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Contextual and psychosocial factors predicting sanitation behaviours in rural Indonesia

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Abstract

Background Rural areas in the Southern hemisphere bear the brunt of inadequate sanitation services and high prevalence of open defecation. Our study in an Indonesian remote village underscores the critical role of psychosocial factors influencing sanitation behavior in such marginalised communities. This study explores contextual and RANAS (Risk, Attitudes, Norms, Abilities, and Self-regulation) psychosocial factors determining sanitation behaviour in rural Indonesia.

Methods In a cross-sectional survey of 371 rural households, we gathered data on personal characteristics, sanitation behaviours, and RANAS factors and performed regression analysis.

Results We found that most respondents do not use the toilet regularly, and no household has safely managed sanitation facilities. Among all contextual factors, households with equal power in determining household expenses between husbands and wives and households with access to hygiene information tend to practice better sanitation behaviours and latrine use. Meanwhile, RANAS factors that primarily affect sanitation behaviour in this study are *remembering* (part of *self-regulation,* OR = 0.35), followed by *feeling* (*attitude,* OR = 0.31) and *commitment* (*self-regulation,* OR = 0.18).

Conclusions One in every four people interviewed in rural Luwu practices open defecation and no household has access to safely managed sanitation. In reducing open defecation rate in rural areas of Indonesia, the government should strengthen their efforts and concentrate on programmes that address the three identified psychosocial variables, along with improving access. While many studies on the determinants of sanitation behaviours in LMICs analyse contextual factors only, we argue that Indonesian sanitation behavioural interventions should use the RANAS model to identify psychosocial factors.

Keywords Contextual factors, RANAS, Rural Indonesia, Sanitation behaviour

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Background

Sustainable Development Goal (SDG) 6.2 aims to provide access to adequate and equitable sanitation and hygiene for all by 2030 and eliminate open defecation. Human excrement-related infectious illnesses, such as diarrhoea, typhoid, cholera, and viral infections, are the primary health concerns of open defecation [1]. Open defecation can impact everyone, but women are more at risk of violence and health complications. For example, hookworm infestation causes maternal anaemia [2], and diarrheal disorders cause undernutrition [3]. Moreover, open defecation may make women more vulnerable to assaults and is detrimental to women's health and their psychosocial well-being in the long term [4, 5].

The WHO/UNICEF Joint Monitoring Programme (JMP), obliged to monitor global progress on SDG 6, has devised a service ladder that categorises sanitation access. Safely managed sanitation sits at the top of the ladder, followed by basic, limited, unimproved, and open defecation. Previously, basic and limited sanitation were classified as 'improved,' which consists of facilities that are shared by two or more households (basic access) and those that are not shared (limited access) [6]. Global estimates indicate that in 2020, out of 120 countries with an available estimate for safely managed sanitation, only eight had achieved universal access to safely managed sanitation [7]. As a result, 3.6 billion people could not access safely managed sanitation services, including 1.9 billion with basic services, 580 million with limited services, and 616 million with unimproved facilities [7]. In 2017, 673 million continued to defecate in the open [8]. Although this number was reduced to 494 million by 2020 [7], open defecation remains the primary concern among many low- to middle-income countries (LMICs).

While many countries in the Global North have attained near-universal access to improved sanitation services, many LMICs, especially in the Southern hemisphere, struggle to provide their citizens with adequate sanitation facilities [9]. In Indonesia, access to improved sanitation in 2021 is 80.29% [10]. However, sanitation access is the lowest among people in the lowest expenditure quintile [11]. In addition, there are significant discrepancies between urban and rural communities: seven out of ten people who lack even the most basic services live in rural areas [8]. Open defecation is primarily a rural phenomenon; 92% of those who practiced open defecation lived in rural areas [7]. Indonesia reduced its open defecation rate by 23% from 2000 to 2017 [8]. In 2022, the open defecation rate was recorded to be 2.73% in urban areas and 10.15% in rural areas [12]. The Indonesian Ministry of Health [13] recorded that out of 61,737 villages reached by *Sanitasi Total Berbasis Masyarakat* (STBM – the Indonesian version of Community-led Total Sanitation or CLTS), only 30,780 have been verified as open defecation free. Therefore, although most SDG regions[1] are estimated to be on track to eliminate open defecation before 2030 [7], acceleration and multiple efforts must be made in rural settings.

Studies have investigated factors affecting open defecation practices in LMICs and linked such behaviours with personal and household demographics [14] and latrine ownership [15]. A qualitative study in Nepal suggests that open defecation is a voluntary choice or a compulsion, depending on personal preferences, cultural and traditional norms, and particular privacy concerns [16]. A study in rural eastern Indonesia suggests that latrine ownership and open defecation practices are associated with economic status, perceived cost of latrine construction, access to water during the dry season, acceptance of open defecation, latrine use behaviour in their communities, and perception around latrine ownership [17]. This study also highlights the importance of establishing and reinforcing new social norms around sanitation.

The RANAS (Risks, Attitudes, Norms, Abilities, and Self-Regulation) model is one theoretical framework that explains behavioural determinants in the water, sanitation, and hygiene (WASH) sector [18]. Combining the health action process approach [19] and the theory of planned behaviour [20], this model explains behaviour change through many psychosocial variables favouring a new behaviour [18]. RANAS has been popular in studies investigating latrine ownership and open defecation practices (e.g., [21–23]. The psychosocial factors, however, are integrated into contextual landscapes, which may impact sanitation behaviour [24, 25].

Using the RANAS model by considering personal contexts, this study intends to investigate contextual and psychosocial factors that influence sanitation behaviour in rural Indonesia. The RANAS framework provides a comprehensive method for studying the factors that drive behaviour, guiding us in predicting sanitation behaviours in rural Indonesia. This study will generate fresh insight for an increased understanding of designing effective behaviour change programs to eliminate open defecation practices in rural areas and, ultimately, public health in rural communities. We studied a remote village in Luwu, South Sulawesi Province, Indonesia. The role of remoteness in sustaining open defecation practices was highlighted [26]. Physical and social distances of remote communities have excluded them from access to infrastructure, information, and

[1] SDG regions are geographic groupings based on the United Nations standard, combining certain regions for presentation purposes in reporting SDG achievements. These replace the earlier "developed" and "developing" categorizations used in previous UN reports.

income. Therefore, it is essential to focus sanitation studies in remote areas to harness renewed commitment to accelerating progress in rural sanitation. Sanitation challenges and open defecation problems in remote areas have been highlighted in many regions, such as India [26, 27], Nepal [28], and Indonesia [29]. Moreover, despite many sanitation projects conducted in rural Indonesia, to the best of our knowledge, little is known about significant psychosocial factors related to sanitation behaviour in rural Indonesia. This study aims to fill that gap.

Method

Data collection

A cross-sectional survey was conducted in the rural Bassesangtempe Utara Sub-district, District of Luwu, South Sulawesi Province (Fig. 1). In this province, access to improved sanitation is 91.57% while safely managed sanitation accounts for 12.92% of the population (with access to safely managed sanitation is 11% in rural areas) [10, 30] These figures are higher than the national average: 83.60% for improved sanitation and 7.42% for safely managed sanitation [31, 32]. However, open defecation is

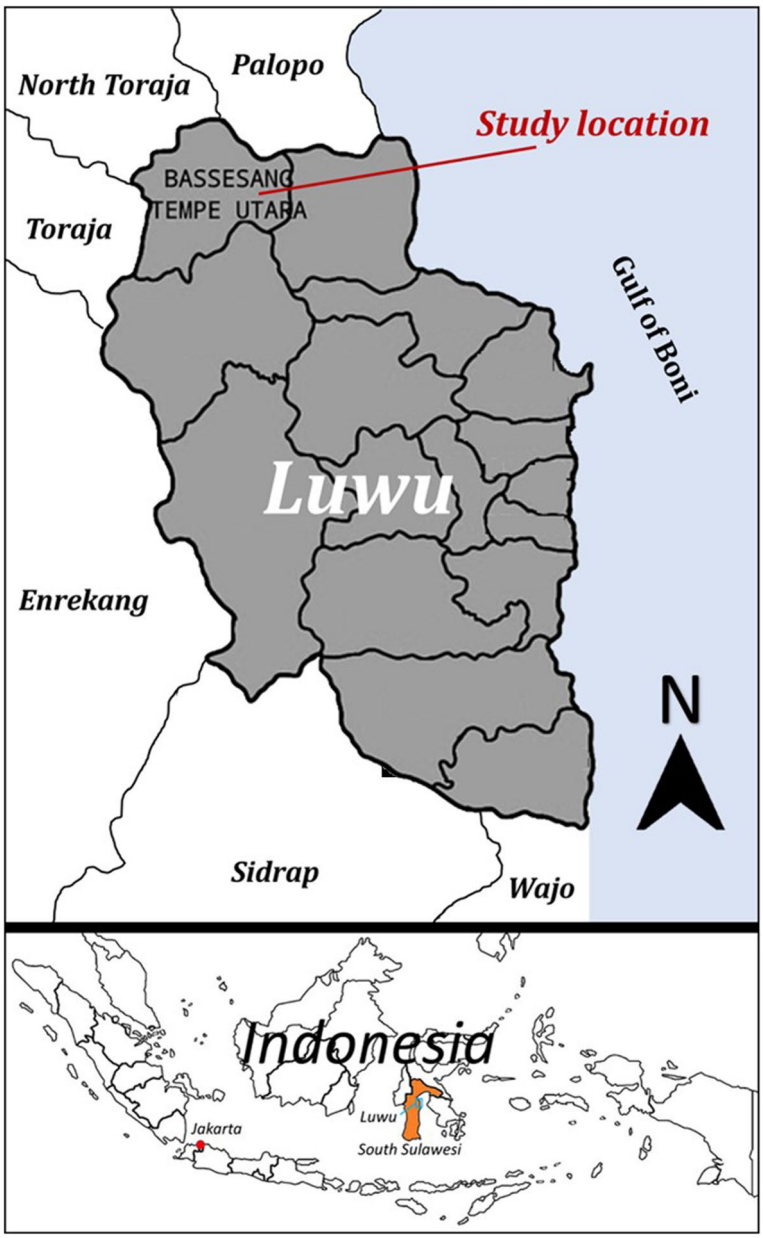

Fig. 1 Map of the study location

still practised by 5.21% of the rural South Sulawesi population [12]. In Luwu, 27.27% of the population does not own a latrine [33]. In Bassesangtempe Utara Sub-district, however, 73.7% of the population still practices open defecation in the fields and the rivers [34].

With a margin of error of 5% and considering non-response by 12% [35], the total number of households visited in the survey is 371. The study included all twelve hamlets in the sub-district. The sample sizes in each hamlet were determined proportionally concerning their respective populations. A trained team of local health sector employees conducted structured face-to-face interviews utilising a validated paper-and-pencil questionnaire. Randomly selected households were interviewed using the random-route method [36]. Each interview lasted between 45 and 60 min. Only one person was interviewed per household and answered questions regarding their household. The majority of interviews were conducted in the local and the Indonesian languages. Before the survey, all the interviewers participated in a one-day intensive training program during which they learned about the survey background, the objective, the structure, and the instrument's questions. During the survey, the heads of the hamlet accompanied the interviewers. The Medical and Health Research Committee of Universitas Gadjah Mada, Yogyakarta, approved the study (No. KE/FK/0820/EC/2022). All study participants gave their informed consent in writing.

The questionnaire included questions about sanitation behaviour, contextual information, and psychosocial factors from the RANAS model. The questionnaire developed for this study is shown in the Supplementary Material.

Contextual factors

We used fifteen contextual factors that are assumed to be associated with household sanitation behaviours. They cover the socio-economic and demographic characteristics of the respondents, decision makers of household expenses, and health promotion activities (from health agencies, relatives, or media). Those items are (a) education of the respondent, (b) education of the household head, (c) monthly household income, (d) household size, (e) number of children < 17 years, (f) living in own house, (g) gender, (h) age, (i) decision maker in home related to household expenses is whether the father, (j) the mother, or (k) both father & mother, (l) frequency of hearing about clean and healthy lifestyle at home, (m) Frequency of receiving clean and healthy lifestyle promotion from health-related agencies, (n) Frequency of talk about clean and healthy lifestyle at home, (o) frequency of looking for information about clean and healthy lifestyles from social or online media.

RANAS psychosocial factors

There are five main factors in RANAS: *risk, attitude, norms, ability*, and *self-regulation* [18]. *Risk* measures someone's awareness and understanding of the behaviour. *Attitude* measures a person's positive or negative feelings towards the behaviour. *Norms* measures the social pressure towards the behaviour. *Ability* indicates the person's confidence in performing the behaviour. Lastly, *self-regulation* assesses someone's attempts to self-monitor the continuation of the behaviour. Furthermore, there are some sub-factors under each main factor, which address more specific behavioural determinants. For example, there are three sub-factors under norms, i.e., others' behaviour, others' approval, and personal importance. The questions addressing all sub-factors can be seen in Table 1.

Dependent variable: sanitation behaviour

We used four variables to assess the sanitation behaviour of the respondents: (1) "How often do you practice defecating in the latrine?", (2) "How much do you want to practice defecating in the latrine?", (3) "How regularly do you defecate in the latrine?" and (4) "Do you practice open defecation?". The scale of the first three questions is from 1 to 5, e.g., "never" to "always" for the first question, while the answer for the fourth question is "yes" or "no". The main reason for combining those variables was to minimise the bias of self-reported behaviour, which can under or overestimate the appraisal of the sanitation behaviour of the respondents [37].

Data analysis

Using the Principal Component Analysis, we first combined four variables related to sanitation behaviour. The value of Cronbach's α of the PCA indicates whether the component can represent variation in those four variables. Scholars usually use the minimum Cronbach's $\alpha > 0.7$ [38]. The PCA's scores were then used as a dependent variable in the linear regression analyses. We conducted two regression analyses, firstly, with fifteen contextual factors. Significant variables were then used in the second regression with twenty-two RANAS sub-factors. We followed the approach of Gamma et al. [39]. Statistical analyses were performed in IBM SPSS© Statistics 24.

Results

Respondent's characteristics

There is no shared sanitation facility or public toilet in the visited hamlet. Table 2 shows the characteristics of the participants interviewed in this study. According to JMP classification [31, 32], 47.4% of the respondents had basic sanitation facilities, 26.7% had unimproved facilities, and

Table 1 Descriptive statistics of RANAS psychosocial sub-factors and questions related to sanitation behaviour (M = mean, SD = standard deviation)

Psychosocial factors		Questions	Scale	M (SD)
Risk	Health knowledge	How much do you know that defecating in rivers/gardens/open places can cause diarrhoea? (1 = I have no knowledge at all; 5 = I am very knowledgeable)	1–5	2.89 (0.87)
	Perceived vulnerability (on themselves)	How high do you feel is the risk that you will get diarrhoea due to defecation in the river/garden/open place? (1 = No risk at all; 5 = Very high risk)	1–5	3.69 (0.73)
	Perceived vulnerability (on a child)	How high do you feel is the risk of your child getting diarrhoea due to defecation in the river/garden/open place? (1 = No risk at all; 5 = Very high risk)	1–5	4.03 (0.78)
	Perceived severity (on themselves)	If you had diarrhoea, how severe would your illness be? (1 = Very mild; 5 = Very severe)	1–5	2.28 (1.00)
	Perceived severity (on a child)	If your child has diarrhoea, how severe will your child's illness be? (1 = Very mild; 5 = Very severe)	1–5	2.44 (1.11)
Attitude	Time	In your opinion, does defecation in the latrine take up a lot of time? (1 = Very time-consuming; 5 = Not at all)	1–5	4.21 (0.68)
	Health benefit	How sure are you that defecating in the latrine will prevent you from getting sick? (1 = Very unsure; 5 = Very sure)	1–5	1.92 (1.13)
	Cost (1)	How hard could you find the money to build your own latrine? (1 = Very hard; 5 = Very easy)	1–5	1.70 (0.97)
	Cost (2)	How expensive do you think it would be to build your own latrine? (1 = Very expensive; 5 = Very cheap)	1–5	4.15 (0.56)
	Feeling	Do you like the practice of defecating in the latrine? (1 = Strongly dislike; 5 = Strongly like)	1–5	3.89 (1.44)
Norm	Descriptive	How many of your relatives in your community have built their own latrines? (1 = Almost none (0–25%); 5 = Almost all population (100%))	1–5	2.17 (0.82)
	Injunctive	Do people around you approve of you building a private latrine? (1 = Strongly unapproved; 5 = Strongly approve)	1–5	3.74 (0.92)
	Personal	Do you feel obligated to practice defecation in the latrine? (1 = Not obligated at all; 5 = Very obligated)	1–5	3.86 (0.85)
Ability	Confidence in recovering	Imagine you have a lot of work to do (e.g. gardening, farming, raising livestock, etc.). How sure are you that you can always defecate in the latrine? (1 = Very unsure; 5 = Very sure)	1–5	2.55 (1.31)
	Confidence in continuation (1)	Imagine if your latrine was broken; how sure would you be that you would be ready to fix the broken latrine? (1 = Very unsure; 5 = Very sure)	1–5	2.65 (1.00)
	Confidence in continuation (2)	Imagine if you are temporarily building a latrine, and then you face a problem (eg limited funds); how sure are you to stick with it? (1 = Very unsure; 5 = Very sure)	1–5	2.13 (0.90)
Self-regulation	Action planning	How strong is your plan in setting out the time to build your personal latrine? (1 = Not strong at all; 5 = Very strong)	1–5	2.93 (1.16)
	Barrier planning	Imagine if you were building a latrine. How strong would your plan to build a latrine be if you ran out of construction materials? (1 = Not strong at all; 5 = Very strong)	1–5	2.30 (0.85)
	Remembering	How often do you forget to defecate in the latrine? (1 = Always; 5 = Never)	1–5	2.63 (1.22)
	Commitment	How committed are you to practising defecation in the latrine? (1 = Strongly not committed; 5 = Strongly committed)	1–5	3.08 (1.37)
Sanitation behaviour	Frequency	How often do you practice defecating in the latrine? (1 = Never; 5 = Always)	1–5	2.75 (1.23)
	Intention	How much do you want to practice defecating in the latrine? (1 = Never; 5 = Always)	1–5	4.19 (0.86)
	Habit	How regularly do you defecate in the latrine? (1 = Never; 5 = Always)	1–5	2.45 (1.13)
	Open defecation	Do you practice open defecation? (0 = Yes, 1 = No)	0–1	0.74 (0.44)

Table 2 Participants' characteristics ($n=371$)

Demographic variables	Total (%)	Variables	Total (%)
Female	164 (44.2)	Monthly Income (in thousand IDR)	
Age		< 500	335 (90)
17–21	3 (0.8)	500 to 1,000	19 (5.1)
22–31	45 (12.1)	1,000 to 3,000	15 (4)
32–41	72 (19.4)	3,000 to 6,000	3 (0.8)
42–51	116 (31.3)	Occupation	
52–61	74 (19.9)	Farmers	226 (60.9)
62–71	31 (8.4)	Not working	123 (33.2)
72–81	30 (8.1)	Others	22 (5.9)
Education		Sanitation facilities	
Did not attend school	92 (24.8)	Basic	176 (47.4)
Primary school	90 (24.3)	Unimproved	99 (26.7)
Secondary School	73 (19.7)	Open defecation	96 (25.9)
High School	104 (28)		
College	12 (3.2)		

25.9% were open defecation. The diagram is shown in Fig. 2. The assessment indicates that although 223 households had the pour flush latrine, 49 do not have a tank to store the faeces, thus categorised as unimproved sanitation. Furthermore, among 99 households with a containment type is "hole in the ground", 23 (23.3%) have a hole less than 10 m from the water source or well, indicating a high chance of contamination to the water source.

The mean scores of four questions related to sanitation behaviour are relatively at the middle of the score ranges, especially for questions 1 and 2, i.e., 2.75 and 2.45, respectively. However, the respondents' intention to defecate in the latrine is relatively high, i.e., mean score = 4.19 in question 2. The PCA of the four variables related to sanitation behaviour indicates that those four agree with each other, shown by the high value of Cronbach's α, i.e., 0.92, and % variance explained by the first component, i.e., 88%. After normalising the data, the PCA scores range from 0 – 2.90, and the mean score is 1.85 (SD = 1.00). Considering the mean score of the PCA and four questions related to sanitation behaviours (Table 1), we may conclude that people in the study area do not regularly defecate in the toilet.

Regression analyses

Table 3 shows the first regression analysis with contextual factors. There are two significant variables found: (1) decision maker in the home related to household expenses is both father & mother ($p \leq 0.01$), and (2) frequency of looking for information about clean and healthy lifestyles from social or online media ($p \leq 0.05$). These 15 contextual factors explained an 11.0% variance in the dependent variable (sanitation behaviour). These two variables were then included in the second regression with other RANAS sub-factors.

Table 4 shows twelve significant variables, i.e., all are RANAS sub-factors, while the two contextual factors become insignificant. The second regression explained a 95.6% variance in sanitation behaviour. The most influential variable is *remembering* (part of *self-regulation,* OR = 0.35), followed by *feeling* (*attitude,* OR = 0.31) and *commitment* (*self-regulation,* OR = 0.18). Meanwhile, the previous two contextual factors become insignificant (see Table 3). Remembering refers to the ability to remember to engage in good sanitation practices, i.e., defecating in the latrine. Feeling refers to the emotions associated with sanitation behaviour (i.e., defecating in the latrine), and commitment refers to the intention to defecate in the latrine consistently. Finally, there are three variables that have negative associations with sanitation behaviour, i.e., Perceived vulnerability (2), cost perception (2), and barrier planning.

Discussion

This paper explores sanitation behaviours in rural Indonesia and further assesses contextual and psychosocial factors predicting them. The respondents in rural Luwu reported a low frequency of defecating in the latrine, shown by the tendency to respond with 'never' and 'rarely' when being asked how often or how regularly they defecate in the latrine. Our survey indicated that more than 60% of the respondents have access to improved sanitation facilities; however, one-fourth do not own a latrine. Click or tap here to enter text. Despite the low self-reported use of latrine, the respondents express a relatively high willingness to practice defecation in the latrine. The underlying drivers for this willingness are not explored further in this study. However, affiliating with the urban elite, expressing new experiences & lifestyle, family health & safety, and convenience & comfort were found to be the primary drivers for switching to latrine in rural Benin [40].

The first regression analysis to determine the effect of contextual factors on sanitation behaviour revealed that only two contextual factors significantly affect sanitation behaviour: (1) the decision maker in the home related to household expenses is both father & mother, and (2) the frequency of looking for information about clean and healthy lifestyles from social or online media. The first predictor indicates that the authority of women within the households may affect the adoption of using latrine. This may be linked to women's desire for comfort and privacy [40]. Meanwhile, the frequency of receiving clean and healthy lifestyle promotion from the health-related agency does not significantly predict sanitation

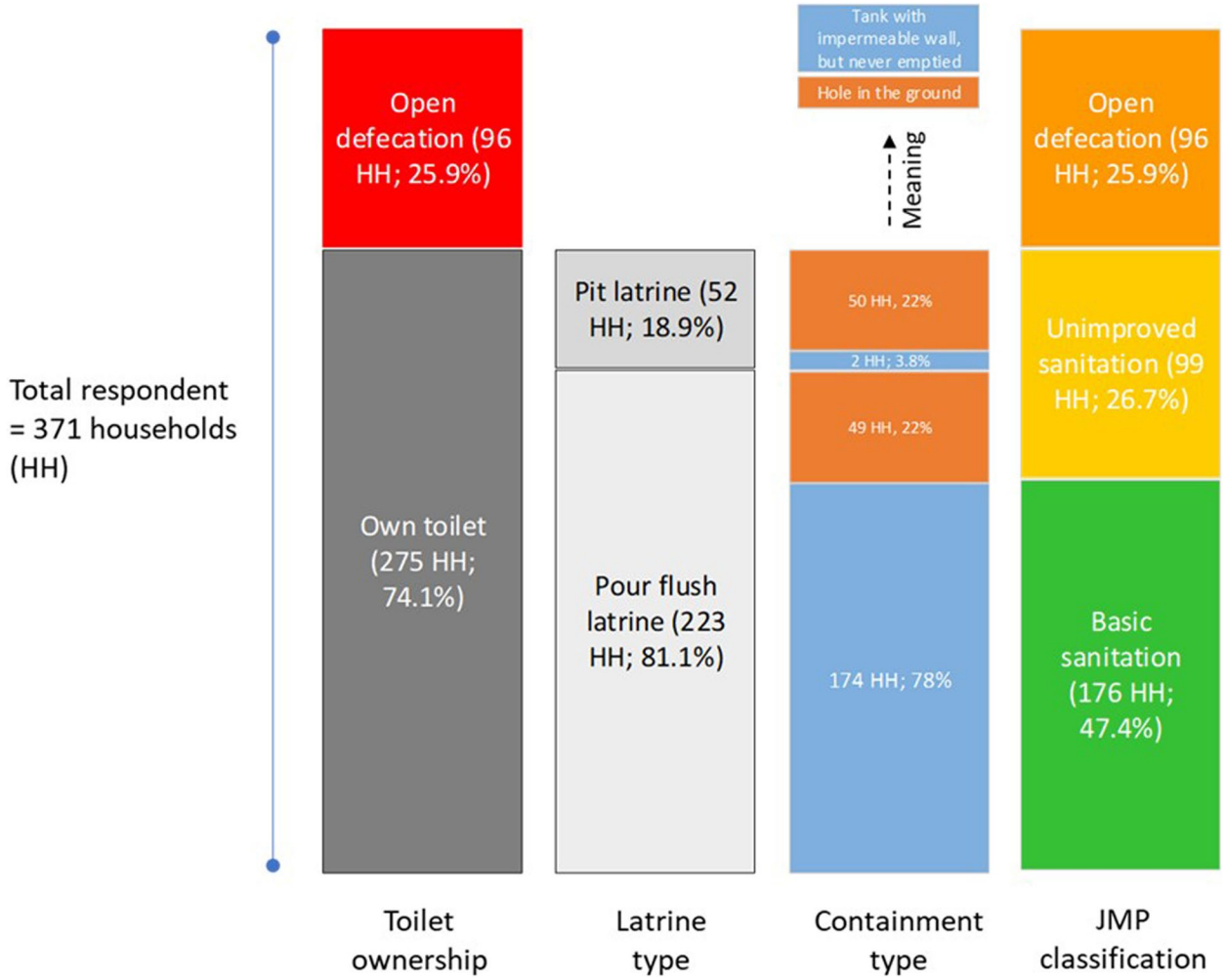

Fig. 2 Classification of the sanitation service of the respondents. The percentages in "latrine type" and "containment type" are based on the total number of households on the left

behaviours. This finding suggests that messages distributed through social or online media are more effective than through health agencies. Social networks and online media have become a significant part of life among rural communities. As many as 58% of people living in rural areas use social media; the trend has increased in the past decade [41]. Belay et al. found that media exposure had a significant association with open defecation practice [42]. Individuals' knowledge can be increased through social media, community-based media, and interpersonal communication channels, encouraging changes in attitudes and behaviours [43].

In the first regression, two contextual factors are significantly related to sanitation behaviour. However, they were insignificant when RANAS sub-factors were included as regressors in the second regression. This has been "predicted" by Lilje & Mosler [44], who argue that contextual factors will explain only a slight variance in WASH behaviour if psychosocial factors are included in the regression. However, Daniel et al. [45] suggest that contextual and psychosocial factors are still needed to understand the complex situation behind the behaviour better. For example, in our context, we found that equal decision-maker power at home and access to social/mass media indicate people are more likely to defecate in the toilet regularly. While many sanitation studies in LMICs still analyse contextual factors only [15], we argue that psychosocial factors must be included in any sanitation behavioural study.

We found twelve significant psychosocial factors in the regression. Among them, the most influential variables are *remembering* (part of self-regulation, OR = 0.35), followed by *feeling* (attitude, OR = 0.31), and *commitment* (self-regulation, OR = 0.18). Factors related to self-regulation and perspective are critical for continuing the behaviour [46]. For example, suppose a person cannot manage

Table 3 Regression analysis of sanitation behaviour with contextual factors (15 variables)

Variables	B	SE B	OR	CI (95%)
Education of respondent	0.06	0.17	0.08	−0.27—0.4
Education of household head	−0.03	0.18	−0.04	−0.38—0.31
Income	0.18	0.12	0.09	−0.05—0.4
Household size	0.01	0.03	0.03	−0.04—0.07
Number of children (< 17 years)	−0.04	0.05	−0.05	−0.14—0.07
Own house	−0.01	0.13	0.00	−0.26—0.25
Gender = man	−0.13	0.11	−0.07	−0.36—0.09
Age	0.00	0.00	0.01	−0.01—0.01
The decision maker in home = father	0.34	0.32	0.13	−0.29—0.96
The decision maker in home = mother	0.20	0.34	0.06	−0.46—0.87
The decision maker in home = father & mother	0.82	0.30	0.38**	0.23—1.41
Freq. of hearing about clean and healthy lifestyle at home	0.11	0.07	0.11	−0.02—0.25
Freq. of receiving clean and healthy lifestyle promotion from health-related agency	−0.03	0.07	−0.02	−0.17—0.11
Freq. of talk about clean and healthy lifestyle at home	−0.03	0.13	−0.01	−0.29—0.23
Freq. of looking for information about clean and healthy lifestyles from social or online media	0.25	0.10	0.17*	0.05—0.44

* $p \leq 0.05$

** $p \leq 0.01$, Adj. $R^2 = 0.110$, $n = 369$

and monitor themselves to perform the behaviour regularly. In that case, the chance of relapsing, i.e., returning to the old behaviour, or intermittent user, i.e., sometimes still doing the old behaviour, is high.

On the other hand, experiencing negative emotions about a certain behaviour can lead people to disengage from performing such a behaviour [47]. According to RANAS guidelines, potential interventions to make people defecate regularly in the toilet are to install memory aids at home, e.g., a poster (to address *remembering*), raise a pleasant feeling after using the toilet and inform benefits of it (*feeling*), and make a behavioural contract with the person to strengthen their commitment to always use the toilet (*commitment*). It is also possible to do all these three interventions simultaneously. Moreover, the program officer can also broadcast the information or reminders via social media, e.g., WhatsApp. That is because, if we consider contextual factors only, the frequency of looking for information from social media is associated with defecating in the toilet.

Three psychosocial factors are negatively associated with sanitation behaviour, i.e., Perceived vulnerability (2), cost perception (2), and barrier planning. These associations are contrary to the hypothesis, i.e., positive associations. We do not have a reason for this, but since the odd ratios are relatively small (< 0.05), we consider these associations to be weak.

Furthermore, to our knowledge, the RANAS model has never been used to explain sanitation-related behaviour in Indonesia. The high percentage variance explained in our model (95.6%) indicates that any sanitation behavioural intervention in Indonesia should use the RANAS model to discover significant psychosocial factors. Sanitation program officers can then target the significant factors in the behavioural intervention. However, to enhance sanitation behaviours, structural barriers towards the desired behaviour should be resolved first, i.e. ensuring access to sanitation facilities at homes, public facilities, and in the field. A previous study in rural sanitation system suggested that technical, along with other non-technical factors positively affect community's willingness to participate in sanitation program [48].

Since there are no safely managed sanitation facilities in the study area, we argue that there is a high chance of faecal contamination in the groundwater. This can affect health negatively, especially for households with latrine holes less than 10 m from the water source. Moreover, our results depict the conditions in Indonesia, both urban and rural areas, where households have a containment tank, but mostly not septic or impermeable at the bottom. People in Indonesia may be unable to distinguish whether the containment tank is septic or not. About 47.4% of the people we interviewed said they have a septic tank but further admitted it has never been emptied for more than 3 or 5 years. This may be why about 70% of the water sources in Indonesia were faecally contaminated [49]. Therefore, households must treat their drinking water before consumption and safely store it to

Table 4 Regression analysis of sanitation behaviour with selected contextual factors and RANAS sub-factors (22 variables)

Variables	B	SE B	OR	CI (95%)
Contextual				
The decision maker at home = father & mother	−0.04	0.03	−0.02	−0.1—0.01
Freq. of looking for information about clean/ healthy lifestyles from social or online media	0.00	0.02	0.00	−0.04—0.03
Risk				
Health knowledge	0.13	0.02	0.12***	0.09—0.17
Perceived vulnerability (1)	0.00	0.02	0.00	−0.05—0.04
Perceived vulnerability (2)	−0.12	0.03	−0.09***	−0.17—−0.06
Perceived severity (on life)	0.01	0.02	0.01	−0.02—0.05
Perceived severity (on a child)	−0.03	0.02	−0.04	−0.07—0
Attitude				
Time	−0.01	0.02	−0.01	−0.05—0.03
Benefit	−0.01	0.02	−0.01	−0.05—0.03
Cost (1)	0.04	0.02	0.04*	0—0.07
Cost (2)	−0.07	0.02	−0.07**	−0.11—−0.03
Feeling	0.22	0.02	0.31***	0.19—0.25
Norm				
Descriptive	0.12	0.02	0.10***	0.08—0.16
Injunctive	0.00	0.02	0.00	−0.05—0.04
Personal norm	0.11	0.03	0.09***	0.05—0.17
Ability				
Confidence in recovering	−0.03	0.02	−0.03	−0.07—0
Confidence in continuation (1)	0.06	0.02	0.08**	0.02—0.1
Confidence in continuation (2)	−0.01	0.02	−0.01	−0.05—0.03
Self-regulation				
Action plan	0.06	0.02	0.07**	0.03—0.09
Barrier planning	−0.05	0.02	−0.05**	−0.09—−0.01
Remembering	0.29	0.03	0.35***	0.22—0.35
Commitment	0.13	0.02	0.18***	0.09—0.18

* $p \leq 0.05$

** $p \leq 0.01$

*** $p \leq 0.01$, Adj. $R^2 = 0.956$, $n = 371$

minimise the risk of contamination. To tackle the issue of non-septic tanks in the future, the government must strictly regulate and monitor house construction. House construction must use the septic tank, i.e., impermeable walls and bottom, either emptied regularly (offsite sanitation) or connected to a centralised or decentralised sewer (onsite sanitation). Additionally, the government must prepare a good transport and wastewater treatment system to protect public health and minimise environmental contamination. However, these systems are still an issue in Indonesia [50]. This hampers the progress of SDG 6.2 in Indonesia.

Limitations of study

There are several limitations to this study. Firstly, self-reported sanitation behaviours were susceptible to recall bias because they were self-reported. Since open defecation violates human dignity and safety, some households may not report it, underestimating the occurrence [14]. Secondly, the cross-sectional nature of this study limits causal inferences, meaning that we cannot determine whether the three psychosocial factors significantly predict sanitation behaviours that are causing these outcomes. Longitudinal or randomised control trials using interventions concentrated on the three psychosocial factors are warranted in the future. Thirdly, cultural beliefs and their link to sanitation behaviour are not discussed in this research, although these often serve as significant predictors to open defecation [17, 51]. Moreover, since only one person per household was interviewed, the study did not account for intra-household variations, and the person to be interviewed was selected based on being the first household member encountered who was willing to participate. This approach may introduce selection

bias, as the chosen participant might not represent the perspectives and behaviors of other household members. Lastly, future study needs to analyse the groundwater or water source quality in the study area to estimate the faecal contamination in the water source caused by current sanitation practices.

Conclusion

Although Indonesia has mainstreamed Target 6.2 Sustainable Development Goals, progress towards ODF and improving access to safely managed sanitation in rural areas remain unsatisfactory. This research provides insights into the factors that sustain poor sanitation behaviour in remote rural Indonesia. The results recorded that one in every four people interviewed in rural Luwu is engaged in open defecation practices despite concerted efforts to eradicate the practice from the Indonesian government. Furthermore, no household has safely managed sanitation facilities, threatening the groundwater quality. Using the RANAS framework, the factors influencing sanitation behaviour were remembering, feeling, and commitment. Consequently, to accelerate the elimination of open defecation by 2030 in Bassesangtempe Utara Subdistrict and achieve sustainable open defecation-free status, the local government of Luwu and its partners should reinforce their efforts and focus on interventions targeting the three psychosocial variables. These strategies should be coupled with improving access to sanitation. Our study implies that RANAS is a suitable framework for analysing psychosocial factors affecting sanitation behaviours in rural Indonesia. While many research on sanitation in LMICs continues to focus solely on contextual factors, we suggest that psychosocial elements must be incorporated into WASH behavioural studies.

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12889-025-21893-3.

Supplementary Material 1.

Authors' contributions

AN: Conceptualisation, Methodology, Formal Analysis, Writing—Original Draft, Funding Acquisition; DD: Conceptualization, Methodology, Formal Analysis, Visualization, Writing—Original Draft; HO: Validation, Investigation, Data Curation, Funding Acquisition; HF: Validation, Investigation, Data Curation; AS: Writing – Review & Editing. All authors contributed to the interpretation of the findings and the writing of the manuscript. All authors read and approved the final version for submission.

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Data availability

The datasets generated and/or analysed during the study are not publicly available due sensitivity nature of the research but are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

Ethics approval for this study was obtained from Medical and Health Research Comitte (MHREC) Universitas Gadjah Mada, Yogyakarta Number KE/FK/0820/EC/2022. All participants provided informed consent before participating in the study, and their anonymity and confidentiality were strictly maintained throughout the research process.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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References

1. Prüss-Üstün A, Bos R, Gore F, Bartram J. Safer water, better health: costs, benefits and sustainability of interventions to protect and promote health. Geneva: World Health Organization; 2008.
2. Strunz EC, Addiss DG, Stocks ME, Ogden S, Utzinger J, Freeman MC. Water, sanitation, hygiene, and soil-transmitted helminth infection: a systematic review and meta-analysis. PLoS Med. 2014;11(3):e1001620.
3. Corburn J, Hildebrand C. Slum sanitation and the social determinants of women's health in Nairobi, Kenya. Sridhar MKC, ed. J Environ Public Health. 2015;2015:209505. https://doi.org/10.1155/2015/209505.
4. Pardeshi G. Women in total sanitation campaign: a case study from Yavatmal District, Maharashtra. India J Human Ecology. 2009;25(2):79–85. https://doi.org/10.1080/09709274.2009.11906139.
5. Saleem M, Burdett T, Heaslip V. Health and social impacts of open defecation on women: a systematic review. BMC Public Health. 2019;19(1):158. https://doi.org/10.1186/s12889-019-6423-z.
6. Beard VA, Satterthwaite D, Mitlin D, Du J. Out of sight, out of mind: understanding the sanitation crisis in global South cities. J Environ Manage. 2022;306:114285. https://doi.org/10.1016/j.jenvman.2021.114285.
7. WHO, UNICEF. Progress on household drinking water, sanitation and hygiene 2000–2020: five years into the SDGs. 2021.
8. WHO, UNICEF. Progress on household drinking water, sanitation and hygiene 2000–2017 - special focus on inequalities. 2019.
9. Satterthwaite D, Beard VA, Mitlin D, Du J. Untreated and unsafe: solving the urban sanitation crisis in the global south. Washington D.C.: World Resources Institute; 2019.
10. National Statistical Office. Proportion of households with access to adequate sanitation services (percent), 2020–2022. 2022. https://www.bps.go.id/indicator/29/1267/1/proporsi-rumah-tangga-yang-memiliki-akses-terhadap-layanan-sanitasi-layak.html. Accessed 25 Feb 2023.

11. National Statistical Office. Percentage of households with access to improved sanitation services by expenditure group (percent), 2020-2022. 2022. https://www.bps.go.id/indicator/29/1272/1/persentase-rumah-tangga-yang-memiliki-akses-terhadap-layanan-sanitasi-layak-menurut-kelompok-pengeluaran.html. Accessed 25 Feb 2023.
12. National Statistical Office. Percentage of households still practicing open defecation by province and regional type (percent), 2020-2022. 2022. https://www.bps.go.id/indicator/29/2176/1/persentase-rumah-tangga-yang-masih-mempraktikkan-buang-air-besar-sembarangan-babs-di-tempat-terbuka-menurut-provinsi-dan-tipe-daerah.html. Accessed 25 Feb 2023.
13. Indonesian Ministry of Health. STBM monitoring data. 2022. http://monev.stbm.kemkes.go.id/monev/. Accessed 24 Mar 2023.
14. Paul B, Jean Simon D, Kiragu A, Généus W, Emmanuel E. Socio-economic and demographic factors influencing open defecation in Haiti: a cross-sectional study. BMC Public Health. 2022;22(1):2156. https://doi.org/10.1186/s12889-022-14619-2.
15. Osumanu IK, Kosoe EA, Ategeeng F. Determinants of open defecation in the Wa Municipality of Ghana: empirical findings highlighting sociocultural and economic dynamics among households. Mannocci A, ed. J Environ Public Health. 2019;2019:3075840. https://doi.org/10.1155/2019/3075840.
16. Bhatt N, Budhathoki SS, Lucero-Prisno DEIII, et al. What motivates open defecation? A qualitative study from a rural setting in Nepal. PLoS One. 2019;14(7):e0219246.
17. Odagiri M, Muhammad Z, Cronin AA, et al. Enabling factors for sustaining open defecation-free communities in rural Indonesia: a cross-sectional study. Int J Environ Res Public Health. 2017;14(12). https://doi.org/10.3390/ijerph14121572.
18. Mosler HJ. A systematic approach to behavior change interventions for the water and sanitation sector in developing countries: a conceptual model, a review, and a guideline. Int J Environ Health Res. 2012;22(5):431–49. https://doi.org/10.1080/09603123.2011.650156.
19. Schwarzer R. Modeling health behavior change: how to predict and modify the adoption and maintenance of health behaviors. Appl Psychol. 2008;57(1):1–29. https://doi.org/10.1111/j.1464-0597.2007.00325.x.
20. Ajzen I. The theory of planned behavior. Organ Behav Hum Decis Process. 1991;50(2):179–211. https://doi.org/10.1016/0749-5978(91)90020-T.
21. Friedrich M, Balasundaram T, Muralidharan A, Raman VR, Mosler HJ. Increasing latrine use in rural Karnataka, India using the risks, attitudes, norms, abilities, and self-regulation approach: a cluster-randomized controlled trial. Sci Total Environ. 2020;707:135366. https://doi.org/10.1016/j.scitotenv.2019.135366.
22. Harter M, Mosch S, Mosler HJ. How does Community-Led Total Sanitation (CLTS) affect latrine ownership? A quantitative case study from Mozambique. BMC Public Health. 2018;18(1):387. https://doi.org/10.1186/s12889-018-5287-y.
23. Nunbogu AM, Harter M, Mosler HJ. Factors associated with levels of latrine completion and consequent latrine use in Northern Ghana. Int J Environ Res Public Health. 2019;16(6):920. https://doi.org/10.3390/ijerph16060920.
24. Dreibelbis R, Winch PJ, Leontsini E, et al. The integrated behavioural model for water, sanitation, and hygiene: a systematic review of behavioural models and a framework for designing and evaluating behaviour change interventions in infrastructure-restricted settings. BMC Public Health. 2013;13(1):1015. https://doi.org/10.1186/1471-2458-13-1015.
25. Stocker A, Mosler HJ. Contextual and sociopsychological factors in predicting habitual cleaning of water storage containers in rural Benin. Water Resour Res. 2015;51(4):2000–8. https://doi.org/10.1002/2014WR016005.
26. O'Reilly K, Dhanju R, Goel A. Exploring "the remote" and "the rural": open defecation and latrine use in Uttarakhand, India. World Dev. 2017;93:193–205. https://doi.org/10.1016/j.worlddev.2016.12.022.
27. Coffey D, Gupta A, Hathi P, Spears D, Srivastav N, Vyas S. Understanding open defecation in rural India: untouchability, pollution, and latrine pits. Econ Polit Wkly. 2017;52(1):59.
28. Shrestha A, Kunwar BM, Meierhofer R. Water, sanitation, hygiene practices, health and nutritional status among children before and during the COVID-19 pandemic: longitudinal evidence from remote areas of Dailekh and Achham districts in Nepal. BMC Public Health. 2022;22(1):2035.
29. Odagiri M, Muhammad Z, Cronin AA, et al. Enabling factors for sustaining open defecation-free communities in rural Indonesia: a cross-sectional study. Int J Environ Res Public Health. 2017;14(12):1572.
30. National Statistical Office. Percentage of households using safely managed sanitation services by province and regional type (percent), 2020-2022. 2022. https://www.bps.go.id/indicator/29/2179/1/persentase-rumah-tangga-menggunakan-layanan-sanitasi-yang-dikelola-secara-aman-menurut-provinsi-dan-tipe-daerah.html. Accessed 25 Feb 2023.
31. Government of Indonesia. The National Mid-Term Plan 2020-2024. 2020. https://ditkumlasi.bappenas.go.id/download/file/Narasi_RPJMN_2020-2024.pdf. Accessed 21 Jan 2025.
32. National Statistical Office. Percentage of households with access to improved sanitation, based on Province. 2024. https://www.bps.go.id/id/statistics-table/2/ODQ3IzI=/persentase-rumah-tangga-menurut-provinsi-dan-memiliki-akses-terhadap-sanitasi-layak.html. Accessed 21 Dec 2025.
33. Luwu Statistical Office. Luwu District in figures 2018. 2018.
34. Luwu Statistical Office. North Bassesangtempe Subdistrict in figure. 2018.
35. Yamane T. Statistics: an introductory analysis. 2nd ed. New York: Harper and Row; 1967.
36. Hoffmeyer-Zlotnik JHP. New sampling designs and the quality of data. Developments in applied statistics. 2003;19:205–17.
37. Daniel D, Pande S, Rietveld L. Socio-economic and psychological determinants for household water treatment practices in Indigenous-Rural Indonesia. Front Water. 2021;3. https://www.frontiersin.org/articles/10.3389/frwa.2021.649445.
38. Daniel D, Pande S, Rietveld L. The effect of socio-economic characteristics on the use of household water treatment via psychosocial factors: a mediation analysis. Hydrol Sci J. 2020;65(14):2350–8. https://doi.org/10.1080/02626667.2020.1807553.
39. Gamma AE, Slekiene J, von Medeazza G, Asplund F, Cardoso P, Mosler HJ. Contextual and psychosocial factors predicting Ebola prevention behaviours using the RANAS approach to behaviour change in Guinea-Bissau. BMC Public Health. 2017;17(1):446. https://doi.org/10.1186/s12889-017-4360-2.
40. Jenkins MW, Curtis V. Achieving the 'good life': why some people want latrines in rural Benin. Soc Sci Med. 2005;61(11):2446–59. https://doi.org/10.1016/j.socscimed.2005.04.036.
41. Perrin A. Social media usage. Pew Research Center. 2015;125:52–68.
42. Belay DG, Chilot D, Asratie MH. Spatiotemporal distribution and determinants of open defecation among households in Ethiopia: a mixed effect and spatial analysis. PLoS One. 2022;17(5):e0268342.
43. Ngwu U. The practice of open defecation in rural communities in Nigeria: a call for social and behavior change communication intervention. Int J Commun Res. 2017;7(3):201–6.
44. Lilje J, Mosler HJ. Socio-psychological determinants for safe drinking water consumption behaviors: a multi-country review. Journal of Water Sanitation and Hygiene for Development. 2017;7(1):13. https://doi.org/10.2166/washdev.2017.080.
45. Daniel D, Pande S, Rietveld L. Socio-economic and psychological determinants for household water treatment practices in Indigenous-Rural Indonesia. Frontiers in Water. 2021;3:649445.
46. Hagger MS. Self-regulation: an important construct in health psychology research and practice. Health Psychol Rev. 2010;4(2):57–65.
47. Taufik D, Venhoeven L. Emotions and pro-environmental behaviour. In: Steg L, De Groot JIM, editors. Environmental psychology: an introduction. West Sussex: John Wiley & Sons; 2018. p. 189–97.
48. Sunaryo LR, Soewondo P. Determinants of the influence of community participation on the sustainability of local system community-based sanitation programs in Temanggung Regency. In: E3S Web of Conferences, vol 485. EDP Sciences; 2024. p. 02009.

49. Sarli PW, Soewondo P. Strategic thinking to change behavior and improve sanitation in Jodipan and Kesatrian, Malang, East Java, Indonesia. Eng Technol Int J Urban Civil Eng. 2017;11(10). https://doi.org/10.5281/zenodo.1132599.
50. Irianto J, Zahra, Hananto M, et al. Final research report 2020: a study of household water quality in Indonesia. 2020.
51. Harahap J, Gunawan T, Suprayogi S, Widyastuti M. A review: domestic wastewater management system in Indonesia. IOP Conf Ser Earth Environ Sci. 2021;739(1):12031. https://doi.org/10.1088/1755-1315/739/1/012031.

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