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The Influence of Contextual and Psychosocial Factors on Handwashing

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Abstract. Even though washing hands with soap is among the most effective measures to reduce the risk of infection, handwashing rates in infrastructure-restricted settings remain seriously low. Little is known about how context alone and in interaction with psychosocial factors influence hand hygiene behavior. The aim of this article was to explore how both contextual and psychosocial factors affect handwashing practices. A cross-sectional survey was conducted with 660 caregivers of primary school children in rural Burundi. Hierarchical regression analyses revealed that household wealth, the amount of water per person, and having a designated place for washing hands were contextual factors significantly predicting handwashing frequency, whereas the contextual factors, time spent collecting water and amount of money spent on soap, were not significant predictors. The contextual factors explained about 13% of the variance of reported handwashing frequency. The addition of the psychosocial factors to the regression model resulted in a significant 41% increase of explained variation in handwashing frequency. In this final model, the amount of water was the only contextual factor that remained a significant predictor. The most important predictors were a belief of self-efficacy, planning how, when, and where to wash hands, and always remembering to do so. The findings suggest that contextual constraints might be perceived rather than actual barriers and highlight the role of psychosocial factors in understanding hygiene behaviors.

INTRODUCTION

Contaminated hands have been shown to be the vector for the spread of communicable diseases.[1] The use of soap to wash hands at key moments, such as before eating, before preparing food, and after defecating, has the potential to reduce morbidity and mortality from infectious diseases in poor settings.[2–4] Despite its proven effectiveness, the prevalence of washing hands with soap remains seriously low in developing countries, with a mean handwashing prevalence ranging between 13% and 17% in low- and middle-income regions.[4] In Burundi, one of the 10 poorest countries on earth according to the UN 2014 Human Development Report,[5] common childhood infections such as respiratory and diarrheal illnesses are estimated to cause up to 12,900 deaths per year among children younger than 5 years.[6] With handwashing being the most cost effective way to prevent spreading of communicable diseases,[7] the Swiss Agency for Development and Cooperation launched a handwashing program in the Province Nogzi, Burundi, in 2014. This first phase is seen as a pilot project with outcomes serving for developing a program for upscaling. The primary objective of the intervention is to increase the proportion of persons who wash their hands at key moments. Understanding handwashing practices in rural Burundi is an important baseline assessment for the program.

Research done in the field of health behavior indicates the involvement of a complex set of factors. One model aiming to organize determinants of water, sanitation, and hygiene behavior (WASH) is the integrated behavioral model for water, sanitation, and hygiene (IBM-WASH),[8] a synthesis of eight different models of WASH and WASH-related behaviors. The IBM-WASH model introduces a psychosocial and a contextual dimension to guide future behavior change interventions. Psychosocial factors include psychological determinants such as awareness, personal beliefs, and social norms. Contextual factors are characteristics of the environment that influence the behavior.

Psychosocial factors. To assess the psychosocial dimension of handwashing behavior, we drew on the RANAS (risks, attitudes, norms, abilities, self-regulation) model of behavior change.[9] The RANAS systematic approach to behavior change is an approach designed for behavior change in the water and sanitation sector in developing countries. The model integrates different theories of behavior change and includes a broad set of factors predicting behavior. The approach has successfully been applied to increase safe water consumption in Ethiopia and Bangladesh[10,11] and has moreover proven its effectiveness in increasing handwashing behavior in water-scarce regions in southern Ethiopia.[12]

Contextual factors. The contextual dimension of the IBM-WASH model refers to the environment in which a behavior takes place. Environmental psychologists have highlighted the importance of transactions between individuals and their physical settings.[13,14] In these transactions, individuals change their environment and in return, their behavior is determined by this self-created context. We thus distinguished between relatively fixed contextual factors and self-created contextual factors. To operationalize these constructs, we chose specific handwashing related characteristics that have been suggested by previous studies to be associated with handwashing behavior. We considered household economic constraints and the distance to the water source as fixed contextual factors.[15–18] The quantity of water and soap available at household level and the presence of a designated place for handwashing were examined as self-created contextual factors.[19–21]

Fixed contextual factors. *Household wealth.* Several studies have shown that socioeconomic determinants, such as household assets, housing construction material, and level of education, are associated with handwashing practices.[18,19,22] Luby and Halder[23] constructed a comprehensive household wealth score based on housing construction material, number of living rooms, type of cooking fuel, mother's education, and household assets. We found that respondents from wealthier households in Dhaka, Bangladesh were more likely to report

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washing hands with soap and soap was more often observed in those households.

Water collection time. Both Wang and Hunter[24] and Pickering and Davis[18] were able to show that the time spent walking to the water source was a significant determinant of diarrheal disease. It has, moreover, been assumed that increased accessibility to water is associated with higher volumes of water used.[25] When collection time is longer than 30 minutes, water quantities collected are expected to further decrease, up to the bare minimum of water for daily consumption. In rural Burundi, less than 1% of all households have piped water on their premises.[22]

Self-created contextual factors. *Amount of water per person.* It has been estimated that a minimum of 7.5 L of water per person per day is required in the home for consumption (i.e., drinking water and water for food preparation).[26] This minimum required for drinking and cooking falls below the need for domestic water supplies for basic health protection. Additional volumes are required for handwashing, bathing, basic food hygiene, domestic cleaning, and laundry.[17] In this sense, different studies have found that access to piped water was associated with higher handwashing rates.[18,22,28]

Soap expenses. To evaluate a trial encouraging handwashing with soap in Pakistan, Luby and others[28] used the amount of soap purchased by the households as an indirect measure of handwashing frequency, expecting higher soap purchases in households with higher handwashing frequencies. In a 5-year follow-up study evaluating a handwashing campaign, Bowen and others[20] found that intervention households reported purchasing more bars of soap per household member and were more likely to have soap at the handwashing station than control households.

Designated place for handwashing. Although results are mixed when looking at the association between a designated place for handwashing and respiratory and diarrhea symptoms in children below the age of 5,[22,29] some studies have found increased handwashing behavior in households with a fixed handwashing location.[19,30]

Interactions between fixed and self-created contextual factors. Purchasing soap and the distance to the water source are often discussed as the biggest barriers for handwashing.[15,27] Because economic constraints can limit the amount of soap purchased each month and because the quantity of water available at household level has been shown to be associated with the distance to the water source, we took a closer look at the interaction between household wealth and the amount of money spent on soap per person per month and at the interaction between the time spent for water collection and the amount of water available at household level per person per day.

Objectives. This article reports findings from a cross-sectional survey intended to provide baseline data collected as part of a handwashing behavior change program in rural Burundi targeting caregivers of primary school children. We used self-reported handwashing frequency as the main outcome measure in combination with contextual and psychosocial factors. The primary aim of this study was to investigate the relationship of both contextual and psychosocial factors on handwashing frequency, to determine the relative contributions of fixed contextual factors, self-created contextual factors, and psychosocial factors. Using hierarchical regression, we first examined whether and how fixed contextual factors were associated with handwashing frequency. Second, we looked at the contribution of self-created contextual factors to explained variance in handwashing frequency when controlling for fixed contextual factors. Third, we examined specific interactions of fixed and self-created contextual factors to see whether soap purchase influences handwashing frequency independent of household wealth and whether the quantity of water available at household level influences handwashing frequencies independent of the time spent collecting water. Finally, we looked at the relative contribution of psychosocial factors in explaining variance in handwashing frequency beyond contextual factors. Identifying contextual and psychosocial factors that may be related to high handwashing frequency could provide basic data and evidence for campaign implementation strategies to induce and increase handwashing behavior at key moments.

MATERIALS AND METHODS

Participants and procedures. This cross-sectional study was the baseline for a larger longitudinal study investigating the impact of behavior change interventions in schools and health centers in Ngozi Province, Burundi. Twenty primary schools with access to water had been selected with the assistance of the local rural water agency. One colline (village) was randomly selected within each of the schools' catchment areas. The random route procedure was used for selecting approximately 30 households per colline.[31] Only households with primary caregivers of a child attending primary school were considered. In total, 671 interviews with primary caregivers were conducted. Primary caregivers were targeted because they are in charge of child care and most food preparation and because they serve as important role models for young children. In most cases, the primary caregiver is the mother, but there are some children for whom the primary caregiver is the father, a grandparent, or the nanny.

The study was conducted between February and March 2014 in 20 villages of the Province Ngozi, Burundi. Data were collected by a team of 17 interviewers with a degree in health sciences from the Ngozi Province University. To ensure uniform understanding among all data collectors, we provided a 5-day training for interviewers and field supervisors on the purpose and conceptual framework of the study, data collection process, interviewing skills, and the meaning of the questions. The training included practical sessions on interviewing techniques, and use of the different data collection tools. The survey instrument was translated into Kirundi and back translated into French to ensure accuracy of translation, and then pretested and revised. Data were collected in electronic form using Open Data Kit software (Seattle, WA)[27] on a tablet device. Interviews with the caregivers lasted about 75–90 minutes. Information about the study was given to all participants and oral informed consent was obtained.

Measures. The structured interview included questions on handwashing behavior, sociodemographic characteristics, context factors related to handwashing, and psychosocial determinants from the RANAS model. For measuring handwashing behavior, data collectors asked respondents how often they washed hands at different key occasions: before eating, before preparing food, and after defecation. Frequencies were assessed on a 5-point scale (0 = [almost] never/0–1 times out of 10–1 = [almost] always/9–10 times out of 10). A mean

score was calculated, with higher scores indicating higher handwashing frequency (Cronbach's alpha = 0.83)

The fixed contextual factors included the time spent on collecting water (roundtrip) and socioeconomic status. A roundtrip water collection time of 30 minutes was used as a cutoff value to form two groups for comparison with regard to the time spent collecting water. To measure socioeconomic status, a household wealth index was constructed of variables describing household assets using the first factor from a principal component analysis.[32,33] It is assumed that the first principal component is a measure of economic status.[34] We did not include variables on water and sanitary facilities because we were interested in the impact of wealth independent of specific facilities and supplies that might have an effect on handwashing.[34] To build the household wealth index, respondents were asked about household construction material, animal ownership, and ownership of various assets such as radio and bicycle.

Self-created contextual factors included the quantity of water collected per person per day, the monthly expenses for soap per person, and the presence of a specific location for washing hands in the home or courtyard identified by the respondent as the place where hands are most often washed. To assess the monthly expenses for soap per person, we used the reported average amount of money spent on soap per household each month divided by the number of household members. We estimated the water amount per person by dividing the reported volume of water collected each day by the number of persons living in the household. We then used the minimum required amount of 7.5 L of water per person per day for drinking and cooking as a cut-off indicator to distinguish households where more water than the required minimum for consumption was available from households where not enough water was available to maintain a good standard of hygiene. The characteristics of all participating households are shown in Table 1.

Items assessing the psychosocial factors were based on the RANAS model and derived from previous research on handwashing with soap[35] and from studies in the water and sanitation sectors.[36,37] Subjects were asked four questions to assess knowledge of diarrheal disease transmission and preventive measures. One point was given for a correct answer on each item. The final scores were transformed into the value range of 0–1. A single item was used to quantify perceived vulnerability, perceived severity, and action knowledge. All other psychosocial factors were measured with several items using 5-point rating scales, which were averaged. Example items for each psychosocial factor, along with Cronbach's alpha internal reliability coefficients, are presented in Table 2. Variables were coded so that higher scores were favorable to the behavior. To facilitate interpretation of unstandardized regression coefficients, all items were transformed into a value range of 0–1.

Data analysis. We performed hierarchical regression analyses to determine which contextual factors and psychosocial factors contribute to the explanation of handwashing frequencies. In these analyses, age, marital status, and education were entered as control variables in the first step of the model. In the next step, the two fixed contextual factors were entered, followed by the self-created contextual factors. We then tested whether the relationship between self-created contextual factors and handwashing frequencies was moderated by fixed contextual factors by combining characteristics of hypothesized interactions. We therefore entered the interaction of time spent collecting water and the amount of water and the interaction of household wealth and soap expenses in the regression model after the fixed and self-created contextual factors had been entered. The variables included in the interaction term were centered around their mean before computing the cross products to reduce collinearity between the main effect variables and the interaction terms.[38] If we did not find an interaction effect, we excluded the interaction term from the model to be parsimonious. In the last step, the psychosocial factors were entered as predictors into the regression model. For all regression analyses, confidence intervals were estimated using a bootstrap approach with 5,000 samples. Where potential predictor variables were highly correlated ($r > 0.80$) and conceptually similar, only the variable that correlated most strongly with the dependent variable was included in the regression model to avoid strong multicollinearity between explanatory variables.[39] Residual analyses were performed to determine significant points of influence in the final models. Three individuals were excluded from the analyses, as they were identified as influential and high leverage points. Exclusion of the outliers did not alter the significance of the results, but did tend to reduce the magnitude of the main effects. Eight records with missing values were excluded from our analysis, yielding a final sample of 660. Analyses of the variance inflation factors (VIFs) indicated that multicollinearity was not a problem in the regression equations (all VIFs < 4.0). Though caregivers were nested within villages, no multilevel analyses were conducted, because there was no

TABLE 1
Characteristics of participating households

	n	Percent/mean (SD)
Characteristics of the caregiver		
Age	660	38.8 (10.7)
Completed primary school	244	37.0
Married	550	83.3
Household assets included in the wealth index		
Proportion who own		
Electricity	26	3.9
Radio	404	61.2
Television	19	2.9
Bicycle	188	28.5
Car	6	0.9
Motorcycle	20	3.0
Mobile phone	277	42.0
Table	429	65.0
Chair	591	89.5
Bed	639	96.8
Bank account	98	14.8
Watch	222	33.6
Solar panel	11	1.7
Window	164	24.8
House construction material		
Cement floor	40	6.1
Tin roof	194	29.4
Brick walls	569	86.2
Number of livestock owned		
Cows	–	0.5 (0.9)
Goats	–	1.4 (2.3)
Sheep	–	0.1 (0.8)
Pigs	–	0.4 (0.8)
Rabbits	–	0.4 (1.3)
Poultries	–	1.0 (2.5)
Guinea pigs	–	1.0 (2.7)

SD = standard deviation.

TABLE 2
Descriptive statistics of the psychosocial factors

Factors	Description	Example item	No. of items	α
Perceived vulnerability	Subjective perception of the risk of contracting a disease	Considering your usual handwashing practices, how high do you feel is the risk that you get diarrhea? (inverted)	1	–
Perceived severity	Subjective perception of the seriousness of the consequences of contracting a disease	Imagine you contracted diarrhea, how severe would be the impact on your daily life?	1	–
Health knowledge	Understanding of the causes and knowledge about the consequences of a disease	Can you tell me what causes diarrhea?	3	–
Cost beliefs	Perceived negative aspects of engaging in a behavior	How effortful do you think is it to always wash hands with soap and water at key moments? (inverted)	7	0.80
Benefit beliefs	Perceived positive aspects of engaging in a behavior	How certain are you that always washing hands with soap and water at key moments prevents you from getting diarrhea?	2	0.77
Affective beliefs	Beliefs concerning the feelings associated with performing the behavior	How much do you like washing hands with soap and water?	5	0.72
Social norms	Perceptions of other peoples' actions and opinions	How many people of your household always wash hands with soap and water at key moments?	3	0.75
Action knowledge	Knowledge about how to practice a behavior	What are the different steps to correctly wash hands?	1	
Self-efficacy	Belief in the abilities to perform a certain behavior	How certain are you that you can always wash your hands with soap and water at key moments?	5	0.86
Action planning	Specification of when, where and how to perform a behavior	Do you plan a quantity of water you have to collect for handwashing with soap and water?	8	0.77
Action control	Self-monitoring and effort to continuously evaluate ongoing behavior	How much do you pay attention to always have soap at home to wash hands with soap and water at key moments?	5	0.93
Remembering	Ease of remembering to perform a behavior at specific moments	How often does it happen that you forget to wash your hands with soap and water at key moments? (inverted)	2	0.63
Commitment	Subjective importance of the behavior	How important is it for you to always wash hands with soap and water at key moments?	9	0.80

For factors with multiple items, Cronbach's alpha (α) for scale reliability and the number of items used are indicated. No Cronbach's α for knowledge is indicated because of the additive nature of the scale.

significant between-subject variance for the outcome variable; the intraclass correlation was less than 2%. All analyses were conducted with IBM SPSS Statistics for Windows, Version 21.0 (IBM Corp., Armonk, NY).

Ethics. This study was approved by the National Ethics Committee of Burundi (Comité National d'Éthique pour la protection des êtres humains participants à la recherche biomédicale et comportementale) and from the ethical review committee of the Faculty of Arts, University of Zurich.

RESULTS

Descriptive statistics. The characteristics of all participating households are shown in Table 1. Of all respondents, over 99.0% were female and only 37.0% had completed primary school. Participant ages ranged from 16 to 75 years with the majority of participants aged between 30 and 50 (70.0%) (M = 38.8 years, standard deviation [SD] = 10.7). Most primary caregivers were married (83.3%), the remaining respondents were either widowed, single, cohabiting, or divorced or separated. More than half (61.2%) of the households had a radio and in less than half of the households (42.0%), someone owned a mobile phone. Twenty-four indicators were included in the principal component analysis to create the household wealth index (see Table 1). Whether one person in the household owned a bank account or a mobile phone was the household characteristic that explained the most variance among households. The first principal component retained 15.0% of the total data variability.

Means and SDs for all measures are provided in Table 3. Primary caregivers reported washing hands with soap slightly more than half of the time at critical junctures (M = 0.66, SD = 0.22). A total of 183 respondents (27.7%) of all households reported spending more than 30 minutes per round trip to collect water, and in 247 households (37.4%), respondents reported that less than the recommended 7.5 L of water per person per day were available. On average, households spent 498 Burundi Franc (BIF) (0.31 US dollar [USD]) per person per month on soap. At the time of the survey in 2014, 1,000 BIF equaled 0.64 USD. The survey revealed medium knowledge about the causes of diarrhea and how to prevent the disease (M = 0.45, SD = 0.23) and about the critical junctures when to wash hands with soap and water (action knowledge, M = 0.47, SD = 0.31). Scores on action planning, that is, planning when, where, and how to wash hands, were also below the scale midpoint (M = 0.47, SD = 0.27). Highest scale scores were observed for the perceived severity of the consequences of catching diarrhea (M = 0.84, SD = 0.17), and for cost beliefs (M = 0.82, SD = 0.15), whose scores were inverted so that high values reflected favorable attitudes (i.e., low perceived effort/time).

Multivariate model and interactions. Except for the time spent collecting water, all predictor variables were significantly correlated with handwashing frequency (see Table 3). Bivariate analyses showed that intercorrelations among predictor

TABLE 3

Descriptive statistics and correlations for handwashing frequency and predictor variables ($N = 657$)

	Variable	M/*n*	SD/%	Pearson correlations																	
				1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	Handwashing frequency	0.66	0.22																		
2	Household wealth	1.86	1.41	**0.28**																	
3	Water collection > 30 minutes*	183	27.7%	−0.03	**−0.12**†																
4	LCD ≥ 7.5*	247	37.4%	**0.23**	**0.31**	**−0.12**†															
5	Soap expenses (in USD)	0.31	0.20	**0.17**	**0.26**	−0.07	**0.33**														
6	Designated HW place*	125	18.9%	**0.21**	**0.20**	0.04	0.03	**0.08**‡													
7	Perceived vulnerability	0.60	0.22	**0.11**†	**0.14**	−0.01	**0.08**‡	0.04	**0.18**												
8	Perceived severity	0.84	0.17	**0.10**†	0.07	**0.08**‡	0.01	0.02	0.07	0.01											
9	Health knowledge	0.45	0.23	**0.21**	**0.18**	−0.03	0.07	**0.18**	**0.09**‡	**0.09**‡	**0.31**										
10	Cost beliefs	0.82	0.15	**0.38**	**0.18**	−0.03	**0.19**	**0.15**	0.05	**0.23**	**0.13**†	**0.20**									
11	Benefit beliefs	0.76	0.14	**0.35**	**0.13**†	−0.05	**0.09**‡	**0.11**†	0.06	−0.04	**0.20**	**0.38**	**0.23**								
12	Affective beliefs	0.76	0.11	**0.49**	**0.20**	−0.05	**0.11**†	**0.13**	**0.12**†	0.03	**0.30**	**0.26**	**0.32**	**0.54**							
13	Social norms	0.69	0.19	**0.52**	**0.15**	−0.02	**0.11**†	**0.13**	**0.11**†	0.02	**0.13**	**0.09**‡	**0.22**	**0.38**	**0.45**						
14	Action knowledge	0.47	0.31	**0.33**	**0.22**	−0.01	**0.09**‡	**0.20**	**0.09**‡	**0.12**†	**0.19**	**0.58**	**0.28**	**0.37**	**0.35**	**0.22**					
15	Self-Efficacy	0.70	0.14	**0.67**	**0.33**	**−0.13**†	**0.23**	**0.21**	**0.15**	0.07	**0.17**	**0.23**	**0.44**	**0.54**	**0.62**	**0.64**	**0.38**				
16	Action Planning	0.47	0.27	**0.18**	**0.11**†	0.05	−0.07	0.01	**0.38**	**0.19**	0.04	**−0.09**‡	−0.04	−0.07	−0.04	**0.13**	**−0.14**	0.06			
17	Action Control	0.72	0.15	**0.65**	**0.26**	**−0.09**‡	**0.20**	**0.18**	**0.11**†	0.02	**0.23**	**0.26**	**0.40**	**0.57**	**0.66**	**0.64**	**0.34**	**0.85**	0.07		
18	Remembering	0.74	0.20	**0.44**	**0.14**	−0.01	**0.19**	0.04	**0.12**†	**0.26**	**0.10**‡	**0.13**†	**0.42**	**0.14**	**0.28**	**0.27**	**0.20**	**0.41**	**0.12**†	**0.35**	
19	Commitment	0.72	0.11	**0.47**	**0.23**	**−0.09**‡	**0.11**†	**0.17**	0.03	**−0.09**‡	**0.23**	**0.27**	**0.24**	**0.61**	**0.64**	**0.52**	**0.34**	**0.70**	−0.01	**0.73**	**0.21**

HW = handwashing; LCD = liters per capita per day; SD = standard deviation; USD = U.S. dollar. Handwashing frequency and all psychosocial variables ranged from 0 to 1. Water collection > 30 minutes = 1 and < 30 minutes = 0; LCD ≥ 7.5 = 1 and < 7.5 = 0; and designated HW place = 1 and no designated place = 0.

*For Water collection > 30 minutes, LCD ≥ 7.5 and designated HW place percentages are presented instead of means, and correlations are point biserial correlations.

Boldface: significant with $P < 0.001$, except for those marked with † $P < 0.01$; ‡ $P < 0.05$.

variables were all below 0.80, except for the bivariate correlation between action control and self-efficacy ($r = 0.85$, $P < 0.001$). Since self-efficacy correlated most strongly with handwashing frequency, the scores for action control were omitted from the multivariate analyses to avoid multicollinearity. We conducted a hierarchical linear regression analysis to examine the specific predictive power of fixed and self-created contextual factors and psychosocial factors on handwashing frequency, after we controlled for differences in individual characteristics including age, education, and marital status. Entering age, education, and marital status in the first step of the analysis did not reveal significant prediction for handwashing frequency ($R2 = 0.00$, $F_{(3, 656)} = 0.04$, $P = 0.99$). These variables were therefore removed from all further analyses.

When the fixed contextual factors, household wealth and water collection time, were considered as predictors of handwashing frequency, only household wealth became a significant predictor ($b = 0.044$, SE [standard error] = 0.006, $P < 0.001$) (see Step 1 in Table 4). Thus, higher scores on the household wealth index were predictive of higher reported handwashing frequency, whereas having a round trip water collection time exceeding 30 minutes did not have an effect on the reported frequency. The two fixed contextual factors accounted for 8% of the variation in reported handwashing frequency ($F_{(2, 657)} = 27.50$, $P < 0.001$). Introducing the self-created contextual factors explained an additional 5% of variation in handwashing frequency and this change in $R2$ was significant (F change$_{(3, 654)} = 12.82$, $P < 0.001$) (see Step 2 in Table 4). We found that having more than the recommended 7.5 L per person per day at disposition ($b = 0.067$, SE = 0.016, $P < 0.001$) and having a designated place for handwashing ($b = 0.092$, SE = 0.019, $P < 0.001$) had a significant impact on handwashing frequency, whereas the amount of money spent on soap per person per month did not affect frequency. Household wealth remained a significant predictor.

To assess the potential interaction between household wealth and the amount of money spent on soap and between the time spent collecting water and the quantity of water available at household level, we included the interaction terms into the linear model. The nonsignificant interaction terms indicated that the amount of money spent on soap per person per month appeared to influence handwashing frequency independent of household wealth ($b = -0.040$, SE = 0.032, $P = 0.209$) and that handwashing frequency of respondents whose water collection time was below 30 minutes and who had more than 7.5 L of water per person at disposition every day did not report higher handwashing frequency ($b = 0.039$, SE = 0.036, $P = 0.285$). As both interactions proved not be statistically nonsignificant and did not explain additional variance ($R2 = 0.13$, F change$_{(2, 652)} = 2.36$, $P = 0.095$), they were removed from the model for the sake of parsimony, with no consequences for the values of other variables.

Finally, the addition of the psychosocial factors to the regression model explained an additional 41% of the variation in handwashing frequency and this change in $R2$ was also significant (F change$_{(12, 642)} = 47.67$, $P < 0.001$) (see Step 2 in Table 4). As indicated by the standardized regression coefficients, in the final model, the most important predictor of handwashing frequency was self-efficacy ($\beta = 0.39$, $P < 0.001$), followed by action planning ($\beta = 0.14$, $P < 0.001$) and remembering ($\beta = 0.14$, $P < 0.001$). Together the contextual and the psychosocial factors accounted for 54% of the variance in self-reported handwashing frequency. When all the psychosocial factors were included in the regression model, having

TABLE 4
Summary of hierarchical regression analysis for variables predicting handwashing behavior

				CI (95%)					
	b	SE *b*	*P*	LL	UL	β	*R2*	Δ *R2*	Δ *F*
Step 1							0.08	0.08	27.50*
Household wealth	0.044	0.006	0.000	0.032	0.055	0.28			
Water collection > 30 minutes	0.003	0.019	0.883	−0.034	0.039	0.01			
Step 2							0.13	0.05	12.82*
Household wealth	0.029	0.006	0.000	0.018	0.041	0.19			
Water collection > 30 minutes	0.005	0.018	0.784	−0.032	0.040	0.01			
LCD ≥ 7.5	0.067	0.016	0.000	0.034	0.099	0.15			
Soap expenses	0.063	0.047	0.178	−0.025	0.159	0.06			
Designated HW place	0.092	0.019	0.000	0.053	0.130	0.16			
Step 3							0.54	0.41	47.67*
Household wealth	0.004	0.005	0.364	−0.005	0.013	0.03			
Water collection > 30 minutes	0.020	0.014	0.153	−0.008	0.047	0.04			
LCD ≥ 7.5	0.034	0.014	0.015	0.007	0.062	0.08			
Soap expenses	−0.012	0.034	0.733	−0.077	0.057	−0.01			
Designated HW place	0.024	0.017	0.161	−0.010	0.059	0.04			
Perceived vulnerability	−0.031	0.031	0.321	−0.093	0.030	−0.03			
Perceived severity	−0.096	0.035	0.005	−0.163	−0.028	−0.07			
Health knowledge	0.047	0.034	0.172	−0.020	0.113	0.05			
Cost beliefs	0.097	0.049	0.047	0.003	0.195	0.06			
Benefit beliefs	−0.063	0.062	0.315	−0.187	0.057	−0.04			
Affective beliefs	0.270	0.094	0.005	0.084	0.453	0.13			
Social norms	0.159	0.051	0.002	0.059	0.258	0.13			
Action knowledge	0.047	0.026	0.076	−0.005	0.099	0.07			
Self-efficacy	0.631	0.089	0.000	0.453	0.808	0.39			
Action Planning	0.112	0.026	0.000	0.061	0.163	0.14			
Remembering	0.159	0.038	0.000	0.082	0.233	0.14			
Commitment	−0.017	0.102	0.879	−0.224	0.181	−0.01			

CI = confidence interval; HW = handwashing; LCD = liters per capita per day; LL = lower limit; SE = standard error; UL = upper limit. All psychosocial variables ranged from 0 to 1: water collection > 30 minutes = 1 and < 30 minutes = 0; LCD ≥ 7.5 = 1 and < 7.5 = 0; and designated HW place = 1 and no designated place = 0. 95% CIs and SEs are based on 5,000 bootstrap samples.
*= p< .001.

at least the recommended 7.5 L per person per day at disposition remained significant in explaining handwashing frequency ($\beta = 0.08$, $P = 0.015$). Neither household wealth nor having a designated place for handwashing remained significant predictors, indicating that the effects of household wealth and having a designated place for washing hands on handwashing frequency were mediated through one or more psychosocial factors. Surprisingly, perceived severity had a negative weight in the prediction of handwashing frequency, whereas the zero-order correlation between perceived severity and handwashing frequency was positive ($r = 0.11$). This change in direction of the relationship occurs when one or more confounding variables obscure the direction of the predictor–criterion relationship,[40,41] introduced the concept of "correction for distortion" to describe this reversal in sign. We performed a series of regression analyses using various combinations of the different factors as predictors to identify which variable or variables affected the change in the direction of association. The analyses revealed affective beliefs, self-efficacy, and commitment as variables that affected the change of the direction between perceived severity and handwashing frequency. Moreover, cost beliefs and social norms in combination with benefit beliefs induced a reversal in sign, so did remembering in combination with perceived vulnerability, health knowledge, and benefit beliefs, implying a complex pattern of factors influencing the direction of the effect of perceived severity on handwashing frequency.

DISCUSSION

Understanding the degree to which contextual and psychosocial factors are related to handwashing behavior is important for improving intervention programming. Using the concepts of contextual and psychosocial dimensions represented in the IBM-WASH framework,[8] we specifically investigated the relative contribution of fixed contextual factors, self-created contextual factors, and psychosocial factors on the variation of handwashing frequency among caregivers of primary school children in rural Burundi. To the authors' knowledge, this is the first study to examine the relative contributions of psychosocial factors to handwashing behavior beyond contextual factors.

We found that all factors showed a significant bivariate association with handwashing frequency, except for the time spent collecting water. All factor groups entered stepwise in the regression model significantly contributed to the variation of handwashing frequency. Noteworthy is the finding that household wealth and having a designated place for handwashing lost their influence when the psychosocial variables were entered into the regression. Even though the psychosocial factors mediated part of the effect of having more than the recommended 7.5 L of water per person at disposition on handwashing frequency, this self-created contextual factor remained a significant predictor in the final model. Having to spend more than 30 minutes for water collection per round trip did not significantly influence handwashing frequency. In the multivariate analysis, self-efficacy was found to be the main determinant of handwashing frequency, followed by action planning and remembering.

Sociodemographics. In our study, reported handwashing frequency was independent of sociodemographic factors including age, level of education, and marital status. Recent studies suggest that increasing levels of education and older age are significantly associated with self-reported handwashing behavior,[42,43] whereas many other studies have not been able to find an association with age or education qualification of the mother and the prevalence of diarrheal diseases in young children.[44–46] Obviously, many differences in background characteristics of the respondents, including racial, gender, and age differences and many differences in study design and statistical approach make study-to-study comparisons difficult. Nevertheless, the results of this study suggest that reported handwashing frequencies do not differ between young and old caregivers, between caregivers who have completed primary school and those who have not, and between caregivers who are married and those who are either single, separated, divorced or widowed. Indeed, considering the limited employment opportunities in rural areas in Burundi, with economies based on agriculture and stockbreeding, households are very similar in their standard of living, regardless of the mother's educational attainment or civil status.

Wealth index. When all fixed and self-created contextual factors were included in the model, a high score on the household wealth index was a significant predictor for high handwashing frequency. Even though indicators of handwashing are commonly strongly associated with measures of socioeconomic status,[15,23,47–49] some studies have not been able to confirm this association[16] or to link socioeconomic status to lower diarrhea prevalence.[45,50] As Ram and others[51] suggested, compared with poor households, wealthier households may be able to purchase soap more regularly and may be able to prioritize the use of soap for handwashing as opposed to other purposes. In the present sample, we could not find a stronger relationship between the amount money spent on soap and handwashing frequency when respondents had a higher score on the household wealth index as opposed to when this score was low. Moreover, when including the psychosocial factors into the model, household wealth was not predictive of reported handwashing frequencies anymore, indicating that respondents' risk perceptions, attitudes, beliefs, abilities, and self-regulation wholly explained the effect of household wealth on handwashing frequency. These results may be able to explain the lack of consistency in the effects of household wealth on handwashing behavior and suggest that intervention programs should focus on psychosocial factors.

Water collection time. Whether people had to spend more than 30 minutes per roundtrip to collect water or not did not make a difference in their reported handwashing frequency. The existing literature on water access and handwashing has largely focused on households having access to piped water connections. Most studies found handwashing rates to increase if the household had a water connection,[15,19,52] whereas others could not find this association.[53] The lack of association between the time spent collecting water and reported handwashing practices in this study might also be due to the breakdown of the sample into two groups, that is water collection time above 30 minutes per roundtrip and below 30 minutes, which may have hindered detecting an effect of the time spent collecting water on handwashing practices. Although a number of studies suggest that access to water may play an important role in reducing childhood diarrhea, there is a need for better designed studies to further elucidate the impact of the distance that people have to carry water home on hygiene practices and health.[24]

Amount of water per person. Caregivers reporting procuring more than 7.5 L per person per day also reported higher handwashing frequency. Gilman and others[20] found that households that used more water also washed hands more often at key moments and several studies have shown that access to running water on the household compound increases handwashing rates.[15,19,52] We did not account for an existing water connection on the household compound, because less than 3% of all households in our study was connected to running water. Our results, however, suggest that handwashing practices be more frequent in households exceeding this minimum amount of 7.5 L of water required for consumption. We considered the amount of water per person available at household level to be a self-created contextual factor. It might thus have been reasonable to assume that the effect of this self-created contextual factor on handwashing frequency be reduced after controlling for the psychosocial factors. Nonetheless, the amount of water available per person per day seemed to influence reported handwashing frequency even when considering the caregivers' attitudes and beliefs on handwashing behavior, reinforcing the assumption that water is first of all used for consumption and washing clothes, and that using water for handwashing purposes is of secondary importance. The nonexisting interaction between the time spent collecting water and the amount of water at disposition at household level is in agreement with more detailed studies on the relationship between the distance of the water source and the amount of water brought into the household.[54–56] The average amount of water used seems to be unaffected by the distance the water has to be carried. Apparently, unless water is immediately available within the compound, from a tap or a well, the distance to the source is not important. Nonetheless, access to the water supply should be as close to the home as possible, to foster the use of larger amounts of water for hygiene practices,[56] especially since increasing the volume of water used to rinse hands has been found to significantly reduce hand contamination.[57]

Soap expenses. The cost of soap has frequently been mentioned as a barrier to handwashing with soap.[19,58] On the other hand, Scott and others[19] could not find a statistically significant relationship between affordability of soap and observed handwashing behavior. In our sample, households spent about 0.31 USD per person per month on soap. On average, in Burundi in 2005, people were living on less than 30 USD per month,[59] thus spending about 1% of their income on soap. In this study, soap purchase did not have a significant effect on handwashing frequency and its influence on handwashing frequency was even further reduced by including the psychosocial factors into the model. As soap is most often used for washing clothes, the amount of money spent on soap might indeed not reflect caregivers' soap use for washing hands at key moments. Moreover, in rural Burundi, soap for washing hands if often referred to as a luxury, is thus often only used if hands are visibly dirty, and is to be bought sparingly and conserved carefully, especially for formal occasions, such as going to church on Sunday or attending other social events. Nonetheless, a behavior-change campaign increasing the value of soap and encouraging its purchase for washing hands could be working to motivate households to overcome this perceived cost barrier to using soap.

Designated place for handwashing. Having a designated place to wash hands at home significantly predicted handwashing frequency, thus confirming the results from several studies that found hand hygiene practices to be more frequent in households with a fixed handwashing location.[19,30,60] Overall, less than 20% of all caregivers indicated having a designated place for washing hands, which might be due to the absence of cemented floors inside and outside houses, resulting in habits where hands are washed right next to the water storage containers. In this study, we did not assess the presence of soap and water at this location, which several studies have found to be a good predictor for handwashing behavior and infectious diseases reduction.[23,61] Future research should consider including the presence of agents for handwashing when evaluating the importance of a dedicated handwashing area on handwashing behavior. The fact that the association between having a designated place for handwashing and reported handwashing frequency was reduced when the psychosocial factors were included in the regression model indicates that the effect of this self-created contextual factor on handwashing frequency was mediated by the psychosocial variables. This confirms the assumption of Luby and others[61] that having a designated place to wash hands with soap and water present rather is a manifestation of the intention to wash hands than an independent facilitator. As Contzen and others[12] concluded after the evaluation of an intervention promoting handwashing infrastructure, having a designated place eases behavior performance, serves as a reminder and enhances social norms. The findings thus strongly suggest that encouraging households to decide on a specific area for washing hands would result in more handwashing with soap.

Psychosocial factors. The present results indicate that high handwashing frequency is much more likely for people who are certain that they can always execute the behavior at key moments, who plan when, where, and how to wash hands, and who do not forget to wash hands at key moments. This corroborates recent findings that social-cognitive factors are highly predictive of handwashing frequency.[35] Contzen and others[12] found disgust, norms, motivational self-efficacy, perceived impediments, coping planning, and commitment to consistently explain both stool- and food-related handwashing behavior across two countries. In this study, we did not distinguish between food-related handwashing, that is, handwashing before eating and before preparing food, and stool-related handwashing, that is, handwashing after defecation. Because the respondents' answers did not show disparities between these two behaviors, neither concerning reported handwashing behavior nor concerning the psychosocial factors, all measures had been combined. Regardless of contextual factors, the psychosocial variables included in our questionnaire revealed that caregivers who indicated a high degree of self-efficacy in always executing the behavior at key moments, also reported the highest handwashing rates.

Limitations. Although this study provided information about contextual and psychosocial variables pertaining handwashing frequency, the findings should be interpreted with limitations in mind. All measures were assessed using self-report. We did not use other methods to assess handwashing behavior because of resource limitation to carry out sufficient direct observations and because of the questionable validity of measuring handwashing behavior through hand microbiology and other proxies.[16,47,51,62,63] Over-reporting bias for handwashing frequency is very likely. However, the goal of

this study was not to report and analyze absolute handwashing rates, but rather to assess the relative impact of the different contextual and psychosocial factors on handwashing frequency. Using the amount of money spent on soap as an indicator for soap availability at household level is difficult as soap is used for many other behaviors and the price of a bar of soap varies from brand to brand and location to location. Nevertheless, we would expect more soap purchase in households with higher handwashing rates, especially since the choice of soap brands is extremely limited and the price of one bar does not vary much by location in the province Nogzi. Another limitation is that the study population was restricted to 20 collines in rural Burundi. The sample is not statistically representative of rural Burundi and no urban households were included. In other settings, determinants of handwashing and their interactions may be different. However, the study represents the high need population of rural Burundi. This study was exploratory aiming at hypothesis generation and the conclusions should be viewed as preliminary. The study was a cross-sectional study on the factors influencing caregivers' handwashing frequency and causality relationships could not be determined. Additional research on contextual and psychosocial factors of behavior is required to provide more information and evidence for designing effective health programs to promote behavior change. Additional factors that would be of interest to explore, including climate, access to markets, and household structure, and their relation to additional indicators for handwashing, especially structured observation, were not included. We have presented a selected set of possibly influencing factors in the objective function to represent the relative importance of contextual and psychosocial factors. We did not perform a sensitivity analysis, but given the comparison to other data, we do not believe there would be a significant change in our results or conclusions from this study. Nonetheless, further studies are needed to test the conclusions. We believe, however, that despite these limitations, this work is a good starting point for investigating the influence of and interaction between different contextual and psychosocial factors on handwashing with soap with the goal to design more effective handwashing promotion programs in rural settings.

CONCLUSION

Up until now, little research on the relevance of psychosocial factors on handwashing behavior has been conducted, but more importantly, the reciprocity of contextual and psychosocial factors has largely been neglected. The full and partial mediation effects of contextual factors through psychosocial factors are examples of the potential impact of interactions between those factors on handwashing frequency. It seems likely that contextual constraints are perceived rather than actual barriers. These are interesting findings that merit further investigation and suggest researchers should include both contextual factors and psychosocial factors when trying to understand handwashing frequency among caregivers.

Our results are consistent with behavior change theories and health promotion approaches that stress the importance of a physical environment enabling and facilitating the desired behavior.[64–66] A model including contextual and psychosocial factors is more comprehensive in explaining behavior formation. The findings moreover emphasize the role of psychosocial factors, such as attitudes, beliefs, and abilities, on creating and maintaining health promotive environments. The high importance of psychosocial factors on handwashing behavior beyond contextual factors should be considered for health education and policy regarding handwashing.

Information from this study serves as baseline data for developing an effective handwashing intervention program among primary caregivers in rural Burundi. A comprehensive follow-up survey will allow a rigorous evaluation of the program and assess its success in targeting the relevant contextual and psychosocial factors to promote life-saving handwashing behavior among caregivers with the ultimate goal to reduce child diarrhea.

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