

Diarrheal Disease Awareness Is Associated with Caregiver Handwashing with Soap in the Democratic Republic of the Congo (REDUCE Program)

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Abstract. Diarrhea is one of the leading causes of childhood illness and a major cause of infant and child mortality globally. In the Reducing Enteropathy, Undernutrition, and Contamination in the Environment (REDUCE) prospective cohort study, we investigated the association between diarrheal disease awareness and handwashing with soap among caregivers of children under 5 years of age. A total of 259 caregivers of children under 5 years of age in Walungu Territory, South Kivu, Democratic Republic of the Congo (DRC), were administered an open-ended questionnaire assessing awareness of diarrheal disease transmission and prevention, and key times to wash hands with soap. An overall diarrheal disease awareness score was developed based on the responses to these items. Five-hour structured observation of handwashing behaviors was conducted at the 6-month follow-up. Diarrheal disease awareness among caregivers was low. Only 32% of caregivers were able to correctly identify a method of diarrhea prevention. The median diarrheal disease awareness score was 3 out of 10 (SD: 1.7, range: 0–9). During structured observation, 9% of caregivers washed their hands with soap at a food-related event and 9% washed their hands with soap at a stool-related event. Higher diarrheal disease awareness was associated with an increased odds of handwashing with soap at food-related events (odds ratio: 1.40, 95% confidence interval: 1.03, 1.90). Our findings emphasize the need for targeted water, sanitation, and hygiene interventions to increase diarrheal disease awareness and facilitate handwashing with soap among caregivers of children under 5 years in rural DRC.

INTRODUCTION

Diarrhea is one of the leading causes of childhood illness and a major cause of infant and child mortality globally.¹ Even as the global rates of diarrhea decline, it is estimated that diarrhea causes more than 500,000 deaths in children under 5 years of age annually.² Furthermore, the burden of diarrhea morbidity and mortality is distributed unequally around the world.³ In the Democratic Republic of the Congo (DRC), there are estimated to be over 45 million diarrhea episodes annually among children under 5 years of age, and diarrheal diseases have been attributed to 10% of deaths annually in this age group.^{3,4} Despite being the most water-rich country in sub-Saharan Africa, only 31% of rural Congolese use an improved water source and only 29% use improved sanitation facilities.⁵ Diarrheal diseases are known to be associated with poverty and inadequate water, sanitation, and hygiene (WASH) infrastructure and practices.^{6,7} Water, sanitation, and hygiene (WASH) programs promoting water treatment, safe water storage, and handwashing with soap have the potential to reduce diarrheal disease among children less than 5 years of age by an estimated 30–75%.⁸

Knowledge of when, how, and why to perform a WASH behavior, although not the sole behavioral determinant, is an important component to sustaining these behaviors over time.⁹ Previous studies have found that lack of caregiver awareness of diarrheal disease prevention was a risk factor for diarrheal disease among susceptible pediatric populations.^{10–12} Studies in the DRC and Nigeria found that lack of

knowledge of diarrheal disease transmission was associated with pediatric diarrhea.¹¹ In Bolivia, lack of knowledge of handwashing with soap and proper feces disposal for diarrhea prevention was associated with increased pediatric diarrhea.¹⁰ In Bangladesh, diarrheal disease awareness was found to be a significant mediator of handwashing with soap and stored drinking water quality in the Cholera Hospital-Based Intervention for 7 Days (CHoBI7) program.^{13,14} Beyond diarrheal disease awareness, contextual, technological, and other psychosocial factors also play an important role in WASH behavior change.^{15–17}

The Reducing Enteropathy, Undernutrition, and Contamination in the Environment (REDUCE) study focuses on identifying exposure pathways to fecal pathogens that are significant contributors to diarrheal diseases for young children in DRC, and on developing and evaluating theory-driven and evidence-based scalable interventions to reduce fecal contamination from these pathways. The objective of this study was to determine diarrheal disease awareness among caregivers of young children in rural eastern DRC, and to determine the association between baseline diarrheal disease awareness and subsequent handwashing with soap behaviors at the 6-month follow-up.

MATERIALS AND METHODS

Study design. This prospective cohort study was a part of the REDUCE program conducted in Walungu Territory in the province of South Kivu in the DRC. Households with at least one child under the age of 5 years were enrolled and followed for 6 months. The sample size was based on the number of caregivers with children under 5 years of age that could be enrolled during study recruitment conducted between June 2018 and January 2019. A structured questionnaire on diarrheal disease awareness was administered at baseline. At the 6-month follow-up, 5-hour structured observation of

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handwashing with soap at food- and stool-related events was conducted.

Diarrheal disease awareness questionnaire. Trained research officers administered an open-ended, structured questionnaire to caregivers of children under 5 years of age. Caregivers were administered this form if they were 12 years of age or older. The questionnaire included questions on awareness of diarrheal disease transmission and prevention and handwashing practices. Caregivers were asked three questions on diarrheal disease awareness: 1) “Can you name three ways that someone can get diarrhea?” (diarrheal disease transmission) (one point for each correct response with a maximum of three points); 2) “Can you name three ways that someone can avoid diarrhea?” (diarrheal disease prevention) (one point for each correct response with a maximum of three points); and 3) “Can you name five key times when you should wash your hands with soap?” (key handwashing with soap events) (one point for each correct response with a maximum of four points). Correct diarrheal disease transmission responses were categorized in the following themes: uncovered food, consuming rotten or spoiled food, mouthing feces, not washing hands, not washing hands with soap, unclean water, and food in contact with flies. Correct diarrheal disease prevention responses were categorized in the following themes: eating hygienic food, not eating street-vended food, covering food, handwashing with soap at food- and stool-related events, handwashing with soap, or drinking safe water. The correct key times for handwashing with soap were as follows: after using the toilet, after cleaning a child’s anus, after removing a child’s feces, after touching feces, before feeding a child/serving food, before preparing food, or before eating. Responses were coded based on previous studies in Bangladesh.^{18,19} Even if the participant gave more than three correct responses for the diarrheal disease transmission or prevention questions, the maximum number of points they could receive was still three. No respondent gave more than four correct answers for the key times for handwashing with soap; this led us to assign a maximum of four points to this question. An overall diarrheal awareness score was created based on answers to the three questions based on our previously published methods.¹⁹ The possible range for the diarrheal disease awareness score was from 0 to 10.

Structured observation. Five-hour structured observation was conducted using a structured form at a 6-month follow-up visit. Observations occurred between 8:00 AM and 1:00 PM to include as many household members as possible and to ensure that the timing of the observations was standardized across all households. The research assistant sat in a common living space used for cooking, sleeping, or other indoor/outdoor household activities, and observed household activities with minimal movement and interaction with the household. Households were informed that research assistants were observing daily activities, without specifying WASH events to reduce the Hawthorne effect.²⁰ Handwashing events were recorded by trained research assistants for caregivers 12 years or older during the following food- and stool-related events: 1) before food preparation, 2) before eating, 3) before feeding a child, 4) after toileting, 5) after cleaning the anus of a child, 6) after disposal of child feces, 7) after cleaning child feces, and 8) before serving food.

Statistical analysis. All statistical analyses were conducted in STATA versions 15 and 16 (Stata Corp, Collect

Station, TX). Descriptive statistics were used to calculate basic demographic information. Open-ended diarrheal disease awareness questions were categorized into themes and coded into an overall diarrheal disease awareness score of 0–10 as described to create a composite measure of diarrheal disease awareness. Logistic regression models with generalized estimating equations to account for clustering within households were used to investigate the association between diarrheal disease awareness (continuous) and caregivers’ handwashing with soap at least once during 5-hour structured observation (binary). Handwashing with soap key events at food- and stool-related events at the 6-month follow-up were the outcomes and diarrheal disease awareness score at baseline was the predictor.

Ethical approval. Informed consent was obtained for each study participant. If the participant was 12–17 years old, assent was obtained as well as parental permission from the child’s guardian. The study procedures were approved by the research ethical review committees of the School of the Public Health of the University of Kinshasa (Protocol 043-2017) and the Johns Hopkins Bloomberg School of Public Health (Protocol 8057).

RESULTS

Demographic characteristics. A total of 259 primary caregivers from 241 households enrolled in the REDUCE program were administered the diarrheal disease awareness questionnaire at baseline. The median age for caregivers was 27 years (SD: 8, range: 12–70) and 96% (249/259) were female (Table 1). The most common household wall type was mud, with 64% of households having mud walls (154/241). Ninety-seven percent of caregivers (234/259) resided in a household with an unimproved latrine (latrine without a concrete slab). Fifty-one percent of children (123/241) resided in households where at least one primary caregiver had any formal education. The median household size was six individuals (SD: 2.4 [2–17]).

TABLE 1
Baseline demographic characteristics among caregivers of children under 5 years in Walungu, South Kivu, Democratic Republic of the Congo

	%	n
Households		241
Primary caregivers		259
Baseline age (median ± SD [min–max])		27 ± 8 (12–70)
Gender		
Female		249
Primary caregiver formal education	51	123
Children < 5 years		488
Household wall type		
Mud walls	64	154
Wood walls	7	17
Concrete walls	5	13
Wood and mud walls	4	10
Biomass walls	5	12
Brick walls	3	8
Wood and concrete walls	3	7
Other	7	17
Household animal ownership	51	124
Unimproved latrine	97	234
Household size (median ± SD [min–max])		6 ± 2.4 (2–17)

Unimproved latrine = use of pit latrines without a concrete slab or platform, hanging latrines, or bucket latrines.

Diarrheal disease transmission. Only 6% (16/259) of caregivers were able to correctly report three transmission routes for diarrheal disease, 15% (40/259) gave two correct responses, 41% (106/259) gave one correct response, and 37% (97/259) could not identify a correct diarrheal disease transmission route. The most commonly reported correct diarrheal disease transmission route was consumption of rotten/spoiled food at 39% (101/259) (Table 2), followed by unclean water at 21% (54/259), and lack of handwashing at 17% (44/259) (only 5% of caregivers stated lack of handwashing with soap [12/259]). Reporting uncovered food as a diarrheal disease transmission route was low at 2% (6/259).

Diarrheal disease prevention. Awareness of diarrheal disease prevention was low. Only 32% of caregivers were able to correctly identify a method of diarrheal disease prevention (82/259). One percent of caregivers (3/259) were able to correctly report three ways to prevent diarrhea, 6% (15/259) gave two correct responses, and 25% (64/259) gave one correct response. The most commonly reported correct diarrheal disease prevention method was handwashing with soap at 16% (42/259) (Table 3), followed by eating hygienic food at 10% (25/259) and drinking safe water at 7% (19/259).

Handwashing with soap at key times. None of the caregivers were able to provide five correct key times for handwashing with soap. Two percent (4/259) of caregivers were able to correctly report four key times for handwashing with soap, 10% (25/259) reported three correct key times, 37% (97/259) reported two correct key times, 39% (100/259) reported one correct key time, and 9% (23/259) reported no correct key times. For key times for handwashing with soap, 62% (161/259) of caregivers mentioned handwashing with soap after using the toilet, 56% (147/259) before eating food, 9% (24/259) before preparing food, and 7% after removing a child's feces (Table 4). The most common incorrect key times for handwashing with soap mentioned by caregivers included after working at 48% (125/259), after eating at 15% (38/259), and after waking up at 13% (34/259).

Diarrheal disease awareness score. The median diarrhea awareness score at baseline was 3 (SD: 1.7 [0–9]) (Figure 1). No caregiver had a diarrheal disease awareness score of 10 out of 10, one had a score of 9 (1/259), 3% (9/259) had a score of 7, 3% (9/259) had a score of 6, 7% (18/259) had a score of 5, 15% (39/259) a score of 4, 22% (58/259) had a score of 3, 25% (66/259) had a score of 2, 20% (44/259) had a score of 1, and 6% (15/259) were not able to give any correct responses (score of 0).

TABLE 2
Caregiver reported diarrhea transmission routes: can you name three ways diarrhea is spread?

Diarrheal disease transmission routes Major themes (N = 259)	%	N
Uncovered food	2	6
Consuming rotten or spoiled food	39	101
Mouthing feces	0	0
Lack of handwashing	17	44
Lack of handwashing with soap	5	12
Unclean water	21	54
Food contact with flies	< 1	1
Contact with dirt	19	50
Through diseases	18	46
Eating dirt	15	40

TABLE 3
Caregiver reported methods for diarrhea prevention: can you name three ways diarrhea can be prevented?

Diarrheal disease prevention methods Major themes (N = 259)	%	N
Good hygiene	23	60
Handwashing (no soap mentioned)	17	45
Properly prepared food	17	43
Handwashing with soap	16	42
Eating hygienic food	10	25
Drinking safe water	7	19
Handwashing with soap at food- and stool-related events	4	10
Covering food	2	4
Not eating street vended food	0	0

Handwashing with soap practices. A total of 170 caregivers had stool- or food-related events during 5-hour structured observation (150 caregivers had food-related events and 78 had stool-related events), out of the 259 caregivers observed. Twelve percent (21/170) of caregivers washed their hands with soap at a key event during 5-hour structured observation. Nine percent (14/150) of caregivers washed their hands with soap before a food-related event during structured observation, and 9% (7/78) of caregivers washed their hands with soap after a stool-related event.

Regression analyses. Diarrheal disease awareness was significantly associated with increased handwashing with soap at food-related events (odds ratio [OR]: 1.40, 95% confidence interval [CI]: 1.03, 1.90) (Table 5). There were no other significant associations between diarrhea awareness and handwashing with soap at stool- or food-related events at the 6-month follow-up. When diarrheal disease awareness score was divided into quartiles, there was significantly higher handwashing with soap at food-related events in the fourth quartile compared with the first quartile (OR: 7.16, 95% CI: 1.56, 32.91) (Supplemental Table 1).

DISCUSSION

In the REDUCE prospective cohort study, we investigated the association between diarrheal disease awareness and handwashing with soap behaviors among caregivers of children in rural eastern DRC. Overall diarrheal disease awareness was low, with the average diarrheal disease awareness score being three out of 10 points. Less than a third of caregivers were able to correctly identify a method of diarrhea prevention, and only 5% stated that diarrheal diseases could be transmitted from lack of handwashing with soap. Furthermore,

TABLE 4
Caregiver reported key times for handwashing with soap: can you name five key times you should wash your hands with soap?

Key handwashing with soap events Major themes (N = 259)	%	N
After using the toilet	62	161
Before eating	57	147
After working	48	125
After eating	15	38
After waking up	13	34
Before preparing food	9	24
After removing a child's feces	7	19
After cleaning a child's anus	3	8
After touching feces	1	2
Before feeding a child/serving food	0	0

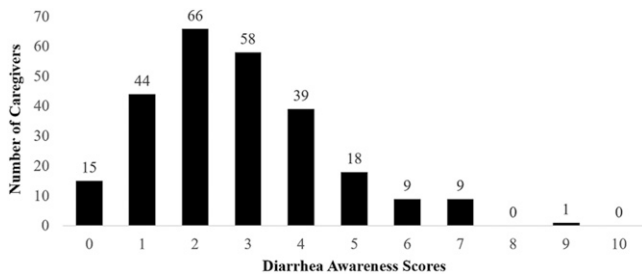


FIGURE 1. Histogram of diarrheal disease awareness scores for caregivers of young children.

handwashing with soap at stool- and food-related events was low (12%). The diarrheal disease awareness score at baseline was positively associated with handwashing with soap at food-related events at the 6-month follow-up. These findings demonstrate the urgent need for WASH programs to increase diarrheal disease awareness to facilitate handwashing with soap behaviors in rural eastern DRC.

Our previous work among this cohort in eastern DRC found that diarrheal disease prevalence among children less than 5 years of age was high at 33%. Despite this high diarrheal disease prevalence, diarrheal disease awareness among caregivers of young children was low.²¹ Furthermore, our present study was also conducted during an ongoing Ebola outbreak in eastern DRC²²; however, knowledge of handwashing with soap was still low. This finding is consistent with previous findings from DRC and Tanzania, which found low diarrheal disease knowledge even during ongoing cholera outbreaks.^{23,24} These findings highlight the need for WASH behavior change communication programs targeting populations at high risk for diarrheal diseases.

Our finding that diarrheal disease awareness was associated with handwashing with soap is consistent with previous intervention studies conducted in Bangladesh.^{13,14} In two randomized controlled trials of the CHoBI7 WASH program, diarrheal disease awareness was found to be a significant mediator of handwashing with soap and stored drinking water quality.^{13,14,18} Diarrheal disease awareness, however, was not the only mediator found in these previous studies; disgust, response efficacy, perceived susceptibility, self-efficacy, and dirt reactivity were also significant mediators of sustained handwashing with soap and improved stored drinking water quality observed with delivery of the CHoBI7 WASH program. Our finding that diarrheal disease awareness was associated with handwashing with soap is in contrast with White et al., which concluded that knowledge

about disease and disease transmission may have limited or no impact on handwashing with soap behavior.¹⁷ In addition, within our present cohort study, we found that self-efficacy, disgust, perceived susceptibility, and dirty reactivity were also associated with handwashing with soap.²⁵ These findings from the CHoBI7 WASH program in Bangladesh, and from other WASH programs in Haiti and Ethiopia highlight the need for psychosocial factors beyond only knowledge to be targeted for the implementation of effective WASH programs.^{13,14,26–28}

The findings that diarrheal disease awareness was low in our study population and that low awareness was a behavioral determinant of handwashing with soap behavior were applied to the development of the REDUCE Baby WASH intervention. The REDUCE Baby WASH intervention was based on extensive formative research including 91 semi-structured interviews to identify the psychosocial, technological, and contextual factors driving WASH behaviors among our target population in eastern DRC.²⁹ Through this formative work, consistent with our current study findings, we found in our qualitative analysis from interviews that low awareness of diarrheal diseases. We also identified that lack of availability of soap, mostly because of poverty, and lack of a designated place for handwashing with soap (a place with water and soap) to be major barriers for handwashing with soap. Consistent with this, a recent systematic review found that access to a designated place with soap and water for handwashing was a key behavioral determinant of handwashing behavior in domestic settings.¹⁷ For the REDUCE Baby WASH program, to address the barriers to handwashing with soap identified through our quantitative and qualitative work, a pictorial flipbook was developed targeting diarrheal disease awareness. The flipbook included a story about a caregiver that did not wash her hands with soap before feeding her child, and how her child then got severe diarrhea and had to be admitted to a hospital. Pictures in the flipbook showed that feces could be present on hands after coming from the toilet, which could get into food causing diarrheal diseases and intestinal worms among young children. To target the lack of a designated place for handwashing with soap, the flipbook explained how to construct tippy taps (a low-cost handwashing station that could be made from readily available materials) and how to prepare soapy water (water and detergent powder, which is a low-cost alternative to bar soap).²⁹

This study has some limitations. First, 5-hour structured observation could be subject to the Hawthorne effect, whereby the behavior of individuals is altered because they are aware their behavior is being evaluated.²⁰ We tried to reduce this bias by not telling caregivers what we were observing and by conducting a 5-hour observation (rather than a shorter duration), since changes to a person's normal behavior in response to an observer being present may reduce over time.³⁰ Second, our analysis focused only on caregivers of children under 5 years of age. Subsequent investigations should assess the association between diarrheal disease awareness and handwashing with soap behaviors among adolescents and other adults who are not caregivers in the household. Finally, we created a composite score for diarrheal awareness based on the epidemiology of fecal-oral transmission routes for diarrhea, as well as our previous studies in Bangladesh, without a factor analysis or other quantitative

TABLE 5

Logistic regression analysis of baseline caregiver diarrheal disease awareness and 5-hour structured observation of handwashing practices at the 6-month follow-up ($N = 170$)

Outcomes of interest	Primary caregivers OR (95% CI)
Handwashing with soap at key events during structured observation	1.16 (0.91, 1.49)
Handwashing with soap at food events during structured observation	1.40 (1.03, 1.90)
Handwashing with soap at stool events during structured observation	0.78 (0.46, 1.32)

CI = confidence interval; OR = odds ratio. Bold face indicates statistical significance ($P < 0.05$).

rationale. Future studies should construct a composite score based on a factor analysis to determine whether there are distinct dimensions of diarrhea awareness and to determine knowledge items are loading on which factors.

There are several strengths of this study. First, the prospective design of this study, which measured diarrhea awareness at baseline and handwashing with soap behavior at a 6-month follow-up. Second, this study measured handwashing with soap behaviors using 5-hour structured observations. This format enabled us to observe behaviors rather than relying on caregivers' reports, which may be susceptible to bias. Third, we created a composite measure of diarrheal disease awareness that included key times for handwashing with soap and diarrheal disease transmission and prevention.

In the REDUCE prospective cohort study, we found that diarrheal disease awareness among primary caregivers was low, and that diarrhea awareness was a behavioral determinant of handwashing with soap behavior. These findings supported the development of the REDUCE Baby WASH modules targeted at increasing diarrheal disease awareness and handwashing with soap. These modules are currently being delivered to over 1 million beneficiaries in South Kivu and Tanganyika provinces of DRC.

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