

## Factors associated with adherence to safe water chain practices among refugees in Pagirinya refugee settlement, Northern Uganda

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### ABSTRACT

Poor adherence to safe water chain practices is a major obstacle to consumption of safe drinking water. In refugee settings, adherence to safe water chain is critical in minimizing water-related diseases. Despite this, little is known about the level of adherence to safe water chain and associated factors, especially in emergency settings. In this study, we interviewed 400 household heads in Pagirinya refugee camp in Northern Uganda and assessed household level adherence to safe water chain practice and associated factors. Modified Poisson regression was used to model the association between adherence to safe water chain and independent variables. All households utilized improved water sources and 74.0% had high adherence to safe water chain. Having post-primary education and high level of knowledge about the safe water chain were positive predictors of high adherence to the safe water chain while round travel time exceeding 1 hour during water collection was negatively associated with high adherence. There is a need for awareness campaigns on safe water chain maintenance among refugees without any formal education. Constructing more water sources would also minimize round travel time during water collection and enable households to collect sufficient water that enables hygienic water storage and use.

**Key words** | adherence, households, refugee setting, safe water chain, Uganda

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### INTRODUCTION

Ensuring access to adequate quantities and quality of water is critical in refugee camps as waterborne diseases are among the most significant threats facing displaced populations (Toole & Waldman 1997; Connolly *et al.* 2004; Salama *et al.* 2004; Cronin *et al.* 2009). The burden of waterborne diseases in refugee camps in low-income countries remains high. In 2005, a seven-country study involving nearly one million people in refugee camps indicated there were 132,000 cases of diarrhoea and over 280,000 reported

cases of malaria attributable to incomplete water and sanitation provision (Cronin *et al.* 2009). A review of trends of the estimates for the years 2005 to 2007 revealed that 1,400 deaths were directly attributable to incomplete water and sanitation alone in refugee camps in Ethiopia, Kenya and Tanzania (Cronin *et al.* 2009). Therefore, there is need to intensify efforts for improving safe water and sanitation provisions in emergency settings.

One critical measure that has been recommended for attaining safe water supplies for people in emergencies is the use of the safe water chain approach (Ali *et al.* 2015). The safe water chain encompasses all practices that aim at ensuring that water remains safe between the water source

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and point of human consumption (Ssemugabo *et al.* 2019). Safe water chain practices include: collection from protected and improved water sources; using clean and narrow-necked covered containers; transportation of the water in covered containers; treatment at the point of use/consumption; storage in hygienic environments and containers with covers as well as drawing the water in a manner that prevents contamination (Ali *et al.* 2015; Ssemugabo *et al.* 2019). According to the World Health Organization (WHO), to reap the benefits of the safe water chain, adherence among populations is highly critical (Brown & Clasen 2012). Adherence to safe water chain practices is a crucial component of the Water Safety Plan (WSP), a comprehensive risk assessment and risk management approach that aims at ensuring that drinking water is safe from the source to the final consumer (WHO 2017).

However, sustaining safe water chain management practices among refugees and internally displaced persons has been reported to be a significant challenge (Mosler 2012; Shaheed *et al.* 2014). Contamination by hands was implicated in faecal contamination of previously safe drinking water stored in wide-necked storage containers in studies conducted in rural Sierra Leone, South Africa and Zimbabwe (Gundry *et al.* 2006; Schmidt & Cairncross 2009). Recontamination of previously safe drinking water was also documented in refugee camps in Uganda (Steele *et al.* 2008) and linked to the spread of diarrhoeal disease and cholera among displaced people's camp populations in Kenya and Sudan (Shultz *et al.* 2009; Mahamud *et al.* 2012). Whereas many humanitarian agencies have guidelines on promoting safe water chain practices, the recontamination occurring after distribution in camp settings is not well understood, in part because this is not explicitly included in guidelines for water treatment in emergencies (Ali *et al.* 2015). The level of adherence to safe water chain practices and associated factors among refugees is not known (Mosler 2012). Adherence to safe water chain management in Uganda has only been assessed among slum dwellers whose adherence was low (Ssemugabo *et al.* 2019). In this study, we sought to determine the level of adherence to safe water chain practices and associated factors among refugees in Pagirinya refugee settlement, Uganda, to establish mechanisms of improving safe water supply for better health outcomes among the refugee population.

## METHODS

### Study setting and design

This was a cross-sectional study carried out in Pagirinya refugee settlement located in Dzaipi county, Adjumani district in Northern Uganda. Pagirinya refugee settlement is a newly gazetted refugee settlement, and as of June 2018, it accommodated at least 36,206 registered refugees, mainly from South Sudan (UNHCR 2018). The refugees are of various ethnicities including Nuer, Dinka, Lolubo, Lotuko, Madi, Acholi and Didinga, and are located in the six blocks of the settlement, namely, A, B, C, D, E and F. The refugees in this settlement obtain water for domestic use from various sources including boreholes, tap stands and a small number from tanker trucks. Pagirinya refugee settlement was the scene of a cholera outbreak in August 2016 (UNHCR 2016).

### Sample size determination

The sample size was calculated using a formula for cross-sectional studies (Kish 1965):

$$N = Z^2 * \frac{P(1 - P)}{\delta^2}$$

The sample size was calculated using  $P$  of 56%, the reported percentage of Ugandans that purify their drinking water according to the National Service Delivery Survey report (Uganda Bureau of Statistics (UBOS) 2016).  $N$  = the required sample size,  $Z$  = standard score corresponding to 95% confidence level and a margin of error/precision of the study ( $\delta$ ) of 5%. After adjusting for a non-response rate of 5%, a total sample size of 400 households was obtained.

### Selection of blocks and households

A multistage sampling procedure was followed. In the first stage, two of the six blocks in Pagirinya refugee settlement (C and D) were randomly selected. Simple random sampling procedure involved writing all block names in the settlement on identical sized small pieces of paper. These were then folded similarly and placed in a round container and

closed. The pieces of paper were shuffled and later, the container was opened. One of the research assistants, with their eyes closed, was requested to pick two pieces of paper from the round container. After selecting the blocks, proportionate sampling was used to select 180 households from block C and 220 from block D. From the list by the settlement commandant, block C had a total of 900 households and block D had 1,100 households, from which we chose households. Individual households were picked using computer-generated random numbers. Systematic sampling was done in each block using a uniform sampling interval of five households. The sampling started at the block leader's household. If a selected household did not accept participation in the study, the next household as per the sampling frame replaced that household. At each household, an adult, i.e., household head or the spouse or any regular household member aged above 18 years was asked to participate in the study after written informed consent.

### Data collection and quality control

A team of 17 research assistants fluent in English and any of the languages spoken by the refugees (Madi, Acholi, Lolubo, Dinka or Kuku) were recruited and trained on data collection for 2 days. The semi-structured questionnaire was pretested in two villages which were not part of the study area. A total of 17 households were reached during the pre-test exercise. The questionnaire was then revised and standardized after the pre-testing exercise.

### Data analysis and management

Data were entered using Epi Info software and then analysed using Stata 14.0 (StataCorp, Texas, USA). The data were then analysed using both descriptive and inferential statistics. Categorical data were presented using frequencies and proportions while continuous data were expressed using means and standard deviation. The main outcome was adherence to safe water chain practices. We assessed adherence using a set of seven indicators developed following the International Federation of the Red Cross (IFRC) manual on household water treatment and safe storage in emergencies (IFRC 2008). The indicators included:

1. Obtaining water from an improved water source.
2. Safe collection using clean, narrow-necked water collection containers.
3. Safe transportation in appropriately covered containers.
4. Practice adequate household water treatment before storage.
5. Safe storage of drinking water in clean and covered storage containers (with no algal growth on the inside).
6. Household drinking water storage container in a clean environment (free from solid wastes, dust and dampness).
7. Safe method of accessing drinking water from the storage container.

In this study, adherence to safe water chain practices was categorized as follows:

1. Low adherence was defined by respondents meeting 1–4 of the 7 indicators.
2. Medium adherence was defined by respondents meeting 5–6 of the 7 indicators.
3. High adherence was defined by respondents meeting all requirements of the dependent variable (7/7).

To study the factors associated with adherence, respondents were dichotomized into two groups: low adherents versus high adherents after medium adherence was combined with high adherence, a similar method was proposed by Al-Ramahi 2015. This was because both the medium and high adherents performed all critical indicators of the dependent variable, namely, indicators 4 to 7. Modified Poisson regression with robust standard errors while applying a forward elimination method was used to model the determinants of adherence to safe water chain. Here, we report prevalence ratios (PR) and their 95% confidence intervals (CI). Prevalence ratios were preferred over odds ratios since odds ratios tend to overestimate the relative risk in instances where the binary outcome is common, usually with a prevalence greater than 10% such as in this case (Schmidt & Kohlmann 2008). Basic models consisting of an outcome and one independent variable were initially run and those with *P*-values of up to 0.1 were added into the multivariable model. Predictor variables such as knowledge and attitudes were obtained by asking 6 and 5 questions, respectively, and the responses coded '1' for right response and '0' for wrong response. Average

scores were obtained, dichotomization was done and those who obtained a higher than average score were reported as having high knowledge and high attitudes, respectively, as recommended in *The SAGE Encyclopedia of Communication Research Methods* (Allen 2017).

### Ethical considerations

Approval to conduct the study was obtained from Makerere University School of Public Health Higher Degree Research and Ethical Committee (HDREC). Permission was also obtained from the Office of the Prime Minister's refugee office in Adjumani district. Informed consent was obtained from each of the interviewed participants.

## RESULTS

### Socio-demographic characteristics of participants

A total of 400 respondents with a mean age of 32.9 years (SD = 8.5) participated in the study. The majority of the respondents were females (286, 71.5%), married (293, 73.3%) and had stayed in the settlement for 6–12 months (334, 83.5%). More than half (234, 58.6%) of the respondents had attained either a primary education or had no formal education. Most households (287, 71.7%) were headed by males (Table 1).

### Domestic water practices and adherence to safe water chain maintenance

Most (371, 92.7%) households obtained drinking water from hand pump boreholes. Most (325, 81.3%) of the water sources were within 500 metres of the dwelling unit. Jerry cans were the most popular containers for collection (373, 93.3%) and storage (237, 59.3%). All respondents (400, 100%) had access to an improved water source. The majority of the households had clean water collection containers (286, 71.5%), adequately treated their drinking water (250, 62.5%) and used methods of drawing drinking water from a storage container that could prevent contamination (325, 81.3%). In summary, the majority (296, 74.0%)

**Table 1** | Baseline characteristics of participants

Characteristics	Frequency, No.	Percentage (%)
All participant	400	100
Gender		
Female	286	71.5
Male	114	28.5
Marital status		
Not married	107	26.8
Married	293	73.3
Age in years		
18–27	107	26.8
28–37	179	44.8
38–47	96	24.0
>47	18	4.5
Mean age (SD)	32.9 (8.5)	
Category of respondent		
Wife	248	62.0
Husband	71	17.7
Sibling to a spouse	24	6.0
Daughter	22	5.5
Son	17	4.3
Other (grandparent)	18	4.5
Gender of the household head		
Male	287	71.7
Female	113	28.3
Education level		
No formal education	61	15.3
Primary	173	43.3
Secondary	123	30.7
Tertiary	43	10.7
Duration of stay in the settlement (in months)		
<6	66	16.5
7–12	334	83.5

of the households had a high level of adherence to safe water chain practices (Table 2).

### Knowledge and attitudes about safe water chain management

Almost all (376, 94.0%) respondents had ever heard about safe water chain and mostly through community health workers (71.3%, 268/376). Although the majority of the

**Table 2** | Water sources and adherence to safe water chain practices

Variables	Frequency, N = 400	Percentage (%)
Water source-related characteristics		
Main water sources		
Hand pump borehole	371	92.7
Motorised water tank	16	4.0
Others (public tap and protected hand-dug well)	13	3.3
Distance to the water source (metres)		
<100	131	32.8
101–500	194	48.5
>500	75	18.7
Round water collection time (total time taken to reach the water source, collect water and head home)		
<30 minutes	181	45.2
30 minutes–1 hour	136	34.0
>1 hour	83	20.8
Main container for collecting water		
Jerry cans	373	93.3
Buckets and clay pots	27	6.7
Main containers for storage of water		
Jerry cans	237	59.3
Clay pots	117	29.3
Buckets	41	10.2
Others (drums and bottles)	05	1.2
Practices on safe water chain		
Obtain drinking water from an improved water source <sup>a</sup>		
Yes	400	100.0
Water collected in clean, containers <sup>a</sup>		
Yes	286	71.5
No	114	28.5
Water collection containers are covered <sup>a</sup>		
Yes	221	55.3
No	179	44.7
Use narrow necked containers for water collection at source <sup>a</sup>		
Yes	373	93.3
No	27	6.7
Adequately treats drinking water <sup>a</sup>		
Yes	250	62.5
No	150	37.5
Drinking water storage is clean, covered and stored hygienically <sup>a</sup>		
Yes	289	72.3

(continued)

**Table 2** | continued

Variables	Frequency, N = 400	Percentage (%)
No	111	27.7
Method of drawing drinking water from storage prevents contamination <sup>a</sup>		
Yes	325	81.3
No	75	18.7
Level of adherence (scores)		
Low (0–4)	104	26.0
High (5–7)	296	74.0

<sup>a</sup>Variable used in assessing the level of adherence to safe water chain.

respondents knew about the benefits of drinking safe water (365, 91.2%) and examples of waterborne diseases (319, 79.8%), only 158 (39.5%) knew all the points/stages in the safe water chain where contamination could occur. Overall, only 164 (41.0%) were classified as having high knowledge on the safe water chain. Regarding attitudes, most participants indicated that it was necessary to clean the water source as a community (398, 99.5%) and that consuming unsafe water is harmful to health (350, 87.5%) (Table 3).

### Institutional aspects of safe water chain management

Less than half (168, 42.0%) of the participants reported facing challenges in accessing safe water, such as long distance (19.6%, 33/168), supply shortages (28.6%, 48/168), difficulties in collecting (27.4%, 46/168), unclean water (8.9%, 15/168) and others (15.5%, 26/168). The majority (307, 76.8%) of the households paid to fetch water from the main water source. Regarding the frequency of water source maintenance, 167 (41.8%) did it daily, 143 (35.8%) weekly while 90 (22.5%) did maintenance after at least a month.

### Factors associated with adherence to safe water chain practices

From the bivariate analysis, being married, having a formal education (primary or secondary or tertiary) over no education, a distance of over 500 m from the water source, a round water collection time exceeding 1 hour and high knowledge of safe water chain were associated with

**Table 3** | Knowledge and attitudes about safe water chain management

Variables	Frequency (N = 400)	Percentage (%)
Knowledge of safe water chain		
Ever heard of safe water chain		
No	24	6.0
Yes	376	94.0
Source of information on safe water chain (n = 376)		
Posters	36	9.6
Community health workers	268	71.3
Radio	106	28.2
Community leaders	118	31.4
Peers	15	4.0
Knows all stages of safe water chain <sup>a</sup>		
No	203	50.7
Yes	197	49.3
Knows all stages where contamination can occur in the safe water chain <sup>a</sup>		
No	242	60.5
Yes (all the stages)	158	39.5
Knew benefits of drinking safe water <sup>a</sup>		
No	35	8.8
Yes	365	91.2
Knew examples of waterborne diseases <sup>a</sup>		
No	81	20.2
Yes	319	79.8
Knows ways of ensuring safe drinking water <sup>a</sup>		
No	91	22.7
Yes	309	77.2
Knows how to prevent waterborne diseases <sup>a</sup>		
No	34	8.5
Yes	366	91.5
Knowledge scores (mean = 5.22 ± 0.07)		
Low (≤5.2)	236	59.0
High (>5.2)	164	41.0
Attitudes of participants		
Necessary to clean water source as a community <sup>b</sup>		
Agree	398	99.5
Disagree	2	0.5
Duty of WASH agencies to clean sources <sup>b</sup>		
Agree	152	38.0
Disagree	248	62.0

(continued)

**Table 3** | continued

Variables	Frequency (N = 400)	Percentage (%)
Drinking water must be treated before being consumed <sup>b</sup>		
Disagree	30	7.5
Agree	370	92.5
Consuming unsafe water is dangerous for health <sup>b</sup>		
Disagree	50	12.5
Agree	350	87.5
Not necessary to always cover the storage container <sup>b</sup>		
Agree	71	17.8
Disagree	329	82.2
Attitude scores (mean = 4.24 ± 0.91)		
Low (≤4.24)	202	50.5
High (>4.24)	198	49.5

<sup>a</sup>Variables used in ascertaining knowledge scores.<sup>b</sup>Variables used in ascertaining attitude scores.

adherence to safe water chain practices. After adjusting for covariates in multivariable analysis, participants with secondary education (adjusted PR = 1.35, 95% CI (1.07–1.70)) and tertiary education (adjusted PR = 1.33, 95% CI (1.03–1.71)) were, respectively, 1.35 times and 1.33 times more likely to observe safe water chain as compared to those with no formal education. Households where it took more than 1 hour to collect water from the water source were 30% less likely to observe the safe water chain as compared to those who could collect it in less than 30 minutes (adjusted PR = 0.70, 95% CI (0.56–0.89)). Participants who had high knowledge on the safe water chain were 1.2 times more likely to adhere to safe water chain practices (adjusted PR = 1.21, 95% CI (1.09–1.36)) (Table 4).

## DISCUSSION

Maintenance of a safe water chain is an important measure in the prevention of most waterborne diseases. Humanitarian guidelines emphasize the need for facilities and practices that preserve the safe water chain which include the use of narrow-mouthed water collection and storage containers with covers, household water treatment with appropriate water treatment methods as well as hygienic access to stored drinking water (IFRC 2008; Ali *et al.* 2015).

**Table 4** | Independent predictors for adherence to safe water chain practices

Variable	Adherence score range		Unadjusted PR (95% CI)	P-value	Adjusted PR (95% CI)	P-value
	High	Low				
Socio-demographic characteristics						
Gender						
Male	81 (71.0)	28 (29.0)	1			
Female	215 (75.2)	24 (24.8)	1.06 (0.92–1.21)	0.413		
Marital status						
Not married	69 (64.5)	38 (35.5)	1		1	
Married	227 (77.5)	66 (22.5)	1.20 (1.03–1.40)	0.019	1.14 (0.98–1.31)	0.090
Age range						
18–27	79 (73.8)	28 (26.2)	1			
28–37	125 (69.8)	54 (30.2)	0.95 (0.82–1.10)	0.462		
38–47	77 (80.2)	19 (19.8)	1.09 (0.93–1.26)	0.281		
> 47	15 (83.3)	3 (16.7)	1.13 (0.89–1.43)	0.314		
Education level						
No formal education	34 (55.7)	27 (44.3)	1		1	
Primary	127 (73.4)	46 (26.6)	1.32 (1.03–1.68)	0.025	1.21 (0.96–1.53)	0.105
Secondary	100 (81.3)	23 (18.7)	1.46 (1.15–1.85)	0.002	1.35 (1.07–1.70)	0.010
Tertiary	35 (81.4)	08 (18.6)	1.46 (1.12–1.90)	0.005	1.33 (1.03–1.71)	0.026
Duration of stay in the settlement (months)						
<6	53 (80.3)	13 (19.7)	1			
7–12	243 (72.8)	91 (27.2)	0.91 (0.79–1.04)	0.156		
Water source factors						
Main water sources						
Hand pump borehole	276 (74.4)	95 (25.6)	1			
Motorised water tank	11 (68.8)	5 (31.2)	0.92 (0.66–1.29)	0.645		
Others (public tap and protected hand dug well)	09 (69.2)	4 (30.8)	0.93 (0.64–1.34)	0.701		
Distance to the water source (metres)						
<100	109 (83.2)	22 (16.8)	1		1	
101–500	147 (75.8)	47 (24.2)	0.91 (0.82–1.02)	0.098	1.03 (0.92–1.17)	0.577
>500	40 (53.3)	35 (46.7)	0.64 (0.51–0.80)	<0.001	0.81 (0.64–1.03)	0.083
Time spent collecting water from the source (minutes)						
<30	150 (82.9)	31 (17.1)	1		1	
30–60	103 (75.7)	33 (24.3)	0.92 (0.82–1.03)	0.128	0.93 (0.82–1.05)	0.246
>60	43 (51.8)	40 (48.2)	0.63 (0.50–0.78)	<0.001	0.70 (0.56–0.89)	0.003
Individual factors						
Knowledge level						
Low	158 (67.0)	78 (33.0)	1		1	
High	138 (84.2)	26 (15.8)	1.26 (1.12–1.41)	<0.001	1.21 (1.09–1.36)	0.001

*(continued)*

Table 4 | continued

Variable	Adherence score range		Unadjusted PR (95% CI)	P-value	Adjusted PR (95% CI)	P-value
	High	Low				
Attitude scores						
Low	156 (77.2)	46 (22.8)	1			
High	140 (70.7)	58 (29.3)	0.92 (0.81–1.03)	0.139		
Institutional factors						
Faces any difficulties in accessing water						
No	178 (76.7)	54 (23.3)	1			
Yes	118 (70.2)	50 (29.8)	0.92 (0.81–1.03)	0.154		
Do you pay for water at the main source						
No	68 (73.1)	25 (26.9)	1			
Yes	228 (74.3)	79 (25.7)	1.02 (0.88–1.17)	0.827		

The study found that all households had access to improved water sources, the majority of whom could access water within a distance of 500 m, and only a small proportion had travel times of less than 30 minutes. Community health workers were the most common source of information on the safe water chain. The majority of households had high adherence to safe water chain practices. Having secondary or tertiary education, high level of knowledge about the safe water chain and taking over 1 hour to collect/fetch water from the water source were significantly statistically associated with adherence to the safe water chain practices.

All households had access to improved water sources. An improved water source is essential in mitigating diarrhoeal incidents in such a vulnerable population. Improved sources such as the tap stands and protected springs used by these refugees are known to provide relatively high quality water (WHO/UNICEF 2006). Although the majority of households accessed water within 500 m, as recommended by the Sphere standards, less than half had a round travel trip of 30 minutes (Sphere Association 2011). This implies excessive queuing time that might be caused by fewer water sources compared to the population or low yields from the sources. Knowledge of the safe water chain was high among the households and this was attributed to health promotion and educational awareness programmes supported by various health promoters in the settlement. The commonest source of information on

the safe water chain was the community health workers. These community health workers regularly conduct house-to-house hygiene promotion activities within the settlement. This shows that community health workers can play a vital role in increasing awareness among refugees, as has been reported in other settings (Torres *et al.* 2017; Scott *et al.* 2018).

The majority of the households had high adherence to the safe water chain. Adherence to safe water practices may lower the risk of households' members getting water-borne diseases. The adherence levels were higher than what was reported in a slum setting in Kampala, Uganda (Ssemugabo *et al.* 2019). It is important to note that in the current study, we used a more systematic and superior approach in the ascertainment of adherence than that employed in a previous study (IFRC 2008). The presence of humanitarian agencies dedicated to promoting water hygiene and safety issues may explain the high adherence in the refugee setting compared to the slum setting. Participants with secondary or tertiary education were more likely to adhere to safe water chain practices. This finding could be explained through the suggestion by Belay *et al.* (2016) and Figueroa & Kincaid (2010), who proposed that literate people might read leaflets and IEC materials and may better understand the health risks of drinking contaminated water. Our findings are also in line with other studies (Freeman *et al.* 2012; Divya *et al.* 2017; Totouom *et al.* 2018) which indicated that high literacy levels coincide with the

adoption of better decisions on safe water management. This underscores the need to devise alternative measures to ensure that illiterate refugees learn about critical safe water chain management practices.

Knowledge and perceived threat of waterborne diseases are key factors that influence the decision at the individual level regarding safe household water handling practices (Kraemer & Mosler 2010; Christen *et al.* 2011; Peletz *et al.* 2013). In our study, a high level of knowledge on the safe water chain was associated with increased adherence to safe water chain practices. The fact that high knowledge of the safe water chain resulted in high adherence can be attributed to frequent hygiene promotion and educational awareness programmes in the refugee settlement by various water and hygiene promoting agencies. It is possible that these efforts created awareness and encouraged refugees to learn more about the risks associated with unsafe drinking water, and how water becomes contaminated and the solutions for getting safe drinking water (WHO 2013). It has been postulated that frequent, personal contact with hygiene promoters could result in increased knowledge level about the safe water chain among populations and consequently impact on their practices (Mosler 2012). Education increases knowledge of the relationship between water and health and the available Household Water Treatment and safe Storage (HWTS) options. Both awareness and knowledge are needed to motivate individuals to act differently and integrate safe water chain aspects, for example, HWTS into their daily routines (WHO 2013).

Households where water collection/fetching from the source took at least 1 hour were less likely to have high adherence to the safe water chain compared to those where it took less than 30 minutes. Households who travel for over 30 minutes to the water source have been shown to collect relatively less water (Cairncross 1987; Thompson *et al.* 2002). If less water is collected, it can affect the implementation of vital safe water chain practices, including frequency of cleaning water collection and storage containers and covers, and as a result, the family may want to save the water so that it lasts longer. Constructing more water sources and reducing distances to water sources may result in shorter travel times due to less queuing and, consequently, more water collected hence little compromise of

water hygiene along the chain. Future studies should be done to better understand the association between travel times in water collection and household safe water chain management.

Our study has some strengths, first, being one of the first studies to document adherence to the safe water chain in emergency settings and second, we assessed adherence to the safe water chain based on the seven indicators in the IFRC manual on household water treatment and safe storage in emergencies. However, the results of our study have to be interpreted with caution due to some limitations. The information on all practices was self-reported and we could not rule out social desirability bias. However, we believe the study makes an important contribution to safe water chain maintenance in emergency camp settings which has been grossly under-researched. These findings can be generalized to other emergency settings in Uganda and around the world due to similar contexts.

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## CONCLUSIONS

The study found that all households had access to improved water sources; the majority of which were located within the recommended 500 m distance. There was high knowledge about the safe water chain and also high adherence to safe water chain practices. Post-primary education and high level of knowledge about the safe water chain were related to higher adherence, while taking over 1 hour to collect water from the water source was conversely associated with high adherence to safe water chain maintenance. There is a need for knowledge and awareness campaigns among refugees without any formal education about household water treatment and safe storage. Constructing more water sources would adequately minimize round travel time during water collection and enable households to collect sufficient water which enables hygienic water storage and use.

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