

Research Paper

Does poor mental health change the influence of interventions on handwashing in a vulnerable population of rural Malawi? The key role of emotions

Jurgita Slekiene  and Hans-Joachim Mosler

ABSTRACT

Poor mental health is a neglected problem worldwide. People living through humanitarian emergencies suffer not only from scarcity of water, food and poor hygiene but also from poor mental health. Mental disorders can impair health-related daily behavior, handwashing with soap, of vulnerable individuals. However, it is unknown whether handwashing interventions have a different impact on people with poor mental health. A longitudinal study collected data from 638 people in Malawi at baseline and follow-up. We conducted face-to-face interviews with a quantitative questionnaire that used the RANAS approach to behavior change to measure factors underlying handwashing. We assessed mental health using the validated Chichewa version of the Self-Reporting Questionnaire (SRQ-20). Mental health was impaired in 27% of the people assessed. We found a negative relationship between mental health and handwashing after the intervention ($r = -0.083^*$). The mediation analysis revealed significant indirect effects of mental health on handwashing via factors feelings and difficulty in getting soap for handwashing. These findings imply that mental health assessment should be included in WASH surveys. Interventions that increase positive emotions would make behavior change more successful in populations with a significant proportion of people with poor mental health. This research is especially relevant to emergency contexts.

Key words | behavior change, emotions, handwashing with soap, mental health, RANAS, WASH

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HIGHLIGHTS

- Persons with poor mental health change their handwashing less after an intervention.
- Changes in psychosocial factors underlying handwashing depend on mental health.
- Feelings play a key role in behavior change for individuals with poor mental health.

INTRODUCTION

Poor mental health is a widespread but neglected problem worldwide (Patel *et al.* 2008; WHO 2013). People in

vulnerable populations in developing countries and those exposed to emergencies in particular suffer from common mental disorders (CMDs), such as depression, anxiety, and PTSD. Other potential risk factors for mental disorders include poverty (Patel & Kleinman 2003), insecure access to key resources such as safe water and food (Patel &

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Kleinman 2003; Cole & Tembo 2011; Jones 2017), hunger and malnutrition (Weaver & Hadley 2009), chronic health problems, exposure to humanitarian emergencies, natural disasters, conflicts, violence, and abuse (WHO 2014). Mental disorders are also related to AIDS/HIV (Myer *et al.* 2008), addictive behavior (RachBeisel *et al.* 1999), and malaria (Jenkins *et al.* 2017). Additional risk factors which may contribute to impaired mental health in developing countries are illiteracy and poor education (Araya *et al.* 2001). Sanitation-related psychosocial stressors such as environmental barriers, social factors, and fears of sexual violence (Sahoo *et al.* 2015) are also potential risk factors and may cause mental disorders among vulnerable people. Therefore, whether there is a direct and/or indirect association between mental health and hygiene-related behavior change is an outstanding question.

Malawi is a vulnerable sub-Saharan country with very high population densities and low income (Wood & Mayer 2006). Poverty, hunger, lack of drinking water, food insecurity, and poor water, sanitation, and hygiene (WASH) conditions lead to a high prevalence of depression (30.3%) (Udedi 2014) and mental disorders in general (29.9%) (Stewart *et al.* 2009). Mental disorders such as depression can substantially impair daily activities and behavior in vulnerable individuals (WHO 2005). One important health-related daily behavior is handwashing with soap, an effective method for reducing diarrheal disease by up to 47% (Curtis & Cairncross 2003; Curtis *et al.* 2011; Freeman *et al.* 2014). Diarrhea is a major killer and cause of malnutrition among poor people (WHO 2005). Recently published research has shown the negative influence of impaired mental health on WASH-related behaviors in primary school children in peri-urban Zimbabwe and in adult populations in rural Malawi (Slekiene & Mosler 2018a, 2018b). However, it is unknown whether WASH interventions have differing impacts on people depending on their mental health. If so, this may provide valuable confirmation of why behavior change interventions should be tailored to the specific needs of vulnerable populations. There is a growing need and interest among NGOs to integrate poor mental health treatment and support WASH programs, and consequentially more research is needed to provide guidelines for practical implications.

The present study

The aim of the present study conducted in rural Malawi is to detect whether behavior change interventions influence changes in psychosocial factors and handwashing differently depending on the mental health of intervention recipients. This study also elaborates the link between mental health, handwashing with soap, and behavior factors as mediators. We used the risks, attitudes, norms, abilities, and self-regulation (RANAS) approach to behavior change (Mosler 2012; Mosler & Contzen 2016) as the theoretical basis for our research, which has been developed using psychological theories (Ajzen 1991; Cialdini 2007; Schwarzer *et al.* 2008). The model consists of five psychosocial factor blocks. Risk factors include health-related knowledge, perceived vulnerability, and perceived severity of contracting a disease. Attitude factors include beliefs about the costs and benefits of a target health behavior and feelings arising while performing the health behavior. Norm factors comprise perceived social influence, such as behavior of others, others' approval, and personal importance. Ability factors include confidence in the performance of a particular behavior. Self-regulation factors cover the management of conflicting goals and barriers, commitment, and remembering to perform the health behavior.

Furthermore, the RANAS model considers not only motivational drivers of behavior but also three domains of contextual factors: social, personal, and physical contexts. For our study, the personal context includes age, gender, education, individual differences in the physical and mental health of the person, and specific conditions such as experiencing hunger. Additionally, for the intervention development, we used specific behavior change techniques (BCTs) which are aligned to each psychosocial factor block, information BCTs to risk factors, persuasive BCTs to attitude factors, norm BCTs to norm factors, infrastructural, skill and ability BCTs to ability factors, and finally, planning and relapse prevention to self-regulation factors (Mosler & Contzen 2016).

The RANAS model has already been successfully applied many times in developing countries and emergency contexts (Contzen & Mosler 2013; Contzen & Inauen 2015; Seimetz *et al.* 2016, 2017; Gamma *et al.* 2017; Friedrich *et al.* 2018).

We hypothesized that poor mental health has a negative influence on changes to behavioral determinants and therefore on changes in handwashing after an intervention. We addressed the following research questions:

1. Are there differences in the effect of a behavior change intervention on handwashing behavior between people with good mental health and those with poor mental health?
2. Are there differences in the effect of a behavior change intervention on changes to RANAS psychosocial factors between people with good mental health and those with poor mental health?
3. Do psychosocial factors mediate the relationship between mental health and handwashing behavior after the intervention?

METHODS

Study design

A longitudinal research design was applied with a survey at baseline and a follow-up survey administered to the same households after intervention delivery. The data collection took place in April, May, and June 2016 and 2017. The quantitative follow-up survey interviewed 638 households. The large number of study participants was required to achieve statistical power for the analysis. According to [Cohen \(2013\)](#), an alpha level of 0.05 and small population effect size for ANOVA calculations requires a sample size of 393 respondents when comparing two groups.

Research area and samples

The surveys were conducted in Malawi, Kasungu district, in the traditional authority of Kapelula. To conduct the household interviews and observations, and to achieve required sample size, five group villages in the Kapelula traditional authority were selected randomly at the time of the baseline survey. This research was conducted within a development research project initiated and funded by Belgian Red Cross Flanders. The interventions were implemented by local partner Malawian Red Cross Society.

Quantitative data were collected using the random route method (interviewing at every third household) during the baseline survey. The target respondent in the survey was the primary care provider of the household or a person responsible for decision making. The same respondents were interviewed in the follow-up survey to measure changes in psychosocial factors and behavior after the interventions.

Data collection method

Prior to data collection, the data collectors attended 5 days of training for the baseline and for the follow-up surveys. The data collection was conducted using tablet devices equipped with OpenDataKit (ODK) software. An EAWAG researcher, a Red Cross officer, and a supervisor coordinated and monitored the interviews and accompanied the data collectors in the field during the entire period of quantitative data collection. The study research protocol obtained the ethical approval of the University of Zurich in Switzerland and of the ethical committee in Malawi (National Committee on Research in the Social Sciences and Humanities, NCRSH; Ref No: NCST/RTT/2/6). All procedures applied in the research study were in accordance with the Declaration of Helsinki. All study participants provided written informed consent.

Questionnaires and measures

The structured, face-to-face interviews were conducted in Chichewa, the local language of Malawi. The quantitative questionnaire was developed using the RANAS behavior change approach ([Mosler & Contzen 2016](#)) which applicability was confirmed in many previous studies ([Gamma et al. 2017, 2019](#); [Seimetz et al. 2017](#); [Chidziwisano et al. 2019](#)). The questionnaire for the survey was adopted to the rural Malawian context. First, the questionnaire included demographic questions, such as gender, age in years, marital status, education in years, literacy, household size, income, wealth index (ownership of radio, TV, mobile phone, electricity, and running water), experiencing hunger, anxiety about the future health situation of the family, and diarrhea. Second, the questionnaire covered the frequencies of handwashing with soap at two

key times, before eating and after using the toilet, which were measured by closed questions on a 5-point response scale (from 'never' to 'very often'). A mean score was built with the two handwashing questions. Next, the questionnaire included questions about psychosocial factors underlying handwashing, and communication. Most of the questions were closed and responses to these questions were recorded using 5-point response scales (from 'not at all' to 'very much') (see Table 1). Finally, records on spot-check rapid observations for the availability of a handwashing facility, soap, and water were included. The applicability of the questionnaire was verified in a pretest conducted before each data collection ($N = 16$).

To identify underlying behavior mechanisms in a vulnerable population of rural Malawi, we assessed mental health with a validated Chichewa version of the Self-Reporting Questionnaire (SRQ) (see Supplementary Material, Table A1), which includes 20 Yes/No questions exploring symptoms of CMDs (Stewart *et al.* 2009, 2013). Each 'yes' answer to a symptom adds one point to the total score, meaning that the higher the score for one person is the worse the mental health of this person is. This screening tool was developed by WHO (Beusenberg *et al.* 1994) and is widely used in many low- and middle-income countries worldwide (de Jesus Mari & Williams 1986; Scholte *et al.* 2011; van der Westhuizen *et al.* 2016). The suggested cutoff point of an initial validity study conducted by WHO was a score of ≥ 7 (score range 0–20) (Beusenberg *et al.* 1994). This means that people who answered seven or more questions with 'yes' are of poor mental health. The binary variable (good versus poor mental health) was defined based on that score. Respondents who scored equal or above 7 points were assigned to a poor mental health group, and those who scored less than 7 points – to a good mental health group.

Behavior change interventions

Data from the baseline survey were used for statistical analysis in order to develop behavior change interventions. BCTs were selected from RANAS catalog (Mosler & Contzen 2016) to target only those psychosocial factors that had a statistically significant influence on

handwashing. Supplementary Material, Table A2 presents descriptions of the intervention strategies, BCTs, corresponding RANAS factors, and communication channels used for interventions.

Statistical analysis of data

The statistical analysis of data was conducted using IBM SPSS 23 Statistics software and the PROCESS macro for SPSS. Frequencies, correlations, Chi-square, ANOVAs, *t*-test, and mediation analyses were applied. The comparison of characteristics of study respondents (good versus poor mental health group) included the following contextual factors: gender, age in years, marital status, education in years, literacy, household size, income, wealth index (ownership of radio, TV, mobile phone, electricity, and running water), experiencing hunger, anxiety about the future health situation of the family, and diarrhea. Differences in handwashing and psychosocial factors explaining handwashing were calculated before and after the interventions in two groups: people with poor mental health and those with good mental health. Comparing the data from the baseline and follow-up surveys revealed changes in handwashing and psychosocial factors. A multiple mediation model was computed using the PROCESS macro for SPSS 23 (Hayes 2013). To estimate the confidence intervals of indirect effects, we used bootstrapping with 10,000× resampling. Only psychosocial factors with significant differences between poor and good mental health group were included in further mediation analyses (mental health as predictor, psychosocial factors as mediators, and handwashing behavior as outcome).

The specific indirect ($a*b$), direct (c'), and total effects (c) of mental health on handwashing were calculated. The path a estimates the effect of mental health (predictor) on the mediator, and path b estimates the effect of mediators on handwashing (outcome) controlling for mental health (predictor) and other mediator variables. A specific indirect effect is the effect of mental health via psychosocial factors on handwashing. The direct effect is the effect of mental health on handwashing independent of psychosocial factors (holding all them constant). The total effect is the sum of the indirect effects and the direct effect.

Table 1 | Questionnaire about RANAS psychosocial factors for handwashing behavior

Behavior determinants	Selected items
<i>Risk factors</i>	
Vulnerability	In general, how high do you think is the risk that you get diarrhea?
Severity	Imagine that you contracted diarrhea how severe would be the impact on your life in general?
Health knowledge	Can you tell me what causes diarrhea? Could you please tell me for each following aspects whether it is a cause or not? E.g., Water contaminated by bacteria
<i>Attitudinal factors</i>	
Belief about costs and benefits (effort)	How effortful do you think is washing hands with soap and water?
Belief about costs and benefits (time consuming)	How time consuming do you think it is to always wash hands with soap and water?
Belief about costs and benefits (expensive)	How expensive is it for you to always wash hands with soap and water?
Belief about costs and benefits (distance)	Do you think that the handwashing facility is far away from your usual area of activity?
Belief about costs and benefits (certain for prevention)	How certain are you that always washing hands with soap and water prevents you and your family from getting diarrhea?
Feelings (like)	How much do you like always washing hands with soap and water?
<i>Normative factors</i>	
Others' behavior household	How many people of your household always wash hands with soap and water?
Others' behavior village	How many people of your village always wash hands with soap and water?
Others' approval	People who are important to you like your family members, friends, the chief of the village, NGO workers, or Pastor, how much they approve that you always wash hands with soap and water?
Personal importance (obligation)	How strong do you feel a personal obligation to yourself to wash hands with soap and water?
<i>Ability factors</i>	
Confidence in performance	How sure are you that you can wash hands with soap and water?
Confidence in performance (difficult water)	How difficult is to get as much drinking water as you need to always wash hands with soap and water?
Confidence in performance (difficult soap)	How difficult is to get much soap as you need to always wash hands with soap and water?
Confidence in continuation (distance)	How confident are you that you can wash hands with soap and water, even if you have to walk some distance to reach the next handwashing facility?
<i>Self-regulation factors</i>	
Barrier planning (water)	Do you have a plan what to do so that you always have water for handwashing? Please specify.
Barrier planning (soap)	Do you have a plan what to do so that you always have soap for handwashing? Please specify.
Remembering (pay attention)	How much do you pay attention to always have enough soap at home to wash hands with soap and water?
Remembering (forgetting last 24 h)	When you think about the last 24 h: How often did it happen that you forgot to wash your hands with soap and water?
Commitment (important)	How important is it for you to wash hands with soap and water?
Commitment (committed)	How committed do you feel to wash hands with soap and water?
<i>Self-reported behavior</i>	
Handwashing (before eating)	Before you eat, how often do you wash your hands with soap and water?
Handwashing (after using the toilet)	After you defecated, how often do you wash your hands with soap and water?

Note. Response scales: 5-point response scale [from 'not at all' to 'very much'; from 'at no time' to 'almost each time'; from 'never' to 'very often'; from 'nobody' to 'almost all of them']; [yes; no; I don't know].

RESULTS AND DISCUSSION

Out of the 638 study respondents, 171 (26.8%) reported poor mental health based on a score on SRQ-20 scale of 7

or above ($M = 4.46$, $SD = 3.99$, SRQ-20 cutoff point ≥ 7). Almost a third of the respondents reported poor mental health. Of 171 respondents with poor mental health, 63.2% ($N = 108$) were female and 36.8% ($N = 63$) were

male, and of 467 respondents with good mental health, 57.8% ($N = 270$) were female and 42.2% ($N = 197$) were male.

The ANOVA mean comparison analysis of contextual factors revealed that people with poor mental health experienced significantly more hunger, were more anxious about their families' future health situation, and reported suffering more from diarrhea compared with respondents with good mental health. Further analysis (Chi-square) showed significant differences in marital status (married versus others) and literacy (can read and write) (see Table 2).

To answer our first research question (different effects of a handwashing intervention on people with good versus poor mental health), we applied correlation, frequencies, ANOVAs, and t -test analyses. The results showed that the relationship between mental health (binary variable, good = 0, poor = 1; cutoff point ≥ 7) and changes in handwashing (baseline–follow-up) is significant and negative ($r = -0.083^*$). We found significant differences between baseline and follow-up surveys in both groups (good and poor mental health) and significant differences in changes to handwashing in both groups: good and poor mental health ($*p \leq 0.05$) (Table 3). While handwashing with soap increased among all participants, the level of increase was significantly

lower among people with poor mental health compared with those with good mental health.

To answer our second research question (different effects of an intervention on psychosocial factors of people with good versus poor mental health), we applied frequencies, ANOVAs, and t -test analyses. We found significant differences between people with poor mental health and those with good mental health in changes to psychosocial RANAS factors for the belief that handwashing is more expensive (the belief-expensive factor) and for experiencing positive feelings while washing hands with soap (the feelings factor). In people with good mental health, the belief that handwashing is expensive decreases and the experience of positive feelings while washing hands with soap increases significantly more after the intervention than in people with poor mental health. Table 4 presents differences in changes of psychosocial factors between people with good versus poor mental health.

To answer our third research question (effects of mental health on changes in handwashing via changes in psychosocial factors (mediators)), we used a mediation analysis method with PROCESS for SPSS 23. To select psychosocial factors for mediations analysis, we used a t -test for independent samples.

Table 2 | Differences in contextual factors of participants of good versus poor mental health

Variables	Scale	Good mental health <i>M</i> (SD) and % <i>N</i> = 467	Poor mental health <i>M</i> (SD) and % <i>N</i> = 171	Differences <i>p</i> -value
Gender	Male/Female	Female 57.8%	Female 63.2%	0.224
Age in years		38.39 (15.29)	38.83 (15.73)	0.747
Marital status***	Yes/No (married = 1, unmarried = 0)	Married 87.7%	Married 70.6%	0.000
Education in years		5.97 (3.57)	5.58 (3.76)	0.239
Literacy**	Yes/No	Yes 72.4%	Yes 59.6%	0.002
Household size		5.46 (2.28)	5.25 (2.21)	0.321
Income (MWK: Malawi Kwacha)		12,296.00 (24,442.62)	9,273.73 (14,064.33)	0.133
Wealth Index (radio, TV, mobile phone, electricity, and running water)	Yes/No; sum scale range min. 0 to max. 5	0.95 (1.02)	0.87 (1.00)	0.363
Hunger***	5-point response scale from 1 to 5	2.60 (1.52)	3.18 (1.39)	0.000
Anxiety about health situation***	5-point response scale from 1 to 5	1.78 (1.22)	2.25 (1.38)	0.000
Diarrhea**	6-point response scale from 1 to 6	1.42 (0.67)	1.62 (0.90)	0.003

Note. Good mental health $N = 467$; poor mental health $N = 171$. Questions: Do you suffer from hunger often? Measure ranged from 1 – never to 5 – very often. How anxious are you about the future situation of your family? Measure ranged from 1 – not at all to 5 – very much. How frequently do you suffer from diarrhea? Response: from 1 – never to 6 – more than 1 day per week.

* $p \leq 0.05$, ** $p \leq 0.01$, *** $p \leq 0.001$.

Table 3 | Changes of handwashing of people with good versus poor mental health

Behavior	Good mental health			Poor mental health			Diff. in changes p-value
	M (SD)F	M (SD)BL	M (SD) diff. of mean t-test	M (SD) F	M (SD)BL	M (SD) diff. of mean t-test	
Handwashing with soap (combined factor)	4.02 (1.09)	3.27 (1.38)	0.75 (1.72)***	3.79 (1.22)	3.36 (1.39)	0.43 (1.83)**	0.028

Note. Good mental health $N = 466$; poor mental health $N = 169$. Handwashing with soap combined factor: before eating + after using the toilet. Baseline (BL); Follow-up (F); Difference (diff), t-test.

* $p \leq 0.05$, ** $p \leq 0.01$, *** $p \leq 0.001$.

Only four psychosocial factors with significant differences between people with poor mental health and those with good mental health were included as mediators: the vulnerability factor ($t = 4.23$, $p = 0.000$), the belief-expensive factor ($t = 3.39$, $p = 0.001$), the feelings factor ($t = -2.08$, $p = 0.04$), and the difficult-soap factor ($t = 4.04$, $p = 0.000$). Mental health was included as a predictor, and handwashing after the intervention was included as an outcome in a parallel multiple mediator model. Estimation of indirect effects in the multiple mediator model with all four factors simultaneously tested both underlying mechanisms while taking into account a possible association between them (Figure 1).

We calculated specific indirect (a^*b), direct (c'), and total effects (c) of mental health on change to handwashing behavior. First, the specific indirect effects (a^*b) are the effects of poor versus good mental health condition (predictor) via psychosocial factors (mediators) on handwashing (outcome). Our findings showed significant specific indirect effects via the feelings ($b = -0.063$, CI -0.129 to -0.002) and difficult-soap ($b = -0.079$, CI -0.139 to -0.032) factors, which explain the underlying relationship between mental health and handwashing after the intervention. That is, the influence of mental health on handwashing behavior is mediated by two factors, feelings and difficulty in getting enough soap for handwashing. Second, the direct effect (c') quantifies the effect of mental health on handwashing independent of the effects of mediators on handwashing. This direct effect is not significant because it is mediated by the psychosocial feelings and difficult-soap factors. The total effect, the sum of the direct effect and the specific indirect effects of mental health, on handwashing with soap was significant but negative. In summary, the mediation analysis revealed an underlying mechanism; the direct effect

between mental health and handwashing is not significant, but the specific indirect effects via the psychosocial feelings and difficult-soap factors explain handwashing after the intervention, which depends on the mental health condition of the respondent.

Interpretation of results

This longitudinal study investigated the influence of mental health on changes to behavior motivational drivers and consequently to changes in handwashing at key times after the intervention. The aim of our study was to provide recommendations for NGOs and governments in developing countries on how to design specific evidence-based behavior change interventions by integrating people's mental health treatment with addressing behavior change in handwashing with soap at key times.

Almost a third of respondents in our study population in rural Malawi reported poor mental health – in line with previous studies in Malawi (Stewart *et al.* 2009; Udedi 2014).

Our first research question was whether there are differences in the effect of behavior change intervention on handwashing between people with good mental health and those with poor mental health after the behavior change intervention. In line with our expectations, we found a significant negative association between poor mental health and changes in handwashing after the behavior change intervention. We found that handwashing in people with poor mental health improved less after the intervention than it did in people with good mental health.

Our second research question was whether there are differences in the effect of a behavior change intervention on changes to RANAS psychosocial factors between people with good mental health and those with poor

Table 4 | Differences in changes in RANAS psychosocial factors between people with good mental health versus poor mental health

Factor group	Behavioral factors	Good mental health			Poor mental health			Diff. in changes p-value
		M (SD) F	M (SD) BL	M (SD) diff. of mean t-test	M (SD) F	M (SD) BL	M (SD) diff. of mean t-test	
Risk factors	Vulnerability	1.85 (1.16)	2.33 (1.23)	-0.48 (1.55)	2.32 (1.36)	2.51 (1.28)	-0.21 (1.81)	0.000
	Severity	4.12 (0.99)	4.47 (0.85)	-0.34 (1.23)	4.18 (0.99)	4.41 (0.87)	-0.23 (1.34)	0.490
	Health knowledge	9.97 (1.77)	10.31 (1.81)	-0.34 (2.25)	9.87 (1.91)	9.97 (2.00)	-0.13 (2.56)	0.518
Attitude factors	Belief about costs and benefits (effort)	1.16 (0.70)	1.23 (0.74)	-0.06 (1.04)	1.18 (0.72)	1.14 (0.60)	0.04 (0.97)	0.867
	Belief about costs and benefits (time consuming)	1.14 (0.67)	1.20 (0.70)	-0.06 (0.99)	1.26 (0.91)	1.17 (0.72)	0.10 (1.19)	0.062
	Belief about costs and benefits (expensive)*	1.29 (0.84)	1.50 (0.98)	-0.21 (1.24)	1.57 (1.14)	1.49 (1.04)	0.07 (1.56)	0.001
	Belief about costs and benefits (certain for prevention)	3.98 (1.12)	3.79 (1.27)	.22 (1.67)	4.04 (1.09)	3.86 (1.21)	0.17 (1.56)	0.569
	Feelings (like)*	3.94 (1.11)	3.33 (1.37)	0.61 (1.75)	3.73 (1.26)	3.43 (1.42)	0.30 (1.90)	0.041
Norm factors	Others' behavior HH	4.19 (1.16)	3.37 (1.46)	0.83 (1.83)	4.09 (1.23)	3.33 (1.48)	0.77 (1.92)	0.358
	Others' behavior Village	3.59 (1.15)	2.85 (1.22)	0.75 (1.64)	3.52 (1.20)	2.89 (1.16)	0.64 (1.64)	0.511
	Others approval	4.30 (1.00)	3.92 (1.24)	0.38 (1.57)	4.24 (1.07)	4.06 (1.18)	0.19 (1.62)	0.547
	Personal importance (obligation)	2.67 (1.72)	2.43 (1.48)	0.23 (2.33)	2.82 (1.77)	2.57 (1.63)	0.27 (2.41)	0.303
Ability factors	Confidence in performance	3.98 (1.12)	3.62 (1.27)	0.35 (1.75)	3.88 (1.21)	3.67 (1.26)	0.22 (1.74)	0.332
	Confidence in performance (difficult water)	1.20 (0.78)	1.40 (1.01)	-0.20 (1.28)	1.16 (0.65)	1.43 (1.02)	-0.27 (1.19)	0.538
	Confidence in performance (difficult soap)	1.52 (1.00)	1.96 (1.26)	-0.44 (1.62)	1.92 (1.29)	2.11 (1.43)	-0.18 (1.90)	0.000
	Confidence in performance (difficult time)	1.22 (0.72)	1.27 (0.79)	-0.05 (1.05)	1.31 (0.94)	1.36 (0.97)	-0.04 (1.32)	0.182
	Confidence in continuation (distance)	3.87 (1.16)	3.49 (1.29)	0.37 (1.72)	3.83 (1.24)	3.64 (1.23)	0.17 (1.65)	0.743
Self-regulation factors	Commitment (committed)	4.11 (1.05)	3.86 (1.16)	0.26 (1.60)	4.05 (1.15)	3.88 (1.15)	0.15 (1.55)	0.489
	Commitment (important)	4.19 (1.12)	4.17 (1.08)	0.03 (1.51)	4.21 (1.03)	4.18 (1.05)	0.02 (1.48)	0.808
	Remembering (pay attention)	3.81 (1.11)	3.31 (1.28)	0.50 (1.67)	3.61 (1.29)	3.31 (1.31)	0.28 (1.78)	0.060
	Remembering (forgetting last 24 h)	1.95 (1.31)	2.39 (1.45)	-0.44 (1.92)	2.07 (1.36)	2.60 (1.51)	-0.52 (2.00)	0.296
Add. factor	Communication	3.72 (1.07)	3.10 (1.23)	0.62 (1.56)	3.68 (1.14)	3.19 (1.15)	0.49 (1.59)	0.685

Note. $N = 611$. ANOVA mean comparison. BL = baseline, F = follow-up. All questions included 5-point response scales and response choices from '1 – not at all' to '5 – very much'. Health Knowledge: sum scale (0–15).

* $p \leq 0.05$, ** $p \leq 0.01$, *** $p \leq 0.001$.

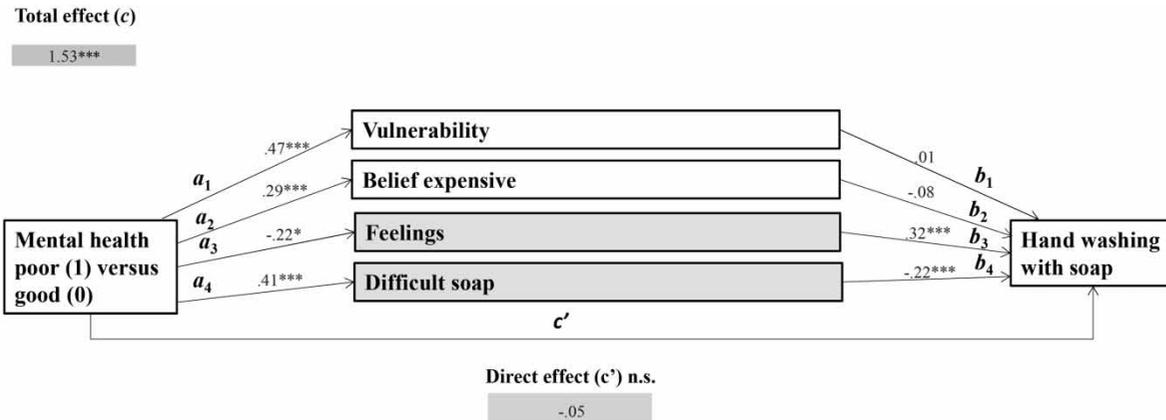


Figure 1 | Multiple mediation analysis: effects of mental health on changes in handwashing via changes in psychosocial factors (mediators). Legend: * $p \leq 0.05$, ** $p \leq 0.01$, *** $p \leq 0.001$. Displayed are unstandardized betas. $N = 632$, $R^2 = 0.20$ (b). Number of bootstrap samples for bias corrected bootstrap confidence intervals: 10,000. Level of confidence for all confidence intervals: 95% CL [LL, UL]. Specific indirect effects: vulnerability (0.005, [-0.024, 0.036]) a_1*b_1 ; belief expensive (-0.019, [-0.063, 0.010]); a_2*b_2 ; feelings (-0.063, [-0.129, -0.002]) a_3*b_3 ; difficult soap (-0.079, [-0.139, -0.032]) $=> a_4*b_4$.

mental health. We found significant differences in changes to two psychosocial factors: the belief that handwashing is more expensive (the belief-expensive factor) and for experiencing positive feelings while washing hands with soap (the feelings factor). The changes in the attitude factor (belief-expensive) after the intervention decreased more in people with good mental health than in people with poor mental health. That is, people with poor mental health are more inclined to believe that handwashing with soap is expensive. According to our findings, the group of people with poor mental health are also the more vulnerable part of the population: they experience more hunger, suffer more from diarrhea, are more anxious about the future health situation of their families, and are more likely to be illiterate and unmarried. This is in line with previous studies showing that risk factors of mental disorders include insecure access to key resources such as food (Patel & Kleinman 2003; Cole & Tembo 2011; Jones 2017), hunger and malnutrition (Weaver & Hadley 2009), and illiteracy (Arya *et al.* 2001). This may explain why people with poor mental health are more likely to believe that handwashing is expensive because they have fewer resources and are more vulnerable (Rogers 2010; Slekiene & Mosler 2018a).

The feelings factor increased more in people with good mental health than in people with poor mental health. In general, people with good mental health experience more positive feelings than people with poor mental health. This finding is supported by other mental health research that

has documented how people differ in their emotional experiences, abilities to differentiate emotions, and emotion regulation (Barrett *et al.* 2001). People with poor mental health, especially mood disorders, are less able to express and discriminate emotions (Ciarrochi *et al.* 2002). They often report difficulties in identifying emotions (Rude & McCarthy 2003), or show an absence of emotion (i.e., flat affect, blunted affect, and apathy) (WHO 1992). Previous research has shown that emotional dysregulation has a negative impact on mental health (Berking & Wupperman 2012).

In summary, people with poor mental health experience fewer positive emotions (WHO 2005), which in turn leads to a lower liking of handwashing and to a lower change to handwashing than those with good mental health.

Our third research question was whether RANAS psychosocial factors mediate the relationship between mental health and handwashing after the intervention. Only the feelings and difficult-soap factors were found to be significant mediators between mental health and handwashing after the behavior change intervention. Our study results support our assumptions that people with poor mental health experience fewer positive emotions while washing hands than those with good mental health, which in turn influences negatively their handwashing behavior. This is not surprising because poor mental health is directly related to emotional condition and influence people's abilities to cope with arising thoughts and feelings, to manage daily life, and to be emotionally resilient (WHO 2005). Healthy

emotion regulation and expression play a key role in good mental health, and these are impaired in people with poor mental health (Berking & Wupperman 2012). The difficulty to make soap available for handwashing in people with poor mental health is not surprising either and closely mirrors symptoms of depression such as difficulty to cope with daily life because mental health is generated in people's everyday lives at home and other activities (WHO 2005). Poor mental health can substantially impair daily activities and behavior, such as handwashing with soap in affected people (WHO 2005). The link between mental health and handwashing after behavior change intervention was mediated by feelings and difficult-soap factors. In summary, our finding that mental health affects mediators which in turn influence handwashing behavior coheres with a range of other studies. In other words, poor mental health hinders the influence of feelings and making soap available to handwashing in the behavior change process that in turn underlines the need to consider mental health in WASH programs.

Practical implication

The findings of this study can be used for developing projects and in emergencies for several reasons. First, mental health assessment should be included in WASH surveys. The SRQ-20 self-report questionnaire is an easy screening tool to measure mental health in the field surveys and does not require psychological training for data collectors. Second, vulnerable people with poor mental health should receive mental health treatment before or parallel with interventions on handwashing in order to increase their positive emotions. Next, specific interventions from the RANAS catalog of BCTs (Mosler & Contzen 2016) targeting the attitude factors belief-expensive, feelings, and difficult-soap would be more effective after the mental health treatment for people with poor mental health. Our study revealed that especially emotions play a key role in the behavior change process that are closely related to mental health. In general, the intervention targeting poor mental health would make any behavior change intervention more successful for vulnerable populations with a significant proportion of people with poor mental health. We believe that this research is especially relevant to emergency contexts, such as natural disasters,

conflict situations, and disease outbreaks but should be considered in all WASH initiatives.

Previous research shows that specific therapies at the population level have a positive effect on mental health, and they have been successfully applied in refugee camps in Africa for treatment of depression and anxiety in vulnerable populations, e.g., narrative exposure therapy, NET (Neuner *et al.* 2008; Gwozdziwycz & Mehl-Madrona 2013); or group-based interpersonal therapy, IPT-G (Bolton *et al.* 2003; Verdelli *et al.* 2003; Petersen *et al.* 2012).

CONCLUSIONS

Our study confirmed the association between mental health condition and change in handwashing with soap after a behavior change intervention. Study results also revealed differences between people with good mental health and those with poor mental health in two psychosocial factors, the belief that handwashing is more expensive and experiencing positive feelings while washing hands with soap. The perception of difficulties in getting enough soap for handwashing is another important mechanism that explains the lower participation of people with poor mental health in daily activities, such as handwashing with soap. Additionally, the study results showed that the mediation analysis method is useful for discovering and testing possible underlying causal relationships in psychological constructs and confirmed that emotions play a key role in the changes that people with poor mental health undergo in handwashing with soap. Overall, our findings underline the need to include consideration of mental health when planning public health interventions. Further research is needed to confirm our study results and to test other potential mediators, e.g., poverty and hunger.

DATA AVAILABILITY STATEMENT

All relevant data are available from an online repository or repositories (<https://doi.org/10.6084/m9.figshare.13166612.v2>).

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