treatment interventions (chlorine, filters, membrane filters, etc.) on health and non-health outcomes among populations affected by crises?
- What is the occurrence of *E. coli* and fecal coliforms in drinking water at source and household point-of-use in refugee and internally displaced persons camps?
- What is the prevalence and characterization of multidrug-resistance and other anti-microbial resistance in drinking water samples collected from refugee or internally displaced persons camps?
- How can intra-agency coordination aid in the selection, promotion, and monitoring of chlorine tablet distribution and use in crises context?
- Do simple targeted messages in an SMS campaign have an impact on chlorine purchased and use in crises context?

- What is user acceptability (including taste and odor concerns) of chlorination during emergencies?
- How can existing development household water treatment programs be scaled up in the advent of cholera or other outbreaks?
- What is the efficacy, effectiveness, and cost-effectiveness of bucket chlorination, in-line, and piped water chlorination on health and non-health outcomes among populations affected by crises?
- What are the post-distribution chlorine decay and household water safety in humanitarian response, including refugee and internally displaced persons camps?
- Can practitioners generate site-specific and evidence-based chlorination targets for refugee and internally displaced persons camp water systems, and evaluate whether these site-specific free residual chlorine targets could increase the proportion of households having safe water at the point of consumption compared to the status quo Sphere free residual chlorine target?
- What disinfection by-products are generated from emergency water supply interventions?
- What are effective community chlorination strategies (including passive chlorination) during a cholera epidemic and humanitarian response?
- What is the monitoring data on chlorine program efficacy in emergencies?

### **Section 3.3.8: Disinfection materials questions**

The two disinfection materials questions refer to the promotion or distribution of disinfection and cleaning of households and community spaces and/or materials. These questions focus on the effectiveness of different disinfection materials. The questions are as follows:

- What is the efficacy, effectiveness, and cost-effectiveness of well disinfection on health and non-health outcomes among populations affected by crises?
- What is the efficacy of chlorine-based household spraying, and can other compounds be used for spraying solutions?

### **Section 3.3.9: Menstrual hygiene management questions**

The nine menstrual hygiene management (MHM) questions focus on the promotion or distribution of safe MHM practices or materials. These questions focus on distribution of material, culturally competent interventions, and waste disposal programs. The questions are as follows:

- What MHM materials are appropriate for distribution in the acute phase of an emergency?
- What constitutes friendly and supportive MHM environment that provides education, absorbent sanitary materials, and adequate WASH facilities in crises contexts?
- What are the knowledge, attitudes, and community practices and impact of religious and cultural beliefs on menstrual hygiene management and their impact on girls in crises contexts?

- What are effective approaches to integrate menstrual hygiene management into existing emergency responses? And different phases of an emergency?
- What are new approaches and practical insights on innovating menstrual disposal, waste management, and laundering in emergency contexts?
- What is the availability of menstrual hygiene management and MHM-appropriate facilities in crises contexts?
- What are social and cultural barriers to accessing and uptake of safe MHM interventions among women and girls affected by humanitarian crises (during natural disasters such as floods, earthquakes and drought, during displacement, or in areas affected by conflict)?
- What are appropriate and effective MHM waste streams, disposal behavior, absorbent materials, and waste management technologies used in crises contexts?
- What are thermal treatment strategies and technology for MHM waste management in crises contexts?

### **Section 3.3.10: Solid waste disposal question**

The solid waste disposal question focuses on the provision of interventions that improve solid waste disposal. The question is as follows:

- What is the effect of environmental clean-up campaigns and solid waste disposal on health and non-health outcomes among populations affected by crises?

### **Section 3.3.11: WASH policy questions**

The three WASH policy questions refer to WASH policy, coordination, and governance. These questions also ask how women and girls can be more involved in decision making. The questions are as follows:

- What are the experiences of, and barriers to, women and girls in participating in WASH decision-making and coordination in crises contexts?
- What is the best guidance for the decentralization of the response with remote monitoring of epidemics in fragile and conflict-affected states according to different contexts?
- What are the current coordination mechanisms for transitional handover of WASH services from response agencies to national government and/or other development actors?

### **Section 3.3.12: WASH risk factors questions**

These three questions refer to the effect of humanitarian crises on WASH behaviors. The questions are as follows:

- What is the current status, areas for improvement and effect of conflict on infant and young child feeding practices among crises-affected populations?
- What are the WASH risk factors and risk factor cascades for communicable disease outbreaks in humanitarian emergencies?
- What is the risk of cholera outbreaks during droughts, floods, and other natural disasters?

### **Section 3.4: Conclusions**

The 62 questions that resulted from the review of 404 research articles are not yet prioritized. The work of prioritization is ongoing as part of the CHNRI process. However, some general observations can be made about the questions.

The questions generally focus on higher level questions than asking what an appropriate intervention is for a WASH category or context. Instead these questions seem to focus on evaluations of these interventions including questions of effectiveness and appropriateness. These questions also focus on the characterization of populations, population management, and analyzing health impacts.

## **CHAPTER 4: RESEARCH QUESTION EXTRACTION FROM KEY INFORMANT INTERVIEWS**

### **Section 4.1: Methodology for Key Informant Interviews**

#### **Section 4.1.1: The Importance of the key informant interviews**

Overall, 23 key informant interviews were conducted by myself and Lauren D'Mello-Guyett in the fall of 2021. These interviews were conducted as part of the fifth step of the CHNRI methodology. The key informant interviews are meant to gather information from subject experts about what research gaps currently exist within humanitarian WASH. These interviews draw from numerous different backgrounds and allow a more complete picture of the sector to be developed than is known from the rapid literature review alone.

#### **Section 4.1.2: Selection of key informants**

The 23 key informants were selected from a list of WASH researchers, technical working group leads, and the member agencies of the Global WASH cluster. Interviewees were randomly selected from this list and emailed for consent to participate. IRB approval was obtained from both Tufts University and the London School of Hygiene and Tropical Medicine. Interviewees were also chosen to reflect various professional, geographical, and gender configurations.

#### **Section 4.1.3: Key informant interview guide**

The interviews were semi-structured and asked respondents about published, existing, or upcoming research within their agency or working group.

The interviews also asked respondents about perceived research gaps for humanitarian WASH.

#### **Section 4.1.4: Key informant demographics**

Of the key informant interviews nine were based at academic organizations, six at international NGOs, five at donor organizations, and two at multilateral organizations. Thirteen of the respondents were from the World Health Organization-defined European region, five from the Americas region, two from the African region, and one each from the Eastern Mediterranean region and the South-East Asian region. 14 of the respondents were female and eight were male.

#### **Section 4.2: Resulting Extracted Research Questions**

271 questions were extracted from the key informant interviews. After removal of duplicates and condensing similar questions, 108 total research questions were extracted from the interviews. Interviews were recorded via Zoom and transcribed. From these transcriptions the research questions were extracted to a central data set. Similar to the questions extracted from the literature review, these questions can be organized into themes based on their applicable WASH intervention category. The extracted questions are presented below, organized by their WASH intervention theme. Figure 4 presents an overview of the number of extracted questions in each WASH intervention category. These interviews were completed with WASH researchers, technical working group leads, and member agencies of the Global WASH cluster.

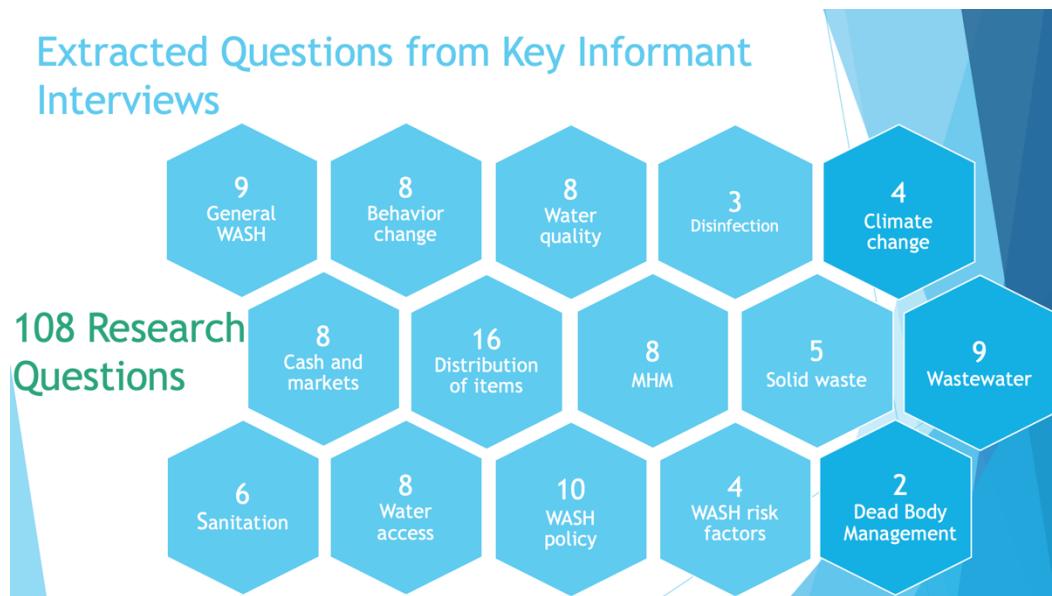


Figure 4: Extracted questions from key informant interviews.

#### Section 4.2.1: General WASH questions

The nine general WASH questions refer to general WASH interventions. These questions look at the WASH conditions for different vulnerable populations and wonder how WASH interventions can be made more sustainable. They are as follows:

- How are poor mental health outcomes related to poor WASH conditions among populations affected by crises?
- What is the effect of improvements to WASH conditions on mental health among people affected by crises?
- What is the coverage of WASH interventions in refugee or internally displaced persons camps globally, and are Sphere standards being met?
- What are the water use patterns among crises affected populations (e.g., drinking, cooking, personal, and domestic hygiene)?

- What WASH improvements to health care facilities are needed to be resilient to future outbreaks (e.g., cholera or Ebola)?
- What adaptations to WASH interventions or WASH services are appropriate and effective for people affected by disabilities in emergency contexts (e.g., refugee or internally displaced persons camps, natural disasters, host populations)?
- What are the increased WASH needs from populations influx to urban centers or where the population is hosted by the local population?
- What minimum package of WASH interventions are required to prevent outbreaks (e.g. COVID-19, cholera, vector-borne diseases) across contexts?
- What elements of WASH can be made sustainable in a refugee camp setting?

#### **Section 4.2.2: Behavior change intervention questions**

The eight behavior change interventions refer to behavior change interventions to improve hand, domestic, and food hygiene practices. These questions ask about the circumstances surrounding hand hygiene and how information and education can most effectively be communicated. They are as follows:

- How do people make decisions around what kind of hand hygiene programming to do during an emergency?

- How can perceptions of risk alter across the COVID-19 pandemic (e.g., community perception tracker) and how can those insights be used to inform future behavior change programming?
- Are there specific circumstances that occur in a crisis that mean people wash their hands differently?
- What is the effectiveness of using an image box to explain the fecal oral transmission route?
- What approaches are appropriate, effective, and cost-effective to increase and sustain handwashing of children in emergency contexts?
- What are appropriate, effective, and sustainable methods of hygiene behavior change for migrant populations or people on the move?
- What are effective methods to inform populations on disease transmission in outbreaks and how can hygiene promoters reduce disinformation or myths associated to outbreak prone diseases?
- How can we improve and sustain hygiene practices within different humanitarian contexts (e.g., natural disasters, outbreaks, or protracted crises)?

### **Section 4.2.3: Cash and markets questions**

The eight cash and markets questions refer to the provision of cash or use of markets to provide WASH interventions. These questions ask about how feasible cash and voucher systems are and if they are more effective than providing physical products. They are as follows:

- What are the barriers, enablers, and contextual influences that affect the use of cash and markets in humanitarian WASH programs?
- Can a cash or voucher system be used as an alternative to hygiene kit distribution?
- What assessments of local markets for hygiene kit components can be made in crises contexts?
- Is the distribution of non-food items or cash/vouchers more effective for crises affected populations?
- What are the cost investments of large-scale WASH -related in crises contexts?
- What interventions for market-based supply of water are appropriate and feasible in humanitarian contexts?
- Can cash and vouchers be utilized by populations affected by crises to improve their water supply access?
- How do household water treatment products connect with local markets?

#### **Section 4.2.4: Climate change questions**

The four climate change questions ask about the impacts of climate change on WASH programming. They are as follows:

- How does drought and variability of rainfall affect how populations utilize water resources in crises affected populations?

- What designs or adaptations are required for climate change resilient water supply and sanitation interventions that are appropriate and effective in humanitarian crises?
- What WASH interventions are available, adaptable, and effective at improving household resilience to climate change induced shocks (e.g., floods and droughts) in crises affected contexts?
- How can WASH in crises programs be integrated with climate change action?

#### **Section 4.2.5: Distribution of hygiene materials and non-food items questions**

The sixteen distribution of hygiene materials and non-food items questions refer to providing WASH materials to a population facing crisis. These questions examine methods of improving current interventions and increasing accessibility to new populations. They are as follows:

- What are innovative technologies, products, or infrastructure that could facilitate hand hygiene in crises contexts?
- What is really needed from a handwashing unit, in terms of acceptability, use, and sustainability, from both the humanitarian population and the crises-affected population?
- How can shared handwashing services be made more accessible?
- How can female users be protected when using handwashing and other WASH facilities?

- What is the efficacy and effectiveness of different handwashing product to prevent Ebola or cholera transmission in health care facilities and the community?
- What is the most appropriate and most effective time for the delivery of non-food items to populations affected by outbreaks, natural disasters, or population influx? And how frequently do WASH non-food items need restocking among populations affected by crises and what is the cost-effectiveness of different intervals for restocking?
- Are populations affected by crises using their WASH non-food item distributions? Why and what are people selling from their non-food items distribution?
- Can non-food items distributed for outbreaks and other health crises be standardized between agencies?
- How do you maintain communal handwashing infrastructure in refugee/ internally displaced persons camps?
- Can hygiene kit distribution be used as a moment for behavior change?
- What are the options for no-touch handwashing devices during the COVID-19 pandemic?
- What is the impact of distribution of WASH or hygiene kits to reduce severe acute malnutrition and improve recovery?
- What are the modalities of delivery for WASH non-food items in crises contexts, and how can we improve modalities of distribution of WASH non-food items to crises affected populations?

- How can community participation and engagement be increased when selecting hygiene kit components and modalities of delivery in crises contexts?
- What products and services are effective and appropriate for adults with incontinence who are affected by crises?
- To what extent are the current portfolio of designs for handwashing stands or units appropriate, effective and cost-effective for use in crises contexts?

#### **Section 4.2.6: Dead body management questions**

The two dead body management questions refer to the management of bodies during outbreaks during which the body may act as a vector of disease.

They are as follows:

- What are the minimum requirements for safe and culturally appropriate dead body management for outbreak prone diseases (e.g., Ebola, cholera, plague, other hemorrhagic fevers)?
- Are there better technologies for body bags?

#### **Section 4.2.7: Sanitation questions**

The six sanitation questions refer to improving access to and use of sanitation facilities and reducing exposure to feces. These questions focus on improving sanitation interventions to be more inclusive of different populations and more culturally competent. They are as follows:

- What additional featured can improve the experience and utilization of sanitation in humanitarian contexts (e.g., lighting, locks, privacy

screens, space for menstrual hygiene management, roof), and particularly by women and girls?

- What are the most acceptable sanitation interventions for increasing dignity by the population?
- What interventions can be provided, or sanitation design changes are required for people with incontinence in emergencies?
- How can we improve the satisfaction and use of sanitation facilities among crises-affected populations, particularly among women and girls in regard to menstrual hygiene management?
- What is the acceptability and effectiveness of sanitation types in different locations and different cultural groups?
- How can we better improve sanitation designs in crises to be inclusive of people with disabilities, and include access to disabled populations within crises contexts?

#### **Section 4.2.8: Water access questions**

The eight water access questions refer to improving access to water sources or quantity of water. These questions look at how to increase access to water through different methods and the impact of increased access on different health indicators. They are as follows:

- What systems can be used in humanitarian contexts to monitor and regulate quantity and quality of water supply systems?
- What is the potential of treating rainwater? Is the treatment of rainwater scalable in protracted crises?

- What solutions, including non-conventional options, are available, effective, and sustainable to improve water security in crises contexts?
- Are there water-resource related conflicts between refugee/internally displaced persons populations and the host community?
- What multi-use water systems are appropriate, effective, and cost-effective in humanitarian contexts and how do they affect rates or burden of disease and poor health outcomes in crises contexts?
- How can we improve water source planning, hydrogeology, and water point construction in humanitarian contexts?
- What is the association between the groundwater access and quality with rates of malnutrition in water scarce areas?
- What is community acceptance of reusing wastewater for drinking water?

#### **Section 4.2.9: Management of wastewater and fecal sludge questions**

The nine management of wastewater and fecal sludge questions focus on how this can be improved in emergency contexts. These questions ask about the most effective management methods and how these methods can be improved.

They are as follows:

- Are the lessons learned from wastewater management in more developed contexts applicable to the humanitarian setting?
- How is wastewater used and disposed of in closed emergency contexts (internally displaced persons/ refugee camps)?

- What are appropriate and effective fecal sludge management technologies (e.g., geotubes bio-additives) that can serve both crises and host populations?
- Can fecal sludge management be made profitable for refugee/ internally displaced persons camps?
- How do we engage crises-affected populations with wastewater and fecal sludge management, including operations and maintenance of services?
- What are options for fecal sludge management in the different phases of emergencies?
- What is the prevalence, characterization, and pathogen survival of pathogens and anti-microbial resistance in fecal sludge and wastewater collected from closed emergency contexts?
- What are the impacts of floods to fecal sludge management?
- What options (including lime) are effective for treatment of fecal sludge management in Ebola and cholera treatment centers?

#### **Section 4.2.10: Water quality questions**

The eight water quality questions focus on improving the quality of water, point of use, and safe storage, as well as water treatment at the source. These questions look at the chemical quality of water and the best methods to improve water quality, especially with regards to the reduction of pathogenic material.

They are as follows:

- What field-based methods are effective to monitor novel pathogens in drinking water?
- What tools can be used to aid decision by practitioners on which water treatment technology to be distributed in crises?
- Are there potential risks to malnourished children from the chemical quality of drinking water?
- Are there potential risks to immunocompromised patients in hospitals from the chemical quality of drinking water?
- What household water treatment options are available and what is the effectiveness of household water treatment to reduce severe acute malnutrition?
- What are appropriate, effective, and cost-effective methods for centralized water treatment in emergency contexts, and what barriers are there to centralized treatment across crises contexts?
- What water treatment methods are effective at treating uncommon pathogens such as Hepatitis E and other viruses?
- What are ways to remove high chemical content from water in areas affected by crises?

#### **Section 4.2.11: Disinfection materials questions**

The three disinfection materials questions refer to the promotion or distribution of disinfection and cleaning of households and community spaces and/or materials. These questions focus on the efficacy of disinfection programs in humanitarian contexts. The questions are as follows:

- How can you clean water storage containers to prevent biofilm development?
- How efficacious is chlorine on different types of surfaces found in low-resource households and healthcare settings against SARS-CoV-2?
- Are household spraying programs and household disinfection programs effective, cost-effective, acceptable, and do they reduce cholera or other outbreak prone disease (e.g., Ebola, COVID-19)?

#### **Section 4.2.12: Menstrual hygiene management questions**

The eight menstrual hygiene management (MHM) questions focus on the promotion or distribution of safe MHM practices or materials. These questions focus on increasing the involvement of different populations and designing culturally appropriate interventions. The questions are as follows:

- What is the effect of menstrual hygiene management interventions among populations affected by crises on school absenteeism, UTIs, RTIs, dignity, and other outcomes?
- How can men and boys be involved in menstrual hygiene management program delivery in crises settings?
- What options are there for the collection and/or solid waste disposal of menstrual hygiene management materials in refugee or internally displaced persons camp settings?

- What are culturally appropriate and effective menstrual hygiene management interventions for women and girls affected by humanitarian crises?
- How can we provide and design safe, accessible toilets for women and girls in crises-contexts, and/or crises with water insecurity?
- What other supplies around managing their period are needed to support women and girls' menstrual hygiene management practices in emergency contexts?
- How do we target child-headed households, orphaned children, or people with disabilities with menstrual hygiene management information and supplies in emergencies?
- How can we improve consultation with women and girls in sanitation facility designs?

#### **Section 4.2.13 Solid waste disposal questions**

The five solid waste disposal question focuses on the provision of interventions that improve solid waste disposal. These questions also ask about the environmental impacts of interventions. The questions are as follows:

- What is the environmental damage from poor solid waste disposal in crises contexts?
- How can medical and other solid waste be managed in the absence of recycling in crises contexts?
- What are and how appropriate, effective, and cost-effective are solid waste solutions within emergency contexts including

burning/incinerating, recycling, biodegradable options, and other waste management options?

- What non-burn technologies are available for solid waste management in emergency contexts?
- How is solid waste managed by households in crises contexts, and how willing are households to separate waste or recycle?

#### **Section 4.2.14: WASH policy questions**

The ten WASH policy questions refer to WASH policy, coordination, and governance. These questions ask about the transition between emergency to development and how the COVID-19 pandemic has affected coordination. The questions are as follows:

- What is the role of WASH within outbreak coordination teams or networks?
- How can we bridge the gap between implementing emergency WASH during the acute phase and more long-term sustainable programs?
- How can the national government lead WASH responses in humanitarian crises?
- How can water resources be managed by informal water management bodies in humanitarian contexts?
- What institutions, financial management, and coordination are required to maintain water resources and services in refugee/ internally displaced persons contexts?

- What are effective ways of working with (formal and information) water service institutions in emergency contexts?
- What factors facilitate transition and handover of WASH services from emergency actors to national governments and institution and other development actors?
- What are effective mechanisms to build the capacity of WASH professionals who work in emergency contexts?
- How can we better integrate WASH interventions within humanitarian mental health programs?
- What has the impact been of COVID-19 on humanitarian coordination?

#### **Section 4.2.15: WASH risk factors questions**

These four questions refer to the effect of humanitarian crises on WASH behaviors. These questions mostly ask about the impact of WASH on different factors such as sexual assault and mental health. The questions are as follows:

- What are the sexual abuse and assault risks related to water and sanitation access in emergency contexts?
- What is the burden of outbreak-prone diseases in crises contexts?
- How is inadequate WASH related to psychosocial stress in crises contexts?
- What are the risk factors for diarrhea within water insecure contexts?

### **Section 4.3: Conclusions**

The 108 questions that resulted from the 23 key informant interviews are not yet prioritized. The work of prioritization is ongoing as part of the CHNRI process. More questions developed from the key informant interviews than the literature review potentially because respondents were asked directly to name research gaps instead of the researchers looking for them in the research articles. Some general observations can be made about the questions.

Similar to the questions that developed from the rapid literature review, these questions are generally focused on a higher level than just asking what interventions are suitable for a given context. They look at evaluations of interventions including effectiveness and appropriateness. They also focus on characterizing and engaging populations along with analyzing health impacts. There was more of a focus on community engagement and inclusion of previously neglected populations than was seen in the questions developed from the literature review. Every WASH category saw an increase in questions asked except for menstrual hygiene management. There was also the addition of three new categories, including climate change, wastewater and fecal sludge management, and dead body management questions.

## **CHAPTER 5: FINDINGS FROM ADDITIONAL QUESTIONS ASKED DURING KEY INFORMANT INTERVIEWS**

### **Section 5.1: Methodology**

The researchers, myself and Lauren D’Mello-Guyett, conducted key informant interviews between September and December 2021 during which extra questions were asked with enough time.

The section of the KII guide relevant to this report contained 10 questions. These questions were designed to understand informants’ perceptions about the research and what value research holds. For example, informants were asked: to choose a single gap to fill for research in WASH in humanitarian emergencies; what features of research make them trust research; which voices are not included in the research process; and the impacts of climate change and COVID-19 on WASH research in humanitarian emergencies. The transcripts of these questions were coded by Elizabeth Mitchell, an undergraduate researcher trained in NVivo, and the results were grouped to identify themes.

Only if there was time remaining following the gap identification-based questions were informants asked this set of questions. For this reason, different numbers of informants were asked each of these questions.

## **Section 5.2: Results**

Ten “if time allowed” questions were asked. These questions allowed themes to develop about how the WASH research community could improve the research process and dissemination of research results. Presented below are responses organized by question asked.

### **Section 5.2.1: What is the research community doing right?**

Six respondents were asked what they believe the research community is doing right about WASH humanitarian research. A variety of themes were identified, including the benefits of evaluating existing systems, good communication between different stakeholders, informed decision-making, long-term humanitarian response, moving past traditional research areas, and prioritizing humanitarian response.

- One respondent specifically mentioned the WASH cluster system saying, “but it turns out the WASH cluster system actually is pretty effective it sounds like according to that research.”
- Two respondents discussed how the research community is allowing for good communication between different stakeholders. One respondent stated: “We try to bring together NGOs, practitioners and researchers and think this kind of formed a really great... community for researchers to understand the feasibility”.
- One respondent mentioned that research can be used for informed decision making, saying that research can be used for, “decision making around

where the funding goes and what the support and what their calls for funding include.”

- One respondent mentioned the shift to the research around long-term response saying that “there’s some sort of higher-level kind of more policy brief information and studies that are coming out about that.”
- One respondent mentioned the importance of moving beyond the “traditional areas and into some of the more advanced and more niche areas.”
- One respondent said the research community is correctly prioritizing humanitarian response.

### **Section 5.2.2: What is the research community doing wrong?**

Seven respondents were asked what they believe the research community is doing wrong about WASH humanitarian research. They identified a lack of climate change considerations, lack of economic analysis, lack of partnerships with academic actors, lack of working with implementers, the issues of research interfering with humanitarian response, and the timeline of grant cycles.

- One respondent mentioned the lack of climate change considerations in current research, saying “I don’t know if there’s a lot of kind of forward-thinking about how this current situation is likely to get worse in the next couple of decades.”
- One respondent expressed the lack of economic analysis as the biggest issue the research community has at present.

- Another respondent mentioned the lack of partnership saying, “so pushing for more partnership, uh, I think one thing that maybe is under-done at the moment”.
- Three respondents mentioned the lack of working with implementers. One respondent said, “Lack of working with actual implementors, not just like friendly people but actual implementors on what the evidence basis should be.”
- One respondent mentioned the tension between the research process and the humanitarian response: “Research can feel like it’s interfering in what they’re trying to do or get in the way.”
- Two respondents said that the largest issue with research are problems stemming from timelines and grants. One respondent mentioned that “the pace of research and the pace of development are really mismatched.”

### **Section 5.2.3: What is the most urgent WASH research gap?**

Seven respondents were asked to identify the most urgent research gap.

Behavioral barriers, evaluation of design and implementation, non-camp settings, sanitation, and WASH and malnutrition were identified.

- Two respondents said that the most urgent research gap involve behavioral barriers. One person said, “there are technologies that can kind of overcome some of these behavioral barriers.” The other said that behavioral barriers around handwashing are important to answer.

- Two respondents mentioned that the most important gaps evaluating designs and implementations. Specifically, “female friendly toilet” designs and “monitoring and evaluation of WASH activities”.
- One respondent answered that “non-camp settings gap I think is really urgent... because... that’s where most displaced people end up”.
- One respondent answered that the most urgent gap to fill is sanitation, particularly “the reuse of sludge and the wastewater for agricultural purposes”.
- One respondent replied that investigating the connection between WASH and nutrition is the most urgent gap, “understand how WASH can impact nutritional recovery”.

#### **Section 5.2.4: What WASH research should be stopped?**

Six respondents were asked which strands of research they would stop. The answers provided were none, household water treatment, invasive interventions, and Western-centric design.

- One respondent mentioned that research should go “beyond water treatment” for household water quality and to use “more imagination around ensuring water quality in the home”.
- Another respondent mentioned that the research community should move way from invasive interventions such as household spraying because of how impactful the chlorine can be to surfaces in the home, the risk to sprayers, and the environmental and health impacts of the chemicals used in the spray.

- A respondent answered that Western-centric design should be moved away from. “There are innovations from the West that people really, really wanna see, and they push strongly to have them tries in an emergency context and I think sometimes they’re not always sensitive to the social and cultural realities of those places.”
- Finally, four respondents answered that they wouldn’t stop any research in the WASH humanitarian response field.

### **Section 5.2.5: What is the value of research?**

Six respondents were asked what they believe the value of research to be. The themes identified included combining WASH research with other sectors, developing proactive procedures, the evaluation of current research, meeting the needs of beneficiaries, and using resources efficiently.

- One respondent answered that research is valuable because it combines WASH knowledge with other sectors. They provide the example of WASH and nutrition sectors combining, “see how we can integrate WASH into nutrition programming.”
- Another respondent answered that research allows for proactive procedures to be developed before the humanitarian emergency occurs. “I think research can help, you know, inform before those crises happen so that, you know, you’re developing standard operative procedures.”
- One respondent answered that research can be used to evaluate current research and determine if it is “practical, pragmatic, or the right direction” and if there is “value for money”.

- Three respondents answered that research is valuable because it can be used to determine if the interventions are meeting the needs of the beneficiaries. “It helps to tailor the response really to the crises and the population need” said one respondent.
- Three respondents also answered that research can determine if resources are being used efficiently.

#### **Section 5.2.6: What do you look for in research you trust?**

Four respondents were asked what they look for in research they trust. They mentioned inclusion of limitations, peer-reviewed research, and research embedded in context.

- Two respondents mentioned that the inclusion of a well-described limitations section increases their trust in a piece of research, “having a robust limitation section I think is really important, because that shows that you know what the limits of your research are.”
- One respondent mentioned that they most trust “peer-reviewed research in quality journals.”
- One respondent mentioned that they most trust “the work coming from people who are deeply embedded in the context.”

#### **Section 5.2.7: What voices are not included in the research process that should be?**

Five respondents were asked which voices are not included in the research process that should be. They answered donors, implementors and partners, local researchers, refugees, and women and children.

- One respondent mentioned that “we don’t always interview donors, which we probably should think about just because they obviously ultimately influence what gets funded.”
- Three respondents answered that implementers and partners are not included in research enough. “I would really love to see more partner. lead projects” answered one respondent.
- One respondent answered that local researchers were not included enough, specifically that there should be “more opportunities for local researchers to present in bid conferences.”
- One respondent answered, “displaced people themselves” and another answered women and children, specifically “young girls from Africa”.

### **Section 5.2.8: Is research easily accessible and how could it be made more accessible?**

Six respondents were asked if they believe research is made easily accessible and how research could be made more easily accessible.

- One respondent answered that research could be made more accessible by “making it open access” as there are people in low- and middle-income countries who can’t afford the access fees while another answered that conferences should be made virtual.
- Respondents also answered that research could be better presented if communication with technical experts is made more accessible and if existing programs were evaluated.

- Four respondents answered that improving organizations sharing relevant information would improve the accessibility of research.
- One respondent mentioned that social media could be used as a “powerful” method of research distribution.

### **Section 5.2.9: How will climate change impact research?**

One respondent was asked how they believe climate change will impact research and they mentioned the impacts of permanent displacement and water security.

- “It’s a permanent displacement. That’s something that we have kind of dealt with in the past but that’s gonna continue to gain some kind of attention deservedly so.”
- “I think climate change is bringing a larger focus on water security.” “We need to think through seasonality, and storage, and maintaining a water supply that’s consistent over the course of the year.”

### **Section 5.2.10: How has COVID-19 revealed research gaps?**

One respondent was asked how COVID-19 has revealed WASH research gaps and they discussed the shift to focus on crowding and handwashing.

## **Section 5.3: Conclusions and Recommendations**

The KIIs conducted with the respondents exhibited key themes that can lead to the development of recommendations for the WASH research sector.

These recommendations are as follows:

1. Include implementers and donors when writing grants and deciding research directions.
2. Have research made freely available via the Global WASH Cluster.
3. Make research outcomes easily accessible on social media, potentially through well-written Twitter threads.
4. Include affected populations in research grant determinations and directions.
5. Make stronger partnerships between larger organizations and academic institutions and local universities.

## **CHAPTER 6: SUMMARY AND CONCLUSIONS**

### **Section 6.1: Summary of Completed Work and Key Findings**

#### **Section 6.1.1: Summary of Completed Work**

WASH interventions which are designed to prevent the transmission of bacteria, viruses, and parasites between people, attempt to control and prevent communicable disease. Emergency WASH interventions, following a disaster, conflict, or outbreak, are implemented to provide safe water and sanitation and promote hygiene practices with dignity, comfort, and security (Sphere, 2018).

This project worked to develop research gaps within the humanitarian WASH sector which would be prioritized following the CHNRI methodology. Steps 4 and 5 of the CHNRI methodology were completed through this thesis. This included the rapid literature review and key informant interviews. Also completed was a report on the findings from extra questions asked during the key informant interviews.

#### **Section 6.1.2: Key Findings**

The rapid literature review and the key informant interviews led to the production of 170 research questions, with 62 coming from the rapid literature review and 108 coming from the key informant interviews. These research questions represent a variety of areas within WASH and include climate change and COVID-19 considerations. The duality of the rapid literature review and the key informant interviews also allowed for an examination of research that has been completed, is currently ongoing, or is planned for the future. Every area of

the WASH sector was represented by the research questions that were found which will eventually lead to a robust prioritization.

Most of these questions do not look to identify a suitable intervention for an area in WASH, as there are many interventions that are currently used to respond to different contexts and meet the needs of affected populations. However, many of the developed questions focus on an analysis of the effectiveness of the interventions, looking at cost-effectiveness, health impacts, and sustainability. These questions also look to improve the research and intervention implementation process through including populations that have been neglected, including women and girls, the elderly, the disabled population, and children.

This thesis also presents findings from the extra questions asked at the end of the key informant interviews. These findings make recommendations about including different stakeholders in the research decision making process, including implementers, donors, and affected populations. These findings echo those of the research questions pulled from both the literature and key informant interviews. Many of these questions, across many areas of WASH reflect the need to include different voices in the evaluation and implementations of different programs.

The findings from these extra questions also led to the recommendation that there should be stronger partnerships between larger organizations and academic institutions and local universities. Finally, it is recommended that research is made freely available through the Global WASH Cluster resource

centre and research outcomes are made easily accessible on social media, potentially through well-written Twitter threads. While the prioritization of research is a crucial step in improving the research process and increasing its utility, making the research accessible to implementers and program designers is crucial.

Throughout this thesis the overall theme of including previously excluded voices in the research process. This is reflected across the identified research gaps from both the literature review and the key informant interviews as well as the recommendations from the extra questions report. The general findings also focus on a higher level of WASH research, analyzing the effectiveness of interventions and the WASH research community has a whole.

This research also demonstrates the importance of including both a literature review and key informant interviews in the CHNRI methodology as they led to the development of unique questions.

## **Section 6.2: Value of Work**

This research contributes to the development of a prioritized research list to guide the humanitarian WASH research sector for the next ten years. As humanitarian disasters become more common it is important that research responds to the most urgent questions. The consensus-based research agenda for WASH in humanitarian crisis will allow WASH programming to be better informed which will help progress global health. This new research agenda will allow for responses to recognized needs and gaps and further ensure fair and direct benefits

to participants. This includes planned dissemination of research to participants, collaborators, and funders (Kohrt et al., 2019).

The CHNRI methodology is a valuable tool because it is a consensus-driven approach to prioritization. It allows for many different stakeholders to impact the project and prioritization from a variety of different roles. However, the CHNRI methodology can be challenging because of the amount of time it can take to build a consensus-based research agenda. However, it is a worthwhile project, especially when the research agenda will be used for many years.

### **Section 6.3: Limitations**

This thesis was primarily limited by its timeline. The survey, in which the WASH sector will score each question, is being administered at the time of writing. This prevents an actual prioritization from being presented at this time. Further, the rapid literature review could have been more comprehensive and there could have been more key informant interviews if there was more time allotted. However, despite time constraints, the results presented encompass the entire WASH sector and accurately represent the understood research gaps.

Other limitations include the limited number of interviews that could be completed because of the time constraints. Further, the interviews were limited to those who replied to being interviewed. It is possible there was bias in who was selected for interviews and these interviews were therefore not representative of the WASH sector.

There was also bias within the key informant interview data. Because gaps were specifically asked about by each WASH intervention category it is possible that the respondents answered with gaps they would not have without prompting. There was also bias in the rapid literature review as only articles in English that were published were reviewed. This likely excluded significant research works published in another language or those that were not yet published, along with grey literature.

### **Section 6.4: Next Steps**

This research will continue as the questions are sent to the sector for scoring. Once the questions are scored, the scores will be averaged leading to the development of a prioritized list. Feedback and revision will be sought about the final results of the list and changes will be made as needed. The full results of the CHNRI prioritization for WASH in humanitarian crises will be presented in May 2022.

### **Section 6.5 Personal Reflection**

This research significantly improved my own research skills, including conducting a rapid literature review and key informant interviews. I also learned about the process of receiving ethical approval from an Institutional Review Board. Through writing this thesis, I also strengthened my technical writing skills.

I also developed a more complete picture of the WASH sector. As I continue into graduate school in humanitarian WASH, I more fully understand the different career path options. It was also interesting to learn about the many

different potentials for research directions. I am very grateful to have had this experience.

## REFERENCES

- Abdelmagid N, Checchi F, Garry S, Warsame A. Defining, measuring and interpreting the appropriateness of humanitarian assistance. *Journal of International Humanitarian Action*. 2019;4(1).
- Ager A, Burnham G, Checchi F, Gayer M, Grais RF, Henkens M, et al. Strengthening the evidence base for health programming in humanitarian crises. *Science*. 2014;345(6202):1290-2.
- Blanchet K, Ramesh A, Frison S, Warren E, Hossain M, Smith J, et al. Evidence on public health interventions in humanitarian crises. *Lancet*. 2017.
- Blundell H, Milligan R, Norris SL, Garner P. WHO guidance for refugees in camps: systematic review. *BMJ Open*. 2019;9(9):e027094.
- CRED. The International Disaster Database 1990 to present [Available from: <http://www.emdat.be/>].
- Dangour AD, Watson L, Cumming O, Boisson S, Che Y, Velleman Y, et al. Interventions to improve water quality and supply, sanitation and hygiene practices, and their effects on the nutritional status of children. *Cochrane Database Syst Rev*. 2013(8):CD009382.
- Development Initiatives. *Global Humanitarian Assistance Report 2020*. 2020.
- D'Mello-Guyett L, Gallandat K, Van den Bergh R, Taylor D, Bulit G, Legros D, et al. Prevention and control of cholera with household and community water, sanitation and hygiene (WASH) interventions: A scoping review of current international guidelines. *PLoS One*. 2020;15(1):e0226549.
- Duffield A, Reid G, Shoham J, Walker D. Evidence base of interventions in complex emergencies. *Lancet*. 2017;365.
- Farrar JJ. Stopping the Gaps in Epidemic Preparedness. *N Engl J Med*. 2019;380(19):1788-9.
- Guisolan, S. C., Aambrogi, M., Meeussen, A., Althaus, F., & Eperon, G. (2022). Health and security risks of humanitarian aid workers during field missions: Experience of the International Red Cross. *Travel Medicine and Infectious Disease*, 46, 102275. <https://doi.org/10.1016/j.tmaid.2022.102275>
- JMP. WHO/UNICEF Joint Monitoring Programme for Water Supply, Sanitation and Hygiene [Available from: <https://washdata.org/monitoring>].

Kohrt BA, Mistry AS, Anand N, Beecroft B, Nuwayhid I. Health research in humanitarian crises: an urgent global imperative. *BMJ Glob Health*. 2019;4(6):e001870.

Leaning, J., & Guha-Sapir, D. (2013). Natural Disasters, Armed Conflict, and Public Health. *New England Journal of Medicine*, 369(19), 1836–1842.  
<https://doi.org/10.1056/NEJMra1109877>

PRISMA-ScR. Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews. 2018.

Ramesh A, Blanchet K, Ensink JH, Roberts B. Evidence on the Effectiveness of Water, Sanitation, and Hygiene (WASH) Interventions on Health Outcomes in Humanitarian Crises: A Systematic Review. *PLoS One*. 2015;10(9):e0124688.

Rudan I, Gibson JL, Ameratunga S, El Arifeen S, Bhutta ZA, Black M, et al. Setting priorities in global child health research investments: guidelines for implementation of CHNRI method. *Croat Med J*. 2008;49(6):720-33.

Rudan I, Yoshida S, Chan KY, Cousens S, Sridhar D, Bahl R, et al. Setting health research priorities using the CHNRI method: I. Involving funders. *J Glob Health*. 2016;6(1):010301.

Rudan I, Yoshida S, Wazny K, Chan KY, Cousens S. Setting health research priorities using the CHNRI method: V. Quantitative properties of human collective knowledge. *J Glob Health*. 2016;6(1):010502.

Samarasekera U, Horton R. Improving evidence for health in humanitarian crises. *Lancet*. 2017.

Smith KF, Goldberg M, Rosenthal S, Carlson L, Chen J, Chen C, et al. Global rise in human infectious disease outbreaks. *J R Soc Interface*. 2014;11(101):20140950.

Sphere. The Sphere Project: Humanitarian Charter and Minimum Standards in Humanitarian Response. Geneva, Switzerland; 2018.

Spiegel PB, Le P, Ververs MT, Salama P. Occurrence and overlap of natural disasters, complex emergencies and epidemics during the past decade (1995-2004). *Confl Health*. 2007;1:2.

Taylor DL, Kahawita TM, Cairncross S, Ensink JH. The Impact of Water, Sanitation and Hygiene Interventions to Control Cholera: A Systematic Review. *PLoS One*. 2015;10(8):e0135676.

Tricco AC, Lillie E, Zarin W, O'Brien KK, Colquhoun H, Levac D, et al. PRISMA Extension for Scoping Reviews (PRISMA-ScR): Checklist and Explanation. *Ann Intern Med.* 2018;169(7):467-73.

UNHCR. Figures at a Glance 2021 [Available from: <https://www.unhcr.org/en-us/figures-at-a-glance.html>].

Waldman RJ, Toole MJ. Where is the science in humanitarian health? *The Lancet.* 2017.

Watts N, Adger WN, Ayeb-Karlsson S, Bai Y, Byass P, Campbell-Lendrum D, et al. The Lancet Countdown: tracking progress on health and climate change. *Lancet.* 2017;389(10074):1151-64.

Yates T, Vujcic JA, Joseph ML, Gallandat K, Lantagne D. Efficacy and effectiveness of water, sanitation, and hygiene interventions in emergencies in low- and middle-income countries: a systematic review. *Waterlines.* 2018;37(1):31-65.

Yates T, Vujcic JA, Joseph ML, Gallandat K, Lantagne D. Efficacy and effectiveness of water, sanitation, and hygiene interventions in emergencies in low- and middle-income countries: a systematic review. *Waterlines.* 2018;37(1):31-65.

Yates T, Vujcic JA, Joseph ML, Gallandat K, Lantagne D. Water, sanitation, and hygiene interventions in outbreak response: a synthesis of evidence. *Waterlines.* 2018;37(1):5-30.

Yoshida S, Cousens S, Wazny K, Chan KY. Setting health research priorities using the CHNRI method: II. Involving researchers. *J Glob Health.* 2016;6(1):010302.

Yoshida S, Wazny K, Cousens S, Chan KY. Setting health research priorities using the CHNRI method: III. Involving stakeholders. *J Glob Health.* 2016;6(1):010303.

Yoshida S, Rudan I, Cousens S. Setting health research priorities using the CHNRI method: VI. Quantitative properties of human collective opinion. *J Glob Health.* 2016;6(1):010503.