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Rachael Ross Date

An evaluation of household latrine coverage in Kewot woreda, Ethiopia three years after implementing interventions to control blinding trachoma

By

Rachael Ross
Master of Public Health

Global Epidemiology

_____

Philip Brachman, MD
Committee Chair

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Rachael Ross

Bachelor of Arts
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An abstract of
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Abstract

An evaluation of household latrine coverage in Kewot woreda, Ethiopia three years after implementing interventions to control blinding trachoma
By Rachael Ross

The SAFE strategy for trachoma control includes surgery, antibiotic distribution, facial cleanliness and environmental improvements including promotion of latrine construction. In this study we estimate household latrine coverage to evaluate SAFE implementation in an area of Ethiopia where reported coverage in rural areas was 97%, and explored characteristics of latrine adopters and non-adopters.

Interviews were conducted in 442 households selected at random in a multi-stage, cluster survey. Estimated household latrine coverage was 56.2% (95% CI 37.5 – 74.8) and, in rural areas, was 67.7% (95% CI 59.6 – 75.7). Previous latrine ownership was reported by 12.7% (95% CI 8.9 – 16.5) of households of which 32.0% (95% CI 15.9 – 48.2) had built a replacement. Latrine adopters were more likely to be male, have more than 5 residents in their household and live in a rural area. Heads of household who were advised by a health extension worker or development agent were more likely to have built a latrine.

Household latrine coverage has increased from the 2007 zonal estimate (8.9%), but was lower than that reported. Latrine promotion should include emphasis on re-building latrines. More support may be needed by small and female-headed households, if universal latrine access is to be achieved in Kewot.

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Chapter I: Literature Review

Disease Background

Cause

Trachoma is an ocular infection with *Chlamydia trachomatis*, an intracellular bacterium. Serovars A, B, Ba and C infect the conjuctiva of the eye causing trachoma and serovars D to K can infect the genital tract causing sexually transmitted diseases (1). The primary reservoir for trachoma is the eyes of infected people, particularly children (2). Humans are the only host. Infection may be asymptomatic and repeated infections are common suggesting there is weak immunity (1). There is evidence of some acquired immunity as rates of infection and duration of infection decrease with increasing age (3). There is also increasing evidence that some patients have chronic infection (4).

Morbidity

Infection can be diagnosed by multiple laboratory techniques of varying sensitivity and specificity, including ELISA for detection of chlamydial lipopolysaccharide antigen and PCR techniques which identify *C. trachomatis* DNA. Clinical signs of trachoma infection are diagnosed using the World Health Organization's (WHO) simplified grading scale (5).

In order to examine for clinical signs of trachoma, a trained individual will evert the eyelid and examine the conjunctiva (5). The grade is based on the worst-affected eye. Figure 1 illustrates the five grades of the simplified grading scale.

Inflammatory trachoma, also called active trachoma, presents as inflammation of the conjunctiva of the eye (6) and is most often seen in children. Using the simplified grading scale, active trachoma is graded as trachomatous inflammation follicular (TF) and/or trachomatous inflammation intense (TI) (5). Most commonly active trachoma is considered TF and/or TI.

Cicatricial or scarring trachoma is the result of repeated active presentations or chronic inflammation and is a precursor to potentially blinding trichiasis (6). It is observed predominantly in adults though in hyperendemic area, where prevalence of active infection is greater than 40%, it may be found in people as young as 15 years old. Scarring, diagnosed as trachomatous scarring (TS) on the simplified grading scale, causes the epithelium on the inside of the tarsal plate to tighten causing the position of the eye lashes to shift from a horizontal orientation on the upper lid margin to a vertical position on the edge of the eyelid. When one or more eye lashes rest on the eyeball, it is diagnosed as trichiasis (TT) (5). The eye lashes resting on the cornea may scratch the surface and cause corneal opacity (CO). CO can result in low vision or blindness.

Figure 2: WHO simplified grading scale for trachoma (5)

Note: Reprinted from "A simple system for the assessment of trachoma and its complications." by Thylefors B, Dawson CR, Jones BR, et al., 1987, Bull World Health Organ, 65(4), p. 477-83. Reprinted with permission.

Studies have indicated that typically one-third of those with active trachoma (TF and/or TI) do not have a detectable infection by PCR suggesting that inflammation may persist after the infection has been cleared (4). Additionally, it has been found that approximately one-third of those with a detectable infection do not show clinical signs

(4). Hypotheses to explain those individuals with positive laboratory tests but no clinical signs include cross contamination during eye examination, poor test specificity, and/or low sensitivity of the WHO grading scale (4).

Prevalence

Reference to trachoma can be found in Egyptian Ebers papyrus in 1900 BC (7). The disease was previously endemic in Western Europe and North America. In the 19th century, due to improved living standards in these regions, trachoma was eliminated from these regions. In the developing world, trachoma remains a serious cause of blindness.

Trachoma is the leading infectious cause of blindness worldwide and the eighth most common cause of blindness overall (8). In 2002, trachoma caused an estimated 3.6% of blindness worldwide and 6.8% of blindness in the least developed countries (8).

In 2008, the WHO estimated that in 57 countries endemic for trachoma 40.6 million people were suffering from active trachoma and 8.2 million had trichiasis (9). The estimate of active trachoma was a significant decrease from an estimate calculated in 2003. The difference is attributed to previous over-estimates for India and China and the development of some countries and successful interventions in others (9). The highest prevalence of active trachoma and trichiasis is found in Africa which is estimated to have 68.5% and 46.6% of the total burden respectively (9, 10).

In 2002, Frick et al used multi-country survey data from 1980 to 2001 and population estimates from 2000 to estimate the economic impact associated with low vision resulting from trachoma (11). The study estimated 3.8 million cases of blindness and 5.3 million cases of low-vision caused by trachoma resulting in $2.9 billion (1995 US $) annual potential productivity loss. Sixty-nine percent of the estimated loss came from sub-Saharan Africa.

The National Survey on Blindness, Low Vision and Trachoma in Ethiopia, conducted in 2006, found that corneal opacity as a result of trachoma was the second highest cause of blindness (11.5%) and the third highest cause of low vision (7.7%). The national prevalence of active trachoma, which was assessed in children aged 1-9 years old, was 40.1% (42.5% rural vs. 10.7% urban) with the highest burden in the Amhara region (62.6%). Using these estimates, over 9 million children had active trachoma (12).

The SAFE Strategy

In 1997, the Global Alliance of the Elimination of Blinding Trachoma by the year 2020 (GET2020) was established. It was sponsored by the World Health Organization (WHO) as part of the global initiative for the elimination of avoidable blindness, VISION2020: The Right to Sight. The WHO has set the goal to globally eliminate trachoma as a public health problem by 2020. This is defined as less than 5% clinical activity in children per country at the district level.

The WHO has endorsed the SAFE strategy, an integrated strategy for the treatment and prevention of trachoma: S for trichiasis surgery, A for antibiotics for treatment of infection, F for facial cleanliness and E for environmental improvement (13-15). The S and A components are treatment for trichiasis and infection respectively and the F and E components are prevention. As will be discussed in depth in this review, flies have been identified as a vector for the bacterium. The flies are attracted to ocular and nasal mucous. Facial cleanliness is promoted to reduce fly-eye contact. Environmental improvements often focus on latrine promotion and access to water. The particular fly vector has been shown to preferentially breed in human feces but do not breed in latrines, so theoretically increase in latrine use should decrease the fly population. Increased access to water is hypothesized to increase cleanliness and in turn reduce direct and indirect transmission of the bacteria.

As outlined in WHO guidelines, programmatic decisions are based on estimated prevalence of TF among children aged 1-9 years old and TT among people aged 15 years or older at the district level (16). TF is used instead TI because TI has a similar clinical appearance as produced by other eye infections. If the district prevalence of TF among children aged 1-9 years old is 10% or more, annual mass treatment of all residents with antibiotics should be conducted for three years. Additionally, the F and E components of the strategy should also be implemented during that time. If the prevalence is less than 10%, prevalence should be assessed at the community level. Subsequently, if prevalence at the community level is 10% or greater, the full strategy should be implemented for three years. If prevalence at the community level is between 5% and 10%, only the F and

E components should be implemented for three years. If prevalence at the community is less than 5%, implementation of the SAFE strategy is not a priority. However, diagnosed active cases are treated. Prevalence should be reassessed every three years, at least twice after discontinuing antibiotic treatment.

Can antibiotics alone achieve elimination?

Multiple antibiotics can be used for the treatment of *C. trachomatis* infection. The most commonly used are oral azithromycin and tetracycline eye ointment. The companies that produce these products have provided substantial donations for countries that wish to conduct mass treatment campaigns. Because of the known high proportion of asymptomatic cases, it is recommended that all residents receive treatment during mass treatments.

While antibiotics have been successful in rapidly reducing prevalence of infection, there is continued debate about whether reduced prevalence is sustained and whether antibiotics alone can achieve elimination. Mathematical models suggest that local elimination of trachoma can be achieved with mass treatment with antibiotics alone but it depends on a number of factors: coverage, frequency, baseline prevalence, and re-infection rate. Studies examining recurrence of trachoma after treatment(s) have had mixed results. Because antibiotics treat *C. trachomatis* infection and there is a discrepancy between clinical signs of active trachoma and infection with *C. trachomatis* (17, 18), the majority of studies discussed below use presence of *C. trachomatis* DNA as

found by PCR assay to indicate disease. Since other ocular pathogens may cause similar clinical signs, using these signs to analyze the effect of treatment can be misleading.

Mathematical Models

Lietman et al constructed a epidemiological transmission model to understand the effects of mass treatment with antibiotics on trachoma and to determine the treatment schedule required for elimination (19). In hyperendemic areas, where prevalence of active disease is over 50%, the authors predict that after mass treatment, prevalence will double every 1-2 months. In these areas it would be impossible for annual mass treatments to eliminate trachoma and the model suggests that biannual treatments are required. In areas with lower baseline prevalence, around 30%, annual treatments would be sufficient to achieve elimination. These scenarios assume nearly universal coverage which is not realistically achievable and the model does not take into account reintroduction of the infection either through migration or contact with neighboring communities. Lastly, the model uses disease as diagnosed clinically and this is not an exact indicator of infection, especially after mass treatment (17).

Two other studies used data collected from hyperendemic areas to build models (20, 21). Both models suggest that biannual treatment is required for elimination (20) and one model further estimated it would take five years of biannual treatment to eliminate infection from 95% of villages (21). Additionally, the model estimated that if trachoma is not locally eliminated after several mass treatments the average prevalence of infection in these villages will return to approximately the same level with each subsequent

treatment, thus no longer reducing infection. This finding suggests that other methods of control will be required in a subset of villages in order to achieve elimination. In the field trial component of the study it was found that in some villages where no children had infection at one visit, infection was found at the subsequent visit suggesting reintroduction from neighboring communities.

In summary, while mathematical models generally predict that infection can be eliminated with biannual mass treatments, there are many variables which can impact the results, such as coverage and re-infection. Additionally, one model found that even with biannual treatment, there will remain villages where antibiotics alone will never eliminate trachoma. It is also important to highlight that these are theoretical models only and continued biannual treatments with high coverage may not be realistic or feasible.

Treatment Studies

In the majority of studies examining the effect of a single mass treatment, elimination has not been achieved but results have been heterogeneous. It is seen that prevalence of infection drops significantly immediately after treatment but subsequently, as soon as 4 weeks after treatment, prevalence increases again (20, 22-25), although in studies with longer follow up (18-24 months) prevalence does not reach baseline prevalence (22, 24).

When villages have been examined individually, instead of averaged, it was found that a subset of villages did achieve elimination after one treatment (22, 25). In a study in one village in Tanzania, elimination was nearly maintained even 24 months after a single

mass treatment (26). Just a single individual was found to be infected at follow-up. While these studies indicate that single villages may achieve elimination after mass treatment, results are not uniform illustrating great village-to-village heterogeneity.

A number of studies, presented below, have examined the effect of multiple annual and biannual treatments in the Gurage Zone in Ethiopia, a hyperendemic area.

Melese et al compared two annual and four biannual treatments in 16 villages over 24 months (27). Assessment occurred six months since the last treatment. Chlamydia infection was completely eliminated from 1 of 8 annual treatment villages and 6 of 8 biannual treatment villages. At 24 months, average prevalence in the annual treatment group was on an increasing trend since the last treatment. In the biannual treatment group, there was no increasing trend. Two of the six biannual treatment villages which achieved complete elimination were followed for another 18 months and received two more biannual treatments (28). At the final follow-up, one year after the last treatment (of six total treatments), not a single person had infection in either village. As the models suggested, the multiple annual treatments were ineffective in achieving elimination at six months after last treatment. Although biannual treatments were more successful, follow-up was too short to assess sustainability. While two villages were followed for one year after the final treatment and elimination maintained, heterogeneity between villages has been observed in other studies.

In another study in the Gurage zone, three villages, which had achieved elimination six months following four biannual treatments, were followed for an additional six months (29). At the final follow-up, infected individuals were found in two of the three villages thus the elimination achieved by biannual treatments was not sustained.

The Lakew et al study in the Gurage zone had the longest follow-up time after the final treatment, two years (30). Sixteen villages received four biannual treatments. At follow-up, infection was present in all villages. During the study, nine of the sixteen villages achieved local elimination (zero infections), but none of the villages maintained complete elimination at the 42 month follow-up point. Lakew et al indicates that treatment with antibiotics cannot achieve elimination and additional strategies focused on disease prevention must be included in trachoma control. Additionally, there is individual village heterogeneity in results.

Flies, Latrines and Trachoma

Flies as a Vector

Eye-seeking flies are one of five possible routes of transmission of trachoma (2). The five possible routes of transmission are:

- Direct spread between people during play or when sharing a bed
- Conveyance on fingers
- Indirect spread on fomites (shared handkerchiefs, towels, etc…)
- Eye-seeking flies

- Coughing/sneezing

Flies can act as a vector by placing their front feet, which have taste receptors, and their proboscis into a food source when feeding. Eye mucosa can be a food source for flies and the bacteria can transfer to the front feet of the fly. When the fly travels from person to person, the bacteria can be transferred (31).

There are four criteria that must be demonstrated for an arthropod to be considered a vector (32):

1. Demonstration that the suspected vector commonly feed upon the host of the pathogen
2. Demonstration of biological association in time and space between suspected vector and infected host
3. Demonstration that vectors collected under natural conditions harbor the pathogen
4. Demonstration of transmission of pathogen by suspected vector under experimental conditions

Below, evidence is presented satisfying each of these criteria for the *Musca sorbens* fly as a vector of *C. trachomatous* in ocular infection.

Vector commonly feeds upon host of pathogen:

In a trachoma endemic areas of The Gambia, there were estimated three fly-eye contacts every 15 minutes (33). *M. sorbens* accounted for 92.2% of the flies caught from

children's eyes. Although the majority of flies caught in the open air were *Chrysomya albiceps*, this species was never caught around children's eyes. In two other studies conducted in the area, *M. sorbens* comprised 79% of the 196 flies and 87% of the 3600 flies caught from children's eyes (34, 35).

Temporal and geographic association of presence of vector and infection:

In the Gambia, two pairs of villages were selected; one pair was examined in the dry season and the other in the wet season (31, 36). In one village in each pair, spraying of insecticide was carried out for three months resulting in a 75% reduction in the *M. sorbens* population and a 96% reduction in child eye-fly contacts after three months. While baseline prevalence of trachoma was similar in the two villages in each pair, the intervention village had significantly reduced prevalence after spraying compared to control villages. Overall, fly control reduced prevalence of trachoma by 61%. The number of new cases was also significantly lower in intervention villages. Similar results were found in Kenya. A fly-trap reduced fly populations by half and the number of cases of trachoma was reduced by one-third (37).

A study in Tanzania examined the effect of insecticide use combined with antibiotic treatment and did not find an association between fly density and trachoma rate (38). All communities received mass treatment and half received insecticide spraying. While spraying resulted in a significantly decreased number of flies caught for the majority of weeks of the study, there was not a significant difference in average trachoma rate between sprayed villages and non-sprayed villages one year after treatment. The authors

could not explain why the results contradicted previous findings but they suggested that compared to the strong effect of antibiotic treatment on trachoma rate, the effects from spraying may be negligible. Additionally, the authors suggested that the fly-eye transmission route may be more substantial in some areas than others and thus fly control will have varying effects by area.

Vectors collected under natural conditions harbor the vector

In the Gambia, *C. trachomatis* DNA was identified by PCR on two *M. sorbens* flies caught from children's eyes (33). In the Gurage zone of Ethiopia, 15 *M. sorbens* flies caught from children's eyes tested positive for C. trachomatis (39).

Transmission of pathogen by vector under experimental conditions

In the laboratory, flies were fed on egg yolk sac infected with *C. trachomatis* (40). The bacteria were isolated from the legs and/or proboscises for up to two hours after feeding. Additionally, flies effectively transmitted the pathogen from infected to uninfected guinea pigs.

Latrines and fly control

Realistically, using insecticidal spraying for fly control in the prevention of trachoma is not feasible (2). It must be conducted at regular intervals (in the studies discussed above it was often conducted every two weeks) making it costly and time consuming. Latrines have been suggested as a method of fly control, specifically of *M. sorbens*, based on a

number of studies on preferred breeding areas of the fly and on observational studies on risk factors for trachoma.

Three studies were conducted in The Gambia to identify the breeding sites of *M. sorbens* and to investigate whether the fly breeds in pit latrines. Previously, Hafez and Attia stated that *M. sorbens* breed "almost exclusively in human excrement"(34). In the Gambia, various types of feces were presented in the open nine times each to observe breeding. *M. sorbens* bred in feces from humans in six of the trials, milk-fed calf in three trials, cow in three trials, dog in two trials and goat in one trial (34). This type of fly was not captured breeding in horse feces, composting kitchen scraps or soil. When adjusted for mass, human feces produced the greatest quantity of flies and adult flies emerged from human feces twice as often as any other tested medium. Additionally, it was observed that flies caught from children's eyes were similar in size to flies emerging from human feces but larger than the flies emerging from other medium. The authors concluded that human feces were most likely the primary source of *M. sorbens*, but not exclusively. In some circumstances feces from cattle could also be a significant source. The findings imply that removing human feces as a breeding medium may significantly reduce fly density.

Two studies examined whether pit latrines were a viable option for reducing fly breeding sites. In one study, 2,000 flies were caught exiting latrines, but none were Muscid flies despite comprising nearly 30% of the flies captured in open areas around the village (33). In the other study, fly collections were conducted from 16 latrines monthly for one year

(41). Over 55,000 flies were caught. *M. sorbens* accounted for 0.12%. These studies provide evidence that household pit latrines are not a major source or perhaps a source at all of *M. sorbens*.

The results indicate that eliminating open defecation through the adoption of latrines would remove the primary breeding source of the fly vector of trachoma. A large number of observational studies conducted worldwide have identified the absence of a household latrine, pit or other, as a risk factor for trachoma. In Ethiopia multiple studies have found that households without a latrine have a significantly increased odds of disease compared to households with a latrine (42-44). In these studies, latrine ownership was associated with a decrease in trachoma prevalence between 16% (44) and 82% (42).

An evaluation in Ethiopia after three years of implementation of the SAFE strategy found that the presence of a household pit latrine was an independent predictor of trachoma prevalence (20% decreased odds of trachoma), when implemented with antibiotic treatment and facial cleanliness health education (45).

To examine the effect of latrine provision on trachoma prevalence, a randomized-control trial was conducted in The Gambia (35, 46). Twenty-one clusters of a total of over 8000 people were randomized into one of three arms. Seven clusters received insecticide spraying, seven clusters were provided with household latrines without health education and the seven remaining clusters received no intervention. The follow-up occurred 6-months after the start of the intervention. Child eye-fly contacts with *M. sorbens*

decreased 30% in latrine clusters. When compared to the no intervention clusters, spraying decreased trachoma prevalence among all ages by 55.8% (18.8 – 92.7). When compared to the no intervention clusters, latrine provision decreased trachoma prevalence by 29.5% (80.8% reduction – 21.9% increase) though the findings were not significant.

In Ethiopia, a randomized-clinical trial was conducted to explore whether latrine construction reduces the return of infection after mass treatment (47). Twenty-four communities were randomized to receive either a single treatment of antibiotics alone or treatment combined with new latrine provision for all households. At 12 months and at 24 months, prevalence had decreased and was equivalent in both groups. The effect of latrines could not be assessed because there was no re-infection even 24 months after mass treatment.

Isolating the impact of latrine promotion alone on trachoma may be impossible because many factors are involved and most likely any latrine promotion program includes elements of health education (48). Based on the varied results of studies examining the association of fly density with trachoma and latrine presence as a protective factor, the contribution of the fly-eye route of transmission likely varies temporally and spatially. Control programs may not be able to rely on latrine provision alone as prevention.

Alternatively, trachoma was completely eliminated from Europe and North America without any specific intervention implying that general environmental improvements (including water provision) alone or in combination with health education could have

substantial impacts on the disease (49). Environmental improvements are an important component of the integrated SAFE strategy and should not be neglected.

Current access to sanitation

In 2000, the United Nation's (UN) General Assembly ratified the Millennium Development Goals (MDG) which included the goal to halve the proportion of people without basic sanitation by 2015 (50, 51). This formally incorporated the promotion of improved sanitation into international health policy.

In 2010 it was estimated that 2.6 billion people worldwide, 39% of the population, do not use improved sanitation (52). At the current rate of progress, the MDG goal will be missed in 2015 by one billion people. Since 1990 access to sanitation in Sub-Saharan Africa has improved from 28% to just 31% in 2008. It is the region with the lowest coverage.

The Demographic Health Survey from 2000 reported that less than 20% of the population in Ethiopia had access to a sanitation facility. In rural areas, where trachoma is often localized, 8% of the population had access to sanitation (53). In 2005, the proportion of the population with access to sanitation had improved to 38% overall and 30% in rural areas.

Latrine Promotion

Sanitation is defined as the hygienic disposal of human excreta. Sustainable excreta disposal is achieved when (54):

- Latrines are consistently used by all members of a household
- Community/society maintains 100% coverage without external support
- There is no risk to community health from disposal techniques
- There is no significant degradation of environment
- It can be maintained over a prolonged period.

The Old Model: If you build it, they will use it

Historically, sanitation projects have focused on providing physical facilities either by building latrines directly or providing subsidies for individuals to use toward construction. Continued evaluation of these projects have concluded that this model is ineffective and unsustainable and have recommended moving away from this emphasis (55). Jenkins and Scott summarized the conclusions as the "overall failure of supply-side sanitation investments to yield any significant sustainable impact over the past 25 years, particularly at scale"(56).

There are a number of problems with directly providing facilities for free. It has been observed that this method does not stimulate willingness to pay in the future, to maintain facilities or even use them at all (57). In Maharashtra, India 1.7 million latrines were constructed over four years and just 57% of the latrines were used (58). Projects have often failed because of emphasis on technology and building at the expense of changing

behavior (59). In a study of 36 communities in Indonesia, Vietnam and Cambodia, over 300 latrines were inspected (60). Latrines which were completely self-financed were better maintained than ones provided by a project working in that area. In two Cambodian communities where latrines were provided for free, one third of the latrines were broken or abandoned.

Beyond use and maintenance in the short term, these programs are not sustainable because once the project concludes and the subsidy and supply chain are removed, there are no remaining resources for adoption (57). When subsidies are applied in this way, dependency on the project develops and people participate without any intention to use, either during the program and/or after support ceases. The programs are incredibly expensive and often do not focus on affordable options or replication but rather short term construction goals. Additionally, use of the subsidy is often restricted to a particular technology and ignores varying needs and preferences.

A New Model: Demand-led Programs

"The most fundamental lesson to be drawn from low-cost sanitation programs of the last decade is that success or failure and rates of progress are determined principally by consumer demand" (61).

The acknowledged failure of the long accepted paradigm has inspired projects to explore alternative strategies. Lafond concluded in a review of sanitation program evaluations that successful programs are centered around promotion and focus on stimulating

demand, not on construction (59). Many others have come to the same conclusion from observations and comparative analyses of successful sustained programs and failures (60, 62). Additionally, it has been observed that when people choose to spend money and/or time, it is more often accompanied by behavior change than if technology is provided to them (63).

If a program is going to focus on getting a household to decide to adopt a latrine, it is important to understand how this type of decision is made. Jenkins and Scott developed a model of household sanitation adoption decision making and applied it in Ghana (56). The model includes three main stages: preference (called motivation in other similar models (64)), intention and choice. In the first stage, the individual becomes aware of the personal benefits of sanitation change and the availability of products and services. Motivation to change develops from dissatisfaction with current practices and awareness of the advantages of another option. Once awareness and motivation reach a critical point, a consumer may move into the intention stage where they seek information on the options available, materials, technical skills and costs. If the individual perceives the requirements to be too great or opportunities lacking, the intention is unlikely to be followed through. The final stage, choice, is the individual's actual ability to use and take advantage of the opportunity to adopt a sanitation change.

In order to progress to and beyond the first stage, individuals must learn about the advantages of latrines. This awareness and drive is necessary though not sufficient to

achieve adoption. Latrine promotion programs must include focus on increasing awareness and generating demand.

Drivers of Adoption

It is important to understand drivers of sanitation behavior change so that programs can promote these messages. In Benin, Jenkins and Curtis conducted interviews to investigate why people adopted improved sanitation on their own. Since no current sanitation interventions were present the authors were able to understand how the demand for household latrines spread naturally without the influence of an intervention (65).

These authors identified 11 distinct drivers for latrine adoption which could be grouped into three categories: prestige-related, well-being and situational. Prestige-related and well-being drivers were mentioned most often, where as situational drivers, such as desire to increase rental income or physical barriers to open defecation such as decreased mobility of the elderly, were less frequently mentioned (65). Prestige-related drivers surrounded ideas of social status including avoiding embarrassment of sending visitors, specifically urban elite, to the open to defecate and achieving the good and settled lifestyle evidenced by a latrine. Well-being drivers included desires of family health and safety, convenience and comfort, cleanliness and privacy. All men mentioned prestige related drivers. Women mentioned convenience, comfort and privacy more commonly than men. Overall health factors as having to do with fecal-oral transmission were rarely mentioned and the authors recommend avoiding disease transmission messages when promoting latrines because health factors are not major drivers.

Mukherjee conducted a participatory assessment in Cambodia, Indonesia and Vietnam to explore drivers under a variety of interventions (60). Thirty-six rural communities with high sanitation coverage (at least twice the national average) were purposively selected for the study. The author identified a number of factors that increased demand: easy availability of sanitation materials and construction skills, awareness of advantages of latrine use compared to open defecation, social status/prestige reasons, and economic prosperity.

In interviews with both males and females, in all three countries, the most frequently mentioned benefits of a household latrine were cleanliness and reduced smell and flies. Convenience was the next most mentioned followed by health benefits. The author compared factors that stimulated demand and benefits perceived after acquiring a latrine and found they were different. While social status factors stimulated demand, they were mentioned less frequently as a benefit of adoption. Conversely, health was not a driver, but was mentioned as a benefit of adoption. In Ghana (56) and Niger (66), awareness of health benefits were also found not to be drivers of adoption.

Overall, it is suggested that health benefits cannot be the only messages of sanitation promotion programs. Messages must focus on social status, convenience and cleanliness in order to generate demand.

Project Characteristics to Increase Chances of Sustainability

Sanitation experts have identified key characteristics of interventions that they feel will result in more sustainable outcomes. These recommendations are summarized below and loosely follow the outline developed by Jenkins and Sugden (57).

There must be choices offered of locally adapted products for construction of the facility. It is best if there are multiple options at varying prices and it is important for the designs to take into account local beliefs and practices. Mukherjee strongly recommends this based on findings in Vietnam (60). Agricultural practices in the area depended on using fresh excreta but the only latrine design offered did not allow access for agricultural purposes. Some families altered the design after construction while many others simply abandoned them. These options must be coupled with good access to consumer information including options, costs and technical skills. Without this knowledge, households will not be able to adopt latrines even if they have the motivation.

Promotion techniques must focus on raising awareness and motivation. This can be most successfully conducted through locally devised strategies that utilize community networks (60). Mukherjee observes that the majority of households defer making a decision until there is support from within the community. They wait for a trusted person such as a neighbour or relative to report their experiences. This is why, as Lafond also suggests, that community participation is integral in project execution (59). For communicating messages, Jenkins and Sugden specifically recommends using door-to-door promotion techniques (57). Cairncross and Shordt agree that intensive

communication through small groups and personal communication are most likely to produce sustained effects (62).

Mukherjee also emphasizes that any sanitation project has "twin" challenges, neither of which can be ignored: increasing demand for sanitation facilities/supporting development of supply and achieving sustained sanitation behavior change (60). The availability of a latrine does not necessarily imply consistent use or the elimination open defecation. In East Java, Indonesia, 18% of unimproved latrine owners and 16% of improved latrine owners still defecate in the open at times (64). Eliminating open defecation is the ultimate outcome, not just adoption of a household facility.

Sanitation programs can be sustainable, even after cessation of promotion (62, 67), but it is not a given. Design and implementation of the program focusing on generating demand are important factors that will affect success.

Characteristics of Adopters and Non-adopters

It is important to identify adopters for two important reasons: the experience of these people with impact the success of the project and promotion techniques must adapt to target non-adopters.

In Benin, without any formal promotion program, adoption was clustered around urban centers and then spread outward along road networks. There was a strong positive association between the adoption rate within 2.5 km of a village and the villages own

adoption rate. Without outside pressures on promotion, information spread from adopters to non-adopters through personal communication and exposure to technology (68). Additionally, adopters were most likely to be male, have higher income, have larger families, have traveled to urban areas and be active in the community. Mukherjee recognized that even within rural communities in Vietnam and Cambodia which had relatively high sanitation coverage, coverage was much higher among rich households and decreased among middle-income households and decreased even more among poor households (60).

Previous studies in the Amhara region of Ethiopia have explored characteristics of adopters and non-adopters and results were similar to those found in Benin, Vietnam and Cambodia.

O'loughlin et al defined adopters in the Amhara region of Ethiopia as member of a household with a latrine in use as evidence by feces in the pit verified during inspection (69). Non-adopters were all other households included in the study, including those with an unused latrine. In univariate analysis, adopters were more likely to have had any education, have a larger household (>5 members), live in an urban setting, have an iron sheet roof, not have cattle and have traveled to the district capital. Living in an urban setting was correlated with have an iron sheet roof, not having cattle and having traveled to the district capital, so these four factors were all interpreted as indicators of wealth. No association was found between adoption status and gender, primary occupation or

religion. Adopters were more likely to mention convenience and privacy as perceived advantages of latrines than non-adopters.

After three years of implementation of the SAFE strategy, Ngondi et al completed a study in five districts in Amhara to explore adoption behavior (70). Adopters were defined as members of a household which had a latrine, regardless of use. In univariate analysis, latrine adoption was significantly associated with increasing household size, tin roof, male head of household and literate head of household. In multivariate analysis, increasing household size and tin roof were independent predictors of latrine ownership.

In summary of the O'loughlin and Ngondi studies in the Amhara region, latrine adoption has been associated with wealth (tin roof), large household, education/literacy of head of household, male head of household, living in urban setting and travel to a district capital.

Promotion in the Amhara Region

In 2001, the Amhara National Regional State Health Bureau began implementing trachoma control interventions in four pilot woredas (districts) in the South Gondar Zone of Amhara. By 2007, the trachoma control program had expanded to cover all zones of the Amhara region with the full SAFE strategy. The Amhara Region trachoma control program engages Health Extension Workers (HEWs) to conduct health education and promote household latrine construction in kebeles (communities). On average, each kebele has a population of 5,000 people, with two HEWs residing and working fulltime. HEWs train community members as volunteers to assist them with health education

sessions and construction of demonstration latrines. HEWs promote latrine construction not only in the context of trachoma control, but also to encourage improvements in family and child health along with non-health benefits such as privacy and convenience.

Because of the plethora of locally available construction materials, HEWs promote latrine construction using only these materials. A water tight cement slab platform is not required because of the soil composition, notably the lack of sand. No subsidies or construction materials are supplied by the promotion program. Demonstration latrines are constructed in each community to teach technical skills for construction. Additionally, community volunteers and HEWs may help families with construction.

Chapter II: Manuscript

An evaluation of household latrine coverage in Kewot *woreda*, Ethiopia three years after implementing interventions to control blinding trachoma

Rachael K Ross[a], Jonathan D King[b], Mesele Damte[c], Firew Ayalew[c], Teshome Gebre[c], Elizabeth A Cromwell[b], Tesfaye Teferi[c], Paul M Emerson[b*]

a. Rollins School of Public Health, Emory University, 1518 Clifton Road, Atlanta, Georgia 30322. USA
b. The Carter Center, 1149 Ponce de Leon Avenue, Atlanta, Georgia 30306. USA
c. The Carter Center, P.O. Box 13373, Addis Ababa. Ethiopia

*Corresponding author. Tel.: +1 404 420 3842; fax: +1 404 874 5515
E-mail address: paul.emerson@emory.edu (P.M. Emerson)
1149 Ponce de Leon Avenue, Atlanta, Georgia 30306

Running title: Evaluation of latrine coverage in Kewot *woreda*, Ethiopia

Abstract

The SAFE strategy for trachoma control includes surgery, antibiotic distribution, facial cleanliness and environmental improvements including promotion of latrine construction. In this study we estimate household latrine coverage to evaluate SAFE implementation in an area of Ethiopia where reported coverage in rural areas was 97%. Additionally, we explore characteristics of latrine adopters and non-adopters and investigate previous latrine ownership.

Interviews were conducted in 442 households selected at random in a multi-stage, cluster survey. Estimated household latrine coverage of the district was 56.2% (95% CI 37.5 – 74.8) and, in rural areas, was 67.7% (95% CI 59.6 – 75.7). Previous latrine ownership was reported by 12.7% (95% CI 8.9 – 16.5) of households of which 32.0% (95% CI 15.9 – 48.2) had built a replacement. Latrine adopters were more likely to be male, have more than 5 residents in their household and live in a rural area. Heads of household who were advised by a health extension worker or development agent were more likely to have built a latrine.

Household latrine coverage has increased from the 2007 zonal estimate (8.9%), but was lower than that reported in rural areas. Latrine promotion should include emphasis on re-building latrines. More support may be needed by small and female-headed households, if universal latrine access is to be achieved in Kewot.

Keywords
Trachoma, latrines, Ethiopia, SAFE strategy, sanitation promotion, sanitation coverage

1. Introduction

Trachoma is a chronic inflammatory eye disease caused by an ocular infection with *Chlamydia trachomatis*, which, after repeated bouts of infection and inflammation, may lead to permanent low vision and blindness. Trachoma is the leading cause of preventable blindness worldwide (1). The highest burden is found in Africa (2) and a large portion of that burden is in Ethiopia. The 2006 National Survey on Blindness, Low Vision and Trachoma in Ethiopia found that corneal opacity as a result of trachoma was the second highest cause of blindness (3).

The World Health Organization (WHO) has endorsed the SAFE strategy for trachoma treatment and prevention: S for surgery to correct trichiasis, A for antibiotic therapy to treat active infection, F for improved facial cleanliness, and E for environmental improvements to increase access to sanitation and water (4). *Musca sorbens*, an eye-seeking fly, has been shown to be a vector of ocular *Chlamydia* which causes trachoma(5, 6) and reductions in the density of the *M. sorbens* population have been associated with decreased trachoma prevalence (7-9). Household latrine promotion was adopted for trachoma control based on evidence that *M. sorbens* preferentially breed in human faeces (10), but do not breed in faeces within pit latrines (11). In 2000, the United Nation's General Assembly ratified the Millennium Development Goals (12) which formally incorporated the promotion of improved sanitation into international global healthy policy.

In 2001, the Amhara National Regional State Health Bureau began implementing trachoma control interventions, and by 2007 the programme had expanded to cover all

zones of the region with the full SAFE strategy. The programme engages Health Extension Workers (HEWs) to conduct health education and promote household latrine construction. On average, each *kebele* (community) has a population of 5,000 people, with two HEWs residing fulltime. HEWs train community members as volunteers to assist them with health education sessions and building demonstration household latrines. HEWs promote latrine construction not only in the context of trachoma control, but also to encourage improvements in family and child health along with non-health benefits such as privacy and convenience.

In Kewot *woreda*, in North Shewa Zone of Amhara Region, the trachoma control interventions began in 2007 based on findings from an integrated malaria and trachoma survey conducted late in 2006. The results showed that only 8.9% of households had a pit latrine in this zone (13). In December 2009, field reports to the Kewot Health Office estimated that 97% of rural households had a latrine and the health office requested that this statistic be formally evaluated.

This study, conducted in 2010, was designed to estimate household latrine coverage in Kewot *woreda*; investigate previous latrine ownership and frequency of rebuilding latrines; and explore characteristics of latrine adopters and non-adopters to identify opportunities for improving the future delivery of latrine promotion activities.

2. Methods

2.1 Study Area and Sampling

Kewot *woreda* is about 200 km from Addis Ababa and has an estimated total population of 106,727 (Figure 2). The predominant ethnic group is the Amhara though the Argoba and the Oromo also live there.

Structured interviews and latrine inspections were conducted in June 2010, at the start of the rainy season. A sample size of 446 households was calculated to provide an estimate of the prevalence of latrines at the household level, assuming that the true prevalence was 50%, within a precision of 10% at α=0.05, with a design effect of 4.0 and non-participation rate of 15%.

A multi-stage, cluster sampling design was used. Development teams (smallest administrative unit, comprising 30 households on average) were selected as primary sampling units (clusters). A comprehensive geographically ordered list of development teams was compiled by the Kewot Health Office. In the first stage, 30 areas (development teams for the rural areas and larger 'State Teams' for Shewa Robit town) were systematically selected from the list. Where a state team was selected, a list of development teams within the state team was developed on arrival with local leaders, and one development team was selected by having the local leader pull a number from a hat. In the final stage, 14-16 households were selected in each cluster (development team) by compact segment design (14). Local leaders selected five segments of three households by lottery to ensure local involvement in household selection and remove subjective household selection by survey teams.

2.2 Study Tool and Data Collection

The head of each selected household was interviewed. If the head of household was not available, another household member answered questions on behalf of the head of household. If no members of the household were available, the household was skipped and not replaced. No return visits were made to skipped households. The survey tool was developed in English, translated into Amharic and pre-tested in another woreda in the Amhara region. Surveys were administered in Amharic by experienced local staff. The survey teams attended a two-day training and administered the survey for practice in another *woreda*. Questions were asked open-ended and the response was selected from a pre-coded list or written-in if an appropriate choice was not available.

Basic demographic and household data, information about previous and current latrine ownership, and knowledge of latrines and latrine promotion was gathered for all households. Variations in the questionnaire allowed respondents with and without latrines to provide information about their current sanitation practices and beliefs. Survey teams conducted visual inspection of the latrine, if one was present. Inspection included assessing whether the local surveyor would feel comfortable using the latrine (ignoring whether there were walls for privacy) and whether there were faeces present in the pit. Only latrines considered usable by the survey team were considered as a current latrine irrespective of whether it had faeces in it. Additionally, remnants of previous latrines were inspected. Household roof material was also observed as a proxy indicator for wealth.

2.3 Data Analysis

Data were double entered using Epi Info 6 and compared using Epi Info version 3.5.1. Statistical analysis was completed using SAS (version 9.2). Results have been weighted by selection probabilities and adjusted for variation due to the sampling design. N-sizes included in data tables and results section have not been weighted. Normally distributed data were described by the mean and 95% confidence interval and not normally distributed data were described by the median and range. Univariate analysis was conducted to investigate the association between each explanatory variable and latrine adoption. A multivariable logistic regression model was developed using backward elimination strategy. The initial full model included all explanatory variables that were statistically significant in univariate analysis. Potential interaction between urban/rural setting and other factors could not be assessed due to collinearity. An alpha value of 0.05 was used to assess statistical significance.

3. Results

3.1 Response Rate

Overall, 447 households in 30 clusters were selected. At five households, no members were present. Per protocol, the households were skipped and not replaced. No households declined to participate. A total of 442 households were surveyed (Figure 3) for a response rate of 98.9%. Visual inspection of existing latrines was systematically done incorrectly by one survey team comprising 47 observations. Latrine inspection was complete for 231 of 278 households with a latrine.

3.2 Household latrine coverage

A latrine was present in 278 of 442 households. Overall, estimated household latrine coverage for Kewot *woreda* was 56.2% (95% CI 37.5 – 74.8). In rural areas of the *woreda* (areas outside Shewa Robit town), estimated household latrine coverage was 67.7% (95% CI 59.6 – 75.7). Due to small n-size, coverage in urban areas could not be calculated.

3.3 Latrine characteristics

Observed latrine characteristics of 231 latrines are summarized in Table 2. Evidence of use was observed in 222 (96.5%) latrines. Local materials, such as sticks, local mud plaster and/or stones, were used to construct the platform in 218 (93.4%) latrines, while only 11 (6.2%) latrines had a cement slab. Walls for privacy were present at 173 (76.1%) latrines and the majority (163/173, 95.1%) used only local materials. A hand-washing container was present at 58 (29.6%) latrines and 33 (60.9%) of these contained water at the time of our unannounced visit. Soap was present at 11 (5.5%) those latrines with a hand-washing container.

Reported period of use, construction time and costs were collected for all 278 latrines. Median reported latrine period of use was 1.5 years (range 0 to 11 years). The majority of latrines (235, 81.0%) had been built within the last three years. Household heads reported that construction took a median of seven days (range 2 – 75 days). Latrine construction

was reported to have been completed with no cash cost for 228 (79.5%) households. Among the 50 latrine owners who spent any money on latrine construction, the median cost was approximately 35 USD (range 0.70 – 586 USD). Latrine owners who paid anything for construction paid most often for labour (36, 76.7%), wood (27, 55.1%) and hinges/nails (50, 50.7%).

3.4 Previous latrine ownership and rebuilding

Of the 442 households interviewed, 57 reported having had a latrine in the past. Evidence of the previous latrine was visually verified for 40 of the 57. Overall, an estimated 12.7% (95% CI 8.9 – 16.5) of households previously had a household latrine. For latrines where the head of household was able to recall (49), the previous latrines lasted for a mean of 2.3 years (95% CI 1.9 – 2.7, range 4 months – 9 years). Ten (23.6%) latrines were used until they were full, while 44 (70.9%) could no longer be used because of a structural problem. Of the 57 household heads who previously owned a latrine, 16 (32%, 95% CI 15.9 – 48.2) had built a new latrine. The most-cited reasons for not rebuilding the latrine were too busy (27, 55.4%), lack of money (7, 26.4%) and cannot provide labour (12, 26.0%).

3.5 Association of household latrine ownership and potential predictors

Figure 3 shows the characterization of latrine adopters and non-adopters. Of 442 surveyed respondents, 278 who currently had a latrine and 41 who reported previously

having a latrine were defined as adopters. The 123 heads of household who had never had a latrine were defined as non-adopters.

Table 3 summarizes household and household head characteristics by latrine adoption status. The majority of household heads were male (369/441, 80.2%) and reported agriculture, including farming and animal rearing, as their main occupation (412/442, 77.6%). Mean age was 44.2 years (95% CI 41.7 – 46.6 years) and mean family size was 4.7 people (95% CI 4.0 – 5.4).

Comparing households by adoption status, there were no statistically significant differences in education, religion, ethnicity or travel experience of head of household, education of children or household roof material (Table 3). There was also no association between adoption status and age of household head (adopter 45.7 years vs. non-adopter 41.2 years, p=0.06). Adopters were significantly more likely to have a household with more than five people, report primary occupation as agriculture, be male and live in a rural kebele than non-adopters.

Table 4 summarizes reported advisors of latrine construction and advantages of latrine ownership by latrine adoption status. Of 442 respondents, 431 (91.1%), with or without a latrine reported being advised to build a latrine by at least one person. HEWs advised 417 (79.9%) heads of household. Latrine adopters were significantly more likely to report being advised by a HEW and/or by a development agent than non-adopters.

All respondents except one had awareness of at least one perceived advantage. Cleanliness (228, 68.2%) and health benefits other than trachoma (270, 63.4%) were the most frequently mentioned advantages. Trachoma control was specifically mentioned as a benefit of latrines by 98 (19.8%) respondents. Latrine adopters were significantly more

likely to mention the reduction of flies and convenience as advantages than non-latrine adopters. Five of the 442 respondents (1.0%) reported that latrines have disadvantages. Table 5 summarizes multivariable logistic regression of associations between latrine adoption and potential factors. The analysis showed that being advised by a health extension worker, larger household size, reporting convenience as a latrine advantage, and being advised by a development agent were independent predictors of household latrine ownership. While not significant, the association between gender and latrine adoption was strong ($p = 0.055$).

4. Discussion

Our study estimated that 56.2% of households in Kewot *woreda* and 67.7% of households in the rural areas had a latrine. In 2007, just 8.9% of households in the zone had access to sanitation (13). Without baseline data for the *woreda*, we are not able to estimate actual improvement in latrine coverage over three years of promotion but, if zonal baseline data is a proxy, there appears to have been a five to six fold increase in coverage. Nearly 98% of respondents reported having been advised by at least one person to build a latrine and over 80% reported they had built their latrine in the past three years. The Kewot Health Office reported 97% household latrine coverage in rural areas of the *woreda*. HEWs complete regular reports on the number of latrines built for the health post. Data is compiled at the health centre and coverage is calculated by the health office. These reporting methods were validated by a study conducted in 2004 in Hulet Eju Enesie *woreda* in East Gojjam Zone in the Amhara region (15). The study found

reporting methods were accurate and 87% of households listed in district reports as having a latrine actually had one. Our results suggest that reporting methods in Kewot *woreda* may not be sufficiently robust to distinguish between latrines built in households where no latrine had previously existed and latrines that have been constructed to replace an existing latrine. Additionally, coverage estimates may not be updated to reflect latrines no longer in use. The evaluation in Hulet Eju Enesie was conducted less than a year after latrine promotion began, while latrine promotion has been ongoing for three years in Kewot. It is possible that reporting errors over a longer period of time may become more frequent and this may have resulted in higher reported latrine coverage. Accurate reporting of access to sanitation is important in order to quantify the impact and effectiveness of the programme and to assist the *woreda* health office plan future sanitation interventions. Our results show that evaluation and estimation of latrine coverage through a population based survey is a useful exercise to validate administrative data. Additionally, an audit of reporting records may be useful to better understand where inaccuracies originate and to develop more refined tools for routine collection of programme monitoring data.

Latrine promotion activities have focused on creating demand for latrines through community mobilization by increasing knowledge about the benefits of latrines, both health and non-health related, and providing supervision on construction techniques. No compensation is provided for materials or labour as part of the latrine promotion activities. In our study, over 90% of latrines were built using exclusively local materials. Because of these construction methods, the latrines were low cost or even no cost, potentially empowering those physically able and who decide they want to change their

sanitation behaviour to take the initiative and build their own latrine. The success of community mobilization for uptake of latrines in the Amhara region has been documented in other studies (15, 16), though the sustainability of the strategy has not previously been investigated. Simple pit latrines are promoted because of cost, appropriateness of technology and availability of local materials, but concerns exist regarding how long the latrines last and maintenance requirements. On average the previous latrines lasted 2.3 years. Most of the previous latrines were not used until full, but were decommissioned because of a structural problem. Instruction for rebuilding and repairing structurally damaged latrines may need to be incorporated into the programme. Additionally, households should be reminded that regular maintenance will prolong the life of the latrine.

The proportion of previous owners who had not rebuilt (68%) was high and the reasons for not rebuilding appeared to be post-hoc justification provided to the interviewer rather than genuine. For example, being too busy to rebuild or having no money to rebuild is not consistent with latrines that, on average, take less than a week to build and usually cost nothing. Further investigation of non-rebuilders is warranted to elucidate sustainability of the program. Other studies have found that hygiene behaviours are often maintained after promotion has ceased. A case study in Vietnam found that access to sanitation was not only sustained but increased three years after a rural sanitation marketing programme, similar to the promotion programme used in Amhara, had concluded (17). In a multi-country study in Africa and Asia, Cairncross and Shordt found that hygiene behaviours, including latrine use, were sustained after cessation of promotion programmes (18). The Amhara promotion programme utilizes multiple strategies that have been suggested by

previous studies to achieve sustained outcomes including utilizing community networks, such as community volunteers, for promotion through repeated one-on-one and small group interactions (18) and generating demand for sanitation which can be met locally instead of supplying programme-subsidized technology (19). These studies suggest that projects which focus on providing technical assistance to households for building latrines and promoting awareness of sanitation rather than directly subsidizing latrines may have greater chances of sustained success. These previous studies examined sanitation programmes that promoted improved latrine designs or flush toilets, not simple pit latrines. Satisfaction with the simple pit latrines in Amhara needs to be investigated. Alternative longer lasting sanitation technologies which require less maintenance may be more satisfactory, but these advantages need to be weighed against affordability. It is not feasible to promote these advanced technologies without incorporating a subsidy component to the promotion programme. In Kewot, as more latrines begin to reach the end of their lifespan, rebuilding of latrines by community members will need to be monitored.

HEWs were the most frequently reported latrine promotion advisors. They are the primary disseminators of information in the programme and respondents who reported being advised by them were significantly more likely to be latrine adopters. Being advised by development agents was also significantly associated with latrine adoption. Frameworks for understanding behaviour change in sanitation have suggested that knowledge acquired from leaders and experts who are also members of the community are important drivers (20). HEWs and development agents are often from the communities in which they work, so they are seen as both peers and experts.

All respondents believed that latrines have advantages and, except for one, all could cite at least one specifically. Only five respondents mentioned any disadvantages. A study in Benin found that positive awareness of latrines is essential to drive behaviour change around sanitation (21). Another model, developed in Ghana, describes a three stage process of the household decision to adopt a sanitation behaviour (22). The first stage is centred on motivation driven by perceived utility gain. This perceived gain is based on awareness of advantages of the new option compared to disadvantages of the current situation. Although change in awareness of latrine advantages cannot be analyzed because baseline data is not available, the current high level of awareness is a positive indicator that the programme is effectively disseminating information.

The most frequently perceived benefits of latrines were cleanliness, health benefits, privacy and reduction of flies and smell. These results are consistent with other studies conducted in the Amhara region (15, 16) and a study in Ghana (23). In Benin, Jenkins and Curtis found that prestige, for men, and convenience, comfort and privacy, for women, were the strongest drivers of building a latrine, while health benefits were not primary drivers (21, 24). Improvement of status was mentioned by less than 5% of respondents in our study which is similar to other studies conducted in the region. While 73% of respondents mentioned a health benefit, either for trachoma or other diseases, there was no significant association between knowledge of health benefits and adoption of a latrine. Significantly more latrine adopters mentioned convenience of latrines than non-adopters. This finding suggests that while theoretical knowledge of health benefits is widespread, the felt benefits of convenience may be more important to the consumer.

Non-health messages focused on convenience, cleanliness and privacy should be included in latrine promotion programmes.

Our study found latrine ownership, past and present, to be associated with male gender and larger family size. In univariate analysis only, primary occupation of agriculture and rural residence were also associated with latrine ownership. Other studies have found strong associations between latrine ownership and wealth indicators, such as roof material, travel history and education (15, 16, 23, 24). Our findings suggest that in Kewot, it is not wealth that distinguishes owners from non-owners but the ability to supply labour. Simple pit latrines are only free if the household can provide the labour and collect the materials. Women, smaller households or heads whose primary occupation is not agriculture may struggle to provide this labour. HEWs, community volunteers and development agents should be encouraged to suggest sources of additional assistance such as extended family, neighbours and friends to households that lack their own sources of labour.

We chose to estimate household latrine coverage to evaluate the promotion programme but coverage may not reflect access and use. Data collectors visually inspected latrines to ensure that a person was physically able to use them and to estimate usage rates, but owning a household latrine does not necessarily mean there is consistent use by all household members (19). Additionally, adoption status was defined using presence of verified current latrine or reported previous latrine. Other studies have chosen to restrict adopters to households with a completed latrine that is in use (15, 23).

Our study is the first in the region to examine rebuilding of the simple pit latrines. Although our evidence suggests that the minority of households are rebuilding, only a

small portion of the respondents reported having a latrine previously. In future studies, it will be important to continue to investigate the sustainability of the programme. Promotion activities should include emphasis on re-building latrines. The programme may also need to provide additional support for households less able to provide labour/materials, such as smaller-sized and female-headed households.

Authors' contributions: RKR, JDK, PME and TG designed the study with input from MD and FA; RKR, MD and FA supervised and conducted field work; RKR, JDK and PME conducted data analysis; RKR, JDK and PME drafted the manuscript which all authors edited and approved. PME is the guarantor of the paper.

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Ethical Approval: The Institutional Review Board of Emory University approved the survey under IRB protocol 1030 and clearance to conduct the evaluation was granted by the Amhara Regional State Health Bureau and Kewot Health Office. Upon arrival in the village, the purpose of the study was explained to kebele and development team leaders. After granting approval, leaders helped with creation of household lists and sample

selection. Informed verbal consent to participate was provided by the survey respondent in accordance with the tenets of the declaration of Helsinki. Personal identifiers were not included in the data collection.

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Figure 2. Map of Ethiopia showing location of study area, Kewot woreda in the North Shewa Zone in Amhara Region

Note: Map does not reflect official administrative boundaries

Figure 3. Division of respondents by latrine ownership

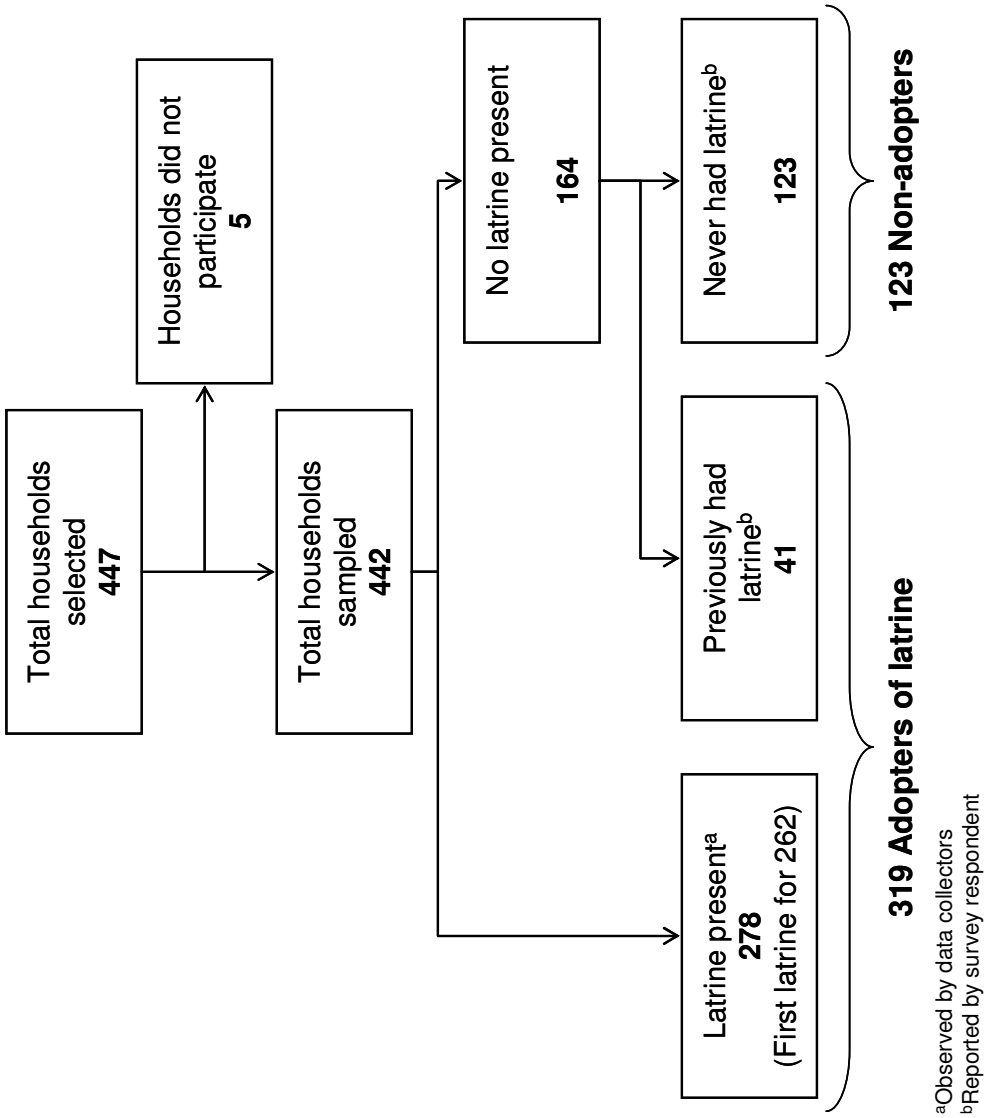

Table 1
Observed latrine characteristics in Kewot woreda, Ethiopia (N=231)

Characteristic	N	%	95% CI
Evidence of use (n=231)			
Faeces present	222	96.5	(94.2-98.8)
Platform Material (n=230)			
Local materials (incl. wood, mud, stones)	218	93.4	(86.5-100)
Cement	11	6.2	(0.0-13.1)
Plastic	1	0.4	(0.0-1.1)
Walls present (n=231)	173	76.1	(67.1-85.0)
Wall material, where present (n=173)[a]			
Wood/bamboo	146	83.4	(73.9-92.9)
Grass/small branches	52	28.8	(14.5-43.2)
Mud	17	11.8	(3.5-20.0)
Cotton/grain sack	8	3.8	(0.0-8.7)
Plastic	2	1.0	(0.0-3.1)
Iron sheet	1	0.6	(0.0-1.7)
Roof present (n=231)	169	75.6	(66.6-84.5)
Roof material (n=169)			
Local materials	146	81.8	(65.3-98.3)
Iron sheet	17	14.9	(0.0-30.1)
Plastic	6	3.3	(0.0-7.7)
Container for hand washing (n=230)			
None	172	70.4	(57.7-83.2)
Present without water	25	11.5	(4.5-18.6)
Present with water	33	18.0	(9.6-26.4)
Soap present (n=230)	11	5.5	(1.8-9.1)

Note: N-sizes are not weighted. All other data are weighted by selection probabilities and adjusted for cluster design

[a]Sums to more than 100% because more than one material could be selected

Table 2
Estimated characteristics of households and head of households in Kewot woreda, Ethiopia (N=442)

	Total		Adopters		Non-adopters			
Characteristic	N	%	N	%	N	%	OR[a]	95% CI
Gender (n=441)								
Male	369	80.2	277	69.9	92	30.1	2.5	(1.6-3.7)
Female	72	19.8	42	48.6	30	51.4	1.0	
Education (n=442)								
Any (incl. informal and religious)	191	49.0	145	62.6	46	37.5	0.8	(0.4-1.8)
None	251	51.0	174	67.0	77	33.0	1.0	
Travel to zonal capital (n=442)								
Yes	327	73.7	247	67.5	80	32.5	1.5	(0.9-2.8)
No	115	26.3	72	57.3	43	42.7	1.0	
Main occupation (n=442)								
Agriculture	412	77.6	311	77.4	101	22.6	12.7	(8.1-20.0)
Other	30	22.4	8	21.3	22	78.7	1.0	
Religion (n=442)								
Christian	380	81.7	284	70.2	96	29.8	3.4	(0.9-13.1)
Muslim	62	18.3	35	40.9	27	59.1	1.0	
Ethnicity (n=442)								
Amhara	404	93.0	295	64.7	109	35.3	0.9	(0.2-3.7)
Argoba	38	7.0	24	66.8	14	33.2	1.0	
Household Size (n=442)								
>5 people	175	34.4	145	85.4	30	14.6	5.0	(1.6-15.6)
≤5 people	267	65.6	174	54.1	93	45.9	1.0	
Children's education (n=342)[b]								
No children attend	33	12.6	25	68.8	8	31.1	0.8	(0.4-1.6)
Some/all attend	309	87.4	239	72.9	70	27.1	1.0	
Roof material (n=442)								
Metal	221	57.0	170	63.7	51	36.3	0.9	(0.4-2.1)
Local material	221	43.0	149	66.4	72	33.6	1.0	
Setting (n=442)								
Rural	412	75.9	307	76.5	105	23.5	8.3	(2.9-23.6)
Urban	30	24.1	12	28.2	18	71.8	1.0	

Note: N-sizes are not weighted. All other data are weighted by selection probabilities and adjusted for cluster design

[a]Analysis is univariate

[b]School-aged is 7 to 15 years old

Table 3
Reported advisors and latrine advantages in Kewot woreda, Ethiopia (N=442)

	Total		Adopters		Non-adopters			
	N	%[a]	N	%	N	%	OR[b]	95% CI
Advised to build by								
No one	11	8.9	1	14.3	10	85.7	0.0	(0.0-0.1)
Health extension worker	417	79.9	313	77.1	104	22.9	17.2	(8.9-33.0)
Trachoma/Community health volunteer	180	40.7	135	63.6	45	36.4	0.9	(0.5-1.6)
Government official	161	37.3	112	59.5	49	40.5	0.7	(0.4-1.1)
Development agent	138	27.8	119	83.4	19	16.6	3.7	(2.0-6.9)
School child	12	2.3	10	83.1	2	16.9	2.7	(0.6-11.7)
On the radio	5	0.9	5	100	0	0.0		–
Advantages of latrine								
Cleanliness	288	68.2	214	61.6	74	38.4	0.6	(0.2-2.0)
Non-trachoma health benefits	270	63.4	193	64.0	77	36.0	0.9	(0.6-1.3)
Privacy	161	33.8	120	69.3	41	30.7	1.4	(0.8-2.2)
Reduces flies	144	30.6	112	74.6	32	25.4	1.9	(1.2-3.1)
Does not smell	132	29.8	91	66.2	41	33.8	1.1	(0.5-2.5)
Convenience	111	20.8	91	46.9	20	12.1	2.5	(1.6-3.8)
Prevents trachoma	98	19.8	74	68.5	24	31.5	1.2	(0.7-2.1)
Improves my status	15	4.7	13	69.2	2	30.7	1.2	(0.7-2.1)
Place to dispose of child's faeces	28	4.5	24	81.4	4	18.6	2.5	(0.6-9.9)

Note: N-sizes are not weighted. All other data are weighted by selection probabilities and adjusted for cluster design

[a]Sums to more than 100% because more than one response could be selected

[b]Analysis is univariate

Table 4
Multivariate logistic regression analysis of association between latrine adoption and explanatory variables (N=440)

Factor	OR	95% CI	*P*-value
Advised by health extension worker	7.6	(3.9-14.9)	<.0001
>5 residents in household	3.1	(1.4-6.7)	0.005
Reported convenience as advantage	2.0	(1.1-3.7)	0.025
Advised by development agent	2.3	(1.1-4.8)	0.032
Male head of household	1.6	(1.0-2.7)	0.055

Chapter III: Public Health Implications

The following conclusions and recommendations are derived from the findings of this study. Estimated household latrine coverage for Kewot woreda in 2010 is 56.2% (95% CI 37.5 – 74.8). If the zonal estimate from 2007 (8.9%) can be used as a proxy for baseline in the woreda, there appears to have been a substantial increase in latrine coverage since the implementation of the SAFE strategy. In 2009, the Kewot woreda health office reported that 97% of households in rural areas, those outside of Shewa Robit town, had a pit latrine. This study estimated latrine coverage in these areas at 67.7% (95% CI 59.6 – 75.5). Reported coverage and estimated coverage are not in agreement. Current reporting methods may not distinguish if the latrine was the first at a household or if the latrine replaced a previous latrine. Without this distinction, reported coverage estimates would be inflated. Additionally, estimates may not be updated for latrines which are no longer used which would also lead to inflated coverage. The latrine promotion program should ensure that routine reporting accurately distinguishes between new and replacement latrines and include a mechanism to capture no longer used latrines. It may be beneficial for the program to audit reporting records to better understand where inaccuracies originate in order to develop more refined tools for regular data collection.

Previously owning a latrine was reported by 12.7% of respondents. Respondents reported that these latrines lasted, on average, 2.3 years. The majority of the latrines (70.9%) were no longer used because of a structural problem, while 23.6% were used until the pit was full. Pit latrines using local materials are expected to require regular maintenance. The short reported life-span of the latrines and the large proportion which

were not used until full suggest that owners may not be conducting maintenance. The latrine promotion program should include an emphasis on maintenance of already existing latrines. Additionally, because the latrine use of all local materials, the life span of these latrines, even with maintenance, may be significantly less than that of an improved pit latrine. Simple pit latrines are a short-term solution for sanitation and the program should explore alternative longer lasting construction options, such as improved pit latrines with cement slabs. It is unlikely that a longer lasting option will be as affordable as the current design.

Among the heads of household which reported previously owning a latrine, 32.0% currently owned a latrine. The promotion program should include emphasis on rebuilding latrines targeted at current latrine owners. Future studies should continue to investigate rebuilding behaviors and try to determine why heads of household do not rebuild.

Female heads of households, heads with a non-agriculture occupation and heads of smaller households were significantly less likely to have a latrine. These heads may not be able to supply the labor required for latrine construction. Even latrines built using locally available materials are low cost only if the head of household can supply the labor. For heads of household that may not be able to supply labor, promotion should include information about additional sources of assistance such as community volunteers. Heads of households who were advised by a HEW and/or a development agent were significantly more likely to own a latrine suggesting that HEWs and development agents

are effective latrine promoters. The promotion program should continue to utilize HEWs as the primary disseminators of information. Development agents could be utilized to target heads of household which may be unable to supply labor and to promote latrine maintenance.

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Appendices

IRB Documentation

EMORY UNIVERSITY | Institutional Review Board

FROM: Sean Kiskel
Emory University IRB

TO: Paul Emerson
Principal Investigator

CC:

Cromwell	Elizabeth	Carter Center - Main
King	Jonathan	Carter Center - Main
Ross	Rachael	Public Health
Rotondo	Lisa	Task Force/Child Sur

DATE: 4/29/2010

RE: **Notification of Amendment Approval**
AM2_IRB00001030
Amendment 2 for IRB Study #IRB00001030
Program Evaluation of Latrine Promotion by The Carter Center

This is your notification that your above referenced amendment was reviewed and APPROVED by the IRB on 4/29/2010.

Changes to Study Team members: Add Rachael Ross.

All correspondence and inquiries concerning this research study must include the IRB ID, the name of the Principal Investigator and the Study Title.

Sincerely,
Sean Kiskel
Emory University Institutional Review Board
This letter has been digitally signed

Emory University
1599 Clifton Road, 5th Floor - Atlanta, Georgia 30322
Tel: 404.712.0720 - Fax: 404.727.1358 - Email: irb@emory.edu - Web: http://www.irb.emory.edu/
An equal opportunity, affirmative action university

Questionnaire

Serial Number			
Observer/ Interviewer name		Informed consent given?	Yes = 1 No = 0
Development Team #		State Team # (only for urban kebeles)	
Kebele Name		Kebele setting (Circle one)	Urban = 1 Rural = 2
Date today (DD/MM/YYYY)	|__|__|/|__|__|/|__|__|__|__|	GPS Coordinates of HH	Elevation |__|__||__|__|
			Longitude |__|__|__|__|__|__|__|__|
			Latitude |__|__|__|__|__|__|__|

Please do not prompt answer choices. Unless otherwise noted, please select only one answer

Demographics

#	Question	Answer Choices	
1	Is the respondent the HoH?	No =0 Yes =1	 →7
2	Sex of respondent	Female = 1 Male = 2	
3	Age of respondent	Write in years Don't know = 99	
4	Did you ever attend school? If "No" ask: "Have you ever attended non-formal or religious education?"	No = 0 Informal or religious school = 1 Primary school = 2 Secondary school = 3 Higher education = 4	
5	What is your main occupation? *Circle only one (select the one he or she spends most time doing)*	Farming and Cattle rearing = 1 Petty trade (business) = 2 Cattle rearing only = 3 Formal employment (monthly salary) = 4 Daily labourer = 5 Farming only = 6 Child = 7 Other (write in)_____ = 98	
6	Have you ever travelled to (closest major city)?	No =0 Yes =1	
7	Sex of head of household (HoH)	Female = 1 Male = 2	
8	Age of head of household (HoH)	Write in years Don't know = 99	
9	Did HoH ever attend school? If "No" ask: "Have you ever attended non-formal or religious education?"	No = 0 Non-formal or religious school = 1 Primary school = 2 Secondary school = 3 Higher education = 4	
10	What is HoH's main occupation? *Circle only one (select the one he or she spends most time doing)*	Farming and Cattle rearing = 1 Petty trade (business) = 2 Cattle rearing only = 3 Formal employment (monthly salary) = 4 Daily labourer = 5 Farming only = 6 Child = 7 Other (write in)_____ = 98	

11	Has HoH ever travelled to (closest major city)?	No =0 Yes =1	
12	How many people usually sleep in this household?	Write in number, including children	
13	Do school age children (start at age 7) in this household attend school (including religious or non-formal education)?	No school age children = 0 Have school age child(ren) but don't attend = 1 Some but not all school age children attend = 2 All school age child(ren) attend = 3	
14	What religion does the household follow?	Orthodox Christian = 1 Muslim = 2 Protestant Christian = 3 Other (write in)_____ = 98	
15	What is your ethnicity?	Amhara = 1 Oromo = 2 Argoba = 3 Afar = 4 Tigre = 5 Other (write in)_____ = 98	
16	Have you ever been advised by someone to build a latrine? If yes, who? *Circle all that apply.*	No = 0 Health extension worker = 1 School child = 2 Trachoma/Community health volunteer = 3 Government official/ kebele admin = 4 Development agent = 5 On the radio = 6 Observed others = 7 Other (write in)_____ = 98	
17	Are there any advantages to having a latrine?	No =0 Yes =1 Don't know =99	→19 →19
18	What are the advantages of having a latrine? *After each response ask:* 'Anything else' *Circle all that apply*	Prevents trachoma = 1 Other health benefit = 2 Convenience = 3 Privacy = 4 Does not smell = 5 Improves my status = 6 Cleanliness = 7 Reduces flies = 8 Place to dispose children's faeces = 9 Convenient when someone is sick = 10 Other (write in)_____ = 98 Don't know = 99	
19	Are there any disadvantages to having a latrine?	No =0 Yes =1 Don't know =99	→21 →21
20	What are the disadvantages of having a latrine? *After each response ask:* 'Anything else' *Circle all that apply*	Needs cleaning = 1 Needs maintenance = 2 Bad odour = 3 Takes up too much space = 4 Encourages flies = 5 Dangerous for small children = 6 Other (write in)_____ = 98 Don't know = 99	
21	Observation: Record the main material of the head of household's roof	Grass = 1 Iron sheet = 2 Wood/mud bricks = 3 Other (write in)_____ = 98	
22	Observation: Is there a latrine present	No =0 Yes =1	→56 →23

Latrine Observations

#	Question	Answer Choices	
23	What is the platform made of?	Only wood = 1 Wood with mud plaster = 2 Cement slab = 3 Plastic = 4 Stones with wood = 5 Mud only = 6 Other (write in)_____ = 98	
24	Is the platform higher than ground level (so unlikely to flood)?	No =0 Yes =1	
25	Is there a superstructure?	No =0 Yes =1	→28
26	Does the superstructure provide adequate privacy?	No =0 Yes =1	
27	What materials are used in the construction of the superstructure, excluding the roof? *Circle all that apply.*	Grass/small branches = 1 Wood/bamboo = 2 Mud plaster = 3 Cotton or grain sack = 4 Cement bricks = 5 Cement plaster = 6 Iron = 7 Plastic tarp = 8 Other (write in)_____ = 98	
28	Does the latrine have a roof? If yes, what materials are used?	No = 0 Yes, thatch/local materials = 1 Yes, iron sheet = 2 Yes, plastic = 3 Yes, other material: _____ = 98	
29	Is there a clearly worn path to the latrine?	No =0 Yes =1	
30	Are faeces present in the latrine?	No =0 Yes =1	
31	Is the latrine in a usable condition? If not, why not? (Could the interviewer use it?)	Yes = 1 No, slab is broken = 2 No, it is collapsed = 3 No, other (write in) _____ = 98	 →56 →56 →56
32	Is there a water container for hand washing?	No =0 Yes =1	→34
33	Does the container have water in it?	No =0 Yes =1	
34	Is there soap or ash for hand washing?	No =0 Yes =1	

Interview

Latrine present

#	Question	Answer Choices	
35	Why did you decide to build the latrine? *Select all that apply* *After each response, prompt* "anything else?"	Felt that I needed one = 1 Advised by someone = 2 Copied neighbour = 3 Replacement for old latrine = 4 Heard about latrines on radio = 5 Religious beliefs = 6 So I don't have to go in the bush = 7 Ordered to build = 8 Other (write in)_____ = 98 Don't know = 99	

36	When did you build the latrine?	Month |__|__| Don't know = 99 Year |__|__|__|__| Don't know = 9999	
37	How long did it take to build the latrine?	Write approximate # of days _____ Don't know = 99	
38	Did you pay money for anything for the construction of the latrine?	No =0 Yes =1	→41
39	What did you pay for? *After each response, prompt "anything else?"* *Circle all that apply.*	Labor = 1 Wood = 2 Grass/Thatch = 3 Sand = 4 Cement = 5 Slab = 6 Hinges, nails = 7 Iron sheet = 8 Vent pipe = 9 Plastic/tarp = 10 Other (write in)_____ = 98	
40	In total, how much did you pay (in cash) to build the latrine?	Write total amount in Birr_____ Don't know = 9999	
41	Did anyone help you to build the latrine? If yes, who helped you? *Circle all that apply.*	No one = 0 Yes, health extension worker = 1 Yes, trachoma/ health volunteer = 2 Yes, development agent = 3 Yes, members of the household = 4 Yes, relative not in the household = 5 Yes, neighbour = 6 Yes, kebele administration = 7 Other (write in)_____ = 98	
42	In the last year have you done any additional work to the latrine?	No =0 Yes =1	→44
43	What kind of work have you done in the last year? *(For each one, ask about frequency and additional cost)* *Codes for frequency:* *0 = Never* *1 = Once a year* *2 = Twice a year* *3 = Once a month* *98 = Other*	Type of work / Freq / Cost 43.1 Fix roof 43.2 Fix superstructure walls 43.3 Fix door 43.4 Fix cracks in slab 43.98 Other: _____	
44	Are there feces in the latrine? (Look at observation 30 above)	No =0 Yes =1	→47
45	Why do you not use the latrine? *Circle all that apply.*	Smells bad = 1 It is not safe = 2 Prefer to go in field = 3 There are flies = 4 No superstructure = 5 Other (write in)_____ = 98	
46	Where does your family usually go?	Bush = 1 Neighbours' latrine = 2 Public latrine = 3 Other (write in)_____ = 98	
47	Is there anyone in the household who is not allowed to use the latrine? If yes, who? *Circle all that apply.*	No, everyone can use it = 1 Yes, young children (<5 yrs old) = 2 Yes, all children = 3 Yes, old people = 4 Yes, women = 5 Yes, men = 6	→49

		Other (write in)_____ = 98	
48	Where do those people who are not allowed to use the latrine go?	Bush = 1 Neighbours' latrine = 2 Public latrine = 3 On the ground in the compound = 4 Other (write in)_____ = 98	
49	Was there a latrine in the household before this one?	No =0 Yes =1	→DONE
50	Is there evidence of the previous latrine? *Ask to see where the latrine used to be. Record observations*	No evidence = 0 Yes, a latrine is present but it is unusable = 1 Yes, an indentation/hole in ground = 2 Yes, part of superstructure = 3 Yes, can see slab = 4 Other (write in)_____ = 98	
51	Why did you stop using the previous latrine?	It collapsed = 1 Slab broke = 2 It became unsafe = 3 It was full = 4 I am still using it = 5 Other (write in)_____ = 98	
52	Did anyone advise you to replace it? If yes, who? *Circle all that apply.*	No = 0 Health extension worker = 1 School child = 2 Trachoma/ health volunteer = 3 Government official = 4 Development agent = 5 Other (write in)_____ = 98	
53	When did you stop using the previous latrine?	Month |__|__| Still using it = 88 Don't know = 99 Year |__|__|__|__| Still using it = 8888 Don't know = 9999	
54	How old was the latrine when you stopped using it?	Write approximate # of yrs_____ Still using it = 88 Don't know = 99	
55	Is the current latrine built differently than the previous latrine? If yes, what is different? *Circle all that apply.*	No difference = 0 Superstructure/roof material = 1 Superstructure/roof design = 2 Slab material = 3 Pit deeper = 4 Pit wider = 5 Other (write in)_____ = 98	
Thank you! Congratulations on your latrine!			

No Latrine Present:

If there was a latrine that was not usable (check observation 31), mark question 56 as Yes=1

#	Question	Answer Choices	
56	Has there ever been a latrine in this household?	No =0 Yes =1	→62
57	Is there evidence of the previous latrine? *Ask to see where the latrine used to be. Record observations.*	No evidence = 0 Yes, a latrine is present but it is unusable = 1 Yes, an indentation/hole in ground = 2 Yes, part of superstructure = 3 Yes, can see slab = 4 Other (write in)_____ = 98	
58	Why did you stop using the previous latrine?	It collapsed = 1 Slab broke = 2	

		It became unsafe = 3 It was full = 4 Moved = 5 Smelled bad = 6 Other (write in)_____ = 98	
59	Did anyone advise you to replace it? If so, who? *Circle all that apply.*	No = 0 Health extension worker = 1 School child = 2 Trachoma/ Health volunteer = 3 Government official = 4 Development agent = 5 Other (write in)_____ = 98	
60	When did you stop using the previous latrine?	Month |__|__| Don't know = 99 Year |__|__|__|__| Don't know = 9999	
61	How old was the latrine when you stopped using it?	Write approximate # of yrs_____ Don't know = 99	
62	Why have you not built a (new) latrine? *Say "new" latrine if household previously had a latrine* *Select all that apply* *After each response, prompt "anything else?"*	No space = 0 Too busy = 1 Lack of money = 2 Cannot provide labour = 3 It is not my culture = 4 Use neighbours/ families = 5 Don't need/want one = 6 Currently building one/Preparing to build = 7 Too difficult to build = 8 Did not like the previous latrine = 9 Land bad (water, rocks) = 10 Moved = 11 Other (write in)_____ = 98 Don't know = 99	
63	Do you feel that you need a latrine?	No =0 Yes =1	→65
64	Why do you feel you need a latrine? *Circle all that apply.*	Embarrassed by going in the bush = 1 Don't like to send visitors to the bush = 2 Safety = 3 Privacy = 4 Health benefits = 5 Told I need to build one = 6 Want to increase social status = 7 Other (write in)_____ = 98	66
65	Why do you feel that you do not need a latrine? *Circle all that apply.*	Satisfied with bush = 1 Use neighbours latrine = 2 Waste of money = 3 Other (write in)_____ = 98	
66	Where does your family usually defecate?	Bush = 1 Neighbour's latrine = 2 Public latrine = 3 Other (write in)_____ = 98	
67	Do you intend to build a latrine in the future?	No =0 Yes =1	
68	In total, how much do you think a latrine costs (in cash) to build?	Write total amount in Birr_____ Don't know = 9999	
69	How long do you think a latrine takes to build?	Write approximate # of days _____ Don't know = 99	

Household Sampling Methodology

Steps for Household Listing and Segmentation to Select 14-16 Households in a Cluster

1. Meet the highest ranking development team leader available to explain the purpose of the survey, describe what will be done, and obtain consent.

2. Ask the development team leader to tell you how many households are in the cluster
   a. Household – sharing a common food bowl
   b. If the number of households is greater than 16, a household listing of the village is required, proceed to step 3.
   c. If the number of households is 16 or less, no listing is required. Examine all households in the village and disregard the remaining guidelines.

3. Request that others knowledgeable about households join the meeting and assist in helping create a list of all households within the development team:
   a. Make sure you explain what is meant by a "household"
   b. To assist with the listing, boundaries of the development team can be drawn on scratch paper north, south, east and west. Have the development team leader name households according to location within the development team; starting from the north and moving south.
   c. At the same time, another team member must write each household name as it is called out, leaving a blank space after every 3rd household.
   d. If 1 household remains, add to the previous segment to create a segment of four households. A segment of four or a segment of two households is acceptable.

4. Once all households are ticked on the scratch paper and listed in groups of three.
   a. Number each segment
   b. Write the numbers down along the long edge of a sheet of paper. Tear the paper to create equal sized, numbered strips.
   c. Place the paper strips in a hat or bag and have the development team leader select 5 strips (lottery) and record the numbers selected on the scratch paper.
   d. Circle those segments that correspond to the selected numbers on the list.

5. Survey all households in the selected segments. Request the development team chief to appoint a guide to assist the team locate each selected household.

6. Record the total number of households on the list and the number of segments and the number of sampled households. If in an urban cluster, also record the number of development teams in the state team. Report these numbers to the supervisor.