The impact of COVID-19 on households' water use in Uganda

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ABSTRACT

The unprecedented outbreak of COVID-19 necessitated the promotion of better hygiene practices to curb the spread of the virus. Better hygiene requires that households have a stable supply of water. However, little is known about the predictors of changes in water use in emergency situations such as COVID-19 in Uganda. This study uses data from a cross-sectional survey to examine the changes in the quantities of water used by 1,639 Ugandan households due to COVID-19. This article also explores the factors that are associated with changes in water use. The month March 2020 is used in this study as a cut-off because this is the month in which the government implemented a lockdown to curb the spread of the virus. Results indicate that most households had an increase in the quantity of water used after March 2020 when compared with the period before March 2020. Household characteristics that were associated with a change in the quantity of water used were age, sex, education, main occupation of household head, household size and region of residence. The results can be used to inform the prediction and demand modelling of household water use for improved water interventions for equitable water supply during emergencies.

Key words | COVID-19, households, Uganda, water utilisation

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HIGHLIGHTS

- About 2.1 billion people worldwide lack access to clean water for household use.
- The outbreak of COVID-19 emphasises the need to improve hygiene as a behavioural strategy.
- Households changed behaviour due to COVID-19 which increased water use after March 2020 when compared with the period before March 2020.
- There is need to design interventions to cope with the challenges for increased demand for water during emergencies.

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LIST OF ACRONYMS

UA	Umbrella Authorities
NWSC	National Water and Sewerage Corporation
SSA	Sub-Saharan Africa
UNICEF	United Nations Children's Fund
WHO	World Health Organization

INTRODUCTION

The unprecedented outbreak of COVID-19 in December 2019 called for interventions to address and improve behavioural practices (Chan *et al.* 2020; Sohrabi *et al.* 2020). One of the behavioural practices relates to improving hygiene through handwashing with water and a detergent (UNICEF & WHO 2020). Proper handwashing is in line with Goals 3 and 6 of the Sustainable Development Goals that aim to achieve good health and clean water and sanitation (United Nations Statistical Commission 2016). Frequent or regular handwashing with water and soap has been suggested by the World Health Organization (WHO) to prevent the spread of COVID-19 (Ekumah *et al.* 2020). Access to reliable clean water can also boost economic development and reduce poverty levels (Montgomery *et al.* 2009).

However, for proper handwashing to be effective, people need to have enough water that is readily available (Pickering *et al.* 2010). This is a challenge for people in remote areas especially in developing countries or even in areas where water supply is not guaranteed (Ekane *et al.* 2014). A higher demand for water than supply creates an avoidable water shortage (Sahin *et al.* 2015). A stable supply of water is crucial during pandemics when the demand for water to improve hygiene is at its highest (Kalbusch *et al.* 2020). The change in water demand impacts the performance of water distribution systems (Shang *et al.* 2008).

Access to clean water can be a challenge to the smooth functioning of the household (Rosinger *et al.* 2020). According to the WHO & UNICEF (2017) report, about 2.1 billion people worldwide (mostly in developing countries) were estimated to lack access to clean water for home use (WHO & UNICEF 2017). While the quality of water used in homes is deteriorating in both developed and developing countries (Biswas & Tortajada 2019), developed countries are faring much better in terms of having clean and reliable water (Rosinger *et al.* 2020). In sub-Saharan Africa (SSA), limited access to clean water is attributed to poor institutions, bad leadership, poor service delivery and lack of political will address water scarcity (Dos Santos *et al.* 2017).

In sub-Saharan Africa, insufficient water supply is observed to be prevalent mostly in rural, informal or slum settlements (Montgomery *et al.* 2009; Dagdeviren & Robertson 2011; Foster 2013; Naiga *et al.* 2015; Dos Santos *et al.* 2017; Mekuriaw & Gurmessa 2020). In Uganda, clean water supply remains a challenge in rural areas (Naiga *et al.* 2015). This problem is as a result of limited resources and skilled personnel, mismanagement and poor accountability of public funds (Calow *et al.* 2012). In urban areas, proper hygiene can be compromised in situations where households need to pay for the water they use (Naiga *et al.* 2015). This forces urban residents to restrict water use. Yet, this can facilitate the spread the viruses and bacteria (Burton *et al.* 2011). Moreover, limited quantities of water can negatively affect food availability (Quevauviller 2011). Transfer of water between households has been suggested to be a viable solution to help water-stressed households (Rosinger *et al.* 2020). Rainwater harvesting has also been suggested to solve water shortages in water-stressed areas (Zavala *et al.* 2018). Unstable water supply compromises the fight against contagious diseases. While stable water supply is good for the prevention of the spread of diseases, there is limited knowledge on the utilisation of water in Uganda to aid in health-seeking behaviour such as handwashing (Musoke *et al.* 2018). Yet, understanding how people utilise water in their households is critical for building sustainable water systems that can be relied on in situations of a pandemic. This paper contributes to the growing empirical literature on COVID-19 and behavioural hygienic practices, by examining water utilisation due to COVID-19 in Ugandan households. With the public threat created by the emergence of COVID-19, it is important to understand how prepared individuals, governments and relevant authorities are in terms of providing the necessary and needed services as well as designing sustainable interventions under emergencies.

That is, individuals should be able to use water as a means or solution to fight diseases or uphold an acceptable standard of hygiene during an outbreak of COVID-19.

As part of the interventions to promote handwashing during the COVID-19 outbreak, the president of Uganda gave a directive, at the height of the COVID-19 outbreak, to the water body (National Water and Sewerage Corporation) not to carry out any water disconnections during lockdown in order to avoid a failure to practice handwashing that might ensue as a result of limited water supply (NilePost 2020). While this directive was in good faith, water users would still need to clear their water bills at an appropriate time they get money. Regular handwashing would imply an increase in water bills to meet operational costs. These conditions call for citizens to adapt to new ways of life to minimise costs related to the use of water but also impacts on service delivery. Understanding new dynamics about water use before, during and after the COVID-19 pandemic can help shed light on strategies that can be adopted to improve water supply. Behavioural practices may be influenced by socio-economic factors. For example, higher educational attainment, being older and having better knowledge have been reported to be associated with better hygienic practices such as handwashing (Nteli *et al.* 2014).

While previous research (Staddon *et al.* 2018) has investigated the relationship between household socio-economic characteristics and water use in Uganda, little is known about the predictors of changes in water use in emergency situations such as COVID-19 particularly in developing countries such as Uganda (Brown *et al.* 2012; Branz *et al.* 2017). This study therefore addresses two main research questions: (1) How does utilisation of water vary under emergency situations (before and after March 2020)? (2) What are the household characteristics that are associated with either an increase, decrease or no change in water utilisation in emergency situations (before and after March 2020)? A cut-off period of March 2020 is used because that is the month the government of Uganda implemented a total lockdown for the first time due to an outbreak of COVID-19. Understanding the socio-economic predictors for changes in household water use can be used to inform efficient and effective prediction and demand modelling as a first step for the improved design of interventions for equitable water supply during emergencies. Investigating the factors that shape the changes in water use in emergency situations is also important in formulating and implementing more appropriate water policies and interventions aimed at reducing inequalities in maintaining uninterrupted access to improved drinking water under emergency situations.

Theoretical background of impulsive consumption in social emergencies

According to impulsive consumption, people suddenly consume goods unplanned and based on quick decisions (Hoch & Loewenstein 1991). For impulsive consumption to happen, people's behaviour is usually influenced by external environmental factors (Sengupta & Zhou 2007). For example, the emergence of COVID-19 may trigger panic, stress or anxiety which forces people to behave differently from their normal behavioral pattern (Li *et al.* 2020). People's demand for goods tends to increase to satisfy their mood (Maxwell & Kover 2003). People's demand for goods can be influenced by their perceived control or materialism, which are all guided by impulsive consumption. With perceived control, individuals have a belief that they have control of external or environment factors (Burger 1989), while materialism refers to an individual's ability to own something as a measure of success in life (Chan & Prendergast 2007). Based on the theory of impulsive consumption, we hypothesise that water use in households could be influenced by impulsive consumption in many ways. For example, the COVID-19 outbreak could have influenced people's behaviour in terms of drinking water, washing, bathing, handwashing, and cleaning due to fear of death, thereby leading to an increase in demand for water. We contend total lockdown reflected a high severity of the COVID-19 pandemic which could have influenced high water use. Moreover, high demand and consumption for water use could be influenced by those who can afford it.

DATA AND METHODS

Source of data and sample size

The data used in this paper come from a household cross-sectional survey that collected quantitative data from 43 small towns in four regions of Uganda: central (Bukolooto, Kakoge, Kalagi, Katende, Kayunga, Kyikusa, Kyamulibwa, Masaka, Nanziga, Sekanyonyi and Busana), western (Rwene, Rubuguri, Ntala, Mitooma, Kyenjojo, Kiyenje, Kibale, Karuguza, Kakabara, Kabango, Kabale and Isingiro), northern (Kamdini, Ciforo, Kitgum, Matidi, Laropi, Adwari, Agweng, Guruguru and Purong) and eastern (Toroma, Soroti, Budaka, Bulambuli, Kibuku, Masafu, Nankoma, Namutumba, Namagera and Ocaapa). This study aimed at collecting responses about water use in households due to COVID-19, and how the COVID-19 pandemic affected water use in households. The survey collected information from 1,889 households and institutions, but for the purposes of this study, the analyses considered only 1,639 households.

Data collection and ethical clearance

Data collection was conducted by well-trained research assistants using a paper questionnaire. Training of research assistants was carried out for two weeks prior to the start of the data collection exercise. The data collection exercise took place between 1 August 2020 and 31 August 2020. The response rate was 100% since the study had targeted 1,500 household heads. Ethical clearance to conduct the study was granted by the Makerere University Institutional Review Board. All participants had to consent to participate in the study.

Study sampling

Stratified stage random sampling was employed. A stratified random sampling approach was used to select study towns. Umbrella Authorities for water and sanitation were considered as the strata in the sampling procedure so that all regions within the country were well represented. Stratified sampling for data collection considered regions, districts, from where small towns were sampled for the survey. Simple random sampling was used to select households for interviews in study areas.

Measurement of variables

Dependent variable

Household heads were asked to state the average quantity of water (in 20-litre jerrycans) they used in the household in a day before March 2020 and after March. Households whose quantity of water used after March 2020 was less than the quantity of water used before March 2020 were categorised as having had a decrease in the quantity of water used in the household due to COVID-19. Households for which the same quantity of water was used in the household before and after March 2020 were categorised 'same as before', and households whose quantity of water use after March 2020 was more than before March 2020 were categorised as having had an increase.

Independent variables

We created ten-year age groups for the age of the household head: 18–27, 28–37, 38–47, and 48+. The survey collected information from both male- and female-headed households. Household heads were either currently married or not currently married. The 'not currently married' category comprised the widowed, separated, divorced and the never married. Households were categorised into two groups of household size: 1–4 or more than five household members. Educational attainment was grouped into four categories: none, primary, secondary, and tertiary or university. Household heads were asked to report on their main occupation. Responses were categorised into seven groups. For this study, household chores and all other employment are grouped together because of fewer cases. Other categories of main occupation are none, farming, salaried employment, self-employment, casual labour and student.

We lumped together households whose main source of water was wells, spring, stream, or river because of the few cases. Other categories were piped water inside the household, piped water outside the household, harvested and borehole. Households were asked whether they pay for water to use in the household (Yes or No). Household heads were asked to state the average number of times they wash their hands, and households were categorised into two groups: 2–6 or 7–15 times. Household heads were asked to report on whether the quantity of water used in the household for cooking, washing dishes or clothes, cleaning the house, flushing the toilet, bathing, or washing hands after March 2020 increased, decreased or remained the same in relation to the quantity of water before March 2020.

Data analysis

Data analysis was performed using the STATA software. The distribution of household characteristics was presented at the univariate level of analysis. A Pearson-chi-square test was calculated at the bivariate level to test the association between selected household characteristics and a change in the quantity of water used in the household. A multinomial logistic regression model was fitted (because the outcome variable had more than two response categories) to examine the correlates of a change in water use among Ugandan households. Only variables that were significant at the bivariate level were included in the model.

RESULTS

Characteristics of households

The distribution of household characteristics in the study is shown in Table 1. The results show that most household heads were males (80%), currently married (75%), with secondary education (46%) and practiced farming as the main occupation (47%). About a third of household heads were in the age group 28–37 years, and most households had an average of 1–4 members (59%). Finally, most households in the sample were from the western region (29%).

Table 1 | Distribution of household characteristics in the sample

Background characteristics	Frequency	Percentage
Age of household head		
18–27	316	19.3
28–37	561	34.2
38–47	379	23.1
48 +	383	23.4
Sex of household head		
Male	1,311	80.0
Female	328	20.0
Region of residence		
Central	442	27.0
Northern	353	21.5
Eastern	374	22.8
Western	470	28.7
Current marital status of household head		
Currently married	1,229	75.0
Not currently married	410	25.0
Household size		
1–4	960	58.6
5 +	679	41.4
Main occupation of household head		
None	35	2.1
Farming	774	47.2
Salaried employment	334	20.4
Self-employment	359	21.9
Casual labour	92	5.6
Student	17	1.0
Household chores/Other	28	1.7
Level of education of household head		
None	46	2.8
Primary	488	29.8
Secondary	762	46.5
Tertiary/University	343	20.9
Main source of water		
Piped water in household	648	39.5
Piped water outside household	424	25.9
Harvested	56	3.4
Borehole	280	17.1
Wells/Springs/Stream/River	231	14.1
Quantity of water in household used has increased due to COVID since March 2020		
Increased	699	42.7
Decreased	329	20.1
Same as before March 2020	611	37.3
Whether household buys/pays for water used		
Yes	1,243	75.8
No	396	24.2
Number of times wash hands		
2–6	1,141	69.6
7–15	498	30.4
Total	1,639	100

Table 1 shows that most households had piped water in the household (39%) and about 70% washed their hands an average 2–6 times a day. Most households paid for the water used in the household (76%) and 43% of households agreed that the quantity of water used in the household had increased due to COVID-19 since March 2020.

Table 2 shows the distribution of households on whether the quantity of water used after March 2020 either decreased or increased in relation to the quantity of water used in the household before March 2020. Most households reported an increase in the quantity of water used since March 2020 for cooking food and washing dishes, cleaning the house, and washing clothes, flushing the toilet, bathing, and washing hands as a COVID-19 precautionary measure. The results in Table 2 are expected given the current state of the COVID-19 pandemic that calls for better hygiene.

Table 2 | Changes in the quantity of water used in the household for the different purposes relying on quantities used prior to March 2020 as a base

Water quantities used in relation to water quantities used before March 2020	Frequency	Percent
Cooking food and washing dishes		
Significant decrease	69	4.2
Slight decrease	88	5.4
No change	312	19.0
Slight increase	856	52.2
Significant increase	314	19.2
Cleaning house and washing clothes		
Significant decrease	33	2.0
Slight decrease	127	7.8
No change	248	15.1
Slight increase	940	57.4
Significant increase	291	17.8
Flushing toilets		
Significant decrease	53	3.2
Slight decrease	57	3.5
No change	543	33.1
Slight increase	514	31.4
Significant increase	138	8.4
Not applicable	334	20.4
Showering (bathing)		
Significant decrease	37	2.3
Slight decrease	67	4.1
No change	552	33.7
Slight increase	772	47.1
Significant increase	211	12.9
Washing hands as a COVID precautionary measure		
Significant decrease	24	1.5
Slight decrease	83	5.1
No change	240	14.6
Slight increase	716	43.7
Significant increase	576	35.1
Total	1,639	100

Relationship between household characteristics and changes in quantity of water used since March 2020

Table 3 shows associations between selected household background characteristics and changes in the quantity of water used due to COVID-19 since March 2020. According to Table 3, most households (43%) reported an increase in the quantity of water used since March 2020 37% reported the, same as before March 2020 and 20% of households experienced a decrease. Table 3 shows that age, sex, current marital status, main occupation, and educational attainment of the household head, region of residence, household size, main water source and whether a household pays for water were all significantly associated with changes in the quantity of water used due to COVID-19 since March 2020.

Table 4 shows an association between water utilisation and changes in the quantity of water used in the household due to COVID-19 since March 2020. Results from Table 4 indicate a significant association between handwashing, staying at home, cooking food, and washing dishes, cleaning the house, and washing dishes, bathing, and washing hands.

Correlates of changes in the quantity of water used in the household due to COVID-19 since March 2020

Table 5 indicates that the age, sex, marital status, occupation, and educational attainment of the household head, main water source, region of residence, household size, staying at home, cleaning the house and washing dishes, bathing and handwashing were significant factors associated with changes in the quantity of water used.

Table 3 | Association between household characteristics and changes in quantity of water used in the household due to COVID-19 since March 2020

Background characteristics	Decreased	Increased	Same as before	X^2 (*p*-value)
Age of household head				52.4 (0.000)***
18–27	32.3	34.2	33.5	
28–37	20.9	40.6	38.5	
38–47	16.1	49.9	34	
48 +	12.8	45.4	41.8	
Sex of household head				11.2 (0.004)***
Male	18.7	44.4	36.9	
Female	25.6	35.7	38.7	
Region				181.6 (0.000)***
Central	17.2	62.4	20.4	
Northern	21.8	41.6	36.5	
Eastern	16.3	48.1	35.6	
Western	24.5	20.4	55.1	
Current marital status of household head				14.6 (0.001)***
Currently married	18.9	45.3	35.8	
Not currently married	23.7	34.6	41.7	
Household size				73.4 (0.000)***
1–4	25.8	34.9	39.3	
5 +	11.9	53.6	34.5	
Main occupation of household head				77.9 (0.000)***
None	14.3	54.3	31.4	
Farming	19.5	44.3	36.2	
Salaried employment	10.8	52.1	37.1	
Self-employment	24	33.4	42.6	
Casual labour	43.5	23.9	32.6	
Student	17.7	70.6	11.8	
Household chores/Other	28.6	32.1	39.3	
Educational attainment of household head				49.3 (0.000)***
None	19.6	32.6	47.8	
Primary	25	35	40	
Secondary	20.6	41.5	37.9	
Tertiary/University	12	57.4	30.6	
Main water source				53.0 (0.000)***
Piped in household	17.4	46.9	35.7	
Piped outside household	25.2	37.5	37.3	
Harvested	48.2	25	26.8	
Borehole	14.3	48.2	37.5	
Wells/Spring/Stream	18.2	37.7	44.2	

(*continued*)

Table 3 | continued

Background characteristics	Decreased	Increased	Same as before	X^2 (*p*-value)
Buy or pay for water that is used				11.0 (0.004)***
No	21.5	35.6	42.9	
Yes	19.6	44.9	35.5	
Average number of times to wash hands every day				2.6 (0.267)
2–6	19.4	43.9	36.7	
7–15	21.7	39.8	38.6	
Total	20.1	42.6	37.3	

Note: *** = $p < 0.01$.

Households with household heads in the age group 28–37 years (RRR = 0.58; CI = 0.39–0.86), 38–47 years (RRR = 0.61; CI = 0.38–0.98) and 48 years or more (RRR = 0.37; CI = 0.23–0.61) were less likely to have a decrease in the quantity of water used than households with household head aged 18–27 years in relation to households whose quantity of water used was the same as before March 2020. Female-headed households were more likely (RRR = 1.55; CI = 1.03–2.32) than male-headed households to have a decrease in the quantity of water used in the household.

Table 5 shows that households in the northern (RRR = 0.54; CI = 0.33–0.87), eastern (RRR = 0.51; CI = 0.31–0.83) and western regions (RRR = 0.42; CI = 0.27–0.63) were less likely than households in the central region to report a decrease in the quantity of water. Similarly, households in the northern (RRR = 0.31; CI = 0.21–0.46), eastern (RRR = 0.50; CI = 0.35–0.72) and western regions (RRR = 0.11; CI = 0.08–0.16) were less likely to report an increase in the quantity of water used.

Unmarried household heads were less likely to report both a decrease (RRR = 0.65; CI = 0.44–0.96) and an increase (RRR = 0.58; CI = 0.41–0.83) in the quantity of water used. Households with five or more household members were less likely (RRR = 0.59; CI = 0.42–0.84) to have a decrease in the quantity of water used, but obviously more likely (RRR = 1.66; CI = 1.26–2.18) to have an increase in the quantity of water used in the household.

Household heads with salaried employment were less likely (RRR = 0.52; CI = 0.33–0.84) but casual labourers were more likely (RRR = 2.13; CI = 1.22–3.74) than famers to have a decrease in the quantity of water used. On the other hand, self-employed household heads were less likely (RRR = 0.67; CI = 0.48–0.94), but students were more likely (RRR = 7.86; CI = 1.58–39.07) to have an increase in the quantity of water used. Household heads with primary education were more likely (RRR = 1.51; CI = 1.08–2.12) than their counterparts with secondary education to report a decrease in the quantity of water used. Households with harvested water were more likely (RRR = 2.52; CI = 1.20–5.29), but households with boreholes were less likely (RRR = 0.58; CI = 0.36–0.93) to have a decrease in the quantity of water used. As expected, households with a decrease in the water used for cleaning the house and washing dishes were more likely (RRR = 3.39; CI = 1.63–7.06) to report a decrease in the quantity of water used in the household due to COVID-19 since March 2020.

Given the results shown in Table 5, an interaction between current marital status and household size was introduced in the model (see Figure 1). The results shown in Figure 1 indicate that (irrespective of the number of household members) unmarried people were less likely to experience either a decrease or an increase in the water utilisation than married people. On the other hand, a higher proportion of unmarried people reported no change in the quantity of water used than married people before and after March 2020. This finding suggests that comparatively, unmarried people are on average highly mobile and with fewer household members or semi-permanent residents in their households compared with married people. This implies that the constant demand for water utilisation in the household among unmarried people may be less than among married people.

Table 4 | Association between water utilisation and changes in the quantity of water used in the households due to COVID-19 since March 2020

Water utilisation	Decreased	Increased	Same as before	*p*-value (X^2)
Water consumption has greatly increased during COVID-19				6.9 (0.136)
Decrease	18.3	46.6	35.1	
No change	25.3	34.1	40.7	
Increase	20.5	41.5	38.1	
Handwashing has increased water consumption				11.7 (0.019) **
Decrease	23	48.4	28.6	
No change	20.6	38.2	41.2	
Increase	19.4	41.7	39	
Staying at home has contributed to increased water consumption				14.7 (0.005) ***
Decrease	19.8	50.3	29.9	
No change	18.6	35.9	45.5	
Increase	20.3	41.3	38.4	
Water quantities have increased in relation to quantities before March 2020 for cooking food and washing dishes				10.7 (0.030) **
Decrease	16.6	54.8	28.7	
No change	19.9	42.3	37.8	
Increase	20.6	41.1	38.3	
Water quantities have increased in relation to quantities before March 2020 for cleaning house and washing dishes				22.9 (0.000) ***
Decrease	19.4	58.1	22.5	
No change	19.8	37.1	43.2	
Increase	20.2	41.8	38	
Water quantities have increased in relation to quantities before March 2020 for flushing toilet				5.6 (0.229)
Decrease	16.4	49.1	34.6	
No change	24.1	42.2	33.7	
Increase	20.4	42.3	37.3	
Water quantities have increased in relation to quantities before March 2020 for bathing				12.7 (0.013) **
Decrease	9.6	57.7	32.7	
No change	21	40.9	38	
Increase	20.7	42	37.3	
Water quantities have increased in relation to quantities before March 2020 for washing hands as a COVID precautionary measure				29.7 (0.000) ***
Decrease	11.2	54.2	34.6	
No change	20	30	50	
Increase	20.8	44	35.1	
Total	20.1	42.6	37.3	

Note: ** = $p < 0.05$; *** = $p < 0.01$.

Table 5 | Relative risk ratios from a multinomial logistic model predicting changes in the quantity of water used in the household due to COVID-19 since March 2020

	Relative risk ratios	
Variable	**Decreased**	**Increased**
Age of household head (RC = 18–27)		
28–37	0.58*** (0.39–0.86)	0.89 (0.61–1.31)
38–47	0.61** (0.38–0.98)	1.02 (0.67–1.56)
48 +	0.37*** (0.23–0.61)	0.90 (0.59–1.38)
Sex of household head (RC = Male)		
Female	1.55** (1.03–2.32)	1.14 (0.78–1.66)
Region (RC = Central)		
Northern	0.54** (0.33–0.87)	0.31*** (0.21–0.46)
Eastern	0.51*** (0.31–0.83)	0.50*** (0.35–0.72)
Western	0.42*** (0.27–0.63)	0.11*** (0.08–0.16)
Current marital status of the household head (RC = Currently married)		
Not currently married	0.65** (0.44–0.96)	0.58*** (0.41–0.83)
Household size (RC = 1–4)		
5 +	0.59*** (0.42–0.84)	1.66*** (1.26–2.18)
Main occupation of the household head (RC = Farming)		
None	0.94 (0.30–2.88)	1.96 (0.84–4.56)
Salaried employment	0.52*** (0.33–0.84)	0.74 (0.52–1.06)
Self-employment	1.09 (0.76–1.58)	0.67** (0.48–0.94)
Casual labour	2.13*** (1.22–3.74)	0.94 (0.51–1.75)
Student	2.35 (0.36–15.44)	7.86** (1.58–39.07)
Household chores/Other	1.21 (0.44–3.35)	0.71 (0.27–1.87)
Highest educational attainment of the household head (RC = Secondary)		
None	1.13 (0.48–2.67)	0.69 (0.32–1.52)
Primary	1.51** (1.08–2.12)	0.92 (0.68–1.25)
Tertiary/University	0.93 (0.59–1.46)	1.24 (0.89–1.72)
Main water source (RC = Piped water inside household)		
Piped (outside household)	1.09 (0.76–1.58)	1.04 (0.75–1.44)
Harvested	2.52** (1.20–5.29)	0.57 (0.25–1.33)
Borehole	0.58** (0.36–0.93)	0.71 (0.50–1.01)
Wells/Springs/Stream/River	0.69 (0.43–1.11)	0.88 (0.59–1.32)
Buy or pay for water (RC = Yes)		
No	1.03 (0.70–1.49)	0.74 (0.54–1.01)
Staying at home has contributed to my increased water consumption (RC = No change)		
Decrease	1.46 (0.76–2.79)	1.86** (1.10–3.15)
Increase	1.41 (0.77–2.58)	1.32 (0.80–2.15)
Water quantities have increased in relation to quantities before March 2020 for cooking food and washing dishes (RC = No change)		
Decrease	1.01 (0.51–1.99)	1.18 (0.69–2.02)
Increase	1.02 (0.68–1.53)	0.90 (0.64–1.25)

(*continued*)

Table 5 | continued

Variable	Relative risk ratios	
	Decreased	**Increased**
Water quantities have increased in relation to quantities before March 2020 for cleaning house and washing dishes (RC = No change)		
Decrease	3.39*** (1.63–7.06)	2.67*** (1.46–4.87)
Increase	1.14 (0.71–1.83)	1.34 (0.91–1.98)
Water quantities have increased in relation to quantities before March 2020 for bathing (RC = No change)		
Decrease	0.46 (0.19–1.14)	1.32 (0.69–2.51)
Increase	0.98 (0.71–1.36)	0.98 (0.74–1.29)
Water quantities have increased in relation to quantities before March 2020 for washing hands as a COVID precautionary measure (RC = No change)		
Decrease	0.54 (0.21–1.35)	1.11 (0.56–2.20)
Increase	1.41 (0.91–2.17)	1.73*** (1.18–2.53)
Constant	1.11 (0.41–3.03)	1.46 (0.62–3.46)

Note: Base category is 'Same as before'; RC = Reference categories; Confidence intervals in parentheses; ** = $p < 0.05$; *** = $p < 0.01$.

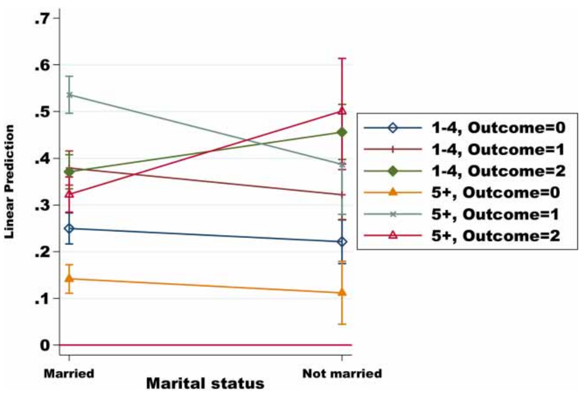

Figure 1 | Marginal effects of marital status and household size on changes in water utilisation. *Note*: Outcome = 0 = decreased; Outcome = 1 = increased; Outcome = 2 = same as before.

DISCUSSION

The aim of this paper was to examine factors associated with water utilisation in Ugandan households before and after March 2020. The cut-off period of March 2020 is used in this analysis because that is when the government of Uganda implemented a total lockdown for the first time in order to prevent the spread of COVID-19. The study also investigated how water utilisation varies under emergency situations. This analysis was motivated by the desire to provide empirical evidence needed to inform efficient and effective prediction and demand modeling by water professionals and water utilities such as the Umbrella Authorities (UA) and National Water and Sewerage Corporation (NWSC). Moreover, having information about water usage is important in informing formulation, revision, interventions, and implementation of more appropriate water policies aimed at reducing inequalities in maintaining continuous water supply under emergency situations.

The results indicate that age, sex, education attainment, marital status, main water source, staying at home and main occupation of the household head, region of residence and average household size were significantly associated with water utilisation. The results in this study resonate with findings reported earlier by Nteli *et al.* (2014), who observed that higher educational attainment was associated with better handwashing practices. In this study, household heads with primary education were more likely to report a decrease in water utilisation than their counterparts with secondary education. While such a finding may imply that household heads with lower educational attainment may have poor hygienic practices, it is also possible that reduced water usage could have been associated with other underlying factors this study did not investigate. We contend that reduced use of water may imply water stress brought about disconnections, high costs, drought, or wastage through leakages. In situations where households are water-stressed, households can help out each other through water transfers between households (Rosinger *et al.* 2020) or even harvest rain water (Zavala *et al.* 2018). However, households that rely on harvested water may experience a decrease in water utilisation because harvested rainwater is seasonal. On the other hand, the increase in water use this study reports may be influenced by impulsive consumption due to COVID-19 (Hoch & Loewenstein 1991; Sengupta & Zhou 2007).

As expected, an increase in the quantity of water used was more likely to happen among households with five or more members compared with households with fewer household members. Households with five or more members are more likely to have a higher demand for water than their counterparts with fewer household members. Casual labourers were more likely to have reduced quantities of water used than farmers. This finding may suggest that during total lockdown, casual labourers were limited with work from which they could get a wage to sustain themselves. Limited disposable income may limit the purchasing power especially for those that rely on buying water and do not have piped water in their households. On the other hand, salaried employees are less likely to reduce the quantities of water they use in their households because they are assured of a monthly pay cheque to sustain themselves and meet their household obligations.

It is expected that older household heads may have better financial capabilities and water storage facilities than younger household heads. In this case, older household heads may be less likely to experience a decrease in water consumption than their counterparts. The results from the model suggest that regionally, there was disruption in water supply (due to the presidential directive). Further, due to limited quantities of water used among unmarried people because of a smaller family size, changes in water utilisation were less likely to be reported even during lockdown.

Evidence of unified or differentiated behaviour of customers of water supply systems and the rationale behind this behaviour can serve as a basis for science-based intervention strategies. Findings indicate that customers can be clustered based on behaviour during COVID-19 times. This clustering is a clear indication that no one generalised intervention strategy would be effective in combating the challenges faced by customers. Effective strategies for avoiding generalised intervention approaches include: (1) phasing (with prioritisation incorporated) implementation of an intervention strategy based on time, location, and demographic factors, among others, while keeping elements of the intervention strategy the same, and (2) adopting and implementing different strategies (that is, have different elements within each of them) that meet the unique needs of each cluster.

Small towns with water supply systems that are plagued with intermittent water shortages should adopt prioritised and phased rationing guided by the demographics of the communities. Communities in small towns that have predominant demographics associated with increased water utilisations should be the least prioritised for cut-offs when rationing water. This is to limit the impact of pandemics similar to COVID-19. Strategies that involve financial incentives or relief (such as changes in tariffs (for example lowering rates), leniency in effecting collections and cut-offs for defaulters, delaying) can be extended to the category of customers that showed a reduction in water utilisation during the pandemic.

CONCLUSION AND IMPLICATION

Water supply is an essential part of public health for society especially during pandemics. The findings reported in this study indicate that on average, most Ugandan households had an increase in the quantity of water utilised after March 2020 than before. The increase could be influenced by impulsive consumption created by an emergence such as COVID-19. The results presented in this study provide a basis for designing water interventions for equitable water supply under emergencies. Water supply policies or interventions should aim for inclusiveness by considering variations and inequalities of users. Eliminating all existing differentials in access to clean water can lead to socioeconomic development.

With regards to evaluation of the variability of household water utilisation under emergency situations such as COVID-19, the study has shown that households changed behaviour which increased water use after March 2020 when compared with the period before March 2020 (COVID-19). The increase in water demand is driven by (i) the desire to mitigate the spread of the pandemic through hand washing and (ii) increased domestic activity such as handwashing, cooking, and cleaning dishes and clothes because of communities being locked down at home. With these activities, communities make efforts to meet the COVID-19 mitigation and restriction guidelines while at the same time maintaining minimum survival standards even when the provision of water sources and the system have not been adjusted to adapt to the new emergencies. The current study therefore shows that with emergencies such as COVID-19, households were able to change their domestic water use practices, hence increasing demand. This is a key finding that feeds into the debate of water demand modelling and variability prediction during emergencies.

Moreover, the increased water demand vis-à-vis a static system and water resources will have a ripple effect on the performance of a water supply system. In such situations it is appropriate to transition existing water supply networks to flexible systems which provide a good performance in the case of normal-situation supply as well as in emergency situations. Therefore, for regular water supply, a centralised supply system will have the option to be changed to a more decentralised system in cases of intermittent supply. Thus, the pressure differences in the network can be reduced and the equity of supply for all water users can be improved. Flexible systems can provide tailored solutions to deal with water supply challenges during emergencies.

In addition, the paper provides a number of water supply intervention strategies. First, there is need to adapt water demand management strategies and innovative approaches to cope with the challenges for increased demand during emergencies. By applying the principles of water demand management strategies and innovative approaches such as integrated urban water management, impacts of increased demand in space and time to satisfy the water needs of a community at the lowest cost while minimising adverse environmental and social impacts can be met. However, technology innovations will have to be coupled with comprehensive system changes of the water supply systems.

Second, there is need to prioritise clean water supply in water-stressed areas such as low-resource environments, particularly in slums, congested areas, or rural areas. This is because most such areas do not have piped water and rely on seasonal harvested rain water or wells, or rivers, or streams. The implication is that in times of drought that may happen during an emergency, people may lack enough water, which may compromise hygiene. Adopting suggested approaches such as water transfer between households or harvesting rainwater can help water-stressed households and can boost economic development and reduce poverty.

Third, unlike salaried employees, seasonal workers such as casual labourers tend to be confined in low-resource settings that are water-stressed. During emergencies when they are not working, such people may not be able to afford to pay for water – calling for the government to either provide free water or water subsidies. Last, as a short-term strategy, the government can institutionalise the implementation and provision of boreholes in areas that do not have piped water to solve the problem of water scarcity. These water supply interventions can go a long way in ensuring that people have clean water to use during times of emergencies.

LIMITATIONS

Three main limitations emerge from this study. First, the dataset used in this study did not collect information that can be used to compute a composite household wealth index. Information on household wealth can offer useful plausible explanations on whether a change in water utilisation in Ugandan households was mediated by wealth. Second, responses recorded in the survey for analysis could be affected by the effect of COVID-19. That is, the results shown in this study about water utilisation may not necessarily reflect the COVID-19 pandemic. Finally, while we report changes in the quantities of water used before and after March 2020, there is a failure to account for factors such as efficiency in the provision of water from the National Water and Sewerage Corporation. It is possible for households to have reduced quantities of water to use because water from the National Water and Sewerage Corporation was not running from the taps.

RECOMMENDATIONS

Incorporating qualitative interviews to such quantitative data can provide hidden insights and help unmask reasons behind changes in water utilisation. Therefore, future studies can consider exploring reasons behind the patterns of water utilisation. Responses from such studies can shed light on areas that require redress, improvement or devise approaches that promote sustainability.

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AVAILABILITY OF DATA AND MATERIALS

The datasets used in this study are available from the corresponding author on reasonable request.

COMPETING INTEREST

The authors declare that they have no competing interests.

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AUTHORS' CONTRIBUTIONS

JIS coordinated manuscript writing and reviewed the literature. JM conceptualised and conducted literature review. MDT coordinated data collection, conceptualisation, and manuscript writing. RE conducted literature review and discussed the results. PK analysed the data and interpreted the findings. All authors read and approved the final manuscript.

DATA AVAILABILITY STATEMENT

All relevant data are included in the paper or its Supplementary Information.

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