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ATINER's Conference Paper Series
HSC2014-0905

Preventing Parasitic and Gastrointestinal Infections in Central Java: The 'Balatrine Intervention

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ATINER CONFERENCE PAPER SERIES No HSC2014-0905

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Email: info@atiner.gr URL: www.atiner.gr
URL Conference Papers Series: www.atiner.gr/papers.htm

Printed in Athens, Greece by the Athens Institute for Education and Research.

ISSN: **2241-2891**
20/5/2014

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This paper should be cited as follows:

Park, MJ, Laksono, B., Hadisaputro, S., Gray, D., Clements, A. and Donald E. Stewart, T., (2014) **"Preventing Parasitic and Gastrointestinal Infections in Central Java: The 'Balatrine Intervention"** Athens: ATINER'S Conference Paper Series, No: **HSC2014-0905.**

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Abstract

Open defecation increases the risk of helminthiasis and other infectious diseases. In rural Indonesia, we tested a household latrine (the 'BALatrine') as a method for controlling soil transmitted helminth (STH) infection. We studied two villages, one of which had household latrines and the other did not. The dependent variable was the presence or absence of worm eggs in stool samples, as confirmed by laboratory analysis. The independent variables were the village of residence, demographic characteristics, and various behaviours associated in the literature with the risk of helminthiasis. The total number of

participants was 475, of whom 392 were worm-free. In a multivariate logistic-regression model, the people who were more likely to be worm-free were younger, female, did not spend time in the paddy fields, and lived in the village that had BALatrines. Compared with the people living in the village without BALatrines, those in the village with BALatrines were twice as likely to be worm-free. A longitudinal controlled study of the BALatrine would allow us to confirm the significance of this household latrine in controlling helminthiasis.

Keywords: BALatrine, bowel infections, hygiene, Indonesia, soil transmitted helminth, sanitation.

Acknowledgments: This work was supported by the UBS Optimus Foundation. We are grateful to the residents of the villages for participating in this study.

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Introduction

According to one estimate, "only 63% of the world's population has access to improved sanitation - defined as a sanitation facility that ensures hygienic separation of human excreta from human contact" and "2.5 billion people lack access to improved sanitation; 1.1 billion still practice open defecation" (Water.org, 2014).

In rural Indonesia open defecation is common. Proper latrines are available to only 35% of the rural population (Water and Sanitation Program, 2010). The Millennium Development target is for 75% sanitation coverage to be achieved by 2015 (WHO and UNICEF Meeting the MDG drinking water and sanitation target: The urban and rural challenge of the decade, 2006), but under the present circumstances that will probably not be achieved. As a result of this situation many people in these areas are infected with viruses, parasites, and pathogenic bacteria (WHO Fact sheets on environmental sanitation, 2013). Helminthiasis is particularly widespread (Laksono, 1995; Central Java Health Department Fundamental Health Research Report, 1998).

Therefore, there is a need for more people in rural Indonesia to use latrines (Fatoni & Stewart, 2012), and there is a need for evidence to quantify the effectiveness of latrines against STH infections. Here we report on the use of Budi's Amphibious Latrine (the 'BALatrine') (Laksono, Gray, Clements, Saddler, Park, & Stewart, 2014). For this cross-sectional study we took advantage of the fact that the BALatrine has already been in use in some villages in rural Indonesia for several years (Stewart & Laksono, 2002). We analyzed stool samples from people with and without BALatrines, looking for evidence of helminth infection. We also assessed hygiene-related behavioural and demographic factors that can contribute to STH infections.

Methods

Setting

The participants lived in two villages in the Gunung Pati sub-district of the city of Semarang, Central Java, Indonesia. BALatrines were in use in only one of those two villages (Laksono, Gray, Clements, Saddler, Park, & Stewart, 2014). We collected data regarding residents of those villages who were over 3 years of age.

Variables and Measurements

The independent variables were the village of residence (that is, the village without BALatrines or the village with BALatrines), age, gender, hygiene-related behaviours (described below), and physical evidence of hygiene-related behaviours (cleanliness of fingernails and of hands).

Information on 8 hygiene-related behaviours was collected by questionnaire. The survey workers who administered the questionnaire also

examined the hands and fingernails of each participant and recorded their cleanliness.

The dependent variable was the result of laboratory examination of a stool sample. The presence or absence of worm eggs in each sample was assessed by a modified flotation method (Dryden, Payne, Ridley, & Smith, 2005; Cringoli, Rinalidi, Maurelli, & Utzinger, 2010).

Data Analysis

As described in the Tables, the differences between the participants with and without worm eggs in stool and were tested with Fisher's exact test, the Mann-Whitney U test, and multivariate logistic regression. Data were analysed with IBM SPSS Version 20.0, Microsoft Excel, and the "Open Source Epidemiologic Statistics for Public Health" at <www.openepi.com>.

Ethics

Ethical approval for this study was obtained beforehand from the Semarang City authorities (ref. 070/613/IV/2011), and from the Human Research Ethics Committees at Diponegoro University and at Griffith University (ref. PBH/17/11/HREC).

Results

Background

Biological, socio-demographic and housing-related details are shown in Table 1. There were 475 participants, about half of whom were in the village with BALatrines. Among residents of the village with BALatrines the average age was slightly lower ($p = 0.004$), and more of them had schooling beyond the elementary level ($p < 0.001$). Still, in both villages more than 90% of the participants had completed at least elementary school. In the village with BALatrines higher percentages of the residents were unemployed or self-employed ($p < 0.001$), and the percentage of residents with no income was also higher ($p < 0.001$). In the village without household BALatrines the housing conditions were somewhat worse: about half of the people in that village lived in a house in which all floors were dry, whereas more than two thirds of those in the village with BALatrines lived in a house in which all floors were dry ($p < 0.001$).

Table 1. *Background*

	Total (n = 475)	Without latrine (n = 226)	With latrine (n = 249)	p[a]
Biological characteristics				
Sex				
Female	241 (50.7%)	120 (53.1%)	121 (48.6%)	0.358[b]
Male	234 (49.3%)	106 (46.9%)	128 (51.4%)	

Age				
Mean ± SD	38.4 ± 12.9	40.2 ± 13.4	36.7 ± 12.2	0.004[c]
Min-Max	18-70	18-70	18-62	
Social-demographic information				
Status in family				
Head of household	189 (39.8%)	92 (40.7%)	97 (39.0%)	0.816[b]
Wife	177 (37.3%)	86 (38.1%)	91 (36.5%)	
Child	91 (19.2%)	41 (18.1%)	50 (20.1%)	
Others	18 (3.8%)	7 (3.1%)	11 (4.4%)	
Schooling				
No schooling	13 (2.7%)	7 (3.1%)	6 (2.4%)	< .001[b]
Elementary	270 (56.8%)	152 (67.3%)	118 (47.4%)	
Junior secondary	112 (23.6%)	43 (19.0%)	69 (27.7%)	
Senior secondary	72 (15.2%)	23 (10.2%)	49 (19.7%)	
University	8 (1.7%)	1 (0.4%)	7 (2.8%)	
Employment				
Unemployed	82 (17.3%)	28 (12.4%)	54 (21.7%)	< .001[b]
Unskilled employee	282 (59.4%)	156 (69.0%)	126 (50.6%)	
Self-employed	76 (16.0%)	24 (10.6%)	52 (20.9%)	
Farmer	26 (5.5%)	14 (6.2%)	12 (4.8%)	
Students/home duties	6 (1.3%)	4 (1.8%)	2 (0.8%)	
Monthly income (Ruphia)				
No income	86 (18.1%)	30 (13.3%)	56 (22.5%)	< .001[b]
< 500K	68 (14.3%)	50 (22.1%)	18 (7.2%)	
< 1,000K	301 (63.4%)	138 (61.1%)	163 (65.5%)	
< 2,000K	19 (4.0%)	8 (3.5%)	11 (4.4%)	
2,000K or > 2,000K	1 (0.2%)	0	1 (0.4%)	
Housing conditions				
Dry floors (entrance, guestroom, bedroom, kitchen)				
No dry space	58 (12.1%)	27 (11.9%)	31 (12.4%)	< .001[b]
1 dry space	81 (17.1%)	46 (20.4%)	35 (14.1%)	
2 dry spaces	9 (1.9%)	6 (2.7%)	3 (1.2%)	
3 dry spaces	34 (7.2%)	28 (12.4%)	6 (2.4%)	
All spaces dry	293 (61.7%)	119 (52.7%)	174 (69.9%)	

a Tests of differences between those with and those without latrine.

b Fisher's exact test.

c Mann-Whitney U test.

Demographic and Behavioural Predictors Of Helminth Infection

Results of basic analyses of potential demographic and behavioural predictors of helminth infection are shown in Table 2. Having no worms in stool was associated with living in the village with BALatrines ($p < 0.001$). Younger people ($p < 0.001$) and women ($p = 0.016$) were less likely to have

worms in stool. Of the 8 hygiene-related behaviours, 2 were associated with not having worms in stool: not going into paddy fields or other fields ($p < 0.001$), and eating with a spoon or similar utensil, rather than eating with one's hands ($p = 0.001$). Regarding physical evidence of personal hygiene, not having worms in stool was associated with fingernails being clean ($p = 0.006$) and with hands being clean ($p < 0.001$).

Table 2. *Potential Demographic and Behavioural Predictors of STH Infection*

	Total (n = 475)	Worms in stool (n = 83)	No worms in stool (n = 392)	p[a, b, c]
Village of residence				
Village with BALatrines	52.4% (249/475)	26.5% (22/83)	57.9% (227/392)	< .001
95%CI[d]	47.9% to 56.9%	17.0% to 36.0%	53.0% to 62.8%	
Age in years				
Median (25%, 75%)	38.0 (27.0, 49.0)	50.0 (36.0, 59.0)	36.0 (26.0, 46.0)	< .001
Gender				
Prevalence	50.7% (241/475)	38.6% (32/83)	53.3% (209/392)	0.016
95%CI	40.2% to 55.2%	28.1% to 49.0%	48.4% to 58.2%	
Self-reported behaviours				
Do you always boil or buy your water for drinking? (Prevalence of "Yes")				
Prevalence	98.9% (470/475)	97.6% (81/83)	99.2% (389/392)	0.211
95%CI	98.0% to 99.9%	94.3% to 100.0%	98.4% to 100.0%	
Do you drink unboiled water from a well or pipe? (Prevalence of "No")				
Prevalence	87.6% (416/475)	86.7% (72/83)	87.8% (344/392)	0.855
95%CI	84.6% to 90.5%	79.4%to 94.0%	84.5% to 91.0%	
Do you wash or peel fruit before eating it? (Prevalence of "Always")				
Prevalence	88.8% (422/475)	83.1% (69/83)	90.1% (353/392)	0.083
95%CI	86.0% to 91.7%	75.1% to 91.2%	84.5% to 91.0%	
Do you wash hands before eating? (Prevalence of "Often")				
Prevalence	89.9% (427/475)	90.4% (75/83)	89.8% (352/392)	> .999
95%CI	87.2% to 92.6%	84.0% to 96.7%	86.8% to 92.8%	
Do you go out into the paddy fields or other fields? (Prevalence of "Never")				

Prevalence	68.6% (326/475)	41.0% (34/83)	74.5% (292/392)	< .001
95%CI	64.5% to 72.8%	30.4% to 51.5%	70.2% to 78.8%	
Do you eat with a spoon or similar utensil? (Prevalence of "Often")				
Prevalence	83.4% (396/475)	69.9% (58/83)	86.2% (338/392)	0.001
95%CI	80.0% to 86.7%	60.0% to 79.7%	82.8% to 89.6%	
Do you bite your fingers or nails? (Prevalence of "Never")				
Prevalence	96.4% (458/475)	97.6% (81/83)	96.2% (377/392)	0.749
95%CI	94.7% to 98.1%	94.3% to 100.0%	94.3% to 98.1%	
Do you routinely cut your nails? (Prevalence of "Once per week")				
Prevalence	58.5% (278/475)	60.2% (50/83)	58.2% (228/392)	0.806
95%CI	54.1% to 62.9%	49.7% to 70.8%	53.3% to 63.0%	
Physical evidence of personal hygiene				
Often see faeces around the house? (Prevalence of "No")				
Prevalence	87.8% (417/475)	87.5% (343/392)	89.2% (74/83)	0.854
95%CI	84.8% to 90.7%	84.2% to 90.8%	82.5% to 95.8%	
Nails (Prevalence of "All clean")				
Prevalence	85.1% (404/475)	74.7% (62/83)	87.2% (342/392)	0.006
95%CI	81.8% to 88.3%	65.3% to 84.0%	83.9% to 90.5%	
Hands (Prevalence of "All clean")				
Prevalence	85.5% (405/475)	72.3% (60/83)	88.3% (346/392)	< .001
95%CI	82.3% to 88.6%	62.7% to 81.9%	85.1% to 91.4%	

[a] Tests of differences between those with and those without worms in stool.
[b] Fisher's exact test.
[c] Mann-Whitney Test.
[d] Confidence interval of prevalence.

Multivariate Model of Helminthiasis

For the multivariate model (see Table 3), the variables regarding fingernail cleanliness and hand cleanliness were not used because of collinearity with other predictor variables. Therefore, the multivariate logistic-regression model had five independent variables: village of residence, gender, age, not going into paddy fields, and using a utensil when eating. As shown in Table 3, having no worms in stool, was statistically significantly associated with living in the

village with BALatrines, with being female, with younger age, and with not going out into paddy fields or other fields. In this model, the association with using a spoon or other utensil when eating (rather than using hands) was not statistically significant. For the going-into-paddy-fields variable the adjusted odds ratio was 2.30, that is, compared with the people who went out into paddy fields or other fields, those who did not were more than twice as likely to be worm-free.

Table 3. *Multivariate Logistic-regression model (dependent variable: absence of worm eggs from stool = 1)*

Independent variables	Coefficientβ (SE)	Wald χ^2	P value	Odds ratio
Intercept	2.10 (5.74)	-	-	-
Village of residence	0.71 (0.34)	4.50	0.034	2.04 (1.06-3.95)
Gender	0.66 (0.27)	5.91	0.015	1.93 (1.14-3.28)
Age	-0.05 (0.01)	21.49	< .001	0.95 (0.93-0.97)
Do you go out into the paddy fields or other fields?				
	0.83 (0.31)	7.45	0.006	2.30 (1.26-4.20)
Do you eat with a spoon or similar utensil?				
	0.53 (0.31)	2.89	0.089	1.70 (0.92-3.15)

Coding of the four dichotomous independent variables: village with latrine = 1; female = 1; never going out into paddy fields = 1; eating with utensils often = 1

Discussion

The main finding of this study was that the people living in the village with household latrines (the BALatrine) were twice as likely to be worm-free as the people living in the village without household latrines.

We also found a number of other variables were associated with the presence or absence of STH. However, reviewing the predictors in Table 3, we note that only 2 of them are amenable to modification by an intervention. Age and gender cannot be modified by an intervention. Also, going out into paddy fields cannot be considered to be easily modifiable, because it is so important to the villagers' livelihoods. In contrast, however, eating habits might be modifiable. Specifically, it might be possible to implement an intervention that would result in more people eating with utensils rather than with their hands. Such health education interventions to prevent helminthiasis should certainly be investigated, but in the present results the association of that specific behaviour (use of utensils when eating) with being worm-free was not statistically significant and the effect (adjusted odds ratio) for eating with a utensil was smaller than the effect of living in the village with BALatrines. In the present study we found among the variables with statistically significant adjusted odds ratios, only one can be modified by an intervention: the presence or absence of BALatrines. As previously noted, the BALatrine is relatively

inexpensive and is easy to construct in these villages. (Laksono, Gray, Clements, Sadler, Park, & Stewart, 2014)

One strength of this study is that the outcome variable was helminthiasis as determined by laboratory examination of stool samples. That laboratory-based outcome is consistent with self-reported outcomes. We previously found that people without access to BALatrines had more self-reported STH-related illnesses and symptoms, and had more self-reported absences from school or work attributed to bowel infection (Park, Laksono, Sadler, Clement, & Stewart, 2014).

The interpretation of these results is limited by the fact that there were only 2 villages in the study and that there were some differences between those 2 villages with regard to housing conditions, etc. Also, this was a cross-sectional study so we cannot be sure how the prevalence of helminthiasis may have changed over time as the BALatrines were introduced.

Nonetheless, the implications for future work are clear. These results give further indication of the need for a randomized, controlled trial of the BALatrine. Such a trial is envisioned to require many more villages and to have an educational component as part of the intervention. It will also include outcomes ranging from the bio-medical (laboratory results) to the individual (knowledge and behaviours) to the social (absence from school and work) (Australian New Zealand Clinical Trials Registry number, ACTRN12613000523707).

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