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ENHANCING A SAFE WATER INTERVENTION WITH STUDENT-CREATED VISUAL AIDS TO PROMOTE HANDWASHING BEHAVIOR IN KENYAN PRIMARY SCHOOLS*

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ABSTRACT

The Nyando Integrated Child Health Education (NICHE) project was a collaborative effort by the U.S. Centers for Disease Control and local partners to assess the effectiveness of multiple interventions for improving child survival in western Kenya. To increase handwashing in schools, NICHE trained teachers and installed handwashing stations with treated water and soap in 51 primary schools. This cluster-randomized trial evaluated an additional educational strategy (a poster contest themed, "Handwashing with Soap") to improve handwashing behavior in 23 NICHE primary schools. Pupils were engaged in the poster development. Pupil handwashing behavior was observed unobtrusively at baseline and after four months. Intervention schools displayed a significant increase in the number of handwashing stations and proportion of teacher-supervised stations over the study period. No significant between-group differences of intervention in handwashing frequency, soap availability, or visibility of handwashing stations was observed. Despite finding a limited effect beyond the NICHE intervention, the trial appeared to promote sustainability across some measures.

INTRODUCTION

Diarrheal diseases cause 1.3 million deaths globally among children under five each year [1]. Together, low-income African and Southeast Asian countries contribute 78% of the global child mortality due to diarrheal disease [2]. Despite efforts to reduce the prevalence of diarrheal disease, it remains one of the top five causes of childhood morbidity and mortality in rural western Kenya [3, 4]. It is estimated that one of every 182 children is hospitalized for diarrhea each year in Kenya (annual incidence 550 per 100,000 children under 5) [5]. In 2010, the country's Ministry of Public Health and Sanitation instituted policies and guidelines that outline plans to reduce child mortality and morbidity caused by diarrheal disease [6].

In the past, interventions to reduce the burden of diarrheal disease have varied considerably, from sanitation and improved water supplies to behavior change efforts, which include point-of-use household water disinfection, safe water storage, and handwashing [7]. Handwashing with soap is a low-cost intervention shown to reduce the risk of diarrheal disease by up to 47% [8] and reduce school absenteeism by 35% [9].

Interventions to promote effective handwashing behavior in Kenya have been implemented previously [10-14]. The U.S. Centers for Disease Control and Prevention (CDC) has been involved in developing and implementing a water quality intervention called the Safe Water System (SWS) in western Kenya for a number of years [12, 15-18]. This three-pronged intervention employs simple, inexpensive technologies for point-of-use treatment and safe water storage, and promotes behavior change through social marketing, community mobilization,

motivational interviewing, communication, and education [17]. Studies from Kenya have shown reductions in diarrheal rates and absenteeism, improvement in parental awareness (e.g., acknowledgment of changing handwashing practices), and observed handwashing behavior, and increases in reported handwashing at appropriate times (i.e., before eating, after defecating, before preparing food) after implementation of SWS in households and schools [9, 19, 20]. SWS and other infrastructure-oriented interventions address physical constraints to adopting handwashing behavior. Knowledge transfer can be approached through either traditional didactic approaches that employ rote learning and lectures or explicitly participatory approaches that emphasize engaging in behaviors and shared learning [21]. In Kenya, studies suggest that action-oriented, participatory health and hygiene education interventions, such as those that engage pupils in developing ideas about behavior changes and actions to carry them out, may be equally or more effective than didactic, conventional education [10, 11, 13]. Active teaching and learning approaches may encourage pupils' full participation and ownership of the behavior change, resulting in increased knowledge and more sustained or effective adoption of behaviors [10, 11].

Interventions that involve posters as a health promotion tool have been shown to successfully promote adoption of beneficial health behaviors (e.g., stair climbing) [22, 23], injury prevention [24], and disease awareness [25]. However, to our knowledge, no study has evaluated individual engagement in the development of health promotion posters and their subsequent impacts to improve handwashing behavior, specifically among primary school-aged children or in Kenya. We sought to combine the development and installation of posters in classrooms as educational and motivational tools for handwashing, applying the Health Belief Model (HBM) as a conceptual structure [26]. The model suggests that handwashing behavior would be influenced by changes in knowledge, perceptions of risks and benefits, and cues action, after perceived barriers to handwashing are addressed. We hypothesized that the development of posters to promote handwashing would encourage pupils to reflect on and creatively convey messages about handwashing, in turn improving pupils' knowledge and perception of health risks and handwashing benefits. There is evidence that individual-level engagement of students through the poster development process may provide important cues to action that can motivate and improve handwashing behavior [27]; here, both installation of pupil-developed posters in classrooms and staff supervision of handwashing behavior would serve as cues to action. Barriers to action would be addressed by SWS infrastructure provided by NICHE.

The objective of this cluster-randomized controlled trial was to evaluate handwashing behavior in schools after engaging pupils in an activity in which they were asked to create posters promoting handwashing behavior and posters were installed in classrooms. It was hypothesized that the intervention would contribute to improvements in handwashing knowledge and health perceptions among pupils and trigger handwashing after latrine use, which would in turn result in

improvement or retention in handwashing behavior in intervention schools. This research took place in Kenyan primary schools already engaged in the NICHE program providing infrastructure for handwashing such as soap and water containers; we evaluated the additional effect of the poster intervention beyond the effects of other NICHE interventions.

METHODS

The NICHE Project, 2007-2009

The Nyando Integrated Child Health and Education Project (NICHE), carried out by the CDC and the Kenyan Medical Research Institute (KEMRI) in rural western Kenya from March 2007 to March 2009, focused on integrated approaches to simultaneously promote multiple community health interventions. The project rationale and protocol are described elsewhere [28]. One component of NICHE involved community-based promotion of the SWS and handwashing with soap. As part of NICHE, 51 primary schools were provided SWS and teacher training in handwashing and hygiene. Twenty-six schools received the NICHE intervention during the first school year (2007-2008) and 25 received the intervention during the second year (2008-2009). It was hypothesized that teachers would spread handwashing knowledge among both themselves and their pupils, and that pupils would transfer SWS knowledge to their households to motivate family members to adopt household-based SWS [19]. Two teachers from each school were trained in a handwashing program that included the use of SWS at schools; these teachers were encouraged to establish SWS and pupil-focused Safe Water Clubs. NICHE provided containers for safe water storage, soap for handwashing, water treatment supplies, and low-cost, locally available materials to set up handwashing water stations. Each school received educational manuals on handwashing and hygiene at the beginning of the NICHE intervention. Beginning one year after the implementation of SWS by NICHE at the schools, the schools were expected to continue the intervention independently of NICHE support, including self-financing of the program. Schools were monitored throughout the year for use of the SWS by pupils and teachers.

Visual Aid (Poster) Intervention, 2008-2009

For this study, of the 25 schools that received the NICHE intervention in the second cohort (2008-2009), 23 were randomized for receipt of the visual aid (poster) intervention (July 2008). Eleven schools received the poster intervention and 12 served as comparison schools where no poster intervention activities took place. Two schools were not included in the study due to transportation and logistical challenges. All schools had received the SWS products from NICHE one to three months before the intervention.

Preliminary guidance from teachers from the first cohort of NICHE schools (2007-2008) suggested that a competition among pupils might improve pupil handwashing rates. We therefore integrated this aspect into the poster intervention. Pupils from intervention schools were invited to create posters themed "Handwashing with Soap, at School and at Home." Each school received poster paper and crayons, along with information about the poster contest. Every child was invited to submit a poster and collaboration was encouraged. Pupils who preferred not to draw were encouraged to submit slogans for selection. After two weeks, during which the students were asked to complete the posters, teachers at each school chose up to three posters and two slogans per school. These winning items were collected from each school and judged by NICHE staff. One poster from each school was selected. Selection criteria included relevance to the theme, accuracy of the hygiene promotion message, artistic merit, and overall clarity. If slogans were submitted, they were evaluated along with the posters based on the same criteria.

The winning posters were scanned and imported into Adobe In-Design CS3 version 5.0.4. (Adobe Systems Incorporated, San Jose, CA). Text and color were manually modified for clarity and resolution in reproduction; slogans were incorporated into the winning posters (Figure 1). Posters were printed in color on large (17 × 22 inches) water- and tear-resistant paper. Posters were distributed in all classrooms of the intervention schools, where NICHE staff installed them to the classroom walls. Every intervention school received one copy of each winning poster, such that a poster was displayed in every classroom and the teachers' lounge.

Evaluation

A pre-test/post-test control group design was employed [29, 30]. Four trained NICHE staff members conducted observations in intervention and comparison schools at two times: baseline (October 2008) and four months after implementation of the intervention (late February and March 2009). During each observation period, one NICHE staff member monitored handwashing stations outside the latrines in each school for two hours in the morning (approximately 9-11 a.m.). Observers recorded numbers of pupils entering the latrines and/or urinating or defecating outside the latrine, and whether the pupil washed hands after exiting the latrine or urinating/defecating outside. Observers also recorded the estimated distance of the handwashing station from the latrine, visibility of stations from the classroom or latrine, and whether the handwashing stations were actively supervised. For each of these measures, observers provided one composite estimate per school, intended to represent the average for all handwashing stations in each school. The presence or absence of water, chlorine, and soap at each handwashing station was also noted.

Figure 1. Examples of handwashing promotion posters created by primary school pupils. Posters on the left are original versions; those on the right illustrate final versions after manual computer modification for text and color clarity.

The proportion of pupils engaging in handwashing behavior after latrine use was calculated for each school by dividing the number of pupils who washed hands by the number entering the latrine or urinating/defecating outside the latrine during the observation period. Pupils were counted as washing hands whether or not they used soap. Baseline and follow-up proportions were calculated for intervention and comparison schools. Handwashing data were only collected at sites when water was present.

Data Analysis

The primary outcome of interest was the mean difference in the proportion of students washing hands after latrine use between baseline and follow-up for intervention schools, compared with the mean difference for comparison schools. Other analyses included changes from baseline to follow-up between intervention and comparison schools in measures of handwashing infrastructure (number of handwashing stations, presence of water or soap at the handwashing station, supervision, and visibility from the latrine or classroom). Bivariate analyses were used to compare baseline differences between intervention and comparison schools. To assess the impact of differences in number of pupils and number of observations at each school, a statistical weighting strategy was employed. School-specific weights were created by dividing the total number of pupils washing in each school by the sum of the total number of pupils washing in all of the schools.

Two sample paired *t*-tests were performed to assess the significance of the change in baseline and follow-up proportions between intervention and comparison schools. The distribution of the data was examined for evidence of non-normality; if skewness or bimodality was observed, the Wilcoxon rank-sum non-parametric test was conducted in addition to *t*-tests. Significance levels were considered at $p < 0.05$. All analyses were conducted in STATA/IC 10.1 for Macintosh (Stata Corp., College Station, Texas).

Ethical Considerations

Human Subjects approval for this study was obtained from institutional review boards at the CDC, the University of Washington, and the Kenya Medical Research Institute. Data were collected anonymously: pupil names were neither known nor recorded by the NICHE staff.

RESULTS

Each classroom had approximately 40-50 pupils. NICHE staff received 26 posters and 7 slogans from 9 intervention schools (two schools did not contribute). Of these items, one was chosen as winner by teachers at each school. In many cases, one pupil produced the posters and slogans, though several were the result

of a collaboration of pairs or small groups of pupils. Two poster examples, in their original formats and digitally refined for reproduction, are shown in Figure 1. All pupils' names and schools were included on their posters.

Baseline handwashing behavior was observed in 10 intervention and 11 comparison schools (one intervention school lacked water at baseline). Follow-up observations were not conducted at three intervention and three comparison schools, due to lack of water or transportation challenges for observers. Analyses did not include the one school without baseline and six schools without follow-up observations. There were no significant differences between comparison and intervention schools with respect to the duration of observation at baseline or follow-up. Weighted analyses did not produce meaningful differences in the magnitude of outcome measures or statistical significance compared to unweighted analyses, so only unweighted analyses are reported here. Approximately equal numbers of male and female pupils were observed at each time point, across all schools. The average number of pupils observed at baseline was approximately 100 at both intervention and comparison schools (Table 1). Fewer pupils were observed at follow-up, but this difference was not significant. On average, the length of the periods during which pupils were observed was 103 to 135 minutes (Table 1).

Handwashing

At baseline, there was almost no difference between intervention and comparison schools in the mean proportion of pupils washing hands (mean difference = 0.02; Table 2). At follow-up, the mean proportion of pupils washing hands differed by 0.07 between intervention and comparison schools ($p = 0.45$). Comparing baseline to follow-up, the proportion of pupils washing hands increased by 2.7% in comparison schools and decreased by 2.8% in intervention schools. This difference represents a non-significant intervention effect over the period of the intervention (0.06, 95% CI: –0.27, 0.38). Handwashing behavior was not significantly associated with distance of the handwashing station from the latrine, visibility from the classroom, or visibility from the latrine.

Stations

The mean number of handwashing stations was 2.1 for intervention and 2.3 comparison schools at baseline (Table 1). Between baseline and follow-up, the average number of handwashing stations observed increased significantly in intervention schools (2.1 vs. 3.4, $p = 0.01$) but not in comparison schools (2.3 vs. 3.4, $p = 0.06$). Three intervention and four comparison schools reported distance of stations from latrines at baseline; all schools reported distances at follow-up. At baseline, most (50%) of intervention schools that provided data reported that their handwashing stations were < 10 meters from the latrine,

Table 1. Mean Number of Pupils and Handwashing Stations Observed, Mean Duration of Observation Period, and Distance of Stations from Latrines at Intervention and Comparison Schools at Baseline and Four-Month Follow-Up

	Intervention (n = 7) Mean (*SD*)	Comparison (n = 7) Mean (*SD*)	*p*-Value
Baseline			
Mean number of pupils observed per school	123 (45)	121 (30)	0.91
Mean duration of observation (minutes) per school	125 (25)	150 (64)	0.35
Mean number of handwashing stations observed in each school	2.1 (0.4)	2.3 (0.5)	0.55
	N (%)	N (%)	
Distance of stations from latrine[a]			0.33
< 10 meters	2 (50.0)	0	
10-30 meters	1 (25.0)	2 (66.7)	
> 30 meters	1 (25.0)	1 (33.3)	
	Mean (*SD*)	Mean (*SD*)	
Four months			
Mean number of pupils observed per school	70 (26)	92 (49)	0.31
Mean duration of observation (minutes) per school	111 (48)	111 (49)	0.98
Mean number of handwashing stations observed in each school	3.4 (1.1)	3.4 (1.4)	1.00
	N (%)	*N* (%)	
Distance of stations from latrine[a]			0.30
< 10 meters	1 (14.3)	1 (14.3)	
10-30 meters	4 (57.1)	6 (85.7)	
> 30 meters	2 (28.6)	0	

Values in this table reflect observations in schools with water present at the time of observation and observation at both baseline and follow-up. Values represent mean, (standard deviation), or *N* (%) when indicated, and *p*-values represent results from student's *t*-test or χ^2 tests and compare intervention and comparison schools.

[a]Distance information was not ascertained from three intervention and four comparison schools at baseline.

Table 2. Changes in the Mean Proportion of Pupils Washing Hands, and Changes in Attributes of Handwashing Stations, in Intervention and Comparison Schools, at Baseline and Four-Month Follow-Up

	Intervention (n = 7) Mean (*SD*)	Comparison (n = 7) Mean (*SD*)	Mean difference[a] (95% CI)
Baseline			
Pupils washing hands	0.74 (0.27)	0.72 (0.19)	0.02 (–0.25, 0.29)
Stations with soap available	1.00	0.67 (0.37)	0.33 (0.03, 0.64)[c]
Stations supervised by faculty[b]	0.50 (0.55)	1.00	–0.50 (–0.99, 0.00)
Stations visible from latrine	1.00	0.94 (0.14)	0.06 (–0.07, 0.18)
Stations visible from classroom	0.75 (0.42)	1.00	–0.25 (–0.63, 0.13)
Four months			
Pupils washing hands	0.77 (0.17)	0.69 (0.18)	0.07 (–0.13, 0.27)
Stations with soap available	0.49 (0.38)	0.45 (0.37)	0.03 (–0.41, 0.47)
Stations supervised by faculty[b]	0.71 (0.36)	0.56 (0.42)	0.16 (–0.34, 0.66)
Stations visible from latrine	0.65 (0.39)	0.53 (0.45)	0.12 (–0.42, 0.66)
Stations visible from classroom	0.77 (0.41)	0.63 (0.45)	0.14 (–0.36, 0.64)
Change over four months			
Pupils washing hands	0.03 (0.33)	–0.03 (0.20)	0.06 (–0.27, 0.38)
Stations with soap available	–0.51 (0.38)	–0.21 (0.45)	–0.30 (–0.79, 0.19)
Stations supervised by faculty[b]	0.21 (0.43)	–0.44 (0.42)	0.66 (0.11, 1.21)[c]
Stations visible from latrine	–0.42 (0.38)	–0.40 (0.60)	–0.02 (–0.75, 0.71)
Stations visible from classroom	0.02 (0.35)	–0.43 (0.46)	0.41 (–0.11, 0.94)

Note: Data reported in this table are based on schools with data at baseline and four months. Values are mean proportions (*SD*) unless otherwise indicated.

[a]Mean difference is the difference in changes from baseline to follow-up, comparing intervention, and comparison schools.

[b]Supervision data not available for one school at baseline (n = 6).

[c]$p \leq 0.05$; p-value refers comparing intervention and comparison schools.

compared to 0% of comparison schools (Table 1). At follow-up, most intervention and comparison schools reported that handwashing stations were located 10-30 meters from the latrines.

Soap Availability

Soap availability was measured as the mean proportion of handwashing stations with soap for each school (Table 2). At baseline, soap was available at all handwashing stations at intervention schools and at 67% of handwashing stations at comparison schools (Table 2), a significant difference ($p = 0.04$). By follow-up, four months later, soap was available in only 49% and 45% of the handwashing stations at intervention and comparison schools, respectively. The change in proportions between baseline and follow-up was not statistically significant comparing intervention and comparison schools ($p = 0.20$).

Supervision and Visibility of Handwashing Stations

At baseline, NICHE staff observed a teacher actively supervising handwashing stations at half of intervention schools and all comparison schools. At follow-up, the mean proportion of supervised handwashing stations increased at the intervention schools (71%), but decreased at comparison schools (56%; Table 2). The change over time was significantly different, comparing intervention and comparison schools ($p = 0.02$). Nearly all handwashing stations were visible from the latrine in intervention and comparison schools at baseline; however, the mean proportion of stations at follow-up declined to nearly half for all schools (Table 2). For comparison schools, handwashing stations were more often reported as visible from the classroom at baseline, compared to follow-up. Intervention schools showed an increase in the proportion of handwashing stations visible from the classroom between baseline and follow-up. Feedback from teachers indicated that stations were moved away from the latrines and classrooms and closer to the school offices in order to deter pupils from "playing with them."

DISCUSSION

We sought to evaluate handwashing behavior among pupils in rural Kenyan primary schools following a health promotion intervention that included a poster design competition and installation in classrooms. This intervention was placed within an existing program that provided handwashing infrastructure, such as handwashing stations and soap. The primary outcome of interest was effect of the intervention on the mean proportion of pupils washing hands after visiting the latrine. It was hypothesized that intervention schools would experience retention or improvement in handwashing behavior over four months, compared to the comparison schools. At baseline, most students in intervention and comparison schools washed hands after using the latrine (72-74%) and the rates were not

significantly different at follow-up (69-77%). This indicates that all schools retained a relatively high rate of handwashing over time, yet no intervention effect was observed. A possible explanation for this observation is the presence of multiple handwashing promotion campaigns. Discussions with teachers in some NICHE schools revealed that other organizations were also engaging pupils in programming to improving handwashing behavior. Other measures evaluated in this study included availability of soap, supervision of handwashing stations, and visibility of handwashing stations from the latrine or classroom. All schools exhibited a decrease in the proportion of stations with soap available, suggesting resource limitations after the baseline observation. Intervention schools also showed a decrease in the proportion of stations visible from the latrine, but an increase in the proportion of stations visible from the classroom and supervised by faculty. Comparison schools exhibited a decreased performance in these measures. While handwashing behavior did not improve in intervention schools, it may be possible that the intervention improved faculty supervision behavior.

The poster intervention was embedded within the NICHE program, and it is not possible to assess the impact of the intervention independent of the physical and educational resources provided by NICHE. Results from this study should be interpreted with this in mind. The NICHE infrastructure itself allowed the schools to overcome substantial environmental and financial barriers (availability of water, soap, buckets, etc.). NICHE did provide educational manuals to promote handwashing; however, it is not known whether teachers or students used these materials in the development of the posters. Supplementing the NICHE intervention with the poster contest intervention was expected to improve handwashing behavior among pupils for whom handwashing facilities were readily available. We did not observe this effect; however, this may be due to the substantially high rates of handwashing already achieved by NICHE, which also included handwashing promotion in pupils' homes. At baseline for this study, which occurred well after the implementation of NICHE, both intervention and comparison schools showed handwashing behavior in most pupils after using the latrine. It is possible that the poster program may not have had sufficient impact to improve handwashing substantially beyond such high baseline levels. Also, insufficient intensity in execution of the program or buy-in from the teachers, suggested by the failure of three intervention schools to participate in the poster competition, might have weakened development of the critical mass of participation necessary to observe the full effect of the intervention.

Although an association between media exposure (through visual aids such as posters or other advertisements) and the formation of handwashing behaviors suggest that health promotion campaigns may show promise, the effects are limited [13]. Pupil engagement in poster development may serve as an educational exercise and posters in classrooms can promote handwashing behavior among pupils [27]. This followed the theory of the HBM, which is an applicable model for hand hygiene interventions [27]. Results from this study show

that the intervention did not improve handwashing behavior, though significant improvements in faculty supervision of handwashing stations were observed. Faculty behavior may have been influenced by intervention activities through improvements in knowledge, understanding, and cues to action within the HBM paradigm.

Our study objectively evaluated health behaviors through unobtrusive observation, which contributed to the study's strength. Comparable studies that have evaluated poster interventions often utilize patient reports and rarely have the opportunity to observe actual behavior [24, 25, 31]. Additionally, most poster evaluation study designs tend to evaluate the poster content, without investigating the effect of the poster on associated outcomes [32]. Candidly observing individuals' choices reduces bias and allows for the authors to clearly assess behaviors and the intervention effect [33] and is more reliable than self-reporting questionnaires, interviews, or focus groups, which may be subject to response bias [34]. Unobtrusively observing the behavior is an efficient and practical evaluation model for handwashing interventions in Kenya and other locations where pupils must wash their hands at public handwashing stations where they can be directly observed. Reducing the "observer effect" by using familiar data collectors (e.g., NICHE staff members) further strengthened this study.

An additional strength of this study was its cluster-randomized controlled design, which ensured that results accounted for the intervention that occurred at the school level. Other school intervention studies often fail to recognize the clustered nature of their study design and analyze results with greater assumption of subject independence than may truly be warranted. Poster study designs, while easy to implement in settings like schools or clinics, are difficult to generalize beyond specific settings.

The CDC is not the only organization in developing countries that focuses on handwashing and hygiene in schools. As mentioned above, teachers who informed the development of the poster intervention reported that NICHE was not the only group that had come to their school in the last year to talk to them about water and handwashing. The results of this evaluation therefore inform not only future CDC and NICHE projects, but also other handwashing and sanitation outreach projects in Africa and elsewhere.

This study had several limitations. The poster intervention took place in one division in the Nyanza Province and was therefore not representative of Nyanza Province or Kenya. Many elements of the NICHE project were inextricably linked to the poster intervention, making it difficult to distinguish the specific poster effect from the NICHE effect (e.g., handwashing stations). Recent research cites challenges in sustaining improved handwashing behavior over time [35]. While it may be possible to improve knowledge about handwashing, presence of resources for handwashing (soap and clean water) is critical for success. This study was embedded within the NICHE program in order to partially address

these concerns. Unfortunately, soap availability was limited through the course of the study for many schools, which limited our ability to assess the change in handwashing with soap. This study sought, however, to improve the behavior of using handwashing stations to wash after using the latrine, not soap use specifically. Washing with water alone is effective in removing contaminants from hands, although less so than washing with soap [36]. Other studies in low income settings have implemented handwashing promotion interventions with water alone [37, 38]. In the future, detailed observations could identify soap use among pupils for each handwashing episode in order to better ascertain soap use while handwashing. It was not possible to gather data on changes in pupil knowledge, attitudes, and beliefs in study schools, which would have provided insight into the impact of the poster development process as a means to improve perceived risk and benefits of handwashing. An additional limitation was our inability to adjust for multiple variables that may have contributed to handwashing behavior in schools (i.e., school size, other handwashing activities that may be occurring at a school). Weighted analyses that functioned as a proxy for school size did not produce materially different results from unweighted analyses, which suggests that school size did not significantly influence handwashing behavior. Other limitations are related to the study setting, including logistical and environmental challenges, which led to lack of follow-up observations in some schools. Water was not available at several sites at the time of observation (six sites at follow-up), hindering data collection at those visits. Finally, a high level of handwashing behavior was exhibited at baseline, which might have limited our ability to measure changes in behavior that may be more nuanced.

While substantial changes in handwashing behavior were not associated with the poster intervention, this evaluation was nonetheless valuable in demonstrating feasibility of a sustainable intervention with engaging educational methods, such as poster development and competition, in primary schools to improve handwashing behavior. Pupil engagement to develop educational posters and the permanent installation of posters in classrooms are creative elements that can be used in future interventions. While generalization of this study's results to non-NICHE areas may not be possible, this study lays the groundwork for further research in this direction. It is possible that success of similar interventions in the future that rely on education and motivation from visual aids might be contingent on a minimal set of circumstances or resources, such as soap and water which were provided by NICHE. Alternately, a follow-up study could use different outcome measures (e.g., self-reported 24-hour handwashing behavior) that are not contingent upon the presence of water.

Further research is warranted to determine the importance of a child-centered approach, which promotes and encourages cooperation and input from pupils to design and implement hand hygiene behavior change programs.

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REFERENCES

1. R. E. Black et al., Global, Regional, and National Causes of Child Mortality in 2008: A Systematic Analysis, *Lancet, 375*:9730, pp. 1969-1987, 2010. doi: 10.1016/s0140-6736(10)60549-1
2. C. Boschi-Pinto, L. Velebit, and K. Shibuya, Estimating Child Mortality Due to Diarrhoea in Developing Countries, *Bulletin of the World Health Organization, 86*:9, pp. 710-717, 2008. doi: 10.2471/BLT.07.050054
3. Adazu, K. et al., Health and Demographic Surveillance in Rural Western Kenya: A Platform for Evaluating Interventions to Reduce Morbidity and Mortality from Infectious Diseases, *American Journal of Tropical Medicine and Hygiene, 73*:6, pp. 1151-1158, 2005.
4. M. Ombok et al., Geospatial Distribution and Determinants of Child Mortality in Rural Western Kenya 2002-2005, *Tropical Medicine and International Health, 15*:4, pp. 423-433, 2010. doi: 10.1111/j.1365-3156.2010.02467.x
5. J. A. Tornheim et al., The Epidemiology of Hospitalization with Diarrhea in Rural Kenya: The Utility of Existing Health Facility Data in Developing Countries, *International Journal of Infectious Diseases, 14*:6, pp. e499-e505, 2010. doi: 10.1016/j.ijid.2009.07.021
6. Kenyan Ministry of Public Health and Sanitation Division of Child and Adolescent Health, *Policy Guidelines on Control and Management of Diarrhoeal Diseases in Children Below Five Years in Kenya.* Retrieved March 11, 2010 from http://www.path.org/files/kenya-diarrhoea-policy.pdf
7. A. P. Zwane and M. Kremer, What Works in Fighting Diarrheal Diseases in Developing Countries? A Critical Review, *World Bank Research Observer, 22*:1, pp. 1-24, 2007. doi: 10.1093/wbro/lkm002
8. V. Curtis and S. Cairncross, Effect of Washing Hands with Soap on Diarrhoea Risk in the Community: A Systematic Review, *Lancet Infectious Diseases, 3*:5, pp. 275-281, 2003. doi: 10.1016/S1473-3099(03)00606-6
9. C. E. O'Reilly et al., The Impact of a School-Based Safe Water and Hygiene Programme on Knowledge and Practices of Students and Their Parents: Nyanza Province, Western Kenya, 2006. *Epidemiology and Infection, 136*:1, pp. 80-91, 2008. doi: 10.1017/S0950268807008060
10. W. Onyango-Ouma, J. Aagaard-Hansen, and B. B. Jensen, Changing Concepts of Health and Illness among Children of Primary School Age in Western Kenya, *Health Education Research, 19*:3, pp. 326-339, 2004. doi: 10.1093/her/cyg034
11. W. Onyango-Ouma, J. Aagaard-Hansen, and B. B. Jensen, The Potential of School Children as Health Change Agents in Rural Western Kenya, *Social Science and Medicine, 61*:8, pp. 1711-1722, 2005. doi: 10.1016/j.socscimed.2005.03.041
12. R. Quick, Changing Community Behaviour: Experience from Three African Countries, *International Journal of Environmental Health Research, 13*(Suppl 1), pp. S115-S121, 2003. doi: 10.1080/0960312031000102877

13. W. P. Schmidt et al., Determinants of Handwashing Practices in Kenya: The Role of Media Exposure, Poverty and Infrastructure, *Tropical Medicine and International Health, 14*:12, pp. 1534-1541, 2009. doi: 10.1111/j.1365-3156.2009.02404.x
14. D. K. Wamalwa, Improving Community Hygiene and Sanitation Practices through Schools: A Case Study of the Personal Hygiene and Sanitation Education (PHASE) Project in Kenya. *Promotion & Education, 12*:3-4, pp. 166-167, 2005. doi: 10.1177/10253823050120030118
15. D. S. Lantagne et al., Disinfection By-Product Formation and Mitigation Strategies in Point-of-Use Chlorination of Turbid and Non-Turbid Waters in Western Kenya, *Journal of Water and Health, 6*:1, pp. 67-82, 2008. doi: 10.2166/wh.2007.013
16. E. Mintz, F. Reiff, and R. Tauxe, Safe Water Treatment and Storage in the Home: A Practical New Strategy to Prevent Waterborne Disease, *Journal of the American Medical Association, 273*:12, pp. 948-953, 1995. doi: 10.1001/jama.273.12.948
17. R. E. Quick, *Safe Water Systems for the Developing World: A Hand-Book for Implementing House-Hold Based Water Treatment and Safe Storage Projects, 2005,* Department of Health and Human Services, Centers for Disease Control and Prevention, Atlanta, Georgia.
18. R. K. Shrestha et al., Cost-Effectiveness of Home-Based Chlorination and Safe Water Storage in Reducing Diarrhea among HIV-Affected Households in Rural Uganda, *American Journal of Tropical Medicine and Hygiene, 74*:5, pp. 884-890, 2006.
19. E. Blanton et al., Evaluation of the Role of School Children in the Promotion of Point-of-Use Water Treatment and Handwashing in Schools and Households—Nyanza Province, Western Kenya, 2007, *American Journal of Tropical Medicine and Hygiene, 82*:4, pp. 664-671, 2010. doi: 10.4269/ajtmh.2010.09-0422
20. J. Migele et al., Diarrhea Prevention in a Kenyan School Through the Use of a Simple Safe Water and Hygiene Intervention, *American Journal of Tropical Medicine and Hygiene, 76*:2, pp. 351-353, 2007.
21. V. Stetson and R. Davis, *Health Education in Primary Health Care Projects: A Critical Review of Various Approaches 1999,* Child Survival Collaborations and Resources Group (The CORE Group), Washington, D.C.
22. J. Kerr, F. Eves, and D. Carroll, Posters Can Prompt Less Active People to Use the Stairs, *Journal of Epidemiology and Community Health, 54*:12, p. 942, 2000. doi: 10.1136/jech.54.12.942
23. E. K. Olander, F. F. Eves, and A. Puig-Ribera, Promoting Stair Climbing: Stair-Riser Banners are Better than Posters . . . Sometimes, *Preventive Medicine, 46*:4, pp. 308-310, 2008. doi: 10.1016/j.ypmed.2007.11.009
24. I. B. Pless et al., Preventing Product-Related Injuries: A Randomized Controlled Trial of Poster Alerts, *Canadian Journal of Public Health, 98*:4, pp. 271-275, 2007.
25. A. Montazeri and A. Sajadian, Do Women Read Poster Displays on Breast Cancer in Waiting Rooms? *Journal of Public Health, 26*:4, pp. 355-358, 2004. doi: 10.1093/pubmed/fdh178
26. J. P. Kirscht, *The Health Belief Model and Predictions of Health Actions, in Health Behavior: Emerging Research Perspectives,* Gochman, D. S. (ed.), Plenum Press, New York, 1988.
27. M. Whitby et al., Behavioural Considerations for Hand Hygiene Practices: The Basic Building Blocks, *Journal of Hospital Infection, 65*:1, pp. 1-8, 2007. doi: 10.1016/j.jhin.2006.09.026

28. Centers for Disease Control (CDC), Baseline Data from the Nyando Integrated Child Health and Education Project—Kenya, 2007, *Morbidity and Mortality Weekly Report (MMWR), 56*:42, pp. 1109-1113, 2007.
29. W. R. Shadish, T. D. Cook, and D. T. Campbell, *Experimental and Quasi-Experimental Designs for Generalized Causal Inference,* Houghton-Mifflin Company, Boston, Massachusetts, 2002.
30. D. Grembowski, *The Practice of Health Program Evaluation,* Sage, Thousand Oaks, California, 2001.
31. K. Ward and K. Hawthorne, Do Patients Read Health Promotion Posters in the Waiting Room? A Study in One General Practice, *British Journal of General Practice, 44*:389, pp. 583-585, 1994.
32. M. Thomas et al., Focus Group Data as a Tool in Assessing Effectiveness of a Hand Hygiene Campaign, *American Journal of Infection Control, 33*:6, pp. 368-373, 2005. doi: 10.1016/j.ajic.2005.03.011
33. E. J. Webb et al., *Unobtrusive Measures: Nonreactive Research in the Social Sciences,* Rand McNally, Chicago, Illinois, 1966.
34. L. A. Aday and L. J. Cornelius, *Designing and Conducting Health Surveys: A Comprehensive Guide* (3rd Edition), John Wiley & Sons Inc., San Francisco, California, p. 568, 2006.
35. S. P. Luby et al., Difficulties in Maintaining Improved Handwashing Behavior, Karachi, Pakistan, *American Journal of Tropical Medicine and Hygiene, 81*:1, pp. 140-145, 2009.
36. R. G. Feachem, Interventions for the Control of Diarrhoeal Diseases among Young Children: Promotion of Personal and Domestic Hygiene, *Bulletin of the World Health Organization, 62*:3, pp. 467-476, 1984.
37. P. A. Haggerty et al., Community-Based Hygiene Education to Reduce Diarrhoeal Disease in Rural Zaire: Impact of the Intervention on Diarrhoeal Morbidity, *International Journal of Epidemiology, 23*:5, pp. 1050-1059, 1994. doi: 10.1093/ije/23.5.1050
38. B. F. Stanton and J. D. Clemens, An Educational Intervention for Altering Water-Sanitation Behaviors to Reduce Childhood Diarrhea in Urban Bangladesh, II. A Randomized Trial to Assess the Impact of the Intervention on Hygienic Behaviors and Rates of Diarrhea, *American Journal of Epidemiology, 125*:2, pp. 292-301, 1987.

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