The importance of collective and individual psychological ownership for safe sanitation:

A multilevel analysis in rural Ghana

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Abstract

Unsafe sanitation practices can severely affect public health. Strengthening psychological ownership, the feeling of owning an object (e.g. the latrine) individually or collectively, may promote safe sanitation practices, e.g. decreased open defecation. This study investigated psychological ownership in communities that participated in a sanitation intervention. We used follow-up survey data of a cluster-randomized controlled trial in rural Ghana (N = 2012 households), which assessed psychological ownership, and safe sanitation outcomes. The data were analyzed using multilevel modelling and generalised estimating equations. In line with our assumptions, greater psychological ownership for the latrine related to decreased open defecation. Higher individual psychological ownership for the open defecation space related to safe sanitation outcomes, whereas collective ownership related to lesser safe sanitation. The present study shows that the concept of psychological ownership may play an important role in safe sanitation. Collective and individual psychological ownership seem to distinctly relate to safe sanitation outcomes, which has high relevance for promoting communities' health behaviour.

Keywords: psychological ownership, psychosocial determinants of health behaviour, safe sanitation, community-led total sanitation, community health interventions

Introduction

Diarrhoea is a leading cause of death, especially among children younger than five years (Adjiwanou & Engdaw, 2017; Troeger et al., 2018). According to the World Health Organization (WHO), poor sanitation is considered to be the main cause of diarrhoeal deaths (WHO, 2015). In 2015, approximately 892 million people practiced open defecation (WHO & UNICEF, 2017). Improvements in sanitation can reduce the rates and severity of various soil- and water-transmitted diseases, malnutrition and stunting in children, and social inequalities (Cumming & Cairncross, 2016; Esrey et al., 1991; Prüss et al., 2002).

Interventions to eradicate open defecation in low-income settings have often failed to produce long term behaviour change (Starkl et al., 2013; Venkataramanan et al., 2018; Winter et al., 2019). One reason for unsuccessful sanitation interventions is a lack of communities' acceptance of new sanitation infrastructure (e.g. accepting latrines as a location for defecation and using and maintaining it) (Carter et al., 1999). Many have argued that 'creating ownership' may be one way to improve this, e.g. by increasing community members' involvement and decision making in development projects (Carter et al., 1999; Dixon et al., 2012; Lachapelle, 2008; Lüthi & Kraemer, 2012). To this end, practitioners developed participatory approaches, involving communities in producing sanitation solutions, instead of giving latrines as subsidies only. While it is plausible that these approaches evoke feelings of ownership, there is only little theory-based empirical research corroborating this assumption.

Psychological ownership is defined as 'the state in which individuals feel as though [a] target of ownership … is *theirs*' (Pierce et al., 2001, p. 299). It indicates a feeling of possessiveness and personal attachment to a material or immaterial object (Pierce et al., 2001). Depending on the target of ownership, it can exist at the individual ('I feel that I own the latrine'), and the collective level ('I feel that we collectively own the school') (Pierce & Jussila,

2010). According to ownership theory, there are three routes that can foster psychological ownership. The more *control* individuals have over a target (e.g. in terms of participating in decision-making on sanitation planning) (Liu et al., 2012; Pierce et al., 2001, 2003, 2004), the more individuals *invest* in a target (e.g. ideas, labour by constructing the latrine) (Pierce et al., 2003), and the more *intimate knowledge* about a target they have (e.g. by frequent interactions), the higher their degree of psychological ownership for it (Pierce et al., 2001, 2003). In turn, stronger psychological ownership is assumed to relate to several outcomes. The more psychological ownership individuals feel towards a target, the more responsibility they will feel for the target of ownership (Pierce et al., 2003). This may result in better acceptance, caretaking and more long-term behaviour change towards the object of ownership (Avey et al., 2009; Dixon et al., 2012; Pierce et al., 2003; Süssenbach & Kamleitner, 2018). These favourable implications of psychological ownership may also find their relevance in the use and caretaking related to sanitation infrastructure.

The role of psychological ownership in safe sanitation

The relevant personal targets of ownership in sanitation include the personal latrine and the open defecation space (defined as any collective space in the community used for open defecation, e.g. bushes, fields, forests). Whereas the latrine as a personal target should evoke feelings of individual psychological ownership, the open defecation space as a collective space may evoke both individual and collective psychological ownership (see Figure 1).

Greater individual psychological ownership for sanitation targets should be related to favourable safe sanitation outcomes, such as greater acceptance of the target (e.g. commitment to construct and use latrines), better caretaking (e.g. by keeping the open defecation space clean) and ultimately reduced open defecation. Collective psychological ownership for the open defecation space, however, may also relate to unfavourable outcomes. Peck & Shu (2015)

found that individual and collective ownership for collective goods distinctly relate to responsibility and caretaking. While individual psychological ownership for a collective good should lead to higher commitment and feeling of responsibility for it, collective ownership might evoke a diffusion of responsibility to take care of it because ownership is not clearly attributed to specific individuals (Ostrom, 1990; Shu & Peck, 2018). For the open defecation space, this could mean that more collective psychological ownership might be related to less responsibility over it, i.e. not constructing latrines and as a consequence continuing open defecation. However, no formal research on psychological ownership in the sanitation context has been carried out to test these assumptions.

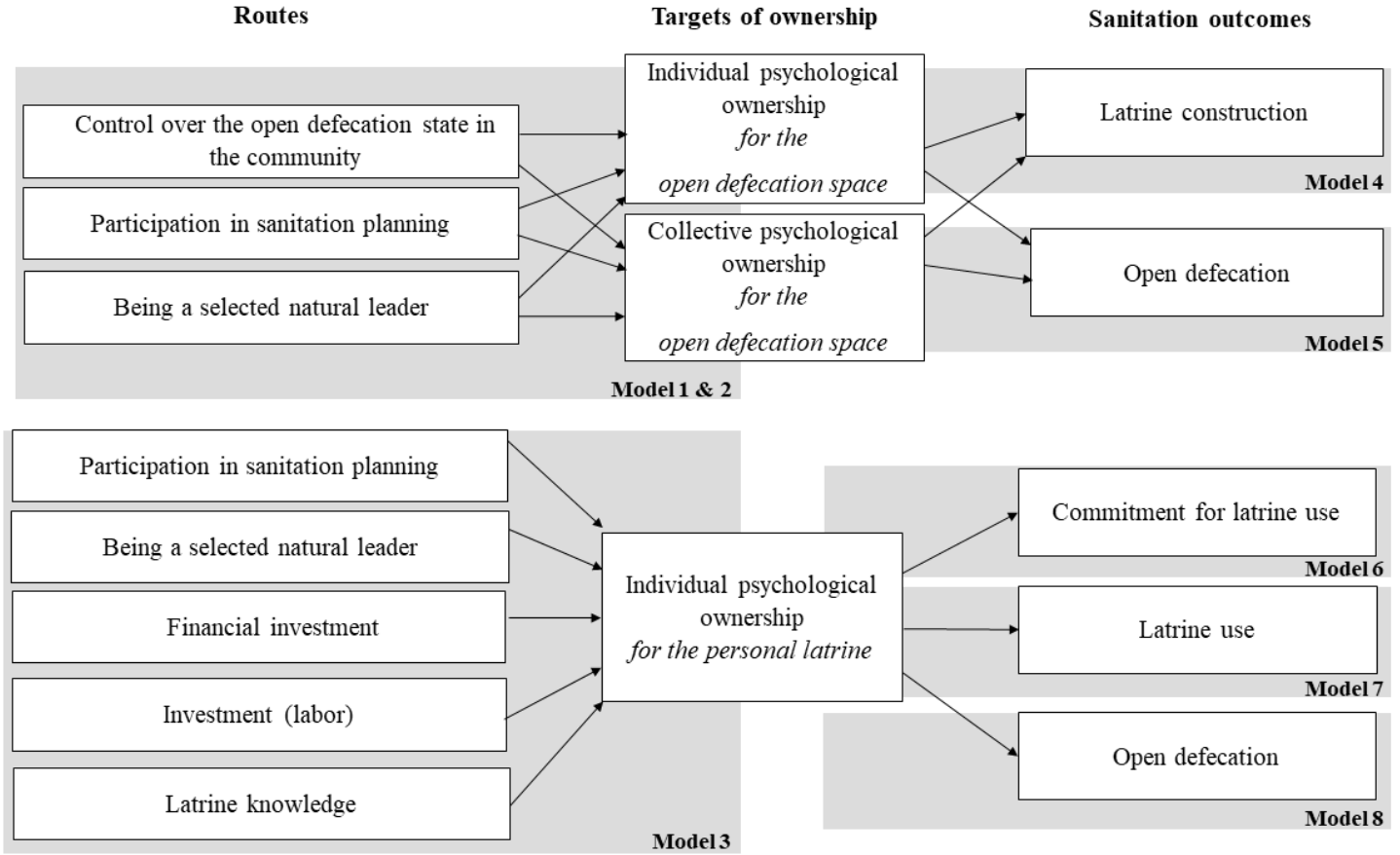

Figure 1. Working model of the hypothesised routes (models 1-3, see data analysis) and sanitation outcomes (models 4-8) of psychological ownership for the open defecation space and the latrine.

Note: This model is based on our literature review of activities in sanitation interventions, e.g. Community-Led Total Sanitation (CLTS).

Psychological ownership in participatory sanitation projects

In terms of routes to psychological ownership for sanitation targets, participatory sanitation approaches should be useful. These projects seek to engage beneficiaries and communities in the decision making on planning, supply and management of resources and facilities in the process of change towards safe sanitation (Lüthi & Kraemer, 2012). One of the most prominent of these participatory approaches is Community-Led Total Sanitation (CLTS), a subsidy-free approach promoting communities to construct their own latrines and hence eradicate open defecation (Kar & Chambers, 2008; Sah & Negussie, 2009). Having a closer look at CLTS, we expect several activities to act as routes to psychological ownership for the latrine and particularly the open defecation space (Kar & Chambers, 2008), by fostering a sense of control, investment and intimate knowledge. A summary of these CLTS activities that may act as routes to psychological ownership are displayed in Figure 1. As one of the key elements of CLTS, the participation in sanitation planning may promote psychological ownership through intensive interaction with the open defecation space, for example by walking to the community sites for open defecation (walk of shame in CLTS). This emotional and mental interaction with the open defecation space may also foster intimate knowledge of this space (Pierce et al., 2003). Further, the community invests ideas in solving the problem of open defecation and which may foster control over open defecation state in the community. In CLTS, natural leaders are selected to take over a more active role in the sanitation process by ensuring implementation and maintenance of latrines in their community (Kar & Chambers, 2008). Natural leaders have greater influence and likely experience more control, investment and intimate knowledge regarding sanitation targets, which should lead to greater psychological ownership (Pierce et al., 2003).

By discussing different latrine types and construction possibilities during sanitation planning, community members should further improve latrine knowledge. Additionally, all

physical (labour) and financial investment for latrine construction needs to be ensured by the community members themselves. To sum up, participation in a sanitation planning intervention like CLTS most likely promotes the routes to psychological ownership (Pierce et al., 2003) for the open defecation space and the personal latrine.

The present study aims at addressing the outlined research gaps by asking two research questions: Do participatory activities in sanitation projects relate to greater psychological ownership for the latrine and the open defecation space (routes to psychological ownership)? And does greater psychological ownership in turn relate to safe sanitation outcomes? We investigate these questions at the example of CLTS as an evidence-based participatory sanitation approach.

Data and Methods

This study is based on a secondary analysis of the data from 14 to 16-months follow-up survey of a cluster-randomised controlled trial (C-RCT) that tested the effectiveness of CLTS interventions (Kar & Chambers, 2008) on the reduction of open defecation in two districts in Northern Ghana (Harter et al., 2019, 2020). In 2013, an average of 81% of households in this area did not have any kind of toilet facilities (Ministry of local government and rural development Ghana, 2013).

Intervention

Global Communities, the partnering NGO, implemented CLTS 14 -16 months before this study (between July and November 2016) following the national guideline on CLTS provided by the Government of Ghana (Ministry of local government and rural development Ghana, 2013) and the original Handbook on CLTS (Kar & Chambers, 2008). Global communities selected and trained local CLTS facilitators that were not part of the communities. These CLTS facilitators invited the members of each community to a meeting with participatory activities. In CLTS, this is called triggering event. The triggering events included the drawing of an improvised community map on the ground with the localisation of the houses of the participants as well as the locations used for open defecation. Through this method, the different pathways of the faecal-oral transmission of bacteria were discussed, and related to diarrhoeal illnesses. The facilitators then provided information on the different steps and materials for latrine construction, and especially the first step of digging a pit for the latrine. Afterwards, motivated community members were identified and their names recorded as role models, also called natural leaders in the process of stopping open defecation. Finally, the facilitators and the community developed an action plan and agreed on a date when the community planned to become open defecation free (i.e. a community where at least 80% have access to safe

sanitation services). Intervention protocols for all intervention arms can be found on https://osf.io/gdcqs/?view_only=eb1238cbaebf403c8618f971e500c206. Detailed information on behaviour change techniques used (Abraham & Kools, 2012; Michie et al., 2013) can be found in Table A1 in the Appendix. The C-RCT was approved by the ethical committee of the University of Zurich, Switzerland and the ethical review committee of the Ghana Health Service (GHS-ERC: 05/01/2016).

Participants and procedures

Global Communities selected 132 communities with a minimum of 25 households per community (see Harter et al., 2020 for sample size calculation). For the present study, we only included participants of the CLTS intervention arms (n = 2012, 102 communities), because we were interested to investigate multiple routes to psychological ownership experienced during the CLTS sanitation planning meeting. The control group did not receive any intervention, wherefore it was not suitable comparison group to study differences in psychological ownership experimentally.

Thirty-three local data collectors were trained in a one-week workshop on the correct implementation of the survey. They selected participating households according to the random route method (Hoffmeyer-Zlotnik, 2003). Inclusion criteria were minimum of 18 years, having lived at least for three months in the community and given informed consent. Interviews lasted 50 min on average and were supervised by the first and second author, local personnel and interns.

Survey instrument and outcome measures

The survey instruments were translated from English to different local languages and pretested in two communities not included in the survey (n = 134) before the study. The

interviewers read out questions on sanitation behaviour, psychological ownership, the different routes to psychological ownership, and further psychosocial factors not relevant to the present study to the participants. Items for psychological factors (e.g. psychological ownership) were answered using a unipolar 5-point Likert scales supported by a visual scale of five dots of increasing size, ranging from 'I do not at all agree' to 'I agree very much'. To create composite scores for continuous factors (e.g. psychological ownership) corresponding items were summed. All scores were normed to values of 0-1, with higher values indicating a higher score on this factor. Further, factors with binary items were dummy-coded, with 1 indicating the presence of an outcome (e.g. 0 = no open defecation, 1 = practicing open defecation).

Please consult Tables A2 – A4 in the Appendix for details on item wordings, their factor loadings in a confirmatory factor analysis, descriptive measures, intra-class correlations and bivariate relationships between all factors.

Psychological ownership

We adapted the validated individual and collective psychological ownership scales from the organisational context (Pierce et al., 2018; Van Dyne & Pierce, 2004) to measure psychological ownership for the open defecation space and the latrine. To identify an understandable term for the open defecation space, we conducted formative research during the pretest. When asked to name the spaces in their community, where they went for open defecation, 63% of respondents named 'bush'. In the following, interviewers therefore referred to the term 'open defecation space' as *bush*[1].

We introduced items for individual psychological ownership for the open defecation space and the latrine with this text: 'The following questions deal with the *sense of ownership*

[1] Please note that *bush* is not an appropriate term for the open defecation space in general as it might imply racist stereotypes. According to results from the qualitative pretest, it was only used to adapt wording to local languages.

that you and the members of your community feel for the bush where most community members go for open defecation [that you feel for your toilet]. How much do you agree with the following statements?' - e.g. 'I am one of the owners of the bush [toilet].' Additionally, we assessed collective psychological ownership for the open defecation space, because it can be owned and is used by the entire community. This text was presented: 'The following questions deal with the *sense of ownership* that you and the members of your community feel for the bush where most community members go for open defecation. How much do you agree with the following statements?' – e.g. 'We (my community members and I) collectively feel that this bush belongs to *us* together.' Internal consistencies for individual psychological ownership for the space ($\alpha = 0.74$), collective psychological ownership for the space ($\alpha = 0.92$) and individual psychological ownership for the latrine ($\alpha = 0.73$) were satisfactory to high.

Routes to psychological ownership

We assessed the routes to psychological ownership detailed in the introduction in line with psychological ownership theory (i.e. corresponding to control, investment, intimate knowledge; Pierce et al., 2001, 2003). We adapted items measuring feeling of control over the open defecation state of the community (i.e. to what extent open defecation was practiced $\alpha = 0.85$) from Avey et al.'s factor self-efficacy (Avey et al., 2009). Financial investment was assessed by asking how much money respondents had paid for the latrine (in Ghanaian New Cedi). Outliers for financial investment $SD \geq 3$ ($n = 19$) were adapted to next highest value $SD < 3$ (1300 GHC ≈ 289 US$) as recommended by Tabachnick & Fidell (1983). Furthermore, we measured investment of labour by a multiple choice item that asked who had constructed the latrine. Answers including 'myself' were coded 1, all other answers (e.g. 'my husband') were coded 0. We assessed latrine knowledge related to latrine safety with a 6-item quiz, asking what the features of a safe latrine are (e.g. decking without holes). For correct answers, 1 point was added to the score, resulting in values from 0 to 6. We also asked respondents whether

they were selected a natural leader, and whether they participated in the CLTS sanitation planning meeting (1 = 'yes', 0 = 'no').

Sanitation outcomes

Commitment for latrine use was measured by a two-item scale (α = 0.643), e.g. 'How committed are you to use your own latrine?' 1 = 'not at all committed' to 5 = 'very committed'.

We identified latrine construction by asking whether a household had a latrine or not: 'Does your household have an own latrine?' 0 = 'no household latrine'; 1 = 'own household latrine (finished or under construction)'. Aggregated to the community level this variable accounts for communities' average latrine coverage.

Latrine use of the personal latrine was observed by the interviewers using a standardized protocol. See Table A3 for details. Latrine use observations were only made when the latrine had a superstructure. For latrines that did not have a superstructure, the latrine use index was set 0 as its use was very unlikely (Nunbogu et al., 2019).

To measure open defecation, we used the Safe San Index (Jenkins et al., 2014), which was adapted to refer to individual behaviour only (rather than the entire household). It is a self-report measure representing the proportion of open defecation frequency, and latrine use in the past seven days. However, the data revealed that individuals either exclusively practiced open defecation or latrine use. Open defecation was therefore coded as a binary variable, 1 for respondents who practiced open defecation on anytime in the last seven days, and coded 0 if respondents never practiced open defecation in the last seven days. Aggregated to the community level it accounts for the proportion of people within one community, who practice open defecation (0-100%).

Data analysis

For modelling the routes and sanitation outcomes of psychological ownership, we performed multilevel analyses (for continuous outcomes), and generalised estimating equations (GEE, for binary outcomes) that account for the nested structure of the data (respondents nested in communities). For each predictor (e.g. participation in sanitation planning), we separated the variation within communities from the variation between communities as these may differ (Bolger & Laurenceau, 2013; Hamaker, 2012). To compute between community predictors, we computed community-averaged scores (or proportions, in case of binary variables). These allow the investigation of differences between communities (Hamaker, 2012). Scores were additionally grand-mean centred by deducting community means (same value for each participant of one community) from the overall mean. Thereby, the coefficients compare to the typical community. To compute the within-community predictors, we subtracted the community mean from raw scores. Within-community predictors therefore indicate individual-level effects, i.e. an individual's deviation from their community level (Enders & Tofighi, 2007).

To identify the routes related to psychological ownership, three linear mixed models were computed in IBM SPSS Statistics 23 version 24 (IBM Corp., Armonk, N.Y., USA) with the outcomes individual (Model 1) and collective (Model 2) psychological ownership for the space and individual psychological ownership for the latrine (Model 3). The theorised routes to ownership were set as predictors (see Figure 1).

To model the sanitation outcomes related to psychological ownership a linear mixed model was fitted for continuous outcomes (commitment for latrine use and observed latrine use, Model 6-8). For the dichotomous outcomes (latrine construction and open defecation, Models 4 & 5) we used GEE (Liang & Zeger, 1986). As effect size measures for the GEE

models, we calculated odds ratios (*OR*s) with asymptotic Wald 95% confidence intervals (CIs). They are interpreted as the percentage increase (values >1) or decrease (values <1) in the outcome (e.g. open defecation) for a unit increase in the predictor (Atkins et al., 2013).

Results

See Table 1 for sample characteristics of participants included in the analysis and all descriptive statistics. Find random effects on variances in outcomes and effects between communities and individuals in Tables A5-A7 in the appendix.

Table 1

Sample characteristics

	f	*f%*	*M*	*SD*
Occupation				
Farming	1712	85.1%		
Other (trading, mining, fishing)	300	24.9%		
Religion				
Islam	434	21.9%		
Christian	1055	52.4%		
Traditional religion	418	20.9%		
Atheists	105	5.2%		
Female respondents	793	39.0%		
Ability to read and write	358	17.8%		
Age			45.7	15.9
Income [c, d]			172.7	530.5
Individual psychological ownership for the latrine, n = 1410 [e, f]			0.91	0.15
Individual psychological ownership for the open defecation space			0.74	0.26
Collective psychological ownership for the open defecation space			0.76	0.31
Routes				
Participation in sanitation planning meeting[a] (% yes)	1340	67%		
Selected natural leader[b] (% yes)	220	11%		
Control [g]			0.84	0.24
Financial investment, n = 1410 [e, h, i]			0.15	0.16
Investment: labour (% yes), n = 1410 [e]	688	49%		
Latrine knowledge			0.41	0.14
Consequences				
Open defecation (% yes)	938	47%		
Latrine construction (% yes)	1410	70%		
Open defecation in latrine owners, n = 1410 [e]	409	26%		
Observed Latrine Use, n = 1410 [e]			0.37	0.27

Note: N = 2012, f = absolute frequency, %f = relative frequency, M = Mean; SD = Standard deviation. All continuous items were recoded to a range between 0 to 1

. [a]Did you participate [in the CLTS sanitation planning meeting]? 0 = 'no' 1 = 'yes', [b]Are you one of the selected natural leaders in CLTS process? 0 = 'no/I don't know', 1 = 'yes'. CLTS = Community-led total sanitation.

[c] ≈ 33 US$

[d] n = 7 missing ('I don`t know')

[e] n =1410 (latrines owners)

[f] n = 43 missing (technical difficulties)

[g] n = 1 missing (technical difficulties)

[h] 290.91 Ghana Cedi (≈ 55 US$, SD = 274.08)

[i] n = 529 missing ('I don`t know')

Routes related to individual and collective psychological ownership for the open defecation space

The results on the routes related to the individual (Model 1, Figure 1) and collective (Model 2) psychological ownership for the open defecation space are presented in Table 2. All between community effects account for differences between communities and within community effects account for differences between persons within a community. As can be seen in the between community effects, communities where control was typically higher on average, and where fewer persons had participated in the CLTS sanitation planning meeting showed greater individual psychological ownership for the space on average. Within communities, persons with higher feelings of control than the typical community member reported 10% higher individual psychological ownership for the space.

In communities where persons had a higher feeling of control, collective psychological ownership for the space was 30% higher on average. Persons with higher feelings of control than a typical community member reported 18% higher collective psychological ownership for the space. Communities where more persons participated in the CLTS sanitation planning meeting had 18% lower collective psychological ownership for the space.

Table 2

Routes to psychological ownership for the open defecation space

	Individual psychological ownership for the open defecation space				Collective psychological ownership for the open defecation space			
			CI_{95}				CI_{95}	
	B (*SE*)	*p*	LL	U L	*B* (*SE*)	*p*	LL	U L
Intercept	0.73 (0.01)	< 0.001	0.71	0.76	0.76 (0.01)	< 0.001	0.73	0.79
Participation in sanitation planning meeting [a] (within communities)	< 0.01 (0.01)	0.960	-0.02	0.03	0.01 (0.02)	0.664	-0.02	0.04
Participation in sanitation planning meeting [a] (between communities)	-0.14 (0.07)	0.046	-0.27	0.00	-0.18 (0.07)	0.017	-0.33	-0.03
Selected natural leader [b] (within communities)	0.02 (0.02)	0.397	-0.02	0.05	0.03 (0.02)	0.209	-0.02	0.07
Selected natural leader [b] (between communities)	0.16 (0.11)	0.139	-0.05	0.38	0.18 (0.12)	0.147	-0.06	0.42
Control (within communities)	0.10 (0.03)	< 0.001	0.05	0.15	0.18 (0.03)	< 0.001	0.11	0.24
Control (between communities)	0.45 (0.12)	< 0.001	0.21	0.68	0.30 (0.13)	0.030	0.03	0.56

Note: Models 1 & 2. *N*= 2012, 102 communities. *B* = unstandardised regression coefficients. *SE* = Standard error, CI_{95} = Confidence interval, LL= lower limit of the confidence interval, UL= upper limit of the confidence interval. Linear mixed models, Probability distribution: normal. [a]'Did you participate [in the CLTS sanitation planning meeting]?' 0 = 'no' 1 = 'yes', [b]'Are you one of the selected natural leaders in CLTS process?' 0 = 'no/I don't know', 1 = 'yes'. CLTS = Community-led total sanitation. All variables were recoded to a range between 0 and 1. All *p*-values are two-tailed.

Routes related to individual psychological ownership for the latrine

As can be seen in Table 3, persons who were selected natural leaders in the sanitation planning process indicated 3% higher individual psychological ownership for latrines than persons who were no selected natural leaders. Persons who invested labour had 4% higher individual psychological ownership for the latrine than persons who did not.

Table 3.
Routes to psychological ownership for the latrine

	Individual psychological ownership for the latrine			
			CI_{95}	
	B (*SE*)	*p*	LL	U L
Intercept	0.89 (0.01)	< 0.001	0.86	0.91
Participation in sanitation planning meeting (within communities)	< -0.01 (0.01)	0.711	-0.03	0.02
Participation in sanitation planning meeting (between communities)	0.01 (0.06)	0.827	-0.10	0.13
Selected natural leader (within communities)	0.03 (0.01)	0.010	0.01	0.06
Selected natural leader (between communities)	-0.08 (0.09)	0.346	-0.25	0.09
Financial investment (within communities)	0.02 (0.03)	0.524	-0.04	0.09
Financial investment (between communities)	-0.06 (0.08)	0.483	-0.22	011
Investment: labour (within communities)	0.04 (0.01)	< 0.001	0.02	0.06
Investment: labour (between communities)	0.06 (0.05)	0.287	-0.05	0.16
Latrine knowledge (within communities)	0.06 (0.04)	0.089	-0.01	0.13
Latrine knowledge (between communities)	0.27 (0.17)	0.107	-0.06	0.60

Note: Model 3. *N* =1367 (1410 households with a latrine, *n* = 43 missing data), 101 communities. *B* = unstandardised regression coefficients. *SE* = Standard error, *CI* = Confidence interval, LL= lower limit of the confidence interval, UL= upper limit of the confidence interval. Linear mixed model, Probability distribution: normal. All variables were recoded to a range between 0 and 1. All *p*-values are two-tailed.

Sanitation outcomes related to psychological ownership for the space

Communities with higher levels of individual psychological ownership for the space, compared to communities with lower levels of individual psychological ownership, had higher latrine coverage, and lower open defecation rates (see Table 4). Effects of collective

psychological ownership on latrine construction and open defecation were reversed compared to effects of individual psychological ownership. Communities with the higher levels of collective psychological ownership for the space, compared to communities with typical levels of collective psychological ownership, had lower latrine coverage and practiced more open defecation.

Table 4

Consequences of psychological ownership for the open defecation space

	Latrine construction					Open defecation				
				CI_{95}					CI_{95}	
	Estimate (*SE*)	*p*	*OR*	*LL*	*U L*	*Estimate* (*SE*)	*p*	*OR*	*LL*	*U L*
Intercept	0.95 (0.15)	< 0.001	2.58	1.91	3.49	-0.23 (0.16)	0.157	0.79	0.58	1.09
Individual psychological ownership for the open defecation space (within communities)	0.42 (0.24)	0.081	1.53	0.89	1.64	-0.05 (0.16)	0.738	0.95	0.71	1.29
Individual psychological ownership for the open defecation space (between communities)	7.84 (2.48)	0.002	2532.70	19.65	326474.82	-9.02 (2.70)	0.001	< 0.01	< 0.001	0.02
Collective psychological ownership for the open defecation space (within communities)	-0.24 (0.21)	0.249	0.79	0.52	1.18	0.01 (0.15)	0.941	1.01	0.76	1.35
Collective psychological ownership for the open defecation space (between communities)	-6.89 (2.26)	0.002	< 0.01	< 0.01	0.09	7.09 (2.42)	0.003	1209.89	10.51	139246.54

Note: Models 4 & 5. *N*= 2012, 102 communities. *Estimate* = Parameter Estimates, *SE* = Standard error, CI = Confidence interval, *OR* = Odds Ratio. Generalized estimating equations: Probability distribution: binominal, link function: logit. Outcome variables: Latrine construction: 0 = no latrine, 1 = latrine (finished or under construction); Open Defecation: 0 = latrine use only, 1 = open defecation only/ mixed use. All variables were recoded to a range between 0 to 1. All *p*-values are two-tailed.

Sanitation outcomes related to individual psychological ownership for the latrine

In line with our assumptions, individual psychological ownership for the latrine was related to stronger commitment to use latrines (see Table 5). Communities with higher individual psychological ownership for the latrine were 32% more committed to use latrines than communities with average individual psychological ownership for the latrine. Similarly, persons with higher individual psychological ownership for the latrine than was typical for their community reported 40% higher committed to use their latrine. Communities with higher individual psychological ownership for their latrines had lower open defecation rates that communities with typical psychological ownership.

Table 5

Consequences of psychological ownership for the open defecation space

	Commitment for latrine use [a]				Observed Latrine Use [a]				Open Defecation [b]				
			CI 95				CI 95					CI 95	
	B(SE)	*p*	LL	U L	*B(SE)*	*p*	LL	U L	*Estimate*(*SE*)	*p*	*OR*	*LL*	*U L*
Intercept	0.94 (< 0.01)	< 0.001	0.94	0.95	0.44 (0.01)	< 0.001	0.40	0.47	-0.62 (0.17)	< 0.001	0.54	0.39	0.75
Individual psychological ownership for the latrine (within communities)	0.32 (0.02)	< 0.001	0.28	0.37	-0.10 (0.06)	0.083	-0.21	0.01	-0.54 (0.37)	0.140	0.58	0.28	1.19
Individual psychological ownership for the latrine (between communities)	0.40 (0.06)	< 0.001	0.29	0.51	< 0.01 (0.25)	0.984	-0.50	0.51	-3.37 (1.68)	0.045	0.03	< 0.01	0.92

Note: Models 6 – 8. *N* = 1367 (households with a latrine only, *n* = 1410), 101 communities. *B* = unstandardized regression coefficients, *Estimate* = Parameter Estimates, *SE* = Standard error, CI = Confidence interval, LL= lower limit of the confidence interval UL= upper limit of the confidence interval, *OR* = Odds ratio. [a] Linear mixed models. Probability distribution: normal. [b]Generalised estimating equations. Probability distribution: binominal, link function: logit. Outcome variable: Open Defecation 0 = latrine use only 1 = open defecation only/ mixed use. All *p*-values are two-tailed.

Discussion

In this paper, for the first time, the role of psychological ownership (Pierce et al., 2001) in the context of safe sanitation was empirically investigated. In line with our assumptions, we found that psychological ownership relates to participatory activities in the context of community-based sanitation projects, and to safe sanitation outcomes. Psychological ownership may therefore be an important target in promoting safe sanitation, extending the literature on the importance of psychological ownership for the use and maintenance of safe water infrastructure (Ambuehl et al., 2021; Contzen & Marks, 2018; Marks et al., 2013; Marks & Davis, 2012).

In line with our assumptions, feeling control over the open defecation state of the community, and participation in a sanitation planning meeting was found to be a route to individual and collective psychological ownership for the space used for open defecation. Participation in the meeting was found to be a route associated with lower individual and collective psychological ownership for the space. Similarly, investment of labour (but not finances), and being a selected natural leader in the sanitation planning process were identified as routes to individual psychological ownership for the latrine. In terms of sanitation outcomes, higher individual psychological ownership for the open defecation space related to greater latrine construction, and less open defecation. Conversely, higher collective psychological ownership for the open defecation space related to less safe sanitation outcomes (e.g. increased open defecation). For households with a latrine, higher individual psychological ownership for the latrine was related to higher commitment for latrine use, but not to observed latrine use. Finally, communities with higher average psychological ownership for latrines practiced less open defecation.

Individual and collective psychological ownership for the open defecation space

Our results showed that the more control individuals and communities feel over the open defecation state in their community, the more individual and collective psychological ownership they feel for the open defecation space. This finding is in line with previous research of the control route, which is the most frequently studied route in ownership research (Liu et al., 2012; O'driscoll et al., 2006; Peng & Pierce, 2015; Van Dyne & Pierce, 2004), and is the most frequently mentioned by participants when describing ownership (Rudmin, 1994).

Our results on the routes to ownership suggest that participating in a sanitation planning meeting like CLTS can modulate psychological ownership for the open defecation space. Even though CLTS activities might encourage an intensive interaction with the open defecation space (intimate knowledge; Pierce et al., 2003), greater participation in CLTS sanitation planning meeting was related to lower collective and individual psychological ownership for the space. CLTS activities (e.g. drawing an open defecation map) are supposed to trigger shame and disgust for open defecation in the community (Kar & Chambers, 2008). Likely, this may cause disaffection towards the open defecation space and may result in people perceiving it as less valuable. The endowment effect (Thaler, 1980) posits that a consumer's valuation of an object increases once they have taken ownership of it. Conversely, we theorise that when a target decreases in its valuation (like the open defecation space in CLTS activities), people might feel less ownership for the target. More generally, this result suggests that interventions may decrease psychological ownership for a target, e.g. unsafe infrastructure as well as increase it, e.g. for safe infrastructure. This holds promise for interventions. Psychological ownership for the new infrastructure could be promoted to increase its acceptance and use (e.g. latrines, a new safe water source). In parallel, psychological ownership for the old infrastructure could be

decreased to lower its acceptance and use (e.g. the open defecation space, an unsafe water sources).

Results on the sanitation outcomes related to psychological ownership for the space are highly interesting for the understanding of psychological ownership in the context of safe sanitation as well as for the distinction of collective and individual psychological ownership in general. Communities with higher individual psychological ownership were found to practice less open defecation and construct more latrines while communities with higher collective psychological ownership practiced more open defecation and constructed fewer latrines.

The most plausible explanation for these contradictory results may be found in the tragedy of common goods (Ostrom, 1990). When ownership of objects is not clearly attributed to specific individuals, the responsibility to care for this object tends to become diffuse. In situations of diffusion of responsibility, individuals wait to allow others to take action (Shu & Peck, 2018). A focus on increasing individual psychological ownership in community-based sanitation projects might be a promising answer to prevent diffusion of responsibility (Shu & Peck, 2018), e.g. through individual action plans rather than a community action plan only. We also recommend a clear division of tasks between community members in community action planning rather than only setting a timeline for the community to be open defecation free as a collective goal (Kar & Chambers, 2008).

Overall, the findings of the role of psychological ownership for the open defecation space bring a new perspective to sanitation research. Whereas sanitation research has previously focused on the latrine, our results suggest that the open defecation space is important for understanding and reducing open defecation, and warrants further attention.

Psychological ownership for the latrine

In line with our assumptions, persons who constructed their latrine themselves (investment in labour) indicated higher psychological ownership for it. Creating something

new is identified as an important source of psychological ownership (Pierce et al., 2001). Through labour, community members invested time, physical effort and mental energy into the latrine (Pierce et al., 2003). Interestingly, financial investment was unrelated to individual psychological ownership for the latrine. A reason for no relation to be found is the fact that the investment route originally refers to the investment of time, energy and effort rather than to money (Pierce et al., 2001, 2003).

Being selected a natural leader related to higher individual psychological ownership for the latrine. Selected natural leaders are opinion leaders with high influence in the sanitation planning process in CLTS (i.e. control) (Kar & Chambers, 2008). Findings are consistent with findings of psychological ownership in the context of water systems. Having a household member in the water committee is associated with higher ownership (Marks & Davis, 2012).

Contrary to our expectations, latrine knowledge and psychological ownership for the latrine were unrelated. The reason for this might be that we only assessed factual knowledge about latrines but knowledge as a route of psychological ownership does not only mean to know *about* the target, but to *get to know* the target, e.g. by frequent interactions (Pierce et al., 2001). Future research may assess knowledge with items of perceived familiarity or comprehensive understanding of the target (Zhao et al., 2016).

In terms of sanitation outcomes, psychological ownership for the latrine was related to higher commitment for its use, which is consistent with results from psychological ownership for water kiosks (Contzen & Marks, 2018). However, we found no association between psychological ownership and observed latrine use. Possibly, commitment did not translate into action, a common phenomenon in health psychology, referred to as the intention-behaviour gap (Orbell & Sheeran, 1998). Still, communities with higher psychological ownership for latrines practiced less open defecation.

Limitations

This large cross-sectional study provided important first insights on the role of psychological ownership in safe sanitation. We showed how psychological ownership relates to sanitation outcomes. A limitation is that all data except observed latrine use were self-reported and we cannot exclude the possibility of social desirability.

Considering the public health benefit of our study, a limitation is that we only investigated latrine construction and open defecation as sanitation outcomes. To investigate long-term sanitation outcomes, the number of open defecation free communities and changes in health outcomes need to be investigated in addition, especially considering the lack of effects of CLTS on these outcomes (Venkataramanan et al., 2018).

Due to its cross-sectional nature, no causal inferences can be made whether *routes* actually promote psychological ownership, and whether this results in *consequences* as proposed by ownership theory. Longitudinal studies and particularly randomised controlled trials that manipulate routes to psychological ownership and compare sanitation outcomes afterwards to a suitable comparison group are the next steps. The data of this study were from a C-RCT designed for a different purpose, and therefore not suitable to experimentally test ownership hypotheses. A suitable experiment testing the routes and sanitation outcomes of psychological ownership would require a control group where latrines are installed 'top down', i.e. without any kind of community participation, hence blocking the development of psychological ownership. This is a crucial next step for the field of public health to provide an evidence base to the practice of evoking psychological ownership in development projects.

Conclusions

In conclusion, this study provided support for the importance of psychological ownership in safe sanitation. Greater involvement in decision making through participation in

sanitation projects, and investing labour in constructing one's own latrine may be important levers to evoke greater psychological ownership, and consequently safe sanitation outcomes. Perhaps most importantly, this research revealed that psychological ownership for the space used for open defecation may be a crucial element to understand collective processes in eradicating open defection. Collective and individual psychological ownership seem to distinctly relate to safe sanitation behaviours, which has high relevance for interventions aiming to promote safe sanitation. Overall, the results encourage further research on the role of psychological ownership in sanitation, which may hopefully contribute to coming closer to the goal of eradicating open defecation and improving public health.

Declaration of interest

The authors declare no competing interests.

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