

## Research Paper

# An assessment of availability of handwashing facilities in households from four East African countries

Peter Kisaakye, Pedzisai Ndagurwa and John Mushomi

### ABSTRACT

The World Health Organization provides guidelines on handwashing as part of the global campaign towards achieving proper hygiene. In East Africa, cholera and diarrhoea outbreaks and, most recently, COVID-19 remain a threat to public health – calling for the promotion of handwashing to prevent infection. Using data from demographic and health surveys in four East African countries (Kenya, Rwanda, Tanzania and Uganda), we estimate the prevalence and identify the predictors of the availability of handwashing facilities in households. Findings indicate that the presence of a handwashing facility is not universal in the four countries: Kenya (66.4%), Rwanda (76.4%), Tanzania (80.7%) and Uganda (59.2%). Results from the pooled binary logistic regression model indicate that age, sex and education of the household head, type of place of residence, number of children, and household wealth are strong predictors of having handwashing facilities in all countries. However, the likelihood of having a handwashing facility in Uganda is lower than other countries. This study provides a rich understanding of the factors that explain the availability of handwashing facilities. Findings indicate how prepared the four countries are in the face of the COVID-19 pandemic – and can guide the policy direction in the prevention of infection.

**Key words** | demographic and health survey, East Africa, handwashing

### HIGHLIGHTS

- About 40% of the world's population do not have a handwashing facility.
- Results from Demographic and Health Survey datasets from Kenya, Rwanda, Tanzania, and Uganda indicate that hand hygiene facilities are not universal in all households.
- The type of place of residence, household wealth, number of children, age, sex and education of the household head are strong predictors of having a handwashing facility.

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## GRAPHICAL ABSTRACT



- About 40% of the world's population do not have a handwashing place with soap and water, yet hand hygiene is a cost-effective measure to prevent infection.
- We use Demographic and Health Survey datasets from four countries (Kenya, Rwanda, Tanzania, and Uganda) to assess the access to handwashing facilities and provide a comparative analysis between the countries.
- Hand hygiene facilities are not universal in all households in the four countries, with only 66.4% of households in Kenya, 76.4% in Rwanda, 80.7% in Tanzania and 59.2% in Uganda with a handwashing facility.
- The type of place of residence, household wealth, number of children, age, sex and education of the household head were strong predictors of having a handwashing facility in a household in all countries.
- The findings highlight the current state of handwashing facilities in the countries under study and indicate the level of preparedness in the face of a pandemic such as COVID-19.

## ABBREVIATIONS

AIDS	Acquired immunodeficiency syndrome
CHEWs	Community health extension workers
DHS	Demographic and health survey
EAC	East African community
FOAM	Focus on opportunity, ability, and motivation
HIV	Human immunodeficiency virus
MERS	Middle East respiratory syndrome
SARS	Severe acute respiratory syndrome
SDGs	Sustainable Development Goals
SSA	Sub-Saharan Africa
UNICEF	United Nations Children's Fund
USAID	United States Agency for International Development
WHO	World Health Organization

## INTRODUCTION

The emergence of the new coronavirus in Hubei province of China in November/December 2019 (Chan *et al.* 2020) and its quick spread across the world brought to the forefront the importance of handwashing as one of the primary behavioural preventive measures against the public health threat posed by the virus. Handwashing with soap, use of alcohol-based sanitizer, quarantining for 14 days in the event of a COVID-19 positive test or direct contact with a positive case and physical distancing have been promoted as the

behavioural practices to curb the spread of infections (World Health Organization 2020b). Handwashing is also highlighted in health campaigns for fighting pandemics such as cholera and diarrhoea (Lankford *et al.* 2003). Health centres, schools, commercial areas, refugee settings, prisons, market centres, transport hubs, worship centres and residential areas have been highlighted as important areas to focus on in the promotion of hand hygiene (UNICEF & WHO 2020). It is important to understand the existing patterns and determinants of access to proper handwashing facilities in the context of sub-Saharan Africa (SSA). The countries in SSA that have experienced infections of diarrhoea, cholera and the recent COVID-19 need to emphasize handwashing as a behavioural strategy to prevent infection (Nizame *et al.* 2015).

Few studies have examined handwashing facilities in developing countries (Aiello *et al.* 2009; Nizame *et al.* 2015; Mearkle *et al.* 2016; Guo *et al.* 2017). We fill this research gap by conducting a country-comparison of handwashing facilities in East Africa focusing on Kenya, Rwanda, Tanzania and Rwanda using demographic and health survey (DHS) data. Such a comparison is necessary irrespective of individual country interventions because 40% of the world's population – mostly in low-resource settings – do not have a handwashing place with soap and water (UNICEF & WHO 2020). Moreover, a significant proportion of people in SSA lack quality water, and this problem is

compounded by limited resources, corruption, lack of accountability, poor management and limited personnel (Montgomery & Elimelech 2007). Further, diarrhoea is reported to be one of the leading causes of morbidity and mortality in SSA due to limited water and poor sanitation (Fewtrell *et al.* 2005; Prüss-Ustün *et al.* 2014; Musoke *et al.* 2018).

In line with Goal 6 of the Sustainable Development Goals (SDGs), the countries under study have come up with policies to ensure good sanitation. The Kenya Environmental Sanitation and Hygiene Policy (KESHP) aims to improve access to sanitation by 100% by 2030 through public education about sanitation practices (Ministry of Health 2015; Null *et al.* 2018). The Kenyan government has continued to engage community health extension workers (CHEWs). In Rwanda, efforts to increase access to good sanitation have been centred on bringing everyone on board through an inter-sectoral programme. Promoting behavioural change through training CHEWs on sanitation at all levels has been implemented (Ministry of Infrastructure 2016). In Tanzania, sanitation programmes have aimed at increasing water utility points in slums and rural settings (Thomas *et al.* 2013). Non-water hygiene practices (use of sanitizers) have been promoted in areas where there is water scarcity. The government of Tanzania has also promoted community-led programmes to increase sanitation practices but also disseminate sanitation messages through mass media (Madon *et al.* 2018). In Uganda, demonstration campaigns have been adopted using a multi-sectoral approach aimed at promoting sanitation programmes. For example, a participatory hygiene and sanitation transformation (PHAST) and engaging of CHEWs as key strategies to promoting basic public health have been promoted (Dumba *et al.* 2013). In addition to training community volunteers, vulnerable groups have received portable handwashing facilities as well as detergent (UNICEF 2019).

Educational programmes have been associated with improved handwashing practices (Mathai *et al.* 2010; Nteli *et al.* 2014; Teker *et al.* 2015). Existing research suggests that children are more likely to display consistent good handwashing behaviours if they have received relevant education (Chittleborough *et al.* 2012). Urban residence, higher education, household wealth, better knowledge about diseases and being older have been observed to be associated with better hand hygiene (Tao *et al.* 2013; Adank *et al.* 2016).

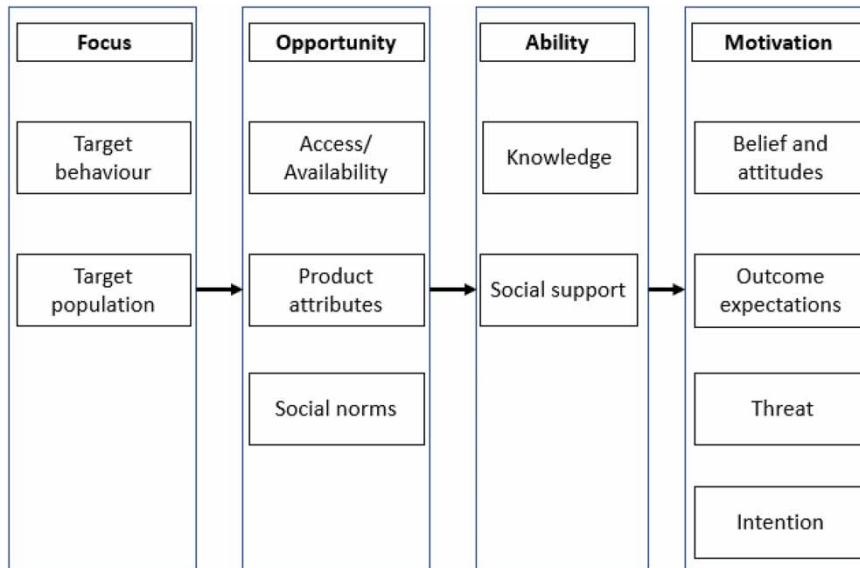
Handwashing with soap or detergents kills germs, and has been effective in preventing the occurrence of diarrhoea in Western Kenya (Brooks *et al.* 2003). However, the majority of households in Western Kenya were observed to not have a handwashing facility (Kamm *et al.* 2014). Insufficient handwashing facilities were also reported in Tanzania (Badowski *et al.* 2011; Briceño *et al.* 2017). Nearly half of all schools worldwide lack handwashing facilities (UNICEF & WHO 2020). In Rwanda, half of rural health-care facilities were observed to have insufficient resources (water and soap) needed to practise handwashing (Guo *et al.* 2017; Morgan *et al.* 2017) while Morgan *et al.* (2017) observed that less than a third of rural schools in Rwanda lacked resources (soap and water) to wash hands.

Having handwashing facilities in households is imperative to the East African Community (EAC) given the recent history of cholera outbreaks in this sub-region. Of the 12 outbreaks of cholera recorded in SSA from 2014 to 2018, seven were from the EAC (World Health Organization 2020a). With the added public health threat from COVID-19, it is imperative to understand the level of preparedness of the EAC countries in providing enough and appropriate hand hygiene facilities using household data. The study addresses three research questions: (1) What is the prevalence of having a handwashing place/facility for households in the four East African countries? (2) What are the key predictors of having a handwashing place in the four countries? (3) How do the four countries compare with each other? Our main contribution to the field of hygiene is that this study makes use of data collected for the first time in some DHS datasets, to provide a regional-country comparison of handwashing facilities in households.

## THEORETICAL FRAMEWORK

We adopt the 'Focus on Opportunity, Ability, and Motivation (FOAM)' framework (Figure 1) that was designed to monitor and evaluate handwashing behaviour in low-resource settings, particularly in SSA (Coombes & Devine 2010).

According to the FOAM framework, for one to perform a certain behaviour, an opportunity and the ability to perform such a behaviour must prevail. The focus relates to the target population and the target behaviour one wishes



**Figure 1** | The Focus on Opportunity, Ability, and Motivation framework. Source: adapted from Coombes & Devine (2010).

to perform (Coombes & Devine 2010). Opportunity relates to the factors such as soap, water, handwashing facilities that would facilitate the behaviour to be performed. Ability measures one's capability to perform a behaviour (Coombes & Devine 2010).

Based on the literature, we hypothesize that: (1) households found in rural areas are less likely to have a handwashing place than households in urban areas; (2) households with no children are less likely to have a handwashing place than households with children; (3) households in the richest wealth quintile are more likely to have a handwashing place than their counterparts in the poorest wealth quintile; and (4) household heads with higher levels of education are more likely to have a handwashing place than their counterparts with no education.

## DATA AND METHODS

### Source of data and sample size

We used data from the DHS programme (<https://dhsprogram.com/>). These surveys use nationally representative samples to provide up-to-date data on household characteristics, sanitation and hygiene among other topics. Data collection in DHSs happens within four to five years between surveys in

each country. The surveys use a standard instrument that allows comparative analysis across both time and space. The selection of households for interview is based on a cluster sampling design which produces a sample of households which is representative of a country's households (Measure DHS 2020). We used the most recent (as of January 2020) DHSs conducted for which the data are publicly available in the four countries that form the EAC to provide a comparative analysis. The surveys employed are those for Kenya (2014), Rwanda (2014/15), Tanzania (2015/16) and Uganda (2016) to analyse the household sample in Kenya (36,430), Rwanda (12,699), Tanzania (12,563) and Uganda (19,588). While the datasets used in this study were not collected at the same time, we argue that the results we present are not affected by the variation of time in data collection because people's behaviours take a long time to change (Blue et al. 2016; Kelly & Barker 2016). Overall, the analysis used data from a total of 81,280 households.

### Measurement of variables

#### Dependent variables

The variables we use in this study largely hinge on the FOAM framework although some aspects of the framework were not analysed due to data limitation. We adopted the

opportunity aspect in the framework to be the dependent variable. The DHS groups households into five categories: observed fixed place, observed mobile place, not observed or not in a dwelling, not observed or not permitted to see, and not observed for any other reason. We created a binary variable coded yes (1) to indicate presence of a handwashing place for households whose handwashing facility was observed and no (0) for the absence of a handwashing place for those not observed.

The DHS also collects data about water and soap – as opportunity factors. We ran checks to determine whether simply having a place for handwashing would yield a variable notably different from one that also takes into consideration the availability of water and soap. We found that having a place for washing hands was strongly correlated with also having soap and running water. Therefore, the findings we report in this study are generalizable to the scope of a handwashing place, water, and soap or detergent.

### Independent variables

According to the FOAM framework, three variables formed the target population (focus): type of place of residence, sex of household head and number of children five years and below. The type of place of residence was either rural or urban. The number of children living in households who are younger than six years was categorized into three groups: households with no children, one to two children, and more than two children. Sex of the household head was a binary variable (male or female). Age, level of education and household wealth are ability factors while interruption of water supply, presence of soap/detergent, location of water source, and presence of water at handwashing place were adopted as opportunity factors. We created seven categories for the age of the household head from reported ages in single years, with the first six categories being in ten-year age groups (10–19, 20–29, 30–39, 40–49, 50–59, 60–69), and the last one being open ended (70 or more). We elected to start from age 10 because the lowest reported age of the household head was 12 years in Tanzania, 13 years in Uganda and 14 years in both Kenya and Rwanda, irrespective of marital status.

Data were collected on whether water was not available for at least a day in the last 2 weeks preceding the survey,

from which we created a variable ‘interruption in water supply’. Households which reported to have experienced an interruption in water supply for a full day or more were coded ‘yes’, otherwise ‘no’. However, data on interruption in water supply were not collected for Kenya and Rwanda. Presence of soap or detergent is a binary variable, ‘yes’ otherwise ‘no’. Households whose source of water to use was in ‘own dwelling, or yard or plot’ were coded ‘own dwelling’ otherwise ‘elsewhere’. The highest education of the household head was categorized into four groups: no education, primary, secondary, and higher. Household wealth was categorized into five groups: poorest, poorer, middle, richer, and richest. Households that never had water available at the handwashing place were coded ‘not available’ otherwise ‘available’.

### Data analyses

Comparative distribution of households was presented at the univariate level of analysis while associations between household characteristics and having a handwashing place were at the bivariate level of analysis. At the multivariate level of analysis, a binary logistic regression model was fitted to examine the household predictors of having a handwashing place because the dependent variable is a dummy variable. The largest category in each variable was used as a reference category. The analysis in the first model was performed for each country separately but the results generated were compared across the four countries.

For comparison between countries, we run a pooled model, first, without interactions and, later, with interactions between country and the selected household variables to estimate accurately the average estimate of the exposure effect (Stukel *et al.* 2001). This is possible because the variables we include in the analyses are uniformly coded and defined across all studies. However, the variable on the interruption in water supply was not included in the pooled model since it was not in some datasets. All the results presented are adjusted to take care of the appropriate weights for representativeness to the whole population and appropriate adjustments for non-response and missing values. All analyses were performed using the STATA version 14 software.

## RESULTS

### Characteristics of households

Results shown in Table 1 show a similar distribution for most variables in all countries. Most household heads in all countries were males, with primary level of education

**Table 1** | Distribution of household characteristics in the sample, four countries, 2014–2016 DHSS

Household characteristics	Kenya 2014	Rwanda 2014/15	Tanzania 2015/16	Uganda 2016
Age of household head				
10–19	0.9	0.6	0.5	1.9
20–29	20.9	18.2	15.4	22.0
30–39	27.7	27.7	25.8	26.7
40–49	19.0	19.6	22.1	19.5
50–59	14.6	16.2	16.0	13.1
60–69	9.4	9.5	10.9	8.9
70 +	7.4	8.3	9.3	7.9
Sex of household head				
Male	67.8	69.0	75.5	69.0
Female	32.2	31.0	24.5	31.0
Type of place of residence				
Urban	42.0	17.2	33.0	25.7
Rural	58.0	82.8	67.0	74.3
Children 5 years and below				
No children	55.8	47.7	42.4	42.2
1–2	40.4	49.3	50.2	49.9
3 +	3.8	3.0	7.4	7.9
Highest education of household head				
No	13.7	26.1	19.6	15.2
Primary	46.2	61.9	63.7	52.1
Secondary	26.5	8.5	14.0	21.4
Higher	13.6	3.5	2.7	11.3
Household wealth				
Poorest	16.7	23.0	16.8	19.6
Poorer	18.0	20.8	19.0	19.2
Middle	19.1	19.2	19.9	18.5
Richer	22.6	18.0	21.4	19.9
Richest	23.6	19.0	22.9	22.8
Total (N)	36,430	12,699	12,563	19,588

Notes: Missing or unknown observations are not shown.

and in the age group 30–39 years. The results in Table 1 show that household wealth varied by country: the lowest proportion of households were in the poorest wealth quintile in Kenya (16.7%) and Tanzania (16.8%) while the richer (18.0%) and middle (18.5%) wealth quintiles constituted the lowest proportion of households in Rwanda and Uganda, respectively. On the other hand, the richest wealth quintile constituted the majority proportion of households in all countries except Rwanda.

Table 1 shows that most households under study are in rural areas. Households with one to two children constituted the majority (about 50%) in Rwanda, Tanzania and Uganda. However, the highest proportion of households (55.8%) never had children in Kenya. The results in Table 2 indicate that the proportion of households with no soap or detergent at a handwashing place is lowest in Tanzania (40.3%), but highest in Uganda (53.3%). Most households had their source of water located outside the dwelling, but the majority had water present at a handwashing place.

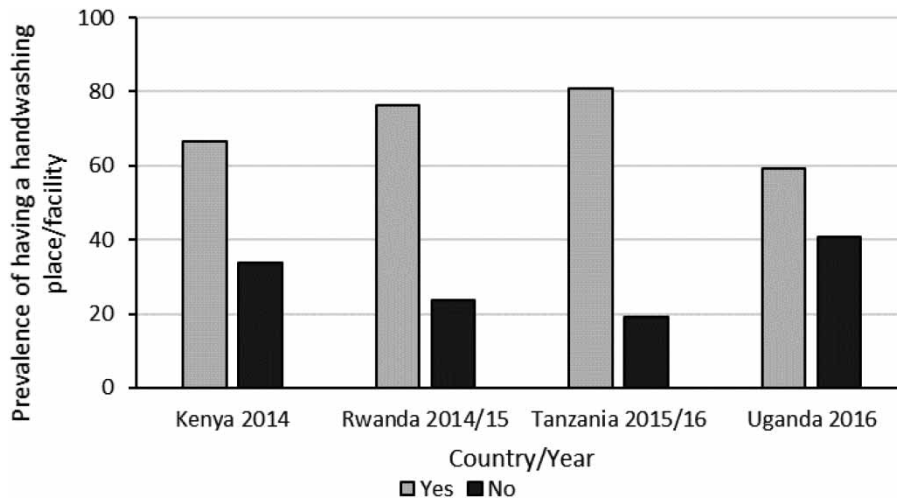
### Prevalence of having a handwashing place/facility

The results in Figure 2 show that more than half of the households in the four countries had a handwashing place,

**Table 2** | Water supply and handwashing, four countries, 2014–2016 DHSS

Household characteristics	Kenya 2014	Rwanda 2014/15	Tanzania 2015/16	Uganda 2016
Interruption in water supply				
No	–	–	45.6	67.2
Yes	–	–	54.4	32.8
Presence of soap or detergent				
No	47.2	46.8	40.3	53.3
Yes	52.8	53.2	59.7	46.7
Location of water source				
Own dwelling	9.8	0.4	6.9	4.6
Elsewhere	90.2	99.6	93.1	95.4
Presence of water at handwashing place				
Not available	26.4	46.5	3.5	24.2
Available	73.6	53.5	96.5	75.8
Total (N)	36,430	12,699	12,563	19,588

Notes: Missing or unknown observations are not shown.



**Figure 2** | Prevalence of having handwashing place/facility, four countries, 2014–2016 DHSs.

with Tanzania having the highest (80.7%) while Uganda had the lowest (59.2%). The implication of such a finding is that having a handwashing place is still not yet universal in the countries under study – causing a threat to preventable infections.

### Association between selected household variables and the presence of a handwashing place

The results in [Table 3](#) show that most households had a handwashing place in their dwelling except for the poorest households in Uganda. This is an expected finding considering the challenges poor households face in terms of accessing clean water, gadgets for keeping clean water and detergents used when washing hands. The results presented in [Table 3](#) show a significant association between having a handwashing facility and the type of place of residence, the highest education level for the household head, and the household wealth in all countries.

### Predictors of having a handwashing place in a household

While it is only households with household heads in the age category 70 or more years significant in Kenya (OR = 1.183; CI = 1.018–1.376), all household heads with different age groups were more likely than those in the age category 30–39 years to have a handwashing place. In Tanzania,

household heads in the age group 10–19 years (OR = 0.090; CI = 0.018–0.451) were less likely to have a handwashing place compared to their counterparts in the age group 30–39 years. In Uganda, household heads in the age group 60–69 years were more likely than those in the age group 30–39 years (OR = 1.205; CI = 1.023–1.419) to have a handwashing place. The results presented in [Table 4](#) show that while it is varied in Tanzania, the likelihood to have a handwashing place in Uganda is higher among older household heads than younger household heads.

Female-headed households were more likely than male-headed households in Tanzania (OR = 1.292; CI = 1.053–1.587) and Uganda (OR = 1.138; CI = 1.035–1.252) to have a handwashing place. Households in urban areas were significant at predicting a handwashing place only in Rwanda (OR = 1.819; CI = 1.558–2.124) and Tanzania (OR = 1.645; CI = 1.287–2.101). The likelihood to have a handwashing place is less among households with no children in Tanzania (OR = 0.817; CI = 0.678–0.985) and Uganda (OR = 0.881; CI = 0.803–0.967) compared to their counterparts with one to two children. On the other hand, households in Uganda with three or more children (OR = 1.174; CI = 1.009–1.366) were more likely than their counterparts with one to two children to have a handwashing place.

Households in Tanzania with an interruption in the water supply were less likely to have a handwashing place (OR = 0.591; CI = 0.500–0.698) than households with no interruption in the water supply. Households with a water

**Table 3** | Association between household characteristics and the presence of a handwashing place, four countries, 2014–2016 DHSs

Household characteristics	Kenya 2014		Rwanda 2014/15		Tanzania 2015/16		Uganda 2016	
	Yes	No	Yes	No	Yes	No	Yes	No
Age of household head								
10–19	74.8	25.2	74.1	25.9	65.4	34.6	46.1	53.9
20–29	67.1	32.9	77.5	22.5	81.8	18.2	57.6	42.4
30–39	66.4	33.6	77.7	22.4	82.6	17.4	59.0	41.0
40–49	67.2	32.8	76.0	24.0	81.1	19.0	60.1	40.0
50–59	64.4	35.7	74.4	25.6	82.4	17.6	60.3	39.8
60–69	66.7	33.4	74.4	25.6	80.0	20.0	60.7	39.3
70 +	64.5	35.5	77.0	23.0	71.7	28.3	61.5	38.5
<i>p</i> -value	0.485		0.083		0.000****		0.000****	
Sex of household head								
Male	66.7	33.3	76.5	23.5	81.3	18.7	58.5	41.5
Female	65.7	34.3	76.1	23.9	78.8	21.2	60.7	39.3
<i>p</i> -value	0.435		0.866		0.001***		0.012**	
Type of place of residence								
Urban	69.9	30.1	86.3	13.7	85.8	14.2	69.3	30.7
Rural	63.8	36.2	74.3	25.7	78.2	21.8	55.7	44.3
<i>p</i> -value	0.000****		0.000****		0.000****		0.000****	
Children 5 years and below								
No children	67.0	33.0	76.7	23.3	77.7	22.3	59.3	40.7
1–2	66.1	34.0	75.8	24.2	82.2	17.8	59.1	40.9
3 +	60.5	39.5	82.3	17.8	87.7	12.3	59.3	40.8
<i>p</i> -value	0.001***		0.041**		0.000****		0.687	
Interruption in water supply								
No	–	–	–	–	82.7	17.3	56.5	43.5
Yes	–	–	–	–	81.4	18.7	63.9	36.1
<i>p</i> -value					0.000****		0.000****	
Location of water source								
Own dwelling	62.6	37.4	79.1	20.9	82.2	17.8	66.0	34.0
Elsewhere	63.2	36.8	75.4	24.6	79.2	20.8	56.0	44.0
<i>p</i> -value	0.471		0.469		0.036**		0.000****	
Highest education of household head								
No	61.9	38.1	77.7	22.3	73.6	26.4	56.7	46.3
Primary	63.9	36.1	74.7	25.3	81.2	18.8	56.3	43.7
Secondary	68.8	31.2	80.2	19.8	86.1	13.9	63.9	36.1
Higher	74.7	25.3	87.6	12.4	92.5	7.5	70.3	29.7
<i>p</i> -value	0.000****		0.000****		0.000****		0.000****	
Household wealth								
Poorest	59.8	40.2	79.8	20.2	75.6	24.4	39.5	60.5

(continued)



Table 3 | continued

Household characteristics	Kenya 2014		Rwanda 2014/15		Tanzania 2015/16		Uganda 2016	
	Yes	No	Yes	No	Yes	No	Yes	No
Poorer	62.0	38.0	75.5	24.5	74.8	25.2	53.9	46.1
Middle	63.2	36.8	72.0	28.0	78.1	21.9	61.1	38.9
Richer	66.8	33.2	71.4	28.6	83.4	16.6	65.3	34.7
Richest	76.5	23.5	82.3	17.7	89.1	10.9	73.6	26.4
<i>p</i> -value	0.000****		0.000****		0.000****		0.000****	

Notes: Results for soap or detergent or presence of water are not shown because there was no variation. Similarly, all households had water for washing hands at a handwashing place. \*\**p* < 0.05; \*\*\**p* < 0.01; \*\*\*\**p* < 0.001.

source in their dwelling in Kenya (OR = 0.853; CI = 0.751–0.968) and Tanzania (OR = 0.663; CI = 0.451–0.975) were less likely to have a handwashing place than their counterparts with a water source elsewhere. In Kenya, household heads with no education (OR = 0.858; CI = 0.774–0.951) were less likely to have a handwashing place compared to household heads with primary education. However, this is different for households in Rwanda. Household heads in Rwanda with no education (OR = 1.221; CI = 1.094–1.363) were more likely than household heads with primary education to have a handwashing place. In Tanzania, household heads with no education (OR = 0.556; CI = 0.450–0.687) or secondary education (OR = 0.652; CI = 0.505–0.842) were less likely than household heads with primary education to have a handwashing place.

All countries except Rwanda exhibit a similar pattern by household wealth. That is, the likelihood to have a handwashing place in Kenya, Tanzania and Uganda was less for households in the poorest, poorer, middle or richer wealth quintiles than households in the richest wealth quintile. However, households in the poorest wealth quintile in Rwanda (OR = 1.500; CI = 1.249–1.802) were more likely than households in the richest wealth quintile to have a handwashing place.

### Pooled model that predicts handwashing

Overall, the results from the pooled model (Figure 3) indicate that household heads in the age group 10–19, 60–69, and 70 or more years old were strong predictors of a handwashing facility. Despite this observation, household heads in the age group 10–19 years were less likely to have a

handwashing place than their counterparts in the age group 30–39 years in all countries. Female-headed households, households living in urban areas, and household heads with no education were predictors of a handwashing place in all four countries. However, the likelihood to have a handwashing place among female-headed households is higher than male-headed households. Results in Figure 3 show that the likelihood to have a handwashing place for households in urban areas is higher than in rural areas in all countries.

Households with three or more children or those with no children emerged to be strong predictors of a handwashing place in all countries. However, the likelihood to have a handwashing place is lower for households with no children compared to households with one to two children.

In all countries, the likelihood to have a handwashing place is lower among households with heads who do not have any form of education compared to their counterparts. Household wealth was significant at predicting a handwashing place, but the likelihood is lower for households in the poorest, poorer, middle and richer wealth quintiles compared to households in the richest wealth quintile. Finally, the results in the pooled model indicate that the likelihood to have a handwashing place is lower in Uganda than the rest of the countries under study.

The predictive margins for the most significant variables – where all categories were significant – are shown in Figure 4, with the use of graphical representations because they have been suggested to be a better way to reflect the effects of interaction terms (Karaca-Mandic et al. 2012).

The graphical representations in Figure 4 show a clear pattern of the type of place of residence by country on

**Table 4** | Odds ratios from a binary logistic regression model predicting the presence of a handwashing place, four countries, 2014–2016 DHSs

Household characteristics	Kenya 2014	Rwanda 2014/15	Tanzania 2015/16	Uganda 2016
Age of household head (RC = 30–39)				
10–19	1.099 (0.762–1.584)	0.765 (0.444–1.318)	0.090*** (0.018–0.451)	0.824 (0.598–1.136)
20–29	1.010 (0.906–1.127)	0.993 (0.868–1.137)	1.020 (0.765–1.360)	0.972 (0.860–1.098)
40–49	1.076 (0.965–1.200)	0.916 (0.803–1.045)	1.038 (0.807–1.335)	0.921 (0.814–1.044)
50–59	1.028 (0.913–1.158)	0.888 (0.770–1.023)	1.250 (0.942–1.659)	1.113 (0.966–1.283)
60–69	1.137 (0.995–1.301)	0.890 (0.750–1.056)	0.986 (0.730–1.333)	1.205** (1.023–1.419)
70 +	1.183** (1.018–1.376)	0.968 (0.801–1.170)	0.945 (0.680–1.313)	1.200 (0.997–1.442)
Sex of household head (RC = Male)				
Female	1.035 (0.959–1.118)	0.923 (0.835–1.020)	1.292** (1.053–1.587)	1.138*** (1.035–1.252)
Type of place of residence (RC = Rural)				
Urban	1.001 (0.917–1.093)	1.819**** (1.558–2.124)	1.645**** (1.287–2.101)	1.066 (0.936–1.212)
Children 5 years and below (RC = 1–2)				
No children	1.010 (0.934–1.093)	1.057 (0.959–1.164)	0.817** (0.678–0.985)	0.881*** (0.803–0.967)
3 +	0.931 (0.795–1.091)	1.305 (0.989–1.720)	1.383 (0.970–1.970)	1.174** (1.009–1.366)
Interruption in water supply (RC = No)				
Yes	–	–	0.591**** (0.500–0.698)	0.952 (0.862–1.053)
Location of water source (RC = Elsewhere)				
Own dwelling	0.853** (0.751–0.968)	1.131 (0.538–2.375)	0.663** (0.451–0.975)	0.909 (0.721–1.145)
Highest education of household head (RC = Primary)				
No education	0.858*** (0.774–0.951)	1.221**** (1.094–1.363)	0.556**** (0.450–0.687)	0.999 (0.883–1.130)
Secondary	1.023 (0.925–1.132)	1.073 (0.893–1.290)	0.652*** (0.505–0.842)	1.046 (0.932–1.174)
Higher	0.911 (0.773–1.074)	1.514 (0.984–2.329)	4.069 (0.950–17.422)	0.995 (0.841–1.177)
Household wealth (RC = Richest)				
Poorest	0.570**** (0.477–0.680)	1.500**** (1.249–1.802)	0.754 (0.503–1.131)	0.287**** (0.239–0.344)
Poorer	0.702**** (0.591–0.834)	1.170 (0.976–1.402)	0.641** (0.439–0.935)	0.469**** (0.390–0.563)
Middle	0.672**** (0.566–0.798)	0.969 (0.810–1.159)	0.574*** (0.402–0.821)	0.638**** (0.530–0.768)

*(continued)*

Table 4 | continued

Household characteristics	Kenya 2014	Rwanda 2014/15	Tanzania 2015/16	Uganda 2016
Richer	0.773*** (0.654–0.914)	0.917 (0.769–1.094)	0.697** (0.500–0.972)	0.784*** (0.657–0.937)

Note: Base category is 'No handwashing place'; RC = reference categories.

Confidence intervals in parentheses.

\*\* $p < 0.05$ ; \*\*\* $p < 0.01$ ; \*\*\*\* $p < 0.001$ .

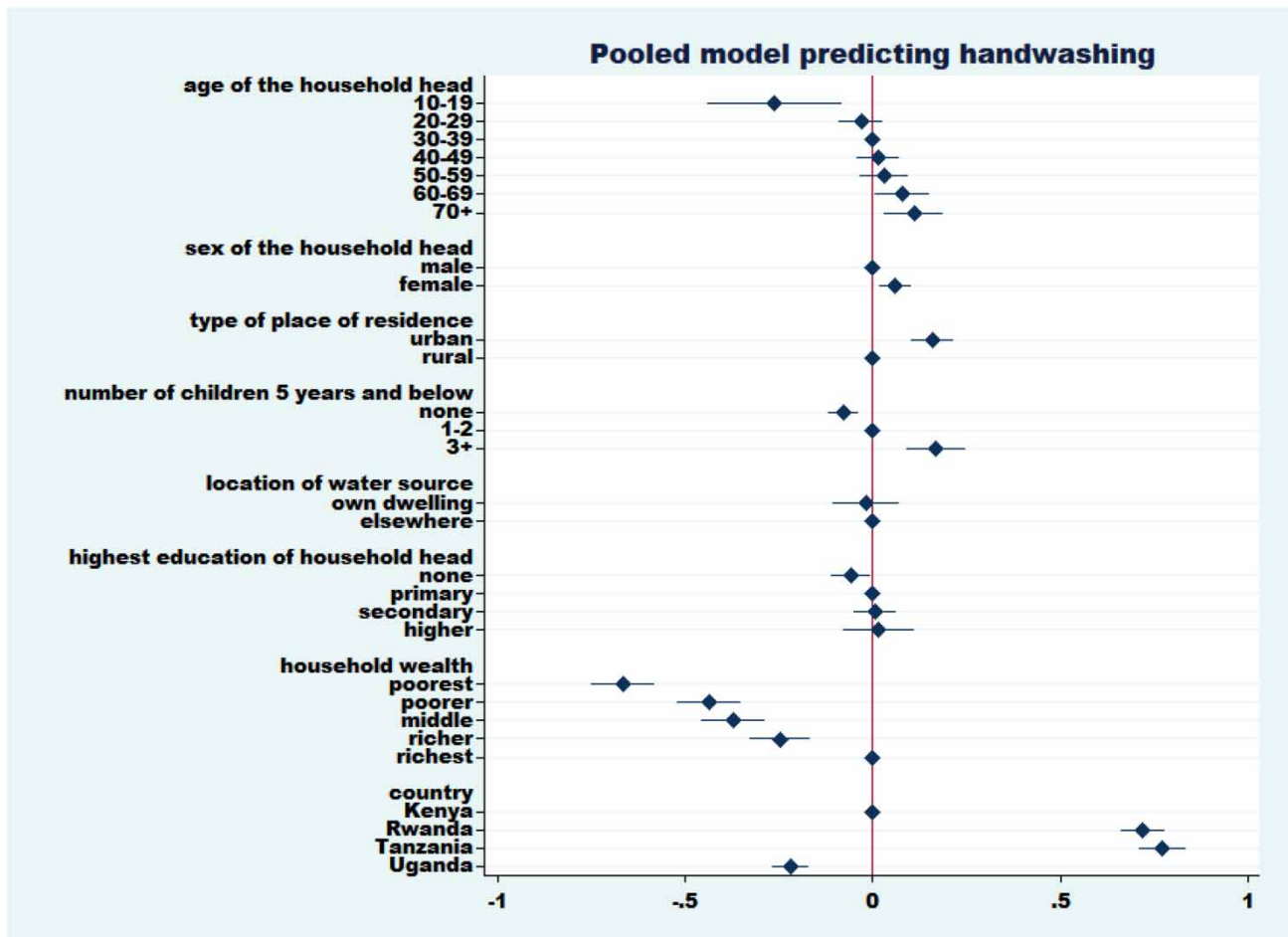


Figure 3 | Pooled model predicting the presence of handwashing facility, four countries, 2014–2016 DHSs.

predicting a handwashing facility. Overall, having a handwashing place was lower in rural areas than in urban areas in all countries. In terms of sex, there was no significant difference in Kenya, but female-headed households were lower in Rwanda and Tanzania while higher in Uganda. There was no significant difference observed between households with no children and those with one

to two children at predicting a handwashing place in Kenya and Rwanda, but households with no children are observed to be lower at predicting a handwashing place in Tanzania and Uganda than households with children. While the pattern observed in Kenya, Tanzania and Uganda by household wealth is expected, Rwanda portrays an unexpected pattern.

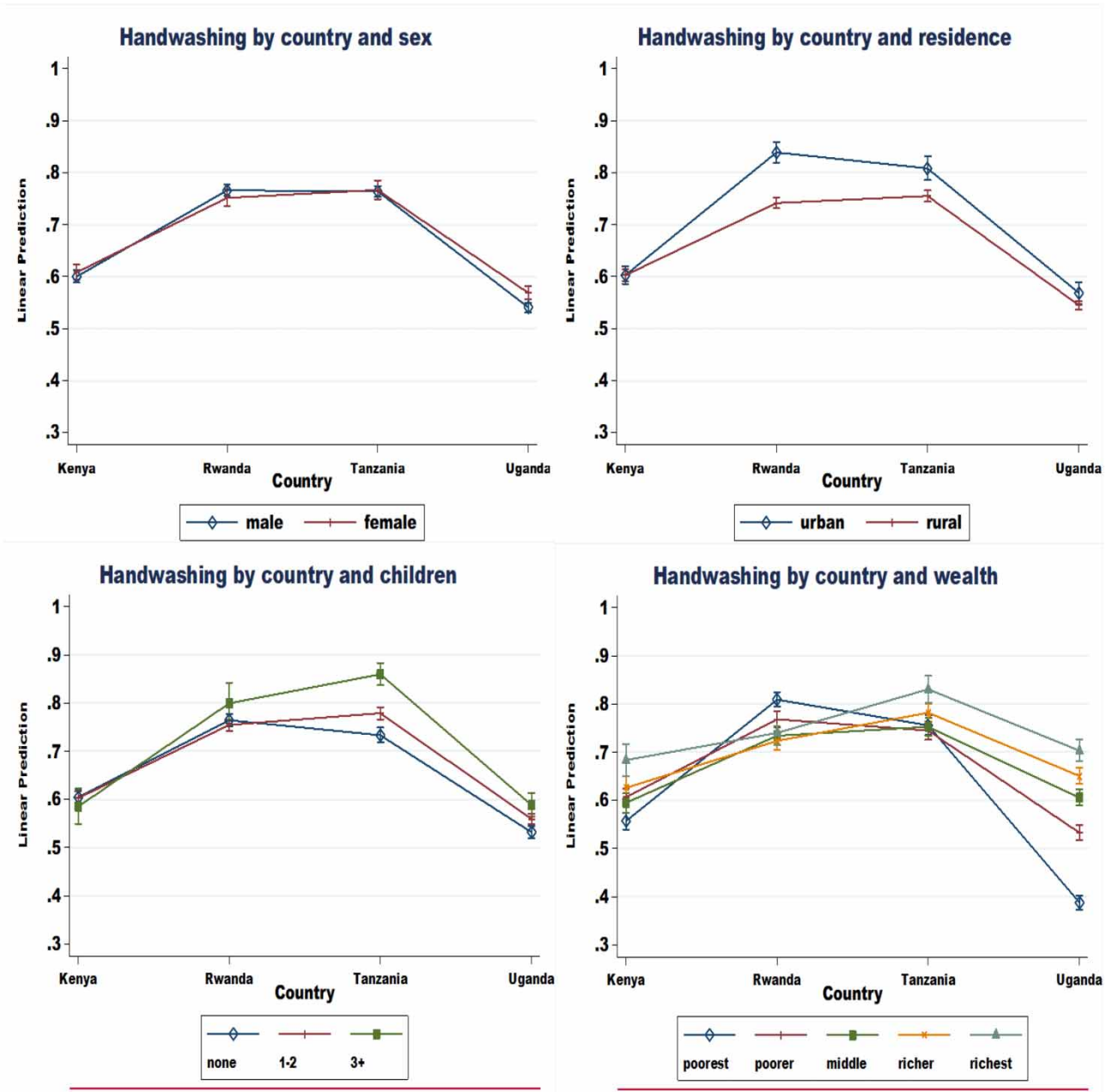


Figure 4 | Marginal effects of selected variables on handwashing, four countries, 2014–2016 DHS.

## DISCUSSION

This study aimed to estimate the prevalence of having a handwashing facility and investigate the patterns and key factors that predict the availability of handwashing facilities in four East African countries (Kenya, Rwanda, Tanzania

and Uganda). The most important finding we report in this study is that hygiene practices are not universal. This has serious health consequences in terms of disease transmission. The differences in hygiene practices between countries can be tied to individual country interventions. Of the four countries, Tanzania’s approaches that increase

awareness and promote better sanitation practices through CHEWs, increase of water utility points and promotion of non-water hygiene strategies are good approaches at promoting sanitation practices (Thomas *et al.* 2013). While all countries make use of CHEWs to promote handwashing with soap and water, only Tanzania has promoted non-water hygiene practices but also increased water utility points. However, the results observed for Uganda may be influenced by the fact that the government is more concerned with policy formulation and not service delivery (Ekane *et al.* 2016). Although this paper did not explore actual handwashing – because of data limitations – we assume that households with handwashing facilities are more likely to practise handwashing behaviours, even though this may not always be true.

Results from the study indicate that the likelihood to have a handwashing place was higher among older household heads in Kenya and Uganda than among younger household heads. This result may point to better hygiene practices among older than younger people in guarding against possible infections. This finding is in agreement with earlier studies that found a similar pattern – handwashing being more prevalent among older individuals (Tao *et al.* 2013). The sex of the household head was only significant in Tanzania and Uganda. This finding implies a distinctive pattern of hygiene practices by the sex of the household head in Tanzania and Uganda compared to Kenya and Rwanda. Challenges in rural areas that are associated with the cost of getting handwashing facilities or clean water may hinder better hygiene practices in Rwanda and Tanzania than in urban areas. However, interventions in Rwanda and Tanzania have promoted the use of CHEWs to promote sanitation practices in remote areas. The number of children in a household predicted having a handwashing place in Tanzania and Uganda. Households in Tanzania and Uganda with no children were less likely to have a handwashing place than households with children. We think this is because households with no children do not regard themselves as being at risk of childhood diseases and therefore do not regard having a handwashing place important (Mearkle *et al.* 2016). Adults living in households with no children may lack knowledge of health effects of poor hand hygiene which includes the risk of transmission of a range of infectious diseases, including COVID-19 (Aiello *et al.* 2009; Biran 2011).

Household wealth was significant in Kenya, Tanzania and Uganda for all wealth quintiles while only the poorest wealth quintile emerged as significant in Rwanda. However, this finding is puzzling, but we expect that intervention programmes aimed at improving handwashing practices have targeted households in low-resource categories such as the poorest in Rwanda. In Uganda, programmes that promote sanitation practices have focused on distributing simple but portable handwashing facilities together with detergents, mainly in vulnerable settings. Another puzzling finding is that households in Kenya and Tanzania whose source of water is in their dwelling were rather less likely to have a handwashing facility. This is likely to be a result of the fact that people are not motivated enough to practise hand hygiene, or they do not see themselves as being at risk. As expected, households in Tanzania who reported to have had an interruption in the water supply were less likely to have a handwashing place. This finding largely speaks of opportunity determinants that influence the handwashing behaviour (Coombes & Devine 2010).

Our results confirm the four hypotheses: First, households in rural areas are less likely to have a handwashing place than households in urban areas. Second, households with no children are less likely to have a handwashing place than households with children. Third, households in the richest wealth quintile are more likely to have a handwashing place than their counterparts in lower wealth quintiles. Finally, the likelihood of having a handwashing place is less among household heads with no education than their counterparts with some form of education.

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## CONCLUSION AND IMPLICATIONS

The findings we report in this study indicate that hand hygiene facilities are still not universal in all households in the four countries, with only 66.4% of households in Kenya, 76.4% in Rwanda, 80.7% in Tanzania and 59.2% in Uganda with a handwashing facility. The danger of this may be catastrophic should an outbreak occur in the region. This calls for the respective governments to step up their efforts in training households on the importance of having and utilizing handwashing facilities.

While individual modelling presents factors that do not necessarily speak of the same story in the four countries, the framework adopted in this study provides an opportunity to group the significant predictors from the pooled model into the three main categories of the framework: focus (age and sex of the household head, type of place of residence, and number of children), opportunity (household wealth) and ability (education of the household head).

This study highlights the need to create awareness of the hygiene practices in the four countries, although more effort would be required in Uganda compared to the rest of the countries – since the results in the pooled model indicate that the odds of having a handwashing place were lower in Uganda than in Rwanda and Tanzania compared to Kenya. Further, results indicate that Uganda had the lowest prevalence of having a handwashing facility compared to other countries in the study.

The findings highlight the current state of handwashing facilities in the countries under study – providing an indication of how prepared they are in the face of a pandemic such as COVID-19. The results provide a rich understanding of the patterns and factors that explain the availability of handwashing facilities in the four countries – and can guide policy direction in the prevention of infection.

### Limitation

The main shortcoming relates to the dependent variable used in this study – which is based on data collected through observation, yet direct observation of handwashing practice is difficult during household surveys.

### Recommendation

It is important that the DHS programme consistently collects data on handwashing facilities to allow a trend analysis for definitive conclusions and to offer better-tailored solutions. Future surveys should review the survey tools used in the countries and embed the core and expanded questions on water, sanitation and hygiene for household surveys developed by the WHO/UNICEF Joint Monitoring Programme for Water Supply, Sanitation and Hygiene (JMP) and assess the progress in hygiene using JMP hygiene service ladders (basic, limited service and no hand washing facility). The

core questions are available at: <https://washdata.org/report/jmp-2018-core-questions-household-surveys>. Incorporating such questions in surveys can provide a rich dataset that can be used to promote further research on handwashing in vulnerable settings, the results of which can then support operationalization of the global call for action on universal hand hygiene. Finally, individual country policy recommendations can focus on adopting strategies that have found to be successful in other areas.

### ACKNOWLEDGEMENTS

Permission to use the data was granted by the Measure DHS program. Access and requests to use the data can be found here: <http://dhsprogram.com/data/>. Consent to participate in the survey was sought from respondents by interviewers and a consent form was issued for signing. PK conceived the study, conducted data analysis, interpreted the results, discussion and conclusions. PN conducted the literature review, discussed the results and reviewed the scientific content of the study. JM conducted the literature review and discussion of the results. All authors read and approved the final manuscript. We did not seek further clearance since the data used for the analyses are in the public domain. No competing interest is declared by authors and no funding was received for the study.

### DATA AVAILABILITY STATEMENT

All relevant data are available from an online repository or repositories (<https://dhsprogram.com/>).

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