

An Integrated Hygiene Model for Reducing Intestinal Parasitic Infections Among Schoolchildren in Meru County Kenya

Judith Naita Ngechu^{1*}, Rosebella Onyango² and Charles Wafula³

^{1 2 3} Great Lakes University of Kisumu, Kenya | * Corresponding author: naitanyce@yahoo.com

Thematic Area: Community Health and Infectious Disease Prevention | Manuscript Type: Original Research

ABSTRACT

Background: Intestinal parasitic infections remain a concern where sanitation and access to safe water are limited. **Objective:** To describe changes in hygiene and food safety practices following a community health intervention in Meru County, Kenya, and assess the evidence available for a prevention model. **Methods:** The source study used a mixed methods, before and after intervention design across 11 sub-counties from December 2022 to May 2023. Six sub-counties received the intervention and five served as controls. Questionnaires, observations, stool examinations and key informant interviews were used. The submitted tables report 211 observations per group at each assessment for the behavioural indicators. **Results:** In the intervention group, the percentage reporting that they always washed hands after toilet use rose from 41.7% to 50.2%, before eating from 32.7% to 48.3%, and after playing from 33.6% to 44.5%. Corresponding control changes were 34.1% to 33.2%, 39.3% to 35.1%, and 28.4% to 35.5%. Boiling drinking water in the intervention group increased from 36.5% to 51.7%. **Conclusion:** The reported behaviours improved in several intervention domains, with mixed control trends. The discussion reports baseline protozoan prevalence of 51.2% and 55.1%, and helminth prevalence of 12.0% and 16.5%, in intervention and control groups respectively. Exact infection counts and follow-up prevalence are absent. The magnitude of an intervention effect cannot be calculated, and inconsistent regression tables require verification.

Keywords: handwashing; school health; intestinal parasitic infections; water, sanitation and hygiene; Meru County

1. INTRODUCTION

Soil-transmitted helminths are linked to sanitation and environmental exposure. The World Health Organization (WHO, 2023) places hygiene education and improved sanitation alongside deworming in its control strategy. Kenyan trials have assessed school water, sanitation and hygiene (WASH) programmes, showing that the effect on infection can depend on context and the intervention delivered (Freeman et al., 2013; Pickering et al., 2019). A local programme therefore needs both reliable behavioural measures and direct measures of infection.

The submitted Meru study combines hygiene training, handwashing facilities, environmental action and treatment for infected children. This paper focuses on what its reported before and after data establish, and sets out a practical model for continued implementation and evaluation. The model is an interpretation of the programme components; it is not a separately validated prediction tool.

2. METHODS

The study used a mixed methods intervention design with measurements before and after programme activities between December 2022 and May 2023. The intervention sites were Igembe North, Buuri East, Imenti North, Imenti Central, Tigania East and Tigania West. Buuri West, Igembe Central, Igembe South, Imenti South and Tigania Central were controls. The manuscript describes systematic sampling, interviewer-administered questionnaires, observation, stool examination and interviews with public health personnel and community health volunteers. It does not clearly document the allocation process, matching of individual children across rounds or site-level clustering in the analysis.

The intervention included handwashing stations, practical hygiene education, cleaning supplies, household instruction and environmental activities; children with detected infections received treatment. The tables consistently imply 211 observations per group per time point for the behaviours reproduced below. Percentages and percentage-point (pp) differences were transcribed or calculated from those tables. No significance tests of the pre/post group differences are presented here. The original regression tables show disagreements among coefficients, test statistics, p-values and odds ratios. The audit below retains reported values only to document those discrepancies; no inferential estimate is treated as valid.

3. RESULTS

Table 1 shows the share of respondents selecting “always” for each handwashing practice. The intervention group improved across all three indicators. In controls, handwashing after playing also improved, while the other two measures declined slightly. These are self-reported behaviours and do not by themselves establish reduced parasitic infection.

Table 1. Consistent handwashing before and after the intervention

Behaviour	Intervention pre	Intervention post	Change (pp)	Control pre	Control post
After toilet use	41.7%	50.2%	+8.5	34.1%	33.2%
Before eating	32.7%	48.3%	+15.6	39.3%	35.1%
After playing	33.6%	44.5%	+10.9	28.4%	35.5%

Note. n = 211 per group and assessment in the source frequency tables. Percentage-point changes use reported percentages; the table does not imply a paired sample.

Food and water practices also shifted. Table 2 reports the intervention percentages; the controls changed little on the same measures. The broad “healthy eating” and “required nutrition” items are not direct parasite-exposure measures, so they should be interpreted separately from cooking and drinking-water practices.

Table 2. Selected food and water practices in the intervention group

Reported practice	Pre	Post	Change (pp)
Healthy eating habits	50.2%	60.2%	+10.0
Required nutrition all the time	20.9%	28.0%	+7.1
Eating properly cooked food	52.1%	58.3%	+6.2
Boiling drinking water	36.5%	51.7%	+15.2

The source also describes key informants observing improved uptake of handwashing. Its discussion gives baseline prevalence percentages but no exact positive counts, stool denominators, assessment dates or follow-up prevalence. Table 3 records what is and is not available; the behavioural sample size must not be assumed to be the laboratory denominator.

Table 3. Infection outcomes reported by group and assessment

Infection and group	Baseline positive / tested	Baseline prevalence	Follow-up positive / tested	Follow-up prevalence
Protozoa, intervention	Not reported	51.2%	Not reported	Not reported
Protozoa, control	Not reported	55.1%	Not reported	Not reported
Helminths, intervention	Not reported	12.0%	Not reported	Not reported
Helminths, control	Not reported	16.5%	Not reported	Not reported

Note. The source describes fieldwork from December 2022 to May 2023 but does not state the date of either stool assessment. Percentages appear in its discussion; they are not a complete outcome dataset. Rounded percentages cannot establish exact case counts without the relevant laboratory denominators.

4. REGRESSION OUTPUT AUDIT

The supplied hand-hygiene table labels its estimates as unstandardized coefficients. In every row, the quotient B/SE differs from its reported t statistic. Table 4 transcribes those values and calculates the quotient. The reported p-values must not be treated as verified inferential evidence.

Table 4. Hand-hygiene regression as reported and arithmetic audit

Predictor	B	SE	Reported t	Reported p	B/SE
Intercept	1.914	0.206	1.885	<0.001	9.29
Age of child	0.745	0.201	1.655	0.017	3.71
After toilet	0.626	0.168	1.382	0.015	3.73
Before eating	0.749	0.192	2.725	0.009	3.90
After playing	−0.119	0.108	−0.739	0.043	−1.10

A second source table identifies a binary infection outcome, but none of its reported odds ratios is consistent with exp(B). Table 5 shows the transcription alongside the arithmetic checks. The original report does not specify outcome coding or whether repeated measurements and site clustering were handled. These figures cannot be repaired by choosing one conflicting column.

Table 5. Binary-outcome regression as reported and arithmetic audit

Predictor	B	SE	Reported OR	Reported p	exp(B)
Age	1.54	0.45	0.58	0.227	4.66
Gender	−1.95	0.91	7.02	0.033	0.14
Healthy eating	2.29	1.88	4.01	0.022	9.87
Required nutrition	3.39	1.17	2.71	0.004	29.67
Cooked food	7.28	2.34	5.06	0.002	≈1,450
Boiled water	2.12	1.27	2.89	0.028	8.33

Notes to Tables 4 and 5. Source values are reproduced solely for verification. B/SE and exp(B) are arithmetic checks, not re-estimated results. The source equations also differ from their accompanying coefficient tables. A defensible model requires the deidentified record-level dataset, laboratory outcome coding, exact assessment dates, specification of covariates, method for clustering and repeated observations, missingness, and the complete software output.

5. DISCUSSION

The largest reported behavioural gains were for washing hands before eating and boiling drinking water. The simultaneous control-group improvement in handwashing after playing illustrates why before and after improvement alone is not an estimate of programme impact. Group comparability, seasonal influences, treatment, measurement conditions and school or sub-county clustering could alter an observed difference. Self-report may also overstate consistent practice; direct observations and functioning water and soap supplies would strengthen evaluation.

An integrated implementation model is appropriate for this setting: maintain reliable handwashing and safe-water infrastructure; teach and reinforce practical hygiene at school and home; coordinate sanitation and clinically indicated parasite control through health services; and monitor behaviour together with laboratory-confirmed infection. WHO (2023) similarly treats hygiene, sanitation and preventive treatment as complementary components. This framework should be tested against prespecified outcomes rather than described as a statistically validated model.

6. CONCLUSION AND RECOMMENDATIONS

The submitted Meru data document improvements in several reported hygiene and food safety practices within intervention sites. Baseline prevalence percentages are reported, but no follow-up stool outcomes or exact case counts substantiate a numerical reduction in intestinal parasitic infections. Schools and county health teams can maintain water and soap, provide repeated practical instruction, monitor facility use and coordinate treatment with authorized health services. A subsequent analysis should report infection counts and species by group and time point, programme exposure, group allocation, attrition, clustering and an adjusted intervention-by-time estimate with confidence intervals.

LIMITATIONS AND DECLARATIONS

The report does not establish whether the same children were assessed twice; it lacks exact laboratory counts and follow-up infection outcomes, and contains internally inconsistent regression output. These limitations preclude a causal estimate here. The submitted manuscript states approval by the Great Lakes University of Kisumu ethics committee, permission from NACOSTI and written consent; approval identifiers and child assent/guardian consent procedures should be confirmed from original records. It reports no funding or conflicts of interest.

REFERENCES

- Freeman, M. C., Clasen, T., Brooker, S. J., Akoko, D. O., & Rheingans, R. (2013). The impact of a school-based hygiene, water quality and sanitation intervention on soil-transmitted helminth reinfection: A cluster-randomized trial. *The American Journal of Tropical Medicine and Hygiene*, 89(5), 875–883. <https://doi.org/10.4269/ajtmh.13-0237>
- Pickering, A. J., Njenga, S. M., Steinbaum, L., et al. (2019). Effects of single and integrated water, sanitation, handwashing, and nutrition interventions on child soil-transmitted helminth and *Giardia* infections: A cluster-randomized controlled trial in rural Kenya. *PLOS Medicine*, 16(6), e1002841. <https://doi.org/10.1371/journal.pmed.1002841>
- World Health Organization. (2023). Soil-transmitted helminth infections. <https://www.who.int/news-room/fact-sheets/detail/soil-transmitted-helminth-infections>