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Associations between presence of handwashing stations and soap in the home and diarrhoea and respiratory illness, in children less than five years old in rural western Kenya

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Abstract

OBJECTIVE—We tested whether soap presence in the home or a designated handwashing station was associated with diarrhoea and respiratory illness in Kenya.

METHODS—In April 2009, we observed presence of a handwashing station and soap in households participating in a longitudinal health surveillance system in rural Kenya. Diarrhoea and acute respiratory illness (ARI) in children < 5 years old were identified using parent-reported syndromic surveillance collected January–April 2009. We used multivariate generalised linear regression to estimate differences in prevalence of illness between households with and without the presence of soap in the home and a handwashing station.

RESULTS—Among 2547 children, prevalence of diarrhoea and ARI was 2.3 and 11.4 days per 100 child-days, respectively. Soap was observed in 97% of households. Children in households with soap had 1.3 fewer days of diarrhoea/100 child-days (95% CI −2.6, −0.1) than children in households without soap. ARI prevalence was not associated with presence of soap. A handwashing station was identified in 1.4% of households and was not associated with a difference in diarrhoea or ARI prevalence.

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CONCLUSIONS—Soap presence in the home was significantly associated with reduced diarrhoea, but not ARI, in children in rural western Kenya. Whereas most households had soap in the home, almost none had a designated handwashing station, which may prevent handwashing at key times of hand contamination.

Keywords

handwashing; diarrhoea; acute respiratory infection; Kenya

Introduction

Diarrhoea and pneumonia are the leading causes of death in children < 5 years old worldwide, accounting for 11% and 18% of the 7.6 million deaths that occurred in 2010, respectively (Liu *et al.* 2012). In Kenya in 2010, 9% of the deaths in children < 5 years old were attributed to diarrhoea and 17% to pneumonia (World Health Organization 2010).

Interventions promoting handwashing with soap can reduce diarrhoea and pneumonia in resource-poor settings (Curtis *et al.* 2001; Stanton & Clemens 1987; Luby *et al.* 2004, 2005; Peterson *et al.* 1998). A meta-analysis assessing the health impact of promoting handwashing with soap reported a 31% reduction in risk of acute gastrointestinal disease and 21% reduction in risk of acute respiratory illness (Aiello *et al.* 2008). Of the ten studies conducted in resource-poor settings included in the meta-analysis, only one was conducted in sub-Saharan Africa. In that study, in Zaire, the prevalence of diarrhoea during the 3 months after the handwashing intervention was 11% lower among children in the intervention arm than children in the control arm (Haggerty *et al.* 1994).

Large-scale efforts to promote handwashing are ongoing in many low- and middle-income countries. Robust evaluations of handwashing promotion programmes are necessary to determine their impact on behaviour. Handwashing behaviour can be directly observed by placing trained enumerators in households who record key transmission events, such as before eating or after toileting, and associated hand cleansing, but this method requires extensive field staff time and the respondent may alter behaviour due to the presence of the observer (Manun'ebo *et al.* 1997; Ram *et al.* 2010). Because of these limitations, surrogate measures that reliably characterise handwashing behaviour are needed. Such measures should be objective and relatively immune to social desirability, which adversely affects both self-report and directly observed behaviour (Manun'ebo *et al.* 1997; Curtis *et al.* 1993; Ram *et al.* 2010).

A potential surrogate measure of handwashing behaviour is the presence of soap for handwashing in the home. Studies in several resource-poor settings have found an association between the presence of handwashing materials and lower rates of diarrhoea or respiratory disease (Luby & Halder 2008; Peterson *et al.* 1998; Dubois *et al.* 2006). The presence of any kind of soap in the home for handwashing, and soap at specific handwashing places, can be objectively measured and feasibly incorporated into large studies. Community-based studies assessing an association between these surrogate household measures and health outcomes in children living in sub-Saharan Africa have not been published.

Our objective was to evaluate whether the presence of soap in the home or a fixed, designated location for handwashing with soap and water was associated with lower prevalence of diarrhoea and acute respiratory illness in children < 5 years old in rural western Kenya.

Methods

Surveillance site

The U.S. Centers for Disease Control and Prevention (CDC) and the Kenya Medical Research Institute (KEMRI) have operated a population-based infectious diseases surveillance system (PBIDS) in 33 villages in the Asembo area in Nyanza Province, Kenya, since 2005. Enrolled households are visited biweekly by a trained interviewer to collect daily information about symptoms, care-seeking and treatment for each participant during the previous 2 weeks (Feikin *et al.* 2010). Mothers or other primary caregivers report information for children < 5 years old (Feikin *et al.* 2010).

In April 2009, we identified all households enrolled in PBIDS with a child < 5 years old. A trained interviewer administered a survey to the mother or other primary caregiver of the child about handwashing and water use (handwashing survey). Interviewers asked respondents to show the location in their home or courtyard where they most often washed their hands and recorded whether soap, ash, mud or water was present. The presence of soap anywhere in the home identified by the respondent as used for handwashing was also recorded. Respondents reported usual source and proximity of drinking water, water treatment process and frequency, and water use. Interviewers asked about water source and uses during dry and wet seasons separately to characterise seasonal variations.

We constructed a household wealth index of variables describing household assets using the 2007 KEMRI/CDC Health and Demographic Surveillance System administered to households participating in PBIDS using principal component analysis (Gwatkin *et al.* 2007; Filmer & Pritchett 2001; Odhiambo *et al.* 2012). Households were categorised into quintiles based on the wealth scores generated by the analysis.

Ethical review

The protocol for PBIDS and the handwashing survey were approved by the Ethical Review Committees of CDC and KEMRI. Caretakers of participating children provided signed informed consent.

Data analysis

The sample population included all children < 5 years old in April 2009 living in a household that had participated in at least one PBIDS home visit between January 1 and April 30 2009 and completed a handwashing survey in April 2009.

We measured two potential surrogate measures of handwashing behaviour: presence of soap in the home and the presence of a handwashing station. These measures were collected once during the handwashing survey in April 2009. Soap presence was defined as observation of any of the following types of soap: beauty bar soap (marketed for personal cleansing), multipurpose bar soap (marketed for both household and personal cleansing), powdered soap (laundry detergent) and liquid soap. We defined a handwashing station as a specific location in the home or courtyard identified by the respondent as the place where hands are most often washed with soap and/or water present. The presence of water included running water and water in any type of storage container or basin. A fully stocked handwashing station was defined as a handwashing station where both soap and water were observed. A partially stocked handwashing station had either soap or water observed, but not both. Households that identified a specific location for handwashing where neither soap nor water was present were excluded from the handwashing station analyses to reduce likelihood of misclassifying the exposure.

Outcomes of this study were prevalence of diarrhoea and acute respiratory illness (ARI) in children < 5 years old reported by mothers or caregivers during PBIDS visits between January 1 and April 30 2009. We conducted these analyses using prevalence as an indicator of the burden of disease, which has been shown to be more strongly associated with mortality than incidence in a study of childhood diarrhoea in Ghana (Morris *et al.* 1996). Diarrhoea was defined as the report of ≥ 3 looser than normal stools in a 24-h period (Feikin *et al.* 2011). ARI was defined as the report of acute onset of cough or difficulty breathing (Feikin *et al.* 2011). Although interviewers recorded symptom data for each day of the previous 2 weeks, we used symptoms reported for the 3 days prior to each visit based on substantial reductions in recall for periods longer than 3 days (Feikin *et al.* 2010; Alam *et al.* 1989). We defined prevalence for each syndrome as the number of days with syndrome-specific symptoms divided by the number of days of observation. The independent association between each handwashing indicator and the prevalence of diarrhoea or ARI was estimated using mixed-effect regression models with PROC MIXED (SAS v 9.2, Cary, NC). Illnesses among children living in the same household may be correlated; thus, we included clustering at the household level in all regression models. Potential confounders were selected based on previously published literature and retained in the multivariate models if statistically significantly associated with the outcome ($P < 0.05$) (Lopez *et al.* 2006; Luby & Halder 2008; Pickering *et al.* 2010; Masangwi *et al.* 2010). All multivariate models were adjusted for household wealth quintile, gender, and age. Both handwashing indicators were included in the multivariate models to determine their independent association with each health outcome. We calculated the difference in adjusted square means of the prevalence between the groups with and without each indicator and estimated the 95% confidence interval around the differences.

Results

Study population

We included 2547 children < 5 years old in 1745 households (Figure 1). The sample population was 47% female, and the mean age was 32.8 months (Table 1). During the dry season, 58% of the households reported an unimproved water supply, such as a pond or unprotected spring, as their drinking water source. Nearly 80% of the population had no sanitation facility or shared a latrine.

Prevalence of soap and handwashing stations

Soap was observed in 97% (*n* = 1688) of the households. Multipurpose soap was the most common, observed in 96% of all households (*n* = 1668). Households without soap were more likely to be in the lower wealth quintiles; 52% (*n* = 28) of households without soap were in the lowest two wealth quintiles and 24% (*n* = 13) were in the highest two wealth quintiles ($P = 0.05$). Six percentage of households had more than one type of soap. The presence of beauty bar soap ($P < 0.001$) and > 1 type of soap ($P < 0.001$) in the home was associated with increased household wealth; 11% of households in the wealthiest quintile had > 1 type of soap and 10% had beauty bar soap; whereas, in the lowest quintile, 3% of households had > 1 type of soap and 3% had beauty bar soap. Ash or mud for handwashing was present in 5% (*n* = 97) of homes, but only two homes had ash or mud, but not soap.

A handwashing station was identified in 24 (1.4%) households; six of these households (0.34%) had soap and water present, 13 (0.74%) only had soap present, and five (0.29%) only had water. Handwashing stations were more commonly observed in wealthier households, but the association was not statistically significant ($P > 0.05$) (Table 1). A handwashing station was observed at 4% of households with a water source at the home or courtyard and at no households with a water source > 1 km away ($P = 0.0008$).

Prevalence of diarrhoea and ARI

A median of eight PBIDS visits were completed per child. The prevalence of diarrhoea was 2.3 days of illness per 100 child-days (SD 5.7) (Table 2). The prevalence of ARI was 11.4 days of illness per 100 days observed (SD = 15.0). Prevalence of diarrhoea was highest among children in the 12- to 23-month-old age group. ARI was highest among children 6–11 months old. Children in the lowest two wealth quintiles had higher prevalence of diarrhoea compared with children in the upper three wealth quintiles, but prevalence of ARI did not differ by wealth quintile.

Presence of soap in the home and prevalence of disease

The presence observed soap in the household was associated with 1.3 fewer days of diarrhoea per 100 child-days (95% CI: −2.6, −0.3, $P = 0.04$) when compared to children in households with no observed soap, after adjustment for household wealth, age, gender, presence of a handwashing station, and accounting for household level clustering (Table 3). There were 2.8 fewer days of ARI per 100 child-days among children living in households where soap was present, but the difference was not significant (95% CI: −6.3, 0.7, $P = 0.11$). Beauty bar soap was not significantly associated with a lower prevalence of diarrhoea (−1.3 days/100 child-days, 95% CI −3.4, 0.7) or ARI (−2.4 days/100 child-days, 95% CI −7.3, 2.5) (Table 3).

Presence of a handwashing station and prevalence of disease

The presence of a designated handwashing station with soap and/or water was not independently associated with prevalence of diarrhoea (−1.3 days/100 child-days, 95% CI −3.3, 0.8) or ARI (3.7 days/100 child-days, 95% CI −2.0, 9,4) in children in the adjusted models (Table 4). The presence of a fully stocked designated handwashing station was not associated with a difference in diarrhoea prevalence. However, children living in a household with a fully stocked handwashing station had a 2.3-fold increased prevalence of ARI, an average of 14.7 more days of illness per 100 child-days, than children living in households without a designated handwashing station (95% CI 2.6, 26.7).

Discussion

Children < 5 years old living in homes with soap for handwashing experienced a 41% lower prevalence of diarrhoea than children living in homes without soap. The presence of soap in the home may indicate caregivers of young children are washing their hands during key events that disrupt transmission of diarrhoea pathogens to the children, such as after faecal contact and before feeding the child. In Bangladesh, observed handwashing with soap by caregivers at key events was associated with reduced diarrhoea in children < 5 years old (Luby *et al.* 2011a; Alam & Wai 1991). Although the presence of soap does not necessarily result in handwashing with soap, its absence minimises opportunities for the behaviour.

Given the nearly universal presence of soap in our sample, soap presence is likely an insensitive predictor of handwashing behaviour. Using an insensitive measure will limit the ability to detect a moderate effect of handwashing on child health. The small number of households without soap also increases the possibility that the association might be explained by other factors. Rather than predicting handwashing behaviour, the absence of soap may only discriminate the small fraction who are least likely to wash. Because soap presence was widespread in our sample, a community-wide intervention to promote maintenance of soap in the home is unlikely to have a large impact on reducing child morbidity. However, diarrhoea prevalence was higher in children in households without soap, and half of the households without soap were in the poorest two quintiles. An intervention that identifies households without soap and provides soap to the households that have financial constraints could reach children at higher risk of illness.

We did not find reduced prevalence of ARI in children living in households with soap. Handwashing with soap after contact with respiratory secretions may be rare; a study in Bangladesh reported that no participants were observed to wash hands after coughing or sneezing into their hands (Nasreen *et al.* 2010). Furthermore, repeated handwashing throughout the day may be necessary to interrupt transmission from hands to nasal mucosa because of frequent hand-to-face contact (Nicas & Best 2008; Jefferson *et al.* 2011).

Our study is consistent with previous research showing an inverse association between soap presence in the home and child diarrhoea but no association with ARI. During epidemic cholera in Zambia, healthy controls had significantly higher odds of having hand soap in the home compared with cholera cases (Dubois *et al.* 2006). In a refugee camp in Malawi, diarrhoea incidence was lower when soap was present in the household compared with when soap was absent. (Peterson *et al.* 1998). A study in urban Bangladesh found no association between observation of soap in the home and reduced cough or difficulty breathing in children after adjustment for household wealth (Luby & Halder 2008).

We did not find an association between the presence of a fixed handwashing station and prevalence of diarrhoea or ARI in children < 5 years old. Evidence for a beneficial relationship between a designated place for handwashing and diarrhoea or ARI in children is mixed. In the previously mentioned investigation of a cholera epidemic in Zambia and one study of diarrhoea in Bangladesh, a designated handwashing station was not significantly associated with reduced illness (Dubois *et al.* 2006; Luby *et al.* 2011b). A randomised controlled trial in Bangladesh that placed and maintained a handwashing station with soap and water in homes did not reduce secondary transmission of influenza (DiVita *et al.* 2011). In contrast, two observational studies in Bangladesh found that a convenient place to wash hands with water inside the home was associated with a lower prevalence of respiratory illness in children (Luby & Halder 2008; Luby *et al.* 2011b). In rural western Kenya, it is common practice to bring a pitcher and basin to the persons to wash hands before meals; by limiting our observation to fixed locations for handwashing, we may have underestimated the proportion of households among whom regular handwashing occurred.

Unexpectedly, the presence of a handwashing station with both soap and water was associated with a significantly higher prevalence of ARI in children. Given the very limited data available for this specific analysis, it is possible an unidentified bias influenced the estimate. Only six households had soap and water present at a designated handwashing station at the time of the interview. The association may have been due to confounding that was not measured; respondents with a handwashing station may have been more health conscious and reported more symptoms.

Although we did not see an association between a handwashing station and reduced child morbidity, placing soap and water near latrines, food preparation, or eating areas may promote handwashing with soap by acting as a visual reminder. A handwashing station placed near the kitchen or latrine may create an environment favourable to handwashing with soap by reducing the effort needed to wash hands (Aunger *et al.* 2010; Schmidt *et al.* 2009; Biran *et al.* 2012).

Our study had several limitations. Both indicator measures of handwashing showed a lack of heterogeneity in this sample; 97% of the households showed soap to the field worker, and 1% had a handwashing station. Thus, these measures have limited usefulness to discriminate handwashing behaviour and may only serve to identify the small groups who are either the most or least likely to wash hands in this sample. The lack of heterogeneity also limits the precision of the point estimates and increases the possibility that the associations are confounded by characteristics we did not measure or residually confounded by characteristics we included. Furthermore, we did not observe handwashing behaviour and cannot confirm the measured indicators are associated with behaviour, although other studies have reported an association (Luby *et al.* 2009; Biran *et al.* 2005).

The handwashing surrogate measures were collected in a single visit at the end of the study period after the health data were collected. The presence of handwashing materials during this visit may not indicate presence prior to the measure of health outcomes or their usual presence in the household. In Bangladesh, a study that measured the presence of soap repeatedly in the same households over one month showed that a majority had soap present at any one visit, but only half had soap present during every visit, reflecting the inconsistency in soap availability in the home (Gadgil *et al.* 2011).

Handwashing behaviour and the presence of materials for washing hands may change seasonally in response to changes in availability or perceived risk of infection. The presence of a handwashing station was associated with a water source on the premises during the dry season. Many more households may have an accessible handwashing station in the wet season when four times as many households reported a water source on the premises, compared with the dry season. The incidence of diarrhoea and ARI also varies seasonally, and handwashing may increase when perceived risk of disease is high. We used health data collected during the same season as the handwashing measures survey to reduce the effect of seasonality, but the association may differ during the wet season.

A study in Kenya observed that handwashing with water was more common than washing with soap, and in Bangladesh, washing with water was protective against diarrhoea in children (Aunger *et al.* 2010; Luby *et al.* 2011a). The presence of soap in the home or at a handwashing station would not identify those who wash with water and lead to misclassification of a handwashing practice that could decrease illness.

Several factors regarding handwashing behaviour in sub-Saharan Africa warrant further exploration. There are no published data describing handwashing behaviour after contact with respiratory secretions or knowledge about these events as critical times for handwashing in Africa. This information could inform large-scale handwashing programmes that aim to reduce the high burden of ARI among young children in Kenya. A fixed, designated location for handwashing may not represent a handwashing station in this region. Additional research could help to elucidate the times at which soap and water are brought out for handwashing, how often this is done during the day, whether or not this type of handwashing station is associated with childhood illness, and how these materials serve as a cue to wash hands when recommended.

The majority of households in our sample had soap, but few maintained the soap at a specific handwashing station. The presence of observed soap in the home was protective against diarrhoea, but not ARI, among children < 5 years old. Despite being low-cost, objective measures, the homogeneity in both surrogate measures suggests the limited utility of these data to determine whether the presence of soap or a handwashing station can differentiate people who wash their hands at key times for transmitting pathogens to and from hands. Soap should be universally available to facilitate the handwashing behaviour that can reduce the burden of diarrhoea among young children in western Kenya. The behavioural and health effects of efforts to promote maintaining soap in an accessible location where it may act as a visual cue to washing hands at times of pathogen transmission should be further investigated.

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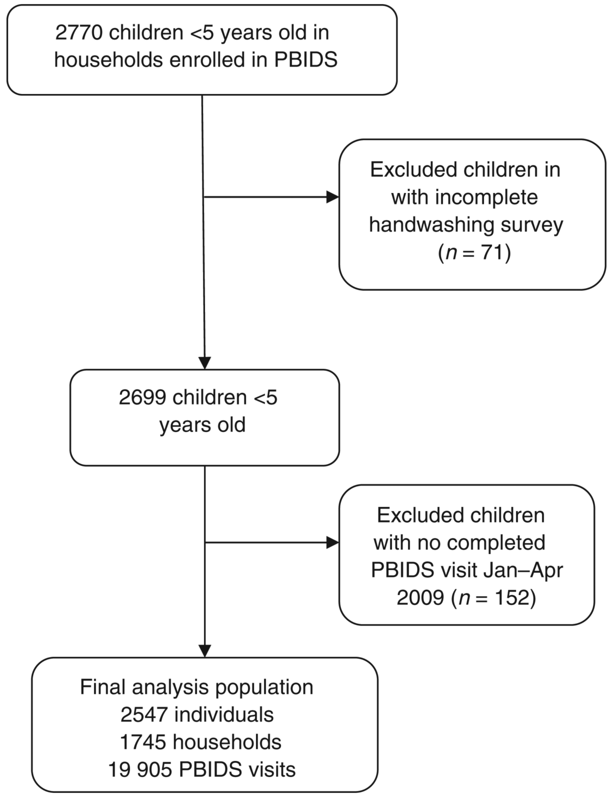

Figure 1.

Determination of analysis population: children < 5 years old living in households with a completed handwashing survey and at least one morbidity surveillance home visit between January 1 and April 30, 2009.

Table 1

Sample population characteristics, Asembo, Kenya, April 2009

	Frequency (%)
Child characteristics (*N* = 2547)	
Female	1194 (47)
Male	1223 (48)
Missing	130 (5)
Age group	
0–5 months	97 (4)
6–11 months	278 (11)
12–23 months	505 (20)
24–59 months	1667 (65)
Household characteristics (*N* = 1745)	
Improved drinking water source (dry season)	736 (42)
Water source on compound premises (dry season)	186 (11)
Median distance to water source (dry season), km (SD)	0.5 (2.3)
Water source on compound premises (wet season)	1448 (83)
Median distance to water source (wet season), km (SD)	0 (0.6)
Sanitation facility	
Private latrine	313 (18)
Shared latrine	752 (43)
No sanitation facility	628 (36)
Missing	52 (3)
Asset ownership	
≥ 1 mobile phone	679 (39)
≥ 1 bicycle	1153 (66)
Television	196 (11)
Own ≥ 1 acre of land	1104 (63)
Missing	52 (3)
Observed presence of soap in the home (*N* = 1745)	
Soap observed (any type)	1688 (97)
No soap observed	57 (3)
Type of soap*	
Beauty bar soap	88 (5)
Multipurpose bar soap	1668 (96)
Powdered detergent	48 (3)
Liquid soap	33 (2)
Ash	72 (4)
Mud or sand	27 (2)
Observation of beauty bar soap by household wealth	
Household wealth quintile 5 (wealthiest)	35/336 (10)
Household wealth quintile 4	17/342 (5)

	Frequency (%)
Household wealth quintile 3	15/340 (4)
Household wealth quintile 2	10/337 (3)
Household wealth quintile 1 (poorest)	9/338 (3)
Missing wealth quintile	2/52 (4)
Observed presence of a handwashing station	
Observed handwashing station (soap and/or water present)	24 (1)
No observed handwashing station	1688 (97)
Designated handwashing location, soap and water absent	33 (2)
Presence of materials at handwashing station	
Fully stocked (soap and water present at observation)	6 (0.3)
Partially stocked (soap or water present at observation)	18 (1)
Observation of handwashing station by household wealth	
Quintile 5 (wealthiest)	9/336 (3)
Quintile 4	6/342 (2)
Quintile 3	3/340 (1)
Quintile 2	3/337 (1)
Quintile 1 (poorest)	1/338 (0.3)
Missing wealth quintile	2/52 (4)
Observation of handwashing station by distance to water (dry season)	
0 km	8/186 (4)
0.1–0.5 km	13/872 (2)
0.6–1 km	3/476 (0.6)
> 1 km	0/211 (0)

[*] 102 households with > 1 type of soap observed.

Table 2

Prevalence per 100 days of acute respiratory illness and diarrhoea in children under 5 years old reported at biweekly household visits, Asembo, Kenya, January–April 2009

	Prevalence diarrhoea per 100 child-days mean (SD)	Prevalence ARI per 100 child-days mean (SD)
Overall	2.3 (5.7)	11.4 (15.0)
Age group		
0–5 months	1.9 (4.9)	10.9 (14.8)
6–11 months	5.0 (8.6)	15.2 (18.7)
12–23 months	5.1 (8.0)	12.7 (15.4)
24–59 months	1.1 (3.6)	10.4 (14.1)
Household wealth		
Quintile 5 (wealthiest)	2.0 (4.8)	10.3 (14.2)
Quintile 4	2.0 (5.5)	11.0 (14.5)
Quintile 3	1.9 (4.6)	12.2 (15.4)
Quintile 2	2.6 (6.3)	12.2 (15.0)
Quintile 1 (poorest)	2.9 (6.5)	11.9 (15.7)

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Table 3

Association between presence of soap in the home and prevalence of diarrhoea and acute respiratory illness in children < 5 years reported at biweekly household visits, Asembo, Kenya, January–April 2009

	Child-days observed	Crude prevalence/100 child-days (95% CI)*	Adj. prevalence/100 child-days (95% CI)†	Adj. difference in prevalence/100 child-days (95% CI)b	*P*-value (adj.)
Diarrhoea					
Soap not observed	2004	4.5 (3.3, 5.7)	3.2 (1.4, 5.1)	Referent	0.04
Any soap observed	57 711	2.3 (2.0, 2.5)	1.9 (0.5, 3.3)	–1.3 (–2.6, –0.1)	
Soap not observed	2004	4.5 (2.8, 6.1)	3.7 (–0.1, 7.6)	Referent	0.19
Beauty bar soap observed	2988	1.8 (0.4, 3.1)	2.4 (–1.6, 6.4)	–1.3 (–3.4, 0.7)	
Ash/mud not observed	56 214	2.3 (2.1, 2.6)	2.7 (0.9, 4.4)	Referent	0.84
Ash/mud observed	3501	2.4 (1.4, 3.3)	2.6 (1.1, 4.1)	0.1 (–0.8, 1.0)	
Acute respiratory illness					
Soap not observed	2004	14.1 (10.9, 17.3)	18.0 (13.0, 23.0)	Referent	0.11
Any soap observed	57 711	11.3 (10.7, 11.9)	15.2 (11.4, 19.0)	–2.8 (–6.3, 0.7)	
Soap not observed	2004	14.1 (10.8, 17.4)	22.2 (12.8, 31.6)	Referent	0.34
Beauty bar soap observed	2988	10.2 (7.5, 12.9)	19.8 (10.0, 29.5)	–2.4 (–7.3, 2.5)	
Ash/mud not observed	56 214	11.3 (10.7, 11.9)	16.5 (12.4, 20.6)	Referent	0.57
Ash/mud observed	3501	12.6 (10.2, 15.0)	17.3 (12.5, 22.0)	0.7 (–1.8, 3.3)	

*Mixed regression model, adjusted for clustering within households.

†Mixed regression model, adjusted for age at the time of handwashing survey, household wealth quintile, gender, clustering within household, and presence of handwashing station.

Table 4

Association between presence of a handwashing station and prevalence of acute respiratory illness and diarrhoea in children under 5 years old, Asembo, Kenya, January – April 2009

	Child-days observed	Crude prevalence/100 child-days (95% CI)*	Adjusted prevalence/100 child-days (95% CI)†	Adjusted difference in prevalence/100 child-days (95% CI)†	*P*-value (adj.)
Diarrhoea					
No designated handwashing station	57 804	2.3 (2.1, 2.5)	2.8 (2.1, 3.4)	Referent	0.22
Handwashing station present	696	1.2 (–0.9, 3.2)	1.5 (–0.6, 3.6)	–1.3 (–3.3, 0.8)	
No designated handwashing station	57 804	2.3 (2.1, 2.5)	2.8 (2.1, 3.4)	Referent	0.76
Fully stocked handwashing station present	171	1.8 (–2.4, 6.0)	2.1 (–2.2, 6.4)	–0.7 (–5.0, 3.6)	
Acute respiratory illness					
No designated handwashing station	57 804	11.3 (10.7, 11.9)	12.4 (10.6, 14.2)	Referent	0.20
Handwashing station present	696	15.8 (10.4, 21.2)	16.2 (10.3, 22.0)	3.7 (–2.0, 9.4)	
No designated handwashing station	57 804	11.3 (10.7, 11.9)	12.2 (10.4, 14.0)	Referent	0.02
Fully stocked handwashing station present	171	21.5 (10.3, 32.7)	26.9 (14.7, 39.0)	14.7 (2.6, 26.7)	

*Mixed regression model, adjusted for clustering within households.

†Mixed regression model, adjusted for age at the time of handwashing survey, household wealth quintile, gender, clustering within household, presence of soap in the home.