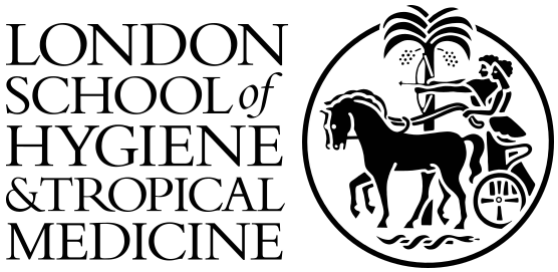

A cross-sectional survey to assess household sanitation practices associated with uptake of 'Clean Team' serviced home toilets in Kumasi, Ghana

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Abstract

'Clean Team' provides serviced, free-standing toilets as a sanitation option in low income areas of Kumasi, Ghana. A cross-sectional survey was carried out to assess sanitation and hygiene practices in 199 Clean Team households and 201 neighbouring, non-Clean Team households. Adults in non-Clean Team households were no less likely to report unsafe defecation (use of a latrine) than their non-Clean Team neighbours, although their frequent reliance on public toilets may lead to occasional unsafe practice. Children in Clean Team households used the household toilet from a younger age than those in non-Clean Team households and their faeces were thus more often disposed of safely. Soap and water were more frequently found at the latrine in Clean Team households than in latrine-owning non-Clean Team households.

Use of Clean Team toilets is likely to reduce faecal contamination of the environment through safer child defecation and stool disposal practices and may increase the opportunity for post-defecation handwashing with soap.

KEYWORDS container-based sanitation / handwashing / hygiene / Kumasi / toilets / Ghana

Introduction

Clean Team is a social enterprise in Kumasi, Ghana offering serviced, free-standing toilets as a sanitation option for households in dense, low-income areas. This paper reports the findings of a study to explore the household sanitation and hygiene practices associated with Clean Team toilet uptake, practices which have the potential to impact on public health. In this cross-sectional study the current practices of Clean Team households are compared with their pre- Clean Team practices and with the practices of non- Clean Team neighbours.

Background

Kumasi is the administrative capital of the Ashanti region of Ghana, home to West Africa's largest open-area market and a commercial and transport hub in both Ghana and neighbouring countries. With a population of over two million and a high annual growth rate of 5.5%, Kumasi is a close second to the capital Accra some 270km away for the position of Ghana's largest city.[(1)] Half of the inhabitants of Kumasi live in high-density areas characterised by poor infrastructure. An estimated 43 percent of Kumasi's homes use a toilet connected to a septic tank, 36% use fee-charging public toilets (60% in indigenous, traditional material, housing areas [(2)]) and 18% use a pit latrine or a Kumasi Ventilated Improved Pit Latrine (KVIP).[(3)] Open defecation is rare in the city (2% of households practice it) and the use of bucket latrines – previously commonplace – has been made illegal as it is associated with indiscriminate dumping of faecal waste. The use of a bucket latrine,

[1] Ghana Statistical Service (2013), *2010 Population and Housing Census, National Analytical Report*, accessed Oct 2015 at http://www.statsghana.gov.gh/docfiles/publications/2010_PHC_National_Analytical_Report.pdf; Kumasi Metropolitan Assembly (2006), *Kumasi Metropolitan Assembly, About this Metropolis*, accessed Oct 2015 at http://www.kma.ghanadistricts.gov.gh/?arrow=atd&_=6&sa=5490.

[2] Salifu L (2013), *A Rapid Field Evaluation of the Pilot Asafo Simplified Sewerage Scheme in Kumasi, Ghana*, accessed Oct 2015 at http://www.pseau.org/sites/default/files/fichiers/r_d/case-study_non-conventional-sewers_ghana.pdf.

[3] Ghana Statistical Service (2014), *2010 Population & Housing Census, District Analytical Report, Kumasi Metropolitan*, accessed Oct 2015 at http://www.statsghana.gov.gh/docfiles/2010_District_Report/Ashanti/KMA.pdf.

reported by 0.2% of the population, may be under-reported.[4] 'Flying toilets' (faeces-filled plastic bags that may be disposed of in the environment) are still anecdotally reported to be in use. A sewerage system serves around 300 dwellings in a small area in the city centre only,[5] at a cost prohibitive to further expansion.[6] Clean Team provides customers with a free-standing, urine-diverting, chemical toilet in their home. Urine is diverted either to a drain or a storage vessel and faeces are retained in a sealable container within the toilet. A reservoir of perfumed, anti-bacterial, chemical solution in the container covers the faeces and reduces smell and insect problems (Figure 1).

The design allows for easy and hygienic emptying. The waste container can be sealed and removed by a service operative and replaced with a fresh one. This is done between 2 and 4 times per week depending on the level of service for which the client pays. The containers of faeces are taken off-site, the faeces are disposed of at a waste treatment plant and the containers cleaned for re-use. In contrast to the outlawed bucket latrines, the physical separation and containment of faeces within the Clean Team toilets, the training and equipment provided for service operatives, and the site of the final disposal of waste ensure safe management of faeces. The benefits of container-based sanitation systems over the bucket latrine are explored elsewhere in more detail.[7] Further information can also be found at www.cleanteamtoilets.com.

Clean Team Ghana Limited has been operating in Kumasi since July 2011, and currently serves over 500 households. The first clients were recruited door-to-door by Clean Team sales representatives and thereafter through mass recruitment drives in the community and by word of mouth.

[4] See reference 3
[5] See reference 2
[6] IWA Water Wiki (2015), *Kumasi: Sanitation Status,* accessed Oct 2015 at http://www.iwawaterwiki.org/xwiki/bin/view/Articles/24)+KUMASI+(Ghana)+3
[7] Tilmans S, Russel K, Sklar R, Page L, Kramer S, Davis J (2015), "Container-based sanitation: assessing costs and effectiveness of excreta management in Cap Haitien", *Haiti Environ Urban* Vol 27, No 1, pages 89-104.

Figure 1: The Clean Team, Container-Based, Free-Standing Toilet

Clean Team customers pay an average of US $11.02 per month for their toilet (by contrast, once daily use of a public toilet by a family of four would cost between US $5.31 and $26.58 depending on the fee charged by the operator of the toilet they use). If either party wishes to end the Clean Team contract, the toilet can simply be removed. Most Clean Team customers continue to subscribe, however, implying that they value the service provided.

From a public health perspective the value of Clean Team toilets depends partly on the safe handling and final disposal of faeces by service operatives but also on how the service influences the sanitation and hygiene practices of individuals in subscribing households. Specifically, the public health implications depend on the extent to which uptake of Clean Team toilets results in i) the household-level containment of faeces that would otherwise end up in the environment and ii) increased likelihood of handwashing with soap after defecation.[8] Safe stool disposal, particularly of child faeces which more frequently contaminate the home environment, is important for reducing

[8] Biran A, Rabie T, Schmidt W, Juvekar S, Hirve S, Curtis V (2008), "Comparing the performance of indicators of hand-washing practices in rural Indian households", *Trop Med Int Health*, Vol 13, No 2, pages 278-85; Biran A, Tabyshalieva A, Salmorbekova Z (2005), "Formative research for hygiene promotion in Kyrgyzstan", *Health Policy Plan,* Vol 20, No 4, pages 213-21; Hernandez O, Devine J, Karver J, Chase C, Coombes Y (2012), *Water and Sanitation Program: Technical Paper. Measuring the Behavioral Determinants of Handwashing with Soap*, accessed Dec 2014 at http://www.wsp.org/sites/wsp.org/files/publications/WSP-measuring-the-behavioral-determinants-of-handwashing-with-soap.pdf.

risk of diarrhoea.[9] As discussed by Cairncross and colleagues, the health benefits of sanitation are unlikely to be realised unless the majority of individuals in a community adopt safe sanitation practices.[10] Indeed, the limited impact shown by recent sanitation trials can be largely attributed to low sanitation coverage (and use).[11]

This study sought to address the following questions: Is the Clean Team toilet used as the usual place for defecation for all household members or for certain individuals only? How do Clean Team households compare with non- Clean Team households and with their own pre- Clean Team conditions with respect to usual place of defecation, disposal of children's faeces and presence of soap and water at the place of defecation?

Methods

Study design and setting

A cross-sectional survey and a small qualitative study were carried out in low-income urban areas of Kumasi city, Ghana. Homes in the study areas, as in much of Kumasi,[12] were typically single and multi-storey traditional compound houses, in which five to ten individual households occupied single-rooms and used communal cooking and bathing areas or had small private bathing areas separated off inside their dwelling room. Single storey compounds - the 'indigenous' sector - are generally characterised as high density and low socio-economic status housing.[13]

The survey covered two exposure groups; households with a Clean Team toilet and neighbouring households who had never been Clean Team customers.

[9] Curtis V, Cairncross S, Yonli R (2000), "Domestic hygiene and diarrhoea - pinpointing the problem", *Trop Med Int Health,* Vol 5, No 1, pages 22-32.
[10] Cairncross S, Blumenthal U, Kolsky P, Moraes L, Tayeh A (1996), "The public and domestic domains in the transmission of disease", *Trop Med Int Health*, Vol 1, No 1, pages 27-34.
[11] Schmidt WP (2015), "Seven trials, seven question marks", *Lancet Glob Health*, Vol 3, No 11, pages 659-60.
[12] See reference 2.
[13] Kumasi Metropolitan Assembly (2006), *Kumasi Metropolitan Assembly, About this Metropolis*, accessed Oct 2015 at http://www.kma.ghanadistricts.gov.gh/?arrow=atd&_=6&sa=5490.

Outcome measures

The survey collected data on the outcome measures listed below.

- The proportion of household members practicing safe faeces disposal.
- The proportion of households where the faeces of all household members are disposed of safely.
- The proportion of those households using a sanitation facility at home in which presence of soap and water was observed beside the facility.

In this study we defined 'safe faeces disposal' as defecation or disposal of faeces in a public toilet or any household toilet or latrine including a Clean Team toilet, i.e. a sanitation option that allows faeces to be isolated from the environment.

Our definition differs from the WHO/UNICEF Joint Monitoring Programme (JMP) for Water Supply and Sanitation definition of 'improved' sanitation, which refers to any sanitation solution *"that hygienically separates human excreta from human contact"*.[(14)] The current JMP definition would classify the Clean Team toilet as a bucket latrine and it includes bucket latrines along with public toilets among those solutions classified as 'unimproved' sanitation. The JMP definition offers a measureable indicator of progress towards the Millennium Development Goal target for provision of basic sanitation.[(15)] However, it is a broad measure intended for monitoring trends and does not take into account nuances such as safely managed manual emptying or consistent usage, and well-maintained shared or public sanitation. Our purpose was not to challenge the JMP definition but simply to define terms appropriate for our own study.

[14] WHO/UNICEF Joint Monitoring Programme for Water Supply and Sanitation, *Improved and unimproved water and sanitation facilities*, accessed June 2014 at http://www.wssinfo.org/definitions-methods/watsan-categories/.

[15] WHO/UNICEF Joint Monitoring Programme for Water Supply and Sanitation (2014), *Progress on Sanitation and Drinking Water - 2014 Update*, Geneva, New York, accessed Dec 2014 at http://www.wssinfo.org/fileadmin/user_upload/resources/JMP_report_2014_webEng.pdf.

Sampling

The sample size was calculated for comparison of proportions for two primary outcomes: proportion of individuals practicing safe faeces disposal and proportion of households with all members practicing safe faeces disposal. A household was defined as individuals who normally live and eat together (same 'room'). Sample size was computed for a range of possible proportions and based on simple random sampling with 90% power and an alpha of 0.05. The final sample size was selected pragmatically (proportion in Clean Team households = 0.5, proportion in non-Clean Team households 0.35) that was anticipated to reflect what the study would find and was feasible for data collection: n=200 per group.

Clean Team households were randomly selected from 569 entries in the Clean Team customer database. Households that had been with Clean Team for less than one month were excluded. An equal number of neighbouring, non- Clean Team households were randomly selected using a standardised protocol to identify target households from an adjacent compound or floor (in the case of multi-storey residential blocks). Selected households that declined to participate or could not be contacted after a repeat visit were replaced by the next household on the randomised client list (Clean Team sample), or by re-numbering and randomising the remaining households (non- Clean Team sample).

Data collection

Data were collected from 199 Clean Team households and 201 non- Clean Team households in 16 poor neighbourhoods. A verbally administered, structured questionnaire was used to collect data on household characteristics and sanitation and hygiene practices. Data were recorded using the mobile phone based application *nfield capi*. Clean Team households were asked to report on current practice and pre- Clean Team practice. Primary respondents were female heads of household or senior female caregivers as they were considered best placed to report on disposal of child faeces.

Questions on usual and occasional defecation practices and disposal of adult faeces from chamber pots (if reported) were administered to all household members aged 7 years and over who were present at the time of the survey. The primary respondent answered on behalf of younger children and any household members absent at the time of survey. The primary respondent also reported on the usual place of disposal of child faeces. Spot-check observation was used to collect information on the functional condition of a household latrine – modified from Jenkins et al., to include structural safety of use, adequate containment of waste, privacy achieved and presence of a slab (if pit latrine)[16] - and the presence of soap and water at the place of defecation. In addition, spot-check observation at a minimum of two public toilets in each survey area was used to record the type of facilities and presence of soap and water at these common places of defecation. Public toilets were selected by asking inhabitants of the respective areas for the location of the nearest public toilet, which was subsequently visited.

Qualitative study

Qualitative data were collected through two focus group discussions (one each with Clean Team and non- Clean Team users) and semi-structured interviews with 10 Clean Team users. Respondents came from a convenience sample from two neighbourhoods. Information on user fees and policies on allowing disposal of child faeces from chamber pots at public toilets was obtained through interviews with the caretaker at each facility visited.

Data analysis

The quantitative data were transferred into *Stata 13* for cleaning and analysis. The relative socio-demographic status of participating households was determined by principal components analysis of

[16] Jenkins M, Cumming O, Scott B, Cairncross S (2014), "Beyond 'improved' towards 'safe and sustainable' urban sanitation: assessing the design, management and functionality of sanitation in poor communities of Dar es Salaam, Tanzania", *Journal of Water, Sanitation and Hygiene for Development*, Vol 4, No 1, pages 31-141.

household assets following Vyas and Kumaranayake.[17] Simple descriptive analyses were performed and differences between Clean Team and non-Clean Team household means and proportions compared using appropriate statistical tests (independent samples t test and chi-square, including score test for trend) stratified by age.

Differences in use of a potty by children aged 2-6 in Clean Team and non- Clean Team households with a latrine and non-Clean Team households without a latrine were explored using a risk difference regression model (generalised linear model with identity link and binomial distribution). Standard errors were adjusted for household level clustering by using robust standard errors. Reported and self-reported usual defecation practices were used to generate a binary individual level measure of safe faeces disposal whereby anyone reporting that they usually defecate somewhere other than in a latrine was considered unsafe *unless* their faeces were ultimately disposed of in a latrine. A household-level measure of safe faeces disposal was created by considering the safety of faeces disposal of all household members. Differences between the proportion of Clean Team users and households practicing safe defecation were compared with pre-Clean Team practices using the Mcnemar test for paired data.

Ethics and consent

Ethical approval for the study was given by the ethics committee of the London School of Hygiene and Tropical Medicine and the Ghana Health Service Ethical Review Committee. Witnessed, written informed consent was obtained for all respondents over 18 years. Caregivers gave written consent on behalf of all household members under the age of 18. Individuals aged 7 to 17 were presented with simpler information and also provided written assent.

[17] Vyas S, Kumaranayake L (2006), "Constructing socio-economic status indices: how to use principal components analysis", *Health Policy Plan*, Vol 21, No 6, pages 459-68.

Results

Characteristics of households participating in the cross-sectional survey

Data were collected from 199 Clean Team households and 201 non- Clean Team households in 16 poor urban neighbourhoods. Eighty-seven Clean Team households had been using a Clean Team toilet for more than one year. Overall, 5 Clean Team and 23 non- Clean Team households declined to participate in the study or were unavailable after a repeat visit to the home.

Clean Team households were slightly larger in size than those of their non- Clean Team neighbours (mean of 3.0 household members vs. 2.6 respectively, $p = 0.038$), more frequently housed older individuals (25% vs. 11% had one or more inhabitants over 65, $p < 0.001$) and had more educated household heads (*p trend* <0.001). Clean Team households were of higher socio-economic status than non- Clean Team households (*p trend* = 0.039). More Clean Team than non- Clean Team households (37% vs. 29%) fell into the highest socio-economic grouping in this sample. Slightly more than half of all households in both groups identified themselves as Muslim (57% Clean Team, 56% non- Clean Team); the remainder were Christian. These results are shown in Table 1.

Table 1. Characteristics of participating Clean Team and non-Clean Team households and their inhabitants

	Non-Clean Team (N=201)	**Clean Team (N=199)**	***P*-value**
Household characteristics			
Total number of inhabitants	525	601	
Mean household size (range)	2.6 (1 to 9)	3.0 (1 to 13)	0.038
No. of single person households (%)	68 (33.8)	54 (27.1)	0.146
Age of household members , median (interquartile range)	26 (12 to 37)	29 (13 to 48)	<0.001
Household composition, n (%)			
One or more member aged 65 and over	22 (10.9)	49 (24.6)	<0.001
One or more member aged 15 to 64	196 (97.5)	180 (90.5)	0.003
One or more member aged 5 to 14	75 (37.3)	79 (39.7)	0.622
One or more member under 5	31 (15.4)	24 (12.1)	0.338
Socio-demographic status[a], n (%)			

Poorest	88 (43.8)	67 (33.7)	
Middle	54 (26.9)	59 (30.0)	0.039*
Least Poor	59 (29.4)	73 (36.7)	
Religion[b], n (%)			
Christian	90 (44.6)	86 (43.4)	0.581
Muslim	111 (55.5)	112 (56.6)	
Head of household characteristics			
Education level of head of household, n (%)			
No formal education	28 (14.0)	17 (8.5)	
Some primary	24 (12.0)	18 (9.0)	
Completed primary	50 (25.2)	52 (26.1)	0.059*
Some secondary	36 (18.2)	41 (20.6)	
Completed secondary	42 (21.2)	52 (26.1)	
Higher than secondary	18 (9.1)	19 (9.5)	
Occupation of head of household, n (%)			
Salaried employee	26 (13.1)	40 (19.9)	
Self-employed, trader	150 (75.4)	138 (68.7)	0.353
Unemployed	14 (7.0)	17 (8.5)	
Other[c]	9 (4.5)	6 (3.0)	

Denominators vary for some variables and not all column percentages add to 100% due to rounding. Household composition categories are not mutually exclusive hence denominators do not total 100 per cent

a Socio-demographic status derived from principal components analysis of 11 household assets : ownership of their home, land for farming, non-domestic animals, bicycle, motorbike, car, mobile phone, radio, television, refrigerator, and a water tap inside the home.

b One Clean Team household had no religion.

c Self-employed or a trader, i.e. irregular work in informal sector. Other occupations: agriculture; traditional chief; footballer; retired and student.

** P trend*

Reasons for uptake of a Clean Team toilet

Respondents in interviews and focus groups gave reasons for taking up the Clean Team service that were related to dissatisfaction with their previous sanitation. The main sources of dissatisfaction were lack of cleanliness, smell and lack of convenience. The pedestal design of the Clean Team toilets was also valued by elderly users who had difficulty squatting. Clean Team toilets were believed to particularly benefit the sick or those with mobility problems and families with elderly or young members. An elderly respondent said: *'Previously we would use a chamber pot as we cannot get out of the house easily to the public toilet. That was difficult with my bad back and it was very smelly.'* Other household members commented that addressing the needs of older members was a motivation for uptake of Clean Team since Clean Team toilets were easier to use for older people,

both because they did not have to walk so far to access them and because they were seated rather than squatting toilets. Focus group participants with young children commented that the Clean Team toilet was cleaner and safer, especially at night, and *'easier when they need to go and you are busy doing something*'.

Sanitation access

A quarter (n=52) of non- Clean Team households owned or used a sanitation facility at their home or compound (Table 2). The majority of these were flush or pour-flush toilets connected to a septic tank. The remainder were pit latrines, all of which had slabs and adequate privacy (full height walls and a door). Most of these toilets were situated in the compound rather than inside the dwelling (which requires permission from the landlord) and 63% were shared between households. By contrast, half of Clean Team toilets were inside the dwelling and almost all were used by one household only (p<0.001). Toilets in non-Clean Team households were more frequently shared than those in Clean Team households. Furthermore, shared toilets in non-Clean Team households were shared between a greater number of households than the shared Clean Team Toilets (mean of 6.5 vs. 3.1 households, p=0.007).

Table 2. Observed Sanitation Facilities in Clean Team and Non-Clean Team Households

	Non-Clean Team (N=52)[a]	**Clean Team (N=199)**	***P*-value**
Type and location of facility, n (%)			
Clean Team toilet	0	199 (100)	
Flush / pour flush connected to septic tank	37 (71.1)		
Simple pit latrine (dry or water-flushed)	14 (26.9)		
Kumasi ventilated-improved pit latrine	1 (1.9)		
Location of facility, n (%)			
Within the home	16 (30.7)	96 (48.2)	
Within the compound	36 (69.2)	96 (48.2)	0.017
At another compound	0	7 (3.5)	
Instance of shared sanitation			
Private use of individual household, n(%)	19 (36.5)	183 (92.0)	<0.001*

Shared with family-related households, n (%)	15 (28.9)	11 (5.5)	
No. of households sharing, mean (range)	4.8 (1 - 20)	2.2 (1 - 7)	
Shared with non-related households, n (%)	18 (34.6)	5 (2.5)	
No. of households sharing, mean (range)	8.0 (2 - 16)	5.2 (3 - 6)	
Functional condition[b], n (%)			
Slab present (if applicable) & flooring sound & safe	52 (100)	199 (100)	-
Waste adequately contained (i.e. in tank or pit not full)	48 (92.3)	199 (100)	0.002
Facility has at least half height walls and door	50 (96.2)	184 (92.5)	0.346
Facility has full high walls, door and roof	50 (96.2)	172 (86.4)	0.051
Opportunity for post-defecation handwashing, n (%)			
No water or soap at or near latrine	15 (28.9)	36 (18.1)	0.055
Water available only	9 (17.3)	31 (15.6)	
Soap available only	0	1 (1.9)	
Water and soap available	27 (51.9)	132 (66.3)	

a 52 of 201 (25.9%) non-Clean Team households own or have use of a latrine at home. Latrines observed in all but 14/199 Clean Team households and 15/52 non-clean team households where the respondent elected to describe the latrine instead.
b Criteria for assessment of functional condition modified from Jenkins et al., 2014. Percentages show the proportion of sanitation facilities that meet each criteria.
** P value for differences in type of sanitation (private, family shared, and non-family shared) between the two groups*

Access to soap and water

Water availability was generally good. Many households had either a tap in the yard or compound or a tap on the street immediately outside. Almost all households had containers of stored water beside the house. Soap and water were more commonly found together near the Clean Team toilets (66%) than by the toilets in non- Clean Team households (52%), p=0.055 (table 2). Independent of having a Clean Team toilet, availability of soap and water was 25% more likely in households with a private latrine. Both water and soap were also more frequently present at the main handwashing location in Clean Team homes than in non- Clean Team homes: water present = 173 (87%) Clean Team households vs. 132 (66%) non- Clean Team households, p <0.001; and soap present = 156 (78%) CT households vs. 89 (44%) non- Clean Team households, p = <0.001. Two Clean Team and 3 non- Clean Team households did not have soap anywhere in the home at the time of survey.

Place of defecation for adults and older children

Defecation place was self-reported by 247 (41%) and 229 (44%) individuals in Clean Team and non-Clean Team homes respectively. Data on defecation practices for the remaining individuals were reported by the principal respondent in each household. Table 3 compares usual defecation and faeces disposal practices of Clean Team and non- Clean Team householders and households respectively. It also presents reported practices in Clean Team households before they acquired a Clean Team toilet. As the form of sanitation used is related to age, findings are presented separately for household members above and below 7 years of age.

Table 3. Sanitation and Faeces Disposal Practices in Clean Team and Non-Clean Team Households

	Non-Clean Team (Current Practice)	Clean Team (Current Practice)	Clean Team (Pre-Clean Team Practice)
Usual sanitation practices among household members aged 7 years and over, n (%)			
No. of individuals	461	543	529
Clean Team toilet	0	515 (94.8)	0
Bucket or chamber pot	3 (0.7)	2 (0.4)	7 (1.3)
Latrine in house, compound or neighbouring compound	156 (33.8)	3 (0.6)	138 (26.1)
Latrine at school or work	20 (4.3)	3 (0.6)	29 (5.5)
Nappy or polythene bag, including flying toilet	5 (1.1)	1 (0.2)	2 (0.4)
Public toilet	277 (60.1)	18 (3.3)	336 (63.5)
Open defecation	0	0	7 (1.3)
Other	0	0	2 (0.4)

Unknown	0	1 (0.2)	8 (1.5)
Usual sanitation practices among household members under 7 years old, n (%)			
No. of individuals	64	58	68
Clean Team toilet	0	32 (55.2)	0
Potty, bucket or chamber pot	36 (56.3)	12 (20.7)	33 (48.5)
Latrine in house, compound or neighbouring compound	6 (9.4)	0	9 (13.2)
Latrine at school or work	1 (1.6)	0	1 (1.5)
Nappy or polythene bag, including flying toilet	15 (23.4)	11 (19.0)	13 (19.1)
Public toilet	6 (9.4)	2 (3.5)	12 (17.6)
Open defecation	0	0	0
Other	0	0	0
Unknown	0	1 (1.7)	0
Faeces disposal practices in households where the place of defecation is not a latrine, n (%)			
No. of households	47	22	22
Clean Team toilet	0	7 (31.8)	0
In the garbage	35 (74.0)	14 (63.6)	15 (68.2)
In the gutter or drain	9 (19.1)	1 (4.5)	4 (18.2)
Latrine	1 (2.1)	0	0
Public toilet	2 (4.3)	0	3 (13.7)

Sanitation practices were measured by self report or report on behalf of absent household members or children under the age of seven. Practices refer to usual practice only.
Faeces disposal practices are presented for households with a child under seven years of age when the child did not usually use a latrine for defecation (i.e. uses a chamber pot or potty) and any other households where one or more individual indicated they usually defecate in a bucket or chamber pot).

Sixty percent of the 461 individuals aged 7 years and over living in non- Clean Team households reported that they usually defecate in public toilets, while almost all remaining individuals reported that they usually use a latrine at home or in a neighbouring compound. Twenty individuals reported that a latrine at work or school was their usual place of defecation. All but one of these individuals was from a household with no form of home sanitation and half were from the lowest socio-economic grouping. Although only three older individuals used a chamber pot as their main place of

defecation and none reported that they usually open defecate, a further thirty-seven individuals admitted that they occasionally open defecate or use a chamber pot or flying toilet, in total representing nine per cent of all individuals. In Clean Team households the Clean Team toilet was the usual (n=515) or occasional (n=3) place of defecation for 95% of individuals 7 years and older. Twenty-four individuals preferentially used public toilets or a latrine at school, work or home instead of the Clean Team toilet and two-thirds of individuals occasionally used these facilities alongside their usual place of defecation.

Interviews in Clean Team households suggested that household members who chose not to use the Clean Team toilet disliked the possibility of being splashed, seeing other people's faeces and the smell that developed after a few days of use. Practices of Clean Team household members prior to uptake of Clean Team were similar to the current practices of their non- Clean Team neighbours, with the majority of individuals reporting use of public toilets or another latrine (Table 3).

Place of defection for younger children

Use of the Clean Team toilet by children under 7 in Clean Team households was more frequent than use of other home or public latrines by children of this age group in non- Clean Team households. Use of chamber pots as the usual place of defecation by children under 7 was significantly lower in Clean Team households than in non- Clean Team households (21% vs. 56%, $P<0.001$) (Table 3).

We explored these relationships further using a regression analysis that excluded children under-two years old who would be unlikely to use a latrine (n= 102). Thirty-two (65%) of 49 children 2-6 in Clean Team households primarily used the Clean Team toilet (mean age 4.9 years), while only 5 (28%) of the 18 children of the same age in non- Clean Team households with a latrine use this latrine to defecate ($P<0.001$) After controlling for age of the child and household level clustering, we observed a risk difference in child chamber pot use of 35.0% (95%CI: 15.6% - 54.4%; $P<0.001$) between Clean Team households and non- Clean Team households with no latrine and a risk

difference of 27.6% (95%CI: 0.1% - 55.0%; *P*=0.049) between Clean Team households and non- Clean Team households with a latrine.

Disposal of faeces from chamber pots and disposal of children's faeces

The usual place reported for disposal of adult faeces from chamber pots or the stools of young children who did not defecate in a latrine was the public garbage sites. This was the case for Clean Team (64%) and non-Clean Team (74%) households. Nappies or plastic bags of faeces were reportedly dumped at these sites alongside other household garbage, sometimes when visiting public toilets (which are often adjacent to solid waste sites). Some faeces were also disposed of in the gutter or drain by the house (Table 3). According to focus group discussion participants, this occurred mainly at night as it is considered a *'bad, dirty practice'*. The Clean Team toilet was also used to dispose of faeces from chamber pots in some Clean Team households instead of in the gutter, drain or a public toilet as was common before having the Clean Team toilet (Table 3).

Safe faeces disposal

Individuals in Clean Team households were significantly more likely to defecate in or have their faeces disposed of in a toilet than were individuals in non-Clean Team households. This effect was largely due to the differences in defecation and faeces disposal practices for children under 7 years of age. In 72% of Clean Team households the faeces of children under 7 were disposed of safely in the toilet compared with 22% of non-Clean Team households (P<0.001) (Table 4). Consequently, when looking at faeces disposal for all households members we find a greater proportion of Clean Team than non- Clean Team households in which the faeces of all household members are disposed of safely (93% vs. 78%, *P*<0.001). Comparison of current practices in Clean Team households with those prior to having a Clean Team toilet followed a similar pattern (Table 4).

Table 4. Comparison of safety of stool disposal in Clean Team and non-Clean Team households

	Non-Clean Team (Current Practice)	**Clean Team (Current Practice)**	***P – value*[a]**	**Clean Team (Pre-Clean Team Practice)**	***P – value*[b]**

	N	n (%)	N	n (%)		N	n (%)	
Proportion of individuals aged 7 and over practicing safe faeces disposal	461	453 (98.3)	542	539 (99.5)	0.092	532	513 (96.4)	<0.001
Proportion of individuals under 7 years old practicing safe faeces disposal	64	14 (21.9)	58	42 (72.4)	<0.001	46	8 (17.4)	<0.001
Proportion of households where all members practice safe faeces disposal	201	157 (78.1)	199	184 (92.5)	<0.001	199	156 (78.4)	<0.001

a P value for comparison of current practice between Clean Team and Non-Clean team individuals and households, taking account of household level clustering.

b Mcnemer exact *P* value for comparison of current practice in Clean Team households with the practice in those households prior to having a Clean Team toilet (paired data).

Public toilets

In total, 25 public toilets were visited and caretakers interviewed. All but 1 had separate facilities for men and women. The quality and construction varied from simple, dry pit latrines to water closets and consequently facilities varied in price per use (0.10 to 0.50 Ghanaian cedis (US$ .03 to .135 as of Oct March 20162014 when the study was conducted) and cleanliness. Seventeen facilities (68%) had water available in buckets for handwashing, but only nine (36%) had soapy water in a bucket at the communal entrance and one had a small piece of bar soap that could be requested from the attendant. Eight public toilets permitted emptying of chamber pots at the same price as for latrine usage. Toilet staff at these facilities reported that they rarely observe people emptying chamber pots, but they do see people disposing of faeces in plastic bags in the solid waste collection sites next to the latrines. Several attendants in public toilets with septic tanks stated that they do not allow faeces to be disposed of at their latrine because plastic bags clog the drains.

Discussion

There are, as noted, two principal routes by which Clean Team toilets could benefit public health through their influence on household practices. First, they may reduce faecal contamination of the environment by increasing the number of individuals who follow safe sanitation and child stool disposal practices. Second, by bringing the place of defecation closer to home, they may increase the number of people who have access to soap and water convenient to their usual place of defecation and consequently increase the frequency of handwashing with soap post-defecation.

Public toilets are the predominant form of sanitation for those living in high density low-income areas in Kumasi, as found in this study as well as others.[18] Open defecation and the use of flying toilets and chamber pots which are emptied to the environment occur but are not common. The majority of Clean Team households are drawn from the population of public toilet users. Clean Team toilets may therefore have done little to reduce faecal contamination of the environment resulting from routine unsafe sanitation practice by adults. However, Clean Team toilets may have served to reduce occasional unhygienic sanitation practices, for example, during illness or at night, that is likely to occur in households that must rely on public toilets.

Our findings suggest that having a Clean Team toilet was associated with children ceasing use of a chamber pot or potty and starting to use a toilet at an earlier age than children in non-Clean Team households. This was the case not only for non-Clean Team households using a public toilet but also for non-Clean Team households that had their own latrine. Faeces emptied from potties or chamber pots were most commonly disposed of in garbage, gutters or drains, even in Clean Team households. Our qualitative findings suggest that this was because Clean Team toilets are urine-diverting and emptying in the mixture of faeces and urine from a child's potty or chamber pot is not recommended as it may increase the problem of smell. The earlier cessation of potty use associated

[18] See reference 13.

with uptake of a Clean Team toilet has potential public health significance in decreasing the contamination of the environment with the faeces of young children.

Some Clean Team users commented that the current toilet design is not suitable for small children. Modification of the design to facilitate use by younger children and/or disposal of waste from potties or chamber pots could further increase their contribution to safer, disposal of children's faeces.

Although observation of actual handwashing practices was not within the scope of this study, the presence of conveniently placed soap and water facilitates handwashing and is consequently a useful proxy for handwashing practice.[19] A greater proportion of Clean Team households had soap and water in close proximity to the toilet than non- Clean Team households with access to a toilet at home. Possibly this reflects the higher income levels of Clean Team households, but is also likely due to the fact that Clean Team toilets were more often exclusively used by single households so increasing the security of soap placed there .

Among public toilet users the availability of soap for post-defecation handwashing was lower than among users of household toilets. Given that most Clean Team households previously used public toilets, it is likely that uptake of a Clean Team toilet increased the probability of having convenient soap available for handwashing after defecation. This in turn is likely to have increased handwashing rates. However, we cannot discount entirely the possibility that current Clean Team users were already more concerned with hygiene than their neighbours before they acquired a Clean Team toilet, or that they previously elected to use only public toilets where handwashing with soap was possible.[20]

[19] Biran A, Rabie T, Schmidt W, Juvekar S, Hirve S, Curtis V (2008), "Comparing the performance of indicators of hand-washing practices in rural Indian households", *Trop Med Int Health*, Vol 13, No 2, pages 278-85; Hernandez O, Devine J, Karver J, Chase C, Coombes Y (2012), *Water and Sanitation Program: Technical Paper. Measuring the Behavioral Determinants of Handwashing with Soap*, accessed Dec 2014 at http://www.wsp.org/sites/wsp.org/files/publications/WSP-measuring-the-behavioral-determinants-of-handwashing-with-soap.pdf.

[20] Luby SP and AK Halder (2008), "Associations among handwashing indicators, wealth, and symptoms of childhood respiratory illness in urban Bangladesh", *Trop Med Int Health*, Vol 13, No 6, pages 835-44.

This study has two main limitations. One is that the cross-sectional design does not allow us to make statements about causality with respect to the practices we report on. The other is the reliance on self-report of defecation and faeces disposal practices, leading to the possible underreporting of unsafe practices, which may mask some of the impact of Clean Team. Nevertheless, reporting of unsafe practices was higher than the official figures for Kumasi.[21]

It is likely that unsafe faeces disposal was most common amongst the poorest Kumasi households .[22] Such households had not been the target customers for Clean Team to date and uptake of Clean Team was highest among relatively wealthier households within the low-income neighbourhoods where Clean Team operates. If the Clean Team service is able to penetrate lower economic strata it may have a greater impact on unhygienic defecation.[23] In the same vein, if Clean Team toilets were successfully introduced in urban areas with a bigger open defecation problem, then the potential for public health benefits would also be greater. Nevertheless our findings suggest that Clean Team toilets can contribute to safer sanitation practices in Kumasi by reducing the age at which children start to use a latrine and thus improving the safety of household sanitation practices.

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[21] See reference 13.
[22] See reference 15.
[23] Rheingans R, Cumming O, Anderson J, Showalter J (2012), *Estimating inequities in sanitation-related disease burden and estimating the potential impacts of pro-poor targeting, SHARE Research Report*, accessed Dec 2014 at http://www.shareresearch.org/research/exploring-inequities-sanitation-related-disease-burden-and-estimating-potential-impacts-pro.

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