Shared sanitation facilities versus individual household latrines: use, pathogen exposure and health

Anna Maria Marieke Heijnen

Department of Disease Control
Faculty of Infectious and Tropical Diseases

LONDON SCHOOL OF HYGIENE & TROPICAL MEDICINE

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DECLARATION

I, Anna Maria Marieke Heijnen, confirm that the work presented in this thesis is my own. Where information has been derived from other sources, I confirm that this has been indicated in the thesis.

Signed  Date: February 25, 2015

Anna Maria Marieke Heijnen

ABSTRACT

A large and growing proportion of the world's population rely on shared sanitation facilities. These have historically been excluded from international sanitation targets due to concerns about acceptability, hygiene and access. With the development of new targets and indicators for the Sustainable Development Goals, it has been proposed to include shared facilities as 'improved' sanitation based on the number of users, if the facility is of an 'improved' technology and if the users are known to each other.

The aim of this research was threefold: i) to provide an overview of the available evidence on shared sanitation and outcomes related to health, access, use, operation and maintenance, gender and cost, ii) to describe the geographic and demographic scope of shared sanitation globally, and iii) to develop and pilot methods exploring factors that may explain any increased risk of adverse health outcomes associated with shared sanitation.

Results from a systematic literature review on shared sanitation and health showed that households accessing shared sanitation facilities were more likely to suffer from ill-health, specifically diarrhoea. However, the methodological quality of the available studies was limited. The global analysis of household survey data showed that households sharing sanitation facilities were poorer, less educated and more likely to live in urban areas. The majority of households accessing shared sanitation were found in Africa and South-East Asia.

The results from the literature review and household survey data led to the development of a cross-sectional study in Orissa, India. This study aimed to assess differences in shared and private sanitation access in 30 slums—both in terms of the users and the actual facilities. Results from this study show that households accessing shared sanitation were poorer, less educated and less likely to have water access in or near their home. In addition, significant differences in terms of cleanliness and presence of water were observed between private and shared facilities. Users of shared sanitation were more likely to continue practicing open defecation and significantly more cases of diarrhoea were reported by individuals living in these households.

The underlying reasons for this potential increased risk of disease for users of shared sanitation are not clear, but the type of users, cleanliness of facilities and opportunities to practice good hygiene are all expected to play a role. As such, these factors may also be of importance, in addition to the number of users and sanitation technology, if a shared sanitation facility is expected to be considered 'improved' sanitation in future monitoring targets.

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LIST OF ABBREVIATIONS

BMC	Bhubaneshwar Municipal Council
CBO	Community Based Organisation
CFU	Colony Forming Units
CI	Confidence Interval
CMC	Cuttack Municipal Council
DALY	Disability Adjusted Life Years
EPOC	Effective Practice and Organisation of Care
FGD	Focus Group Discussion
GEMS	Global Enteric Multicentre Study
GPS	Global Positioning System
HUP	Health for the Urban Poor
JMP	Joint Monitoring Programme
LMIC	Low and Middle Income Countries
LSMS	Living Standards Measurement Surveys
LWS	Lutheran World Service
MDG	Millennium Development Goal
NGO	Non-Governmental Organisation
OD	Open defecation
OR	Odds Ratio
PR	Prevalence Ratio
SAI	Social Awareness Initiative
SDG	Sustainable Development Goals
STROBE	Strengthening of the Reporting of Observational Studies in Epidemiology
TNTC	Too Numerous To Count
TTC	Thermo tolerant coliforms
UNICEF	United Nations Children's Fund
VIP	Ventilated Improved Pit latrine
WHO	World Health Organisation
WHS	World Health Survey

1 INTRODUCTION

1.1 BACKGROUND

Access to safe water and sanitary means of excreta disposal are a universal need and a basic human right [1]. They are essential elements of human development and poverty alleviation and constitute an indispensable component of primary healthcare [2]. Despite this, it is estimated 748 million people still lack access to an improved drinking source and 2.5 billion people do not have access to an improved sanitation facility [3]. In developing regions, where people are most vulnerable to infection, only one in every three people has access to improved sanitation [3].

This first chapter will describe the following: the importance of sanitation, the definition of shared sanitation, the policy environment surrounding shared sanitation, the aims of the research project and the structure of the thesis.

1.2 SANITATION

In its broadest sense, sanitation deals with the safe collection, storage, treatment, and disposal, reuse or recycling of human excreta (faeces and urine), as well as the drainage, disposal, recycling and re-use of waste water and storm water, and household, industrial and hazardous waste [4]. However, the main focus here will be on the safe collection and disposal of human waste. Approximately 6.3 percent of deaths and 9.1 percent of DALYs (disability-adjusted life years) worldwide are attributable to unsafe water, sanitation and hygiene [5]. A recent review estimated that in 2012, half a million diarrhoea deaths were caused by inadequate drinking water and over a quarter of a million deaths by inadequate sanitation [6]. Much of this disease burden consists of diarrhoeal disease, the second largest killer of young children in low-income countries [7]. In addition, inadequate sanitation is implicated in schistosomiasis, intestinal nematode infections, enteric fevers and trachoma [8].

It is mainly the contact, whether direct or indirect, with faeces that can be hazardous to health. One gram of fresh faeces from an infected person can contain about 10^6 viral pathogens, 10^6-10^8 bacterial pathogens, 10^4 protozoan cysts or oocysts, and 10-10^4 helminth eggs [9]. The F-diagram, as proposed by Wagner and Lanoix in 1958, (Figure 1) is a framework still in use to understand how faeces in the environment can lead to disease transmission [10]. Primary barriers to faecal exposure include the use of improved sanitation facilities and practicing good hygiene, such as handwashing with soap.

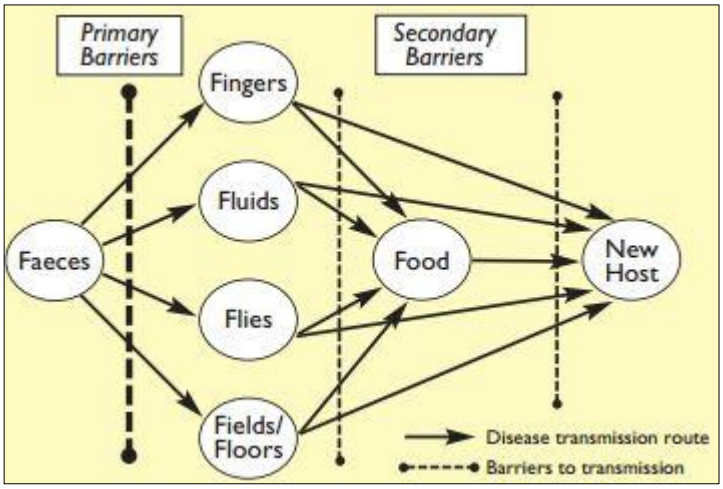

Figure 1. F-Diagram, proposed by Wagner and Lanoix, image source: [11]

Due to the clear link between faecal exposure and health, sanitation is often promoted to improve health, yet householders rarely adopt and use toilets for health-related reasons [12]. Motivations for sanitation adoption and use include the desire for privacy, avoidance of embarrassment, the desire for convenience and wanting to be modern, as well as to avoid discomforts or dangers in the bush (such as from rain or snakes) [13-15]. In addition, it can be seen as a status symbol to own a latrine [15]. Particularly for women and girls, sanitation has significant non-health benefits, including security, privacy, school attendance and basic human dignity [16]. In addition, the economic benefits of improved sanitation include lower health system costs, fewer days lost at work or at school through illness or through caring for an ill relative, and through the time savings (time not spent queuing at shared sanitation facilities or walking to the open defecation site)[17]. As can be seen in Figure 2, sanitation has multiple benefits and plays an important role in the achievement of all 8 Millennium Development Goals (MDGs) [18].

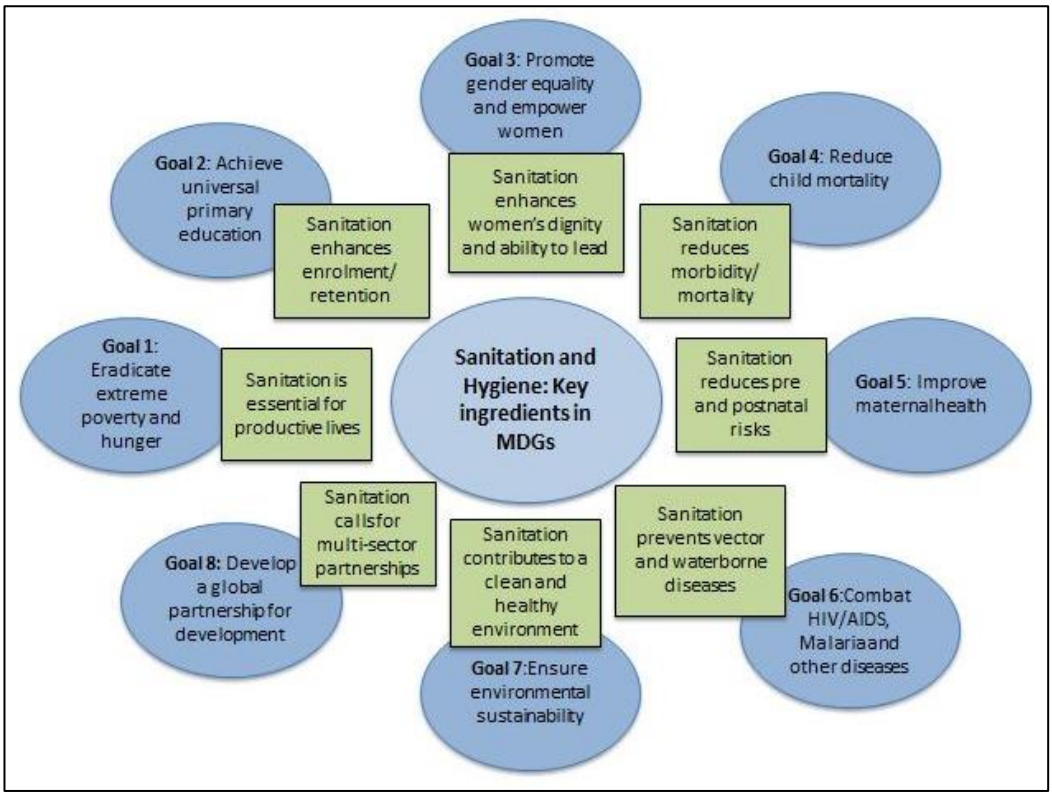

Figure 2. Sanitation: a key ingredient in the Millennium Development Goals (MDGs)[18]

1.3 IMPROVED SANITATION

The Joint Monitoring Programme (JMP) on Water & Sanitation of the World Health Organisation (WHO) and United Nations Children's Fund (UNICEF) have categorised sanitation as 'improved' and 'unimproved' depending on the service level. A flush or pour-flush toilet or latrine connected to a piped sewer system or septic system, a simple pit latrine with a slab, a ventilated improved pit latrine (VIP) or a composting toilet used by only one household is considered 'improved'. Any other flush or pour-flush latrine, open pit latrine, bucket latrine, hanging latrine or open defecation and any type of latrine shared by more than one household is considered 'unimproved' and not scored towards the MDG target [19].

This categorisation does not take into account potential contamination from the environment, such as dangers to the users from ill-maintained facilities or incorrect disposal of the waste once the septic tank or pit is full. As can be seen in Figure 3, poorly-managed sanitation facilities can contaminate water sources. In addition, if non-sewerage latrines are emptied manually without protective gear, this may pose a risk for the individual doing the work. Similarly, if the waste from non-sewerage latrines is not treated and disposed of properly, this may contaminate water sources and be a risk to the community as a whole.

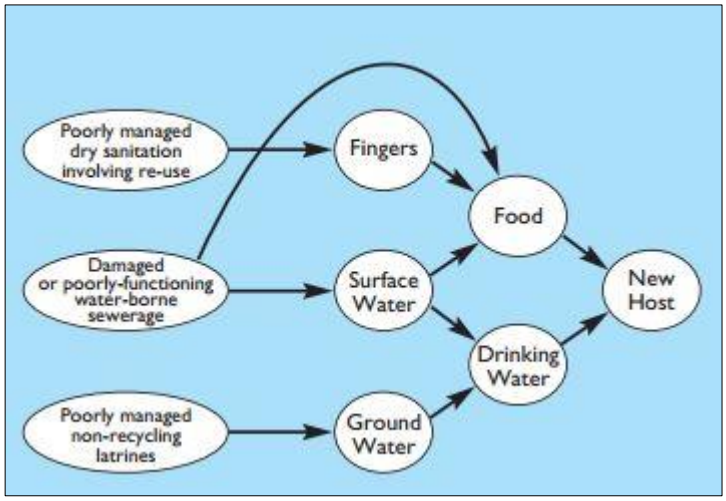

Figure 3. Additional transmission pathways due to poorly-managed sanitation, adapted from Prüss et al. [20], in [11]

As such, it is clear that access and correct use of well-managed sanitation facilities are an essential step in preventative health. A well-managed facility requires sound construction of an appropriate structure (in terms of culture, soil conditions, and climate) with safe and affordable waste management. In many low-income countries, these conditions are difficult to achieve for users of private household latrines, and potentially even harder for users of shared sanitation due to the facility being considered a 'communal good'.

1.4 SHARED SANITATION

Public and other 'shared facilities'—those used by two or more households—are excluded from the JMP definition of 'improved sanitation' regardless of the service level [19]. The reason stems from concerns that shared facilities may be unacceptable in terms of cleanliness (toilets may not be hygienic and fully separate human waste from contact with users) and accessibility (facilities may not be available at night, or have limited privacy or cannot be used by children, for instance) [21]. Despite this, UN–Habitat recognises a shared sanitation facility to be improved if a 'reasonable' number of individuals use it [22].

Nevertheless, shared facilities represent a large and growing proportion of sanitation options available in low-income countries. Nearly a fifth of the population of sub-Saharan Africa and Eastern Asia reports using shared sanitation; the practice is particularly common in Ghana (59%), Gabon (34%) and Congo (30%) [3]. Globally, the number of users has increased from 6 to 11 percent between 2008 and 2012, with approximately 784 million people using public and shared facilities of an otherwise improved type [3]. In many countries, particularly in crowded urban areas, shared sanitation is the only technically and economically viable option for those wishing to avoid open defecation [23]; in rural areas, families often keep costs down by sharing latrines between two or more households with family ties [21].

1.4.1 DEFINITIONS OF SHARED SANITATION AND INDIVIDUAL HOUSEHOLD LATRINES

Shared sanitation facilities encompass a wide range of facilities—from a facility shared amongst tenants to large public toilets shared by transient and residential population. This may cause important differences which monitoring agencies and policy makers do not always recognise [24]. There is no consensus on the terminology used when describing shared sanitation. The JMP considers any facility used by more than one household as shared, but many different terms are used in the literature [25]. In some instances, 'public', 'communal', and 'shared' are used interchangeably, whereas in other cases the exact number of households using the latrine is expressed. For example a report on sanitation in slums noted that there is a need for sanitation services beyond private facilities, such as: 'toilets shared between a compound of houses, or communal toilets for the use of the general public' [26]. This statement has the potential to confuse facilities available to the general public with facilities which may be intended only for the immediate community. Some reports specify what is meant by a shared toilet in the setting of interest—in Ashaiman, Ghana, the term 'shared toilet' is generally understood to refer to a large public toilet block [27]. Some definitions distinguish between 'shared toilets', 'community toilets' and 'public toilets' [28], whereas in the sanitation case-studies described by Schaub-Jones et al., a distinction is made between a shared facility (where a small group of defined households share a facility) and a communal facility (open to a broad community or all-comers, often on a pay-per-use basis) [29]. Mazeau et al. [30] provide an overview of different forms of urban shared sanitation (Table 1), making a distinction between 'household-shared', 'community' and 'public' facilities .

Table 1. Typology of urban sanitation, source [30]

	Communal toilet facilities								
	Public toilet facilities			**Community toilet facilities**			**Household shared toilet facilities**		
Location	Town centre, stations, markets			Neighbourhood			Backyard/compound		
Management Model	Public sector management	Private sector development	Private leasing	Community-based	Household(s) based		Private		
	Municipal Agencies	Private	Municipal agencies		Municipal agencies	Group of households		Individuals	Landlords
Access	Open			Community members	Group of households			Group of households	Tenants
Charges	Various	Yes		Yes (subsidies?)	Shared between households/pay-per-use			Yes	Yes
Payment mode	Pay-and-use/taxes	Pay-and-use		Pay-per-use/monthly fees				Pay-per-user/non-monetary	Tenancy
Construction	Municipal agencies	Private sector		Donors, municipal agencies	Municipal agencies, CBOs, group of households		Group of household	Individuals/ owner	Agreement landlord/ tenants
Operation and maintenance			Private contractors, individual	CBO, NGO, urban poor federation, women's cooperative					
Permanent caretaker	Various	Yes		Yes	No			Various (member of household)	No
No. of cubicles/ facility	Mostly over 10 cubicles			Various				<3	
No. of users	Between 500-1000 users/facility/day			<500 users/facility/ day	3-4 households/ cubicle	10-20 households/ cubicle		2-10 households	

Throughout this thesis, the term 'shared sanitation' will refer to any type of shared sanitation facility used by more than one household, irrespective of the service level. Where necessary or known, the level of service as per JMP definitions will be stated. Where distinctions between the different types of sanitation are made, these will be defined as follows:(i) 'public' facilities that are intended to be used while in public spaces (markets, transport stations, schools, etc.), (ii) 'communal' facilities that are used by householders primarily from home but are available to all members of the community, these may include Sulabh[1]-style facilities, and (iii) 'neighbour-shared' latrines that are also used primarily from the home but by neighbouring households or households on the same compound or sharing with the landlord, not the community at large. These definitions do not depend on ownership or management; the facilities may be owned, managed or maintained by government, community, Non–Governmental organisations (NGO), private individuals or companies.

By contrast, I use the term 'individual household latrine' (and sometimes 'private sanitation' or 'private latrine') to mean a facility used solely by one household.

1.5 Millennium Development Goals

As mentioned above, an estimated 2.5 billion people lack access to improved sanitary facilities, and at the current pace, the MDG sanitation target—to halve the proportion of people without access to basic sanitation by 2015—will not be reached until 2026 [21].

The MDG target, which is expressed in terms of 'basic sanitation', was deemed to be context specific and to include 'the lowest-cost option for securing sustainable access to safe, hygienic, and convenient facilities and services for excreta and sullage disposal that provide privacy and dignity, while at the same time ensuring clean and healthful living environment both at home and in the neighbourhood of users' [4].

However, in the last two decades, governments have been encouraged to move away from shared sanitation facilities in favour of private facilities. As noted above, these recommendations stem from concerns that these facilities may be unacceptable both in terms of cleanliness and accessibility [21].

As will be seen in Chapter 2 and 3 however, limited research has been done on shared sanitation, presenting important knowledge gaps. Despite this, the JMP is re-considering the definition of shared sanitation as unimproved [31]. The suggestion for the post-2015 'Sustainable Development Goals' is that otherwise improved facilities (flush toilets, pits

[1] Sulabh sanitation facilities are managed by the Sulabh International Social Service Organisation, providing pay-per-use sanitation and bathing facilities in central locations of many Indian cities. These facilities may provide a sanitation service to both the general public, as well as local residents.

with slabs, etc.) which are shared by no more than 5 families or 30 persons, (whichever is fewer) will be considered improved sanitation, if the users know each other [32].

1.6 Research aims, questions and hypotheses

1.6.1 Aims of the research

This research seeks to contribute to the evidence base on shared sanitation, with the aim of informing future policy.

The specific objectives of this research are:

a. To review, summarize and analyse the available research on shared sanitation and outcomes related to health, access, use, operation and maintenance, gender and cost.
b. To describe the geographic and demographic scope of shared sanitation globally, and to provide an indication of who the users are and where they live.
c. To develop and pilot methods to explore factors that may explain any increased risk of adverse health outcomes associated with shared sanitation over individual household latrines.

1.6.2 Research questions

The questions this thesis asks are:

1. What information is currently available (both published and unpublished) on shared sanitation in relation to health, access, use, operation and maintenance, gender and cost for compiling and analysing into a systematic literature review.

2. What is the scope of shared sanitation, i.e. how many households report that they rely on shared sanitation, how many households do they share with, what countries and regions represent the largest concentrations of people relying on shared sanitation, and how do users of shared sanitation differ from those with individual household latrines by wealth?

3. If existing evidence suggests that shared sanitation is associated with adverse health outcomes, what methods can be used to explore whether the increased risk may be attributable to differences in users, latrine access and use, or exposure to pathogens while using communal latrines, rather than on differences between individual and shared latrines?

1.6.3 HYPOTHESES

During the course of the research, especially after addressing the first two research questions, the following hypotheses arose:

1. People relying on shared sanitation instead of private latrines are at greater risk of enteric infection due to greater poverty, less education, less access to improved water supplies, sharing a house with many people, and having overall lower health status.
2. People relying on shared sanitation instead of private latrines are subject to greater exposure to enteric pathogens because (i) they are less likely to use the latrines consistently and more likely to continue to practice open defecation, (ii) they are more likely to have contact with faecal material during use of the latrines, and (iii) they are less likely wear shoes or to wash their hands with soap after using the latrine.
3. Differences in use, exposure and hand washing behaviour among people that rely on shared sanitation versus private sanitation can be mitigated through maintenance and management of the latrines.

1.7 THESIS COMPONENTS

This thesis consists of 6 chapters, the content of each of which is summarized below.

Chapter 1: Introduction

Research goals and questions

Chapter 2: Systematic literature review on shared sanitation

Provides an overview of published and unpublished studies, reviewing any reported outcomes associated with shared sanitation use. Includes a published systematic literature review assessing shared sanitation and health outcomes.

Chapter 3: Geographic and demographic scope of shared sanitation

Through the analysis of household survey data, a global and regional overview of shared sanitation is presented. Includes a published paper assessing the geographic and demographic scope of shared sanitation.

Chapter 4: Shared sanitation versus private latrines in Orissa, India

Provides an overview of the fieldwork conducted in Orissa, India, comparing users of shared sanitation and private latrines in terms of latrine use,

maintenance and potential contamination. Includes a paper ready for submission describing the main results.

Chapter 5: Shared sanitation in Orissa, India

This chapter takes a closer look at the households reporting use of shared sanitation, and considers the different sharing categories present in the study, comparing the use, maintenance, costs and potential contamination exposure for its users. Includes a paper ready for submission describing the main results.

Chapter 6: Reflections, summary of results and future research

In this last chapter, I reflect on things I would have liked to do differently, with the benefit of hindsight. I also provide a brief summary of results and suggest areas for future research.

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2 SYSTEMATIC LITERATURE REVIEW ON SHARED SANITATION

2.1 BACKGROUND

There is a need to better understand the users of shared sanitation facilities—who they are, where they live, what type of facility they use and what impact the use, or lack thereof, has on them. A small but growing number of research articles, reports and studies are available on shared sanitation use, but the substantial heterogeneity in study settings, size and location, as well as the language and date of publication complicates the collation and use of this information.

The systematic review methodology was designed to address such a challenge—it attempts to identify, synthesize and explain a variety of studies relating to a particular (health) intervention. The distinctive characteristic of the systematic review is that it is performed using a carefully planned, documented and repeatable approach—much like the methods and materials section of any scientific paper—in order to minimize bias and random errors [33]. This approach is outlined in a protocol that governs all-important aspects of the review procedure. Key elements of the systematic review include (i) a well-formulated research question, (ii) clear criteria for including and excluding studies based on the scope of the review and an objective assessment of quality, (iii) transparent and exhaustive methods for searching for studies that potentially meet the inclusion criteria, (iv) joint application of inclusion criteria and extraction of data from studies to minimize bias, and (v) a clear statement of findings. A systematic review may or may not include meta-analysis, a statistical method to summarize and combine the results of independent studies and thus produce a pooled measure of effect [34].

An important goal of the systematic review is to establish whether scientific findings are consistent and can be generalised across populations, settings and variations of the intervention. For some interventions, for example those with a clear definition (i.e. administering a vaccine of a specified dose) this generalisation is easier than for others. In the case of shared sanitation, there is little consensus on the exact definition of 'shared sanitation' and the interpretation of different sanitation facilities may vary between countries and cultures. However, this can be partly ameliorated by following a detailed protocol, specifying all terminology accepted in the search.

2.2 PROTOCOL

In 2011, UNICEF and WHO commissioned research to assess the available evidence on shared sanitation facilities, considering all available sources, both published and grey literature. This included a systematic literature review with the main objective to compare shared sanitation with individual household latrines. The original protocol for this review

considered a variety of health and non-health outcomes as part of the search strategy. The protocol was drafted by M. Heijnen, with input from co-authors, namely O. Cumming, Dr R. Peletz, Dr J. Brown and Dr T. Clasen. A copy of the full protocol is included in the Supplementary Information of the published review, available in Appendix 1 of this thesis.

2.3 CRITERIA FOR INCLUSION IN THE REVIEW

As stipulated in the search protocol, shared sanitation included any type of facilities intended for the containment of human faeces, whether on-site (e.g., pit latrines, toilets connected to septic systems) or connected to sewerage systems. The sanitation facilities may be owned or maintained individually by one or more households or by a commercial or governmental entity. In order to capture all such studies, all studies reporting on shared sanitation facilities were included in the initial sweep, irrespective of the type of hardware (i.e., whether it met the JMP definition of 'improved' or 'unimproved'). However, sanitation facilities designed primarily for use by householders when they are away from the home, such as schools, markets, train or bus stations, city streets, health facilities, governmental buildings or other public places, were excluded.

Studies were eligible for inclusion in the review if they reported on any of the following outcomes: (i) health impact (diarrhoea, helminth infections, enteric fevers, other faecal-oral diseases, trachoma and adverse maternal or birth outcomes), (ii) measures of exposure to pathogens via faecal-oral transmission pathways (drinking water quality, hand contamination, flies, presence of faeces), (iii) measures of sanitation uptake (latrine use, changes in open defecation, etc.), and (iv) equity and other social impacts of sanitation. Studies were included regardless of design, location, language or publication status.

Overall, 19 databases were searched, including MEDLINE; EMBASE; LILACS; Cochrane Central Register of Controlled Trials and Chinese-language databases available under the Wan Fang portal, and the China National Knowledge Infrastructure (CNKI-CAJ). Relevant conference proceedings were hand-searched and relevant researchers and organizations working in the field were contacted. In addition, the references in any identified study were checked for further documents. The key search terms used can be seen in Table 2.

Table 2. Search terms used

Search strategy	
(**BLOCK 1** ***AND*** **BLOCK 2) *AND* (BLOCK 3 *OR* BLOCK 4)**	
BLOCK 1	**BLOCK 2**
Sanita*	Shared
Excreta Disposal	Commu*
Fe*ces disposal	Common
Toilet*	Public
Latrine*	Improve*
Toilet facilities/	Slum*
Sanitation/	Collective
Waste disposal, fluid/	Safe
Waste disposal	
Sewage/	
Sewerage	
Sewage disposal	
Refuse disposal/	
BLOCK 3	**BLOCK 4**
Diarrh*eal disease	Water access
Cholera/	Equity
Infant welfare/	Uptake
Child welfare/	Adherence
Hygiene/	Compliance
Health promotion/	Maintenance
Hand washing/	Cost
Infant nutrition disorder/	Cost analysis/
Child nutrition disorder/	Operation and maintenance

Water quantity	Utili*ation
Diarrhea, Infantile/	Stress, Psychological/
Diarrhea/	Gender identity/
Diarrh*ea	Violence/
	Sex Offenses/
	Social change/
*indicates truncation	/indicates MESH term

2.4 CONDUCTING THE LITERATURE REVIEW

Except where otherwise noted, M. Heijnen conducted each element of the review, including executing the search, extracting the data, performing the meta-analysis, and drafting the review itself.

2.4.1 SEARCH FOR AND IDENTIFICATION OF STUDIES INCLUDED IN THE REVIEW

During the first few months of 2012, M. Heijnen conducted the initial literature search, with an inclusion cut-off established for April 15th 2012. During this time, all 19 databases were searched and all digital results were collated in Endnote X5 (X5.0.1 Thomson Reuters). This allowed for the removal of any duplicate titles—this was facilitated by the Endnote programme and verified manually. The large number of search terms, as well as the wide variety in databases resulted in a vast number of search results. Overall, 8582 duplicates were removed, and 17064 titles were screened for relevance. Abstracts for all relevant titles were compiled and reviewed by M.Heijnen, and verified by O.Cumming. In addition, any results from manual searches and experts in the field were cross-checked with the Endnote database, and included in the final list if the title and abstract were deemed relevant as per protocol. The final number of abstracts reviewed was 207 and after checking the full-text, 27 documents remained. A total of 22 studies reported on health outcomes and were included, but only 5 documents reported on non-health factors outlined in the protocol. Unfortunately most of the studies contained only anecdotal information on shared sanitation use, without presenting any interventions or results. For Chinese-language search results, a third author, G.K-S. Chan, undertook the same process individually.

2.4.2 DATA EXTRACTION

Relevant data, including a brief description of the study (i.e. study design, setting and year), details of the study population, specifications of the sanitation facilities and the outcome measures investigated were extracted from all eligible studies using a standard

data extraction matrix; this was independently crosschecked by O. Cumming. If an article or abstract was considered relevant, but the data were not available in the format needed, attempts were made to contact the corresponding authors or publishers.

2.4.3 Assessment for methodological quality

Each study included in the review was assessed for methodological quality. For observational studies, the STROBE (Strengthening of the Reporting of Observational studies in Epidemiology) statement was used as a guideline to extract data on the risks of bias. While the protocol for the review contemplated assessing studies with a specified intervention group using the Cochrane EPOC (Effective Practice and Organisation of Care) criteria, no such studies met the review's inclusion criteria.

2.5 Results

The health results of the systematic literature review have been written up and the published manuscript has been included in this chapter. Due to the limited data on non-health outcomes, the published review only covers the association between shared sanitation and health outcomes. Before publication, the literature review was updated with results up to September 2013, following the same procedure as outlined in the protocol. The limited search results on non-health outcomes (n=5) have been described below (section 2.6) and contain the systematically searched data up until April 2012. This section has been updated where relevant with published and unpublished documents retrieved through regular literature searches.

2.6 Non health outcomes associated with shared sanitation use

In the past, using sanitation facilities has often been encouraged because of the expected health benefits. However, many users do not consider improved health to be an important motivator, instead considering issues of privacy, practicality and status [12]. This section provides an overview of current knowledge on non-health outcomes associated with the use of shared sanitation, compared to the use of private sanitation where possible.

2.6.1 Exposure pathways

Exposure to faecal indicator bacteria and potential transmission pathways was investigated in a study in Tanzania, which considered the cleanliness of private versus shared latrines, including the density of *E. coli* —a common indicator of faecal contamination [35]. Though there were differences in *E. coli* densities between shared and private latrine facilities, these were not statistically significant (OR 0.61, 95%CI 0.26 – 1.43). The author concluded that the density of *E. coli* may be more dependent on the level of maintenance of the facility, rather than the type of use. Fobil and colleagues used census data to examine urban neighbourhood environmental quality, as measured

through various indicators including public toilet use [36]. The study reported strong evidence of a real difference in environmental quality across the 5 socioeconomic classes with respect to the proportion of households using public toilets (p=0.005). The authors suggest that socioeconomic conditions are important drivers of change when it comes to urban environmental quality—as people become wealthier, they are less likely to need a public toilet. Another study found no statistically significant difference between the number of flies—a mechanical vector for faecal contamination—in private latrines versus shared latrines [37].

2.6.2 Outcomes related to acceptability and determinants of use

In an assessment of communal facilities in Kibera slum in Nairobi, Kenya, it was found that users evaluate the appropriateness of sanitation facilities on different criteria than Non-Governmental Organisation or Community Based Organisation (CBO) [38]. The most important variable for users was cleanliness (47% of respondents), followed by not having to use a 'flying toilet'[2] (20%), having a separate bath room from the toilet (11%), affordability (7%), safety (6%), having responsive management (5%) and being well built (2%). This corresponds with an earlier study in Benin, where cleanliness of sanitation was rated highly by users [13].

Biran et al. conducted a comprehensive quantitative survey assessing the determinants of communal latrine usage [39]. The study reports that use was negatively associated with distance (OR 0.36, 95% CI 0.22 – 0.58) and opening hours (OR 0.02, 95% CI 0.00 – 0.84). The facilities were more likely to be used if there was a facility subscription fee (and thus regular cleaning) (OR 1.16, 95% CI 1.09–1.24) and there was a variable effect of cost on the usage of communal latrines (OR 0.88, 95% CI 0.76–1.01). Interestingly, despite women reporting use of the communal facilities in household interviews, there was a clear 2:1 male:female ratio of users observed at the latrines.

In a cross-sectional study in 50 slums in Kampala, Uganda, the main reasons for sub-par cleanliness of the shared toilets was reported to be the lack of cleaning equipment (32%), no cooperation to clean toilets among user households (31.5%) and careless use, often leaving it dirty after use (29.2%)[40]. Just over half of the shared toilets had no locks and thus were open and accessible to the public which may have influenced their cleanliness. In this same study, the users' intentions for cleaning were assessed. The respondents' cleaning intention were very strongly associated with their perceived importance to use a

[2] A 'flying toilet' is a common term for defecating into a plastic bag, which is then disposed of in the nearby rubbish heap or gutter. Unfortunately these are occasionally 'thrown' out, hence the reference to flying.

clean toilet, followed by their perceived disgust associated with the use of dirty toilets and the effort it would require for them to clean the toilet. This study shows that factors such as one's understanding of the importance of using a clean toilet and the perceived disgust from using dirty toilet are essential in fostering users' cleaning intention for shared toilets [40]. In this same setting, most of the household respondents who were very dissatisfied with their sanitation facilities were users of shared toilets (65.9%), and there was a positive correlation (Pearson 0.233;$p<0.001$) between satisfaction and not having to wait before one can use a toilet during the day [41]. The main reasons for respondents' dissatisfaction included sharing sanitation facilities with too many users (36.7%) and facilities that were dirty and smelly (28.5%) [41]. Günter et al. compared cleanliness with rates of sharing and noted that below 4 households per stance or cubicle, the cleanliness of the shared latrines was comparable to private facilities (about 80% were clean), while above 10 households per stance the proportion of clean toilets dropped to 40 percent [42]. Users in this study (especially private owners) accepted a lower standard of cleanliness compared with a more objective observer, highlighting that cleanliness may be quite subjective. Interestingly, in a study in Burundi assessing latrine cleanliness, neither sharing nor the number of households sharing was found to have an effect on cleanliness, though it must be noted that the shared latrines included in this study were mostly shared by two households only [43].

Research on sanitation conducted in India concluded that small, limited access sanitation facilities tend to be cleaner and used more responsibly than large scale community toilets—in the more intimate settings of these micro-communities, people can be directly held liable and reprimanded for misuse, thus making the system more reliable and self-sustaining [44].

In one slum in Mumbai, India, women reported preferring to be in an open space rather than use an unclean toilet, even though this made them more vulnerable to harassment [45]. This was also mentioned in a study in Ghana, where residents in Ashaiman openly admitted to preferring open defecation to using shared toilets which they considered to be dirty and smelly [27]. In interviews with slum dwellers in Mumbai, open defecation was considered preferable because the public toilet was about 30 minutes away by foot, and even then there would be long queues [46]. In a cross-sectional study in rural Maharashtra, despite the presence of community latrines, 67 percent of the respondents resorted to open defecation [47]. The main reason stated for not using the community latrine was inadequate water supply (48.6%). The importance of water was also highlighted in a separate study in Maharashtra where women rated cleanliness and the availability of water as the most important features of a 'good' toilet [48].

Tiimub et al. reported that in their study area in Ghana, public latrines account for nearly half (43%) of the toilet facilities [49]. However, as the user ratio can be as high has 1 toilet for 500 people, many prefer open defecation. Of the respondents, 42 percent were unskilled labourers, whilst 27 percent were students. Both groups reportedly were unable to afford household toilet facilities. Oduro-kwarteng and colleagues assessed attitudes towards shared sanitation facilities and possible demand for household sanitation [50]. It was found that households without improved household toilets (86%) who used the public toilets were dissatisfied with their current public toilets. The two attributes of public toilets that engendered the most dissatisfaction were odour and uncleanliness (86%). Other attributes included walking long distances to toilet facilities (57%) and having to share with others (percentage not provided). One of the barriers for constructing a household toilet was that often each multi-family house is owned by a number of individual families, and not everybody may be willing to contribute [50].

In a study in East Java, defecating in the neighbour's latrine was found to be a taboo in several districts [51]. Often people sharing latrines were embarrassed and hesitated to ask for such a favour from their neighbours. They report that sharing is done only occasionally, such as when sick, in bad weather, or at night when it is risky to go the river. They reported sharing on a regular basis only if it is a relative's latrine rather than the neighbours, the latrine is situated within the same family compound or they had contributed or co-invested in building of the latrine. The researchers found that the co-owners were sharing and maintaining their facilities together satisfactorily. In addition, it highlighted that people who share latrines only at specific times of day or in specific situations often resort back to open defecation for their daily needs [51].

Murthy et al. studied the defecation habits of 172 adults pre- and 170 adults post-intervention [52]. The intervention was an intense health campaign during a cholera outbreak, during which a community latrine was constructed. Some of the most frequently stated reasons cited for not using the community service facility among those defecating in the open were 'distance' (37.5% of women mentioned versus 13.1% men), 'cost is too high' (43.5% of men, vs 0 women) and 'latrines are open irregularly' (16.7% of women, 0 for men). For this particular study it is of interest to note that women and children did not have to pay for use of the community latrine facility.

In Ashaiman, Ghana, household surveys showed that depending on the area of the town, distance to the facility was important—a factor which is strongly influenced by urban planning [27]. In addition, though users preferred to use a facility which was close by, they also expressed concern regarding the management arrangements which influenced aspects of price, cleanliness and the level of privacy. Especially if facilities were located in

a badly-lit part of the neighbourhood, lighting in- and around the toilet block was also considered very important [27].

A briefing note published by the SHARE research consortium highlighted some of the difficulties faced by women in slums in relation to sanitation facilities [53]. It was reported that men only needed the communal facilities for defecation, whilst women would have to go for both urination and defecation, increasing the cost as well time taken to walk to the facility and queue. High cost, lack of cleanliness and scarcity of the facilities available in the study communities were key reasons why women considered their sanitation to be inadequate. However, the risk of illness, injury and rape was also a significant dimension of inadequacy in this context, and shame and fear were associated with the use of the latrines, especially at night [53].

2.7 DISCUSSION OF THE NON-HEALTH RESULTS

The non-health results discussed above cover issues related to cost, privacy, cleanliness, waiting times and time to facility as well as availability of water. There are reports of varying use of shared facilities, especially for women. There are also studies reporting on other outcomes, such as number of flies or *E.coli* between shared and private facilities.

There is very little consensus on how the different types of shared sanitation are defined. Public latrines often require pay-per-use and are government or institutionally managed, whereas communal facilities can be managed by the surrounding community and may or may not be on a paid system. Compound latrines are shared latrines within the housing compound, often shared between neighbours and sometimes with the landlord. These are usually privately managed. The descriptions of 'sharing with a neighbour' or 'other family' may be the same as compound sharing in some settings, and similarly indicate use by a limited, often known or related set of households. The description of 'shared' as was used in some studies, leaves out much detail and thus limits general conclusions about the potential exposures.

When considering these results, the study types and quality must also be taken into account. All of the studies discussed above follow an observational study design. This limits their potential for causal inference. Moreover, the strength of evidence must be qualified by certain methodological issues presented by the studies included in the review. Less than half of the studies (n=6) reported using some type of randomisation or random selection of the study sites or sample population. Many of the reasons for choosing one community over another in a study may well be associated with the outcome (e.g.

willingness to co-operate, the presence of infrastructure, level of education, wealth), potentially introducing a systematic bias. A further shortcoming of most studies is the potential for observer and responder bias in assessing the outcomes of interest. None of the studies was blinded, though this is likely unavoidable in assessments of shared sanitation.

In addition to the methodological limitations of all studies, differences in study populations and settings, baseline sanitation levels, water and hygiene practices, methodologies, case definitions and outcome surveillance, and types of shared sanitation limit the comparability of results from the studies included in this review. Lastly, eight of the studies considered only slum populations, which may be very different from other urban or rural settlements.

Thus it is clear that there is heterogeneity of exposures observed among the different types of shared sanitation. The main comparator may also be ill-defined in the included studies; it is often not specified if a latrine is an improved and well maintained facility, or a fairly basic, potentially hazardous one. Most clearly, only six of the studies were designed specifically to focus on shared sanitation [27, 38-41, 50].

Notwithstanding these limitations on the ability to generalize from these studies, there are some common findings. Cleanliness appears to be an important factor in use of the shared sanitation facility. Similarly, distance to the facility plays a role, especially for women at night. Overcrowding and queues have been mentioned in some settings, whereas cost was an important factor in others. As there is considerable variation in sanitation type, number of households sharing and local context, it appears especially important to consult the users of a proposed shared sanitation facility prior to construction in order to try and mitigate some of these barriers to use.

London School of Hygiene & Tropical Medicine
Keppel Street, London WC1E 7HT
www.lshtm.ac.uk

Registry
T: +44(0)20 7299 4646
F: +44(0)20 7299 4656
E: registry@lshtm.ac.uk

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Shared Sanitation versus Individual Household Latrines: A Systematic Review of Health Outcomes

Marieke Heijnen[1], Oliver Cumming[1], Rachel Peletz[1], Gabrielle Ka-Seen Chan[1], Joe Brown[3], Kelly Baker[2], Thomas Clasen[1,2]*

1 Faculty of Infectious and Tropical Diseases, London School of Hygiene & Tropical Medicine, London, United Kingdom, **2** Department of Environmental Health, Rollins School of Public Health, Emory University, Atlanta, Georgia, United States of America, **3** School of Civil and Environmental Engineering, Georgia Institute of Technology, Atlanta, Georgia, United States of America

Abstract

Background: More than 761 million people rely on shared sanitation facilities. These have historically been excluded from international sanitation targets, regardless of the service level, due to concerns about acceptability, hygiene and access. In connection with a proposed change in such policy, we undertook this review to identify and summarize existing evidence that compares health outcomes associated with shared sanitation versus individual household latrines.

Methods and Findings: Shared sanitation included any type of facilities intended for the containment of human faeces and used by more than one household, but excluded public facilities. Health outcomes included diarrhoea, helminth infections, enteric fevers, other faecal-oral diseases, trachoma and adverse maternal or birth outcomes. Studies were included regardless of design, location, language or publication status. Studies were assessed for methodological quality using the STROBE guidelines. Twenty-two studies conducted in 21 countries met the inclusion criteria. Studies show a pattern of increased risk of adverse health outcomes associated with shared sanitation compared to individual household latrines. A meta-analysis of 12 studies reporting on diarrhoea found increased odds of disease associated with reliance on shared sanitation (odds ratio (OR) 1.44, 95% CI: 1.18–1.76).

Conclusion: Evidence to date does not support a change of existing policy of excluding shared sanitation from the definition of improved sanitation used in international monitoring and targets. However, such evidence is limited, does not adequately address likely confounding, and does not identify potentially important distinctions among types of shared facilities. As reliance on shared sanitation is increasing, further research is necessary to determine the circumstances, if any, under which shared sanitation can offer a safe, appropriate and acceptable alternative to individual household latrines.

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* E-mail: tclasen@emory.edu

Introduction

Unsanitary disposal of human excreta, together with unsafe drinking water and poor hygiene conditions, is a leading cause of morbidity and mortality in low-income countries [1,2]. Much of this disease burden consists of diarrhoeal disease, a leading killer of young children. In addition, inadequate sanitation is implicated in schistosomiasis, helminth infections, enteric fevers and trachoma [3]. Lack of access to sanitation also has significant non-health consequences, particularly for women and girls, including lack of security and privacy, decreased school attendance and basic human dignity [4].

An estimated 2.5 billion people lack access to improved sanitation facilities [5]. In developing regions where people are most vulnerable to infection, only one in every three people has access to improved sanitation [5]. At the current pace, the Millennium Development Goal (MDG) sanitation target—to halve the proportion of people with access to basic sanitation by 2015—is set to miss the target by half a billion people [5].

The MDG target, which is expressed in terms of 'basic sanitation', was deemed to be context specific and to include 'the lowest-cost option for securing sustainable access to safe, hygienic, and convenient facilities and services for excreta and sullage disposal that provide privacy and dignity, while at the same time ensuring a clean and healthful living environment both at home and in the neighbourhood of users' [6]. However, the Joint Monitoring Programme for Water Supply and Sanitation (JMP), which monitors progress toward the target, defines "improved sanitation" in terms of service levels. This includes a private flush or pour-flush toilet or latrine connected to a piped sewer system or septic system, a simple pit latrine with a slab, a ventilated improved pit latrine or a composing toilet. Any other flush or pour-flush latrine, an open pit latrine, bucket latrine, a hanging latrine, or open defecation is "unimproved" and not scored toward the MDG target [5].

Significantly, public and other "shared facilities"—those used by two or more households—are excluded from the definition of

Table 1. Electronic databases searched.

Database		Last search date	Number of results
OvidSP (Ovid Technologies 2013)	EMBASE	October 7th, 2013	4248
	MEDLINE	October 7th, 2013	2976
	CAB Abstracts,	October 12th, 2013	6586
	Global Health,	October 7th, 2013	5660
	HMIC,	October 7th, 2013	74
	Social Policy & Practice	October 7th, 2013	42
Virtual Health Library	DESASTRES	October 3rd, 2013	332
	LEYES	October 3rd, 2013	29
	LILACS	October 3rd, 2013	36
	MedCarib	October 3rd, 2013	28
	REPIDISCA	October 3rd, 2013	73
Individually searched databases	Africa wide	October 4th, 2013	3495
	Cochrane	October 3rd, 2013	16
	IMEMR	October 4th 2013	10
	CEHA	October 4th, 2013	2
	HISA	October 4th, 2013	5
	WPRIM	October 4th, 2013	4
Chinese language databases	WANFANG	October 23rd, 2013	915
	CNKI	Ocotber 23rd, 2013	946

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"improved sanitation" regardless of the service level [7]. The reason stems from concerns that shared facilities are unacceptable, both in terms of cleanliness (toilets may not be hygienic and fully separate human waste from contact with users) and accessibility (facilities may not be available at night or during periods of high demand) [5].

Nevertheless, shared facilities represent a large and growing proportion of sanitation options available in low-income countries. Nearly a fifth of the population of sub-Saharan Africa (18%) and Eastern Asia (19%) reports using shared sanitation; the practice is particularly common in Ghana (59%), Congo, and Gabon (both 34%) [5]. Globally, the number of users has increased by 437 million since 1990 – increasing from 6 per cent of the global population to 11 per cent in 21 years. In many countries, particularly in crowded urban areas, shared sanitation is the only viable option for those wishing to avoid open defecation; in rural areas, families often keep costs down by sharing latrines between one or more households with family ties [8]. In addition, shared sanitation might provide the opportunity for individuals to move away from open defecation and take the first step on the sanitation ladder.

Perhaps as a result, the JMP is considering a revision to its policy that would include shared sanitation as "improved" – and thus scored toward the post-MDG targets – if the facilities meet the required level of service and are shared among no more than 5 families or 30 persons, whichever is fewer [5]. This proposed change is based on advice from an expert committee [9].

We undertook this review to examine the evidence comparing the impact of shared sanitation versus individual household latrines (IHLs) on health outcomes.

Methods

The review was undertaken in accordance with a protocol, a copy of which is available on request.

Eligibility criteria

Studies were eligible for inclusion if they compared health outcomes of populations relying on shared sanitation with those relying on IHLs. In some cases the latrine type was inferred from the study report. For purposes of this review, shared sanitation included any type of facilities intended for the containment of human faeces and used primarily from home; this excludes "public" sanitation facilities designed primarily for use by householders when they are away from the home, such as schools, markets, train or bus stations, city streets, health facilities, governmental buildings or other public places. Health outcomes included diarrhoea, helminth infections, enteric fevers, other faecal-oral diseases, trachoma and adverse maternal or birth outcomes. Studies were included regardless of study design, location, language or publication status.

Information sources

Our search was performed through September 2013. We employed keywords for health related outcomes. The full lists of key search terms are listed in Table S2.

We performed an electronic search of 19 databases, including 2 Chinese language databases. An overview of the databases is shown in Table 1. Where possible, the same key search terms were used to search the grey literature sources for relevant literature. Conference proceedings from the following institutions were searched for relevant abstracts: WEDC (Loughborough University), IRC International Water and Sanitation Centre, and the German Agency for International Cooperation (GIZ). In addition, governmental agencies, non-governmental organisations (NGOs), universities and others involved in funding, implementing or investigating sanitation were contacted to solicit other studies that met the review's inclusion criteria. In all cases, references lists of studies were also reviewed for additional possible studies.

Study selection

Two authors independently examined the full text of potentially relevant articles using the standard protocol developed by the authors. For Chinese-language search results, a third author undertook the same process individually.

Data collection process

Relevant data, including a brief description of the study (study design, setting and year), details of the study population, specifications of the sanitation facilities and the outcome measures investigated were extracted independently from all eligible studies by two authors. If an article lacked necessary information, we contacted the authors or publishers to attempt to secure it.

Assessment for methodological quality

Each study included in the review was assessed for methodological quality. For observational studies, the STROBE (Strengthening of the Reporting of Observational studies in Epidemiology) statement was used as a guideline to extract data on the risks of bias. While the protocol for the review contemplated assessing studies with a specified intervention group using the Cochrane EPOC (Effective Practice and Organisation of Care) criteria, no such studies met the review's inclusion criteria.

Synthesis of results

We pooled studies reporting on diarrhoea and conducted a meta-analysis based on a random effects model. No further synthesis of results was undertaken to due to the limited number of studies reporting on other health outcomes.

Results

Study selection

Execution of the search strategy resulted in 25477 titles and abstracts. In addition, 169 unpublished documents were retrieved. These titles and abstracts were screened and the full text articles of 202 documents were obtained for further assessment. Of these studies, 22 documents met the review's inclusion criteria. A detailed overview is provided in Figure 1. Reasons for exclusion of documents are provided in Table S5.

Study characteristics

General diarrhoea was the outcome of interest in six studies [10–15], with two studies focusing specifically on watery diarrhoea [16,17] and another on bloody diarrhoea [18]. While other studies included all ages, Baker et al. [14], Chakraborty et al. [13], and Sobel et al. [12] limited the studies to diarrhoea in children under the age of 5 years. A variety of intestinal parasites were investigated in seven studies [11,19–24]. Other health outcome measures included *S.typhi* and *S. paratyphi* A [25], poliomyelitis [26], trachoma [27], *Shigella dysenteriae* type I [28], perinatal death and antenatal foetal death [29], preterm birth and low birth weight [30], and hospital admissions [31]. One study investigated diarrhoea specifically in an HIV-positive population [15].

Participants and settings. Most studies took place in urban settings, though one conducted a comparative urban-rural investigation [23]. Except for one study among an aboriginal population in Australia [31], all studies were conducted in low- and middle- income settings. Three studies were conducted in Kenya [16–18] and two in India [10,13], Bangladesh [11,21], and in Egypt [20,22]; and one in each of Brazil [12], Zambia [28], the Democratic Republic of Congo [24], Nigeria [30], Malawi [23], Zimbabwe [19], Taiwan [26], Jamaica [29], Ghana [32], Nepal [25], South Africa [15] and Tanzania [27]. One study was conducted in multiple countries [14]. Two studies, Shultz et al. and Mahamud et al., were conducted in long-established refugee camps [16,17].

The study population varied considerably, from only women in the studies on maternal and new born health [29,30], to only men in a study in Egypt [20]. Seven studies focused specifically on children, with ages ranging from children under the age of 5 [13,14,22], children under the age of three [10], children aged 1–5 [12,27] and children aged 3–14 years old [23]. As many of the health outcomes vary considerably with age, socio-economic class, population density and other covariates, the comparability of these results must be viewed with the significant differences in study populations and settings in mind.

Types of shared sanitation. The types of latrines assessed and reported on also varied considerably (Table 2). In most cases, the common facilities were shared with other families [14,18,23,31]; only Montgomery et al. provided information on the number of families sharing [27]. Shultz et al. looked at three or more households sharing a latrine (without a clearly specified comparison group) [16]. In some instances IHL was compared to 'sharing with at least one other family' [12,22,26]. Olusanya et al. [30] compared shared latrines with IHLs, though with no further details of the type of shared latrine. Similarly, Karkey et al. compared household latrines use versus community latrines [25], whereas Moshabela et al. report sharing sanitation facilities with an average of two other households [15].

In several cases, the type of shared sanitation was not well defined, with the authors using terms such as "communal" [13,21] to distinguish them from IHLs. Moreover, potentially important information such as ownership, management or approximate numbers of users was often omitted.

Ghosh [10] and Tuttle [28] looked at the sharing of a common latrine, and Golding [29] considered the sharing of toilets; in these cases, however, it was not clear that the comparison was an IHL. Tshikuka et al. investigated the number of persons per toilet as well as the number of people practicing open defecation [24]. Chandiwana et al. looked at the number of persons per latrine, without specifying a comparison group [19]. In these two cases where the number of people per toilet was reported, it was not clear whether this was actually counted, or if an average of households or persons per latrine was calculated.

Some studies included multiple comparisons, for example, Khan reported on communal latrines versus private or compound shared latrines [11] whereas Curtale looked at different settings, including rural IHLs and some sharing of family latrines in urban areas [20].

Study designs. All studies included in the review followed an observational study design. These were either cross-sectional, case control or cohort studies (Table 2).

Summary measures. The large variety of studies included resulted in different study measures (Table 2). Odds ratios were reported in 14 studies and for the remainder of studies only the percentages or differences in means were reported.

Assessment of methodological quality

The Supplementary Material provides detailed information on the methodological assessments (Table S3). Only one of the included studies reported a sample size calculation [23]. Similarly, only one study reported the interview response rate [27]. Seven studies reported using some form of random sampling [13,15,17,20,23–25], though only four of these clearly described the randomisation method [15,17,23,25]. Eight of the 11 included case control studies report matching of the cases and controls

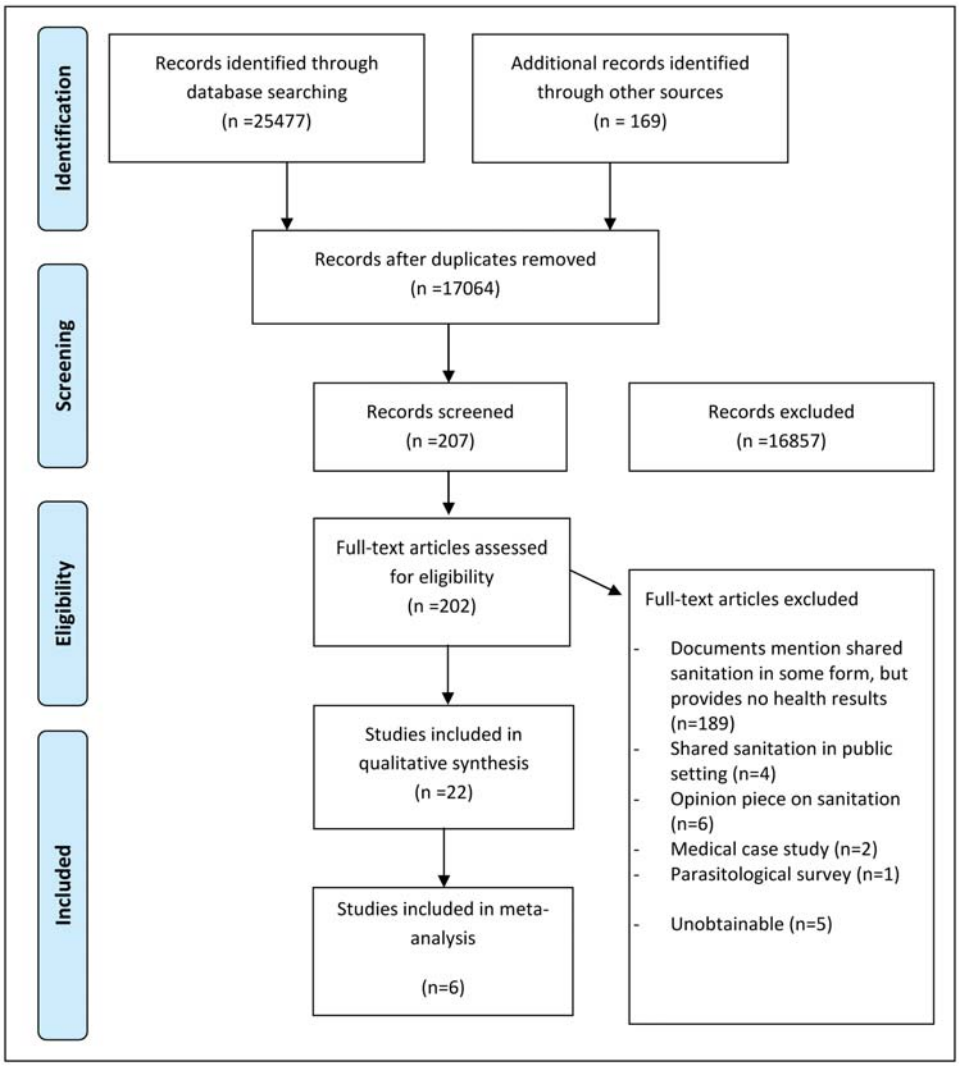

Figure 1. PRIMSA Flow Chart.
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(matched [12,14,16–18,25,27,28], while three used unmatched cases and controls [10,15,26].)

Among the nine studies reporting on diarrhoea, only Baker et al. and Shultz et al. used clinically confirmed cases. All others relied on self-reported diarrhoea and failed to report on the recall period, both potential sources of bias [33].

Outcomes

Twenty-two studies reported on health outcomes associated with shared sanitation. These are summarized in Table 3.

Diarrhoeal disease. Nine studies investigated diarrhoeal disease as an outcome measure (Table 3). In all but two [13,15], sharing a latrine was found to be associated with an increased risk of diarrhoeal disease. Shultz et al. found that sharing a latrine with at least three households was associated with an increased risk of watery diarrhoea (Matched OR 2.17 [95% CI 1.01–4.68] [16]. Sobel et al. found that sharing a toilet with another household was a risk factor for acute diarrhoea cases presented at hospital (OR 1.48 [95% CI 1.07–2.04]) [12]. Similarly Tuttle et al. reported that households with shigella cases were more likely to share latrines than control households (Matched OR 3.3 [95% CI 1.1–10.2]) [28]. Initial results from a multi-country study by Baker et al. showed increased odds of moderate and severe diarrhoea when latrines are shared (matched OR 1.2 [95% CI 1.1–1.3]) [14]. A significant association between shared latrines and the incidence of diarrhoea is also reported by Ghosh et al. ($p = 0.008$) though no odds ratios or confidence intervals are presented [10]. Brooks et al. report an increased risk of bloody diarrhoea if other families are allowed to use the latrine (OR 2.40 [95% CI 1.19–4.48]), though no data is provided on the number of families sharing latrines [18].

Table 2. Summary of data extracted from included studies.

Author	Study design	Type of Shared Sanitation	Type of Comparison Sanitation	Main outcomes	Summary measures
Brooks 2003	Case control	'allowing other families to use the compound latrine'	Latrine for private use only	Risk factors for bloody diarrhoea	Matched Odds Ratio (95% CI)
Chakraborty 1983	Cross sectional	Community latrines in slum	Private latrine connected to sewer	Episodes of diarrhoea	Mean
Chandiwana 1989	Cross sectional	Shared latrines	No comparison	Prevalence and intensity of hookworm and roundworm	Prevalence, correlations
Curtale 1998	Cross sectional	Family latrine not shared with others	Latrine shared with others	Prevalence and intensity of intestinal helminth infection	Prevalence
Ghosh 1994	Case control	Sharing latrine	Private latrine*	Diarrhoeal disease	Percentages
Golding 1994	Cross sectional	Toilet used by others outside of family	Toilet only used by family	Perinatal death, antepartum fetal death	Adjusted OR (95% CI)
Hall 1994	Cross sectional	Shared and community latrine	Private latrine	*Strongyloides stercoralis* infection	Odds ratio (95% CI)
Khan 1987	Cross sectional	Communal latrines in peri urban slums	Open pit latrines in peri urban slums	Diarrhoea cases and intestinal parasite prevalence†	Prevalence
Kim-Farley 1984	Case control	Toilet shared >1 family	Private latrines*	Poliomyelitis	Odds ratio (95% CI)
Mahfouz 1997	Cross sectional	Sharing toilets with other family	Sole use of household latrine*	Prevalence of intestinal parasites and protozoa	Adjusted OR (95% CI)
Montgomery 2010	Case control	Shared latrines	Private latrines	Trachoma	Adjusted OR (95% CI)
Munoz 1992	Cohort	Communal toilet	Private toilet	Hospital admissions	Percentages, factor scores
Olusanya 2010	Cross sectional	Shared sanitation	Private sanitation	Preterm and low birthweight	Unadjusted OR (95% CI)
Phiri 2001	Cross sectional	Shared latrine	Private latrine*	Prevalence of helminths	Adjusted OR (95% CI)
Shultz 2009	Case control	Three or more households sharing same latrine	Not specified	Watery diarrhoea	Matched OR (95% CI)
Sobel 2004	Case control	Shared latrine with other household	Private latrine*	Acute diarrhoeal disease	Matched OR (95% CI)
Tshikuka 1994	Cross sectional	Sharing a toilet with others	Private latrine*	*Ascaris lumbricoides* infection	Means, Beta coefficient
Tuttle 1995	Case control	Shared latrine	Private latrine*	*Shigella dysenteriae* type1	Matched OR (95% CI)
Baker 2011	Case control (abstract)	Shared sanitation	Private latrine	Risk of diarrhoea	Matched OR (95% CI)
Moshabela 2012	Case control	Sharing latrine with an average of 2 households	Private latrine*	Diarrhoeal disease	Prevalence
Karkey, 2013	C ase control	Community latrine	Household latrine	Enteric infection (*S. typhi* or *S. paratyphi* A.)	Adjusted OR (95% CI)
Mahamud 2012	Case control	Communal latrine	Compound latrine	Diarrhoea and Cholera	Odds ratio (95% CI)

*Latrine type inferred from study report.
†Study mentions measurement of incidence. As this is a cross sectional study, it is interpreted as prevalence.
doi:10.1371/journal.pone.0093300.t002

Chakraborty et al. found no difference in the incidence of diarrhoea between children living in the slum, where public latrines are available, and children living in a housing project, where each family had their own latrine [13]. It must be noted however, that the study population is children under 5 years, and the study also reports that few of these young children use latrines, irrespective of where they live. Similarly, Moshabela et al. found no difference between diarrhoeal disease for those reporting sharing sanitation facilities with other households (25.3% of cases and 23.7% of controls shared sanitation facilities, $p = 0.76$). All the subjects in this study were HIV positive individuals [15].

The studies reporting an effect on diarrhoea have been pooled in a meta-analysis using a random effects model (Figure 2). This yielded a pooled odds ratio (OR) of 1.44 (95%CI: 1.18–1.76), suggesting increased risk associated with shared sanitation. The pooled estimate is characterized by substantial heterogeneity ($I^2 = 77.9\%$). Some of the studies contributing data to our pooled analysis (Figure 2) on the effect of shared sanitation on diarrhoea is

Table 3. Summary of health outcomes.

Author	Study design	Main outcomes	Outcome measure
Diarrhoea			
Brooks 2003	Case control	Risk factors for bloody diarrhoea	OR 2.40 (95% CI 1.19–4.48)
Chakraborty 1983	Cross sectional	Episodes of diarrhoea	On average, there were 1.6 episodes of diarrhoea in the slum, versus 1.4 in the housing project
Khan 1987	Cross sectional	Diarrhoea cases and intestinal parasite prevalence	On average, there were 0.81 episodes of diarrhoea in the area with communal latrines, versus 0.7 in the area with open pit latrines ($p<0.01$). No CI.
Baker 2011	Case control (abstract)	Risk of severe to moderate diarrhoea	OR 1.20 (95% CI 1.1–1.3)
Shultz 2009	Case control	Watery diarrhoea	OR 2.17 (95% CI 1.01–4.68)
Sobel 2004	Case control	Acute diarrhoeal disease	OR 1.48 (95% CI 1.07–2.04)
Ghosh 1994	Case control	Diarrhoeal disease	$P=0.008$ No CI.
Moshabela 2012	Case control	Diarrhoeal disease	25.3% of cases and 23.7% of controls ($p=0.76$)reported sharing sanitation
Mahamud 2012	Case control	Watery diarrhoea/cholera	OR 3.33 (95% CI 1.34–8.30)
Helminths			
Chandiwana 1989	Cross sectional	Prevalence and intensity of hookworm and roundworm	Correlations between number of households and hookworm $r=0.72$, ($P<0.1$), roundworm $r=-0.009$, ($P<0.1$)
Curtale 1998	Cross sectional	Prevalence and intensity of intestinal helminth infection	Sharing latrines and the absence of piped water in the house were associated with a significantly higher intensity of infection for *A. Lumbricoides* ($p<0.001$) and *T. Trichiura* ($p<0.05$)
Hall 1994	Cross sectional	*Strongyloides stercoralis* infection	OR 2.72 (95% CI 1.57–4.72)
Mahfouz 1997	Cross sectional	Prevalence of intestinal parasites and protozoa	Intestinal helminths: OR 1.95 (95% CI 1.38–2.75) Protozoa: OR 1.65 (95% CI 1.06–2.58)
Phiri 2001	Cross sectional	Prevalence of helminths	
Tshikuka 1994	Cross sectional	*Ascaris lumbricoides* infection	Nr of persons/toilet Beta 0.45 ($P<0.01$, SE 0.02)
Other health outcomes			
Tuttle 1995	Case control	*Shigella dysenteriae* type1	OR 3.3 (95% CI 1.1–10.2)
Karkey 2013	Case control	*S. typhi* and *S. paratyphi A*	aOR 4.92 (1.2–19.5) for *S. paratyphi* A aOR 7.26 (1.4–37.2) for *S.typhi*
Montgomery 2010	Case control	Trachoma	OR 0.95 (95% CI 0.55–1.67)
Munoz 1992	Cohort	Hospital admissions	'communal sanitation' was a significant variable in the factor analysis ($p<0.01$)
Olusanya 2010	Cross sectional	Preterm and low birthweight	Prematurity aOR 1.36 (95% CI 1.07–1.48) Low birth weight aOR 1.27 (95% CI 0.98–1.65)
Kim-Farley 1984	Case control	Poliomyelitis	OR 4.0 (95% CI 1.9–8.3)
Golding 1994	Cross sectional	Perinatal death, antepartum fetal death	Antepartum fetal death aOR 1.62 (95% CI 1.28–2.03) Perinatal death aOR 1.41 (95% CI 1.21–1.64)

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drawn from preliminary, yet-to-be published results from seven countries included in the Global Enterics Multi-Centre Study (GEMS) [14]. However, the GEMS study design as well as the general methods for collection of water and sanitation exposure data and the definition for moderate and severe diarrhoea used to screen and enrol case and controls has been published [34,35]. The study used a case-control design where cases were based on clinical diagnoses of moderate to severe diarrhoea in children <5 years. As shown in Figure 2, initial results, adjusting for wealth and faeces visible in the facility, show that shared sanitation was a statistically significant risk factor in two countries (Pakistan, Mali) and was trending toward increased risk in three other countries (Gambia, Mozambique and Kenya). Interestingly, shared sanitation trended in the opposite direction, appearing protective in Bangladesh. This study reports that even though there is site variability, there is an overall trend among most sites. Except for Bangladesh, cases are more likely to live in a household that shares a latrine. The pooled odds ratio from the seven GEMS studies yields an OR of 1.26 (95% CI 1.01–1.57) compared to OR 2.01 (95% CI 1.44–2.81) for the five published studies (Figure S2).

Helminths and protozoan parasites. Six studies reported associations between shared sanitation facilities and helminth infections, of which only one study reported no association (Table 3). Tshikuka et al. found that the number of persons per toilet was statistically associated with *Ascaris lumbricoides* infection intensity [24]. However, it is not clear whether the persons per latrine were counted or calculated as an average. Mahfouz et al. found that sharing toilets with another family increased the risk of intestinal helminths (*A.lumbricoides*, *Trichuris trichiura*, *Hymenolepis nana*, *Oxyuris*, *Ancylostoma duodenale*, *Schistosoma mansoni)* (adjusted OR 1.95[95% CI 1.38–2.75]) and from protozoan parasites [*Giardia lamblia*, *Entamoeba histolytica*] (adjusted OR 1.65 [95% CI 1.06–2.58]) [22].

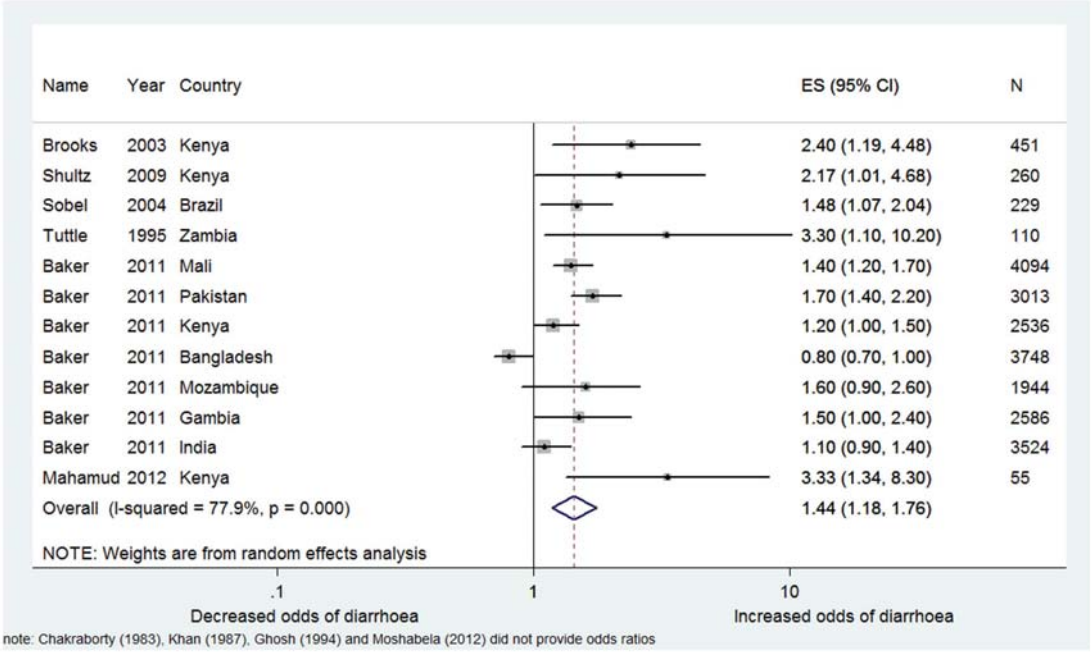

Figure 2. Meta-analysis for the use of shared sanitation and diarrhoea. Image produced using Stata (Statacorp LP, TX USA). CI: Confidence Interval. ES: Effect size (Odds Ratio).
doi:10.1371/journal.pone.0093300.g002

Hall et al. found that for adults, using a community latrine rather than a private latrine was statistically significant risk factor for *S. stercoralis* infection (adjusted OR 2.72 [95% CI 1.57–4.72] [21]. On the other hand, they found that using a latrine shared between neighbours versus a private latrine showed no significant association. Similarly, for children the risk of *S. stercoralis* infection was increased when using communal latrines (adjusted OR 2.43 [95% CI 1.35–4.38]), whereas no such association could be found for shared latrines. No information was provided on the number of people or households using either the shared or the communal latrines.

In a study in Egypt, sharing latrine with other families and the absence of piped water inside the house were associated with a significantly higher intensity of infection for *A. lumbricoides* ($p<0.001$) and for *T. trichiura* ($p<0.05$) but not *for S. mansoni* [20]. No separate data were presented for shared latrines and no information was provided on the number of households sharing. Lastly, Phiri et al. found no statistically significant risk associated with *A. lumbricoides*, hookworm, *T. Trichiura*, or *S. stercoralis* infection and shared latrine facilities [23].

Other health outcomes. A study by Montgomery et al. found that shared latrines provided as much protection as private latrines in regard to the risk of trachoma (adjusted OR 0.95 [95% CI 0.55–1.67]) [27]. Also, the number of households sharing did not significantly alter the risk.

Kim-Farley et al. investigated a poliomyelitis outbreak in Taiwan using a case control design [26]. It was shown that more cases than controls shared toilets with other families (OR 4.0 [95% CI 1.9–8.3]). However, this was a univariate analysis, not controlled for other exposures.

Karkey et al. investigate enteric infection with either *S. typhi* or *S. paratyphi* A and found that communal latrine use (versus individual household latrines) was protective (adjusted OR 4.92 [95% CI 1.2–19.5] for *S. paratyph*i A and adjusted OR 7.26 [95% CI 1.4–37.2] for *S. typhi*). In this study, 92.2 per cent of the cases used a household latrine versus 77.9 per cent of the controls [25].

Several studies reported on adverse birth outcomes. Olusanya et al. investigated preterm birth and low birth weight risk factors [30]. Living in a house with shared sanitation facilities was found to be a risk factor for prematurity (adjusted OR 1.26 [95% CI 1.07–1.48]), whereas there was only a weak association with low birth weight (adjusted OR 1.27 [95% CI 0.98–1.65]). Golding and colleagues found an increased risk of perinatal death among women who had to share toilet facilities with people other than members of their family [29]. This was associated especially with antepartum fetal deaths (adjusted OR 1.62 [95% CI 1.28–2.03]) and perinatal death (adjusted OR 1.41 [95% CI 1.21–1.64]). In rural aboriginal communities in Australia, Munoz et al. reported that communal toilets were associated with an increased risk of hospital admissions for children [31]. However, the authors acknowledged that many community characteristics were strongly associated with differences in admission rates between communities thus limiting the potential for causal interferences.

Discussion

In general, the evidence suggests that those relying on shared sanitation facilities compared to IHLs are at increased risk of adverse health outcomes, including diarrhoeal disease, helminth infection, poliomyelitis, as well as prematurity, antepartum fetal death and perinatal death. The evidence on diarrhoeal disease and on helminth infection reflects a consistent pattern across most

studies and study sites, while the evidence on poliomyelitis and adverse birth outcomes was generated from single studies. On the other hand, research found no increased risk of trachoma associated with reliance on shared sanitation.

Although most of the studies reviewed suggest a pattern of shared sanitation and adverse health outcomes, the quality of these studies varies and the actual strength of evidence is weak, and should be interpreted with caution. This is due to at least four major limitations.

First, as noted, many of the studies included in the review are of uncertain methodological quality. Fewer than a third of the studies reported using random selection of the study sites or population, presenting the potential for selection bias. The type of sanitation facilities being compared was not blinded to the study population or assessors. This and the fact that many studies relied on reported outcomes raises questions of reporting bias. Many of the studies fail to report on case definitions, participant eligibility and selection procedures, methods for assessing outcomes, potential sources of bias, etc. There are also statistical shortcomings, such as the failure to adjust for clustering and the treatment of populations as multiple rather than single units. Moreover, many studies reflect methodological problems common in assessments of environmental health interventions [36] and in the assessment of faecal-oral diseases such as diarrhoea [37].

Second, few of the studies report on possible factors other than the type of sanitation facilities that could be important confounders or effect modifiers. Most obvious of these, perhaps, is actual latrine use. There is evidence, for example, that a variety of factors such a distance, waiting time and cost can significantly impact the use of shared sanitation facilities [38,39]. Other factors that may vary between shared sanitation facilities and IHLs include latrine maintenance, distance to and quantity/quality of water supplies, the presence and use of hand washing facilities and soap, the manner in which users dispose of child faeces, and the way in which the waste is subsequently removed from the facilities and ultimately disposed of in the setting. Additionally, the population density, socio-economic status, gender or other equity issues of the users of shared facilities versus IHL may differ, aspects which are infrequently reported on in the studies specifying shared sanitation.

Third, there are substantial differences among the studies that limit their comparability. This includes differences in study design, settings, study populations and ambient conditions. It also includes fundamental differences (and in many cases, uncertainty) in the actual types of shared sanitation and the types of IHLs being compared. There are also important differences in outcomes, the manner in which they were assessed and in the methods for their analysis.

Finally, and perhaps most important, the studies undertaken to date allow only for only a weak causal inference between shared sanitation and adverse health outcomes. None of the studies identified in the review followed an experimental design. While many studies adjusted for known confounders, others did not. As observational studies, all are at risk of unknown confounders. We cannot rule out the possibility that that reliance on shared sanitation is simply a proxy for more direct causes of adverse health outcomes.

There is a need for rigorous studies in multiple study settings in order to determine the extent to which reliance on shared sanitation is causally associated with adverse health outcomes. There is also a need to identify the factors that may mitigate or otherwise modify any increased health risk associated with shared sanitation. Studies have found evidence that shared sanitation may be more poorly maintained, more costly, less accessible and less frequently used than IHLs [38–41]. These and other factors are likely to vary considerably depending on population density, the ratio of latrines per household or person, the quality of construction and upkeep, and the manner in which the latrines are managed. Future research, using both qualitative and quantitative methods, may help identify the circumstances in which shared sanitation might be a safe and effective alternative for increasing populations that do not have access to IHLs or where household-levels sanitation solutions are not possible or appropriate. Pending this research, policymakers and public health professionals should exercise caution in taking steps that may encourage the promotion of shared sanitation.

Supporting Information

Checklist S1
(DOCX)

Figure S1 Sub group forest plot-Published data only. Image produced using Stata (Statacorp LP, TX USA). CI: Confidence Interval. ES: Effect size (Odds Ratio).
(TIF)

Figure S2 Sub group forest plot-Unpublished data only. Image produced using Stata (Statacorp LP, TX USA). CI: Confidence Interval. ES: Effect size (Odds Ratio).
(TIF)

Protocol S1
(PDF)

Table S1 Key search terms.
(DOCX)

Table S2 Search strategy as performed in OVID databases.
(DOCX)

Table S3 Methodological quality.
(DOCX)

Table S4 Extracted data.
(DOCX)

Table S5 Excluded documents.
(DOCX)

Author Contributions

Conceived and designed the experiments: MH TC. Performed the experiments: MH OC RP GC JB KB. Analyzed the data: MH OC GC RP JB KB. Wrote the paper: MH TC.

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2.9 ADDITIONAL INFORMATION ON PUBLISHED SYSTEMATIC LITERATURE REVIEW

The published review contained in section 2.8 was accepted in March 2014 and published in April 2014. The Supplementary Information accompanying the publication can be found in Appendix 1. One main point of discussion during the publication process was the inclusion of a large amount of data that was not yet published but included in the forest plot (meta-analysis). The data from the Global Enteric Multicentre Study (GEMS) provided information from seven countries, and assessed moderate to severe diarrhoea in children living in households accessing shared sanitation facilities. One of the co-authors of the GEMS studies was also a co-author of my review.

The GEMS study design, including the general methods for collection of water and sanitation exposure data, and the definition for moderate and severe diarrhoea used to screen and enrol case and controls has been published [54, 55]. As GEMS data provides seven out of 12 results used for meta-analysis, it deserves some additional consideration. One potential concern is that the results from the GEMS study somehow prejudice the overall result. This was therefore explored in a sensitivity analysis. The separate forest plots, including and excluding the GEMS data, are provided below (Figure 4 and Figure 5).

The overall forest plot, showing all results for the association between shared sanitation and diarrhoea can be seen in the published review in section 2.8. In this meta-analysis, all studies are combined and the effect shows increased odds of disease for users of shared sanitation (OR 1.44, 95% CI 1.18 – 1.76 for all 12 studies). Figure 4 presents all studies, but without the GEMS data—the pooled odds ratio is larger than for all 12 studies (OR 2.01, 95% CI 1.44 – 2.81, 5 published studies). When only the GEMS studies are considered (Figure 5) the results of the meta-analysis present increased odds of diarrhoea for users of shared sanitation (OR 1.26, 95% CI 1.01 – 1.57). Under these circumstances we found no reason to exclude the GEMS data.

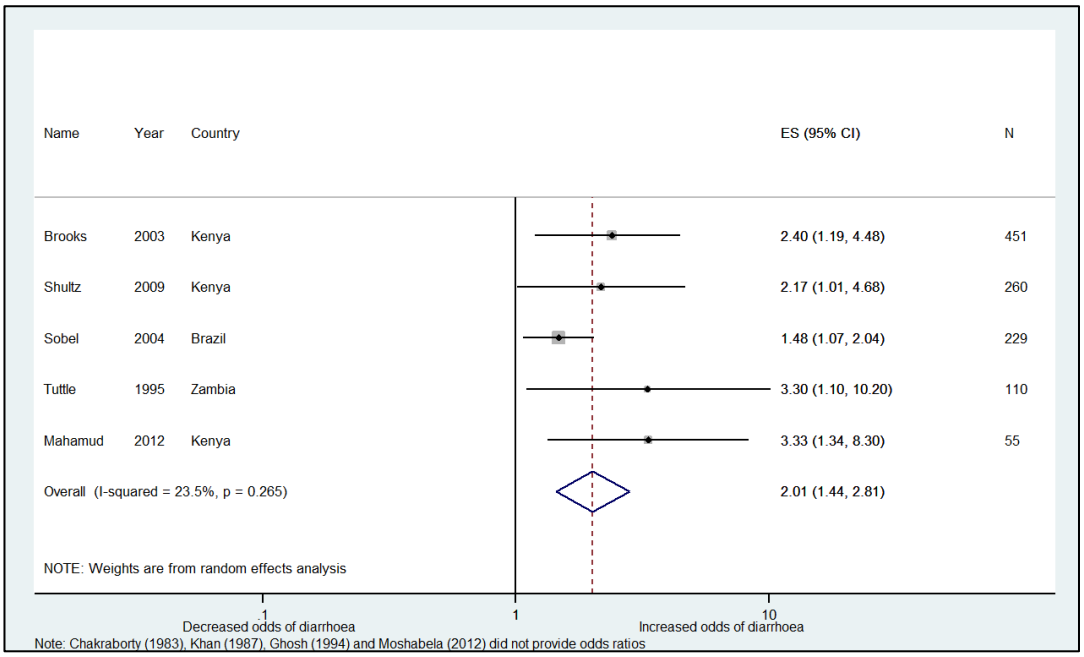

Figure 4. Meta-analysis of the effect of shared sanitation use on diarrhoea, excluding GEMS data

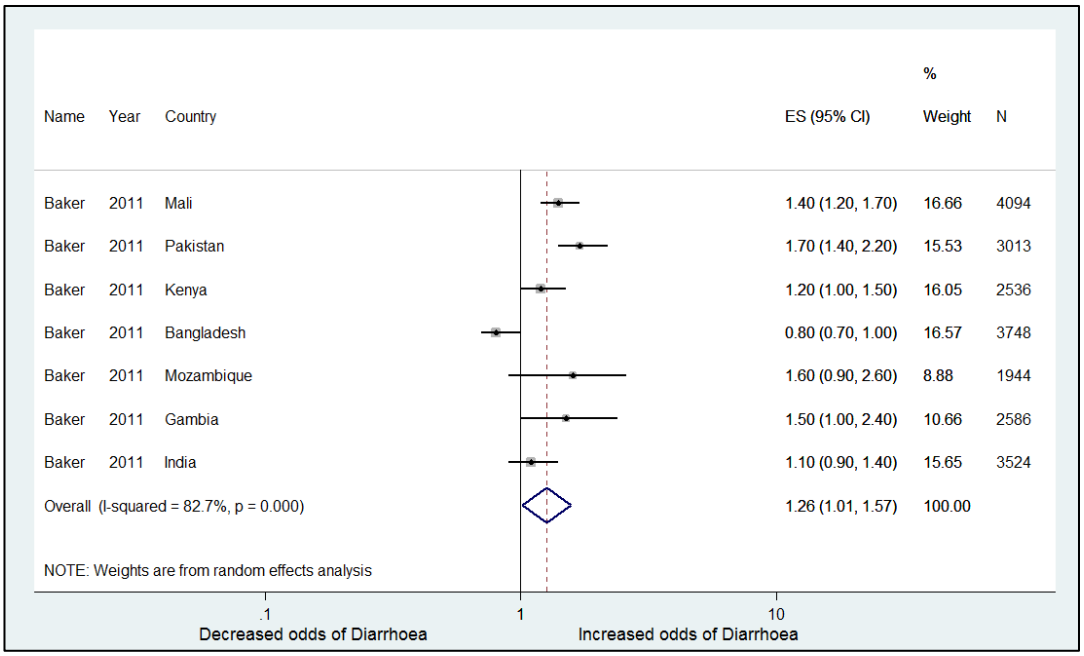

Figure 5. Meta-analysis of the effect of shared sanitation use on diarrhoea, using only GEMS data

One of the strengths of systematic reviews of the literature is the inclusion of unpublished studies as well as published ones, as exclusion of unpublished studies can be a major source of bias. For this reason, most reviewers agree that systematic reviews should include all studies that meet the eligibility criteria regardless of publication status [56]. At the time of writing, the GEMS data on shared sanitation and diarrhoea have not yet been published.

2.10 ADDITIONAL PUBLICATION ON SHARED SANITATION

Additional material has become available since the publication of the systematic review looking at health outcomes. A study by Fuller et al. analysed the association between the use of a shared sanitation facility and the prevalence of diarrhoea in children <5 years, using 51 Demographic and Health Surveys [57]. The study used log-binomial regression, accounting for the complex sampling strategy to generate the prevalence ratios (PR) for diarrhoea. This was done for individual country surveys, as well as for regional and global analyses (pooled). For the pooled data from 51 countries, a 9 percent higher prevalence of diarrhoea was observed among households that used a shared facility (crude PR: 1.09, 95% CI: 1.06 – 1.12). The effect of sharing, however, varied across countries— for example, the unadjusted PR ranged from 0.65 in Nigeria to 2.15 in Moldova. The confounders controlled for in the adjusted analysis were asset ownership, highest level of education in the household, mother's education attainment, mother's age and the type of sanitation facility used (flush toilet, improved latrine, unimproved latrine). Adjusting for confounding attenuated the pooled results (adjusted PR: 1.2, 95% CI: 1.02 – 1.08). In particular, socio-economic factors appeared to play a role in the attenuation of the pooled results. Overall, these results indicate that shared sanitation appears to be a risk factor for diarrhoea. However, the heterogeneity across countries suggests that the social and economic context is an important factor. As a co-author of this study, I have included a copy of the published paper in Appendix 2.

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3 GEOGRAPHIC AND DEMOGRAPHIC SCOPE OF SHARED SANITATION

3.1 BACKGROUND AND RATIONALE

The Global Water Supply and Sanitation Assessment 2000 was the first systematic effort to report on improved sanitation on a global scale [2]. This report defined improved facilities as a connection to a public sewer, a connection to septic system, pour-flush latrines, simple pit latrine or a ventilated improved pit latrine. In addition, it stated that the excreta disposal system was considered adequate if it was private or shared (but not public) and if it hygienically separated human excreta from human contact. As a result, the possibility exists that some shared facilities were counted as improved. In the 2006 report, the JMP made clarifications on the technical definitions of improved facilities, and in 2008 it went further to add shared facilities as a step on the four-step sanitation ladder (open defecation, unimproved, shared, improved)[58, 59]. As such, facilities which were public or shared between two or more households, but of an otherwise improved type, were considered unimproved sanitation. This 2008 definition has been in use ever since.

The JMP reports annually on the status of water and sanitation, and since 2008 the report includes country data on shared sanitation. However, this only includes shared sanitation which is of an 'improved' type. The JMP adjusts for shared sanitation in its final estimates for access to improved sanitation by subtracting the mean overall available survey estimates for shared sanitation use individually by country. However, this approach is currently not homogeneous, as for 34 low- and middle income countries (LMIC) no data on shared sanitation use are available, in which case no value will be subtracted [60]. Therefore JMP final estimates cannot be compared across countries, as the final value for access to improved sanitation sometimes includes and sometimes excludes shared sanitation facilities.

3.1.1 INTERNATIONAL SANITATION TARGETS

The MDG target concerning drinking water and sanitation was repeatedly edited until adopted in its final form in 2006 as Target 7C:

> 'to halve, between 1990 and 2015, the proportion of the population without sustainable access to safe drinking water and basic sanitation' [61-63]

The JMP is considered the main source of comprehensive and internationally-comparable information on drinking water and sanitation coverage, and as such serves as the UN-recognised instrument for monitoring progress towards the MDG target [64]. Indicators for MDG monitoring were agreed in 2006 based on recommendations from WHO and UNICEF in light of JMP approaches [61, 64].

As the finalisation of the MDGs approaches in 2015, the JMP has convened working groups to advise on potential future targets and indicators for the post-2015 Sustainable Development Goals, as well as on the implications of such targets and indicators for monitoring [65]. One of the changes proposed is to include shared sanitation as an improved form of sanitation if it meets certain criteria, as outlined below:

> 'Adequate sanitation at home [65]: each of the following sanitation facility types is considered as adequate sanitation for monitoring progress toward the household sanitation targets, if the facility is shared among no more than 5 families or 30 persons, whichever is fewer:
>
> - A pit latrine with a super structure and a platform or squatting slab constructed of durable material. [A variety of latrine types can fall under this category, including composting latrines, pour-flush latrines and VIPs]
> - A toilet connected to a septic tank
> - A toilet connected to a sewer (small bore or conventional)'

Further consultation added that users of shared facilities must know each other, as highlighted below [31]:

> 'Adequate sanitation facility:
>
> - Separates excreta from human contact and ensures that excreta does not re-enter the immediate household environment (note, but does not include 'full' management as defined below)
> - Safe (protects the user from risks such as vermin, falling into the pit etc.)
> - Durable
> - Household or shared toilet within or nearby the plot, shared by no more than 5 families or 30 people, whichever is fewer, used by people who know each other
> - Accessible at all times (7 days a week, 24 hours a day)
> - Protects users from culturally inappropriate exposure or invasion of privacy'

Though these specifications of an adequate sanitation facility are commendable, the actual measurement or monitoring of these factors may be more difficult. For example, it may be difficult to find a globally understood interpretation of 'knowing each other'. In addition, the research on shared sanitation, with however many households, remains limited and deserves further investigation.

As part of the effort to document the current status of shared sanitation at a global level, the demographic and geographic scope of shared sanitation was assessed, using data from

Demographic and Health Surveys (DHS) and Multiple Indicator Cluster Surveys (MICS). This work has been published and can be found in section 3.2.

Initially, it was planned to include other data sources as well as the DHS and MICS. For example, the World Bank's Living Standards Measurement Surveys (LSMS) and the World Health Organisation's Health Surveys (WHS). The WHSs are nationally representative household surveys with a target sample size of 5,000 households, and these surveys have been conducted in 70 countries. The LSMS surveys are much smaller in size, with sample sizes generally in the range of 600 – 3200 households per country. No data on shared sanitation was collected in the WHS, and thus none of the surveys were included in the analysis. Of the 11 LSMS surveys which included information on shared sanitation, only 4 (Ecuador 1998, Guatemala 2000, Bulgaria 2001, Tajikistan 2009) were taken into consideration as they provided the most recent information on the particular country. Unfortunately, these surveys did not provide information in adequate detail to allow collation of all data into one global, or several regional datasets. As such, it was decided to not include these surveys.

3.1.2 CORE QUESTIONS

Data on shared sanitation were derived from two core questions included in all surveys: (i) 'Do you share this toilet facility with other households?', and, if the response is affirmative, (ii) 'How many households use this toilet facility?' This last question specifies that the respondents should provide the number of households, not the number of people. Also, whereas the first question asks for a yes or no response, the second question allows for the exact number of households to be stated, up to 10, after which the '10+' is indicated. 'Don't know' is also an option. The latest round of available MICS surveys, MICS 4, has an additional question pertaining to the sharing patterns, i.e. is the facility shared with household known to the respondent, or shared with the general public. Information on the type of latrine (i.e. pour-flush, pit-latrine, etc.) used by the household is also collected in most surveys.

3.1.3 OTHER SURVEY DATA

Data was extracted from each country and tabulated by region for geographic comparisons. Additional data on other variables was extracted to characterize households based on their access to shared versus individual household latrines. This included residence status (urban or rural), access to improved water supplies, education level of the head of the household, the number of children < 5 years of age in the household, the number of individuals in the household and for those reporting access to shared sanitation, the number of households with whom they were sharing their latrines. Information on the ownership of assets, as well as cooking fuel and house structure was

extracted for use in the development of a wealth index. The newer rounds of MICS surveys include a question about the type of people the household shares the facility with and this data was also extracted.

London School of Hygiene & Tropical Medicine
Keppel Street, London WC1E 7HT
www.lshtm.ac.uk

Registry
T: +44(0)20 7299 4646
F: +44(0)20 7299 4656
E: registry@lshtm.ac.uk

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I extracted all survey data and conducted all analyses. The co-authors provided feedback on the manuscript after which I dealt with any revisions and additional analyses. I acted as corresponding author and responded to any peer review queries.

NAME IN FULL (Block Capitals) ANNA MARIA MARIEKE HEIJNEN

STUDENT ID NO: 11950

CANDIDATE'S SIGNATURE ..... Date 17 OCTOBER 2014

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The geographic and demographic scope of shared sanitation: an analysis of national survey data from low- and middle-income countries

Marieke Heijnen[1], Ghislaine Rosa[1], James Fuller[2], Joseph N. S. Eisenberg[2] and Thomas Clasen[1,3]

1 *Faculty of Infectious and Tropical Diseases, London School of Hygiene & Tropical Medicine, London, UK*
2 *Department of Epidemiology, University of Michigan School of Public Health, Ann Arbor, MI, USA*
3 *Department of Environmental Health, Rollins School of Public Health, Emory University, Atlanta, GA, USA*

Abstract

OBJECTIVE A large and growing proportion of the world's population rely on shared sanitation facilities that have historically been excluded from international targets due to concerns about acceptability, hygiene and access. In connection with a proposed change in such policy, we undertook this study to describe the prevalence and scope of households that report relying on shared sanitation and to characterise them in terms of selected socio-economic and demographic covariates.

METHODS We extracted data from the most recent national household surveys of 84 low- and middle-income countries from Demographic and Health Surveys and Multiple Indicator Cluster Surveys. We describe the prevalence of shared sanitation and explore associations between specified covariates and reliance on shared sanitation using log-binomial regression.

RESULTS While household reliance on any type of shared sanitation is relatively rare in Europe (2.5%) and the Eastern Mediterranean (7.7%), it is not uncommon in the Americas (14.2%), Western Pacific (16.4%) and South-East Asia (31.3%), and it is most prevalent in Africa (44.6%) where many shared facilities do not meet the definition of 'improved' even if they were not shared (17.7%). Overall, shared sanitation is more common in urban (28.6%) than in rural settings (25.9%), even after adjusting for wealth. While results vary geographically, people who rely on shared sanitation tend to be poorer, reside in urban areas and live in households with more young children and headed by people with no formal education. Data from 21 countries suggest that most sharing is with neighbours and other acquaintances (82.0%) rather than the public.

CONCLUSIONS The determinants of shared sanitation identified from these data suggest potential confounders that may explain the apparent increased health risk from sharing and should be considered in any policy recommendation. Both geographic and demographic heterogeneity indicate the need for further research to support a change in policies.

keywords sanitation, Demographic and Health Surveys

Introduction

An estimated 2.5 billion people lack access to 'improved sanitation facilities'(Joint Monitoring Programme 2014). In developing regions where people are most vulnerable to infection, only one in every three people has access to improved sanitation (Joint Monitoring Programme 2014). At the current pace, the Millennium Development Goal (MDG) sanitation target – to halve the proportion of people with access to basic sanitation by 2015 – is set to miss the target by half a billion people (Joint Monitoring Programme 2014).

Progress towards the MDG sanitation target is monitored by the WHO/UNICEF Joint Monitoring Programme for Water Supply and Sanitation (JMP). The JMP defines 'improved sanitation facilities' to include a flush or pour-flush toilet or latrine connected to a piped sewer system or septic system, a simple pit latrine with a slab, a ventilated improved pit latrine (VIP) or a composting toilet used by only one household (Joint Monitoring Programme 2010). Any other flush or pour-flush latrine, open pit latrine, bucket latrine, hanging latrine or open defecation is 'unimproved' and not scored towards the MDG target (Joint Monitoring Programme 2010).

Significantly, public and other 'shared facilities' – those used by two or more households – have been excluded from the definition of 'improved sanitation' regardless of the service level (Joint Monitoring Programme 2010). The reason stems from concerns that shared facilities are unacceptable, both in terms of cleanliness (shared toilets may not be as hygienic as private ones or they may result in increased contact with human waste) and accessibility (facilities may not be available at night, or easily used by women and children) (Joint Monitoring Programme 2012a). This original policy on shared sanitation was consistent with contemporaneous evidence that shared sanitation was associated with adverse health outcomes including perinatal mortality (Golding *et al.* 1994), helminth infection (Curtale *et al.* 1998) and risk of polio during an outbreak (Kim-Farley *et al.* 1984).

Nevertheless, shared facilities comprise a large and growing proportion of sanitation options available in low-income countries – the JMP reports an increase from 6 to 11% between 2008 and 2012, with approximately 784 million people using public and shared facilities of an otherwise improved type worldwide (Joint Monitoring Programme 2014). The JMP considers shared sanitation to be a step on the sanitation ladder, where users of unimproved sanitation upgrade to a shared facility, and eventually to an improved private facility. Communal or public latrines are considered by some to be the only realistic option for high-density populations in many urban slums (Wegelin-Schuringa & Kodo 1997; Nelson & Murray 2008; Joint Monitoring Programme 2012a,b).

Perhaps as a result, the JMP is considering a revision to its policy that would include shared sanitation as 'improved' – and thus scored towards the MDG and future targets – if the facility otherwise meets the definition of improved sanitation and is shared among no more than five families or 30 persons, whichever is fewer, and if the users know each other (Joint Monitoring Programme 2012c). While this proposed change is based on advice from an expert committee, recent evidence raises questions about the evidentiary basis for the change in policy. A systematic review (Heijnen *et al.* 2014) showed shared sanitation to be associated with adverse health outcomes (as compared to private sanitation facilities), though acknowledging that there were few studies, many with methodological shortcomings. It was not possible to distinguish between improved or unimproved shared facilities in the above-mentioned review. In addition, a recent study analysing shared sanitation and diarrhoea using DHS data showed an increased risk of diarrhoea associated with sharing sanitation facilities (Fuller *et al.* 2014). This increased risk remained when only considering shared facilities of an otherwise 'improved' type.

We undertook this study on behalf of the JMP to examine the geographic and demographic scope of shared sanitation access among low- and middle-income countries. We also sought to identify factors associated with reliance on shared sanitation that help explain why shared sanitation might increase the risks of adverse health outcomes. We extracted and tabulated data from national household surveys, and compared results across countries, regions and basic socio-economic characteristics. We then used log-binomial regression to examine factors that may be associated with reliance on shared sanitation.

Methods

Data sources

We extracted data from the major national survey programmes relied on by the JMP, including the UNICEF-supported Multiple Indicator Cluster Surveys (MICS), and the United States Agency for International Development-supported Demographic and Health Survey (DHS). MICS and DHS are nationally representative household survey programmes with sample sizes ranging from 2500 to 60 000 households. These surveys are conducted in a range of low- and middle-income countries and are typically repeated every 5 years. For countries that had multiple surveys available, we used only the most recent one. Most data gathered in these surveys are collected through a questionnaire administered by paid enumerators. Further details about the sampling design, survey management and quality control are provided in the individual survey reports (DHS 2013; MICS 2013). Data from the household surveys were extracted and data sets were pooled for regional and global analyses.

Shared sanitation

Data on shared sanitation were derived from two core questions included in all surveys: (i) 'Do you share this facility with other households?' and, if the response is affirmative, (ii) 'How many households use this facility?'. Whereas the first question asks for a yes or no response, the second question allows for the exact number of households to be stated, up to 10, after which the '10+' is indicated. The response 'do not know' is also accepted. The latest round of available MICS surveys has an additional question on whether the facility is shared with persons known to the respondent, such as neighbours, or shared with the general public. Information on the type of facility (i.e. pour flush, pit latrine, etc.) used by the household is also collected in most surveys, which allows

classification of the facilities into 'improved' or 'unimproved' per the JMP definitions. As only respondents with access to sanitation facilities are asked whether the facility is shared, in all analyses, respondents without a sanitation facility were excluded. Thus, all comparisons are with households that report using individual household latrines, not with those that report practising open defecation.

Other survey data

To characterise the potential determinants of sharing sanitation, we extracted data on: residence status (urban or rural), wealth tertiles (poorest, middle and least poor), access to water supplies (improved or unimproved), education level of the head of the household (no education, primary or secondary and above), the number of children under 5 years of age in the household, the number of individuals living in the household and for those reporting access to shared sanitation, the number of households with whom they share their latrines.

Wealth tertiles

The original wealth variable included in the household surveys is often constructed using water and sanitation variables. To avoid codetermination, we constructed a new relative index of socio-economic status or wealth that combined household-level information on type of cooking fuel and household flooring, as well as ownership of specific items (which varied per country), using principal component analysis to define the summed weights (Filmer & Pritchett 2001). Each primary component explained a minimum of 25% variance (range 25–58%). To better discriminate wealth within these low-income settings, the resulting indices were used to categorise each household into poor, middle and least poor tertiles (Nundy *et al.* 2011). For analyses at regional and global level, the wealth tertiles were recalculated from the pooled wealth index to ensure a uniform distribution of the households.

Statistical analysis

All analyses were performed using Stata SE/13 (Stata Corp., College Station, TX, USA). Weights were used throughout the analysis to restore the representativeness of the sample, and the complex design was taken into account by using the Stata *svyset* and *svy* commands. The regional and global estimates were calculated as the weighted averages of the country estimates. As the analyses were performed at household level, the number of households in each country was estimated using population figures (United Nations 2014) closest to the corresponding survey year and the average number of people per household, as provided by the survey. This allowed us to weigh each survey based on the number of households available for sampling (estimated) and the number of households included in the survey. Log-binomial regression was used to generate both unadjusted and adjusted prevalence ratios (PR) and 95% confidence intervals (CI) for shared sanitation and for neighbour or general public sharing. The prevalence ratio indicates the prevalence of shared sanitation in one group (i.e. rural households) relative to another group (i.e. urban households). In the case of a continuous variable (e.g. number of people or children in the household), the prevalence ratio indicates the prevalence increase/decrease of sharing sanitation facilities for each additional household member/child under 5 years of age. We chose the list of potential predictive factors *a priori* and analysed them individually to assess their impact on the prevalence of shared sanitation (univariate analysis), after which all significant variables were included in the multivariate model. As wealth was expected to interact with the other variables, a stratified analysis was also conducted.

Results

The analysis included surveys from 84 countries with survey completion years ranging from 2000 to 2013. These countries represent approximately 54% of the total population of low- and middle-income countries. These combined surveys include data on over one million households, comprising over 3 million individuals.

The overall proportion of households that rely on any type of shared sanitation is 27.3% (Table 1). Significantly, about half of the shared latrines globally would be classified as 'improved' and count towards the MDG target but for the fact that they are shared. As noted in Table 1, however, this proportion varies considerably by region and country. Just over half (56.0%) of improved shared facilities are shared with five or fewer households and thus could be included in the new definition of 'improved sanitation' if the JMP proceeds with its policy change; (Table 1). Once again, these proportions are characterised by considerable geographic heterogeneity.

Geographic profile

While shared sanitation is relatively rare in Europe (2.5% total, 2.4% 'improved') and the Eastern Mediterranean (7.7% and 4.6%), it is more common in the Americas (14.2% and 9.4%), Western Pacific (16.4% and 11.5%)

Table 1 Summary statistics of surveyed households by country, among households sharing sanitation facilities. Data from 49 Demographic and Health Surveys and 35 Multiple Indicator Cluster Surveys, 2000–2013

Country (year)	Sample size (*N*)	No toilet facility (%)	Improved toilet facility (%)	Any shared toilet facility (%)	Improved shared toilet facility (%)*	Any Shared with ≤5 households (%)	Improved shared with ≤5 households (%)†
Africa	389 652	26.4	37.1	44.6	17.7	72.2	34.8
Benin (2011–2012)	17 422	54.2	32.6	56.8	18.1	63.2	44.9
Burkina Faso (2010)	14 422	62.3	31.3	51.0	16.0	70.0	57.7
Burundi (2010)	8591	4.0	39.8	18.3	8.0	89.6	37.2
Cameroon (2011)	14 195	7.0	59.3	36.2	23.3	78.1	52.5
Central African Republic (2010)	11 732	31.0	5.0	40.3	2.0	87.7	5.6
Congo, Democratic Republic of the (2010)	11 391	17.0	12.2	52.5	7.6	85.6	14.2
Congo, Republic of the (2012)	11 631	8.7	41.6	69.8	30.2	72.4	33.1
Cote d'Ivoire (2006)	7591	34.1	56.9	55.4	30.8	57.1	48.5
Ethiopia (2011)	16 690	38.3	13.3	38.1	7.9	73.4	19.1
Gabon (2012)	9754	2.3	64.6	49.9	30.6	65.0	38.9
Gambia (2005–2006)	6066	4.2	86.3	46.2	41.1	77.5	70.2
Ghana (2011)	11 925	18.4	65.8	77.8	51.1	66.8	51.6
Guinea (2012)	7108	19.5	44.2	58.4	25.2	75.8	37.6
Guinea-Bissau (2006)	5280	33.5	11.6	48.4	3.3	44.1	3.7
Kenya (2009)	9056	12.1	48.6	50.2	25.9	66.2	34.7
Lesotho (2009)	9385	33.0	35.0	36.6	13.4	63.8	31.7
Liberia (2007)	6808	54.6	27.7	71.4	17.3	31.0	17.7
Madagascar (2009)	17 841	42.6	4.4	63.5	2.1	85.7	4.4
Malawi (2010)	24 815	10.8	13.7	43.2	5.4	92.1	12.9
Mali (2006)	12 968	21.4	59.7	42.8	23.2	79.6	55.8
Mauritania (2007)	1033	47.5	37.2	28.3	9.7	1.6	1.5
Mozambique (2011)	13 191	41.7	23.2	15.8	4.3	92.5	42.2
Namibia (2007)	9195	48.6	46.7	27.4	12.4	61.4	55.9
Niger (2012)	10 743	72.8	18.9	45.1	9.4	80.6	61.1
Nigeria (2011)	29 050	28.9	52.6	44.1	24.2	55.5	45.0
Rwanda (2010)	12 532	1.4	73.9	21.9	16.6	93.9	71.9
Sao Tome and Principe (2009)	3536	61.4	38.1	19.2	7.2	64.4	64.4
Senegal (2011)	7902	17.7	60.2	28.6	19.1	80.2	58.0
Sierra Leone (2010)	11 344	29.6	41.0	73.1	29.7	69.5	39.6
Swaziland (2010)	4830	13.9	79.8	42.8	34.6	51.8	48.0
Tanzania, United Republic of (2010)	9620	14.0	20.6	33.7	7.7	83.3	20.1
Togo (2010)	6031	51.1	29.2	70.1	27.5	50.3	42.1
Uganda (2011)	9030	9.7	50.4	44.1	21.6	71.9	41.2
Zambia (2007)	7160	25.2	35.4	40.7	15.1	86.9	41.8
Zimbabwe (2010–2011)	9756	26.2	64.4	44.2	28.9	81.2	72.0
Americas	185 172	10.3	83.6	14.2	9.4	83.2	66.3
Belize, Plurinational State of (2011)	4423	1.7	96.9	9.8	9.3	76.4	74.4
Bolivia (2008)	19 564	–	–	28.6	–	88.3	–
Colombia (2010)	54 447	4.8	95.1	10.8	10.3	–	–
Cuba (2010–2011)	9183	1.1	94.4	5.4	5.0	86.9	81.0
Dominican Republic (2007)	32 366	4.1	87.3	13.0	4.5	–	–
Guyana (2009)	5623	1.0	93.1	10.6	9.1	88.8	77.5
Haiti (2012)	13 179	25.1	54.6	51.2	28.9	79.0	61.1
Honduras (2012)	21 359	9.4	77.3	14.9	10.6	96.6	75.5
Nicaragua (2001)	11 313	14.5	84.9	8.4	7.2	–	–
Peru (2000)	28 881	22.5	73.6	7.4	5.1	–	–
Suriname (2010)	7398	5.7	91.4	13.0	11.1	81.5	74.5

Table 1 (*Continued*)

Country (year)	Sample size (*N*)	No toilet facility (%)	Improved toilet facility (%)	Any shared toilet facility (%)	Improved shared toilet facility (%)*	Any Shared with ≤5 households (%)	Improved shared with ≤5 households (%)†
South-East Asia	162 485	49.3	42.8	31.3	12.6	76.0	59.7
Bangladesh (2007)	17 140	4.6	52.6	39.6	18.9	86.4	43.0
Bhutan (2010)	7680	4.1	66.1	13.2	10.4	88.1	71.3
India (2006)	108 939	55.4	41.1	29.1	11.7	71.5	64.8
Maldives (2009)	6437	1.5	96.3	2.5	2.1	43.3	36.9
Nepal (2011)	10 826	35.5	56.8	31.7	18.8	92.6	84.7
Timor-Leste (2010)	11 463	37.4	49.3	15.1	8.6	94.3	86.0
Western Pacific	71 279	11.5	79.0	16.4	11.5	84.1	57.0
Cambodia (2011)	15 662	56.7	41.1	18.3	7.5	91.9	86.8
Lao People's Democratic Republic (2011–2012)	18 830	35.3	62.0	4.5	2.6	74.7	67.3
Mongolia (2005)	10 087	13.5	82.6	36.5	29.8	98.6	93.3
Philippines (2008)	12 468	9.5	85.9	22.8	19.0	–	–
Vanuatu (2007)	2622	3.2	63.6	31.9	19.1	86.1	49.0
Viet Nam (2010–2011)	11 610	6.0	78.9	10.9	5.4	81.9	49.9
Eastern Mediterranean	140 800	11.2	82.0	7.7	4.6	90.7	77.3
Afghanistan (2010–2011)	13 103	18.5	30.9	10.9	3.3	69.4	25.8
Djibouti (2006)	4857	4.7	65.5	11.1	5.5	82.5	38.8
Egypt (2008)	18 959	0.4	99.5	3.3	3.3	90.5	89.8
Iraq (2011)	35 688	0.6	97.3	3.6	3.5	94.3	92.2
Jordan (2012)	15 190	0.0	100	0.2	0.2	85.6	85.6
Morocco (2004)	11 509	15.9	83.8	7.7	6.3	–	–
Pakistan (2012–2013)	12 935	21.2	69.7	16.3	10.9	93.2	79.8
Somalia (2006)	5956	56.6	35.3	41.1	14.9	82.0	69.9
Syria (2006)	19 019	1.0	97.3	4.0	3.8	97.7	90.5
Yemen (2006)	3584	24.1	49.5	6.4	2.4	87.7	42.7
Europe	134 635	0.3	97.3	2.5	2.4	72.1	68.3
Albania (2009)	7999	0.0	93.6	2.3	2.0	99.9	89.2
Armenia (2010)	6699	0.1	80.7	1.6	1.1	41.4	17.4
Azerbaijan (2006)	7174	0.3	85.0	8.0	7.5	67.3	62.4
Belarus (2012)	8284	0.0	98.2	3.3	3.1	65.2	60.6
Bosnia and Herzegovina (2011–2012)	5770	0.0	94.8	0.8	0.7	90.8	74.3
Georgia (2005)	12 000	0.0	96.2	2.1	2.0	57.5	54.5
Kazakhstan (2010–2011)	15 800	0.0	99.4	2.6	2.6	64.0	63.0
Kyrgyzstan (2005–2006)	8039	0.0	98.7	4.0	4.0	73.6	73.2
Macedonia, The Former Yugoslav Republic of (2011)	4013	0.7	94.7	1.8	1.6	92.3	83.1
Moldova, Republic of (2005)	11 086	6.1	76.8	6.5	5.9	80.3	69.0
Montenegro (2005–2006)	2357	0.2	99.1	3.5	3.4	81.7	79.6
Serbia (2010)	6386	0.0	98.5	0.8	0.7	95.6	94.3
Tajikistan (2005)	6684	0.5	93.7	3.4	3.2	56.9	55.2
Turkey (2003)	10 829	0.5	98.8	2.4	2.4	–	–
Ukraine (2012)	11 317	0.0	99.0	1.8	1.7	74.1	72.9
Uzbekistan (2006)	10 198	0.0	99.4	2.0	1.9	99.0	97.9
Global averages	1 084 023	40.9	49.0	27.3	12.1	75.9	56.0

*Among households that access a sanitation facility (improved shared).
†Among households accessing an improved shared sanitation facility. '–' indicates data not collected.

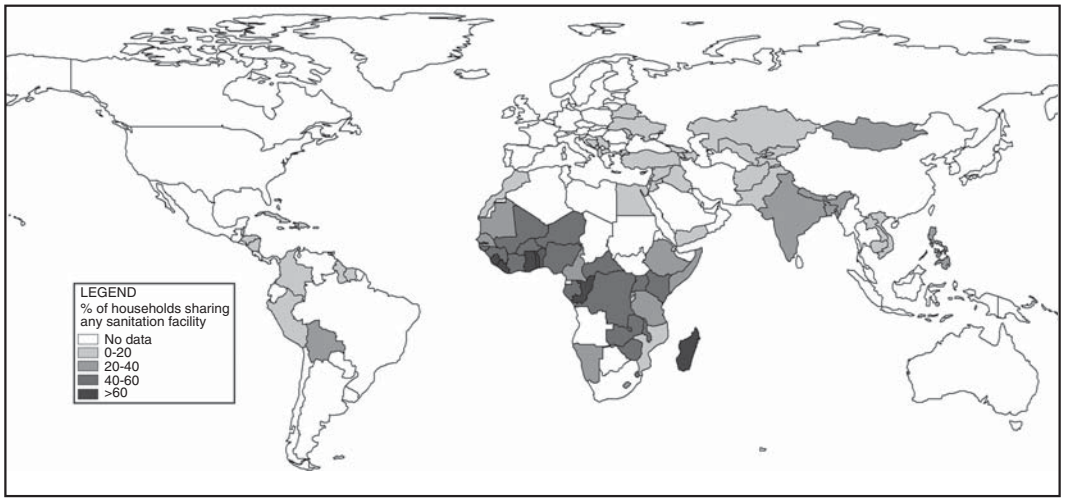

Figure 1 Overview of households sharing any sanitation facilities in the 84 included survey countries.

and South-East Asia (31.3% and 12.6%). Reliance on shared sanitation is most common in Africa, where the overall prevalence is 44.6% but where less than half (17.7%) otherwise qualify as 'improved' sanitation facilities.

Figure 1 shows that some of the highest rates of sharing sanitation facilities are found in Africa, particularly West Africa. Sharing is practised by over half the population of 13 African countries, with especially high rates of sharing in Ghana (77.8%), Sierra Leone (73.1%), Liberia (71.4%), Togo (70.1%), Republic of the Congo (69.8%), Madagascar (63.5%), Guinea (58.4%), Benin (56.8%), Côte d'Ivoire (55.4%), Democratic Republic of the Congo (52.5%), Burkina Faso (51.0%) and Kenya (50.2%); it is just under half in Gabon (49.9%). The only non-African country with over half the population sharing sanitation is Haiti (51.2%) (Table 1).

Overall, the prevalence of shared sanitation is slightly higher in urban (28.6%) than in rural settings (25.9%) ($P < 0.001$) (Table 2). In other words, more households access shared sanitation in urban areas (53.8%) than in rural areas (46.2%) (of a total of 385 383 households in urban areas, and 737 528 households in rural areas). Globally, taking into account potential confounders, households in rural areas are 36% less likely to rely on shared sanitation facilities than urban households (adjusted PR 0.64, 95% CI: 0.60–0.69) (Table 3). This urban predominance is most notable in the African and Asian region, whereas the Americas, Western Pacific and Eastern Mediterranean region show a higher prevalence of sharing sanitation in the rural regions (Table 2), which is confirmed by the crude prevalence ratios in Table 3. The global urban predominance of shared sanitation is consistent across wealth tertiles (Table S1).

Socio-economic and Demographic profile

At a global level, sharing is more common among households in the most poor (lowest) wealth tertile (Table 3). People in the least poor (highest) tertile are 51% less likely to share than those in the most poor tertile (adjusted PR 0.49, 95% CI: 0.45–0.52); those in the middle tertile are 26% less likely to share (adjusted PR 0.74, 95% CI: 0.71–0.78). This pattern is consistent across all regions except Africa; here households in the middle wealth tertile were slightly more likely to share sanitation facilities (adjusted PR 1.05, 95% CI: 1.00–1.10), whereas there was no effect in the least poor tertile. The wealth exposure was expected to interact with other covariates (region, education), and as such a stratified analysis by wealth tertile was conducted (Table S1).

Overall results indicate that increasing numbers of individuals in the household results in lower prevalence of shared sanitation (adjusted PR 0.84, 95% CI: 0.83–0.85) (Table 3). This association is consistent across all regions. On the other hand, increasing numbers of children under the age of five in the household is associated with a higher prevalence of shared sanitation (adjusted PR 1.38,

Table 2 Regional prevalence of any type of shared sanitation, per urban/rural with the associated 95% confidence interval and the results of a two-sample t-test assessing the difference between urban and rural prevalence, accounting for survey design

Region	Urban prevalence (95% CI)	Rural prevalence (95% CI)	*P*-value
Global	28.6 (27.4–29.8)	25.9 (25.2–26.5)	<0.001
Africa	57.1 (55.6–58.6)	37.0 (36.1–37.9)	<0.001
Americas	14.0 (13.5–14.4)	14.6 (13.8–15.3)	0.220
South East Asia	33.8 (31.9–35.6)	28.6 (27.7–29.6)	<0.001
Western Pacific	16.0 (14.7–17.3)	16.6 (15.6–17.6)	0.436
Eastern Mediterranean	4.6 (4.2–5.0)	11.6 (10.7–12.5)	<0.001
Europe	2.5 (2.0–2.9)	2.5 (2.2–2.9)	0.798

95% CI: 1.35–1.41). Again, this effect is consistently shown across all regions.

Overall, if the head of the household has completed primary education, the prevalence of shared sanitation is 13% lower than if the head of the household had no formal education (adjusted PR 0.87, 95% CI: 0.83–0.91) (Table 3). The direction of this effect is consistent across regions except in Africa (adjusted PR 1.16, 95% CI: 1.11–1.22). There was no association between shared sanitation use and education of the head of the household in the Western Pacific, Eastern Mediterranean and European region. Similarly, the prevalence of sharing sanitation is lower if the head of the household has completed secondary education or higher compared with no formal education (Global: adjusted PR 0.48, 95% CI: 0.47–0.51). Similar to the above, in the African region more education is associated with an increased prevalence in sharing, with no effect seen in the Western Pacific and European region.

In general, there is no apparent association between access to an improved water source and access to shared sanitation (adjusted PR: 1.06 95% CI: 0.98–1.13) (Table 3). Similarly, in the Western Pacific region there is no association between improved water access and shared sanitation access, whereas in the African, South-East Asian and Eastern Mediterranean region households accessing improved water sources also report accessing shared sanitation, whereas the opposite is seen in the remaining regions (Table 3).

Countries reporting high prevalence of shared sanitation

Further analysis was conducted considering only the 13 countries in which 50% or more of the households report shared sanitation access (Table S2). The only difference between this subgroup analysis and the main table of results (Table 3) is that households accessing improved water sources are also more likely to access shared sanitation facilities (adjusted PR 1.18, 95% CI: 1.07–1.31). This result is similar to the effect seen for the African region in Table 3.

Sharing sanitation: public or persons known?

Thus far, 21 country surveys provide information on whether the sanitation facility was shared with the general public or with persons known to the respondent. An overview of the included countries and their sharing prevalence can be found in Table 4. Overall, 23.8% of the households from these 21 surveys reported using some type of shared sanitation; just over half of these (52.5%) reporting the use of 'improved' shared facilities. Of those households sharing any sanitation facility, 82.0% reported sharing with neighbours and other known individuals *vs.* the general public. Sharing with the general public was more common among rural householders (adjusted PR 1.30, 95% CI: 1.06–1.61) (data not shown). No effect was found for households in the middle wealth tertile, but households in the least poor tertile were more likely to share with neighbours or known households as opposed to the general public (adjusted PR 0.71, 95% CI: 0.59–0.86). No association was found between heads of household with primary or secondary education *vs.* no formal education (primary: adjusted PR 0.89, 95%CI: 0.76–1.05, secondary: adjusted PR 1.16, 95% CI: 1.00–1.34). More children under the age of five in the household increased the likelihood of sharing with neighbours or other known households (adjusted PR 0.85, 95% CI: 0.80–0.91). There was no association between the number of household members and type of water source accessed and the type of household sharing (known or general public).

To further assess the impact of a potential change in policy by the JMP, the estimated increase in coverage of 'improved' sanitation was calculated (Table 4). This shows that not only does the prevalence of households sharing sanitation facilities vary considerably between countries, but so does the prevalence of sharing with

Table 3 The crude and adjusted prevalence ratios* and 95% confidence limits of any shared sanitation access by households, controlling for the following factors: rural or urban location, access to improved water, the number of people and children under five in the household, wealth tertile of the household and education level of the head of the household. The outcome (shared sanitation) is coded (0) no sharing and (1) sharing; thus, ratios of <1 reflect lower prevalence of sharing and ratios of >1 represent greater prevalence of sharing. Data from 49 Demographic and Health Surveys and 35 Multiple Indicator Cluster Surveys, 2000–2013

		Region	Wealth tertile†		Number of people in HH*	Education level of household head‡		Number of children under 5	Water source used
		Rural (1) *vs.* urban (0)	Middle (1) *vs.* Poorest (0)	Least Poor (2) *vs.* Poorest (0)	Continuous Variable	Primary education (1) *vs.* none (0)	Secondary education and above (2) *vs.* none (0)	Continuous Variable	Improved source (1) *vs.* unimproved source (0)
Global	Crude	0.87 (0.81–0.93)	0.77 (0.73–0.81)	0.45 (0.43–0.49)	0.89 (0.88–0.90)	0.84 (0.80–0.88)	0.47 (0.44–0.49)	1.07 (1.05–1.09)	0.95 (0.88–1.02)
(*N* = 870 786)	Adjusted	0.64 (0.60–0.69)	0.74 (0.71–0.78)	0.49 (0.45–0.52)	0.84 (0.83–0.85)	0.87 (0.83–0.91)	0.48 (0.47–0.51)	1.38 (1.35–1.41)	1.06 (0.98–1.13)
Africa	Crude	0.44 (0.41–0.47)	1.11 (1.06–1.17)	1.62 (1.51–1.73)	0.85 (0.84–0.86)	1.26 (1.20–1.33)	1.82 (1.72–1.94)	0.84 (0.83–0.86)	1.40 (1.31–1.49)
(*N* = 269 338)	Adjusted	0.49 (0.45–0.53)	1.05 (1.00–1.10)	1.03 (0.96–1.10)	0.83 (0.82–0.84)	1.16 (1.11–1.22)	1.29 (1.21–1.37)	1.19 (1.16–1.22)	1.12 (1.06–1.19)
Americas	Crude	1.05 (0.97–1.13)	0.69 (0.65–0.73)	0.34 (0.32–0.37)	0.87 (0.86–0.88)	0.64 (0.59–0.68)	0.51 (0.48–0.55)	1.20 (1.18–1.23)	0.52 (0.47–0.56)
(*N* = 167 732)	Adjusted	0.61 (0.56–0.67)	0.73 (0.69–0.78)	0.39 (0.35–0.42)	0.79 (0.77–0.80)	0.73 (0.68–0.79)	0.67 (0.62–0.73)	1.59 (1.54–1.64)	0.61 (0.55–0.67)
South-East Asia	Crude	0.79 (0.72–0.86)	0.75 (0.70–0.80)	0.37 (0.34–0.40)	0.86 (0.85–0.88)	0.72 (0.69–0.77)	0.43 (0.40–0.47)	1.07 (1.04–1.10)	1.43 (1.23–1.66)
(*N* = 111 318)	Adjusted	0.56 (0.51–0.62)	0.72 (0.68–0.77)	0.36 (0.33–0.40)	0.82 (0.81–0.84)	0.79 (0.74–0.84)	0.54 (0.50–0.59)	1.39 (1.35–1.43)	1.61 (1.39–1.87)
Western Pacific	Crude	1.05 (0.93–1.18)	0.64 (0.58–0.71)	0.23 (0.20–0.26)	0.95 (0.93–0.98)	0.84 (0.74–0.97)	0.76 (0.65–0.88)	1.28 (1.22–1.35)	0.72 (0.60–0.85)
(*N* = 53 646)	Adjusted	0.71 (0.63–0.81)	0.62 (0.56–0.69)	0.20 (0.17–0.23)	0.93 (0.91–0.96)	0.94 (0.81–1.08)	1.11 (0.95–1.29)	1.38 (1.30–1.47)	0.92 (0.77–1.10)
Eastern	Crude	2.69 (2.37–3.06)	0.17 (0.14–0.19)	0.28 (0.25–0.32)	1.01 (1.00–1.02)	0.78 (0.68–0.88)	0.38 (0.33–0.43)	1.21 (1.17–1.26)	0.79 (0.65–0.95)
Mediterranean (*N* = 128 406)	Adjusted	1.74 (1.50–2.03)	0.24 (0.20–0.28)	0.42 (0.36–0.48)	0.94 (0.92–0.96)	1.05 (0.91–1.20)	0.64 (0.56–0.74)	1.25 (1.19–1.32)	1.66 (1.31–2.12)
Europe	Crude	1.03 (0.81–1.32)	0.48 (0.39–0.58)	0.31 (0.25–0.38)	0.94 (0.90–1.00)	0.85 (0.63–1.14)	0.71 (0.54–0.95)	1.27 (1.17–1.38)	0.69 (0.52–0.90)
(*N* = 140 364)	Adjusted	0.83 (0.64–1.07)	0.47 (0.38–0.58)	0.32 (0.25–0.40)	0.88 (0.84–0.93)	0.94 (0.70–1.26)	0.77 (0.58–1.01)	1.58 (1.44–1.73)	0.77 (0.60–1.00)

*Prevalence ratio indicates the prevalence of an event in one group (i.e. HH in a rural area) relative to another group (i.e. HH in an urban area). In the case of a continuous variable (i.e. Number of people or <5 child in HH), the prevalence ratio indicates the prevalence increase/decrease of sharing sanitation facilities for each additional household member/child under 5 years of age.
†Cuba excluded from analysis on wealth as these data are not collected.
‡Somalia and Uzbekistan excluded from analysis on education.

Table 4 Sanitation coverage implications if shared sanitation is considered 'improved' sanitation. 21 MICS surveys with data on sanitation facilities shared with other households known by the respondent or the general public

Country	Total number of households	Number of households reporting sharing sanitation	Percentage of households reporting sharing sanitation	Of the households sharing, percentage of those sharing with 'known' households (*vs.* 'general public')	Of the households sharing, percentage of those sharing with five or fewer households	Of the households sharing, percentage of those sharing a facility of an 'improved' type	Of the households sharing, percentage of those sharing a facility with five or fewer households, known to the respondent and of an 'improved' type	Percentage of households using an improved sanitation facility (excluding shared facilities)	Expected coverage of improved sanitation if shared proposed JMP policy is implemented
Belarus	8563	268	3.3	100	65.2	93.9	57.8	91.2	93.1
Central African Republic	11 966	3114	40.3	91.9	87.7	4.9	3.5	3.0	4.4
Afghanistan	13 468	1326	10.9	80.4	81.7	30.3	21.1	27.5	29.8
Belize	4900	433	9.8	93.7	76.4	94.9	68.4	87.6	94.3
Bhutan	7681	829	13.2	94.4	88.1	78.8	64.4	55.7	64.2
Bosnia	6838	49	0.8	99.3	90.8	87.5	75.0	94.0	94.6
Cuba	9525	483	5.4	91.8	86.7	92.6	74.1	89.4	93.4
Democratic Republic of the Congo	11 490	4761	52.5	92.2	85.6	14.5	10.9	4.6	10.3
Ghana	12 150	5616	77.8	43.9	66.8	65.7	18.5	14.7	29.1
Iraq	36 592	1402	3.6	93.2	94.3	97.2	86.1	93.8	96.9
Kazakhstan	16 380	481	2.6	75.4	64.0	100	50	96.9	98.2
Lao PDR	19 960	491	4.5	85.8	74.7	56.5	37.8	59.2	60.9
Macedonia	4703	80	1.8	85.3	92.3	88.9	72.2	92.9	94.2
Nigeria	29 349	7296	44.1	87.0	55.6	54.9	27.7	28.4	40.6
Serbia	6885	42	0.8	78.4	95.7	87.5	75.0	97.5	98.1
Sierra Leone	11 923	5703	73.1	87.3	69.4	40.6	24.2	11.2	28.9
Suriname	9356	1028	13.0	88.2	81.1	85.4	61.5	80.3	88.3
Swaziland	5475	1856	42.8	97.4	51.7	80.8	40.2	45.2	62.4
Togo	6651	1856	70.1	81.5	53.5	39.2	17.5	11.6	23.9
Viet Nam	11 874	1092	10.9	88.7	81.9	49.5	41.3	73.5	78.0
Ukraine	12 459	163	1.8	94.5	74.1	94.4	66.7	97.1	98.3
OVERALL	205 343	38 222	23.8	82.0	68.9	52.5	27.3	54.1	60.6

'known' households, sharing with five or fewer households and sharing of an sanitation facility which is considered 'improved' in terms of service type. Though the proposed policy change does not increase the coverage of 'improved' sanitation dramatically in countries which already have high improved sanitation coverage (i.e. some countries in Europe and the Americas), it at least doubles the level of improved sanitation in three countries (Togo, Sierra Leone, Democratic Republic of the Congo), and almost doubles it in one (Ghana).

Discussion

Sharing latrines with other households represents a large and growing sanitation option that policymakers are proposing to endorse under certain conditions by counting it as 'improved' for purposes of international targets. However, evidence that shared sanitation is may be associated with adverse health outcomes (Fuller *et al.* 2014; Heijnen *et al.* 2014) raises questions about the circumstances under which it can be a safe, effective and sustainable solution. We undertook this study to characterise the geographic and demographic scope of shared sanitation and to identify factors that could help explain the apparent increase in health risks associated with the practice.

Shared sanitation prevalence is highest in the African and the South-East Asian regions. There are 13 countries, many of which in West Africa, where shared sanitation actually represents the predominant approach. While the shared sanitation facilities in most regions meet the JMP's definition of 'improved' sanitation, less than half of those in Africa meet this definition. As unimproved sanitation is associated with a risk of diarrhoea (Clasen *et al.* 2010; Norman *et al.* 2010; Fink *et al.* 2011; Lim *et al.* 2012; Fuller *et al.* 2014), helminth infection (Ziegelbauer *et al.* 2012) and poor growth (Fink *et al.* 2011), it is important for analyses of the risk of shared sanitation to control for the type of sanitation.

Our results also suggest that shared sanitation is substantially more common in urban than in rural settings, a finding consistent with the JMP's own conclusions (Joint Monitoring Programme 2012a). Sharing of facilities is also likely to be higher in urban slums and other high-density informal settlements with poor services.

In a prior analysis of shared sanitation and the risk of diarrhoea, we showed that even after taking into account potential confounders, a residual risk was present, though it varied geographically (Fuller *et al.* 2014). Many of the determinants of sharing used in this study (number of household members, education of the head of household, etc.) were also considered as confounders in the study by Fuller *et al.* (2014) and were found to attenuate the risk of diarrhoea. As such, though there may be aspects of sharing sanitation that increase risk, it is likely that there are other processes at play that are independent of reliance on shared sanitation. While results vary geographically, people who rely on shared sanitation tend to be poorer, reside in urban areas, and live in households with more young children and headed by people with no formal education. Households in urban areas are more likely to share sanitation than those in rural areas. Significantly, these each represent independent risk factors for diseases associated with poor sanitation (Fink *et al.* 2011).

Our results show that larger households are less likely to share sanitation facilities. It is possible that increasing family size is associated with home ownership or more adults contributing earnings to the households, or other factors that the surveys do not measure but may be reasons for not relying on shared sanitation. Interestingly, our results consistently show that increasing numbers of young children in the household is associated with increased sharing. The results remain strong when separated by wealth tertile. Reasons for this are not clear, but an in-depth analysis of wealth or fertility might help explain this result.

Although data from only 21 countries are available so far, sharing of latrines is predominantly with family members or other persons known rather than the public. Under the proposed change in JMP definitions, these would count towards international sanitation targets if they are shared by five or fewer households and are otherwise improved. As more country surveys become available, it will be possible to explore whether households which fit these new criteria actually have access to 'safer' sanitation, or whether other factors, such as wealth, education and access to improved water supplies – may be more relevant to restricting risk. Perhaps surprisingly, sharing with the general public was found to be slightly more common among rural householders. In some rural villages, all households may know each other, which might make the division between 'known households' and the 'general public' less distinct. As more surveys with this information become available, additional data may help to explain this.

This study has several limitations. First, the data were drawn from JMP surveys based on questionnaires subject to measurement and reporting bias (Boerma & Sommerfelt 1993). While the JMP recommends standard questions for eliciting information on shared sanitation, there are potentially important differences between DHS and MICS surveys and among many national surveys and survey methodologies that could impact the validity of pooling the results. Moreover, the questions have not been rigorously validated. Even though a particular facility is

reportedly used by the household members, this facility might not be used the same or consistently by all household members. The reliability of the data on shared sanitation has been questioned previously, mostly due to varying shared sanitation prevalence reports from the same country during the same time period (JMP Taskforce 2010). For this reason, we chose to use only the most recent dataset for each country, as few countries have repeat measures on shared sanitation, and further questions on the number of households that use shared sanitation facilities have only been added to all DHS and MICS surveys since 2005 (JMP Taskforce 2010).

Second, although we endeavoured to control for potential confounders, this is not always possible. Land tenure or size of plots, for example, could impact the ability of householders to construct their own latrines, but these data are not always collected (Isunju *et al.* 2011). Moreover, the potential for controlling for confounders is limited when characteristics are codetermined. This may be the case, for example, for characteristics associated with urban–rural settings. Similarly, the prevalence of shared sanitation is likely to vary considerably within urban areas – either in high-density slum settlements or surrounding peri-urban areas. Unfortunately no such detailed data is available through the household surveys used.

Third, while this study includes 84 countries, these countries only represent 54% of the population of low- and middle-income countries (World Bank 2014). Due to a lack of DHS or MICS data, it excludes some large countries, such as China, South Africa and Brazil. It is reported that almost a fifth of the population (19%) or an estimated 256 million people in China access improved shared sanitation (24% in urban, 14% rural) (Joint Monitoring Programme 2013). Similarly, approximately 8% of the South African population accesses shared sanitation (9% urban, 6% rural) (Joint Monitoring Programme 2013). Although it is important to include these countries' data in the analysis when it becomes available, the substantial geographic heterogeneity that we have already observed suggests that each country's results should be viewed carefully on its own.

Notwithstanding these limitations, our results provide the first specific large-scale global and regional estimates for the prevalence of shared sanitation and exploration of factors associated with the practice. These estimates clearly identify countries where shared sanitation predominates. This allows for targeting interventions to help minimise any adverse consequences of the practice. We also identified factors associated with increased reliance on shared sanitation, some of which are likely to also be associated with increased health risks. Future research using more robust study designs will be necessary to determine whether these are actually part of a causal chain between shared sanitation and health or merely confounders.

Our other main finding is the substantial variability in the geographic and demographic characteristics of those who report relying on shared sanitation. This variability underscores the importance of the contextual factors that may increase dependence on and any risks associated with shared sanitation. At the same time, this heterogeneity may make it difficult to implement a single, uniform and global policy on shared sanitation that is effective in rendering it a safe, effective and sustainable solution that can be promoted universally as part of international targets. Lastly, the proposed policy change considering certain types of shared sanitation as 'improved' may affect funding allocation, government interest and local policies, especially in countries where the coverage of improved sanitation stands to increase considerably as a result. As such, all available evidence must be carefully considered before such a policy is implemented.

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Supporting Information

Additional Supporting Information may be found in the online version of this article:

Table S1. The crude and adjusted prevalence ratios and 95% confidence limits of any shared sanitation access by households, by wealth tertile.

Table S2. Data specific for those 13 countries reporting a shared sanitation prevalence of 50% and above.

Corresponding Author Marieke Heijnen, Faculty of Infectious and Tropical Diseases, London School of Hygiene & Tropical Medicine, Keppel Street, London WC1E 7HT, UK. Tel.: +44 20 7927 2213; E-mail: Marieke.Heijnen@lshtm.ac.uk

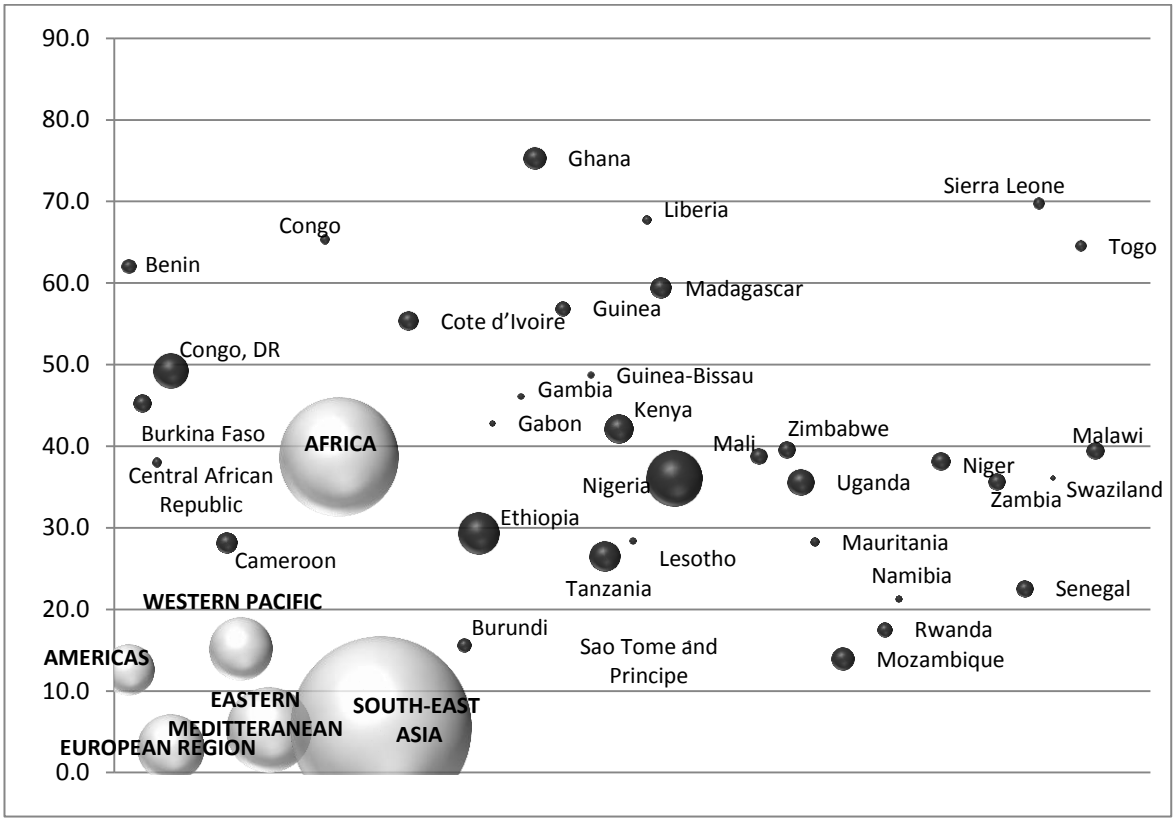
3.3 Additional information on the scope of shared sanitation

3.3.1 Household-level versus population-level analysis

The data for the final publication went through several revisions, mostly on the analysis level. The initial analysis was conducted at household level, as this was considered most logical for a sanitation facility. However, in order to allow comparisons with the JMP publications (annual updates on the progress of water and sanitation) the analysis was re-done at a population level. This allowed expressions of shared sanitation coverage as a percentage of the total population, which may be a more powerful motivator when influencing policy. In addition, there was limited information on the number of households in each country (some countries provided very accurate information as per their census, whereas other countries had no data on household size), which meant it was difficult to provide clear information on the prevalence of households sharing sanitation, as a percentage of all the households in the country or region.

However, after some consideration of the initial multivariate results, it proved difficult to remove the potential inter-household correlation—as several members of the household were expected to use the same shared facility. Finally, returning to the original argument that a sanitation facility is expected to be a household facility, the analyses were re-done at household level. This removed any issues with inter-household correlation, but the lack of data on the number of households in different countries remained. This in turn made it difficult to provide weighted estimates when country surveys were combined into regional or global estimates. This was resolved by estimating the number of households in each country using population figures [66] closest to the corresponding survey year and the average number of people per household, as provided by the survey. This allowed the weighting of each survey based on the number of households available for sampling (estimated) and the number of households included in the survey, and as such allowed the regional and global estimates to be weighted based on the number of households contributing data per country. As an indication of which countries in Africa, as well which regions have the highest prevalence of households sharing sanitation, Figure 6 provides an overview, with the size of the bubbles proportional to the population size. As can be seen, several West African countries stand out with very high rates of shared sanitation use, namely Ghana, Liberia, Togo and Sierra Leone.

Figure 6. Percentage of households sharing any type of sanitation facilities per region and per African country. Bubble size proportional to population using population estimates from 2012 [67]



3.3.2 WEALTH INDICATOR

The standard wealth indicator which is included in the MICS and DHS surveys is usually based on a number of variables, including water and sanitation variables. As such, it was necessary to re-calculate a wealth variable for each individual country survey. This was done by combining household-level information on type of cooking fuel and household flooring, as well as ownership of specific items (which varied per country—an overview of the included items available Appendix 3), using principal component analysis to define the summed weights [68]. The index is the first principal component, as it summarises the largest amount of information common to the asset variables [69]. Each primary component explained at least 25 percent of the variance, with a range from 25 – 58 percent.

3.3.3 SURVEY YEARS

In the analysis only the most recent country survey was chosen for inclusion, instead of using multiple surveys from the same country. The main reason for this was that few consecutive country surveys provided information on shared sanitation. Questions on shared sanitation have only been included in the majority of surveys since 2005 (though

some country surveys started earlier), and as most of these surveys are only done every 5 years, there were limited benefits to using multiple time points [70].

3.3.4 Sharing a facility with persons known to the respondent

As was discussed above (section 3.1.1), part of the proposed inclusion of shared sanitation as improved sanitation is the requirement that users 'know' each other. This information is sought through the latest MICS surveys, where the following question has been added: 'Do you share [the sanitation facility] only with members of other households that you know?'. This question aims to differentiate the use of facilities that anyone can use, which are expected to be largely public sanitation facilities, from the use of facilities only by a known group of people, which are expected to be largely shared private facilities [71]. The rationale for this is understandable—it is expected that when households are familiar with each other, they feel more responsibility or ownership of the facility they all use. However, many shared sanitation facilities are found in dense urban settlements, or slums, and the heterogeneous and transient nature of users of shared toilets in urban slums might complicate their relationship with other households in regard to the cleaning of the shared toilets [40, 72]. In addition, there is little information on what constitutes 'knowing' someone in terms of the MICS question, and 'knowing' may be vary according to setting, culture and country.

3.3.5 Potential policy change affecting 'high-sharing' countries

As highlighted in Table 4 of the published paper in section 3.2, though the proposed policy change does not increase the coverage of 'improved' sanitation dramatically in countries which already have high improved sanitation coverage (i.e. some countries in Europe and the Americas), it at least doubles the level of improved sanitation in three countries (Togo, Sierra Leone, Democratic Republic of the Congo), and almost doubles it in one (Ghana).

Wolf and colleagues modelled the different classifications of shared sanitation and their impact on the prevalence on improved sanitation coverage by 2015 [60]. When all shared sanitation facilities of an improved technology were classified as 'improved' only 23 percent of the world population would be without sanitation access in 2015 compared to 34 percent with the current classification (shared considered unimproved). In addition, the model predicts a constant increase of shared sanitation use between 1990 and 2015 worldwide (from 13% to 17%, or an additional 511 million people) [60].

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4 SHARED SANITATION VERSUS PRIVATE SANITATION IN ORISSA, INDIA

The previous three chapters highlighted the importance of shared sanitation, as well as the relative lack of studies focussing specifically on users of shared sanitation. Chapters 4 and 5 report on the fieldwork conducted in the Indian State of Orissa focussing on households with access to shared or private sanitation facilities. Chapter 4 provides an introduction to that fieldwork. It describes the field site and the data collection methods, and includes a manuscript prepared for publication exploring the demographic and microbiological associations of shared sanitation versus private latrines. Some additional results, which are not included in the manuscript in section 4.4, are presented in section 4.5 and discussed briefly at the end of the chapter.

4.1 SANITATION CRISIS IN INDIA

India hosts the largest number of people not using sanitation facilities, with 597 million people practicing open defecation [73]. Progress on sanitation has proven slow, with the percentage of open defecators dropping only from 64 percent to 50 percent over the decade 2001 (191.96 million households) to 2010 (246.69 million households) [74-76]. Even so, global and other official estimates of open defecation rates for India may be considerably underestimated as these are based largely on latrine coverage and imprecise questions about use [77].

The latest JMP data shows that 14 percent of the Indian population has gained access to improved sanitation since 2000 [73]. A fifth of the urban population (20%) is reported to share sanitation facilities, as compared to 18 percent in 2000 [73]. The proportion of people sharing in rural areas is lower, but also rising (increased from 3% to 5% between 2000 and 2012) [73].

As can be seen in Figure 7, there is a considerable disparity in sanitation access between the poorest and richest population quintiles. Between the years 1995 – 2008 the poorest 40 – 60 percent of the population hardly benefitted from any sanitation improvements.

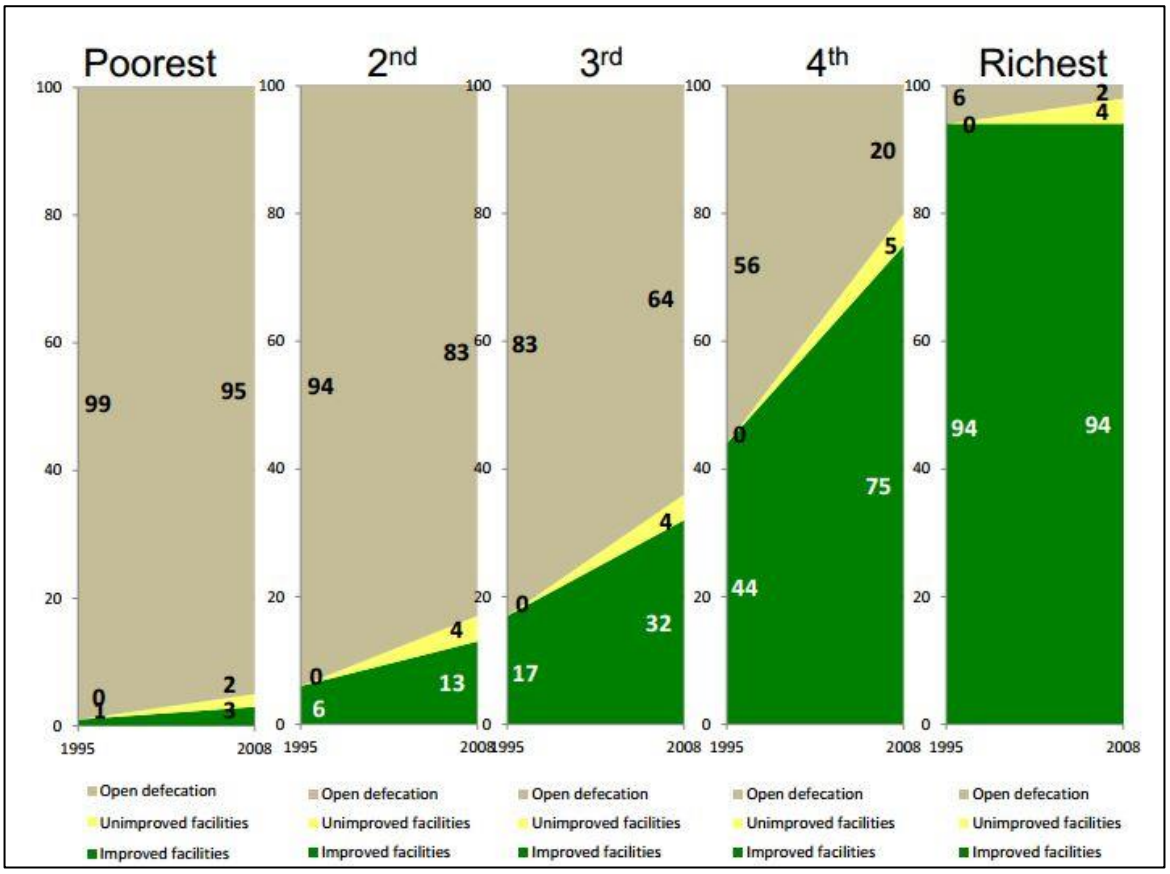

Figure 7. Inequity in sanitation access in India. Source: [78]

4.1.1 ORISSA

The state of Orissa (also known as Odisha) has a population of 41,974,218 with just under a fifth of the population (7,003,656) living in urban areas [75]. Orissa is one of India's poorest states, with 33.7 percent of the population living below the national poverty line (as compared to 21.9% for the whole of India) [75, 79]. In addition, the state is extremely vulnerable to natural disasters, such as flooding and cyclones.

Orissa has some of the lowest household sanitation coverage figures—as can be seen in Figure 8, the proportion of household in Orissa with a latrine facility available within their premises increased from 14.9 percent to 22.0 percent between 2001 and 2011 [80]. Similarly, there is significant urban-rural disparity, as shown in Figure 9. Open defecation in the state declined only from 85 percent to 78 percent between 2001 (7.66 million households) and 2011 (9.87 million households) [74, 75] which means a concerted effort is required to achieve an open defecation-free state by 2025 [76].

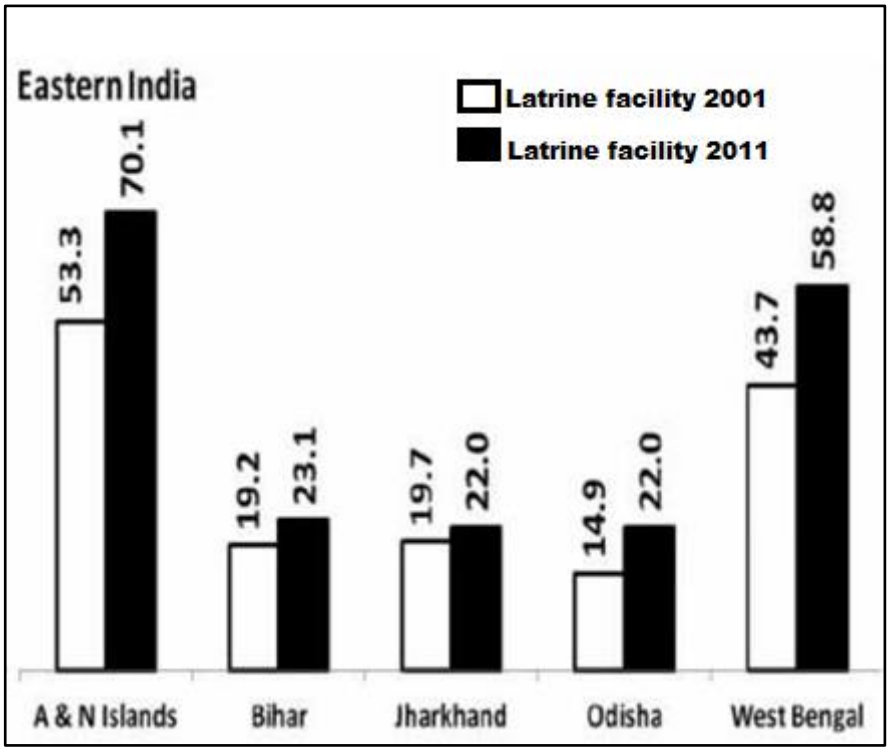

Figure 8. Proportion of households with sanitation facility on premises, adapted from [80]

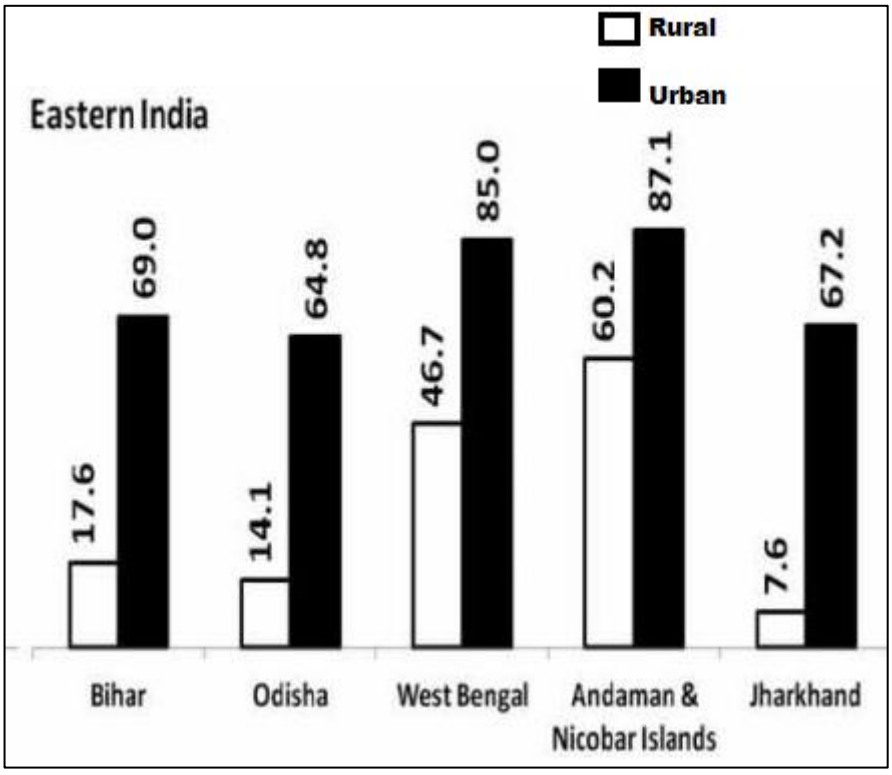

Figure 9. Proportion of households with access to sanitation on the premises, per region, adapted from [80]

4.1.2 SLUM SANITATION

The increasing global trends in urbanization, combined with poor governance, absence of coherent policies and institutional support structures is leading to the rapid growth of informal settlements (commonly known as slums) in most low-income country cities [72]. In India, the latest census (2011) reports that over 65 million people live in slums, up from 52 million in 2001, but slum populations have grown slower than the average urban population over the last decade (37.1% growth in slums versus 44.9% growth in all urban areas) [75]. The census of India defines slums as 'residential areas where dwellings are unfit for human habitation' because they are dilapidated, cramped, poorly ventilated, unclean, or 'any combination of these factors which are detrimental to the safety and health' and covers all 4,041 statutory towns in India. In addition, it categorises slums into three distinct groups, namely:

- All notified areas in a town or city notified as 'Slum' by State, Union territories Administration or Local Government under any Act including a 'Slum Act' may be considered as *Notified slums*
- All areas recognised as 'Slum' by State, Union territories, Administration or Local Government, Housing and Slum Boards, which may have not been formally notified as slum under any act may be considered as *Recognized slums*
- A compact area of at least 300 population or about 60-70 households of poorly built congested tenements, in unhygienic environment usually with inadequate infrastructure and lacking in proper sanitary and drinking water facilities. Such areas should be identified personally by the Charge Officer and also inspected by an officer nominated by Directorate of Census Operations. This fact must be duly recorded in the charge register. Such areas may be considered as *Identified slums* [75]

Dealing with water and sanitation needs in slums in India has been shown to be a stressful and time-consuming challenge [46]. Though no slum in the same and each has its own particular challenges in terms of location, politics and mix of residents, most have been shown to have inadequate access to water sources, as well as acceptable sanitation and hygiene facilities. For example, residents of slums in Mumbai report using the railway tracks as toilets—even though public toilets were available some 30 minutes away on foot, the lack of cleanliness and long queues induced them to use the tracks instead. The women responded that they only use the tracks after 10 pm or early in the morning, between 4 and 5 am [46]. A study in a dense urban settlement in Bhopal reported that despite the presence of communal facilities, women were relatively poorly served by them, and cost was a barrier for the poorer households [39]. It also highlighted that provision of a

communal facility may reduce, but does not end the problem of open defecation in urban poverty pockets. Slums in Delhi were also reported to be particularly difficult for women—their main fear was sexual violence, especially when using public toilets, but also when defecating in the open and in public spaces in general [81]. The NGO SPARC, active with slum residents throughout India, notes that although slum dwellers provide cities with cheap, informal services, they are treated as non-citizens which have 'encroached' in a city that needs their labour, but it unwilling to pay their housing needs [82].

4.1.3 Slum sanitation in Orissa

According to the 2011 Census, Orissa has no notified slums, 812,737 recognised slums and 747,566 identified slums [75]. Orissa is also one of the top 5 states reporting a high proportion of slum households versus urban households (23.1%)[75], though this may be related to relatively low level of urbanisation in general. Despite this limited level of urbanisation, its cities are growing rapidly and currently over 20 percent of Orissa's urban population live in slums [82].

4.1.4 Shared sanitation in slums

In the previous chapters it was highlighted that users of shared sanitation are more likely to live in urban areas, be poor and have limited education. In addition, several of the documents included in the systematic literature review in Chapter 2 highlighted that many users of shared sanitation lived in slums. It is recognised that due to lack of space, infrastructure and land tenure, shared sanitation is often the most appropriate sanitation option in slums, for those wishing to avoid open defecation [83].

Shared sanitation facilities encompass a wide range of facilities—from a facility shared amongst tenants to large public toilets shared by transient and residential population [24]. One method to distinguish between types of shared sanitation is to consider the user groups, such as has been done by Water and Sanitation for the Urban Poor (WSUP) [28]: '

- Household toilets are used only by a single household, typically a single family or extended family. However, facilities classified as 'household toilets' often serve very large households, or they may be regularly used by neighbours, as such the boundary between household toilets and shared toilets is not always clear-cut.
- Shared toilets are shared between a group of households in a single building or plot. This can cover very different situations: for example, a toilet shared by 20 tenant families each occupying one room in a large building or a toilet shared by three related families living within a single plot or compound.
- Community toilets are shared by a group of households in a community. In some cases, each household will have a key to one of the toilets within a block: this may

be one toilet per household or one toilet for a group of households. Communal toilets may be owned by the group of households.

- Public toilets are open to anybody, in public places or in residential areas: typically, there will be a charge for each use. Sometimes each user pays for a monthly ticket. Users of public toilets will generally feel less 'ownership' than users of communal toilets.'

Many of the distinctions made by WSUP are also used in this thesis, as noted in section 1.4.1 of Chapter 1, though these are slightly more condensed.

1) Public: facilities that are in public spaces (markets, transport stations, schools, etc.)
2) Communal: latrines that are used by householders primarily from home and are intended chiefly for the community, these may incur a charge
3) Neighbour shared: latrines that are shared by neighbouring households or households on the same compound or with the landlord

The definition of a household used here is the sharing of a cooking pot, i.e. a household is a unit that eats together. This distinction is important as a single household may live in more than one building, or several distinct households may share the same building [84]. Though public toilets at markets and bus stations may be the prime sanitation facility for people living locally, these are not included in the definition as these are not considered a long-term solution for sanitation from the home.

4.2 INTRODUCTION TO THE FIELDWORK

As was stated in the systematic review included in section 2.8 of Chapter 2, the limited evidence available on shared sanitation has established an association with reduced health. In addition, factors related to cleanliness, distance, access, number of users, waiting time and opening hours of the facility have been shown to play a role in the actual use and acceptability of the shared facilities by the users (Section 2.6).

With the aim to contribute to the evidence-base on shared sanitation, the objective of the field work was to develop and pilot methods to explore factors that may explain any increased risk of adverse health outcomes associated with shared sanitation over individual household latrines. As hypothesized in section 1.6.3, I hope to elucidate whether any increased health risk for users of shared sanitation is as a result of (i) elevated risk factors associated with the actual user (socio-economic status, education level etc.), (ii) elevated risk factors associated with the shared facility they use (cleanliness, accessibility, privacy, etc.), (iii) a combination of the factors, which may be mitigated by maintenance.

In order to address these questions, an exploratory study was conducted comparing users of shared and private sanitation in two of the largest cities in the state, namely Bhubaneshwar—the state capital—and Cuttack. These two cities were chosen for convenience—the two cities were within driving distance from each other (approx. 30-45 minutes), thus allowing any microbiological samples to be returned to the laboratory in Bhubaneshwar in good time.

4.3 METHODS

4.3.1 SANITATION RESEARCH IN ORISSA

My field research in Orissa was facilitated by the recent completion of a large cluster-randomised controlled trial, assessing sanitation in 100 rural villages in Puri District. The trial, led by researchers from the London School of Hygiene and Tropical Medicine, aimed to assess the effectiveness of a rural sanitation intervention, within the context of the Government of India's Total Sanitation Campaign, to prevent diarrhoea, soil-transmitted helminth infection, and child malnutrition [85]. Though the research was conducted in rural villages, the main office and laboratory were located in Bhubaneshwar. As the trial was coming to completion during my fieldwork, knowledgeable field teams, trained in data collection, focus group discussions and microbiological laboratory techniques, were able to assist my research in urban slums.

4.3.2 ACTORS IN SLUM SANITATION IN BHUBANESHWAR/CUTTACK

As part of the exploratory research and in order to me to understand the roles of the different actors working on sanitation in slums in Bhubaneshwar and Cuttack, I met with various NGOs and government officials at the start of the fieldwork. Meetings were held with J-Pal, UNICEF, Health for the Urban Poor (HuP) and WaterAid to establish their roles in urban sanitation, in so far relevant. Through these contacts, I was introduced to other potential actors in urban sanitation, namely the Lutheran World Service (LWS) and Engineering & Management consultants. In addition, the Slum Improvement Officer of both Bhubaneswar Municipal Council (BMC) and Cuttack Municipal Council (CMC) were visited for information on the slums in their cities.

Through HuP, the local NGO SAI (Social Awareness Initiative) was contacted and was able to provide names and locations of 5 slums in Cuttack with shared sanitation facilities. Though WaterAid was not active in urban sanitation at the time of the research, the regional director, Ms Bishakha Bhanj had previously worked for LWS and was able to provide some insights into the work done in slum sanitation in Cuttack—unfortunately the slums suggested for research were the same slums proposed by SAI. At the time of the meeting, UNICEF did not have any active programmes in urban sanitation.

At the time of research J-Pal was actively working in a number of slums in Bhubaneswar and Cuttack on the project 'Communal Sanitation Solutions for Urban Slums in Orissa, India'. Though the opportunity to collaborate and work in the same slums was discussed extensively, the different research time-lines did not align. The final list of slums used in this research may overlap with those targeting by J-Pal, but this was not done so intentionally.

4.3.3 DEVELOPMENT OF THE HOUSEHOLD QUESTIONNAIRE

The initial questionnaires were developed based on the research questions (see Chapter 1, Section 1.6.3.) The overall questionnaire consisted of five parts, namely:

- Section A: Basic demographics (for all respondent households),
- Section B: Specific questions for users of shared sanitation,
- Section C: Specific questions for users of private sanitation,
- Section D: Latrine survey for private latrine,
- Section E: Latrine survey for shared sanitation facility.

As such, a 'sharing' household would be asked questions from Sections A, B and E, whereas a 'private' household would be asked questions from Sections A, C and D. Section B and C consisted of specific questions related to the cost, use, maintenance and emptying of the latrines. Section D and E consisted of a simple checklist for each seat or cubicle, considering privacy (door or screen, roof), evidence of use (floor wet), functionality (pan in working order, no leaves or rubbish in the squatting pan) and cleanliness (flies, smell and presence of faeces).

The questionnaires were prepared in English and translated into Oriya, the local language, for ease of use by the enumerators. Two enumerators and one supervisor were trained on the use of the questionnaire and the questionnaires were tested in 10 households in 6 slums (3 in Cuttack and 3 in Bhubaneshwar, resulting in a total of 60 questionnaires). These trial slums were not included in the final slum selection. The data was single-entered into Epi-Info 3.5.4 (Epi Info™, CDC Atlanta, USA) and each questionnaire and the results were scrutinised by M.Heijnen. Based on the testing, the questions were amended or re-worded and translations were checked to ensure the questions were eliciting the expected data. Some questions (for example, a question on disposal of child faeces) were removed as the questionnaire was deemed too time consuming after testing.

The final questionnaires were translated and printed. The final questionnaire presented in Appendix 4 show the questions in both English and Oriya.

4.3.4 FOCUS GROUP DISCUSSION

Concurrent with the development of the questionnaires, 4 separate focus group discussions (FGDs) were held, two with men and two with women (one male FGD and one female FGD in both Cuttack and Bhubaneshwar). These focus groups targeted sanitation users (both shared and private) in various slums, and relevant responses were used to strengthen the household questionnaire. Detailed methods of data collection and analysis are presented in Chapter 5.

4.3.5 SLUM SELECTION

In order for a slum to be included in the study, it had to include a minimum of 10 households using shared, communal or Sulabh sanitation facility (hereafter referred to as 'shared') and 10 households using private sanitation (self-reported). I started with lists of slums provided by the BMC and CMC. For Bhubaneswar, where the list included information on slums reporting both shared and private latrines, I selected all 33 (of 293) eligible slums, as well as an additional 6 slums identified through local contacts. All 39 slums were visited to verify the availability of any shared facility, in addition to the reported number of users of these facilities and households with a private latrine. After these visits, three slums were eliminated due to broken or non-existent shared latrines. Fifteen of such eligible slums were randomly selected for inclusion the study. This was done by writing the name of each eligible slum on a piece of paper, and 15 pieces of paper were selected blindly by an individual not involved in the study. In Cuttack, the CMC reported 309 recognised slums, though no additional data on the slums was available. Five slums with a shared latrine were visited and included based on a recommendation from a local NGO (SAI). A random selection of the 309 slums was made, and each was visited to verify the sanitation facilities available. This was done until a total of 15 slums were identified which met the inclusion criteria (84 slums visited until enough slums were identified). The 30 slums are listed in Table 3.

Table 3. Names of the slums included in the field study

Bhubaneshwar	**Cuttack**
Vani Vihar old Colony	Piligrim Road Das Sahi
Jagannath Sahi	Sidheswar Sahi Pana Sahi
Kargil Basti	Tanla Sahi

Kela sahi	Pana Sahi
Kalyani Krushna Nagar	Murad khan Patna Samal Sahi
Sudhanidhiswar Basti	Pana Sahi
Santi Palli- Sahid Nagar	Hatua Sahi and Bauri Sahi
Tiranga Sahi	Gopal Sahi, Kumbhar Sahi, Dhobba Sahi, and Bauri Sahi
Mashid Colony	Bauri Sahi Kanheipur
Old town (Gyanagar)	Tinigharia Level Crossing
Sahid Nagar (Birsa Munda)	Jobra Nadikula Basti
Sian Sramika	Malha Sahi Near railway bridge
Mahinsa Kahl, Hari nagar	Raushapatna Main Bastee
Siripur Kandha sahi	Balabhadrapur
Kanjiahoda Harijan sahi	Sagadia sahi and Teli sahi

4.3.6 HOUSEHOLD SELECTION

Within each slum, a total of 20 households were targeted, approximately half using private latrines and half using shared sanitation. There was no census available for the slums and no resources available to conduct one. As a result, there was no sampling frame from which to draw a random sample using conventional approaches. As a result, an adapted EPI approach [86] was chosen to select households in the 30 selected slums. This household selection method, described below, was tested in 2 slums and changes were made as required. This purposive sample was intended to provide an overview of the situation, rather than a representative sample of the slum populations of these two cities. As the size of the slum could not be accurately determined, no weighting was applied.

In the selected slum, a central location (intersection, meeting place) was identified and a pencil was spun to determine the direction in which to proceed. Every second household on the left side was asked to participate in the research. If the household refused, or if the no-one was home, the next household was selected after which the enumerators continued with every second household on the left. If the road ended, the enumerators turned around to continue sampling every second household on the left, until they returned to the central point, where a new direction was randomly chosen. At any side-road or bifurcation, a coin was tossed to determine direction. This continued until 10

household questionnaires were completed, irrespective of the type of sanitation used by the households (shared or private).

On day two, sampling continued in the same slum until all 20 questionnaires were completed, with the accepted balance between the two types of sanitation of 12-8, 11-9 and 10-10. For example, if on day 2 the total number of questionnaires for households with private sanitation reached 12, the remainder of the day was spent recruiting households with shared sanitation facilities (8 households), to ensure a balance of 12-8. A minimum of 30 minutes was spent following the random methodology, asking every second household, until the required number was completed. If this did not result in additional questionnaires of the required sanitation type, after 30 minutes a 'snowballing' approach was implemented, asking the respondent household if they knew others in the slum with the required type of sanitation [87, 88]. A flowchart of the slum selection procedure is available in Appendix 5.

Figure 10. Communal sanitation complex in Bhubaneshwar

4.3.7 SLUM CHARACTERISATION

All thirty slums were visited to collect general information on the approximate size and specific sanitation characteristics. Using a simple checklist, various characteristics of the slums were recorded (presence of streetlights, open defecation sites etc.). A copy of the checklist is included in Appendix 6. Through this checklist, I tried to get an approximate number of households by asking random slum residents, but the responses were varied and did not allow for a useful approximation of the number of households in the slum. Global positioning system (GPS) data were collected in the slums using hand-held devices (Garmin, Schaffhausen, Switzerland) to allow the mapping of the perimeter of the slum, as well any open defecation sites.

4.3.8 GIS MAPPING

During the fieldwork, GIS data were collected on two occasions. First, during the slum characterisation, where the boundary of the slum was mapped taking a GPS point every 2-3 steps and at every corner, as previously trialled by Livengood et al. [89]. The boundary points were mapped in Google Earth (Google Inc. 2 version 7.1.2.2041) on the day of collection to ensure accurate recollection of any points where it was not possible to follow the exact border of the slum (i.e. a structure blocking the way by foot). The 'path tool' in Google Earth was used to connect the points, creating a polygon—a shape on the map representing the land area of the settlement. As such, for every slum included in the study, an outline of the slum boundary was collected and saved in Google Earth. Secondly, during the household questionnaires, the GPS point of the 'front door' of the house was marked, and a note was made whether the household shared a sanitation facility or used a private sanitation facility. These data were also exported to Google Earth.

4.3.9 MICROBIOLOGICAL METHODS

A sample of the drinking water used in the household was collected for microbiological analysis. Similarly, a 'hand-rinse' sample of both hands of the primary caretaker (generally the person taking care of the house and/or children) was taken, as per methods described by Pickering et al. [90]. Both the hand-rinse and the drinking water sample were tested for the presence of thermotolerant coliforms (TTC), an indicator of faecal contamination [91].

Drinking water samples were collected directly from the drinking water vessel— or from the water source used for drinking if no water was stored in the home— using sterile 125 mL Whirl-Pak bags (Nasco) containing sodium thiosulphate to neutralise any halogen disinfectant and were placed on ice for transport to the laboratory.

A 69-oz Whirl-Pak bag containing 350 mL distilled water was used for the hand-rinses. The respondent was asked to rub their fingers and thumb together for 15 seconds inside the water-filled bag, after which the enumerator massaged the hand through the outside of the bag. The process was repeated with the other hand. The bag was closed and stored on ice for transport.

Both samples were processed within 4 hours using the membrane filtration technique on 0.45-micron membrane (Millipore Corporation), culture on membrane lauryl sulphate medium (Oxoid Limited) and incubated at 44°C for 18 hours [92].

The number of yellow colonies were counted and recorded as individual TTCs and reported as the number of colony forming units (CFUs) per 100 mL of analysed sample

water. Plates that yielded CFUs that were too numerous to count (TNTC) were reported as 300 TTC/100 mL for purposes of our analysis.

4.3.10 Activities undertaken prior to hand-rinse

Before taking the hand-rinse sample, respondents were asked what they were doing immediately prior to questionnaire. The types of answers were based on a previous study conducted in urban Tanzania [93], and pre-tested during the questionnaire piloting.

Figure 11. Enumerator collecting a hand-rinse sample from respondent in Cuttack, Orissa

4.3.11 Statistical analyses

All data were double entered into Epi-Info 3.5.4 and were analysed using Stata 12 (StataCorp LP, TX, USA).

In order to generate a relative asset index, we combined household-level information on assets such as type of cooking fuel and ownership of specific items (i.e. fridge, bicycle, radio etc.) using principal component analysis to define the summed weights [68]. This score was then categorised into 'poor', 'middle', and 'least poor'.

Two sample t-tests and Chi-squared tests were used to assess any differences between the two groups (households using private or shared facilities, or between different categories of shared sanitation, where applicable).

Statistical analyses of microbiological data were conducted after log10 transformation of TTC counts to account for the skewed distribution. Geometric mean TTC counts were reported for each sanitation category. Means of the log-transformed values were compared between the private and shared households, or the different sharing households using non-parametric tests.

The microbiological results were recoded to a binary variable (evidence of contamination vs no evidence of contamination) for use in logistic regression. No significant differences in the standard errors were observed when controlling for clustering, as such the logistic regressions were done without taking into account slum clusters.

In order to determine differences between hand-rinse contamination and the activity undertaken prior to the hand-rinse, the Kruskal-Wallis test was conducted on the non-parametric hand rinse data. Dunn's test was used as a follow up to account for the pooled variance assumed by the null hypothesis, using the same ranks as the Kruskal-Wallis test [94]. In order to determine any difference in hand contamination between users of private and shared sanitation or between the different categories of shared sanitation, the Wilcoxen-rank sum tests were used.

Due to the exploratory nature of this study, inadequate information was available at the start to conduct a power calculation. The use of a 'post-hoc' power calculation to determine whether the sample size was 'big enough' is heavily contested [95]. However, the results from this study can be used to inform a sample size or power calculation of any future research on this topic.

4.3.12 Ethical approval and consent

The study was approved by the Ethics Committee of the London School of Hygiene and Tropical Medicine (No. 5561) and the Ethics Committee of Xavier University (No. 31050). Consent was obtained from all individuals participating in the study. Participants of the focus group discussions provided verbal (recorded) consent, except for the first FGD where written consent was provided. Household questionnaire participants signed a consent form and were provided with an information sheet on the study with contact information in case of questions. The consent form for the household questionnaire included consent for the hand-rinse sample and water sample taken from the house. In all instances, respondents were able to withdraw their consent at any time. An example of the consent form is included in the questionnaire in Appendix 4.

4.4 Shared sanitation versus private latrines in urban slums: a cross-sectional study in Orissa, India

The main results are included in the manuscript prepared for publication. Any additional results which are not included are presented and discussed in section 4.5

London School of Hygiene & Tropical Medicine
Keppel Street, London WC1E 7HT
www.lshtm.ac.uk

Registry
T: +44(0)20 7299 4646
F: +44(0)20 7299 4656
E: registry@lshtm.ac.uk

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Marieke Heijnen, Parimita Routray, Belen Torondel, Thomas Clasen

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.....

I prepared the field work tools, with input from Parimita Routray. I analyzed all the results and drafted the manuscript.

NAME IN FULL (Block Capitals) ANNA MARIA MARIEKE HEIJNEN

STUDENT ID NO: 119580

CANDIDATE'S SIGNATURE ..... Date 17 OCTOBER 2014

SUPERVISOR/SENIOR AUTHOR'S SIGNATURE (3 above) .....

Shared sanitation versus private latrines in urban slums: a cross-sectional study in Orissa, India

Marieke Heijnen, Parimita Routray, Belen Torondel, Thomas Clasen

ABSTRACT

Objective

A large and growing proportion of the global population rely on shared sanitation facilities—especially in urban slums—despite evidence of a potential increased risk of adverse health outcomes compared to individual household latrines. We sought to explore whether there were differences between persons relying on shared versus private latrines in terms of demographics, sanitation facilities and exposure to faecal pathogens that might explain this apparent increase in risk.

Methods

We surveyed 570 households (298 using shared latrines and 272 using private latrines) from 30 slums in Bhubaneshwar and Cuttack, Orissa, India. We conducted spot-checks of their latrines to collect data on indicators of use (water in squatting pan.), privacy (presence of door and roof) and cleanliness (presence of water inside for cleaning, presence of faeces and flies). We collected samples of household drinking water and hand-rinse samples from household caretakers to assess faecal contamination using membrane filtration techniques to measure thermotolerant coliform levels.

Results

Users of shared sanitation were less wealthy, had less formal education and lived in households consisting of fewer individuals compared to users of private sanitation. Twice as many individuals in the sharing households reported practicing open defecation, and significantly more individuals residing in shared sanitation households reported suffering from diarrhoea in the 7 days prior to the questionnaire. Shared latrines were less clean, less likely to have hand-washing facilities and more likely to have visible faeces and flies. No differences were found in the level of faecal contamination of the stored drinking water or the hand-rinse samples.

Conclusions

We identified potentially important differences among users of shared versus private latrines that may explain the apparent increase in adverse health outcomes associated with shared sanitation use. Some of these differences are attributable to latrine facilities and maintenance. As the prevalence of shared sanitation is likely to continue to expand, further research is required to ensure shared sanitation is an acceptable step on the sanitation ladder.

INTRODUCTION

Inadequate sanitation is associated with diarrhoea, soil-transmitted helminths, trachoma and schistosomiasis [1]. Diarrhoea accounts for the largest share of sanitation-related morbidity and mortality, causing an estimated 1.4 million deaths annually [2] or 19 percent of all deaths in low-income settings [3]

Globally, an estimated 2.5 billion people lack access to improved sanitation [4]. India represents a particular challenge, where 792 million people lack access to an improved sanitation facility, and an additional 597 million people practice open defecation, representing nearly two thirds of the global estimate for open defection [4].

Public and other 'shared facilities'—those used by two or more households—have been excluded from the definition of 'improved sanitation' used to monitor progress toward international targets [5]. The reason stems from concerns that shared facilities are unacceptable, both in terms of cleanliness (shared toilets may not be as hygienic as private ones or they may result in increased contact with human waste) and accessibility (facilities may not be available at night, or easily used by women and children) [6].

Nevertheless, shared facilities represent a large and growing proportion of sanitation options available in low-income countries, with approximately 784 million users of a shared sanitation facility of an otherwise improved type [4]. In India, 9 percent of the overall population accesses some form of shared sanitation, which has steadily increased from 5 percent in 1990 [4]. In terms of urban areas, 20 percent of the Indian population is reported to access shared sanitation (up

from 17% in 1990) [4]. Shared latrines are considered by some to be the only realistic option for high-density populations in many urban slums [6-8]. With the development of new targets and indicators for the Sustainable Development Goals, it has been proposed to include shared facilities as 'improved' sanitation based on the number of users and whether they are known to each other [9].

However, evidence evaluating shared sanitation use and various health outcomes does not support this change in policy [10-12]. A recent systematic review found that users of shared sanitation had an increased risk of diarrhoea, though the methodological quality of the included studies varied considerably [10]. An analysis of data on shared sanitation and diarrhoea from 51 Demographic and Health Surveys reported that sharing sanitation facilities was a risk factor for diarrhoea, though differences in socioeconomic status were important [12]. A more detailed analysis of JMP data suggests that the increased risk associated with shared sanitation may be due to the other factors, as people who rely on shared sanitation tend to be poorer, have less access to improved water supplies, live in households with more young children and are managed by people with no formal education [11].

The objective of this study was to explore whether the potential increased health risk may be attributable to differences in users (socio-economic status, education level, etc.) and differences in latrines (privacy, cleanliness, accessibility, hand washing stations etc.).

METHODS

Study design and setting; selection of slums and households

We conducted a cross-sectional design study in a convenience sample of 30 informal settlements (slums), half in Bhubaneshwar and half in Cuttack, the largest cities in Orissa. Eligible slums required a minimum of 10 households using a shared, communal or public sanitation facility (hereafter referred to as 'shared') and 10 households using individual household latrines that were not reported to be shared with other households (hereafter referred to as 'private'). Working from lists of slums provided by municipal authorities, we visited all 33 potentially eligible slums in Bhubaneswar and an additional 6 slums identified through local

contacts and randomly selected 15 for inclusion the study. In Cuttack, for which lists did not identify shared versus private latrines, we consulted with a local NGO and visited 84 slums before identifying 15 that met the inclusion criteria. Within each slum, we targeted a total of 20 households, half using private latrines and half using shared sanitation. An adapted EPI approach [13] was chosen as no accurate population or household data was available for the 30 selected slums. Sampling continued in the same slum until all 20 questionnaires were completed, with the accepted balance between the two types of sanitation of 12-8, 11-9 and 10-10.

Household questionnaire and latrine spot-checks

Trained field staff used a pre-piloted household questionnaire and spot-checks of sanitation facilities. The structured questionnaire was used to collect demographic and socio-economic data on all households from the main caretaker of household. During the household questionnaires, respondents were asked if anyone in the household had suffered from diarrhoea on the day of the questionnaire or the two days prior (3-day recall) or at any time in the past 7 days (7-day recall). Diarrhoea was defined using the WHO definition of three or more loose stools in 24hrs [14]

Field staff also conducted spot-checks of the latrines that householders identified as their primary sanitation facility. During the spot-check, enumerators recorded observations on the functionality of the cubicle—if the cubicle was blocked in a way that prevented use, if there were leaves or rubbish blocking the squatting pan or if the pan was broken, the cubicle was considered non-functional. In addition, information on indicators of use [15] and perceived cleanliness, and whether the facility was shared or private was collected. Use of the cubicle was confirmed on the basis of several indicators: wet floor in the cubicle, colour change in the squatting pan and standing water in the pan. The duplicate latrine spot-checks (for sharing households reporting use of the same facility) were removed for the analysis to ensure each latrine facility was counted only once. Data on a place for hand-washing was collected during the latrine spot-check. A designated hand-washing place was defined as a specific location in the home or the courtyard, or at the (shared) latrine, with water (and possibly soap or ash) available.

Microbiological methods

A sample of the drinking water used in the household was collected for assessment of faecal contamination. Samples were collected directly from the drinking water vessel, or from the water source used for drinking if no water was stored in the home, using sterile 125 ml Whirl-Pak bags (Nasco) containing sodium thiosulphate to neutralise any halogen disinfectant. The samples were placed on ice for transport to the laboratory. In addition, a 'hand-rinse' sample of both hands of the primary caretaker (generally the person taking care of the house and/or children) was taken using the methods described previously [16]. A 69-oz Whirl-Pak bag containing 350 mL distilled water was used for the hand-rinses. The respondent was asked to rub their fingers and thumb together for 15 seconds inside the water-filled bag, after which the enumerator massaged the hand through the outside of the bag for an additional 15 seconds. The process was repeated with the other hand. The bag was closed and stored on ice for transport. Both the hand-rinse and the drinking water sample were tested for the presence of thermotolerant coliforms (TTC), an indicator of faecal contamination [17]. The samples were processed within 4 hours using the membrane filtration technique on 0.45-micron membrane (Millipore Corporation), culture on membrane lauryl sulphate medium (Oxoid Limited) and incubated at 44°C [18].

The number of yellow colonies were counted and recorded as individual TTCs and reported as the number of colony forming units (CFUs) per 100 mL of analyzed sample water. Plates that yielded CFUs that were too numerous to count (TNTC) were reported as 300 TTC/100 mL for purposes of our analysis.

Statistical analyses

All data were double entered into Epi-Info 3.5.4 (Epi Info™ , CDC Atlanta, USA) and were analysed using Stata 12 (StataCorp LP, TX, USA).

In order to generate a relative asset index, we combined household-level information on assets such as type of cooking fuel and ownership of specific items (i.e. fridge, bicycle, radio etc.) using principal component analysis to define the summed weights [19]. This score was then categorised into 'poor', 'middle', and 'least poor'.

Descriptive measures in the form of geometric means and 95 percent confidence intervals were prepared for the microbiological count data. Further analyses of

microbiological data were conducted after log10 transformation of TTC counts to account for the skewed distribution. Means of the log-transformed values were compared between the private and shared households, using non-parametric tests. We also used ordinal logistic regression to explore associations between covariates and drinking water and hand contamination. For this purpose, the microbiological results were converted to a binary variable (presence or absence of faecal contamination). Two sample t-tests and Chi-squared tests were used to assess differences between the two groups (households using private or shared facilities).

Ethical approval and consent

The study was approved by the Ethics Committee of the London School of Hygiene and Tropical Medicine (No. 5561), and the Ethics Committee of Xavier University (No. 31050). Household questionnaire participants signed a consent form and were provided with an information sheet on the study with contact information in case of questions. The consent form for the household questionnaire included consent for the hand-rinse sample and water sample taken from the house.

RESULTS

Household questionnaires

Overall characteristics of the included households can be seen in Table 1. A total of 570 households were visited, covering 3022 individuals. While users of shared and private latrines were generally similar, there were some differences. Households relying on shared sanitation were almost twice as likely to lack any formal education ($p<0.001$) and almost three times more likely to be in the poorest wealth tertile (73.2% sharing vs. 26.8% private). Households in the 'least poor' category were less likely to access shared sanitation than those in the 'poorest' category ($p<0.001$). On the other hand, households with private sanitation were slightly larger than those accessing shared sanitation (average 5.7 vs. 4.9, $p<0.001$), and also had more rooms used for sleeping (average 2.1 vs 1.5 rooms, $p<0.001$). Households with access to a private facility were more likely to live in a house with a cement wall and roof (pucca) (60.4% vs. 39.6%) and half as likely to

live in a house with no cement structure (kucha) (32.1% vs. 67.4%). Households relying on shared sanitation were more than twice as likely to collect their water from a source outside of their dwelling ($p<0.001$) (Table 1). In addition, these households were more than twice as likely to have a household member reporting practicing open defecation.

A total of 24 individuals—half accessing private sanitation and half accessing shared sanitation—reported suffering from diarrhoea at any time in the 7 days prior to the questionnaire, indicating a total period prevalence of less than 1 per cent (0.79%). The period prevalence for individuals accessing shared sanitation was slightly higher (0.82%) than that for individuals accessing private sanitation (0.77%) ($p=0.001$).

Latrine spot-checks

Overall, 273 privately used sanitation facilities were assessed, compared to 197 shared facilities. All facilities assessed used pour-flush technology, with basic ceramic or tiled squatting slabs. While 250 of the 273 (91.6%) private facilities were functional, only 142 of 197 (72.1%) of the shared facilities were functional (blocked or broken squatting pans, etc.) or were being used exclusively for storing rice or other supplies. These non-functional latrines were excluded from the analysis as we were interested in facilities and cubicles which could actually be used.

A total of 250 private facilities (226 cubicles) and 142 shared facilities (277 cubicles) were included in the analysis (Table 2). At facility level, no large differences were observed between shared facilities and private facilities. Most private facilities only had one cubicle, with 24 facilities consisting of double cubicles, 2 with triple cubicles, and one with 5 cubicles (this last facility was reportedly used by a household consisting of 21 individuals). The shared facilities ranged from 1-25 functional cubicles. Significantly, however, only 60.2 percent of all shared cubicles were deemed functional compared to 74.3 percent of cubicles in private latrines ($p<0.001$) (Table 2). Though no exact data on the number of households using each shared facility was collected, the majority (60.3%) of the households report sharing their facility with neighbouring households or their

landlord, whereas the remaining households use a communal or larger pay-per-use facility, such as a Sulabh facility.

In terms of privacy, the same proportion of shared cubicles as private cubicles provided a door or screen as well as a roof (Table 2). Similar numbers of shared and private squatting slabs had standing water in the pan and a wet floor, both of which are indicators of use of the cubicle. Significantly more private cubicles had water for cleansing available inside compared to shared cubicles (86.7% vs 55.6%, $p<0.00$). The shared cubicles had significantly more faeces visible in and around the squatting slab (23.8% shared vs 2.2% private, $p<0.001$), in addition to a reported stronger smell and larger number of flies, as compared to the private cubicles (Table 2).

Hand-washing stations

The households using private sanitation were more likely to have a place near the latrine where hands could be washed (79.6%) than households using some type of shared sanitation (66.9%, $p<0.001$) (Table 2). Households with water inside the dwelling or yard were more likely to have a place for hand-washing ($p<0.001$) (Data not shown). Soap was observed in 89.8 percent of the households using private sanitation versus 59.0 percent in the sharing households ($p<0.001$). Just under half of all the shared facilities had a place where hands could be washed (n=142, 47.5% verified during latrine spot-check), and 85 of these had soap present.

Drinking water samples and hand-rinses

Our measures of faecal contamination revealed no statistically significant differences among householders relying on shared versus private latrines. For households accessing shared sanitation, the geometric mean TTC in the drinking water samples was 18.8 (95% CI: 12.4-28.5) per 100ml, versus 18.3 (95% CI: 12.1-27.7) ($p=0.15$) for households using private sanitation facilities. In terms of hand-rinse contamination, the geometric mean TTC was 35.9 (95% CI: 22.9-56.4) per 100ml for households accessing shared sanitation, compared to 27.6 (95% CI: 18.0-42.2) for households using private facilities ($p=0.37$). No statistically significant association was found between the activity undertaken prior to hand-rinse (i.e. cooking, cleaning, visiting latrine) and the level of contamination in the

hand-rinse. Overall, 59.6 percent (162/272) household water samples in private sanitation households had no detectible thermotolerant coliforms, as compared to 65.8 percent (196/298) of the samples from the sharing households. Similarly, 62.6 percent (171/273) of the hand-rinse samples from private sanitation households had no detectible TTC, as compared to 67.1 percent (200/298) of the sharing households (Figures 1 and 2)

Univariate analysis

In order to assess which factors may have had an effect on the contamination of hands and drinking water samples, logistic regression was used with the presence or absence faecal contamination as the outcome. Very few factors were significantly associated with an increased level of TTC. (Table 1 of the Supplementary Information). Overall, increased education (secondary and higher) was associated with the absence of TTC in a 100ml sample of the drinking water (OR 0.55, 95% CI: 0.34-0.89 for some secondary education, OR 0.51, 95% CI: 0.27-0.95 for secondary and higher education). Households who had to walk outside of their dwelling to access water were slightly more likely have TTC in their drinking water, though this result was not statistically significant. In terms of hand contamination, households in the middle wealth tertile were more likely to have a contaminated hand-rinse sample than those in the poorest tertile (overall: OR 0.59, 95% CI: 0.39-0.90, shared households: OR 0.49, 95% CI: 0.28-0.87). In the households sharing sanitation, household respondents with some or complete primary education were less likely to have a contaminated hand-rinse sample than those with no formal education (OR 0.43, 95% CI: 0.22-0.87). This effect remained for the respondents with some secondary education, though only borderline significant (OR 0.55, 95% CI: 0.29-1.02).

DISCUSSION

Though several studies have indicated that the use of shared sanitation may be associated with adverse health outcomes, these have also highlighted that there is significant heterogeneity and that the use of shared sanitation may be a confounding factor [10-12]. This study aimed to identify potential factors that could explain an association between shared sanitation and increased risk of

adverse health outcomes. We investigated differences in types of users, differences in the actual shared or private latrines themselves, differences in hand-washing facilities and differences in hand or drinking water contamination.

Overall, the results of this study show that users of shared sanitation are poorer, less educated and reside in households with fewer members. These results are consistent with a recent study assessing the scope of shared sanitation using MICS and DHS data [11]. In addition, we found that more users of shared sanitation still practice open defecation. This has previously been reported in a variety of other settings, where users were ashamed to be seen using shared sanitation and thus went for open defecation [20], or where users found the shared facilities too filthy to use, again preferring open defecation [21, 22]. The facilities may be used differently by different member of the household—in a study in India, twice as many men used the facilities as compared to women [23]. In addition, long waiting times at shared facilities may compel users to defecate elsewhere.

Some potentially important differences were seen in the actual latrines. Shared facilities and shared latrine cubicles were more likely to be non-functional. Water availability was significantly higher in the private cubicles compared to the shared. Other studies have identified water availability as a factor affecting latrine use [24]; it could also impact hand-washing after latrine use [25]. Shared sanitation facilities were also less clean and more likely to have faeces and flies and present—all factors associated with increased risk [26] and decreased use [21, 27] .

Despite these differences, we detected no differences in levels of faecal contamination of household drinking water or hands of household caretaker. While we used these metrics to explore differences in faecal exposure, other studies have raised questions about their sensitivity and specificity [28, 29]. In addition, TTC are not direct indicators of contamination—they only infer that pathogens may be present [30]. Moreover, the level of contamination of drinking water was significantly lower than that observed in previous studies in Orissa [31, 32]. Thus, our study may not have had the power to detect a difference between the groups.

The overall prevalence of diarrhoea was lower than expected, particularly as this study took place during the monsoon season when several areas of Orissa

including Cuttack are prone to flooding [33]. However, a significant difference could be seen between the individuals using shared sanitation reporting a higher period prevalence of diarrhoea than users of private sanitation.

Our study has several important limitations. First, the manner for selecting slums and households in this study was purposely designed to achieve balance and internal validity and not external validity. While our approach allows us to make comparisons between householders in the same slums that rely on private or shared sanitation facilities, our results should not be generalized beyond the slums comprising our study population. Second, as a cross-sectional study conducted over a period of three months, we had no ability to capture potentially important differences over time and seasons that a longitudinal study would reveal. Third, much of our data was self-reported and is subject to recall, courtesy and other reporting biases. Lastly, no accurate data was collected on the number of households sharing a particular facility. Assumptions can be made based on the type of sharing (i.e. smaller number of households using neighbour or family-shared latrine versus larger households accessing communal or Sulabh facilities) but additional data would have to be collected to justify these assumptions.

Despite these limitations, we identified important differences between users of shared versus private latrines. Some of these, such as socio-economic status and education, cannot be easily changed. However, they do point to vulnerable groups that can be targeted. Other differences, however, such as cleanliness of latrine facilities, presence of hand washing facilities, and factors that may discourage use and contribute to open defecation, could be addressed through improved management and maintenance of latrine facilities and promotion of latrine use and hand washing. They are also factors that international monitoring may wish to consider rather than simply counting numbers of users in determining whether to designate a shared latrine as improved. As shared sanitation is expected to increase globally, it is important to ensure that steps are taken to ensure that it can be safe, acceptable and sustainable.

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TABLES AND FIGURES

Table 1. Basic characteristics of study households (n= 570)

Characteristics		**Private**		**Sharing**		**Significance test** (Chi-squared test unless indicated otherwise)
	Total	N	Percentage	N	Percentage	
Total number of households	570	272	47.7	298	52.3	
Total number of individuals (reported) in households	3022	1555	51.5	1467	48.5	
Sex head of HH						
Male	476	225	47.3	251	52.7	p=0.628
Female	94	47	50.0	47	50.0	
Education level of the household caretaker						
No formal education	100	35	35.0	65	65.0	p<0.001
Some or Complete Primary	133	52	39.1	81	60.1	
Some secondary	241	120	49.8	121	50.2	
Secondary +	74	50	67.6	24	32.4	
Years in house						
<5 years	59	22	37.3	37	62.7	p=0.09
>5 years	511	250	48.9	261	51.1	
Average number of Individuals in Household Mean (SD)		5.7 (2.7)		4.9 (2.1)		Two sample T-test p<0.001
Average number of children under 5 in household Mean (SD)		0.61 (1.0)		0.61 (0.9)		Two sample T-test p=0.50
Average number of rooms used for sleeping in household		2.11 (1.2)		1.50 (0.7)		Two sample T-test p<0.001

Mean (SD)						
Has BPL[1] card						
Yes, verified	152	67	44.1	85	55.9	p=0.546
Yes, reported	47	23	48.9	24	51.1	
No	371	183	49.3	188	50.7	
Open Defecation practiced (at least one member of household, on some occasions)	63	20	32.3	42	67.7	p=0.01
Diarrhoea [2](at individual level)	24	12	0.77	12	0.82	Two sample T-test p=0.001
Water source (drinking water)						
Piped water	460	219	47.6	241	52.4	p=0.914
Non-piped water	110	53	48.2	57	51.8	
Location of (drinking) water source						
in own dwelling	166	92	55.4	74	44.6	p<0.001
In own yard/compound	190	114	60.0	76	40.0	
Outside of dwelling	213	65	30.5	148	69.5	
House structure						
Cement wall and roof (pucca)	217	131	60.4	86	39.6	p<0.001
Cement wall (semi pucca)	296	123	41.6	173	58.5	
No cement (kucha)	56	18	32.1	38	67.4	
Wealth Tertile						
Poor	190	51	26.8	139	73.2	p<0.001
Middle	193	94	48.7	99	51.3	
Least Poor	128	128	68.5	59	31.6	

[1] BPL=Below-Poverty line card, provided by the Government indicating financial disadvantage and identifies households and individuals in need of assistance
[2] Number of individuals reporting diarrhoea, can be different from households as several individuals reporting diarrhoea may reside in the same place

Table 2. Descriptive data on functional private and shared latrines from latrine spot-checks. Data excludes 23 private and 55 shared facilities that were not functional.

	Private	**Shared**	**Two sample test of proportions**
Total number of cubicles assessed	304	460	
Average number of cubicles per facility, (min, max)	1.11 (1,5)	2.34 (1, 42)	
Nr and percentage of *functional* cubicles	226 (74.3%)	277 (60.2%)	p<0.001
Average number of *functional* cubicles per functional facility (min, max)	0.90 (1, 5)	1.95 (1, 25)	
Does the facility have space for bathing? (n, %)	211 (84.4)	114 (39.4)	p=0.30
Is the pipe from the pan to the pit intact? (n, %)	n=249	n=142	
Yes	44 (17.7)	25 (17.6)	p=0.99
No	3 (1.2)	0 (0)	p=0.19
Not Visible	175 (70.3)	107 (75.4)	p=0.28
Not Applicable	33 (13.3)	10 (7.0)	p=0.06
Is there a cover over the pit? (n, %)			
Yes	79 (31.7)	58 (40.8)	p=0.07
No	10 (4.1)	2 (1.4)	p=0.15
Not Visible	133 (53.4)	72 (50.7)	p=0.61
Not Applicable	27 (10.8)	10 (7.0)	p=0.21
Does the facility have a place for hand-washing? (n, %)	199 (79.6)	95 (66.9)	p=0.01
For all proportions below, only the functional cubicles are used			
Nr of cubicles with water inside (n, %)	196 (86.7)	154 (55.6)	p<0.001
Nr of cubicles with a door or screen up to 1 meter (n, %)	214 (94.7)	262 (94.6)	p=0.96
Nr of cubicles with a roof (n, %)	216 (95.6)	268 (96.8)	p=0.49
Nr of cubicles where the floor is wet (n, %)	211 (93.4)	253 (91.3)	p=0.39
Is there colour change in pan? (n, %)	60 (26.5)	198 (71.5)	p<0.001
Is there standing water in pan? (n, %)	221 (97.8)	272 (98.2)	p=0.75
Are there faeces in cubicle? (n, %)	5 (2.2)	66 (23.8)	p<0.001
Flies in cubicle (n, %)	n=224	n=277	
None	85 (37.9)	20 (7.2)	p<0.001
Some	120 (53.6)	75 (27.1)	p<0.001

Many	19 (8.5)	182 (65.7)	p<0.001
Smell in cubicle (n, %)	n=224	n=277	
No detectable smell	92 (41.1)	26 (9.4)	p<0.001
Some detectable smell	131 (58.5)	114 (41.2)	p<0.001
Strong detectable smell	1 (0.4)	137 (49.5)	p<0.001

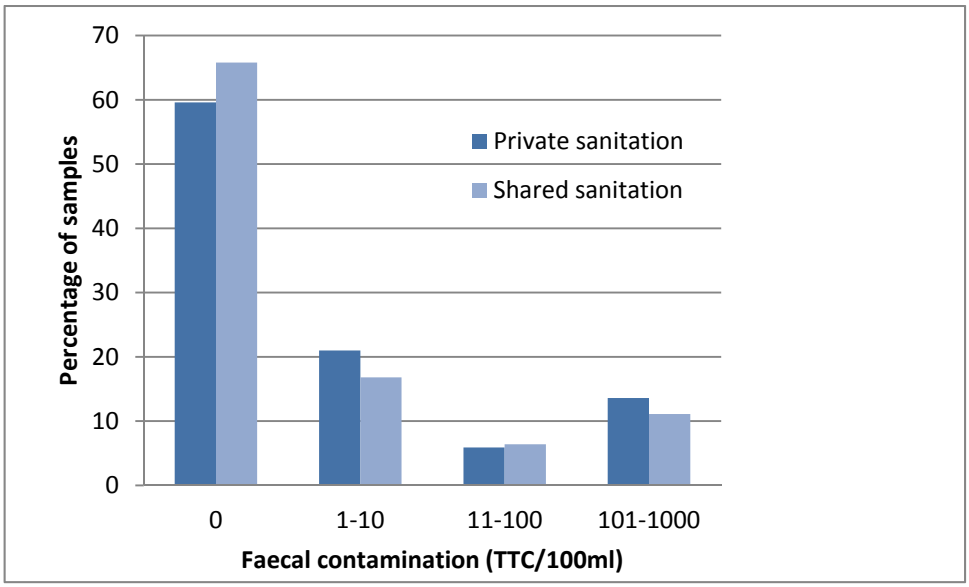

Figure 1. Distribution of faecal contamination level in household water samples by sanitation access

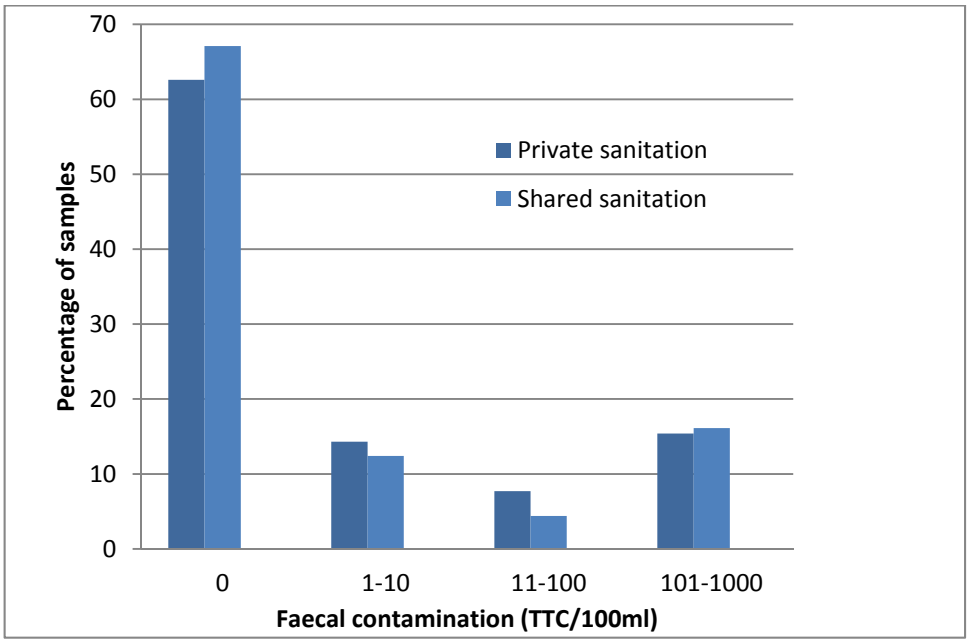

Figure 2. Distribution of faecal contamination level on hands by sanitation type access

Supplementary Information Table 1. Results of univariate ordered logistic regression assessing potential factors which may be associated with faecal contamination of water and hand-rinse samples. Binary outcome coded as absence of coliforms =0 and presence of coliforms=1

WATER SAMPLES	OVERALL		PRIVATE		SHARING	
	OR (95%CI)	p-value (2 sided)	OR (95%CI)	p-value (2 sided)	OR (95%CI)	p-value (2 sided)
Water source used						
Piped water	Ref		Ref		Ref	
Shallow tubewell	1.11 (0.64-1.93)	0.71	0.93 (0.44-1.97)	0.85	1.30 (0.57-2.97)	0.53
BH with pump	2.23 (1.13-4.43)	0.02	0.82 (0.23-2.88)	0.76	3.93 (1.66-9.30)	0.002
Protected dug well	0.36 (0.04-3.08)	0.35	0.36 (0.04-3.26)	0.36	-	-
Unprotected dug well	1.34 (0.30-6.1)	0.70	2.87 (0.26-32.1)	0.39	0.74 (0.08-7.2)	0.79
Wealth quintile						
Poorest	Ref		Ref		Ref	
Middle	1.05 (0.70-1.59)	0.82	1.34 (0.67-2.67)	0.41	0.75 (0.43-1.30)	0.31
Least poor	0.85 (0.56-1.30)	0.46	0.75 (0.38-1.46)	0.39	0.88 (0.47-1.68)	0.71
Education level of the household caretaker						
No formal education	Ref		Ref		Ref	
Some or Complete Primary	0.75 (0.44-1.26)	0.28	0.69 (0.29-1.64)	0.40	0.77 (0.40-1.49)	0.44
Some secondary	0.55 (0.34-0.89)	0.02	0.57 (0.27-1.23)	0.15	0.49 (0.26-0.91)	0.02
Secondary +	0.51 (0.27-0.95)	0.04	0.44 (0.18-1.08)	0.07	0.51 (0.19-1.40)	0.19

Number of people living in the household	1.01 (0.95-1.09)	0.69	0.97 (0.89-1.06)	0.53	1.07 (0.95-1.20)	0.29
Number of children <5 years in the household	1.17 (0.87-1.56)	0.30	1.11 (0.75-1.63)	0.61	1.24 (0.80-1.92)	0.33
Location of water source						
In own dwelling	Ref		Ref		Ref	
In own yard	0.88 (0.57-1.36)	0.55	0.94 (0.54-1.66)	0.84	0.74 (0.37-1.51)	0.41
Outside	1.28 (0.84-1.94)	0.25	1.46 (0.77-2.78)	0.25	1.34 (0.75-2.42)	0.33
Time to collect water (return journey, continuous variable)	1.04 (0.98-1.11)	0.17	0.98 (0.86-1.11)	0.75	1.06 (0.98-1.14)	0.16
Faeces visible in courtyard?	1.08 (0.65-1.79)	0.77	0.68 (0.29-1.56)	0.36	1.54 (0.81-2.95)	0.19
Is the facility shared? (yes/no)	0.77 (0.55-1.08)	0.13	-	-	-	-
Anyone in household practice open defecation? (yes/no)	1.34 (0.78-2.28)	0.29	0.97 (0.38-2.46)	0.95	1.71 (0.88-03.32)	0.11

House structure						
Cement wall and roof (pucca)	Ref		Ref		Ref	
Cement wall (semi-pucca)	1.26 (0.87-1.82)	0.22	1.42 (0.86-2.35)	0.17	1.30 (0.74-2.27)	0.37
No cement (kucha)	1.37 (0.75-2.51)	0.3	1.10 (0.40-3.03)	0.85	1.77 (0.80-3.93)	0.16
HAND-RINSE	OVERALL		PRIVATE		SHARING	
	OR (95%CI)	p-value (2 sided)	OR (95%CI)	p-value (2 sided)	OR (95%CI)	p-value (2 sided)
Water source used						
Piped water	Ref		Ref		Ref	
Shallow tubewell	1.06 (0.60-1.86)	0.84	0.97 (0.46-2.08)	0.95	1.13 (0.48-2.63)	0.78
BH with pump	1.50 (0.76-2.95)	0.24	0.85 (0.25-2.92)	0.80	2.08 (0.91-4.78)	0.08
Protected dug well	1.97 (0.39-9.86)	0.41	2.56 (0.42-15.6)	0.31	-	-
Unprotected dug well	4.92 (0.94-25.6)	0.06	3.41 (0.30-38.2)	0.32	6.78 (0.69-66.2)	0.1
Wealth quintile						
Poorest	Ref		Ref		Ref	
Middle	0.59 (0.39-0.90)	0.01	0.61 (0.30-1.22)	0.16	0.49 (0.28-0.87)	0.02
Least poor	0.73 (0.48-1.11)	0.14	0.61 (0.32-1.18)	0.14	0.73 (0.38-1.38)	0.33
Education level of household caretaker						
No formal education	Ref		Ref		Ref	

Some or Complete Primary	0.66 (0.38-1.12)	0.12	1.19 (0.50-2.84)	0.70	0.43 (0.22-0.87)	0.02
Some secondary	0.63 (0.39-1.02)	0.06	0.78 (0.36-1.69)	0.53	0.55 (0.29-1.02)	0.06
Secondary +	0.81 (0.44-1.49)	0.49	0.84 (0.35-2.05)	0.71	0.89 (0.34-2.29)	0.8
Number of people living in the household	0.97 (0.90-1.04)	0.41	0.95 (0.86-1.04)	0.29	0.98 (0.87-1.11)	0.79
Number of children <5 years in the household	1.00 (0.74-1.33)	0.97	1.03 (0.70-1.52)	0.88	0.95 (0.60-1.49)	0.82
Location of water source						
In own dwelling	Ref		Ref			
In own yard	1.19 (0.76-1.85)	0.44	1.08 (0.61-1.91)	0.78	1.32 (0.66-2.67)	0.43
Outside	1.26 (0.82-1.93)	0.30	1.19 (0.62-2.29)	0.60	1.51 (0.82-2.78)	0.19
Time to collect water (return journey, continuous variable)	1.00 (0.95-1.04)	0.94	0.97 (0.85-1.10)	0.66	1.00 (0.95-1.05)	0.99
Faeces visible in courtyard?	0.80 (0.47-1.36)	0.41	0.80 (0.35-1.84)	0.60	0.83 (0.41-1.66)	0.59
Is the facility shared? (yes/no)	0.82 (0.58-1.16)	0.26	-	-	-	-

Anyone in HH practice open defecation? (yes/no)	1.10 (0.63-1.89)	0.74	0.88 (0.34-2.29)	0.80	1.30 (0.66-2.56)	0.45
House structure						
Cement wall and roof (pucca)	Ref		Ref		Ref	
Cement wall (semi-pucca)	0.90 (0.62-1.30)	0.58	1.00 (0.60-1.66)	0.99	0.85 (0.49-1.46)	0.553
No cement (kucha)	1.36 (0.75-2.48)	0.31	2.23 (0.83-6.05)	0.11	1.09 (0.49-2.41)	0.83

4.5 ADDITIONAL RESULTS NOT INCLUDED IN MANUSCRIPT FOR PUBLICATION

4.5.1 STUDY SITES

The two study sites—Bhubaneshwar and Cuttack—were chosen as they allowed a range of slums to be sampled, whilst being close enough together for logistical convenience. As shown in Table 4, the results in the two study sites are broadly similar — though a few key differences do exist. The differences, which include education, water access and wealth tertile are important and should be kept in mind. However, given the exploratory nature of this study, the household data are combined to allow a broader analysis of factors which may differ between households accessing shared and private sanitation.

	Bhubaneshwar (%)	**Cuttack (%)**	**Two sample t-test of proportions**
Sex of Head of HH			
Male	88.7	78.7	p=0.001
Female	11.3	21.3	
No formal education	13.6	22.3	p=0.01
Nr people in HH	4.9	5.6	0.06
BPL card (yes)	33.5	36.5	0.44
Wealth tertile			
Poorest	30.0	37.0	0.08
Middle	31.0	37.0	0.13
Rich	39.0	26.0	<0.001
Households reporting diarrhoea	50.0	50.0	1.00
Water (piped)	92.3	70.0	<0.001
Water (access)	66.1	73.2	p=0.08
Shared sanitation			
Private	50.2	46.4	0.36
Neighbour/family	6.1	6.9	0.67
Landlord	14.2	14.8	0.84
Community	9.5	11.1	0.53
Sulabh/public	23.0	17.9	0.13

Table 4. Basic characteristics of households in Bhubaneshwar and Cuttack

4.5.2 NON-RESPONSE

Out of the 30 slums visited, I was able to collect accurate non-response data in 16 slums (9 in Cuttack, 7 in Bhubaneshwar). There were some errors on the cover sheets prepared for each day of data collection, and as a result only limited information is available. On the

whole, 499 households were visited in 16 slums. Of these 499 households, 304 agreed to participate (60.9%, average of 15.2 households per slum). Thirty households declined to participate (6.0%), and 77 households (15.4%) were not home at the time of the slum visit. An additional 2 households were open, but no adults were home (0.4%). Lastly, 86 households (17.2%) practiced open defecation exclusively, and thus were not included in the study.

4.5.3 SLUM CHARACTERISATION

Data was collected on street lighting, guttering and general rubbish collection in slums in both cities to assess how established they are, and how much government support they may receive. An overview of the results is presented in Table 5.

Table 5. Slum characteristics in Bhubaneshwar and Cuttack

	Bhubaneshwar (N=15)	**Cuttack (N=15)**	**Two sample t-test of proportions**
Streetlights in present (n)	13	15	
%	87	100	p=0.05
(Concrete) drainage canals (n)	9	12	
%	60	80	p=0.23
OD sites (n)	7	8	
%	47	53	p=0.74
Agreed Solid waste site (n)	3	5	
%	20	33	p=0.42
Waste collected by municipality? (n)	9	12	
%	60	80	p=0.23
Presence of at least one communal/public latrine facilities (n)	11	15	
%	73	100	p=0.03
Observed faeces in open/communal spaces (human or animal) (n)	12	15	
%	80	100	p=0.07

4.5.4 GIS MAPPING

The initial aim of the collection of GIS data was to try and map out dispersion of the households (i.e. are users of private sanitation more likely to live in one part of the slum than users of shared sanitation), as well as to assess patterns or compare distances between homes and shared facilities versus OD sites (if present).

However, as the resolution on Google Earth was not high enough to accurately distinguish individual plots or structures, the polygons and data points were exported to ArcGIS (Version 10, Esri, California, USA) and the data were plotted onto a base map of India. Unfortunately, the limited detail on the maps prevented accurate calculations of distances of households to OD sites. In addition, as only 20 households in the slum were selected (and thus marked on the map), no meaningful dispersion of particular households (users of shared or private) could be determined, as no information was collected on the remaining households in the slum, nor did I know the total number of households in the slum.

Another of the aims of the collection of GIS data was to try and estimate housing or population density. Counting individual dwelling units is undoubtedly the most reliable method of slum population estimation, but it requires a lot of time and resources. Remote sensing and advanced image processing methods have been suggested as a useful alternative to field data collection in such situations [96]. Unfortunately, due to the resolution of the Google Earth images available, it was very difficult to distinguish roofs of shacks or structures in a dense urban settlement. Another approach considered was the purchase of detailed aerial maps (i.e. provided by LandScan). However, after contacting a number of providers, the cost was prohibitively high.

4.5.5 ACTIVITIES UNDERTAKEN PRIOR TO HAND-RINSES

Table 6 provides an overview of the households reporting certain activities prior to the hand-rinse sample, and their associated geometric mean of TTC. Most of the respondents were preparing food or eating food (70.8%), followed by cleaning the house or washing clothes and dishes (15.3%). Though a statistically significant result was found between the activity performed before the hand-rinse and the level of hand contamination, this result may be less reliable due to the small sample size of some of the groups. The multiple comparison test (Dunn's test) did not provide any statistically significant results (data not shown)

Table 6. Analysis of association between activities undertaken prior to the hand-rinse and the level of hand contamination (TTC) using the Kruskal-Wallis equality of populations rank test.

	Preparing or eating food	**Cleaning house or dishes/ clothes**	**Bathing (self or child)**	**Caring for animal**	**Visiting latrine or cleaning child after visiting latrine**	**Sitting/ talking/ watching TV**	**Outside/ shopping /other**
Nr of households (n, %)	402 (70.8)	87 (15.3%)	15 (2.6%)	3 (0.5%)	5 (0.9%)	36 (6.3%)	20 (3.5%)
Geometric mean TTC	32.2	34.0	21.8	38.7	69.6	15.9	32.1
chi-squared with ties = 14.1 with 6 degrees of freedom probability = 0.03							

Table 7. Number of households accessing private and shared sanitation undertaking particular activities prior to the hand-rinse, with a 2 sample Wilcoxen rank-sum test to asses any difference in geometric mean

Activity undertaken prior to hand rinse	**Private households**		**Sharing households**		**2 sample Wilcoxen-rank sum test**
	n	**Geometric mean TTC**	**n**	**Geometric mean TTC**	
Preparing or eating food	189	29.6	208	35.5	p=0.13
Cleaning house or dishes/clothes	40	29.5	47	37.6	p=0.48
Bathing (self or child)	9	20.6	6	24.5	p=0.74
Caring for animal	1	300	2	5	P=0.22
Visiting latrine or cleaning child after visiting latrine	4	42.7	1	300	p=0.28
Sitting/talking/watching TV	18	9.6	18	23.8	p=0.39
Going outside/ shopping/other	7	15.6	13	57.4	p=0.66

To further assess which households undertook certain activities prior to the hand-rinse, I segregated the data by households using private and shared sanitation (Table 7). No statistically significant difference between the mean hand contamination levels after specific activities can be seen between shared and private households.

4.5.6 Focus group discussions

Observations from the focus group discussions are presented and discussed in Chapter 5.

4.6 Discussion

As noted, only the results which were not included in the manuscript in section 4.4 will be discussed.

Non-response data was collected in just over half of the slums to provide an indication of the level of non-response and the possible reasons for this. The initial forms used to log the number of households visited and whether the households were willing to participate or not, were drafted and revised when the data collection had already started. As such, they were only used for the last 16 slums visited—this by itself can have created a bias, as it is likely that the enumerators would have developed a familiarity with the process and the questionnaire, and were perhaps more persuasive.

However, when considering the non-response in the 16 slums, just over half of all households selected through the adapted EPI selection method were home and agreed to participate. Thirty households declined to participate. Though a reason was not always provided, lack of time (n=1) or lack of interest (n=3) was stated. Three of the households who declined to participate were reported to have a private latrine. It is not known what type of sanitation facility access was available to the remaining households who declined participation or the in households where nobody was home.

Almost a fifth of all households visited practiced open defecation exclusively, and thus were not included in the study. Interestingly, this highlights a segment of the population which was not considered in this study—users with no latrine access at all, shared or otherwise.

The slum characterisation checklist was done to try and establish a sense of 'service' provided in each slum (i.e. cemented gutters, municipal rubbish collection). However, whilst collecting the data, I realised the realities on the ground were often more complicated than could be captured on a simple form. For example, one slum in Bhubaneshwar did not have municipal waste collection within the slum boundaries (as determined by slum residents). However, households on one side of the slum were able to dispose of their waste in a municipal 'pick-up' location just outside the slum. Similarly, though information on water sources was collected, these results were complicated by some sources being reportedly private, and others being non-functional.

However, when considering all thirty slum, the slums in Cuttack appeared more established than those in Bhubaneshwar, with street lighting and some form of communal or public latrine in each included slum. However, no firm conclusions can emerge from this data collected on the slums, and future work on the slums may require more detailed data to be collected to allow for the different nuances in service to be explored.

The collection of GIS data in the slums was done in order to explore linkages and patterns between households accessing shared or private sanitation facilities. Unfortunately however, the methods were not adequately trialled, and though I could plot an outline of the particular slum on a map in Google Earth, further analysis has not been possible at this time.

Data on activities undertaken prior to the hand-rinse sample was collected in the household questionnaire. Though a statistically significant association was found between prior activity and geometric mean contamination of the hand-rinse, the small sample sizes in some of the categories did not allow for further analysis. Research in Tanzania has shown that various activities—including cleaning up a child's faeces and washing dishes—were associated with increased faecal indicator bacteria on hands [93]. Though this corroborated that hands can be significant vectors of disease, the results also showed that the faecal indicator bacteria were highly variable over time [93].

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5 SHARED SANITATION IN ORISSA, INDIA

The previous chapter introduced the field study site, as well as the main study methods. This chapter focusses on the study methods and results of only the shared sanitation users. The main results are outlined in the manuscript: 'Shared sanitation: a cross-sectional study in Orissa, India exploring use, maintenance and management of neighbour-shared and communal latrines', as can be found in section 5.2 below. Methods and results of work not included in the manuscript are presented in section 5.3 and 5.4, and discussed at the end of the chapter.

5.1 SHARED SANITATION CATEGORIES

The initial shared sanitation categories identified in the fieldwork were as follows (i) those who own a latrine, but allow other households to share it, (ii) those who share a private latrine with other neighbouring or family households, (iii) those who share a latrine with their landlord, (iv) those who rely on communal latrines, and (v) those who rely on public or Sulabh latrines. The households sharing a private latrine (whether they owned it or not) and households sharing with their landlord were grouped together to from the 'neighbour-sharing' category, as used in the manuscript in section 5.2. The communal and Sulabh facilities were also combined. Though these categories are not strictly segregated by number of users, they are segregated by the 'type' of users, i.e. the neighbour-sharing households are most likely to share a facility with fewer other households, with whom they are familiar. The communal/Sulabh users on the other hand, may not have a personal connection with the other households using the sanitation facility. Figure 14 provides a brief overview of the types of shared sanitation observed in the field study. The manuscript in section 5.2 compares the 'neighbour-shared' facilities with 'communal/Sulabh' facilities.

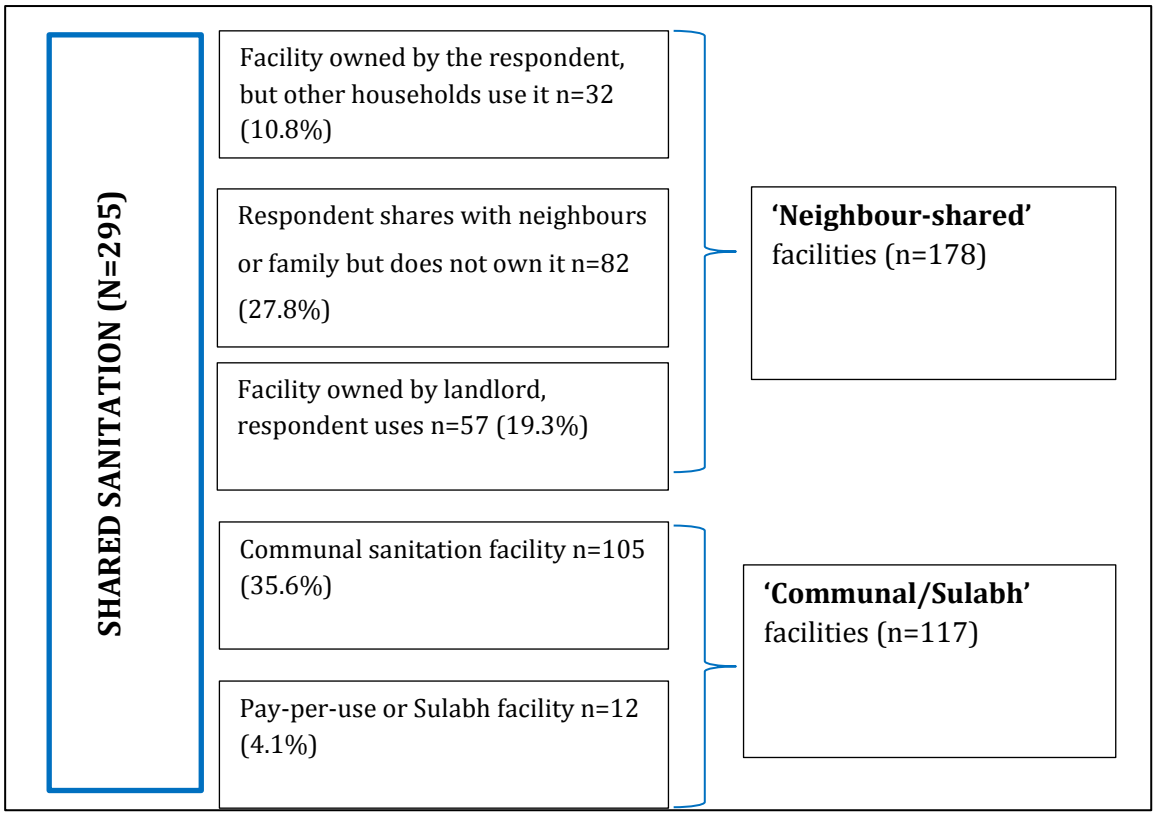

Figure 12. Overview of different forms of shared sanitation in slums of Cuttack and Bhubaneshwar

London School of Hygiene & Tropical Medicine
Keppel Street, London WC1E 7HT
www.lshtm.ac.uk

Registry
T: +44(0)20 7299 4646
F: +44(0)20 7299 4656
E: registry@lshtm.ac.uk

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STUDENT ID NO: 119580

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Shared sanitation: a cross-sectional study in Orissa, India exploring household demographics, accessibility, facilities and maintenance of neighbour-shared and communal latrines.

Marieke Heijnen, Parimita Routray, Belen Torondel, Thomas Clasen

ABSTRACT

Objective

A large and growing proportion of the global population rely on shared sanitation facilities, especially in urban slums. However, shared facilities are classified as 'unimproved' sanitation due to concerns related to cleanliness and accessibility. We sought to explore whether there were differences between neighbour-shared and communal latrines in terms household demographics, accessibility, facilities and maintenance.

Methods

We conducted questionnaires among caretakers of 305 households relying on shared sanitation in 30 slums in Bhubaneshwar and Cuttack, Orissa, India. About half (178 households) were relying on neighbourhood-shared latrines while the balance (117 households) were relying on communal latrines. We conducted spot checks of their latrines to collect data on indicators of use (water in squatting pan), privacy (presence of door and roof) and cleanliness (presence of water inside for cleaning, presence of faeces and flies).

Results

Compared to those relying on neighbour-shared facilities, households relying on communal facilities were poorer, larger, less educated, less likely to have access to piped water and more likely to have a member practicing open defecation. Communal latrines were less accessible, less likely to have a water or a hand washing station on site, and cleaned less frequently than neighbour-shared facilities; they were more likely to be non-functional, have non-functional cubicles and have visible faeces and flies present.

Conclusions

We identified significant differences between neighbour-shared and communal facilities in terms of user demographics, access, facilities and maintenance that may present different risk profiles. These findings highlight the inadequacy of a policy promoting a type of shared latrines based solely on numbers of known users. An approach that focuses on facilities and maintenance of shared sanitation may be more likely to actually improve conditions and reduce risk, especially among the most vulnerable populations that will continue to rely on communal facilities.

INTRODUCTION

Inadequate sanitation is associated with diarrhoea, soil-transmitted helminths, trachoma and schistosomiasis [1]. Diarrhoea accounts for the largest share of sanitation-related morbidity and mortality, causing an estimated 1.4 million deaths annually [2] or 19 percent of all deaths in low-income settings [3].

Globally, an estimated 2.5 billion people lack access to improved sanitation [4]. India represents a particular challenge, with 792 million people lacking access to an improved sanitation facility. An additional 597 million people practice open defecation, representing nearly two thirds of the global estimate for open defection [4].

'Shared' sanitation facilities—those used by two or more households—have been excluded from the definition of 'improved sanitation' used to monitor progress toward international targets [5]. The reason stems from concerns that shared facilities are unacceptable, both in terms of cleanliness (shared toilets may not be as hygienic as private ones or they may result in increased contact with human waste) and accessibility (facilities may not be available at night, or easily used by women and children) [6]. A recent systematic review found that users of shared sanitation had an increased risk of diarrhoea, though the methodological quality of the included studies varied considerably [7].

Nevertheless, shared facilities represent a large and growing proportion of sanitation options available in low-income countries, with approximately 784 million users of a shared sanitation facility (of an otherwise improved type)[4]. In India, 9 percent of the overall population accesses some form of shared sanitation,

which has steadily increased from 5 percent in 1990 [4]. In terms of urban areas, 20 percent of the population is reported to access shared sanitation (up from 17% in 1990) [4]. The Census of India estimates that over 65 million people live in slums, up from 52 million in 2001 [8]. Communal or public latrines are considered by some to be the only realistic option for high-density populations in many urban slums [9, 10].

One hypothesis about the association between shared sanitation and adverse outcomes is that the users are different. An analysis of data on shared sanitation and diarrhoea from 51 Demographic and Health Surveys reported that sharing sanitation facilities was a risk factor for diarrhoea, though differences in socioeconomic status were important [11]. A more detailed analysis of Joint Monitoring Programme (JMP) data suggests, however, that the increased risk associated with shared sanitation may be due to the other factors, as people who rely on shared sanitation tend to be poorer, have less access to improved water supplies, live in households with more young children and are managed by people with no formal education [12].

While it is difficult to implement policies that address these demographic differences, there is another hypothesis about the association between shared sanitation and health that may be more susceptible to intervention: that is that shared facilities present obstacles that limit their use due to poor access and maintenance. Biran et al. conducted a comprehensive quantitative survey assessing the determinants of communal latrine usage in Indian slums [13]. The study reports that distance and opening hours were strongly associated with use. Similarly, residents of slums in Mumbai reported using the railway tracks as toilets—even though public toilets were available 30 minutes away on foot [14]. The distance, lack of cleanliness and long queues induced them to use the tracks instead. Studies in Kenya and Ghana have also reported that cleanliness was the most important variable for use—with users often preferring open defecation to using shared toilets which they considered to be dirty and smelly [15, 16]. Inadequate water at the shared facilities has also been noted as a barrier to use—in a cross-sectional study in rural Maharashtra, despite the presence of community latrines, 67 percent of the respondents resorted to open defecation [17]. The main reason for not using the community latrine was inadequate water supply (48.6%).

The JMP has suggested that any increased risk associated with shared sanitation may be mitigated where the latrine is used by a limited number of people that know each other. They are therefore considering a revision to their policy that would treat shared sanitation as 'improved'—and thus scored toward international coverage targets— if the facility otherwise meets the definition of improved sanitation and is shared among no more than 5 families or 30 persons, whichever is fewer, and if the users know each other [4, 18]. While this proposed change is based on advice from an expert committee, some have questioned the change due to the extensive heterogeneity in shared sanitation use [7]. A policy brief by Water and Sanitation for the Urban Poor (WSUP) notes that the boundaries between the different types of shared facilities are often unclear, especially in dense urban settlements [19]. Mazeau et al. recommends that the focus should be less on the users and more on the facility itself—the authors suggest categorizing shared sanitation facilities by ownership, management, location and finance, rather than technological considerations [20]. For example, the large public sanitation facilities constructed and managed by Sulabh are often cited as success stories—they have provided safe and acceptable sanitation to many underserved communities [21]—yet they are considered 'unimproved', and will remain so under the proposed policy change due to the large number of users.

We undertook this study in informal settlements in Orissa, India to explore whether different types of shared sanitation facilities vary in terms of user demographics, patterns of use, facilities and maintenance in ways that may render them more likely to present health risks.

METHODS

Study design and setting; selection of slums and households

We conducted a cross-sectional design study in a convenience sample of 30 informal settlements (slums), half in Bhubaneshwar and half in Cuttack, the largest cities in Orissa. Shared sanitation facilities were identified in the context of another study that compared them to private latrines and the methods used for slum and household selection have been described previously [22]. Working from lists of slums provided by municipal authorities and local NGOs, we visited slums to identify 15 in each city that had a combination of shared and private latrines.

Within each slum, we targeted a total of 10 households using shared sanitation. An adapted EPI approach [23] was chosen as no accurate population or household data was available for the 30 selected slums. This consisted of selecting households for inclusion by randomly choosing directions in the slum (pencil-spinning and coin-tossing) and selecting every second household on the left. This purposive sample was intended to provide an overview of the situation, rather than a representative sample of the slum populations of these two cities. As the size of the slum could not be accurately determined, no weighting was applied.

Household questionnaire and latrine spot checks

Trained field staff used a pre-piloted household questionnaire and spot-checks of sanitation facilities. The structured questionnaire was used to collect demographic and socio-economic data, as well as information on latrine cleaning, faecal sludge management and open defecation habits from main caretaker of each household. Households were also asked with whom they shared their latrine, the accessibility (opening times) and associated costs of use, if any. During the household questionnaires, respondents were asked if anyone in the household had suffered from diarrhoea in the past 7 days (any time in the past 7 days) as well as on the day of the questionnaire or the two days prior. If the individual with diarrhoea was present, it was recorded as 'self-reported'. Diarrhoea was defined using the WHO definition of three or more loose stools in 24 hours [24].

Field staff also conducted a spot-check of the latrines that householders identified as their primary sanitation facility. They recorded information on indicators of use (i.e. wet floor, water in squatting pan), privacy (i.e. presence of door, roof) and perceived cleanliness (i.e. presence of water for cleaning, faecal material in the cubicle, smell and flies) for each cubicle in each facility. During the spot check, enumerators also recorded observations on the presence of rubbish or leaves blocking the squatting pan, functionality of the pan and whether the cubicle (area around the squatting slab) was blocked in any way thus preventing it from being used properly i.e. through storage. Data on the presence of space for bathing in the shared facility was also collected. The duplicate latrine spot checks (for households reporting use of the same facility) were removed from the analysis to ensure each latrine facility was counted only once. Data on a place for hand-washing was collected both during the household questionnaire and during the

latrine spot check. A designated hand-washing place was defined as a specific location in the home or the courtyard, or at the shared facility, with water (and possibly soap or ash) available.

Definition of shared sanitation. We defined shared sanitation as any facility used by more than one household (a household defined as 'sharing of a cooking pot' or eating together). In this study setting, this included neighbours or families sharing a single cubicle as well as tenants sharing a sanitation facility with their landlord. These users were grouped together and considered 'neighbour-sharing' households. Households using a facility managed by the community or a pay-per-use facility run by a third-party (such as a Sulabh Toilet Complex) were grouped together and considered 'communal' latrine users. As all facilities assessed were of the 'pour-flush' technology, the 'neighbour sharing' facilities are expected to correspond to the 'improved' shared category, as per the proposed new JMP policy. Because of the number of users, the 'communal' facilities are expected to remain 'unimproved' under the new JMP policy, irrespective of the technology used.

Statistical analyses. All data were double entered into Epi-Info 3.5.4 (Epi Info™ , CDC Atlanta, USA) and were analysed using Stata 12 (StataCorp LP, TX, USA). In order to generate a relative asset index, we combined household-level information on assets such as type of cooking fuel and ownership of specific items (i.e. fridge, bicycle, radio etc.) using principal component analysis to define the summed weights [25]. This score was then categorised into 'poor', 'middle', and 'least poor'. Two sample t-tests and Chi squared tests were used to assess any differences between the two groups (households using neighbour-shared or communal facilities). Where appropriate, other descriptive statistics (means, standard error) are presented.

Ethical approval and consent. The study was approved by the Ethics Committee of the London School of Hygiene and Tropical Medicine (No. 5561), and the Ethics Committee of Xavier University (No. 31050). Consent was obtained from all individuals participating in the study. Household questionnaire participants signed a consent form and were provided with an information sheet on the study with contact information in case of questions.

RESULTS

Household Questionnaire

The basic characteristics of the households sharing sanitation facilities can be seen in Table 1. A total of 295 households were included, the majority of which had access to neighbour-shared facilities (60.3%, 846 individuals). Most of the female headed households used communal facilities (55.3%) whilst the male headed households were more likely to use neighbour–sharing options (63.3%, p=0.02). Significantly, household respondents with no formal education were more likely to use communal facilities compared to the neighbour–sharing households (35.9% vs. 12.9%, p<0.001).

Almost double the proportion of households using communal sanitation had a 'below poverty line' (BPL) card as compared to the neighbour-sharing households (Table 1). Similarly, more households using communal facilities were categorised as 'poor' as compared to households using neighbour-shared facilities (59.0% vs 38.8%, p<0.001). In terms of housing structure, households accessing neighbour-shared facilities were more likely to have a house constructed with durable materials (cement walls and roof) than users of the communal sanitation facilities (33.7% vs. 22.2%, p=0.01).

Piped water was used by the majority of the households (80.7%), and most of these were users of communal latrines (77.0% neighbour-shared vs. 86.3% communal, p=0.05). The majority of users of communal latrines had to go outside their house or dwelling to collect water (74.4%). This was significantly more than for the users of neighbour-shared sanitation facilities (33.7%, p<0.001) (Table 1).

Significantly more households using communal sanitation reported that at least one member of their household practiced open defecation on some occasions (24.8% vs. 17.4%, p<0.001).

Though the overall numbers were low (2 individuals in neighbour-shared households versus 10 individuals in communal households), the 7-day period prevalence of diarrhoea was significantly higher in users of communal sanitation compared to neighbour-sharing users (1.64% vs. 0.24%, p=0.004). Of these individuals, 8 self-reported their diarrhoea status. Five of the 12 individuals reporting diarrhoea resided in households which disclosed open defecation

practice on some occasions—four of these five households accessed communal sanitation.

Latrine Spot checks

A total of 460 cubicles in 197 shared facilities were assessed. Of these, 277 cubicles from 142 facilities were deemed functional (cubicles which were used for storage or similar, cubicles in which the squatting pan was broken or filled with rubbish were excluded from the analysis) (Table 2). Overall, only 72.1% of all facilities and 60.2 percent of all cubicles assessed were deemed functional and included in the analysis. Significantly more of the cubicles used by neighbour-shared households were deemed functional than communal households (78.9% vs 47.8%, $p<0.001$).

The majority (80.3%) of the facilities had some bathing facility, though the latrine cubicles themselves were often used as the location for bathing (Table 2). Almost twice as many neighbour-shared facilities had a designated hand-washing facility compared to communal facilities (69.8% vs 43.8%, $p=0.04$). As all facilities assessed were of the pour-flush type, the availability of water inside the cubicle increased the ease of use. Almost twice as many neighbour-shared facilities had water available, as compared to the communal cubicles (69.9% vs 39.7%, $p<0.001$).

In terms of privacy, half of the latrine facilities assessed provided segregated facilities for men and women (n=104), with the remainder making no distinction (data not shown). The majority of these (n=91, 87.5%) were community or Sulabh latrines. None of the facilities included in the study catered specifically for children. No differences were observed between the two types of sharing in relation to the number of cubicles with doors or roofs (Table 2).

Indicators of use of the cubicle included a wet floor (either as a result of recent use or recent cleaning), standing water in the squatting pan and a change of colour in the squatting pan (slight yellowing). Similar number of cubicles in either sharing category had a wet floor at the time of the spot check. Twice as many communal squatting pans had a slight colour change—this may be as a result of inadequate cleaning, or intense use of the cubicle. No significant differences were found on indicators of use between neighbour-shared and communal facilities.

Enumerators inspected every cubicle to assess general cleanliness. Faeces were visible in 39.7 percent of the communal cubicles, compared to only 9.6 percent of the neighbour-shared cubicles ($p<0.001$) (Table 2). Similarly, the communal cubicles had significantly higher number of flies and a reported stronger smell, than the neighbour-shared facilities.

Facility construction, accessibility, lighting and water access

Most of the neighbour-shared facilities were open 24 hours a day, but only 57.1% of the communal were accessible at all times (Table 3). Users of these facilities also reported the highest average one-way travel time of 6.5 minutes, as compared to 2.6 minutes for users of the neighbour-shared facilities.

Four times as many cubicles in the communal facilities had lights inside as compared to the neighbour-shared facilities (12.8 % vs 3.0%, $p<0.001$), whereas almost a quarter of the neighbour-shared latrines had water inside the cubicle (23.0%) (Table 3). For those households using a facility or cubicle where water was not immediately available, the average distance water had to be carried for neighbour-shared users was 11.8 meters, compared to 16.8 meters for the communal sanitation users ($p<0.001$).

Management, cleaning and fees

Faecal sludge management

Septic tanks were the most frequently used faecal sludge management system (61.3%) (Table 3). Over half of the users of the communal facilities did not know when the tank was last emptied (52.5%); similar numbers of the neighbour-shared users reported not knowing when it was emptied (25.7%) and reporting it was emptied in the past 6 months (25.7%). Whereas two-thirds of the communal users did not know how the tank was emptied (65.9%), 61.9 percent of the neighbour-shared users reported emptying by vacuum pump. Whether emptied by vacuum pump or manually, just over half of the neighbour-shared respondents report payment for this service. Very few households report paying for a sewage connection (18.9% of neighbour-shared users).

Cleaning

For both users of neighbour-shared and communal sanitation, the sanitation facilities were most likely to be cleaned just once a week (72.4% neighbour-shared vs 34.0% communal, p<0.001) (Table 3). Significantly more households using communal facilities reported that there was no cleaning at all (14.2% vs 1.2%, p<0.001), and over a quarter of the users of these facilities did not know the cleaning frequency (28.3%). The majority of the households using neighbour-shared facilities cleaned their sanitation facilities themselves (85.4%), whereas for communal facility users, this was only a fifth (20.0%)(p<0.001). The majority of the neighbour-shared households cleaned the facility when they had time (81.3%), with only 11.2 percent reporting a cleaning schedule or rota for each household. Similarly, in almost all instances (97.0%), the household doing the cleaning provided the cleaning materials, with only 2.2 percent of the neighbour-shared households and 30.8 percent of the communal households collecting money to purchase cleaning supplies.

Fees

Four times as many users of the communal facilities pay for the use of the facility as compared to neighbour-shared users (p=0.004) (Table 3). However, overall, only 21 respondents (7.4%) report paying for use of the facility, with the majority (n=15) paying per use. The average price to use the facility per month was considerably more expensive for users of neighbour-shared facilities (Indian Rupee 225) versus users of communal (Indian Rupee 72.5). However, as there are so few paying-users, these figures may not be the norm. The majority of the neighbour-shared users contributed for pit emptying (57.1%) or a sewage connection (18.9%), whereas only 18.2% of the communal users paid for pit emptying, and none paid for a sewage connection. It is expected that in the majority of the communal users, the user fee covers all costs (cleaning, maintenance, emptying) and thus many of the respondents were not sure if they paid for additional services. Twice as many users of communal facilities paid for a sweeper and were more likely to collect money to pay for cleaning supplies. More of the neighbour-shared users cleaned the facility themselves, and in the majority of the cases (97%) the cleaning materials were provided by the household themselves.

DISCUSSION

We identified important differences among households that rely on neighbour-shared versus communal latrines, and on the accessibility, facilities and maintenance of these sanitation facilities. Some of these differences may be associated with significant differences in their risk profiles.

In terms of demographics and household characteristics, households relying on communal facilities were poorer, had more members, and were headed by individuals with less formal education. They were less likely to have access to piped water and more likely to have a member practicing open defecation.

Communal latrines were less accessible than neighbour-shared latrines both in terms of distance, open times and fees for use. They were less likely to have water or a hand washing station on site. They were cleaned less frequently than neighbour-shared facilities and were more likely to have visible faeces and flies present. They were also more likely to be non-functional and have non-functional cubicles.

While we did not measure use directly, these factors are likely to impact use. Studies in varying settings have shown that distance to the shared latrine was an important determinant of use [13, 16, 26, 27] Cleanliness of a shared sanitation facility has also been shown to be an important indicator of use [14-16].

Our study had several important limitations. First, the manner for selecting slums and households in this exploratory study was purposely designed to achieve balance and internal validity and not external validity. While our approach allows us to make comparisons between householders in the same slums that rely on different shared sanitation facilities, our results should not be generalized beyond the slums comprising our study population. Second, as a cross-sectional study conducted over a period of three months, we had no ability to capture potentially important differences over time and seasons that a longitudinal study would reveal. Third, much of our data was self-reported and is subject to recall, courtesy and other reporting biases. Lastly, no accurate data was collected on the number of households sharing a particular facility. Assumptions can be made based on the type of sharing (i.e. smaller number of households using neighbour or family-shared latrine versus larger households accessing communal facilities) but

additional data would have to be collected to justify these assumptions. In this study we combined users of communal and Sulabh facilities—though there may be differences we have not accounted for—the small number of households reporting Sulabh use (n=12) did not allow for a separate analysis.

Despite these limitations, we identified important differences between users of neighbour-shared facilities versus communal latrines. These differences raise questions about the proposed policy of counting shared latrines as 'improved' provided they have a limited number of known users. While the policy may capture a lower risk profile, much of this may simply be due to differences in household demographics—characteristics that the policy will not be able to impact directly. On the other hand, if the policy focused on accessibility, facilities and maintenance—establishing criteria for each in order for shared latrines to meet the definition of 'improved sanitation'—it would directly encourage attention, resources and creative solutions in these areas.

This recommendation is consistent with that of Mazeau and colleagues who suggest that the focus should be less on the users and more on the facility itself [20]. It is an approach that does not simply acknowledge important differences in shared sanitation, but may promote improvements in shared sanitation that would benefit the most vulnerable segments of the population—people who will likely continue to rely on communal latrines even if the proposed policy continues to treat them as unimproved.

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TABLES

Table 1. Basic characteristics of households

Characteristics		**Neighbour sharing**		**Communal**		**Tests of significance** (Chi squared unless specified)
	Total	**N**	**%**	**N**	**%**	
Total number of households	295	178	60.3	117	39.7	
Number of individuals in households	1455	846	58.1	609	41.9	
Sex head of HH						
Male	248	157	63.3	91	36.7	p=0.02
Female	47	21	44.7	26	55.3	
Education level of the household respondent						
No formal education	65	23	12.9	42	35.9	p<0.001
Some or Complete Primary	81	47	26.4	34	29.1	
Some secondary or higher	142	102	71.8	39	27.5	
Average number of Individuals in Household Mean (SD)		4.8 (1.77)		5.2 (2.4)		p=0.03*
Average number of children under 5 in household Mean (SD)		0.58 (0.62)		0.67 (0.73)		p=0.17*
Average number of rooms used for sleeping in household Mean (SD)		1.46 (0.71)		1.55 (0.73)		p=0.16*
Has BPL card						
Yes, verified	84	37	20.8	47	40.2	p<0.001
Yes, reported	24	13	7.3	11	9.4	
No	186	128	71.9	58	49.6	
Wealth Tertile						
Poor	138	69	38.8	69	59.0	p<0.001
Middle	98	58	32.6	40	34.2	
Least Poor	58	50	28.1	8	6.8	
House structure						
Cement wall and roof (pucca)	86	60	33.7	26	22.2	p=0.013
Cement wall	171	103	57.9	68	58.1	

(semi pucca)						
No cement (kucha)	37	15	8.4	22	18.8	
Water source (drinking water)						
Piped water	238	137	77.0	101	86.3	p=0.046
Non-piped water	57	41	23.0	16	1.4	
Location of (drinking) water source						
in own dwelling	72	49	27.5	23	19.7	p<0.001
In own yard/compound	76	69	38.8	7	6.0	
Outside of dwelling	147	60	33.7	87	74.4	
Open Defecation practiced (at least one member of household, on some occasions)	42	13	17.4	29	24.8	p<0.001
Diarrhoea (at individual level, reported in the past 7 days)	12	2	0.24	10	1.64	Two sample test of proportions p=0.004
Diarrhoea (at least one member of household reported diarrhoea in the past 7 days**)**	12	2	1.12	9	7.7	Fishers exact p>0.01

* Two-sample t test with equal variances

Table 2. Latrine spot checks results

	Total	**Neighbour shared**	**Communal**	**Two sample t-test of proportions**
Nr of facilities assessed	197	172	25	-
Nr of cubicles assessed	460	185	274	-
Average nr of cubicles per facility	2.34	1.08	11.0	-
Nr of facilities deemed functional, (%)	142	126 (73.3)	16 (64.0)	p=0.35
Nr of cubicles deemed functional	277	146 (78.9)	131 (47.8)	p<0.001
Average nr of functional cubicles per functional facilities	1.95	1.16	8.19	-
For all analyses, only functional facilities/ cubicles will be considered				
Facility has space for bathing (either in cubicle or just outside)	114 (80.3)	100 (79.4)	14 (87.5)	p=0.44
Does the facility have a place for hand-washing? n (%)	95 (66.9)	88 (69.8)	7 (43.8)	p=0.04
Nr of cubicles with water inside	154 (55.6)	102 (69.9)	52 (39.7)	p<0.001
PRIVACY				
Nr of cubicles with a door or screen up to 1 meter	262 (94.6)	139 (95.2)	123 (93.9)	p=0.633
Nr of cubicles with a roof	268 (96.8)	138 (94.5)	131 (100)	p=0.006
USE				
Nr of cubicles where the floor is wet	253 (91.3)	132 (90.4)	121 (92.4)	p=0.554
Standing water in pan?	272 (98.2)	141 (96.6)	131 (100)	p=0.033
Colour change in pan?	198 (71.5)	72 (49.3)	126 (96.2)	p<0.001
CLEANLINESS				
Faeces in cubicle?	66 (23.8)	14 (9.6)	52 (39.7)	p<0.001
Flies in cubicle				
None	20 (7.2)	20 (13.7)	0 (0)	p<0.001
Some	75 (27.1)	60 (41.1)	15 (11.5)	p<0.001
Many	182 (65.7)	66 (45.2)	116 (88.5)	p<0.001
Smell in cubicle				
No detectable smell	26 (9.4)	26 (17.8)	0 (0)	p<0.001
Some detectable smell	114 (41.2)	96 (65.8)	18 (13.7)	p<0.001
Strong detectable smell	137 (49.5)	24 (16.4)	113 (86.3)	p<0.001

Table 3. Characteristics of the sanitation facility, as reported by households

	Total	**Neighbour shared**	**Communal /Sulabh**	**Two sample t-test of proportion**
Nr of households responding	282	165	117	-
ACCESSIBILITY				
Is the facility open 24/7?	260	159 (96.4)	101 (57.1)	p<0.001
Average time (minutes, one way) to travel to latrine from household (SD)		2.6 (2.3)	6.5 (4.1)	p<0.001
Lights at facility (reported) n (%)				
Near facility (i.e. streetlight) or at the facility	83	51 (30.9)	32 (27.4)	p=0.53
Lights inside each cubicle/stance	20	5 (3.0)	15 (12.8)	p<0.001
No lights	170	100 (60.6)	70 (59.8)	p=0.88
Availability of water at latrine, n (%) (reported)				
Yes, just outside the latrine	81	40 (24.2)	41 (35.0)	p=0.03
Yes inside the cubicle	58	38 (23.0)	20 (17.1)	p=0.17
No, everyone brings their own	143	87 (52.7)	56 (47.9)	p=0.38
Average distance in meters (SD) water has to be carried from source to latrine		11.8 (8.7)	16.8 (14.7)	p<0.001
FAECAL SLUDGE MANAGEMENT				
Where does the waste from the latrine go? n (%)				
Septic tank	173	113 (68.5)	60 (51.3)	p=0.001
Sewer	77	37 (22.4)	40 (34.2)	p=0.02
Canal/gutter	10	3 (1.8)	7 (6.0)	p=0.05
Don't know	22	12 (7.3)	10 (8.5)	p=0.68
Do you know when the (septic) tank was last emptied? n (%)	168	N=109 (3.5 % missing)	N=59 (1.7% missing)	
Last month	4	3 (2.8)	1 (1.7)	p=0.66
In the last year	63	52 (47.7)	11 (18.6)	p<0.001
Don't know	57	26 (23.9)	31 (52.5)	p<0.001
Not emptied	44	28 (25.7)	16 (27.1)	P=0.84
How was the latrine emptied?	128	N=84 (6% missing)	N=44 (6.8% missing)	
Vacuum pump	62	52 (61.9)	10 (22.7)	p<0.001
Manually	36	31 (36.9)	5 (11.4)	p=0.002
Don't know	53	24 (28.6)	29 (65.9)	p<0.001
CLEANING				
How often is the facility cleaned? n (%)(reported)	280	N=163 (1.2% missing)	N=117 (0 missing)	
Once a day	53	35 (21.5)	20 (18.9)	p=0.59
Once a week	154	118 (72.4)	36 (34.0)	p<0.001
Less than once a week	8	3 (1.8)	5 (4.7)	p=0.16
No cleaning	17	2 (1.2)	15 (14.2)	p<0.001
Don't know	35	5 (3.1)	30 (28.3)	p<0.001
Who cleans the facility? n(%)	228	N=158 (0 missing)	N=70 (2.8% missing)	
Sweeper/cleaner	79	23 (14.6)	56 (80.0)	p<0.001

Households themselves	145	135 (85.4)	14 (20.0)	p<0.001
Rotation system for households cleaning?		N=134 (0.7% missing)	N=13 (7.1% missing)	
Yes, everyone cleans in turn	147	15 (11.2)	7 (53.9)	p=0.001
No, people clean as they have time	22	109 (81.3)	5 (38.5)	p=0.007
No, usually few people/households cleaning	114	10 (7.5)	1 (7.7)	p=0.98
PAYMENT				
Do you pay to use the facility?				
Yes, n (%)	21	6 (3.6)	15 (12.8)	p=0.004
Average amount paid per n (average INR[1])				
Use	15	4 (2.25)	11 (3.5)	-
Month	6	2 (225)	4 (72.5)	-
Do you payment for pit emptying? n (%)	128	N=84	N=44	
Yes	56	48 (57.1)	8 (18.2)	p<0.001
No	42	15 (17.9)	27 (61.4)	p<0.001
Don't know	30	21 (25.0)	9 (20.5)	p=0.57
Amount paid for emptying, average, n (INR)				
Per month		4 (400)	0 (0)	
Per year		30 (9733)	6 (150)	
Per occasion		8 (1337.5)	1 (100)	
Do you pay for the sewage connection? n(%)	77	N=37	N=40	
Yes	7	7 (18.9)	0 (0)	p=0.004
No	70	30 (81.1)	40 (100)	p=0.004
If yes, average INR paid (frequency)		300 (per month) 200 (per year)	n/a	
Do you pay for the sweeper? Yes (%)	39	13 (56.5)	26 (46.4)	p=0.42
Average payment for cleaning/sweeper? N, average (INR)				
Amount paid per month		1 (20)	10 (20.5)	
Amount paid per week		11 (30.9)	7 (21.4)	
Amount paid per occasion/cleaning event		1 (20)	7 (12.1)	
Do you pay for the cleaning materials? n (%)	11	N=134 (0.7% missing)	N=13 (7.1% missing)	
None used, only use water for cleaning	147	1 (0.8)	0 (0)	p=0.75
Collect money to pay for supplies	1	3 (2.2)	4 (30.8)	p<0.001
Household who cleans provides	7	130 (97.0)	9 (69.2)	p<0.001

[1] INR- Indian Rupee. Exchange rate October 2010, 1 USD=61.7 INR

5.3 ADDITIONAL INFORMATION NOT INCLUDED IN PUBLICATION

5.3.1 PRIVATE SANITATION VERSUS NEIGHBOUR-SHARED

As sanitation facilities which are shared with neighbours, family members or landlords are likely to fall within the 'improved sanitation' category as per proposed policy change, further analyses to determine any differences between households accessing a private sanitation facility and households accessing a 'neighbour shared' facility were undertaken.

5.3.2 HAND-RINSE AND DRINKING WATER SAMPLES

The methods for hand-rinse and water sample collection have been described in section 4.3.9 of Chapter 4. In brief, a hand-rinse sample and drinking water sample were collected from each respondent household to test for the presence of thermotolerant coliforms (TTC), an indicator of faecal contamination [91]. Results are expressed in numbers of colony forming units (CFU) per 100mL of sample. As the data were not normally distributed, geometric means are presented, with the associated confidence interval. Similarly, count data is presented to provide an overview of the distribution of the contamination per sharing category. Lastly, the hand-rinse and water sample data was recoded into a binary category, with all 0 values considered 'no evidence of contamination' and all values of 1 or higher considered 'evidence of contamination'. Where possible, differences between the types of sharing and the proportion of households presenting a contaminated sample were assessed.

5.3.3 FOCUS GROUP DISCUSSIONS

In an effort to understand the motivations and observations of the users of (shared) sanitation in the slums of Orissa, four focus group discussions (FGDs) were trialled in 4 slums (2 slums in Cuttack, 2 in Bhubaneshwar). Half the discussions were held with adult males, and the other half with adult females. The number of participants invited ranged between 8 – 12. The aim of these FGDs was to gain some preliminary knowledge on the use, management and attitudes towards shared and private sanitation facilities available in the respective slums. This information was also expected to help shape the household questionnaire. Due to the complexity of conducting these discussions in densely populated areas in a short time frame, and partly as a result of the language barrier, the discussions were not as fruitful as they could have been. In addition, as a result of time and funding limitations, only four discussions were held. As such, the standard method of continuing data collection until saturation was not followed [97]. Despite these limitations, the observations from the discussions are shared in section 5.4.3. Efforts were made to ensure the data collection and analyses were conducted with as much methodological rigour as possible. However, due to the limitations expressed above, the findings are presented merely to provide a overview of the sentiments expressed.

The FGD discussion guide was designed to generate open discussion in six key areas: shared sanitation facilities available in slum, individual household latrines, cleaning and maintenance of sanitation facilities, faecal sludge management of any sanitation facilities, motivation for use of a facility or construction of a private facility and the use of facilities by women and children. A copy of the discussion guide can be found in Appendix 7. Facilitation of group discussions was done by two members of the research team in Oriya (local language). All facilitators used in this study had previous experience in facilitation in sanitation and hygiene studies. Informed consent was acquired from the participants, as noted in Chapter 4, section 4.3.11.

The FGDs were recorded digitally and later translated into English and transcribed by a native Oriya speaker, who was part of the research team.

Figure 13. Three communal latrines in Orissa

5.4 RESULTS

5.4.1 PRIVATE SANITATION VERSUS NEIGHBOUR-SHARED

Table 8 provides an overview of the results when comparing households accessing private sanitation facilities with households who use 'neighbour-shared' facilities, such as facilities shared with a small number of families or neighbours, or with their landlord. The results show that households accessing private sanitation are significantly larger (5.7 individuals versus 4.8 individuals, $p<0.01$) than households accessing neighbour shared sanitation facilities. Similarly, private access households have more rooms for sleeping ($p<0.01$). However, significantly more individuals living in households with private sanitation access

reported diarrhoea (12 versus 2), but no significant differences in open defecation practices were observed. Households accessing private sanitation were more likely to have access to water in or near their dwelling, more likely to have a house built with permanent materials and were more likely to be found in the 'least poor' wealth category.

Table 8. Private sanitation facilities versus neighbour-shared facilities

Characteristics		**Private**		**Neighbour sharing**		**Significance test** (Chi-squared test unless indicated otherwise)
	Total	N	Percentage	N	Percentage	
Total number of households	450	272	60.4	178	39.6	
Total number of individuals (reported) in households	2401	1555	64.8	846	35.2	
Sex head of HH						
Male	382	225	58.9	157	41.1	p=0.11
Female	68	47	69.1	21	30.9	
Education level of the household caretaker						
No formal education	58	35	60.3	23	39.7	p=0.46
Some or Complete Primary	99	52	52.5	47	47.5	
Some secondary or higher	272	170	62.5	102	37.5	
Average number of Individuals in Household Mean (SD)		5.7 (2.7)		4.8 (1.77)		p<0.01*
Average number of children under 5 in household Mean (SD)		0.61 (1.0)		0.58 (0.62)		p=0.12*
Average number of rooms used for sleeping in		2.11 (1.2)		1.46 (0.71)		p<0.01*

household Mean (SD)						
Has BPL[6] card						
Yes, verified	104	67	64.4	37	35.6	p=0.55
Yes, reported	36	23	63.9	13	36.1	
No	311	183	58.8	128	42.2	
Open Defecation practiced (at least one member of household, on some occasions)	33	20	60.6	13	39.4	p=0.09
Diarrhoea [7](at individual level)	14	12	85.7	2	14.3	p<0.01
Water source (drinking water)						
Piped water	356	219	61.5	137	38.5	p=0.37
Non-piped water	94	53	56.4	41	43.6	
Location of (drinking) water source						
in own dwelling	229	92	40.2	137	59.8	p<0.01
In own yard/compound	155	114	73.5	41	26.5	
Outside of dwelling	202	65	32.2	137	67.8	
House structure						
Cement wall and roof (pucca)	191	131	68.6	60	31.4	p<0.01
Cement wall (semi pucca)	226	123	54.4	103	45.6	
No cement (kucha)	33	18	54.5	15	45.5	
Wealth Tertile						
Poor	120	51	42.5	69	57.5	p<0.01
Middle	152	94	61.8	58	38.2	
Least Poor	178	128	71.9	50	28.1	

* two sample t-test

[6] BPL=Below-Poverty line card, provided by the Government indicating financial disadvantage and identifies households and individuals in need of assistance

[7] Number of individuals reporting diarrhoea, can be different from households as several individuals reporting diarrhoea may reside in the same plac

Table 9 provides an overview of the facilities used by households privately and by neighbours and landlords. Presence of water, presence of a bathing and handwashing facility provide the largest differences in the actual facilities. No differences are observed in factors of cleanliness (faeces, flies) or use (wet floor).

Table 9. Latrine survey results for private and neighbour shared sanitation facilities

	Private	**Neighbour shared**	**Two sample t-test of proportions**
Nr of facilities	304	126	-
Nr of cubicles	226	146	-
Average nr of cubicles per facility	0.74	1.2	-
Facility has space for bathing (either in cubicle or just outside)	211 (93.4)	100 (68.5)	p<0.001
Does the facility have a place for hand-washing? n (%)	199 (88.1)	88 (69.8)	p<0.001
Nr of cubicles with water inside	196 (86.7)	102 (69.9)	p<0.001
Nr of cubicles with a door or screen up to 1 meter	214 (94.7)	139 (95.2)	p=0.83
Nr of cubicles with a roof	216 (95.6)	138 (94.5)	p=0.64
Nr of cubicles where the floor is wet	211 (93.4)	132 (90.4)	p=0.32
Standing water in pan?	221 (97.8)	141 (96.6)	p=0.49
Colour change in pan?	60 (26.5)	72 (49.3)	p=0.007
Faeces in cubicle?	5 (2.2)	14 (9.6)	p=0.59
Flies in cubicle			
None	85 (37.6)	20 (13.7)	p=0.04
Some	120 (53.1)	60 (41.1)	p=0.13
Many	19 (8.4)	66 (45.2)	p=0.003
Smell in cubicle			
No detectable smell	92 (40.7)	26 (17.8)	p=0.03
Some detectable smell	131 (58.0)	96 (65.8)	p=0.23
Strong detectable smell	1 (0.4)	24 (16.4)	p=0.67

5.4.2 WATER SAMPLES AND HAND-RINSES

For hand-rinse samples, the overall geometric mean TTC count for those relying on neighbour-shared facilities was 61.8 (95% CI: 33.6-113.5), whereas for those relying on communal/Sulabh sanitation, it was 20.8 (95% CI: 10.9-39.8, p=0.27), thus presenting no significant difference between the two categories. In terms of drinking water samples, the geometric mean TTC count for those relying on neighbour-shared facilities was 17.1 (95% CI: 9.7-30.1) versus 20.1 (95%CI: 10.6-38.2) for users of communal/Sulabh sanitation (p=0.54). Figure 15 presents the presence or absence of TTC in water samples, and Figure 16 presents the same for hand-rinse samples. Figure 17 presents the percentage of households with contaminated water samples versus non-contaminated water samples, per sharing category. Figure 18 provides a similar overview, but focussing on hand-rinse samples.

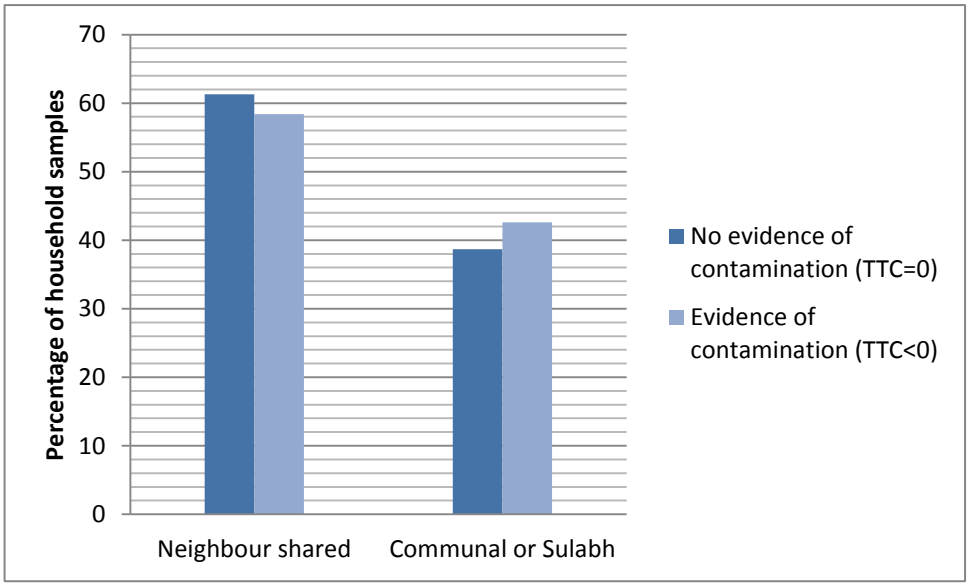

Figure 14. Presence and absence of faecal contamination in drinking water samples, per combined sharing category

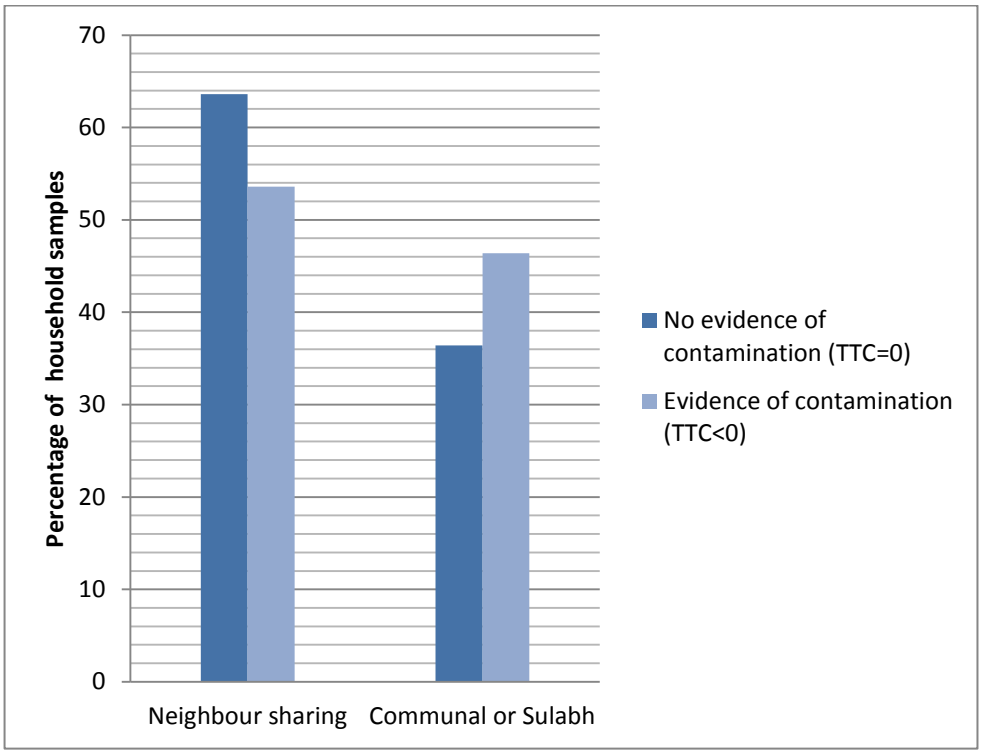

Figure 15. Presence and absence of faecal contamination in hand-rinse samples, per combined sharing category.

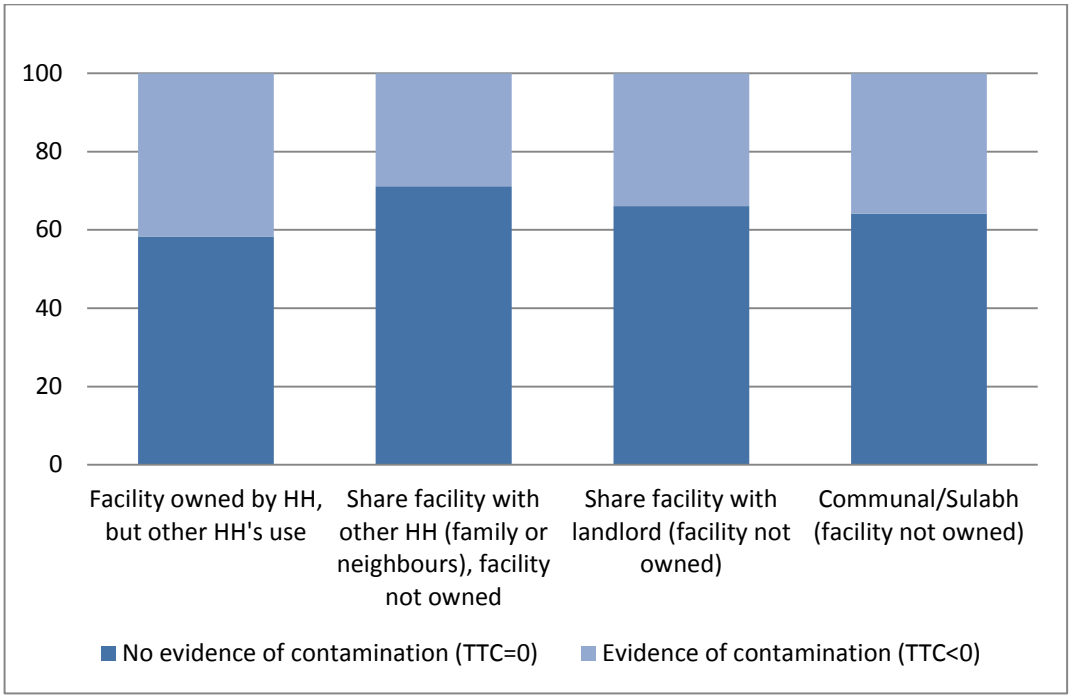

Figure 16. Percentage of households with and without drinking-water contamination, per sharing category

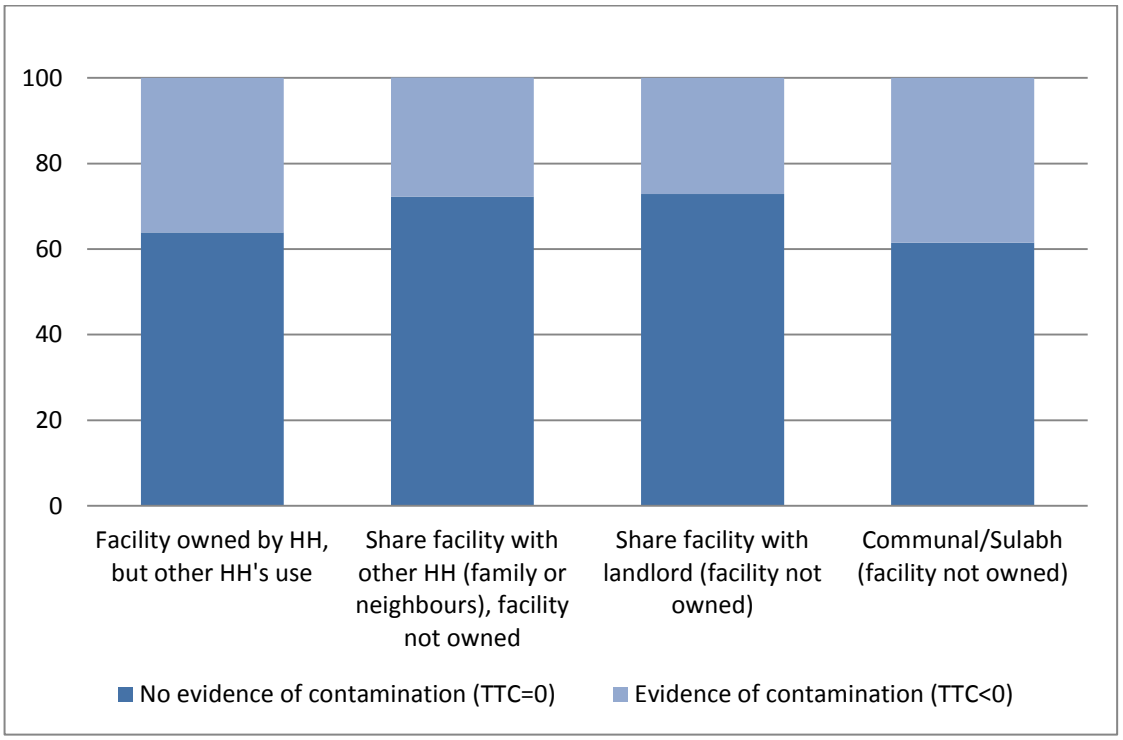

Figure 17. Percentage of households with and without hand-rinse contamination, per sharing category

As was noted in section 4.5.4 of Chapter 4, data was collected and analysed on the activities undertaken by respondents prior to the hand-rinse. In order to assess which activities were undertaken by users of the two types of shared sanitation, an overview is provided in Table 10. The majority of caretakers were preparing or eating food prior to the hand-rinse (73.1%). Though significantly more of the households with access to communal/Sulabh facilities were sitting or talking prior to the hand-rinse, the numbers are generally very small and in some cases insufficient to draw meaningful conclusions.

Table 10. Number of households accessing neighbour-shared and communal/Sulabh sanitation undertaking particular activities prior to the hand-rinse, and activity undertaken prior to hand-rinse sample, with a 2 sample Wilcoxen rank-sum test to asses any difference in the number of TTC.

Activity undertaken prior to hand rinse	**All sharing**		**Users of neighbour-sharing facilities**		**Users of communal/Sulabh facilities**		**2 sample Wilcoxen-rank sum test**
	n	**Geometric mean TTC**	**n**	**Geometric mean TTC**	**n**	**Geometric mean TTC**	
Preparing or eating food	208	35.5	128	72.6	77	18.8	p=0.13
Cleaning house or dishes/clothes	47	37.6	26	46.7	21	32.0	p=0.18
Bathing (self or child)	6	24.5	5	24.5	1	-	p=0.49
Caring for animal	2	5	0	-	2	5	Insufficient data
Visiting latrine or cleaning child after visiting latrine	1	300	1	300	0	-	Insufficient data
Sitting/talking /watching TV	18	23.8	7	47.8	11	8.3	p=0.02
Outside/ shopping/ other	13	57.4	8	37.9	5	300	p=0.40

5.4.3 Focus Group Discussions

The transcripts from the four FGDs were manually coded, highlighting the emerging themes. In addition to information on the types of facilities available to the participants, the following 5 themes emerged: (i) Positives about using sanitation facility, (ii) importance of water, (iii) cleaning and maintenance, (iv) barriers to use, and (v) barriers to construction of sanitation facility. After presenting information on the facilities

available, each theme is addressed in order of frequency mentioned, starting with the most frequently mentioned theme. Some responses are relevant to several sub-themes.

Facilities available

All four slums had a community latrine, as well as some households with private latrines. Three of the slums reported gender segregated facilities: Two cubicles (one male, one female), 10 cubicles (5 male, 5 female) and 4 cubicles (2 male, 2 female). However, in this last slum, it was reported that one of the female cubicles was damaged, and so only one was in use.

In all slums, some households were reported to have a private facility, and in 2 slums the continued practice of open defecation by some members of the community was mentioned.

One slum had separate bathing space (4 cubicles) within the communal latrine structure, but in most instances, the cubicles serviced a double purpose.

> "No, we are bathing inside that latrine."
> - A slum resident in Cuttack, in response to the question if a bathing facility was available

Cleaning and maintenance

The employment of a sweeper/cleaner to clean the facilities was mentioned in three of the four slums. In only one of these instances is the cleaning daily, the other two facilities are cleaned on a weekly basis. In the fourth slum, the households themselves clean the facility. However, it appears that it is one household in particular that does the cleaning.

> A: "yes, they empty the pit. Actually the pit is very big and there is a connection from pit to drain. But this drain is often blocked."
>
> Q: "Where this drain is connected?"
>
> A: "yes. It is connected to a canal"
>
> -Cuttack slum resident

> Q: "So you are collecting money from each household?"

R: “Not monthly. Not everyone, those people who are willing to pay its fine, we do not force them it’s not mandatory. Sometimes we do collection, we collect Rs 10-20 from them”

-Bhubaneshwar slum resident

When asked who cleans the facility, one lady responded that she would clean, or her husband.

A: “I am cleaning madam, my husband is cleaning always by using harpic[8]”

Q: “where does the harpic come from”?

A: “My husband buys this”

As the focus group discussion took place during the rainy season, issues of drainage were also brought up, especially as some of the sanitation facilities empty directly into a drain or gutter.

“That is totally blocked and in rainy season the water comes to our home”

-A slum resident in Bhubaneshwar, referring to a drain near the latrine

“The doors are broken, the pit is sometimes overloaded”

-Cuttack resident responding when asked if crowding was the only problem faced with the communal latrines

Positives of sanitation facility

Very few respondents could highlight benefits of the shared facility which they currently use. One resident in Cuttack however noted that compared to open defecation, the communal facility was an improvement. This result is also relevant to the ‘importance of water’ theme.

“It is better to go to the latrine than going outside. If we go outside then they environment will get dirty and will get polluted. Due to this many problems

[8] Harpic is a brand of bathroom cleaner

are grooming due to this reason slums are being evacuated. Then going for OD is strictly prohibited. It is wrong who go outside for defecation."

-Bhubaneshwar slum resident

"We feel bad when we were going to OD site .because it is open and everybody seeing us. Now its safe."

-Bhubaneshwar slum resident

Q: "Some of you are going outside and some are using this latrine. How you feel about that?"

A: "They feel good to go to outside. We want change and want to stay clean. So we use the latrine"

-Cuttack slum resident

"…outside no water is available nearby so it feels very dirty but in latrine water supply is always available and it feels very clean. This is the change."

-Cuttack slum resident

"It is better to go to the latrine than going outside. If we go outside then the environment will get dirty and will get polluted. Due to this many problems come... slums are being evacuated. Then going for open defecation is strictly prohibited. It is wrong who go outside for defecation."

-Bhubaneshwar slum resident

In a slum in Bhubaneshwar, the residents were asked how they would want their latrine to be:

Q: "How would you want the latrine to be?"

A: "we want it to be large, light and the cleaning materials"

In this particular slum, one household appeared to be the main provider of cleaning materials, which caused some tension.

Barriers to construction

The main barriers to construction of either an additional community latrines or private latrines were lack of space, and cost.

> "To build our own latrine it needs more space which we don't have. We are living in very small house due to scarcity of space. Those who have more space they built their own latrine."
>
> -Cuttack slum resident

> "We have thought [*to build our own latrine*], but we have no strength in terms of money and we do not have place. Some do not have place and those who are interested they do not have enough money"
>
> -Bhubaneshwar slum resident

> Q: "You are saying that the number of latrine is less so why don't you build a new latrine by collecting money?"
>
> A: "We are very poor people sir. We are earning rs100 per day so how can we give rs50?"
>
> -FGD in Cuttack slum

> "I would have money, job, a good family. I have 4 daughter no son and I am alone, how I will build a latrine?"
>
> Cuttack slum resident

Some participants noted that there might be space for a latrine, but not necessarily money.

> "Here everybody has space but they are giving it in rent by making homes"

-Cuttack slum resident

Barriers to use

The main complaint about the facility was crowding. It is noted that users don't have time to wait, and thus may still practice open defecation. One of the causes of the crowding is the fact that many of the latrines are also used as bathrooms, and that some facilities are broken or don't have doors, thus limiting their use, putting a larger strain on the facilities were are functional.

Q: "Suppose there is another person inside the latrine then what will you do?"

A: "We will wait/ will knock the door to come soon/will run towards rail line."

-Bhubaneshwar slum residents

"We are using this both for defecation and bathing… that is the problem."

-Bhubaneshwar slum resident

Q: " Can you tell me any of the benefits you have seen since this latrine was built?"

A: "what benefit nothing… more problems we are facing… only four latrines are here and so many people are using".

Q: "how many people are using this latrine?"

A: "whole slum…about 600 people."

-Bhubaneshwar slum resident

"…this latrine is used by many people of this slum. Though so many people are using this – it gets damaged. People are more, it's too crowded. More than 200 people are using this toilet"

-A slum resident in Bhubaneshwar

"Those that have personal latrine they are using their own and rest of the people are using this latrine but the problem is it is always crowded"

-A slum resident in Cuttack

In a slum in Cuttack, it was reported that only those living close to the communal latrine were using the facility- distance being the main barrier of use, but also noting a lack of space for construction of their own shared or private facility:

Q: "why you are not using this latrine?"

A: "it is always packed and we can't wait because we have work"

Q: "only you are not using or are there others?"

A: "yes there are many people who are not using"

Q: "how many are there?"

A: "it can't be told exactly. The people next to this electric pole are not coming to this latrine"

Q: "they have their own?"

A: "no, they are going to the outside drain near Revenshaw college"

Q: "is this latrine far for them?"

A: "Yes"

Q: "what about you're thinking for a latrine on that side?"
A: "no, there is no space for any latrine"

The lack of lights in the facilities was also highlighted—three of the four slums did not have a light in the latrine, though one of the three had a streetlight nearby.

> "..no light is there…no electric bulb ...so if there will be snake or frog we will go, no other option.."
>
> -Bhubaneshwar slum resident

Importance of water

As was noted above, one of the benefits of latrine use included the availability of water. In one slum, a water tank was constructed on top of the latrine, but the difficulty was not necessarily availability of water, but the actual pumping of the water to the tank.

> "The motor is connected in one household and he is not always available to switch on this so there is shortage of water always" -
> Residents of a slum in Bhubaneshwar

In some slums, water is only available at certain times of the day.

> Q: "Is water available all the time?"
>
> A: "no, it comes in 3.30 pm-4.30 pm"
>
> Q: "What do you do when it is not available?"
>
> A: "We use the tube well"

5.5 DISCUSSION

Only the results presented in section 5.4.1—5.4.3 of the chapter will be discussed here. Some differences were observed between households accessing private sanitation and households accessing neighbour-shared sanitation. If these neighbour-shared facilities meet the other criteria required for inclusion in the post-2015 definition of 'improved sanitation', they will be grouped with the private sanitation facilities for future monitoring targets. However, some important differences were identified—for example the increased wealth, permanent housing structures and access to water on premises for households accessing private sanitation. No differences were observed in education, access to piped water and sex of the household head. The results from the slums in Orissa also show that individuals with access to a private sanitation facility are more likely to suffer from

diarrhoea than individuals in households sharing a facility within the neighbourhood. This result is contrary to what one might reasonably expect, especially as private sanitation facilities were generally cleaner, with more access to handwashing facilities. However, this increased diarrhoea prevalence in private sanitation households may be due to a number of factors—for example, lower food-related hygiene or increased health seeking behaviour may explain the increased reporting of diarrhoea. Unfortunately these factors were not measured as part of this study, but would warrant further investigation in future research.

Overall, sanitation facilities which are used by only one household are more likely to have water in the cubicle, a handwashing facility and space for bathing in or near the cubicle, as compared to facilities used by neighbours or family. From these limited results, it may appear that a facility which is used by a few households may be comparable to private sanitation, as is proposed by the post-2015 policy change on improved sanitation. However, when considering the type of users (households) some significant factors (wealth, water, access) remain which merit further exploration.

Various activities undertaken before the hand-rinse resulted in high mean hand contamination levels—however, the sample sizes were small and as such the results should be interpreted with caution. No differences in either hand-rinse or water sample contamination in the two sharing categories could be observed. Similarly, no predictors of hand-rinse and drinking water contamination in users of shared or private sanitation could be established in this population (see Supplementary Table 1 of the manuscript in Section 4.4). As a result, no further analysis was undertaken to establish possible predictors in the sharing subgroups.

Four focus group discussions were held to assess attitudes, management systems and overall use of shared sanitation facilities. Though limited by methodological rigour, a basic analysis of emerging themes was tried by highlighting similar sentiments expressed in the text. The main themes which emerged related to lack of space, overcrowding of the facilities and lack of money to construct new facilities. In some slums, issues of drainage, water-supply and open defecation were noted. In addition, the frequent 'double-function' of the sanitary facilities—as both latrines and bathing spaces—was highlighted as a difficulty. Despite the infrequent cleaning and the reported high-usage of the facilities, no mention was made by the participants of the facilities being dirty. In terms of accessibility, 3 out of the 4 latrines were accessible at all times, though there was no light in the facility.

Conducting a FGD proved more difficult than anticipated in the selected slums. In only one slum could a suitable, semi-private location be found, which would fit the participants without fear of being overheard or judged.

In the 'women-only' FDG in Bhubaneshwar, men continued to hover in the vicinity, and there were feelings of mistrust when it was noted that women's views were specifically sought.
Similarly, in the men's FGD in Cuttack, one womean insisted on attendance as she was the leader of the women's group, and also the 'manager' of the community latrine. Unfortunately, she often overpowered the voices of the men.

Though in two of the slums some participants disclosed that they occasionally practise open defecation, there may be instances where responses were biased by expectations of 'receiving something' from the researchers. Though it was made clear at the start of each discussion that the facilitators were there for research purposes only, and not to provide additional water or sanitation facilities, there may still have been some expectation of assistance.

In order to further determine additional barriers of use, it would have been beneficial to drill down further into questions of defecation practices for women and children at night, especially in the slum in Cuttack where the communal facility was not open 24 hours.

The quotes included in this chapter are directly translated quotes, and thus may not catch some of the subtle language present in the original statements.

Chapter references

91. WHO/UNICEF, *Guidelines for drinking water quality*, 2004, World Health Organization: Geneva.

97. Hennink, M., *International Focus Group Research: A Handbook for the Health and Social Sciences*. 2007: Cambridge University Press.

6 DISCUSSION AND CONCLUSION

Chapter 2 of this thesis presented results from a systematic literature review, indicating that there may be a negative health impact associated with the use of a shared sanitation facility. This was further explored in Chapter 3, where global data from household surveys were analysed. This showed that households accessing shared sanitation facilities tended to be poorer, less educated, reside in urban areas and reside in households with fewer individuals. The results from these two pieces of work led to the development of the following hypotheses:

1. People relying on shared sanitation instead of private latrines are at greater risk of enteric infection due to greater poverty, less education, less access to improved water supplies, sharing a house with many people, and having overall lower health status.
2. People relying on shared sanitation instead of private latrines are subject to greater exposure to enteric pathogens because (i) they are less likely to use the latrines consistently and more likely to continue to practice open defecation, (ii) they are more likely to have contact with faecal material during use of the latrines, and (iii) they are less likely wear shoes or to wash their hands with soap after using the latrine.
3. Differences in use, exposure and hand washing behaviour among people that rely on shared sanitation versus private sanitation can be mitigated through maintenance and management of the latrines.

Chapters 4 and 5 discussed results from a field study which was designed to help explore the hypotheses and research questions. This last chapter will review the main findings, and discuss the results of the research presented in this thesis conceptually, empirically methodologically and in regard to policy.

6.1 CONCEPTUAL

The concept of shared sanitation is not well defined. As discussed in Chapter 1, no consensus exists on the definition of what constitutes shared sanitation. Shared sanitation can be defined by the number of households or individuals accessing the sanitation facility or by the 'type of access', such as the general public, or only the surrounding community or the location of the facility. In addition, the technology of the facility and the presence of bathing or laundry spaces may play a role in the distinction. In this thesis, any facility used by more than one household is considered shared sanitation, irrespective of the technology, location or additional facilities.

Without a clear consensus of what constitutes shared sanitation, it is difficult to study, measure and report on the impact its use may have. It may also complicate accurately measuring access or use of shared sanitation facilities for use in monitoring towards sanitation targets.

As can be seen in Figure 18, shared sanitation is currently considered 'unimproved' on the sanitation ladder. With the proposed policy change for the Sustainable Development Goals, shared sanitation facilities which are used by 5 households or 30 individuals (whichever is fewer) and which are of an improved type, will be considered 'improved' sanitation. However, this definition does not consider other potentially important factors (socio-economic status, management of the facility) which may contribute to the potential health risk of shared sanitation use. When considering only the households sharing sanitation facilities, the results in Chapter 5 indicate that households accessing communal sanitation facilities are less educated, poorer and more likely to report practicing open defecation, as well as report diarrhoea cases than households accessing a facilities shared with neighbours, landlord or family. Similarly, no differences in terms of education, wealth or open defecation could be observed between the households accessing private sanitation and those sharing a facility with neighbours or family, though there were significantly more cases of diarrhoea reported in the private sanitation households. However, significantly more private facilities had water inside the cubicle as compared to neighbour-shared, and again significantly more cubicles had water in the neighbour-shared facilities as compared to the communal facilities. The same trend was seen in handwashing facilities. This shows that, at least in the slums studied in Orissa, many differences exist within the group of 'shared sanitation'—both in terms of facilities and users. This information may encourage a further division in the 'shared sanitation' step of the sanitation ladder—starting with public facilities at the base, followed by communal, neighbour shared and then private sanitation facilities (Figure 18).

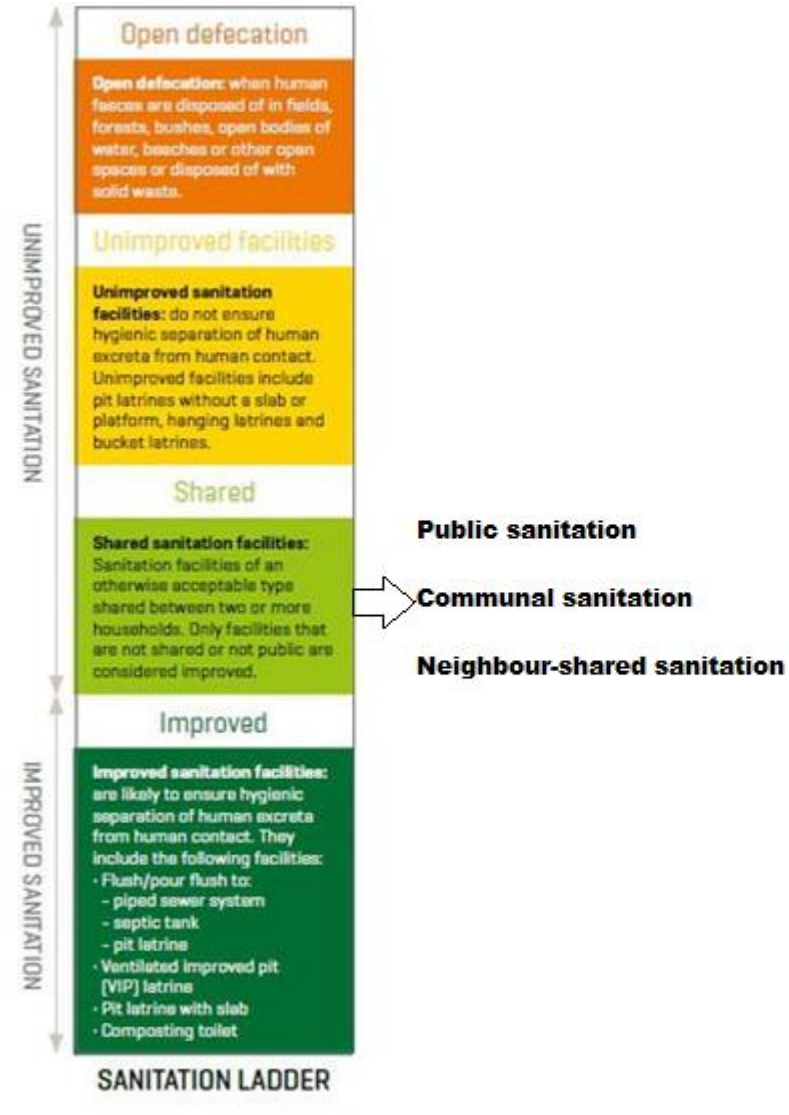

Figure 18. Shared sanitation ladder. Adapted from JMP 2010

Due to the differences observed in the forms of shared sanitation in terms of users, access, facilities, maintenance, it may not be appropriate to combine all shared sanitation into one category. Further research in multiple settings is needed to determine whether these differences within shared sanitation are also evident elsewhere. This could contribute to the development of 'sub' levels of the sanitation ladder, using universally accepted and applicable definitions.

6.2 EMPIRICAL

Little empirical evidence exists on shared sanitation. As discussed in the systematic literature review in Chapter 2, few of the information sources set out to look at shared sanitation in particular. Most of the evidence on shared sanitation and its association

with various health and non-health outcomes is derived from sources which were not powered or intended to investigate shared sanitation facilities specifically.

However, the research conducted for this thesis focussed specifically on shared sanitation access. The evidence presented indicates that shared sanitation is mostly accessed by households who are poorer, less educated, have less access to water in or near their premises and usually consist of fewer individuals, as compared to households accessing a private facility. This is consistent with results from the publication presented in Chapter 3 [98]. Overall, I also found more reported cases of diarrhoea amongst households sharing sanitation, this is in line with similar data presented in the systematic literature review as presented in Chapter 2 [99].

6.3 Methodological

The data presented in Chapter 2 and 3 consists of a systematic literature review and an analysis of household surveys. Though the main methodology and the limitations have been discussed in these chapters, I will briefly review some of the pertinent issues.

Firstly, the main advantage of a systematic literature review is that it allows the compilation of data from a wide range of sources (including both published and unpublished manuscripts), which may or may not be further assessed in a meta-analysis. In the case of the systematic literature review on shared sanitation, the manuscripts which met the inclusion criteria generally reported an increased risk of various diseases, including diarrhoea, for users of shared sanitation. However, the limited documentation on shared sanitation available, as well as the lack of consensus on the definition of shared sanitation meant that a very wide search was done. This was time consuming and labour intensive, and as such the initial screening was only done by one individual. If it would have been feasible, the initial screening could have been done a by second individual, thus improving the quality control.

The advantage of using DHS and MICS household surveys to extract data is that these surveys have been implemented using aligned questions since 2005. As such, the questions are broadly asked in the same manner, and the data can be compared across countries and regions. Using both MICS and DHS surveys (and using the most recent survey for countries where both are implemented) allowed data to be extracted from a wide range of countries. However, despite the aligned questions, some countries have different categories, for example, for the type of latrine facilities available to the households. It is therefore important to verify the definition of each type of facility

presented in the survey (ie. is a basic pit latrine defined in the same manner across two different countries). This is time consuming, but important for comparability. Overall, the collation of data, whether in the form of a systematic review or a large number of household surveys can provide strong evidence, particularly in settings where traditional assessments of cause-effect (such as randomised control trials) are difficult or not possible.

Though discussed in Chapter 4 and 5, some of the methodological limitations of the fieldwork conducted in Orissa are noted here. Firstly, the hand-rinse and drinking water samples which were assessed as part of the field research in Orissa were intended to act as a proxy for cleanliness or general faecal-exposure in the household. As noted, the methods used do not allow for the differentiation between the public and private domain, nor do they allow for identification of the source (i.e. human or animal). Further research needed here is therefore twofold—i) determining the potential transmission routes which may increase disease for users of shared sanitation, and ii) further developing microbial tracking and identification methods which are easier to apply and use in low-resource settings.

Secondly, in the research conducted in Orissa, I refer to the 'users' of sanitation. Unfortunately, even if a household has access to a particular sanitation facility, this does not always mean it is used. Though the difficulty of measuring sanitation use goes far beyond shared sanitation alone, it is an area that requires continued work. Understanding why a facility is (not) used highlights the importance of user involvement in research, both before construction of a shared facility and once it is open for use. Similarly, whilst investigation and documentation of microbial transmission routes would allow identification of strategic areas of intervention, (i.e. handwashing facilities at the latrine to break a transmission route, or improved household water storage), these will have limited effect without the participation and cooperation of the beneficiaries. Further research on motivations and preferences of the users of shared sanitation must be explored to ensure the facilities available are used correctly.

6.3.1 Reflections on Methodology

Systematic literature review

The original systematic literature review was initially submitted to WHO Bulletin for publication. Unfortunately, the peer-reviewers had reservations about the inclusion of the non-published data, especially the GEMS data. The peer-reviewers believed the paper should not be published until the GEMS data itself was peer-reviewed and published. As

the lead author of the GEMS work on shared sanitation and diarrhoea is a co-author on the shared sanitation systematic literature review, I was aware of the process for the GEMS publication and it was expected to be lengthy as a result of the large collaboration. As such, it was decided to withdraw the manuscript from WHO Bulletin, and instead submit it to Plos One, where it was published without objection to the inclusion of unpublished studies. At the time of this writing, the GEMS studies have still not been published. The review, on the other hand, has been available on open access since the 17th of April 2014, and has five citations to date.

Overall, the timing of the review could have been better. I would have liked to have the paper in front of the Sanitation Task Force[9] for the Sustainable Development Goals before their 2012 meeting. The final paper was not completed at the time, but the results, including the meta-analysis showing the pooled effect of shared sanitation use on diarrhoea prevalence, were drafted into a briefing note and provided to UNICEF. Unfortunately, to the best of my knowledge, this was never presented to the working group. Nevertheless, this data has subsequently been presented at conferences and been part of the JMP's consideration of its policy changes.

HOUSEHOLD SURVEY ANALYSIS

Whilst working on the data analysis of the household surveys, it came to light that researchers at the University of Michigan, USA were working on a similar analysis. Whereas I was looking specifically at the global and regional scope of shared sanitation, James Fuller and colleagues were using DHS surveys to assess the association between users of shared sanitation and the prevalence of diarrhoea. As our research had a similar direction, we decided to collaborate on both papers. This proved beneficial for both of us, as I had more background knowledge on shared sanitation, and James had a lot of experience with survey data analysis.

The piece of work went through several iterations. A lot of the analysis was already done and part of the paper written when the Michigan co-authors noted that the wealth quintiles calculated for each country survey sometimes include water and sanitation variables. As such, it became important to recalculate a relative wealth score for each household survey, excluding water and sanitation variables.

[9] In preparation for the post-2015 targets and indicators, the Joint Monitoring Programme set up different taskforces to tackle various issues. Taskforces are made up of wide-range of experts from various countries, ranging from academics, selected WASH sector experts, to NGOs and staff from UNICEF, WHO and other relevant UN agencies.

The paper by Fuller et al. was published online on May 27th 2014, and has been cited twice to date. The final manuscript on the scope of shared sanitation was published online 26th of August 2014, but has not yet been cited.

ORISSA FIELDWORK

FIELD SITE

The fieldwork was conducted in Orissa, India. Due to limited information at State level on the prevalence of shared sanitation use, I was initially unsure whether the fieldwork location was ideally suited to my research questions. However, after a few scouting missions to a number of slums in different towns, it emerged that not only did many households share a sanitation facility, the type of sharing also varied considerably.

At the time of my fieldwork, a large cluster-randomised controlled trial was concluding in the rural areas of Orissa, managed from the state capital, Bhubaneshwar. As a result of this, there was a fully-set up office with trained staff, labs, research vehicles and good connections with local government and research staff. This made the initial stages of the cross-sectional study much easier and reduced the time and money spent on finding staff and organising logistics.

I also considered doing similar research in different settings, for example conducting research in Ghana, which has some of the highest shared sanitation prevalence rates globally. However, I wanted to focus on the difference between users of private latrines and users of shared sanitation, living in a similar setting. The rates of shared sanitation use in Ghana were almost too high, limiting the number of households living in similar settings but using private sanitation.

SAMPLING

With hindsight, I still wonder if I should have conducted a census of the slums in which the research was conducted in order to have a sampling frame. Though it would have allowed me to make other conclusions (total number of households, prevalence of sharing households, etc.) there are other difficulties with such data collection in slums. For example, the exact borders or perimeters of slums may vary depending on whom you speak to, and the slum population may change quite rapidly between doing the census and collecting the data. I even found that names of slums varied slightly—the spelling of certain names as by the municipal council did not always correspond to the spelling of the slum as found on the ground. This was easily resolved by checking with local residents, but on paper, this can create confusion. In the end, in light of the limited research which exists on shared sanitation, it made sense to me to conduct an exploratory study, which

would be able to inform future research; as such an extensive census was not necessary in this initial study.

If I could do the household questionnaires again, I would be more conscience of the households who own a latrine (they constructed it/paid for it) but allow other households/family to use it. There is a potential for misclassification here, as when the enumerator asked if the respondent had access to a private latrine facility, they would say yes. However, at times this 'private' facility was also used by other households. This confusion was cleared up early on in the data collection by verifying if no other households used the facility. In addition, there were follow-up or 'checking' questions built in to the questionnaire which allowed for these 'private but shared' households to be identified. However, the data collected in the first few days, before we added the extra verification may have been less clear, thus forcing me to make an informed decision on whether the respondent household belonged to a private or shared sanitation category.

Focus Group Discussions

The aim of this exploratory study was to learn as much as possible about the differences between users of shared and private sanitation facilities. The focus group discussions had a dual purpose; firstly, to make sure I covered any issues raised by the FGD participants in the household questionnaire, and second, to get a sense of the motivations or problems with the use of private or shared sanitation in the slums of Orissa. Unfortunately, due to time, funding and priorities, the FGDs conducted and analysed were not as methodologically sound as they could have been. However, the participants contributed their time, and I personally found it very interesting to get the user perspective—as such it was included in the final thesis.

The research staff working in Bhubaneshwar were familiar with leading FGDs, but most of these had been done in rural settings. One of the difficulties of conducting a FGDs in a slum setting is finding a suitable space. In general we used a small porch or courtyard to sit, but these areas were rarely large enough to comfortably sit the 8-12 invited participants. In addition, these areas were not private, and anyone passing by could (and sometimes would) contribute or listen. The aim of conducting FGDs separately for men and women was to investigate if there were any differences in their experiences with shared sanitation, but the gender segregation was rarely maintained.

Questionnaire design

For a few questions in the household questionnaires, one of the response options was 'other'. In most instances further information on what this 'other' means was requested, but in cases where it was not, it did not contribute useful information. In future

questionnaires, I would carefully re-pilot the questionnaire if 'other' options are raised, to see if they can be included as an answer to the question. Similarly, though most of the questionnaires were coded and double-entered, some data was written out whole (for example slum names). As local names may be spelled differently by different people, this information may become difficult to decipher. In future questionnaires I would code these names for consistency.

GIS

Using hand-held GPS devices, which were available in the study site because they were previously used in other fieldwork—the perimeter of each of the slums was mapped. In addition, each household was mapped and it was noted whether the household accessed a private or a shared facility. Though good for protecting the identities of the respondents, the resolution on Google Earth was too poor to actually see individual houses. Also, one roof may consist of several households, and some roofs are not houses, which makes it difficult to count the number of 'houses' in the demarked area. So though I had hoped to do an estimate of population density (number of households over the total area), this was not possible. I also considered getting higher resolution maps, which would potentially allow me to count the individual 'houses' (and we could verify on the ground if they were in fact houses). However, these were available for purchase at 600 USD which was considered out of the budget, especially as they were not vital for the research question. A potential solution for such future research would be to demarcate a particular area of the slum and take GPS points, count the number of households/dwellings on the ground and translate this back to the map. This would allow for a rough calculation of housing density, which could be used throughout the slum area.

FUTURE QUESTIONS

One of the factors which the new SDG target intends to focus on is the number of households sharing a particular sanitation facility. Though this was indeed of interest in my field work, I failed to collect accurate data on this. The question was included in the 'follow up' question of the private latrines (to verify that only one household was using the facility) but somehow omitted for the households reporting sharing. As a result, throughout the analysis of the data I have assumed that households sharing a sanitation facility with their neighbours, landlord or family are sharing the facility with no more than 5 households (and thus match the proposed SDG target for 'improved sanitation'). Similarly, I have assumed that households using communal or Sulabh sanitation facilities are likely to share the facility with more than 5 households. The error in not collecting this information is entirely my own.

If I were to do the questionnaire again, I would have liked to further investigate the landlord-tenant relationship, i.e. do the landlords live in the same slum, or are some 'live out' landlords. I would also like to further understand the motivations for landlords to provide sanitation for their tenants, or to share with them.

Similarly, I did not investigate whether the respondent rented or owned their property, or whether they illegally squatted on the land. This data would have been interesting, as it could shed light on motivations for constructing (or not constructing) a private or neighbour-shared latrine.

Though I collected data on the ownership of assets, I did not collect information on employment or level of income. Approximate level of income would have allowed me to calculate the household expenditure on sanitation as a percentage of their income, and compared this across households with private and different variations of shared sanitation access.

In research conducted by Quicksand in various settings in India, it was found that men and women use the (communal) sanitation facility in different ways [44]. For example, men tended to use the communal facility for both bathing and defecation, whereas women only used it for defecation. The women tended to bathe when washing clothes. In my research, some shared facilities were reportedly used for both bathing and defecation, which contributed to queues, especially at busy times. I did not further investigate whether men and women both used the facility for bathing, or whether women did indeed bathe elsewhere. It would have been interesting to collect information on this, as it would consider the habits and needs of the users. Sanitation facilities, shared or private, will only be used exclusively and properly if they provide a service which the users believes he or she needs.

MICROBIOLOGY

As discussed in the manuscript in Chapter 4, the microbiological methods used in this research have been questioned due to the limited sensitivity and specificity [100, 101]. However, these methods were chosen because they are relatively simple and inexpensive to implement, and were expected to provide an indication of potential contamination. Other methods used to measure faecal exposure include using sentinel toys [102] or conducting latrine swabs [103]. None of these methods are perfect however, as they do not consider both the public and domestic domain. These two pathogen transmission pathways have been described by Cairncross et al., as 'domestic domain' transmission corresponding to in-house contamination, and 'public domain' transmission that corresponds to contamination at the water point, or shared latrine [104]. In order to stop

transmission, interventions are needed in both domains. The use of faecal indicator bacteria, as was done in Orissa, does not allow for the distinction between the domestic or public domain. Similarly, presence of pathogens on hands or in drinking water may be a poor indicator of actual exposure [101]. Other factors which are likely to play a role include the virulence of the specific pathogen, the threshold at which different pathogens cause disease and the immune response of the individual. Thus the usefulness of basic microbial indicators to determine an actual 'risk' is limited, and would be enhanced by using methods which can define specific sources of the organism, for example whether it has an animal or human origin [105]. Unfortunately these methods of microbial source tracking are costly and require specialised lab equipment, making them less suitable for work in low-resource settings.

6.4 POLICY IMPLICATIONS

The post-2015 Sustainable Development Goals are expected to include the proposed new definition of 'improved sanitation'—including shared facilities if they meet the set criteria. The research presented in this thesis neither supports nor rejects this suggested policy change.

It is expected that adoption of the new definition of improved sanitation post-2015 will dramatically increase the coverage of improved sanitation in some countries. As was discussed in Chapter 3, Ghana and Togo will almost double the proportion of households accessing improved sanitation if some forms of shared sanitation are included. This may result in decreased funding or government focus on these 'shared improved' facilities, despite the fact that these facilities may not provide the same benefits private sanitation facilities are expected to provide.

The limited evidence has shown there to be an increased risk of disease for the users of shared sanitation, though there was insufficient data to determine the effect of the number of households on health outcome. Further work has shown that users of shared sanitation are likely to be poorer and less educated—these are factors which cannot be resolved easily. However, other factors which appear to play a role—maintenance and cleanliness of the sanitation facilities and availability of handwashing at the latrine, in addition to distance, opening times and number of cubicles maybe easier to target.

To assist researchers, policy makers and the development community, it is pertinent to have a clear set of definitions to distinguish the different types of shared sanitation—bearing in mind that these definitions must be universally applicable. Whether this separation is based on number of users, the management level (household, community, third-party such as Sulabh) or another criterion is up for debate.

6.5 SUMMARY OF THE MAIN FINDINGS

1. Shared sanitation is ill-defined in the literature, which complicates comparisons and generalisations. Though a variety of definitions are in use, including 'private-shared', 'neighbour-shared', 'communal', 'community' and 'public', these all cover different level of management, access and household ownership.
2. In recent studies, shared sanitation use has been shown to be associated with increased risk of disease, diarrhoea in particular. Though the studies included in the systematic review suffered from various methodological shortcomings, the overall effect was consistent. This was corroborated by a study specifically investigating the association between shared sanitation use and diarrhoea. In this study, socio-economic status of the households played an important role, though there was considerable heterogeneity, with the results varying by country and region. In the analysis of DHS and MICS surveys, not only socio-economic status, but also the education level of the head of the household, the number of household members, the number of children under the age of 5 and urban residence appeared to be an important factor in predicting whether a household shared a sanitation facility or not. Again, though some consistent results were observed, the effect sizes varied by region. The results of these studies suggest that shared sanitation itself may be a confounding variable, and that the negative health association observed for users of shared sanitation is actually a result of other, unmeasured factors.
3. The field research in Orissa aimed to identify potential factors that could explain an association between shared sanitation and increased risk of adverse health outcomes. The results were consistent with previous research—users of shared sanitation were poorer, less educated and reside in households with fewer members. In addition, more users of shared sanitation still practiced open defecation and not all households or household members used the shared sanitation facility consistently.
4. Research in Orissa also highlighted that the sanitation facility itself was different when used by private or sharing households. Shared sanitation facilities and cubicles were more likely to be non-functional, lack water, and they were less clean, with more faecal matter and flies present.
5. No differences in hand-rinse contamination or drinking water samples could be detected in the fieldwork in Orissa. However, this may be related to the potentially limited sensitivity and specificity of these methods as well as the relatively small sample size.

6. Shared sanitation encompasses a wide range of levels—varying levels of access (using a neighbour's household or going to the communal latrine), level of management (user involvement in cleaning or maintenance, or payment to cover these costs), as well as the wide range of households using particular facilities. When focussing on the households using shared sanitation facilities in Orissa, there were significant differences in the types of users, as well in their roles the management and maintenance of the shared facilities. Facilities shared on a neighbour, family or landlord level were cleaner, closer to the household, more likely to be accessible at all times of day and night, and the users were more involved in cleaning and maintenance, as compared to users of communal/Sulabh facilities.

6.6 Conclusion

As the global level of urbanisation is expected increase in the near future, it is highly likely that shared sanitation facilities will have to play a role in providing sanitation facilities to those households who do not have their own sanitary facility—due to lack of space, money or land ownership. Though evidence to date suggests that there may be an increased health risk for users of shared sanitation, the number of households at which this risk becomes significant may require further investigation. However, it is likely that it is less a matter of the number of households or individuals using the facility, but more a combination of factors in relation to the health status of the users, the maintenance of the facilities and the access to water and handwashing facilities. As such, shared sanitation should be seen as an important step on the sanitation ladder. Governments, policy makers, researchers and sanitation implementers should endeavour to improve the health, hygiene and sanitation facilities of users of shared sanitation in the short to medium term. It will take a comprehensive, multi-sectoral approach to ensure all households, even the poorest or those living in dense urban settlements have access to an individual household latrine—and until that time the best alternative must be provided. It is likely that this will have to be a safe, accessible, well-managed and culturally appropriate sanitation facility which is shared by a specified number of households.

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APPENDIX 1

Shared Sanitation - A Systematic Review

PROTOCOL

Marieke Heijnen, Oliver Cumming, Rachel Peletz, Joe Brown, Thomas Clasen

March 2012

This is a protocol for a systematic review on shared sanitation. The main objective of the review is to compare shared sanitation with individual household latrines. Outcomes of interest will include (i) health impact (diarrhoea, helminth infections, enteric fevers, trachoma, under-nutrition), (ii) intermediate outcomes that are related to exposure to disease pathogens (drinking water quality, flies, presence of faeces etc.), (iii) measure of sanitation uptake (latrine use, changes in open defecation, etc.), (iv) equity and other social impacts of sanitation. Analysis will focus on comparisons between individual household latrines use (or other practices) and shared sanitation, but we will also analyze studies that identify associations between only shared sanitation and the outcomes of interest.

BACKGROUND

Introduction

According to the United Nations Children's Fund (UNICEF) and the World Health Organization (WHO) an estimated 2.5 billion people lack access to improved sanitary facilities, such as a basic pit latrine, a toilet connected to a piped sewer system or septic tank, or a composting toilet [1]. In developing regions where people are most vulnerable to infection, only one in every two people has access to improved sanitation [2]. Only 41 per cent of people in sub-Saharan Africa and 30 per cent of people in Southern Asia have access to improved sanitary facilities- the remainder use unimproved facilities, share a facility or practice open defecation [1]. However, there are significant differences between the two regions: in sub-Saharan Africa 45 per cent of the population use either shared or unimproved facilities, and an estimated 25 per cent practice open defecation; whereas in Southern Asia, the proportion of the population using shared or unimproved facilities is much lower, and open defecation is the highest of any region (42 per cent)[1].

Though the global population in 2011 was about equally divided between urban and rural, the urban-rural disparities in sanitation are significant. Globally, 79 per cent of the urban population use an improved sanitation facility, compared to 47 per cent of the rural population [1]. Despite significant and encouraging declines in open defecation since 1990, 1.1 billion people – 15 per cent of the world's population – still resort to the practice, the majority of whom live in rural areas [1].

According to the recent update on drinking water and sanitation, sanitation coverage is improving in almost every developing region. Despite this, it is unlikely that Target 10 of Goal 7 of the Millennium Development Goals (MDGs) - aiming to halve the proportion of people with access to basic sanitation by 2015- will be met [1]. Unless the pace of change in the sanitation sector can be accelerated, the MDG target may not be reached until 2026 [1].

Definitions of sanitation

In its broadest sense, sanitation deals with the safe collection, storage, treatment, and disposal, reuse or recycling of human excreta (faeces and urine), as well as the drainage, disposal, recycling and re-use of waste water and storm water, and household, industrial and hazardous waste [3].

The MDG target, which is expressed in terms of 'basic sanitation' follows a more comprehensive approach and also includes concepts of affordability, cultural acceptability and environmental sustainability [4].

The United Nations Millennium Taskforce on Water and Sanitation attempted to consolidate these definitions, defining basic sanitation 'as the lowest-cost option for securing sustainable access to safe, hygienic, and convenient facilities and services for excreta and sullage disposal that provide privacy and dignity, while at the same time ensuring clean and healthful living environment both at home and in the neighbourhood of users [3].

The MDG definition is context specific- in dispersed, low-income rural areas it may include a simple pit latrine, whilst in congested urban slums with a reliable water service, household-based solutions would be deemed inadequate and low-cost sewerage systems would be necessary to ensure the proper collection, treatment, and disposal or reuse of excreta and household wastewater [3].

The Joint Monitoring Programme (JMP) for Water Supply and Sanitation defines "improved sanitation" and "unimproved sanitation" in terms of the facilities available for the disposal of human excreta. Improved sanitation facilities includes a private flush or pour-flush toilet or latrine connected to a piped sewer system or septic system, a simple pit latrine with a slab, a ventilated improved pit latrine (VIP) or a composing toilet. Unimproved sanitation includes any other flush or pour-flush latrine, an open pit latrine, bucket latrine, a hanging latrine, any public or shared facility or open defecation [2].

In locations or situations where there is insufficient space to construct a private sanitary facility, such as in densely populated urban areas, people often rely on public or shared facilities [2]. Shared sanitation facilities as defined for MDG monitoring purposes are facilities of an otherwise improved type that are either public or shared between two or more households [2]. This includes toilets shared between a group of households in a single building or plot, one shared in a community by several households as well as public toilets which are open to anybody and will often include some form of payment [5]. Households that use shared or public facilities are not included in the population defined as using an improved sanitation facility, and as such do not meet the JMP criterion for improved sanitation [6]. The reason stems from concerns that shared facilities are unacceptable both in terms of cleanliness (toilets may not be hygienic and fully separate human waste from contact with users) and accessibility (facilities may not be available at night, or used by children, for instance).

Among the different regions, using a shared facility is most common in sub-Saharan Africa and Eastern Asia (both 19 per cent) and particularly common in certain sub-Saharan African counties such as Ghana (58 per cent), Congo and Gabon (both 34 per cent)[1].

However, JMP recognizes that, globally, the number of people using shared sanitation is growing: The number of users has increased by 425 million since 1990 – increasing from 6 per cent of the global population to 11 per cent in 20 years. In many countries, particularly in crowded urban areas, shared sanitation is the only viable option for those wishing to avoid open defecation; in rural areas, families often keep costs down by sharing latrines between one or more households with family ties. A JMP task force on sanitation is exploring the issue of shared sanitation as part of its mandate [1].

Sanitation and health

Approximately 6.3 per cent of deaths and 9.1 per cent of DALYs (disability-adjusted life years) worldwide are attributable to unsafe water, sanitation and hygiene [7]. While the biological association between diarrhoea and exposure to human faeces is well established, there is little rigorous epidemiological evidence of the effectiveness of sanitation interventions to prevent disease [8]. Much of the evidence of the effectiveness and mechanisms of improved sanitation to prevent diarrhoea derives from observational studies [9-11]. A recent Cochrane review noted that there was some evidence of interventions to improve excreta disposal which were effective in preventing diarrhoeal diseases, however the quality of the evidence was deemed poor [8].

Inadequate water and sanitation are linked to a broad range of health problems; according to the 2011 Human Development Report, billions of people are affected by parasitic diseases: 1.5 billion with *ascaris*, 740 million with hookworm, 200 million with schistosomiasis and 40–70 million with liverfluke. These infections as well as hepatitis, typhoid and polio can be avoided through safe excreta disposal and other hygienic behaviours [12]. Half of all malnutrition is attributable to environmental factors, particularly poor water, and sanitation and hygiene [13]. Malnutrition from these causes is responsible for some 70,000 child deaths a year, while underweight children are more vulnerable to infectious disease and less likely to recover fully when they do fall sick [7].

It is estimated that 15 per cent of deaths in children younger than 5 years worldwide are caused by diarrhoea[14]. Diarrhoea is known to be caused by a wide variety of bacterial, viral, and protozoan pathogens excreted in the faeces of humans and animals. The infectious agents associated with diarrhoeal disease are transmitted chiefly through the faecal-oral route [15]. The importance of individual pathogens varies between settings, seasons and conditions. These pathogens may be transmitted through the ingestion of contaminated food, water, or other beverages, by person-to-person contact and by direct or indirect contact with infected faeces. Due to the different pathways, environmental interventions for the prevention of diarrhoeal disease typically include steps to improve the proper disposal of human faeces (sanitation) as well as improving water quality [16], water quantity and access, and promoting hand washing and other hygienic practices [17, 18] Many studies have reported results of interventions to reduce illness through improvements in drinking water, sanitation facilities and hygiene practices- though limited data is available, it has been suggested that sanitation interventions can significantly reduce diarrhoeal illness, with a pooled relative risk of 0.68 [19]. Excreta disposal is associated with a 36 per cent reduction in diarrhoea morbidity [20], a figure which is confirmed in the more recent review of data [21]. It was noted however, that the data remains very limited and the few available studies are not of high quality.

Shared sanitation and health

There is evidence that shared sanitation is associated with poorer health outcomes compared to individual household latrines, including lower birth weight [22] and higher perinatal mortality [23], helminth infection [24] and risk of polio during an outbreak [25]. The exclusion of shared sanitation in the JMP definition is based primarily on evidence suggesting lower levels of use of these facilities versus individual household latrines, possibly due to poor maintenance of the shared facilities. When Montgomery and colleagues [26, 27] looked more closely at their data from a sanitation intervention (latrines) to prevent trachoma, they found no difference in rates of infection among those with shared sanitation provided they controlled for use. This is consistent with the hypothesis that Clasen and colleagues are pursuing with support from the Bill & Melinda Gates Foundation, 3ie and the SHARE Consortium in Orissa, India, that securing widespread use (and not only coverage) of latrines is the key driver in achieving health gains from sanitation [28].

Non-health outcomes and sanitation

Without access to sanitary facilities people are forced to defecate in fields, plastic bags, ditches and buckets. Besides the considerable public health risk associated with this, it is accompanied by loss of dignity and considered a source of insecurity, especially for women. In settings where people live in very close proximity to one another, such as in urban slums, having no safe, private sanitation facilities means going the whole day without relieving oneself and then risking exposure at night- a humiliating, stressful and uncomfortable daily routine that can damage health [3]. Recent research [29] in various urban slums in Delhi, India highlighted that women were fearful of sexual violence when using public toilets, when defecating in the open and in public spaces in general. In one area, community toilet blocks were not mentioned as dangerous in themselves but the routes to the toilet blocks were associated with sexual violence. It was reported that women and girls faced lewd remarks, physical gestures and rape when they relieved themselves in the bushes- as a result some women attempted to build toilets in their homes [29].

Though difficult to quantify, the pride, social status and comfort which comes with access to a clean and safe latrine has been reported by many new latrine users [3, 30]. In addition to enhancing dignity, privacy and safety- especially for women and girls-, improved sanitation benefits the economy- every dollar spent on sanitation generates economic benefits worth around nine more; sanitary disposal of human excreta also offers certain benefits for the environment [31].

AIMS AND OBJECTIVES

The JMP Taskforce for Water Supply and Sanitation met in 2010 to discuss the decision to consider shared and public sanitation facilities as “not improved”[6]. It was noted during this meeting that a strong evidence base is lacking. As a result, the JMP together with the LSHTM-based, DFID-funded SHARE Research Consortium (http://www.shareresearch.org) commissioned this review as part of an overall research plan aimed at strengthening of this evidence base. This protocol describes the methodology for a systematic literature review on the impact of shared sanitation. Both health and non-health outcomes will be explored. Analysis will focus on comparisons with individual household latrines, but studies related shared sanitation alone will also be considered.

The main objective of the review is to compare shared sanitation with individual household latrines. Outcomes of interest include (i) health impact (diarrhoea, helminth infections, enteric fevers, trachoma etc.), (ii) intermediate outcomes that are related to exposure to disease pathogens (drinking water quality, flies, presence of faeces), (iii) measure of sanitation uptake (latrine use, changes in open defecation, etc.), and iv) equity and other social impacts of sanitation. Analysis will focus on comparisons with individual household latrines, but we will also analyze studies that identify associations between shared sanitation and the outcomes of interest.

CRITERIA FOR CONSIDERING STUDIES FOR THIS REVIEW

Types of studies

Observational designs as well as intervention studies will be included in the review.

Types of participants

Infants, children and adults in low- and middle-income settings.

Types of exposure

All domestic excreta-disposal facilities that are shared by more than one household. This includes any type of sanitation facilities, whether on-site (e.g., pit latrines, toilets connected to septic systems) or reticulated (e.g., toilets connected to sewerage system) regardless of whether they meet the JMP definition of "improved" or "unimproved", though we will do sub-group analysis on such characterization. The sanitation facilities may be owned or maintained individually by one or more households or by a commercial or government entity. However, sanitation facilities designed primarily for use by householders when they are away from the home, such as schools, markets, train or bus stations, city streets or other public places, are excluded. We will include sanitation facilities that combine improvements in excreta disposal with other environmental interventions such as improvements in water quantity or access, water quality or hygiene practices, but will again conduct sub-group analysis on these facilities.

Types of outcome measures

Health outcomes

- Diarrhoeal diseases
- Enteric infection, regardless of microbial agent
- Nutritional status, mainly measured through anthropometry
- Helminthiasis
- Trachoma
- Dracunculiasis
- Enteric fevers such as typhoid
- Stress, psychological

Non-health outcomes

- Knowledge, attitudes and practices of exposed population
- Utilisation, adherence, compliance, uptake of facilities
- Condition, operation and maintenance of facilities
- Utilisation by gender
- (Sexual) violence
- Cost
- Social impact
- Equity

Intermediate outcomes related to exposure to disease pathogens

- Water access
- Water quantity
- Water quality
- Hand contamination
- Flies
- Hand washing behaviour
- Hygiene behaviour

SEARCH STRATEGY FOR IDENTIFICATION OF STUDIES

We will attempt to identify all relevant studies regardless of language or publication status (published, unpublished, in press and in progress), using the following search strategy (individual search terms can be found in table 1):

1. SANITATION/ or SEWAGE/ or WASTE DISPOSAL, FLUID/ or REFUSE DISPOSAL/ or TOILET FACILITIES/ or (SANITA* or (EXCRETA adj2 DISPOSAL) or TOILET* or LATRINE* or SEWERAGE or (SEWAGE adj2 DISPOSAL) or (WASTE adj2 DISPOSAL) or (FE*CES adj2 DISPOSAL)).ti,ab.

2. (SHARED or COMMU* or COMMON or PUBLIC or IMPROVE* or SLUM* or COLLECTIVE or SAFE).ti,ab.

3. DIARRHEA, INFANTILE/ or DIARRHEA/ or (DIARRH*EA or DIARRH*EAL DISEASE*).ti,ab. or CHOLERA/ or GASTROINTESTINAL DISEASES/ or INTESTINAL DISEASES,PARASITIC/ or TYPHOID FEVER/ or PARATYPHOID FEVER/ or NEGLECTED DISEASES/ or STRESS,PSYCHOLOGICAL/ or SEX OFFENSES/ or VIOLENCE/ or INFANT NUTRITION DISORDER/ or CHILD NUTRITION DISORDER/ or CHILD WELFARE/ or INFANT WELFARE/ or INFANT NUTRITION DISORDER/ or CHILD NUTRITION DISORDER/ or GENDER IDENTITY/ or COST ANALYSIS/ or SOCIAL CHANGE/ or HYGIENE/ or HEALTH PROMOTION/ or HANDWASHING/ or WATER QUALITY/ or (COST or UTILI*ATION or (OPERATION adj2 MAINTENANCE) or ADHERENCE or COMPLIANCE or MAINTENANCE or UPTAKE or EQUITY or (WATER adj2 QUANTITY) or (WATER adj2 ACCESS)).ti,ab.

4. 1 and 2

5. 3 and 4

Databases

The key terms for the search can be found in Table 1.

The following databases will be searched using OvidSP (Ovid Technologies 2012):

MEDLINE, EMBASE, CAB Abstracts, Global Health, HMIC, Social Policy & Practice

The following databases will be searched using Virtual Health Library:

DESASTRES, LEYES, LILACS, MedCarib, REPIDISCA

The remaining databases will be searched separately:

BASE, CEHA Database, Chicano Database, CINAHL Plus, ERIC, HISA, IBSS, Library Information Science & Technology Abstracts, TRIP Database, WPRIM, Web of Science, Africa-Wide Information

Grey literature, theses and survey datasets

Additionally, grey literature, theses and survey datasets will be searched using the following sources:

Dissertations & Theses, EThoS, Index to Theses of the British Isles, ELDIS, NBER Working Papers, New York Academy of Medicine Grey Literature Report, Open Grey, ReliefWeb, ESDS International, Cochrane Infectious Diseases group's trial register, Cochrane central register of controlled trials (CENTRAL) published in The Cochrane Library

Conference proceedings

Various conference proceedings will be searched for relevant abstracts, including, but not limited to WEDC (Loughborough University), IRC International Water and Sanitation Centre, World Bank, and German Agency for International Cooperation (GIZ).

Researchers, organisations and companies

Individual researchers working in the field will be contacted- these include the Water Sanitation and Health programme of the World Health Organisation; the World Bank Water and Sanitation programme; UNICEF Water Sanitation and Hygiene (WASH) programme; Environmental Health project (EHP) at USAID; IRC International Water and Sanitation centre; Foodborne and Diarrhoeal Disease Branch, Division of Bacterial and Mycotics Diseases, Centres for Disease Control and Prevention (CDC); UK Department for International Development (DFID); a variety of Non Governmental Organisation working in the field of sanitation including Plan International, WorldVision, WaterAid and Oxfam.

Reference lists

We will also check the reference lists of all studies identified by the above methods

METHODS OF THE REVIEW

Selection of studies

Marieke Heijnen (MH) and Oliver Cumming (OC) will independently review the titles and abstracts resulting from the search and select all studies that potentially fall within the inclusion criteria for the review. After obtaining full copies of all such studies, we will independently determine if the study meets such inclusion criteria. Where there is agreement, the studies will either be included or excluded. Where there is no agreement, Thomas Clasen (TC) will be consulted to make the final decision on eligibility for inclusion. Any studies that MH or OC proposed to include but which were ultimately determined by TC not to be included will be identified together with the reason for exclusion in the 'Characteristics of excluded studies'.

During the search, a list of excluded documents will be maintained with reasons for exclusion. In addition, careful documentation will be maintained on the data source, search strategy and date of search for the included documents.

Data extraction

Data from all relevant articles will be extracted by MH. The data extraction forms will be based on the data collection form from the Cochrane Effective Practice and Organisation of Care (EPOC) Group and Cochrane Public Health Group, modified for use in this review [32, 33]. Quality criteria questions for the different study designs will be built into this form. Data will be extracted, and included in the 'characteristics of included studies', on the following:

- Study design and sample size
- Method of participant selection
- Study duration
- Details of participants
- Study setting (country and urban/rural)
- Description of intervention or exposure (type of sanitary facility used and whether it is shared between households, communities, or a public facility; any promotional campaigns the population may have been exposed to)
- Water, sanitation, and hygiene characteristics (water source, water quality, sanitation facilities, hygiene practices)
- Definition and practices of control group

- Unit of randomization (and whether study adjusted for clustering if randomization is not individual)
- Unit of analysis
- Description of outcomes (including case definition of health outcomes, use and maintenance of the facilities, social impact and knowledge, attitudes and practices of the exposed population, microbiological data, observational data on hygienic conditions compared between the two options, or use frequency data- see table 1 for full list)
- Type of data available (microbiological data, observational data on hygienic conditions, frequency-of-use data)
- Intervention coverage (before and after implementation)
- Intervention uptake
- Information on intervention cost
- Publication status
- Quality control (see assessment of risk of bias below)

Multiple papers reporting results from one study will be treated as one study. We will develop data extraction forms based on the Cochrane Effective Practice

Assessment of methodological quality

MH and OC will independently assess the methodological quality of the studies. The risk of bias of the included studies will be assessed using the EPOC risk of bias tool for studies with a separate control group. This includes the standard Cochrane risk of bias tool items to assess file domains of bias: selection performance, attrition, detection and reporting, as well as additional items to assess the risk of selection bias.

The EPOC tool specifies the following criteria for studies with a separate control group:

- *Was the allocation sequence adequately generated?* (random=adequate, non-random inadequate)
- *Was the allocation adequately concealed?* (centralized randomization scheme, on-site computer system, sealed envelopes= adequate, controlled before/after studies=no)
- *Were baseline outcome measurements similar?* (balances or appropriately adjusted=yes, imbalanced and inadequately adjusted for=no)
- *Were baseline characteristics similar?* We will consider diarrheal morbidity, age, socioeconomic status, water quality, water sources, hygiene practices, and sanitation facilities
- *Were incomplete outcome data adequately addressed?* For example, examining loss-to-follow-up and missing data (adequate if LTFU if ≤15%)
- *Was knowledge of the allocated interventions adequately prevented during the study?* (blinding=yes, non-blinded=no)
- *Was the study adequately protected against contamination?* (unlikely that control group received intervention=yes, control group likely received intervention=no)
- *Was the study free from selective outcome reporting? (*all outcomes in methods are reported=yes, important outcomes omitted from results=no)
- *Was the study free from other risks of bias?* Specifically, we will examine whether the control and intervention groups were assessed at similar points in time.

There is a similar EPOC tool for interrupted time series studies if the same population is examined before/after an intervention.

Dependent on the type of observational studies which may be found, the STROBE statement criteria will be considered [34].

For purely qualitative studies, there is no single validated checklist to use for all types of qualitative studies [32]. The following criteria have been suggested for assessing quality common to all qualitative research:

- Method appropriate to research question
- An explicit l ink to theory
- Clearly stated aims and objectives
- A clear description of context
- A clear description of sample
- A clear description of fieldwork methods
- Some validation of data analysis
- Inclusion of sufficient data to support interpretation[32]

Assessment of reporting biases

If there are adequate number of studies (≥10), bias will be assessed using funnel plots plotting the effect size against the standard error of effect with a measure of heterogeneity (I^2 statistic). If study sizes are too small to calculate standard errors, we will try to plot the effect size against the cluster size.

Data analysis

The data from the included studies will be summarised and tabulated by MH and TC. We will report statistically significant and non-significant outcomes according to type of study design. In the case of insufficient data, a narrative synthesis will be conducted and in this situation we anticipate that studies will be grouped by either outcome type or intervention type. We will attempt to include a summary of findings table to provide information about the primary outcomes, effect sizes, process and implementation factors, cost of intervention and quality of the information.

Subgroup analysis and investigation of heterogeneity

Where sufficient data are available we will perform additional sub-group analyses to compare outcomes by the following characteristics

- Sanitation type (improved vs. unimproved, on-site vs. sewerage)
- Community location (urban, rural)
- Number of households using the facilities
- Level of latrine coverage
- Level of latrine maintenance
- Consistency of use
- Water quality
- Water quantity
- Water access
- Hygiene practices

We expect to find substantial diversity in the methodological approaches, as well as the exposures and outcomes. This includes (i) heterogeneity of exposure- people use different types of sanitary facilities, both in terms of design and the number of people using the facilities, (ii) heterogeneity of outcome- the different health outcomes specified have different etiologies and transmission routes; the non-health outcomes will vary considerably in terms of definitions used and units of measurement, and (iii) heterogeneity of setting – this relates both to the physical setting (rural, urban, peri-urban, formal, and informal) as well as the climate and season. In addition, the actual transmission of diseases depends on the infection intensity (populations with high worm-load but low transmission versus populations with low worm-load but high transmission). Lastly, the setting of the actual interventions of interest will be heterogeneous- water quality, availability and access, level of personal hygiene, knowledge and attitudes in the community.

All of these issues will be considered and the evidence base will determine the prospects for the type of (statistical or non-statistical) aggregation.

Table 1- Key search terms

Interventions/Exposure	**Outcomes**
Sanita*	Diarrhea, Infantile/
Excreta Disposal	Diarrhea/
Fe*ces disposal	Diarrh*ea
Toilet*	Diarrh*eal disease
Latrine*	Cholera/
TOILET FACILITIES/	Infant welfare/
SANITATION/	Child welfare/
WASTE DISPOSAL,FLUID/	Hygiene/
Waste disposal	Health promotion/
SEWAGE/	Handwashing/
Sewerage	Infant nutrition disorder/
Sewage disposal	Child nutrition disorder/
REFUSE DISPOSAL/	Water quantity
Shared	Water access
Commu*	Equity
Common	Uptake
Public	Adherence
Improve*	Compliance
Slum*	Maintenance
Collective	Cost
Safe	Cost analysis/
	Operation and maintenance
	Utili*ation
	Stress, Psychological/
	Gender identity/
	VIOLENCE/
	SEX OFFENSES/
	Social change/
*indicates truncation /indicates MESH term	

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Table S1 has been included in the main thesis as Table 2

Table S2. Search strategy as performed in OVID databases

1. SANITATION/ or SEWAGE/ or WASTE DISPOSAL, FLUID/ or REFUSE DISPOSAL/ or TOILET FACILITIES/ or (SANITA* or (EXCRETA adj2 DISPOSAL) or TOILET* or LATRINE* or SEWERAGE or (SEWAGE adj2 DISPOSAL) or (WASTE adj2 DISPOSAL) or (FE*CES adj2 DISPOSAL)).ti,ab.

2. (SHARED or COMMU* or COMMON or PUBLIC or IMPROVE* or SLUM* or COLLECTIVE or SAFE).ti,ab.

3. DIARRHEA, INFANTILE/ or DIARRHEA/ or (DIARRH*EA or DIARRH*EAL DISEASE*).ti,ab. or CHOLERA/ or GASTROINTESTINAL DISEASES/ or INTESTINAL DISEASES,PARASITIC/ or TYPHOID FEVER/ or PARATYPHOID FEVER/ or NEGLECTED DISEASES/ or STRESS,PSYCHOLOGICAL/ or SEX OFFENSES/ or VIOLENCE/ or INFANT NUTRITION DISORDER/ or CHILD NUTRITION DISORDER/ or CHILD WELFARE/ or INFANT WELFARE/ or INFANT NUTRITION DISORDER/ or CHILD NUTRITION DISORDER/ or GENDER IDENTITY/ or COST ANALYSIS/ or SOCIAL CHANGE/ or HYGIENE/ or HEALTH PROMOTION/ or HANDWASHING/ or WATER QUALITY/ or (COST or UTILI*ATION or (OPERATION adj2 MAINTENANCE) or ADHERENCE or COMPLIANCE or MAINTENANCE or UPTAKE or EQUITY or (WATER adj2 QUANTITY) or (WATER adj2 ACCESS)).ti,ab.

4. 1 and 2

5. 3 and 4

6. Limit 5 to human

PRISMA 2009 Checklist

Section/topic	#	Checklist item	Reported on page #
TITLE			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	Title page
ABSTRACT			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	Abstract
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known.	Introduction
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	Introduction
METHODS			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.	Methods
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	Methods
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	Methods
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	Supplementary Materials
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	Methods
Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	Methods
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	Methods

Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	Methods
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	Table 2
Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I^2) for each meta-analysis.	Figure 2

Section/topic	#	Checklist item	Reported on page #
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).	Methods
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	Methods
RESULTS			
Study selection	17	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.	Figure 1
Study characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.	Table 2
Risk of bias within studies	19	Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12).	Supplementary materials
Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot.	Table 2
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	Figure 2
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	Results
Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).	Results
DISCUSSION			

Summary of evidence	24	Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers).	Discussion
Limitations	25	Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias).	Discussion
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	Discussion
FUNDING			
Funding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review.	Funding

From: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Med 6(6): e1000097. doi:10.1371/journal.pmed1000097

Table S3. Methodological quality

STROBE STATEMENT CRITERIA			Authors																			
		Description	**Brooks**	**Chakraborty**	**Chandiwana**	**Curtale**	**Ghosh**	**Golding**	**Hall**	**Khan**	**Kim-Farley**	**Mahfouz**	**Montgomery**	**Munoz**	**Olusanya**	**Phiri**	**Shultz**	**Sobel**	**Tsikuka**	**Tuttle**	**Moshabela**	**Karkey**	**Mahamud**
1	Title and Abstract	**a)** Indicate the study's design with a commonly used term in the title or abstract **b)** provide in the abstract, an informative and balanced summary of what was done and what was found	+	+	+	+		+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
2	Background/ rationale	Explain the scientific background and rationale for the investigation being reported	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
3	Objectives	State specific objectives, including any pre-specified hypotheses				+						+	+	+	+	+			+				+
4	Study Design	Present key elements of study design early in the paper			+	+	+	+	+	+			+	+	+	+	+	+		+	+	+	+
5	Setting	Describe the setting, location and relevant dates, including periods of recruitment, exposure, follow up and data collection	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
6	Participants	**a)** *cohort studies*- give the eligibility criteria and the sources and methods of selection of participants. Describe methods of follow up. *Case control studies*- give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls. *Cross sectional studies*- Give the eligibility criteria, and the sources and methods of selection of participants. **b)** *Cohort study*- For matched studies, give matching criteria and number of exposed and unexposed. *Case-control studies*- for matched studies, give matching criteria and the number of controls per case	+			+	+	+			+	+	+	+	+	+	+	+	+	+	+	+	+	+
7	Variables	Clearly define all outcomes, exposures, predictors, potential confounders and effect modifiers. Give diagnostic criteria, if applicable	+	+	+	+		+	+	+	+	+		+	+	+	+	+	+	+	+	+	+

8	Data sources/ measurement	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	+	+	+	+		+	+	+	+	+			+	+	+	+	+	+	+	+	+
9	Bias	Describe any efforts to address potential sources of bias											+		+		+	+					
10	Study Size	Explain how the study size was derived									+			+		+			+				
11	Quantitative variables	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen, and why	+					+							+	+	+	+	+	+	+	+	+
12	Statistical Methods	**a)** Describe all statistical methods, including those used to control for confounding **b)** Describe any methods used to examine subgroups and interactions **c)** Explain how missing data were addressed **d)** Cohort study- if applicable, explain how loss to follow up was addressed. Case control study, if applicable, explain how matching cases and controls was addressed. Cross-sectional - if applicable, describe analytical methods taking account of sampling strategy **e)** describe any sensitivity analysis	+		+	+		+	+		+	+	+	+	+	+	+	+	+	+	+	+	+
13	Participants	**a)** Report the nr of individuals at each stage of the study- e.g., numbers of potentially eligible, examined for eligibility, confirmed eligible, included in the study, completed follow-up and analyzed **b)** give reasons for nonparticipation at each state **c)** consider use of a flow diagram	+																		+		
14	Descriptive data	**a)** Give characteristics of study participants (e.g. demographic, clinical, social) and information on exposures and potential confounders **b)** Indicate the nr of participants with missing data for each variable of interest **c)** Cohort studies- summarize follow-up time (ie. average and total amount)	+		+		+	+	+	+	+			+	+	+	+	+	+	+	+	+	
15	Outcome data	*Cohort studies*- report nrs of outcome events or summary measures over time, *case-control study*- report nrs in each exposure category, or summary measures of exposure, *cross-sectional study*- report nrs of outcome events or summary measures	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+

16	Main results	**a)** give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (ie. 95% ci.) Make clear which confounders were adjusted for, and why they were included **b)** Report category boundaries when continuous variables were categorised **c)** if relevant, consider translating estimates of relative risk into absolute risk for meaningful time period	+					+				+	+	+	+	+	+	+	+	+	+	+	+
17	Other analyses	Report other analyses done, ie. Analysis of subgroups and interactions, sensitivity analysis																						
18	Key results	Summarize key results with reference to study objectives	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
19	Limitations	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	+						+					+	+	+	+	+		+	+	+	+	+
20	Interpretation	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies and other relevant evidence	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
21	Generalizability	Discuss the generalizability (external validity) of the study results									+			+	+						+	+		
22	Funding	Give the source of funding and the role of the funders of the present study and, if applicable, for the original study on which the present article is based.							+			+	+	+		+			+			+		

Note: The study by Baker at al. has not been assessed for methodological quality, as the data included in the review comes from a conference abstract and the full study is not yet available at the time of writing.

Table S4. Extracted data

PUBLISHED LITERATURE									
Reference	**Country (location)**	**Year**	**Design**	**Population**	**Sampling/Analysis**	**Outcome of interest**	**Measure**	**Study quality**	**Notes**
Brooks	Kenya - Rural	2003	Case-control study	Patients presenting at clinic with bloody diarhoea	Multivariate logistic regression 2 controls for each case, matched on age and sex	Incidence of bloody diarrhoea	Multivariate analysis showed that 'allowing other families to use the compound latrine' increased the risk of sporadic bloody diarrhoea. [Matched OR 2·76 (95% CI 1·26–6·06)] Specifically for dysentery, the exposure: 'Allowed other families to use their latrine' occurred in 34/94 (36%) cases and 32/145 (22%) controls. This provided a Matched OR of 2·40 (CI 1·19- 4·84), p= 0·01	16/22 [STROBE] Due to difficulties locating controls, few were recruited within the same timeframe as cases	
Chakraboty	India - urban	1983	Comparative cross sectional	200 children (<5 years)	100 children randomly selected from slum, 100 children from multi-story building	Incidence of diarrhea	Average nr of episodes of diarrhea per child during 10 month observation period was 1·6 in slum, and 1·4 in buildings. No statistical methods were performed.	9/22 [STROBE] No mention of what random selection method used	Inadequate information to calculate confidence intervals
Chandiwana	Zimbabwe-rural	1989	Cross sectional study	1635 farm workers and their families from 15 large scale agricultural communities	Stool sample analysis performed. Spearman correlations were calculated to investigate relationships between parasitological measurements and the nr of households per latrine in each community	Prevalence and intensity of infection of hookworm and round worm	There were no significant correlations between nr of households per latrine and hookworm prevalence (r=0·7168, t test p<0·1) and with hookworm geometric mean egg count (r=0·7783, t test p<0·1). Similarly, there was no significant correlation between the nr of households per latrine and the roundworm prevalence (r=-0.009, t test p<0.1)	11/22 [STROBE] Only 36 latrines in the study area- no clear information on how these 36 were distributed among the 15 communities	No data on whether the nr of households per latrine were counted or calculated as an average
Curtale	Egypt- urban	1998	Comparative cross sectional	408 male subjects, aged 8-19, chosen randomly from people aged below 20 and	Differences calculated using a one-way ANOVA, after log (n+1) transformation of the data. Bivariate analyses were	Prevalence and intensity of infection of intestinal helminths	Sharing latrine with other families and the absence of piped water inside the house were associated with a significantly higher intensity of infection for *A. lumbricoides* (p<0·001) and for *T.trichiura* (p<0·05) but not *for S.mansoni*	12/22 [STROBE]	Results not separated for sharing a latrine and the absence of piped water

				working in a private workshop or commercial activities in the Alexandria governate	conducted for the 3 most prevalent parasites to detect significant associations between intensity of infection and exposures				inside the house. Efforts have been made to contact the author
Ghosh	India- Urban	1994	Case control study	980 rural families with children less than 3 years old living near Calcutta	Descriptive statistics	Diarrhoeal disease	At the end of one year, 570 (58·2%) of 980 families had diarrhoea cases and 410 (42·8%) families had no study children with diarrhoea. In n=38 or 36·2% (out of n=105 diarrhoeal families) shared a latrine, whereas n=7 or 15·9% (out of n=49) non-diarrhoeal families shared latrines. This is stat sig at p=0·008 (CI not presented in study)	9/22 [STROBE] No information on how control families were selected	Additional calculation done: SD 0·07 95% CI: 0·08-0·32
Golding	Jamaica - Urban	1994	Comparative cross sectional	9919 mothers delivering a singleton in a specified 2 month period and 1847 mothers who delivered a singleton perinatal death in a contiguous 12 month period	Chi-squared tests Logistic regression	Perinatal death Antepartum fetal death	Increased risk of perinatal death among women who had to share toilet facilities. This was associated especially with antepartum fetal deaths (p<0·001) If the toilet was used by people other than family: Logistic regression analysis Adjusted OR for predict antepartum fetal death 1·62 [95% CI 1·28,2·03] Adjusted OR to predict perinatal death using social and environmental factors: 1·41 [95% CI 1·21-1·64]	14/22 [STROBE]	
Hall	Bangladesh-Urban	1994	Comparative cross sectional	Stool samples from 880 residents of an urban slum in Dhaka were collected on 3 occasions over 1 year	Questionnaire Stool samples No information on how respondents were selected for questionnaire or stool sample	*Strongyloides stercoralis* infection	Proportion of individuals infected with *S. stercoralis* (at any of the 6-monthly examinations) Site of children's defaecation No.infect. OR CI Own latrine 18/217 (8·3%) - Shared latrine 7/157 (4·5%) 0·52(0·22-1·24) Community lat 35/194 (18·0%) 2·43(1·35-4·38) Indiscriminate 41/294 (14·7%) 1.79(1·01-3·17) Site of respondents defecation No.infect. OR CI	13/22 [STROBE]	

							Own lat 17/234 (7.3%) - Shared lat 18/233(7.7%) 1.07(0.55-2.08) Comm lat 59/336(17.6%) 2.72 (1.57-4.72) Indiscrim. 8/71 (11·3%) 1·62 (0·68-3·88)		
Khan	Bangladesh-urban	1987	Comparative cross sectional	Inhabitants of two similar per-urban slums of Dhaka	No mention of random selection of study sites Besides latrine provision, the two study sites were comparable	Diarrhoea incidence and intestinal parasite prevalence (*T. trichiura, E. hystolitica, G. lamblia, S.stercoralis*)	The Kalsi area was provided with 5 communal latrines In the Tongi area, 78% of the people used communal latrines, 6% used pit latrines and 16% had no definite latrine. In the Kalsi area, 69% used open pit latrines and 31% had no definite latrine. The rate of diarrhoea, from all causes, did not differ between the Tongi and Kalsi areas	10/22 [STROBE]	
Kim-Farley	Taiwan- rural	1984	Case –control study	Cases reporting through routine reporting channels or through active surveillance system	Study sites chosen because they represented contiguous rural areas with very different attack rates. Log linear modelling and logistic regression analysis	Poliomyelitis	Univariate analysis of differences between case and non-case families in Yun Lin county. Toilets shared by families, cases had an OR of 4·0 (1·9-8·3) compared to controls. (p value 0·0002) [n=32 cases, n=210 controls] Univariate analysis of differences between non-case families in Yun Lin and non-case families in Chia Yi counties. 24·3% of families (n=210) in Yun Lin shared latrines vs 15% in Chai Yi (n=200) OR 1·6 (1·0-2·7) [p=0·0453]	13/22 [STROBE] No multivariate data presented	Assuming latrines shared by families was compared to latrines shared by more than just family
Mahfouz	Egypt – urban	1997	Cross sectional study	Questionnaire from 1324 families Stool samples from 658 preschool children below 5 years of age	Questionnaire Stool samples Study site was chosen randomly, though method not described Multivariate analysis Maximum likelihood estimates of combined OR and their 95%CI	Intestinal parasites	Exposure ‘Sharing toilets with other family‘ Multivariate, adjusted Odds ratios HELMINTHS 1·95(1·38-2·75) PROTOZOA 1·65(1·06-2·58) (both at p=0·1)	13/22 [STROBE]	

					adjusted for confounders				
Montgomery	Tanzania-rural	2010	Case control study	Sub-study population (part of a larger case control) Children aged 1-5 years. All households in substudy with sentinel child with clinical signs of active trachoma. Control households were randomly selected from the area.	Questionnaire, blinded to reduce interviewer bias Logistic regression modelling using generalised estimating equation techniques 630 households were identified, 593 surveys were completed (92 cases 501 controls) for a response rate of 94%	Trachoma Sanitation sharing practices of households that used latrines	Latrine sharing is practiced by 48·6% of cases and 47·0% of controls. Of all latrine sharing households, the largest proportion shares a facility with just one neighboring household (20·0% cases, 23·7% controls). The maximum number of households sharing a latrine was 9. Sharing among 5 or more households is rare (15 instances) and therefore, these were grouped in the category of "four or more households sharing a latrine." Results indicate that shared latrines provide as much protection compared with private latrines in regard to risk of trachoma. Adjusted OR= 0·95 (0·55-1·67) The number of households sharing a latrine does not significantly alter the association	13/22 [STROBE]	
Munoz	Australia-rural	1992	Historical cohort	Hospital admissions for 1961 children from 10 rural aboriginal communities in the Northern Territory	Generalised linear interactive modelling software was used to calculate the nr of admissions per child-year at risk (admission rate) for each community	Hospital admissions	In the factor analysis, communal toilets was of significant (p<0·01) importance. Authors note that these significance levels may be biased, but they indicate the relative importance of each variable for each factor. Most houses had inside toilets, but some had access only to communal toilets. (ranging from 0-60%) Although many community characteristics were strongly associated with differences in admission rates between communities, interferences about the causal significance of individual variables cannot be made easily, because at least some of the association will be indirect and non-causal.	17/22 [STROBE]	
Olusanya	Nigeria - urban	2010	Historical cross-sectional	Women giving birth at an inner-city tertiary maternity hospital- all live births were eligible for enrolment	Cross tabulation Two-tailed chi square test Backward stepwise multivariable logistic regression	Preterm birth and low birth weight	Risk Factors for Low Birth weight: Living in a house with shared sanitation facilities (aOR, 1·27; 95% CI, 0·98–1·65) was retained in the model but had a weak association with low birth weight (P = 0·07). Risk factors for prematurity Living in a house with shared sanitation facilities Prematurity final model,adjusted	18/22 [STROBE]	

							aOR (95% CI) = 1·26 (1·07–1·48) PAR (%) =11·18 Low birth weight final model, aOR (95% CI) =1·27 (0·98–1·65) (p=0·07) PAR (%) =12·52		
Phiri	Malawi – urban and rural	2001	cross sectional study	Children aged 3-14 years old residing in either of the two areas of investigations: a rural community and a very densely populated township	Questionnaire and stool samples ANOVA Multiple logistic regression Maximum likelihood estimates obtained Clear and random sampling frame for areas of study described	Prevalence of Helminth infection (*A. lumbricodes*, *T. trichiura*, *S. stercolralis)*	73% of urban (n=195) shared a latrine, and 13% in rural (n=13) Some of the non-significant variables (did not meet the p<0·1 criteria for inclusion in the multivariate analysis model), were sex and age of the child, parental occupation, sharing a latrine, source and storage containers of drinking water and geophagy.	18/22 [STROBE]	Sharing a latrine was not found to be a statistically significant exposure, thus not included in model
Shultz	Kenya- camp setting	2009	Cases presenting at IRC camp hospital	Historical case control study	Standardised questionnaires administered to cases and controls Matched cases to controls by location of residence in the camp and age Randomised control finding strategy	Watery diarrhoea	UNIVARIATE N=90 for cases N=170 for controls Exposure: Fifteen or more people sharing the same latrine Cases: 31/52 (60%) Controls:54/112 (48%) MOR 1·5 (0·7, 3·3) P value: 0·33 Exposure: Three or more households sharing same latrine Cases: 34/51 (67%) controls: 57/111 (51%) MOR 1·9 (0·9, 4·4) P value 0·11 MULTIVARIATE MOR Exposure: Three or more households sharing same latrine: MOR 2·17 (1·01–4·68) was associated with an increased risk of watery diarrhoea	16/22 [STROBE]	Camp setting- all that different from very densely populated urban areas?
Sobel	Brazil- urban	2004	Case control study	Children aged 12-59 months with diarrhoea presenting at hospital	Aged-matched controls Questionnaire Multivariate logistic analysis	Acute diarrhoeal disease	Risk factor associated with diarrheal illness in matched pairs of children: sharing toilet with other household MOR 1·48 (1·07-2·04) p=0·02	16/22 [STROBE]	
Tshikuka	DRC- Urban	1995	Cross- sectional survey	42 households in each subdivision	Face-to-face interview	*Ascaris lumbricoides*	Multiple regression analysis results	16/22 [STROBE]	It is unclear whether the

					Stool sample from single index child randomly selected from each household Associations between infection and exposure variables were assessed by univariate and multivariate regression procedures for each subdivision independently MRA. Randomly selected subdivision	infection	Persons per toilet: Beta= 0·45, coefficient 0·07 (S.E. 0·02). This was significant at p<0·01 Families who regularly defecated in the open had a mean number of 27.0 (S.E. 1·9) person/toilet whereas those who did not had a 18·6 (S.E. 1·4) persons/toilet. According to the authors, persons per toilet can be interpreted either as an index of sanitation or as an index of crowding. Therefore if there are more persons/toilet, it is more likely that people will (continue to) defecate in the open		persons/toilet were counted or calculated as an average
Tuttle	Zambia- urban	1995	Case control study	Case patient presenting at clinic when interviewers were present	2 controls for each case matched by age and sex Multivariate analysis used conditional logistic regression. Questionnaire Stool sample	*Shigella dysenteriae type I*	64% of cases, versus 46% of controls shared latrines. OR=3·3 (1·1-10·2). p=0·3	15/22 [STROBE]	" It is possible that houses clustered together function in some ways as a single unit, with many forms of close contact occurring among household members"
Moshabela	South Africa- rural	2012	Case- control	Black African individuals reporting prevalent diarrhoea	Univariate and multivariate logisitic regression. 3 randomly selected controls from same HIV clinic	Diarrhoeal disease	Where data were available, 22/87 (25.3%) of cases and 69/291 controls (23.7%. p=0.763) reported sharing sanitation facilities with other households. An average of 2 households shared sanitation facilities in both cases (range 2-4) and controls (range 2-5).	19/22 [STROBE]	
Karkey	Nepal- Urban	2013	Matched case-control	All febrile patients attending the outpatient or emergency department of Patan Hospital, Kathmandu	Matched univariate analysis, conditional logistic regression. Matched multivariate analysis.	Enteric infection with either *S.* Typhi or *S.* Paratyphi A.	Cases using a household latrine versus those using a community latrine had an adjusted OR of 4.92 (1.2-19.5) for *S.* Parathyphi A. Cases using a household latrine versus those using a community latrine had an adjusted OR 7.26 (1.4-37.2) for *S.* Typhi.	17/22 [STROBE]	

							In total, 92.2% of cases used a household latrine, versus 77.9% of the controls.		
Mahamud	Kenya-refugee camp	2012	Matched case-control	Refugees and non-refugees presenting at Kakuma IRC with watery diarrhoea	Bivariate analysis using matched conditional logistic regression. Multivariate conditional logistic regression.	Watery diarrhoea/Cholera	Sharing a communal latrine with neighbouring household was associated with an increased risk of illness (OR, 3.33 (1.34-8.30, p=0.001). Among the cases, 41% used a communal latrine, versus 23.9% of the controls.	15/22 [STROBE]	

GREY LITERATURE

Author/ Institution	Year	Title	Country/ Type of document	Conclusions	Quality criteria	Reviewed Yes/not specified	Notes
Baker	2011	The risk of moderate and severe diarrhea in children less than 5 years old is increased among families who share a sanitation facility	Various Conference abstract	Outcome: diarrhoeal disease Families of case children more commonly used shared sanitation facilities than control families (47·5% vs. 41·2%, mOR = 1·2; 95% CI: 1·1–1·3), overall and in Pakistan (mOR=1·7; 1·4-2·0), Mali (mOR=1·2; 1·1-1·4), India (mOR=1·3; 1·0-1·6), and Kenya (mOR=1·2; 1·0-1·5). The odds of diarrhoea for shared sanitation were increased two-fold if feces was present (mOR=2·2; 1·6-3·2) than if was absent (mOR=1·2; 1·1-1·3) While access to unshared sanitation facilities was more common among higher-income households, shared sanitation facilities were consistently more common among case than among control households across all wealth index quintiles. Our observations indicate that shared sanitation facilities can increase the risk of diarrhea, regardless of the type of facility, and supports their classification as "unimproved". Increasing access to private sanitation facilities may reduce diarrhea incidence among young	Inadequate information for proper assessment of study	Abstract presented at ASTMH conference. Final data not yet published.	

				children			

Table S5. Excluded documents

Study	Reason for exclusion
Ademuwagun, 1976	No results reported on shared sanitation
Adewara, 2011	No results reported on shared sanitation
Adewara, 2011	No health outcomes on shared sanitation
Alemayehu, 2005	No results reported on shared sanitation
Amaka, 2003	No Health outcomes on shared sanitation
Amnesty International, 2010	Reports on shared sanitation, no health outcomes
Andereck, 2012	No health outcomes on shared sanitation
Anonymous, 2001	No results on shared sanitation
Aryal, 2012	No health outcomes on shared sanitation
Ashraf, 2011	No health outcomes in abstract presented at ASTMH 2011
Aubrey, 2009	No results reported on shared sanitation
Awasthi 2003	No results reported on shared sanitation
Ayee, 2003	No results reported on shared sanitation
Baker, 2012	No health outcomes on shared sanitation
Bannerjee, 1988	No results reported on shared sanitation
Bapat, 2003	No results reported on shared sanitation
Barnes, 2004	No results reported on shared sanitation
Bassett, 1992	No results reported on shared sanitation
Bateman, 1995	No results reported on shared sanitation
Bhardwaj,2013	No health outcomes for shared sanitation users
Bility, 2000	No results reported on shared sanitation
Bindeshwar, 2011	No results reported on shared sanitation
Biran, 2011	Very relevant information on communal sanitation, no health outcomes
Briscoe, 1992	No results reported on shared sanitation
Butala, 2010	No results reported on shared sanitation
Cameron, 2010	No results reported on shared sanitation
Candidate nr 100559, 2011	No health outcomes reported
Candidate nr 100788, 2011	No health outcomes reported
Candidate nr 491174, 2010	No results reported on shared sanitation
Caplan, 2010	No results reported on shared sanitation
Carden, 2007	No results reported on shared sanitation
Chaggu, 2004	No results reported on shared sanitation
Chimbari,1992	No results reported on shared sanitation
Chitkara, 1986	No results reported on shared sanitation
Chowdhury, 2010	Medical description of a cholera case
Clemens, 1987	No results reported on shared sanitation
Colin, 2007	No results reported on shared sanitation
Colombatti, 2009	No results reported on shared sanitation
Cotton, 1995	No results reported on shared sanitation
Coulson, 2001	No results reported on shared sanitation
Cuesta, 2007	Descriptive info on shared sanitation, but no results presented
Cumberland, 2005	No results reported on shared sanitation
De, 1957	No results reported on shared sanitation
Devadas, 2002	No results reported on shared sanitation
Devereux, 1994	No results reported on shared sanitation
Duncker, 2000	No results reported on shared sanitation
Dunstan, 1998	Sanitation report, no results on shared sanitation
Eales, 2008	No results reported on shared sanitation
Ekanem, 1994	No results reported on shared sanitation

Elhag, 2013	No health outcomes on shared sanitation
Feachem, 1977	Book. No results reported on shared sanitation
Feachem, 1983	No results reported on shared sanitation
Ferreira, 2000	Parasitological survey, shared sanitation not assessed
Fobil, 2010	No direct health outcomes. Focuses on environmental contamination
Garbossa, 2013	No health outcomes on shared sanitation
Gichuri, 1999	No results reported on shared sanitation
Govender, 2010	No results reported on shared sanitation
Gracey, 1997	No results reported on shared sanitation
Grimason, 2000	No health outcomes
Gubler, 1989	No results reported on shared sanitation
Gupta, 1996	Descriptive study of cholera cases
Hare, 1938	Unobtainable- contacted publisher
Hare,1940	Unobtainable- contacted publisher
Heeb, 2003	No results reported on shared sanitation
Heng, 2012	Review on sanitation, no specific information on shared sanitation
Hobson, 2000	Discusses the design of a communal sanitation project. No results
Home Office, 2008	Report of public sanitation in the UK
Hoque, 1994	No results reported on shared sanitation
Hunt, 2001	No results reported on shared sanitation
Hutton,2011	Review on sanitation, economic assessment
Illing, 2009	No results reported on shared sanitation
Jha, 2003	Mentions Sulabh latrines. No data collected on shared sanitation
JMP, 2010	No Health outcomes on shared sanitation
JMP, 2012	No Health outcomes on shared sanitation
JMP, 2013	No Health outcomes on shared sanitation
Jones, 2005	No results reported on shared sanitation
Jones, 2008	No results reported on shared sanitation
Joshi, 2011	No results on shared sanitation
Joshi, 2012	No health outcomes on shared sanitation
Kamundi, 2008	No results reported on shared sanitation
Karanja, 2000	Unobtainable
Karim, 2003	Unobtainable
Kavita, 2013	No health outcomes on shared sanitation
Kuria, 2003	No results reported on shared sanitation
Kuria, 2005	No results reported on shared sanitation
Kwagala, 1999	Provides some public opinion on shared sanitation, but no results
Lagardien, 2005	No results reported on shared sanitation
Lal, 1996	No results on shared sanitation
Lunch, 1983	No results reported on shared sanitation
Mahon, 2010	No results reported on shared sanitation
Mara, 2005	No results reported on shared sanitation
Matthys, 2011	No health outcomes for shared sanitation users
Mayumbelo, 2008	No results reported on shared sanitation
Mazeau, 2010	No specific results reported on shared sanitation
Mbere, 1980	No results reported on shared sanitation
McCann, 2001	No results reported on shared sanitation
McCommon, 1998	No results reported on shared sanitation
McElligott, 2013	No health outcomes on shared sanitation
Molotch, 2010	Book discusses public latrines from a sociological point of

	view
Moseti, 2009	No results reported on shared sanitation
Mukherjee, 2012	Reports on shared sanitation, no health outcomes
Mukhopadhyay,2008	No results reported on shared sanitation
Mushtaq, 2008	No results associated with shared sanitation
Naidoo, 2007	No results reported on shared sanitation
Naranjo, 2010	No results reported on shared sanitation
Ndugwa, 2008	No results reported on shared sanitation
Neelin, 2011	No health outcomes on shared sanitation
Ngugi, 1992	Discusses public latrines, not shared sanitation used from a home
Ngui, 2011	No health outcomes on shared sanitation
NgyuenViet Anh, 2012	Guiding policy document on sanitation, economic assessment
Nhapi, 2005	No results reported on shared sanitation
Nock, 2002	Shared sanitation in public institutions, not domestic setting
Obika, 2003	No results reported on shared sanitation
Oduro-Kwarteng, 2009	Reports on shared sanitation, no health outcomes
Okiro, 2007	No results reported on shared sanitation
Omishakin, 1986	Discusses public opinion on shared sanitation, but no data is provided
Opisa, 2012	No health outcomes on shared sanitation
Pardeshi, 2009	No results reported on shared sanitation
Parett, 1983	No results reported on shared sanitation
Patel, 2013	No health outcomes on shared sanitation
Pickford, 1990	Opinion piece, no data collected on shared sanitation
Politzer, 2012	No results reported on shared sanitation
Poti, 1963	Unobtainable-contacted publisher
Pratt, 1991	No results reported on shared sanitation
Putrali, 1980	Pilot study. No results associated with shared sanitation
Rashid, 2009	Policy piece. No results associated with shared sanitation
Reuter, 2003	No results reported on shared sanitation
Rheingans, 2006	No results reported on shared sanitation
Roderiguez, 2011	Review on sanitation, policy document
Roma, 2010	No results reported on shared sanitation
Root, 2001	No results reported on shared sanitation
Rosensweig, 1996	No results reported on shared sanitation
Saha, 2012	No health outcomes on shared sanitation
Saywell, 1996	No results reported on shared sanitation
Scott, 1999	No results reported on shared sanitation
Seager, 1994	No results reported on shared sanitation
Sharma, 2011	No health outcomes on shared sanitation
Shobha, 2013	No health outcomes on shared sanitation
Sikwibele, 1996	Descriptive info, opinions on shared sanitation, no results reported
Silva, 2011	No health outcomes on shared sanitation
Simpson-Hebert,1998	Review on sanitation, not specifically shared sanitation
Siu, 2008	Discusses public sanitation for visually impaired in developed countries
Sobrinho, 1995	Shared sanitation in public institutions, not in domestic setting
Sridhar, 1999	No results reported on shared sanitation
Stanton, 1985	Descriptive info on shared sanitation, but no results
Strudwick, 1962	No results reported on shared sanitation
Sulabh International, 2012	No health outcomes

Sur, 2007	No results reported on shared sanitation
Swami, 2004	No results reported on shared sanitation
Tettey-Lowor, 2009	No results reported on shared sanitation
Thapa Magar, 2011	No health outcomes on shared sanitation
Thomas, 1999	No results reported on shared sanitation
Tiimub, 2009	Information collected on shared sanitation, but no results provided
Tumwebaze, 2013	No health outcomes on shared sanitation
Udayani, 1999	No results reported on shared sanitation
Van Ryneveld, 2003	No results reported on shared sanitation
Van Wijk, 1997	No results reported on shared sanitation
Von Munch, 2005	Information collected on shared sanitation, but no results provided
Water Research Commission, 1993	Sanitation report, no specific results on shared sanitation
WaterAid, 2007	Sanitation report, no specific results on shared sanitation
WaterAid, 2008	Sanitation report, no specific results on shared sanitation
WaterAid, 2011	Sanitation report, no specific results on shared sanitation
WaterAida, 2008	Sanitation report, no specific results on shared sanitation
WEDC, 1986	Sanitation conference proceedings, no results on shared sanitation
Wegelin-Schuringa, 1997	Review on sanitation, not specifically shared sanitation
Westaway, 1998	Sanitation report, no specific results on shared sanitation
Whittington, 1993	No results reported on shared sanitation
Worrell, 2012	No health outcomes in abstract presented at ASTMH 2011
WRC, 1998	Sanitation report, no specific results on shared sanitation
WRC, 1998	No Health outcomes on shared sanitation
WSP, 2001	Guiding policy document on sanitation, economic assessment
WSP, 2006	Guiding policy document on sanitation, economic assessment
WSP, 2010	Guiding policy document on sanitation, economic assessment
WSP, 2011	Guiding policy document on sanitation, economic assessment
WSP, 2012	Guiding policy document on sanitation, economic assessment
WSPa, 2010	Guiding policy document on sanitation, economic assessment
WSPb, 2010	Guiding policy document on sanitation, economic assessment
WSPc, 2010	Guiding policy document on sanitation, economic assessment
WSUP, 2010	Sanitation report, no specific results on shared sanitation
WSUP, 2011	Sanitation report, no specific results on shared sanitation

APPENDIX 2

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Shared Sanitation and the Prevalence of Diarrhea in Young Children: Evidence from 51 Countries, 2001–2011

James A. Fuller,* Thomas Clasen, Marieke Heijnen, and Joseph N. S. Eisenberg

Department of Epidemiology, University of Michigan School of Public Health, Ann Arbor, Michigan; Department of Disease Control, London School of Hygiene and Tropical Medicine, London, United Kingdom

* Address correspondence to James A. Fuller, Department of Epidemiology, University of Michigan School of Public Health, 1415 Washington Heights, Ann Arbor, MI 48103. E-mail: jafuller@umich.edu

Abstract.

Background-shared sanitation is defined as unimproved because of concerns that it creates unsanitary conditions; this policy is being reconsidered. We assessed whether sharing a toilet facility was associated with an increased prevalence of diarrhea among children < 5 years of age. We use data from demographic and health surveys conducted in 51 countries. Crude and adjusted prevalence ratios (PRs) for diarrhea, comparing children from households that used a shared facility with children from households that used a non-shared facility, were estimated for each country and pooled across countries. Unadjusted PRs varied across countries, ranging from 2.15 to 0.65. The pooled PR was 1.09; differences in socioeconomic status explained approximately half of this increased prevalence (adjusted PR = 1.05). Shared sanitation appears to be a risk factor for diarrhea although differences in socioeconomic status are important. The heterogeneity across countries, however, suggests that the social and economic context is an important factor.

INTRODUCTION

Diarrheal disease is a major cause of morbidity and mortality, particularly in low- and middle-income countries.[1] Inadequate sanitation, water, and hygiene are the most significant risk factors for diarrheal disease and are responsible for an estimated 1.9 million deaths worldwide.[2] Since the adoption of the Millennium Development Goals (MDGs), access to improved sanitation has increased around the globe. However, approximately 37% of the world's population (2.5 billion persons) still lacks access to improved sanitation.[3] This finding includes an estimated 761 million persons who rely on public or other shared sanitation facilities.

To track changes in water and sanitation, including progress towards international targets such as the MDGs, The World Health Organization and the United Nations Children's Fund created the Joint Monitoring Program (JMP) for Water Supply and Sanitation. Apart from monitoring, the JMP was tasked with creating a uniform definition of improved and unimproved sanitation to be used across countries. The JMP definition of improved sanitation currently includes flush or pour-flush toilets, pit latrines with a slab, ventilated improved pit latrines, and composting toilets, and unimproved sanitation includes open defecation, pit latrines without a slab, buckets, hanging toilets or latrines, or a flush/pour flush toilet that flushes to an unsanitary destination.[3] Because of concerns about cleanliness and accessibility, facilities that are shared by two or more households are classified as unimproved, regardless of the level of technology used.[3]

Recently, the JMP's Task Force on Sanitation proposed a change in this policy that would allow sanitation facilities to be considered as improved, and therefore scored toward the MDG and other international sanitation targets, provided they meet the other criteria and are shared by

no more than 5 households or 30 persons, whichever is fewer.[4] In 2010, an estimated 11% of the world's population used a shared facility that would otherwise be considered improved, and that percentage is increasing.[3] There is relatively little evidence, however, on whether and at what circumstances sharing sanitation facilities actually poses a health risk to those that use them. Also, public latrines are considered by some to be the only viable option in many urban slums.[3,5–7]

Because of this trend towards shared sanitation, more empirical data are needed to determine whether such facilities increase the risk of disease, and if so, to quantify that risk, identify the causal pathway and explore ways of mitigating it. A recent systematic review has reported that shared sanitation may be a risk factor for diarrhea and other adverse health outcomes when compared with individual household latrines.[8] The review identified eight studies (two cross-sectional and six case-control); shared sanitation was the focus in only two of these studies,[9,10] and the others simply reported statistical associations with little to no mention of potential mechanisms. Although these studies report an association between shared sanitation and diarrhea, the review noted substantial deficiencies in the quality of methods used in most studies, including the failure to account for some potential sources of confounding, unclear comparisons, and failure to distinguish between different types of sanitation technology and ownership.

The objective of our study was to determine whether the prevalence of diarrhea is higher among those that share a toilet facility compared with those that use a facility that is not shared. We used data from 51 low- and middle-income countries that represent much of the developing world. We also define shared sanitation three ways. Finally, we rigorously assessed the extent to which confounding plays a role in the association between sharing and diarrhea.

METHODS

We use data from the Demographic and Health Surveys (DHSs) (measuredhs.com) completed during 2001–2011. Surveys completed before 2001 were excluded. As a result, our findings will better reflect current circumstances and be more able to inform an ongoing policy debate. To achieve a representative sample at the subnational level, these cross-sectional surveys use a two-stage stratified random sample of households. Countries are divided into enumeration areas (clusters), and then households are randomly selected within each cluster with different probability of selection within different clusters. The surveys ask a variety of questions about demographics, reproductive health, and child health. For countries that had multiple surveys in this period, we use only the most recent one to prevent overrepresentation of single countries. We selected the 51 recent surveys from low- and middle-income countries that included data on disease outcome, exposure, and potential confounders (Table 1).

For any children less than five years of age in the household, the caretaker reported whether said child had diarrhea in the past two weeks. Each caretaker also reported the type of toilet facility that the household uses. For each survey, we classified each potential response as being improved or unimproved based on the definitions provided by the JMP but ignoring sharing.[3] Responses considered to be improved were then further classified based on whether the facility used flush technology, yielding three categories: unimproved facility, improved latrine, and improved flush or pour-flush toilet. Caretakers then reported whether their facility was shared by other households. We used this information to create three measures of sharing. First, a binary definition of sharing was used, where a toilet facility was classified as shared if more than one household used it. Those with no facility were excluded. We then accounted for the number of

households that share the facility, creating three exposure categories: 1) facilities that are not shared, 2) facilities shared by five or fewer households, and 3) facilities shared by more than five households. Again, those with no facility were excluded. The data describing the number of households sharing, however, was only available in 40 of the 51 surveys (Table 1). Finally, we use the sanitation ladder of the JMP, which was composed of four categories: 1) no facility, 2) unimproved facility, 3) shared but otherwise improved facility, and 4) improved facility that is not shared. Log-binomial regression, accounting for complex sampling strategy, was used to generate the unadjusted (crude) and adjusted prevalence ratios (PRs) and 95% confidence intervals (CIs) for diarrhea. The prevalence ratios represent the relative difference in diarrhea prevalence comparing children from households with a shared facility compared with children from households with a facility that is not shared.

Households that use a shared sanitation facility are likely different in many respects than households that have their own facility. To account for these differences, we made a list of potential confounding variables to include in the analysis. Characteristics of the household assessed were type of sanitation facility (unimproved, improved latrine, improved flush or pour-flush toilet; improved being defined by JMP, but ignoring sharing), improved water source (as defined by JMP), household ownership of assets (electricity, radio, television, refrigerator, bicycle, motorcycle/scooter, car/truck, improved cooking fuel, and improved floor surface), urban/rural residence, the mother's age, the mother's educational attainment, the highest level of education in the household, and number of children less than five 5 years of age in the household. Characteristics of the child assessed were age, sex, vaccination status, and whether the child had a health card. The DHS includes many more variables, but we selected this group because each captures a different aspect of socioeconomic status. We chose this list of confounders *a priori* and analyzed each of them individually and in groups to assess their impact on the prevalence ratio(s) for shared sanitation and diarrhea. For the sake of parsimony, we only included variables that made a substantial impact on the PR in our final model, namely the type of sanitation facility (unimproved facility, improved latrine, or improved flush toilet), mother's age and education, the highest level of education in the household, and household ownership of assets.

We conducted country-specific and pooled analyses. In the pooled analyses, surveys were combined by the World Health Organization–defined regions of the world (Africa, Latin America and the Caribbean, Southeast Asia, Western Pacific, Eastern Mediterranean, and Europe), and dummy variables for each survey were included. Because of geographic proximity and the small number of countries in the Western Pacific region, Southeast Asia and Western Pacific were combined as a single region. Because they contained relatively fewer countries, the Eastern Mediterranean and Europe regions were also combined. This change resulted in four distinct regions. We analyzed the data stratified by region to detect any regional patterns or differences. We also conducted an overall pooled analysis by using data from all 51 surveys along with survey fixed effects. All data management and analysis was conducted using STATA 11.2 (StataCorp LP, College Station, TX).

RESULTS

There were 435,205 children less than five years of age included in the analysis (Table 1). Of these children, 30.9% were from households with no sanitation facility. Of children from households with a facility, 45.1% were from households with a facility that was improved

(ignoring sharing), and 29.9% were from households that used a shared facility. The amount of sharing varied substantially across countries. The lowest level of sharing was in Armenia (1.4% of those with a facility) and the highest was in Ghana (87.3%). When all 51 surveys were combined, the overall prevalence of diarrhea was 14.3%. Diarrhea prevalence varied substantially across countries from 4.5% in Maldives to 26.2% in Bolivia.

In most countries, the prevalence of diarrhea was higher among households that used a shared toilet facility (Figure 1). This effect of sharing, however, varied across countries. The point estimates of the unadjusted PRs ranged from 0.65 (Nigeria) to 2.15 (Moldova), although only 16 of the 51 unadjusted PRs were significantly different from 1. After adjusting for confounders, many of the point estimates moved towards the null, but some did not. The adjusted PRs ranged from 0.80 (Armenia) to 2.04 (Moldova). There was an apparent clustering of countries in West Africa that showed protective effects, particularly Nigeria, Cameroon, Mali, Senegal, and Liberia. To highlight this geographic pattern, we present the Africa and global estimates with and without West Africa in Table 2.

We observed 9% higher prevalence among households that used a shared toilet facility (Crude PR =1.09, 95% CI = 1.06–1.12) when pooling the data across all 51 counties (Table 2). In absolute terms, this finding represents a prevalence difference of 1.2 (95% CI = 0.8–1.6) percentage points. Adjusting for confounding attenuated the effect (adjusted PR = 1.05, 95% CI = 1.02–1.08). This relationship was consistent across three of the four regions. Only the Latin America and Caribbean region differed, where adjusting for confounding eliminated the effect. In the Eastern Mediterranean and Europe region, we observed the largest harmful effect (adjusted PR =1.20, 95% CI = 1.06–1.36). The level of attenuation after adjustment for confounding differed slightly by region. The estimates did not appear to differ when stratified by urban and rural areas.

As mentioned above, there was substantial heterogeneity among countries within each region (Figure 1). This heterogeneity is best illustrated in Africa (Figure 1 and Table 3). The pooled prevalence ratio for a number of countries within Africa are either protective (Nigeria, Cameroon, Mali, Senegal, and Liberia: adjusted PR = 0.86, 95% CI = 0.80–0.93) or exhibit no effect (Sao Tome and Principe, Namibia, Congo, Burkina Faso, and Burundi). In the remaining subsets of countries in Africa, those that use a shared toilet had a 10–32% higher prevalence of diarrhea than those that do not use a shared toilet (Table 3). The countries in Africa that showed a protective effect are all located in West Africa. The patterns within other regions of the world appear similar. In Europe, there was a large degree of heterogeneity between and within countries, possibly attributable to small sample size.

The second way in which we examined the impact of sharing on prevalence was by stratifying exposure by those that share with five or fewer households and those that share with more than five households. These data were available for only 40 of the 51 surveys (Table 1). Except for Africa, the regional estimates were not statistically significant after adjustment for confounders (Table 4). Each sharing category had an increased prevalence compared with the not shared reference group, but the prevalence of diarrhea was not statistically different when we compared a facility that is shared by fewer than five households with a facility that is shared with by five or more households. Only in Southeast Asia, Western Pacific, Eastern Mediterranean, and Europe did there appear to be a dose-response relationship. In other regions, the prevalence of diarrhea did not differ based on the number of households sharing. Therefore, the stratified

data provide little evidence for a dose response relationship and no support for a threshold of households for which sharing does not present an increased risk of diarrhea.

The sanitation ladder of JMP is another useful way to examine the impact of sharing on prevalence. By using this classification, we found that households that share sanitation facilities that are otherwise improved can be compared with those that use improved facilities that are not shared. When all 51 surveys are pooled, sharing appeared to be harmful even when the facility was improved (Table 5). The prevalence of diarrhea was 10% lower among households that used a non-shared improved facility compared with facilities that were shared but otherwise improved (crude PR = 0.90, 95% CI = 0.87–0.93). Adjusting for confounding modestly attenuated that effect (adjusted PR = 0.95, 95% CI = 0.91–0.99). The strongest effect observed was the in Eastern Mediterranean and Europe (adjusted PR = 0.83, 95% CI = 0.72–0.94) and Africa when West Africa was excluded (adjusted PR = 0.81, 95% CI = 0.75–0.87). In Latin America and the Caribbean and Southeast Asia and Western Pacific the adjusted effect was not significant.

The results are less consistent when we compared sharing (otherwise improved) with no facility or unimproved facility (shared or not shared) (Table 5). Whereas the Eastern Mediterranean and Europe showed a protective effect for no facility and unimproved facility (adjusted PR = 0.81, 95% CI = 0.69–0.94 and adjusted PR = 0.75, 95% CI = 0.63–0.89, respectively), the other regions either did not have significant results (Southeast Asia and Western Pacific), was protective in one category (Africa), or was harmful in one category (Latin America and the Caribbean).

DISCUSSION

Our global pooled analysis shows that there was an increased prevalence of diarrhea associated with shared sanitation. This finding is consistent with those of the few studies that have been conducted,[9–16] although the effect we observed was more modest and attenuated after adjusting for confounding. However, we also report a high level of between-country heterogeneity, which limits the ability to make inferences from our pooled estimates or from the pooled estimates from previous studies.

One strength of our study was the ability to look at differences across a wide array of countries. In most countries, sharing appears to be harmful. However, in Nigeria and Cameroon, sharing appears to be protective, and in many other countries there was no difference in diarrhea prevalence attributable to sharing. These findings are consistent with the recent systematic review that found that sharing latrines was associated with increased risk (although not always significant) of diarrhea in 10 countries but protective in 1 country (Bangladesh).[8] Other research has shown substantial differences among countries in the effectiveness of water, sanitation, and hygiene interventions to prevent disease.[17] Such variability between countries, and possibly within countries, makes a single, uniform, global policy particularly difficult. Future research is needed to elucidate circumstances under which sharing is more harmful.

Confounding appears to play an important role in the relationship between shared sanitation and diarrheal disease. Country-specific and pooled prevalence ratios were substantially attenuated when socioeconomic indicators were included in the models. Because households that share are generally of a lower socioeconomic status than those that do not share, they are at increased risk of diarrhea because of poverty in general, not necessarily because of sharing.[18] These lower-income households are more likely to have inadequate hygiene practices and consume contaminated food. The type of toilet facility (unimproved latrine, improved latrine, or

flush toilet) also explained some of the observed association between shared sanitation and diarrhea but was less important than the socioeconomic variables. In this dataset, shared facilities were less likely to be improved than non-shared facilities, and less likely to use flush technology if improved. The results shown in Table 5, which directly account for type of facility, show similar levels of increased prevalence associated with sharing. Although confounding explains some of observed difference it does not explain all of the differences. Furthermore, the importance of confounding varied across regions, greater in Southeast Asia and Western Pacific, as well as in the Americas than in Africa, the Eastern Mediterranean, and Europe.

In many countries, the adverse effect of sharing was strong even after adjusting for confounding. For example, in Madagascar the prevalence of diarrhea was 44% higher (95% CI = 12–86%) among those with shared facilities than among those with facilities that were not shared, after controlling for socioeconomic variables. In such settings, shared toilets may contribute to the transmission of diarrheal disease. Further research is necessary to substantiate these findings, evaluating whether and to what extent shared sanitation actually increases the risk of disease. Stronger study designs using incidence of diarrhea will enable more robust causal inference in this regard. It is also important to identify the mechanism of transmission and how this can be mitigated. Transmission could be occurring because shared facilities, particularly those that are communally owned, may be more difficult to clean and maintain. Often, some type of institution is required to keep the public facility in good operating condition.[5–7,19–21] When such institutions are insufficient or lacking, the quality of the facility is affected. Also, shared facilities of all types may be overused and increase the amount of epidemiologic contact between users. Other than cleanliness, persons may periodically choose to practice open defecation, or some other less hygienic means of excrement disposal, when shared facilities are deemed unsafe or inconvenient because of distance or long lines. Shared latrines may also fill up more rapidly and require more frequent emptying, which raises additional concerns about unsafe sludge management, creating another source of exposure.

In some countries, sharing appears to be protective, a seemingly counterintuitive result. The protective effect was particularly strong in Nigeria, where the prevalence ratio was substantially protective even after adjusting for confounding. Cameroon also initially showed a protective effect, but it was substantially attenuated after adjusting for confounders. Other countries, namely Mali, Senegal, and Liberia, showed a modest protective effect. Interestingly, these countries are clustered in West Africa, and countries in sub-Saharan Africa generally show benign to harmful effects. Further research is necessary to confirm the validity of this protective effect and, if so, the reasons therefor.

The nature of shared sanitation is often different between rural and urban areas.[3] Sharing in rural areas is often characterized by sharing with a few neighbors or relatives. In urban areas, particularly in urban slums, many of the shared facilities may be public and used by a large number of households. Unfortunately, the DHS data do not allow enough geographic resolution to differentiate between urban slums and other urban areas, which may explain why we did not detect a difference in the effect of shared sanitation between urban and rural areas.

Our study design has other limitations. It is well documented that using a two-week recall period understates disease status, resulting in bias. Some studies[22–24] have suggested that a two-day or three-day recall period will minimize this bias, but Arnold and others[25] reported that one week is optimal when accounting for bias and variance. Although the two-week recall period used in the DHS is not ideal, any bias in our results should be towards the null, as long as disease

misclassification is unrelated to exposure. Second, like any cross-sectional study, causal inference is limited. Reverse causation seems unlikely in this situation, but we cannot rule out residual confounding. However, the DHS collect many potential confounding variables that we were able to use in these analyses. In particular, we were able to examine how much of the potential increase in harmful effect measured in the analysis was caused by confounding by socioeconomic status and how much was likely caused by an actual increase risk when sharing sanitation. Additional information on handwashing, hygiene practices, and food contamination would enhance these analyses. Also, diarrheal diseases are often seasonal. Cross-sectional studies are unable to detect seasonal trends. Even so, for season to be a confounder, it would need to be associated with exposure (sharing) and not just outcome. In addition, the DHS relies on self-reporting of shared sanitation. A compound may be made up of several households of the same family sharing the same facility. In such situations, sharing (and the number of households sharing) may be underreported.

These results provide additional evidence that shared sanitation is generally a risk factor for diarrhea among children. As a result, our results provide support for the existing policy of the JMP to treat shared sanitation as unimproved. However, our results also provide no evidence of a minimum threshold of households that can share a latrine without increasing the risk. Thus, our findings provide no support for the proposed change in the JMP policy that would encourage sharing of latrines by treating latrines shared among five or fewer households as improved.

At the same time, there are settings in which the relationship is neutral, and in a few it appears to be protective. This heterogeneity among countries suggests that the specific social and economic context matters. Because the number of shared latrines is large and likely to increase, particularly in urban settings, it is important to ascertain under what circumstances sharing can be undertaken safely. Also, because the overall increase in prevalence is modest, shared sanitation could potentially be a low cost intervention. Although shared facilities are clearly not optimal, for the same cost, higher coverage rates could be achieved with shared sanitation compared with private facilities. The higher coverage rates achieved could offset any losses to effectiveness.

One clear conclusion from this analysis is that confounding likely plays an important role in the association between sharing and diarrhea. Adjusting for socioeconomic status attenuates the estimated harmful effect of sharing, suggesting that alternative transmission pathways accounts for some of the differences. However, adjusting for socioeconomic status does not account for all of the differences observed, suggesting that shared sanitation may contribute to the transmission of diarrheal diseases caused by issues of cleanliness and maintenance, overuse, or caused by users occasionally opting for less hygienic means of excreta disposal. Future research should attempt to identify the circumstances that make sharing harmful or protective, better understand confounding and its role, and seek to elucidate the mechanism through which sharing could increase the risk of diarrhea. This information will be crucial to help inform policy decisions.

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Authors' addresses: James A. Fuller and Joseph N. S. Eisenberg, Department of Epidemiology, University of Michigan School of Public Health, Ann Arbor, MI, E-mails: jafuller@umich.edu and jnse@umich.edu. Thomas

Clasen and Marieke Heijnen, Department of Disease Control, London School of Hygiene and Tropical Medicine, London, United Kingdom, E-mails: thomas.clasen@lshtm.ac.uk and marieke.heijnen@lshtm.ac.uk.

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*outlegends*f1*FIGURE 1. Crude and adjusted prevalence ratios for diarrhea comparing those with shared toilet facilities with those with non-shared facilities. Presented for each Demographic and Health Survey (n = 51) conducted during 2001–2011. **A**, Crude prevalence ratios and 95% confidence intervals. **B**, Adjusted prevalence ratios and 95% confidence intervals. This figure appears in color at www.ajtmh.org.

TABLE 1

Summary statistics of all children < 5 years of age by country

Country (year)	Sample size	Prevalence of diarrhea (%)	No toilet facility (%)	Improved toilet facility (%)*	Shared toilet facility (%)†	Shared with > 5 households (%)‡
All countries	435,205	14.3	30.9	45.1	29.9	22.2

Africa	220,000	15.4	32.1	31.5	41.8	24.2
Benin (2006)	14,270	9.2	68.6	18.1	69.5	56.1
Burkina Faso (2010)	13,487	14.9	68.1	25.1	51.0	14.0
Burundi (2011)	7,147	25.2	3.0	40.0	15.9	9.0
Cameroon (2011)	9,932	21.8	8.4	53.9	29.4	18.9
Republic of Congo (2005)	4,047	14.1	11.9	17.1	60.6	–
Democratic Republic of Congo (2007)	7,678	16.5	11.6	37.2	55.3	–
Ethiopia (2003)	10,441	13.6	43.1	12.6	27.7	19.0
Ghana (2008)	2,733	20.1	27.6	60.5	87.3	80.8
Guinea (2005)	5,316	16.4	30.1	25.4	60.8	–
Kenya (2009)	5,533	16.8	18.1	39.9	49.4	29.0
Lesotho (2010)	3,322	11.4	41.8	31.7	36.2	34.2
Liberia (2007)	4,930	20.8	59.8	23.5	76.0	64.3
Madagascar (2009)	11,444	8.4	49.9	3.9	63.8	15.2
Malawi (2010)	17,966	17.6	11.1	11.8	42.8	7.0
Mali (2006)	12,070	13.6	19.8	20.4	45.0	3.2
Namibia (2007)	4,238	13.4	58.1	37.8	25.2	36.5
Niger (2006)	7,922	21.3	80.5	8.8	39.3	41.9
Nigeria (2008)	24,733	10.4	30.7	51.8	40.2	41.8
Rwanda (2011)	8,330	13.1	1.3	72.9	19.7	5.4
Sao Tome and Principe (2009)	1,807	15.9	62.1	37.7	20.3	34.4
Senegal (2011)	11,060	21.1	19.1	55.8	24.3	8.6
Sierra Leone (2008)	4,783	13.6	23.9	39.7	77.6	35.1
Swaziland (2007)	2,325	14.3	22.0	28.7	33.6	30.5
Tanzania (2010)	6,995	14.9	18.9	14.8	30.6	13.5
Uganda (2011)	7,015	24.1	11.1	29.8	39.7	23.3
Zambia (2007)	5,582	15.8	27.4	30.8	40.1	9.9
Zimbabwe (2011)	4,894	13.6	32.2	57.1	47.5	17.8
Latin America and the Caribbean	75,910	16.1	18.0	66.1	17.9	8.5
Bolivia (2008)	8,135	26.2	32.5	37.9	33.7	10.3
Colombia (2010)	17,220	12.7	8.4	85.1	13.3	–
Dominican Republic (2007)	10,285	14.8	5.8	90.2	18.0	–
Guyana (2009)	2,027	10.1	1.4	87.8	13.6	3.6
Haiti (2006)	5,358	24.4	41.1	24.7	49.7	12.8
Honduras (2006)	10,198	16.0	21.9	58.5	15.2	2.0
Nicaragua (2001)	6,536	13.0	22.2	27.9	8.6	–
Peru (2008)	16,151	13.8	17.9	78.9	13.7	7.7
Southeast Asia	85,276	10.7	46.5	43.2	25.1	22.0
Bangladesh (2007)	5,201	10.1	8.6	37.6	45.1	11.2
India (2006)	45,144	8.9	62.3	34.3	32.5	25.2
Indonesia (2007)	17,292	13.8	25.1	56.0	14.1	45.0
Maldives (2009)	3,678	4.5	0.7	96.9	2.1	22.6
Nepal (2011)	4,754	13.9	48.8	43.6	30.9	6.9
Timor-Leste (2010)	9,207	15.6	37.5	50.5	16.9	4.5
Western Pacific	13,837	12.4	40.3	56.2	24.5	7.5
Cambodia (2011)	7,670	15.0	61.6	36.1	19.7	7.5
Philippines (2008)	6,167	9.1	12.9	82.0	27.3	–
Eastern Mediterranean	33,605	14.4	11.7	83.6	7.0	1.6
Egypt (2008)	9,992	8.4	0.4	99.5	5.7	1.6

Jordan (2007)	9,791	15.9	0.0	99.5	3.1	–
Morocco (2004)	5,746	11.9	20.8	78.6	7.9	–
Pakistan (2007)	8,076	21.6	32.6	49.3	15.5	–
Europe	6,577	8.2	0.0	84.2	6.3	20.4
Albania (2009)	1,562	5.4	0.0	93.8	2.2	0.0
Armenia (2010)	1,433	8.7	0.0	77.9	1.4	9.2
Azerbaijan (2006)	2,116	10.7	0.1	80.7	10.0	24.6
Moldova (2005)	1,466	7.1	0.0	85.3	9.6	–

* Based on the Joint Monitoring Program categorization, but ignoring sharing.

† Among households that have a sanitation facility.

‡ Among households with a shared sanitation facility. – = data not collected.

TABLE 2

Effect of shared sanitation pooled across countries*

Region and subset of countries	Crude PR (95% CI)	Adjusted† PR (95% CI)
Africa	1.07 (1.03–1.10)	1.05 (1.01–1.09)
West Africa‡	0.89 (0.84–0.94)	0.91 (0.86–0.97)
Excluding West Africa‡	1.19 (1.14–1.25)	1.15 (1.11–1.21)
Latin America and the Caribbean	1.11 (1.04–1.19)	1.03 (0.97–1.10)
Southeast Asia and Western Pacific	1.16 (1.06–1.26)	1.09 (1.01–1.19)
Eastern Mediterranean and Europe	1.26 (1.11–1.42)	1.20 (1.06–1.36)
All regions combined	1.09 (1.06–1.12)	1.05 (1.02–1.08)
Excluding West Africa‡	1.17 (1.14–1.21)	1.11 (1.08–1.15)

* Shown are prevalence ratios (PRs) and 95% confidence intervals (CIs) for diarrhea for comparisons of households with shared toilet facilities with households with facilities that are not shared. Data were obtained from 51 Demographic and Health Surveys during 2001–2011.

† Adjusted for type of facility (flush toilet, improved latrine, unimproved latrine) mother's age, mother's educational attainment, highest level of education in the households, and asset ownership.

‡ West Africa is defined as Benin, Burkina Faso, Cameroon, Ghana, Guinea, Mali, Nigeria, Senegal, and Sierra Leone.

TABLE 3

Heterogeneity of the effect of sharing within Africa*

Countries	Crude PR (95% CI)	Adjusted† PR (95% CI)
Nigeria, Cameroon, Mali, Senegal, Liberia	0.82 (0.76–0.88)	0.86 (0.80–0.93)

Sao Tome and Principe, Namibia, Congo, Burkina Faso, Burundi	1.05 (0.96–1.15)	1.00 (0.92–1.10)
Benin, Malawi, Niger, Zambia, Sierra Leone	1.15 (1.07–1.23)	1.10 (1.03–1.18)
Swaziland, Kenya, Uganda, Democratic Republic of Congo, Guinea	1.23 (1.12–1.34)	1.19 (1.09–1.30)
Ethiopia, Lesotho, Tanzania, Zimbabwe, Rwanda, Ghana, Madagascar	1.35 (1.25–1.45)	1.32 (1.22–1.42)

* Countries are grouped based on quintiles of the crude prevalence ratio (PR). Shown are PRs and 95% confidence intervals (CIs) for diarrhea for comparisons of households with shared toilet facilities with households with facilities that are not shared.

† Adjusted for type of facility (flush toilet, improved latrine, unimproved latrine) mother's age, mother's educational attainment, highest level of education in the household, and asset ownership.

TABLE 4

Number of households sharing a toilet facility and prevalence ratios for diarrhea among children < 5 years of age*

Region	Sharing category†	Crude PR (95% CI)	Adjusted‡ PR (95% CI)
Africa	With ≤ 5 households	1.06 (1.02–1.10)	1.04 (1.00–1.08)
	With > 5 households	1.01 (0.95–1.08)	1.02 (0.95–1.09)
West Africa§	With ≤ 5 households	0.88 (0.82–0.94)	0.89 (0.83–0.95)
	With > 5 households	0.81 (0.73–0.90)	0.87 (0.79–0.96)
Excluding West Africa§	With ≤ 5 households	1.20 (1.15–1.25)	1.15 (1.10–1.20)
	With > 5 households	1.20 (1.10–1.31)	1.17 (1.08–1.28)
Latin America and the Caribbean	With ≤ 5 households	1.09 (1.00–1.18)	1.04 (0.95–1.13)
	With > 5 households	1.10 (0.88–1.38)	1.01 (0.81–1.26)
Southeast Asia and Western Pacific	With ≤ 5 households	1.13 (1.03–1.25)	1.08 (0.98–1.18)
	With > 5 households	1.27 (1.05–1.55)	1.21 (0.99–1.46)
Eastern Mediterranean and Europe	With ≤ 5 households	1.25 (0.93–1.67)	1.15 (0.85–1.54)
	With > 5 households	1.48 (0.67–3.29)	1.36 (0.63–2.94)
All regions combined	With ≤ 5 households	1.08 (1.04–1.11)	1.04 (1.00–1.07)
	With > 5 households	1.05 (0.99–1.12)	1.03 (0.97–1.09)
Excluding West Africa§	With ≤ 5 households	1.16 (1.12–1.21)	1.10 (1.07–1.15)
	With > 5 households	1.20 (1.12–1.30)	1.14 (1.06–1.23)

* Data were obtained from 40 Demographic and Health Surveys during 2001–2011. PR = prevalence ratio; CI = confidence interval.

† Reference category is those that use a not shared facility.

‡ Adjusted for type of facility (flush toilet, improved latrine, unimproved latrine) mother's age, mother's education, highest level of education in the household, and ownership of assets.

§ West Africa is defined as Benin, Burkina Faso, Cameroon, Ghana, Guinea, Mali, Nigeria, Senegal, and Sierra Leone.

TABLE 5

Sanitation ladder and diarrhea*

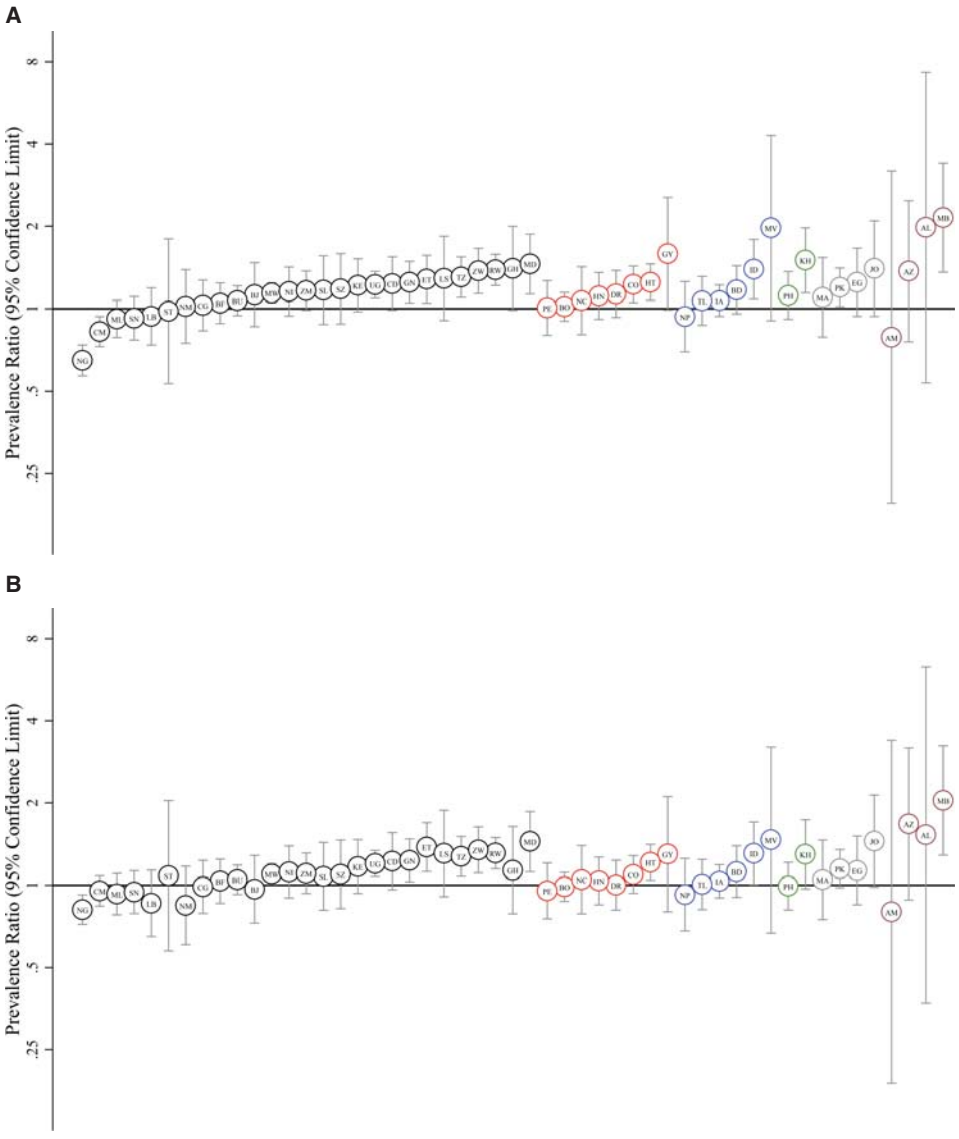
Region	Sanitation ladder category	Crude PR (95% CI)	Adjusted† PR (95% CI)
Africa	No facility	1.06 (1.01–1.11)	0.95 (0.90–1.00)
	Unimproved facility (shared or not shared)	1.03 (0.98–1.08)	0.96 (0.92–1.01)
	Shared facility (otherwise improved)	1.00 (Ref.)	1.00 (Ref.)
	Improved facility (not shared)	0.93 (0.88–0.98)	0.95 (0.90–1.00)
West Africa‡	No facility	1.14 (1.07–1.23)	0.98 (0.91–1.05)
	Unimproved facility (shared or not shared)	1.18 (1.10–1.27)	1.05 (0.98–1.13)
	Shared facility (otherwise improved)	1.00 (Ref.)	1.00 (Ref.)
	Improved facility (not shared)	1.11 (1.03–1.20)	1.10 (1.02–1.19)
Excluding West Africa‡	No facility	0.97 (0.91–1.04)	0.91 (0.84–0.98)
	Unimproved facility (shared or not shared)	0.91 (0.85–0.97)	0.88 (0.82–0.93)
	Shared facility (otherwise improved)	1.00 (Ref.)	1.00 (Ref.)
	Improved facility (not shared)	0.78 (0.72–0.83)	0.81 (0.75–0.87)
Latin America and the Caribbean	No facility	1.24 (1.14–1.35)	1.12 (1.03–1.22)
	Unimproved facility (shared or not shared)	1.13 (1.03–1.24)	1.09 (0.99–1.19)
	Shared facility (otherwise improved)	1.00 (Ref.)	1.00 (Ref.)
	Improved facility (not shared)	0.88 (0.81–0.95)	0.96 (0.89-1.04)
Southeast Asia and Western Pacific	No facility	1.07 (0.98–1.17)	1.04 (0.94–1.14)
	Unimproved facility (shared or not shared)	1.02 (0.90–1.14)	0.99 (0.88–1.12)
	Shared facility (otherwise improved)	1.00 (Ref.)	1.00 (Ref.)
	Improved facility (not shared)	0.90 (0.82–0.98)	0.95 (0.87–1.04)
Eastern Mediterranean and Europe	No facility	0.85 (0.73–0.98)	0.81 (0.69–0.94)
	Unimproved facility (shared or not shared)	0.75 (0.63–0.89)	0.75 (0.63–0.89)
	Shared facility (otherwise improved)	1.00 (Ref.)	1.00 (Ref.)
	Improved facility (not shared)	0.78 (0.69–0.90)	0.83 (0.72–0.94)
All regions combined	No facility	1.08 (1.04–1.12)	0.99 (0.95–1.02)
	Unimproved facility (shared or not shared)	1.03 (0.99–1.07)	0.98 (0.94–1.02)
	Shared facility (otherwise improved)	1.00 (Ref.)	1.00 (Ref.)
	Improved facility (not shared)	0.90 (0.87–0.93)	0.95 (0.91–0.99)
Excluding West Africa‡	No facility	1.04 (1.00–1.09)	0.98 (0.94–1.03)
	Unimproved facility (shared or not shared)	0.97 (0.92–1.01)	0.94 (0.90–0.98)
	Shared facility (otherwise improved)	1.00 (Ref.)	1.00 (Ref.)
	Improved facility (not shared)	0.83 (0.80–0.87)	0.89 (0.85–0.93)

* Prevalence ratios (PRs) and 95% confidence intervals (CIs) for diarrhea by level of the Joint Monitoring Program Sanitation Ladder. Data were obtained from 51 Demographic and Health Surveys during 2001–2011. Ref. = referent.

† Adjusted for mother's age, mother's educational attainment, highest level of education in the households, and asset ownership.

‡ West Africa is defined as Benin, Burkina Faso, Cameroon, Ghana, Guinea, Mali, Nigeria, Senegal, and Sierra Leone.

Figure 1


A
Prevalence Ratio (95% Confidence Limit)
.25
.5
1
2
4
8
B
Prevalence Ratio (95% Confidence Limit)
.25
.5
1
2
4
8

APPENDIX 3: PCA VARIABLES

Country survey	**Variables included in construction of wealth tertile.** Three categories are included: assets owned by the household, the type of floor in the house and the type of fuel used for cooking.
Afghanistan	Assets: Car, watch, fridge, phone, TV ,electricity, Floor: ceramic tiles Fuel: gas, kerosene
Albania	Assets: electricity, TV, phone, fridge, watch, bicycle, car Floor: ceramic tiles, cement Fuel: electricity, LPG, wood
Armenia	Assets: phone, fridge, car Floor: planks, parquet Fuel: electricity, LPG, gas
Azerbaijan	Assets: radio, phone, fridge, watch, car Floor: planks, parquet Fuel: gas, wood
Bangladesh	Assets: radio, phone, fridge, watch, car, TV, electricity Floor: planks, parquet Fuel: gas, wood
Belarus	Assets: phone, fridge, car, microwave, DVD player, TV Floor: linoleum Fuel: LPG, gas
Belize	Assets: car, watch, fridge, phone, TV, electricity Floor: ceramic floors Fuel: kerosene, gas
Benin	Assets: electricity, radio, TV, phone, fridge, watch, bicycle, motor cycle, car Floor: earth, planks, bamboo, ceramic tiles, cement Fuel: gas, kerosene, charcoal, wood
Bhutan	Assets: phone, fridge, car, bicycle, motor cycle, watch, TV, electricity Floor: linoleum Fuel: LPG, gas
Boliva	Assets: phone, fridge, watch, car Floor: planks, parquet Fuel: electricity, LPG, gas
Bosnia	Assets: phone, fridge, car , computer, DVD player, TV Floor: linoleum Fuel: LPG, gas
Burkina Faso	Assets: phone, fridge, watch, car, electricity, radio, TV, motor cycle Floor: parquet Fuel: LPG, gas
Burundi	Assets: phone, fridge, watch, car, electricity, radio, TV, motor cycle Floor: parquet Fuel: LPG, gas
Cambodia	Assets: car, motor cycle, bicycle, watch, fridge, phone, TV, radio, electricity Floor: ceramic tiles, cement Fuel: LPG, charcoal
Cameroon	Assets: phone, fridge, watch, car, electricity, radio, TV, motor cycle Floor: parquet

	Fuel: LPG, gas
Central African Republic	Assets: car, watch, fridge, phone, TV, electricity Floor: ceramic tiles Fuel: gas, kerosene
Colombia	Assets: car, bicycle, fridge, phone, TV, electricity Floor: cement, ceramic tiles, planks Fuel: LPG
Congo, Republic of	Assets: car, bicycle, fridge, phone, TV, electricity Floor: planks, ceramic tiles, cement Fuel: LPG
Cuba	No asset data available in survey
Djibouti	Assets: car, watch, fridge, phone, TV, electricity Floor: ceramic tiles Fuel: kerosene
Dominican Republic	Assets: car, bicycle, fridge, phone, TV, electricity Floor: planks, ceramic tiles, cement Fuel: LPG
Democratic Republic of the Congo	Assets: phone, fridge, car, bed, TV, watch, motor, cycle, bicycle Floor: linoleum Fuel: LPG, gas
Egypt	Assets: car, watch, fridge, phone, TV, electricity Floor: vinyl, ceramic tiles Fuel: gas, kerosene
Ethiopia	Assets: car, watch, fridge, phone, TV, electricity Floor: ceramic tiles, vinyl Fuel: gas, kerosene
Gabon	Assets: car, watch, fridge, phone, TV, electricity Floor: ceramic tiles, vinyl Fuel: gas, kerosene
Gambia	Assets: car, watch, fridge, phone, TV, electricity Floor: ceramic tiles Fuel: kerosene
Georgia	Assets: car, watch, fridge, phone, TV, electricity Floor: ceramic tiles Fuel: kerosene
Ghana	Assets: phone, fridge, car, computer, watch, bicycle, motor cycle TV Floor: linoleum Fuel: LPG, gas
Guinea	Assets: car, fridge, phone, TV, electricity Floor: vinyl, ceramic tiles Fuel: gas, kerosene
Guinea Bissau	Assets: car, watch, fridge, phone, TV, electricity Floor: ceramic tiles Fuel: kerosene
Guyana	Assets: car, watch, fridge, phone, TV Floor: vinyl, ceramic floors Fuel: kerosene, gas
Haiti	Assets: car, watch, fridge, phone, TV, electricity Floor: vinyl, ceramic tiles Fuel: gas, kerosene
Honduras	Assets: car, watch, fridge, phone, TV, electricity Floor: ceramic tiles, vinyl

	Fuel: gas, kerosene
India	Assets: watch, fridge, phone, TV Floor: vinyl, ceramic tiles Fuel: gas, kerosene
Iraq	Assets: phone, fridge, car, watch, bicycle, TV, generator Floor:- Fuel: LPG, gas
Ivory Coast	Assets: car, watch, fridge, phone, TV, electricity Floor: ceramic tiles Fuel: kerosene
Jordan	Assets: car, fridge, phone, TV, electricity Floor:- Fuel: gas, LPG
Kazakhstan	Assets: phone, fridge, car, TV, bicycle, computer, microwave Floor: linoleum Fuel: gas
Kenya	Assets: car, watch, fridge, phone, TV, electricity Floor: ceramic tiles, vinyl Fuel: gas, kerosene
Kyrgyzstan	Assets: car, fridge, phone, TV Floor: carpet, planks Fuel: LPG, kerosene
Lao PDR	Assets: phone, fridge, car, TV, bicycle, computer, motor cycle Floor: linoleum Fuel: gas
Lesotho	Assets: car, watch, fridge, phone, TV, electricity Floor: vinyl, ceramic tiles Fuel: gas, kerosene
Liberia	Assets: car, watch, fridge, phone, TV, electricity Floor: ceramic tiles, vinyl Fuel: gas, kerosene
Macedonia	Assets: phone, fridge, car, TV, bicycle, computer, motor cycle microwave Floor: linoleum Fuel: gas
Madagascar	Assets: car, watch, fridge, phone, TV, electricity Floor: ceramic tiles, vinyl Fuel: kerosene, gas
Malawi	Assets: car, watch, fridge, phone, TV, electricity Floor: vinyl, ceramic tiles Fuel: gas, kerosene
Maldives	Assets: watch, fridge, phone, TV, electricity Floor: vinyl Fuel: gas
Mali	Assets: car, watch, fridge, phone, TV, electricity Floor: ceramic tiles, vinyl Fuel: gas, kerosene
Mauritania	Assets: car, fridge, phone, TV, electricity Floor: ceramic tiles Fuel: kerosene
Moldova	Assets: car, watch, fridge, phone, TV Floor: ceramic tiles, vinyl Fuel: gas, kerosene
Mongolia	Assets: watch, fridge, phone, TV, electricity Floor: ceramic tiles

	Fuel: kerosene
Montenegro	Assets: car, watch, fridge, phone, TV, electricity Floor: ceramic tiles Fuel: kerosene
Morocco	Assets: car, fridge, phone, TV, electricity Floor: vinyl, ceramic tiles Fuel: kerosene, gas
Mozambique	Assets: car, watch, fridge, phone, TV, electricity Floor: ceramic tiles, vinyl Fuel: gas, kerosene
Namibia	Assets: car, watch, fridge, phone, TV, electricity Floor: ceramic tiles, vinyl Fuel: kerosene, gas
Nepal	Assets: car, fridge, phone, TV, electricity, motor cycle Floor: ceramic tiles, vinyl, earth Fuel: dung, wood, kerosene
Nicaragua	Assets: car, fridge, phone, TV, electricity Floor: ceramic tiles, vinyl Fuel: gas, kerosene
Niger	Assets: car, watch, fridge, phone, TV, electricity Floor: ceramic tiles, vinyl Fuel: gas, kerosene
Nigeria	Assets: car, watch, fridge, phone, TV, electricity, motor cycle, sewing machine, computer Floor: ceramic tiles Fuel: kerosene gas
Pakistan	Assets: car, watch, fridge, phone, TV, electricity Floor: ceramic tiles, vinyl Fuel: gas, kerosene
Peru	Assets: car, fridge, phone, TV, electricity Floor: ceramic floors, vinyl Fuel: kerosene, gas
Philippines	Assets: car, watch, fridge, phone, TV, electricity Floor: ceramic tiles, vinyl Fuel: gas, kerosene
Rwanda	Assets: car, watch, fridge, phone, TV, electricity Floor: ceramic tiles, vinyl floors Fuel: gas, kerosene
Sao Tome	Assets: car, watch, fridge, phone, TV, electricity Floor: ceramic tiles, vinyl Fuel: gas, kerosene
Senegal	Assets: car, watch, fridge, phone, TV, electricity Floor: ceramic tiles, vinyl Fuel: gas, kerosene
Serbia	Assets: car, watch, fridge, phone, TV, electricity, stove, computer, bicycle Floor: ceramic tiles Fuel: gas, kerosene
Sierra Leone	Assets: car, watch, fridge, phone, TV, electricity, bicycle, motor cycle Floor: ceramic tiles Fuel: gas, kerosene
Somalia	Assets: car, watch, fridge, phone, TV, electricity Floor: ceramic tiles Fuel: kerosene

Suriname	Assets: car, watch, fridge, phone, TV, electricity Floor: ceramic tiles Fuel: gas, kerosene
Swaziland	Assets: car, watch, fridge, phone, TV, electricity Floor: ceramic tiles Fuel: gas, kerosene
Syria	Assets: fridge, phone, TV, electricity Floor: carpet Fuel: LPG, kerosene
Tajikistan	Assets: car, fridge, phone, TV Floor: carpet, earth Fuel: wood
Tanzania	Assets: car, watch, fridge, phone, TV, electricity Floor: ceramic tiles, vinyl Fuel: gas, kerosene
Thailand	Assets: car, watch, fridge, phone, TV, electricity Floor: ceramic tiles Fuel: kerosene
Timor-Leste	Assets: car, watch, fridge, phone, TV, electricity Floor: ceramic tiles, vinyl Fuel: gas, kerosene
Togo	Assets: car, watch, fridge, phone, TV, electricity Floor: ceramic tiles Fuel: gas, kerosene
Turkey	Assets: car, watch, fridge, phone, TV, electricity Floor: ceramic tiles, vinyl Fuel: gas, kerosene
Uganda	Assets: car, watch, fridge, phone, TV, electricity Floor: ceramic tiles, vinyl Fuel: gas, kerosene
Ukraine	Assets: car, watch, fridge, phone, TV, electricity Floor: - Fuel: gas, electric
Uzbekistan	Assets: car, fridge, phone, TV Floor: carpet, earth Fuel: wood
Vanuatu	Assets: car watch phone TV electricity Floor: ceramic tiles Fuel: kerosene
Vietnam	Assets: car, watch, fridge, phone, TV, electricity, computer, bicycle, motor cycle, air-conditioning Floor:- Fuel:-
Yemen	Assets: car, fridge, phone, TV, electricity Floor: ceramic tiles Fuel: kerosene
Zambia	Assets: car, fridge, watch, phone, TV, electricity Floor: ceramic tiles, vinyl Fuel: gas, kerosene
Zimbabwe	Assets: car, fridge, watch, phone, TV, electricity Floor: ceramic tiles, vinyl Fuel: gas, kerosene

APPENDIX 4: HOUSEHOLD QUESTIONNAIRE AND CONSENT
Information sheet and consent form

The following information sheet and consent form will be presented to each participant

Information Sheet: Questionnaires on sanitation facilities in urban slums in Bhubaneswar and Cuttack, Orissa for the study 'Shared sanitation facilities versus individual household latrines: use, pathogen exposure and health'

Researcher: Marieke Heijnen (marieke.heijnen@lshtm.ac.uk)
Project supervisor: Belen Torondel (belen.torondel@lshtm.ac.uk)

Good morning/afternoon, my name is _____ I work at the London School of
Hygiene and Tropical Medicine. The London School of Hygiene and Tropical Medicine is currently collaborating with the Xavier Institute of Management, Bhubaneswar to conduct research on sanitation. Within this, I am researching the types of sanitation available to people living in the slums of Bhubaneswar and Cuttack. I am specifically interested in the use of the sanitation facilities, as well as environmental contamination and the management of community sanitation facilities.

Why are we inviting you to participate in this questionnaire?

We are hoping to learn more about sanitation facilities in urban slums in Bhubaneswar and Cuttack. As such, we would like you to share your knowledge in this questionnaire.

Risks & Benefits

There are no major risks involved in this study. There is no monetary compensation for taking part in this study.

Privacy, anonymity and confidentiality

All the information we collect will be confidential and will be used only for the purpose of the study.

Right not to participate and withdraw

Taking part in the study is completely voluntary. You may choose not to answer any or all of the questions that will ask. You can drop out of this study at any time, even in the middle of the questionnaire.

Water samples and hand rinses

In addition to the questions, we would like to take a sample of your drinking water. This will be done to test the quality of the water available to you. You have the right to refuse. In addition, we would like to take a hand-rinse of the person who usually takes care of the children, or the person who usually cooks and cleans in the home. The hand rinse is similar to somebody washing your hands and collecting the water. You have the right to refuse.

Persons to contact:

If you have any questions, you can ask me any time. If you have additional questions about the questionnaire, you may contact: Belen Torondel (XIMB)

If at any time during the study you have questions or you wish to know more about your rights as a participant in a research study, you may speak to any of the investigators. Investigators may be contacted through the school or at the following address:-

Prof. Subhajyoti Ray
Xavier Institute of Management,
Xavier Square,
Bhubaneswar – 751 013

PLEASE LEAVE THIS PAGE WITH THE RESPONDENT

PLEASE COLLECT THIS CONSENT PAGE AND ATTACH TO QUESTIONNAIRE

Consent Form Questionnaire

The above description of the research project was read to me by …….…….. Anything I did not understand was explained to me by ……..……..., and any questions I had were answered by ……..……..... I understand that at any time I may withdraw from this study without giving a reason and without repercussions. I agree to take part in this study.

Name of person giving consent:
Signature:
Date:

Household Questionnaire_Section A

Background information			
HH001	Respondent Name ଉତର ଦାତାଙ୍କ ନାମ		HH ID:- Enumerator ID:-
HH002	Head of Household Name ଗୃହ କର୍ତାଙ୍କ ନାମ		
HH003	Location of HH ଘରର ଠିକଣା	Ward: ୱାଡ: Slum name: ବସ୍ତିର ନାମ: GPS:	
HH004	Date of interview ସାକ୍ଷାତକାର ଦିନ	☐☐/☐☐/☐☐☐☐ dd/mm/yyyy	
HH005 **HH006**	Questionnaire start time ପ୍ରଶ୍ନାବଳୀ ଆରମ୍ଭ ସମୟ Questionnaire finish time ପ୍ରଶ୍ନାବଳୀ ଶେଷ ସମୟ	☐☐:☐☐ hh:mm (24 hour) ☐☐:☐☐ hh:mm (24 hour)	

C. Demographic and socio-economic status			
HH 101	Gender of head of household ଗୃହ ମୁଖୀଆଙ୍କ ଲିଙ୍ଗ	Male ପୁରୁଷ Female ମହିଳା	01 02
HH 102	What is the highest level of education that the **head of household** has attained? ଗୃହ ମୁଖୀଆଙ୍କ ସର୍ବତମ ଶିକ୍ଷା ଗତ ଯୋଗ୍ୟତା	No formal education ଅଶିକ୍ଷିତ Some primary (1-4th year) ପ୍ରାଥମିକ Completed primary (5th year) ପ୍ରାଥମିକ ପାସ୍ Some secondary (6-10th year) ଉଚ୍ଚ ମାଧ୍ୟମିକ Completed +2 year (12th year) + ୨ ପାସ୍ Completed +any university +୩ ପାସ୍ Other_____ ଅନ୍ୟାନ୍ୟ Don't Know ଜାଣି ନାହିଁ	01 02 03 04 05 06 07 08
HH 103	What is the highest level of education that the '**main caretaker of house' (cooking /cleaning) has attained?** ପିଲାର ଯତ୍ନ ନେଉଥିବା ବ୍ୟକ୍ତିର ସର୍ବତମ ଶିକ୍ଷା ଗତ ଯୋଗ୍ୟତା	Education level — Primary care giver No formal education ଅଶିକ୍ଷିତ Some primary (1-4th year) ପ୍ରାଥମିକ Completed primary (5th year) ପ୍ରାଥମିକ ପାସ୍ Some secondary (6-10th year) ଉଚ୍ଚ ମାଧ୍ୟମିକ Completed +2 year (12th year) + ୨ ପାସ୍ Completed +any university +୩ ପାସ୍ Other_____ ଅନ୍ୟାନ୍ୟ Don't Know ଜାଣି ନାହିଁ	 01 02 03 04 05 06 07 08

ENUMERATOR NOTE: if multiple families living in the same household, please ask the most senior caregiver			
HH104	How long have you lived in this house? ଆପଣ କେବେଠାରୁ ଏହି ଘରେ ଅଛନ୍ତି	Less than 6 months ୬ ମାସରୁ କମ୍ Less than 1 year ଏକ ବର୍ଷରୁ କମ୍ Less than 5 years ୫ ବର୍ଷରୁ କମ୍ More than 5 year ୫ ବର୍ଷରୁ ଅଧିକ	01 02 03 04
HH105	How many persons live in your household at present? ଏବେ ଆପଣଙ୍କ ଘରେ କେତେ ଲୋକ ଅଛନ୍ତି	☐☐	
ENUMERATOR NOTE: *Household defined as sharing the same cooking pot. Person should have lived here throughout the past 2 month* ଏକତ୍ର ରୋଷେଇ ଘରେ ଖାଉଥିବା ଲୋକ ସଂଖ୍ୟା ।			
HH106	No of male adults in HH କେତେ ଜଣ ବୟସ୍କ ପୁରୁଷ ଘରେ ଅଛନ୍ତି ☐☐ Total number of children in HH କେତେ ଜଣ ପିଲା ଘରେ ଅଛନ୍ତ ☐☐ Nr of children <5 କେତେ ଜଣ ୫ ବର୍ଷରୁ କମ୍ ପିଲା ଅଛନ୍ତି ☐☐ Nr of females adults in HH କେତେ ଜଣ ବୟସ୍କ ସ୍ତ୍ରୀ ଲୋକ ଅଛନ୍ତି ☐☐		
HH107	How many rooms in the house are used for sleeping? ☐☐ ଆପଣଙ୍କ ଘରେ କେତୋଟି ଶୋଇବା କକ୍ଷ ଅଛି ?		
HH108	What is the **principal** source of lighting for your household? ଆପଣଙ୍କ ଘରେ ଆଲୋକିତ କରିବାର ଉତ୍ସ କଣ ?	Electricity ବିଦ୍ୟୁତ୍ Kerosene କିରୋସିନ Gas ଗ୍ୟାସ Oil ତେଲ Other ଆଉ କିଛି	01 02 04 05 88
HH109	What type of fuel does your household **mainly** use for cooking? ଆପଣଙ୍କ ଘରେ ରାନ୍ଧିବା ପାଇଁ କେଉଁ ଇନ୍ଧନ ବ୍ୟବହାର କରନ୍ତି ?	Electricity ବିଦ୍ୟୁତ୍ LPG/natural Gas ଗ୍ୟାସ Biogas ଗୋବର ଗ୍ୟାସ Kerosene କିରୋସିନ Coal/Lignite କୋଇଲା Charcoal କୋଇଲା Wood କାଠ Agricultural crop wasteଫସଲ ଜାତିୟ Dung ଘସି Other ଆଉ କିଛି	01 02 03 04 05 06 07 08 09 88 _____
HH110	Where does the cooking normally take place? ଆପଣଙ୍କର ରୋଷେଇ କରିବାର ସ୍ଥାନଟି କେଉଁଠି ?	Inside house, separate room ଘର ଭିତରେ, ଅଲଗା କକ୍ଷ Inside house, no separate room ଘର ଭିତରେ, ଅଲଗା କକ୍ଷ ନାହିଁ In separate building ଅଲଗା ଘରେ Outdoors ବାହାରେ Other ଆଉ କିଛି	01 02 03 04 88
HH111	What is the **principal** type of kitchenware used in this household ଆପଣ ଘରେ ମୁଖ୍ୟତ କେଉଁ ପ୍ରକାରର ରୋଷେଇ ସାମଗ୍ରୀ ବ୍ୟବହାର ହୁଏ ?	Clay ମାଟି Aluminum ଆଲୁମିନିୟମ Cast iron ଲୁହା Brass ପିତଳ Stainless steel କଂସା Other ଅନ୍ୟ କିଛି	01 02 03 04 05 88

Does any member of your household own the following items? [Please ask or Observe]	ଆପଣଙ୍କ ଘରର କାହା ପାଖରେ ନିମ୍ନ ଲିଖିତ ଜିନିଷ ଗୁଡିକ ଅଛି କି ?	*Yes*	**No**
	HH112 Watch or clock ଘଡି	01	02
	HH113 Pressure cooker ପ୍ରେସରକୁକର	01	02
	HH114 Mobile phone ମୋବାଇଲ	01	02
	HH115 TV ଟିଭି	01	02
	HH116 Dish antenna ଡିସ୍ ଆଂଟିନା/Cable	01	02
	HH117 Refrigerator ଫ୍ରିଜ୍	01	02
	HH118 Radio ରେଡିଓ	01	02
	HH119 Chair ଚୌକି	01	02
	HH120 Mattress ମସିଣା	01	02
	HH121 Cot or bed ଖଟିଆ	01	02
	HH122 Table ଟେବୁଲ	01	02
	HH123 Electric fan ଫ୍ୟାନ	01	02
	HH124 Sewing machine ସିଲେଇ ଯନ୍ତ	01	02
	HH125 Bicycle ସାଇକେଲ	01	02
	HH126 Motorbike/scooter ବାଇକ୍	01	02
	HH127 Trolley (bicycle cart) ଟ୍ରଲି	01	02
	HH 128 Auto-rickshaw ଅଟୋ	01	02
	HH129 Car କାର	01	02

HH130	Does anyone in your household own poultry/livestock or farm animals? ଆପଣଙ୍କ ଘରେ କାହାର ନିଜର କୁକୁଡା ଫାର୍ମ ବା ପଶୁ ଅଛନ୍ତି କି ?	Yes ହଁ No ନା	01 02 *(SKIP to HH132)*
HH131	How many of the following does your household own? ଆପଣଙ୍କ ଏମାନଙ୍କ ମଧ୍ୟରୁ କେତୋଟି ନିଜର ଅଛି ?	**A.** Cattle ଗାଇ ଗୋରୁ **B.** Buffalo ମଇଁଶି **C.** Goats ଛେଳି **D.** Sheep ମେଂଢ଼ା **E.** Chicken କୁକୁଡା **F.** Pigs ଘୁସୁରୀ E. Other, specify_____	☐☐☐ ☐☐☐ ☐☐☐ ☐☐☐ ☐☐☐ ☐☐☐
HH132	Does your household own a BPL/Antyodaya card? ଆପଣ ଘରେ ବି.ପି.ଏଲ୍ କାର୍ଡ ଅଛି କି ?	Yes verified Yes not verified No	01 02 03

Water

HH201	What is the **main** source of **drinking** water for members of your household? ଆପଣଙ୍କ ଘର ସଦସ୍ୟ ପିଉଥିବା ପାଣିର ମୁଖ୍ୟ ଉର୍ସ କଣ ?	Piped water ପାଇପ୍ ପାଣି	01
		Shallow tube well (popular 6) ଅଗଭିର ନଳକୂପ	02
		Deep Borehole fitted with hand pump (India Mark II/III) ଗଭୀର ନଳ କୂପ	03
		Protected dug well ସଂଗ୍ରକ୍ଷିତ କୂପ	04
		Unprotected dug well ଅସଂଗ୍ରକ୍ଷିତ କୂପ	05
		Rainwater ବର୍ଷା ପାଣି	06
		Tanker truck ପାଣି ଟାଙ୍କି ଗାଡି	07
		Surface water: River/ lake/ pond / canal ଭୂଜଳ: ନଦୀ, ପୋଖରୀ, ନାଳ	08
		Other ଆଉ କିଛି	09

HH202	Where is that water source located? ଆପଣଙ୍କ ପାଣିର ଉତ୍ସ କେଉଁଠି ?	In own dwelling ଘର ଅଗଣାରେ	01(skip to HH204)
		In own yard / compound ଘର ପରିସରରେ	02 (skip to HH204)
		Outside compound ଘର ପରିସର ବାହାରେ	03
HH203	How long does it take to go there, get water (for household use) and come back? ଆପଣଙ୍କୁ ପାଣି ଆଣିବାକୁ ଯିବା ପାଇଁ କେତେ ସମୟ ଲାଗୁଛି ?	☐☐☐minutes	
HH204	Are there times that this source is unavailable year round? ଏମିତି କୌଣସି ସମୟ ଅଛି କି, ଯେବେ ଉତ୍ସରୁ ପାଣି ମିଳେ ନାହିଁ ?	Yes ହଁ	01
		No ନା	02 (skip to HH208)
HH205	How many months/days is this water source unavailable? ଏହି ପାଣି ଉତ୍ସଟି କେତେ ମାସ/ଦିନ ବନ୍ଦ ରହେ ?	☐☐months/days	If available all months→ Skip HH208
HH206	What are the reasons for unavailability of water? ଉତ୍ସରୁ ପାଣି ନମିଳିବାର କାରଣ କଣ ?	☐Low water table ଅଳ୍ପ ପାଣି	
		☐Damage to water sources ଉତ୍ସଟି ଅଚଳ ହୋଇଯାଇଛି	
		☐Other ଅନ୍ୟ କିଛି _____	
HH207	Are there times of day when this water is not available? କୌଣସି ସମୟ ଅଛି କି, ଯେବେ ଉତ୍ସରୁ ପାଣି ମିଳେ ନାହିଁ ?	No, always available ନାହିଁ ସବୁବେଳେ ମିଳେ	
		Yes, only available from ହଁ ଦିନରେ କେତେକ ସମୟରେ _____ (specify times of day when water is available)	
HH208	Is there a different source of water used by members of your household for **bathing, washing and anal cleansing**? ଘରର ସଦସ୍ୟମାନେ ଗାଧୋଇବା, ଧୋଇହେବା, ପାଇଖାନା ସଫା କରିବା ପାଇଁ ଅଲଗା କୌଣସି ପାଣିର ଉତ୍ସ ବ୍ୟବହାର କରନ୍ତି କି ?	Yes	01
		No	02 (skip to HH300)
HH209	What is the **main** source of water for bathing and anal cleansing for members of your household? ଗାଧୋଇବା ଓ ସୌଚ କରିବା ପାଇଁ ଆପଣଙ୍କ ଘରର ସଦସ୍ୟମାନେ ମୁଖ୍ୟତ କେଉଁ ପାଣିର ଉତ୍ସ ବ୍ୟବହାର କରନ୍ତି ?	Piped water ପାଇପ୍ ପାଣି	01
		Shallow tube well (popular 6) ଅଗଭିର ନଳକୂପ	02
		Deep Borehole fitted with hand pump (India Mark II/III) ଗଭୀର ନଳ କୂପ	03
		Protected dug well ସଂଗ୍ରକ୍ଷିତ କୂପ	04
		Unprotected dug well ଅସଂଗ୍ରକ୍ଷିତ ପୂପ	05
		Rainwater ବର୍ଷା ପାଣି	06
		Tanker truck ପାଣି ଟାଙ୍କି ଗାଡି	07
		Surface water: River/ lake/ pond / canal ଭୂଜଳ: ନଦୀ, ପୋଖରୀ, ନାଳ	08
		Other ଆଉ କିଛି	09
HH210	Where is that water source located? ଏହି ପାଣିର ଉତ୍ସ କେଉଁଠି ?	In own dwelling ଅଗଣାରେ	01 *(skip to HH300)*
		In own yard ଘର ପରିସରରେ	02 *(skip to HH300)*
		Outside the compound ଘର ପରିସର ବାହାରେ	03
HH211	How long does it take to go there and come back? ଆପଣଙ୍କୁ ଯିବା ଆସିବା ପାଇଁ କେତେ ସମୟ ଲାଗେ ?	☐☐☐minutes	

Observations about house and environment			
HH300	*Is the house in a compound? [fenced or walled area]* ଘରଟିର ପରିସର ଅଛି କି ? ବାଡ ଦ୍ୱାରା ନା କାନ୍ଥ *OBSERVE* ପର୍ଯ୍ୟବେକ୍ଷଣ	Yes	01
		No	02
HH301	*Are there other houses the same compound?* ଏମିତି ଅଲଗା କୌଣସି ଘର ଅଛି ଯାହାର ସେହି ଗୋଟିଏ ପରିସର ଅଛି ? *OBSERVE* ପର୍ଯ୍ୟବେକ୍ଷଣ	Yes	01
		No	02 (skip to HH303)

HH302	*Are these houses occupied by extended family or by paying tenants?* ଏହି ଘର ଗୁଡିକରେ ଅଲଗା ପରିବାର ଅଛନ୍ତି ନା ଘର ଭଡାରେ ଦିଆଯାଇଛି ? *OBSERVE/ASK* ପର୍ଯ୍ୟବେକ୍ଷଣ / ତଦାରଖ କରନ୍ତୁ ଓ ପଚାରନ୍ତୁ	Extended Family ଅଲଗା ପରିବାର Paying tenants ଭଡା ଦିଆଯାଇଛି	01 02
HH303	**Pucca:** walls AND roof made of cement ପକା : କାନ୍ଥ ଓ ଛାତ ସିମେଂଟ୍‌ରେ ତିଆରି ହୋଇଛି **Semi-pucca:** Only ONE of the two is made of cement and bricks ଅଧା ପକ୍କା : କେବେଳ ଦୁଇଟି ମଧ୍ୟରୁ ଗୋଟେ ସିମେଂଟ୍ ବା ଇଟାରେ ତିଆରି ହୋଇଛି **Kuchha:** walls and roof NOT made of cement ମାଟି : କାନ୍ଥ ଓ ଛାତ ସିମେଂଟ୍‌ରେ ତିଆରି ହୋଇନାହିଁ	Pucca ପକ୍କା Semi-Pucca ଅଧା ପକ୍କା Kuchha ମାଟି Other ଆଉ କିଛି_____	01 02 03 04
HH304	***Observe:*** *Are there any faeces present inside the courtyard?* ପାଖରେ କୌଣସି ଝାଡା ଦେଖୁଛନ୍ତି କି ? *OBSERVE*	Yes ହଁ No ନା	01 02

Diarrhoea

ENUMERATOR NOTE: For the question below, ask each HH member present if they have had diarrhoea? ie. Has the mother had diarrhoea in the past 7 days? if yes, ask about the last 3 days. Has the eldest son had diarrhoea? If yes, ask about the last 3 days. etc. DO NOT ask 'has anyone had diarrhoea'. Please note the name, age and sex of the individuals present, and the days during which they had diarrhea. Only tick 'self reported' if the individual is present and tells you about the diarrhea. For children <5 with diarrhoea, please tick 'self reported'for person responding on their behalf.
ତଳେ ଦିଆଯାଇଥିବା ପ୍ରଶ୍ନ ଗୁଡିକ ପାଇଁ ଘରର କୌଣସି ସଦସ୍ୟଙ୍କର ଝାଡା ହେଉଛି କି, ମାଙ୍କୁ ଗତ ସାତ ଦିନ ମଧ୍ୟରେ ପତଳା ଝାଡା ହୋଇଥିଲା କି ଯଦି ହଁ ତେବେ ଗତ ତିନି ଦିନ ବିଷୟରେ ପଚାରନ୍ତୁ । ଘରର ବଡ ପୁଅରର ପତଳା ଝାଡା ହେଉଥିଲା କି, ଯଦି ହଁ ତେବେ ଗତ ତିନି ଦିନ ବିଷୟରେ ପଚାରନ୍ତୁ । ଅନ୍ୟ କୌଣସି ସଦସ୍ୟଙ୍କ ପତଳା ଝାଡା ବିଷୟରେ ପଚାରନ୍ତୁ ନାହିଁ

ID			In the past 7 days, has any one in the HH had diarrhoea? (WHO definition of diarrhoea: passage of 3 or more loose stools (that can take the shape of a container) within a 24-hour period) ଗତ ସାତ ଦିନ ମଧ୍ୟରେ ଆପଣଙ୍କ ଘରେ କାହାକୁ ପତଳା ଝାଡା ହେଉଥିଲା କି ? WHO ପତଳା ଝାଡାର ଲକ୍ଷଣ ୩ରୁ ଅଧିକ ଥର ଝାଡା ହୋଇଥିବ ଯାହା ଏକ ପାତ୍ରର ଆକାର ନେଉଥିବ		If YES, has this person had diarrhoea:									Self reported?
				Today ଆଜି			Yesterday ଗତ କାଲି			The day before ଦୁଇ ଦିନ ପୂର୍ବରୁ						
Name	M/F	Age		**Yes**	**No**		**Yes**	**No**		**Yes**	**No**		**Yes**	**No**	
			HH305	01	02	**HH306**	01	02	**HH307**	01	02	**HH308**	01	02	☐
			HH309	01	02	**HH310**	01	02	**HH311**	01	02	**HH312**	01	02	☐
			HH313	01	02	**HH314**	01	02	**HH315**	01	02	**HH316**	01	02	☐
			HH317	01	02	**HH318**	01	02	**HH319**	01	02	**HH320**	01	02	☐
			HH321	01	02	**HH322**	01	02	**HH323**	01	02	**HH324**	01	02	☐
			HH325	01	02	**HH326**	01	02	**HH327**	01	02	**HH328**	01	02	☐

			HH329	01	02	**HH330**	01	02	**HH331**	01	02	**HH332**	01	02	☐
			HH333	01	02	**HH334**	01	02	**HH335**	01	02	**HH336**	01	02	☐
			HH337	01	02	**HH338**	01	02	**HH339**	01	02	**HH340**	01	02	☐
			HH341	01	02	**HH342**	01	02	**HH343**	01	02	**HH344**	01	02	☐
			HH345	01	02	**HH346**	01	02	**HH347**	01	02	**HH348**	01	02	☐
			HH349	01	02	**HH350**	01	02	**HH351**	01	02	**HH352**	01	02	☐
			HH353	01	02	**HH354**	01	02	**HH355**	01	02	**HH356**	01	02	☐
			HH357	01	02	**HH358**	01	02	**HH359**	01	02	**HH360**	01	02	☐
			HH361	01	02	**HH362**	01	02	**HH363**	01	02	**HH364**	01	02	☐
			HH365	01	02	**HH366**	01	02	**HH367**	01	02	**HH368**	01	02	☐
			HH369	01	02	**HH370**	01	02	**HH371**	01	02	**HH372**	01	02	☐

ଯଉଁ ବ୍ୟକ୍ତି ଉପସ୍ଥିତ ଅଛନ୍ତି ଓ ସେ ତାଙ୍କ ପତଳା ଝାଡା ବିଷୟରେ ଜଣାଉଛନ୍ତି ତେବେ "ନିଜେ ଜଣାଉଛନ୍ତି" ଯାଗାରେ ଠିକ୍ ମାରନ୍ତୁ ।

Sanitation

HH400 Does your household have access to a private toilet facility? ଆପଣଙ୍କ ନିଜର ପାଇଖନା ଅଛି କି ?

Yes 01 — **PLEASE PROCEED TO SECTION C** ଦୟାକରି ସେକ୍ସେନ ସି କୁ ଯାଆନ୍ତୁ

No 02 — **PLEASE PROCEED TO SECTION B** ଦୟାକରି ସେକ୍ସେନ ବି କୁ ଯାଆନ୍ତୁ

Section B – Shared or Communal Sanitation

PLEASE STAPLE TOGETHER WITH RELEVANT SECTION A

Location of Community latrine Slum name:

Ward:

GPS:

SS100	Where do most members of your household go to defecate, the majority of the time? ଘରର ଅଧିକାଂଶ ସଦସ୍ୟ ଅଧିକ ସମୟ କେଉଁଠିକୁ ଯାଆନ୍ତି ?	Community latrine ଗୋଷ୍ଠି ପାଇଖାନା	01	
		Public latrine (sulabh style) ଶୁଲଭ ପାଇଖାନା	02	
		Neighbors' latrine ପଡିଶା ଘର ପାଇଖାନା	03	
		Open defecation ଖୋଲା ଜାଗା	04	(Skip to 135)
		Other, specify_____ ଅନ୍ୟାନ୍ୟ	05	
SS101	Do you pay to use this facility? ଏହି ବ୍ୟବସ୍ଥା ପାଇଁ ପଇସା ଦେବାକୁ ପଡେ କି ?	Yes ହଁ ☐☐☐ rupees ପଇସା	per Month ପ୍ରତି ମାସ ☐	01
			Per Week ପ୍ରତି ସପ୍ତାହ ☐	02
			Per Use ପ୍ରତି ବ୍ୟବହାର ☐	03
			Per Year ପ୍ରତି ବର୍ଷ ☐	04
			No payment ବିନା ମୂଲ୍ୟରେ	77
SS102	Are there additional payments? [multiple answers possible] ଆଉ କିଛି ଅଧିକା ମୂଲ୍ୟ ?	Pay for water ପାଣି ପାଇଁ ପଇସା	01	
		Pay for electricity ବିଦ୍ୟୁତ୍ ପାଇଁ ପଇସା	02	
		Pay for sweeper ଝାଡୁଦାର ପାଇଁ ପଇସା	03	
		Other_____ ଅନ୍ୟାନ୍ୟ	04	
		No additional payment ବିନା ମୂଲ୍ୟରେ	77	
SS103	Is this facility open all day and all night? ୨୪ ଘଂଟା ଏହି ବ୍ୟବସ୍ଥା ଖୋଲା ରହେ କି ?	Yes ହଁ	01 (skip to SS105)	
		No ନା	02	
SS104	Please note down exact opening times ସଠିକ୍ ଖୋଲା ସମୟ କୁ ଲେଖନ୍ତୁ _____			
SS105	Do you know who constructed this facility? ଆପଣ ଜାଣିଛନ୍ତି କି ଏହି ବ୍ୟବସ୍ଥା କିଏ ତିଆରି କରିଛି ?	NGO, specify if known _____ ବେସରକାରୀ ସଂସ୍ଥା	01	
		Government ସରକାର	02	
		Community constructed ସମଦାୟ / ଗୋଷ୍ଠି	03	
		Don' t know ଜାଣି ନାହିଁ	04	
SS106	Approximately how long ago was it constructed? [please note exact year of construction if available] ହାରାହାରି କେତେ ଦିନ ଆଗରୁ ତିଆରି ହୋଇଥିଲା ? ଯଦି ଅଛି ଦୟାକରି ତିଆରିର ସଠିକ୍ ବର୍ଷକୁ ଲେଖନ୍ତୁ ।	Less than 1 year ୧ ବର୍ଷରୁ କମ୍	01	
		Less than 5 years ୫ ବର୍ଷରୁ କମ୍	02	
		Less than 10 years ୧୦ ବର୍ଷରୁ କମ୍	03	
		More than 10 years 10 ବର୍ଷରୁ ଅଧିକା	04	
		Don't know ଜାଣି ନାହିଁ	05	

SS107	Is there electricity at the latrine? ପାଇଖାନାରେ ବିଦ୍ୟୁତ୍ ବ୍ୟବସ୍ଥା ଅଛି କି ?	Yes ହଁ No ନା Don't know ଜାଣି ନାହିଁ	01 02 (skip to SS110) 03
SS108	Are there lights in the latrine? ପାଇଖାନାରେ ଆଲୋକ ବ୍ୟବସ୍ଥା ଅଛି କି ?	Near the facility (ie. Streetlight) ବ୍ୟବସ୍ଥା ଭିତର Lights inside the facility ଘର ଭିତରେ ଆଲୁଅର ବ୍ୟବସ୍ଥା Lights inside each seat ପରିବେଶ ଭିତରେ ଆଲୁଅର ବ୍ୟବସ୍ଥା	01 (skip to SS110) 02 03
SS109	Do you pay for the electricity for these lights? ବିଦ୍ୟୁତ୍ ପାଇଁ କିଛି ଅଲଗା ଦେଉଛନ୍ତି କି ?	Yes ହଁ ☐☐☐ rupees ପଇସା	per Month ପ୍ରତି ମାସ ☐ 01 Per Week ପ୍ରତି ସପ୍ତାହ ☐ 02 Per Use ପ୍ରତି ବ୍ୟବହାର ☐ 03 Per Year ପ୍ରତି ବର୍ଷ ☐ 04 No payment ବିନା ମୂଲ୍ୟରେ 77
SS110	Is there water at the facility? ବ୍ୟବସ୍ଥା ପାଖରେ ପାଣି ଅଛି କି ?	Yes, just outside the latrine ହଁ, ପାଇଖାନା ବାହାରେ Yes, inside the cubicle ହଁ, ପାଇଖାନା ଭିତରେ No, everyone brings their own water ନା, ସମସ୍ତେ ନିଜ ପାଣି ଆଣନ୍ତି	01 02 (skip to SS113) 03
SS111	How far do you have to carry the water to the latrine? ଆପଣଙ୍କ ପାଇଖାନାକୁ କେତେ ଦୂରରୁ ପାଣି ବୋହି ନେଉଛନ୍ତି	Please approximate distance from latrine to water source in meters ପାଇଖାନାର ପାଣି ଉତ୍ସର ହାରାହାରି ଦୂରତା କେତେ ମିଟର ।	☐☐
SS112	Do you pay for the water?	Yes ହଁ ☐☐☐ rupees ପଇସା	per Month ପ୍ରତି ମାସ ☐ 01 Per Week ପ୍ରତି ସପ୍ତାହ ☐ 02 Per Use ପ୍ରତି ବ୍ୟବହାର ☐ 03 Per Year ପ୍ରତି ବର୍ଷ ☐ 04 No payment ବିନା ମୂଲ୍ୟରେ 77
SS113	How often if the facility cleaned? ପ୍ରାୟତଃ କେତେ ଥର ପାଇଖାନାଟି ସଫା ହୁଏ ?	Once a day ଦିନରେ ଥରେ Once a week ସପ୍ତାହରେ ଥରେ Less than once a week ସାତ ଦିନ ଭିତରେ ଥରେ ରୁ କମ୍ No cleaning ସଫା ହୁଏ ନାହିଁ Don't Know ଜାଣି ନାହିଁ	01 02 03 04 (skip to SS121) 05 (skip to SS121)
SS114	Who cleans the facility? ଏହି ବ୍ୟବସ୍ଥାକୁ କିଏ ସଫା କରେ ?	Sweeper ଝାଡୁ ଦାର The hh's themselves ଘରର ସଦସ୍ୟ	01 02 (skip to SS117)
SS115	Do you pay for the sweeper? ଆପଣ ଝାଡୁଦାରକୁ ମୂଲ୍ୟ ଦିଅନ୍ତି କି ?	Yes, every month we pay ☐☐☐ rupees ହଁ ପ୍ରତି ମାସରେ ଆମେ ଦେଉଛୁ Yes, every week we pay ☐☐☐ rupees ହଁ ପ୍ରତି ସପ୍ତାହରେ ଆମେ ଦେଉଛୁ Only when the sweeper comes money is collected. We pay ☐☐ ☐rupees କେବଳ ଝାଡୁଦାର ଆସିଲେ ପଇସା ସଂଗ୍ରହ ହୁଏ, ଆମେ ଦେଉ	

SS116	Are you happy with the cleanliness of the facility? ଏହି ସଫା ସୁତୁରା ବ୍ୟବସ୍ଥାକୁ ନେଇକି ଆପଣ ଖୁସି ଅଛନ୍ତି କି ?	Yes, it is clean ହଁ ସଫା ଅଛି Yes, but it could be cleaner ହଁ ଅଛି, ଆଉ ଟିକେ ସଫା ହବା ଦରକାର No, it is not clean enough ନାଁ ଏତେ ସଫା ନାହିଁ	01 02 03	Skip to SS121

ENUMERATOR NOTE: SKIP SECTION SS117- SS120 IF THERE IS A SWEEPER WHO CLEANS. ONLY ANSWER THE FOLLOWING QUESTIONS IF IT IS THE LATRINE USERS THEMSELVES WHO CLEAN THE LATRINE (HOUSEHOLD CLEANING)

SS117	Is there a rotation system for cleaning of the latrine by the households? ଆପଣଙ୍କ ପାଇଖାନାକୁ ଘରର ସଦସ୍ୟ ମାନେ ପାଳି କରି ସଫା କରିବାର ପ୍ରଥା ଅଛି କି ?	Yes, everyone cleans in turn ହଁ, ସମସ୍ତେ ପାଳି କରି ସଫା କରନ୍ତି No, people just clean as they have time ନାଁ, ସମୟ ଥିଲେ ଲୋକେ ସଫା କରନ୍ତି No, it is usually a few people doing all the cleaning ନା, ସଫାସୁତୁରା କିଛିଟା ଲୋକ କରନ୍ତି	01 02 03
SS118	Are you happy with the cleanliness of the facility? ଏହି ସଫା ସୁତୁରା ବ୍ୟବସ୍ଥାକୁ ନେଇ ଆପଣ ଖୁସି ଅଛନ୍ତି କି ?	Yes, it is clean ହଁ, ସଫା Yes, but it could be cleaner ହଁ, କିନ୍ତୁ ଆଉ ଟିକେ ସଫା ହେବା ଦରକାର No, it is not clean enough ନା, ଏତେ ସଫା ନାହିଁ	01 02 03
SS119	Who pays for the cleaning materials? (broom,harpic etc) ପାଇଖାନା ସଫା ସୁତୁରା ଜିନିଷ ପାଇଁ କିଏ ପଇସା ଦିଅନ୍ତି ?	We don't use, we only use water for cleaning ଆମେ ବ୍ୟବହାର କରୁ ନାହିଁ, ଆମେ କେବେଳ ସଫା ସଫି କରିବା ପାଇଁ ପାଣି ବ୍ୟବହାର କରୁ । We collect money to pay for these supplies ଏହି ଯୋଜନା ପାଇଁ ଆମେ ପଇସା ସଂଗ୍ରହ କରୁ । The household who cleans usually provides ପ୍ରାୟତଃ ଯିଏ ସଫା କରେ , ସିଏ ଦିଏ ।	01 (skip to SS121) 02 03 (Skip to SS121)
SS120	How much money is collected to pay for the cleaning materials? ସଫାସୁତୁରା ଜିନିଷ ପାଇଁ କେତେ ପଇସା ସଂଗ୍ରହ କରନ୍ତି ?	☐☐☐ rupees ପଇସା	per Month ପ୍ରତି ମାସ ☐ 01 per Week ପ୍ରତି ସପ୍ତାହ ☐ 02 Occasion ବେଳେବେଳେ ☐ 03 Per Year ପ୍ରତି ବର୍ଷ ☐ 04 No payment ବିନା ମୂଲ୍ୟରେ 77 Don't Know ଜାଣି ନାହିଁ 88
SS121	Do you know where the waste from the latrine goes? ଆପଣ ଜାଣିଛନ୍ତି କି ପାଇଖାନାର ମଇଳା କେଉଁ ଆଡେ ଯାଉଛି ?	Septic tank ସେପ୍‌ଟିକ୍ ଟାଙ୍କି Sewer ଛୋଟ ନାଳ Canal/gutter କେନାଲ No disposal, remains there ମଇଳା ରୁହେ ନାହିଁ Don't know ଜାଣି ନାହିଁ Other ଅନ୍ୟାନ୍ୟ For Optional response……	01 02 (skip to SS126) 03 04 05 06	Skip to SS128
SS122	Do you know when the (septic) tank was last emptied? ଆପଣଙ୍କ ସେପ୍‌ଟିକ୍ ଟାଙ୍କି ଶେଷଥର କେବେ ଖାଲି ହୋଇଥିଲା ?	Last 6 months ଶେଷ ୬ ମାସ Last year ଶେଷ ବର୍ଷ Don' know ଜାଣି ନାହିଁ	01 02 03

SS123	Do you know how the latrine was emptied? ଆପଣ ଜାଣିଛନ୍ତି କି କିପରି ପାଇଖାନା ଖାଲି କରାଯାଇଥିଲା ?	Vacuum pump ଖାଲି ପମ୍ପ Manually ହାତରେ Other ଅନ୍ୟାନ୍ୟ Don't know ଜାଣି ନାହିଁ	01 02 03 04	
SS124	Did you have to pay to have it emptied? ଖାଲି କରିବା ପାଇଁ ଆପଣ କିଛି ମୂଲ୍ୟ ଦେଇଥିଲେ କି ?	Yes ହଁ No ନାଁ Don't know ଜାଣି ନାହିଁ	01 02 03	Skip to SS128
SS125	How much do you pay to have the pit emptied? ଟାଙ୍କିକୁ ଖାଲି କରିବା ପାଇଁ କେତେ ଟଙ୍କା ଦେଇଥିଲେ ?	☐☐☐ rupees ପଇସା	per Month ପ୍ରତି ମାସ ☐ per Week ପ୍ରତି ସପ୍ତାହ ☐ Per Year ପ୍ରତି ବର୍ଷ ☐ Occasion ବେଳେବେଳେ ☐ No payment ବିନା ମୂଲ୍ୟରେ Don't Know ଜାଣି ନାହିଁ	01 02 03 04 77 88

ENUMERATOR NOTE: SKIP SECTION SS126- SS127 IF THERE IS NO SEWER CONNECTION

SS126	Do you pay for your sewage connection? ନାଳର ସଂଯୋଗ ପାଇଁ ଆପଣ ପଇସା ଦେଉଛନ୍ତି କି ?	Yes ହଁ No ନାଁ	01 02	(Skip to SS128)
SS127	How much do you pay for your sewage connection? ନାଳର ସଂଯୋଗ ପାଇଁ ଆପଣ କେତେ ପଇସା ଦିଅନ୍ତି ?	☐☐☐ rupees ପଇସା	per Month ପ୍ରତି ମାସ ☐ per Week ପ୍ରତି ସପ୍ତାହ ☐ Per Year ପ୍ରତି ବର୍ଷ ☐ Occasion ବେଳେବେଳେ ☐ No payment ବିନା ମୂଲ୍ୟରେ Don't Know ଜାଣି ନାହିଁ	01 02 03 04 77 88
SS128	Is there an open defecation site which people in the community use? ଗୋଷ୍ଠିର ଲୋକମାନଙ୍କ ବ୍ୟବହାର ପାଇଁ ଆପଣଙ୍କର ଖୋଲା ପଡିଆ ଅଛି କି ?	Yes ହଁ No ନାଁ	01 02 (skip to SS130)	
SS129	How long does it take you to go to the (nearest) open defecation site from your house? (Please write '999' for 'do not go to open defecation) ଘରୁ ଖୋଲା ପଡିଆକୁ ଯିବା ପାଇଁ ଆପଣଙ୍କୁ କେତେ ସମୟ ଲାଗେ ?		☐☐☐ minutes ମିନିଟ୍‌ରେ	
SS130	Is there a place you can wash your hands after defecation? ଝାଡା ଯିବା ପରେ ଏମିତି କୌଣସି ଜାଗା ଅଛି କି ଯେଉଁଠି ଆପଣ ହାତ ଧୋଇ ପାରିବେ ?	Yes, at the community latrine ହଁ, ଗୋଷ୍ଠି ପାଇଖାନାରେ Yes, here in my house ହଁ, ମୋ ଘରେ No, not necessary as I bathed ନାଁ, ଦରକାର ନାହିଁ ମୁଁ ଗାଧୋଇଛି No ନାଁ	01 02 (if possible, verify in HH) 03 04	Skip to SS132

SS131	Is there soap or ash for hand-washing? ହାତ ଧୋଇବା ପାଇଁ ସାବୁନ୍ ନା ପାଉଁଶ ଅଛି କି ?	Yes, verified at HH ହଁ , ଘର ତଦାରଖ କରିଛୁ	01
		No, not at household ନା, ଘରେ ନାହିଁ	02
		Yes, reported about community latrine ହଁ , ଗୋଷ୍ଠି ପାଇଖାନା ବିଷୟରେ ଜଣାଉଛୁ	03
		No, reported about community latrine ନା, ଗୋଷ୍ଠି ପାଇଖାନା ବିଷୟରେ ଜଣାଉନୁ	04

Open ended question: ଖୋଲା ପ୍ରଶ୍ନାବଳୀ

Please ask the respondent the following questions, and write down the answer and completely as possible. Take the time you need. ଦୟାକରି ଉତରଦାତାଙ୍କୁ ନିମ୍ନ ଲିଖିତ ପ୍ରଶ୍ନଗୁଡିକୁ ପଚରନ୍ତୁ । ଦରକାର ହିସାବରେ ସମୟ ନିଅନ୍ତୁ ।

SS132 Why do you use the community latrine? ଗୋଷ୍ଠୀ ପାଇଖାନା କାହିଁକି ବ୍ୟବହାର କରୁଛନ୍ତି ?

_____
_____
_____
_____

SS133 Have you always used the community latrine? ଅପାଣ ସବୁବେଳେ ଗୋଷ୍ଠୀ ପାଇଖାନା ବ୍ୟବହାର କରୁଥିଲେ କି ?

_____
_____
_____

SS134 Do some members of your household go for open defecation? [probe: times of day, times of year, which members, primary reason] ଅପାଣ ଘରର କୌଣସି ବ୍ୟକ୍ତି ବାହାରକୁ ଝାଡା ଯାଆନ୍ତି କି ?

_____
_____
_____

SS135 What is preventing you from constructing your own private latrine?
ଆପଣଙ୍କୁ ଆପଣଙ୍କ ନିଜର ପାଇଖାନା ତିଆରି ପାରିବା ପାଇଁ କଣ ବାଧା ଦେଉଛି ?

_____
_____
_____
_____

WATER SAMPLING			
		YES	NO
W1	**HOUSEHOLD SELECTED FOR WATER SAMPLING?** ପାଣିର ନମୁନା ପାଇଁ ଘରଟି ଚିହ୍ନଟ କରନ୍ତୁ	01	02
		PROCEED	**END**
		YES	NO
W2	If your child/household wanted a drink of water right now, which water would you give him/her? Can you show me your child's drinking water storage container? May I take a sample of this water? ଯଦି ଆପଣଙ୍କ ପିଲା ଏବେ ପାଣି ପିଇବାପାଇଁ ମାଗେ, ତାଙ୍କୁ ଆପଣ କେଉଁଠାରୁ ପାଣି ଦେବେ ? ମୁଁ ତାହା ଦେଖିପାରିବି କି ? ମୁଁ ଏହି ପାଣିର ନମୁନା ନେଇପାରିବି କି ?	01	02

W3	Household sample collected ଘର ପାଣିର ନମୁନା ସଂଗ୍ରହ *Take sample from designated drinking water storage container.* ବ୍ୟବହାର କରୁଥିବା ପାତ୍ରରୁ ପାଣି ନିଅନ୍ତୁ । *Mark Household id and **'H'** for household* ଘରରୁ ନମୁନା ନିଆଯାଉଥିବା ଓରିଲ୍ ପ୍ୟାକ୍ ବ୍ୟାଗରେ ଘରର ନମ୍ବର ଓ 'ଏଚ୍' ଚିହ୍ନଟ କରନ୍ତୁ ।	01	02

HAND RINSES

Please request a hand rinse from the primary caregiver of children, or the primary person responsible for cleaning and cooking in the household ଦୟାକରି ଘରକୁ ସଫାସୁତୁରା କରୁଥିବା ଲୋକ ବା ପିଲାର ଯତ୍ନ ନେଉଥିବା ଲୋକ ବା ଘରେ ରୋଷେଇ କରୁଥିବା ଲୋକକୁ ହାତ ଧୋଇବା ପାଇଁ ଅନୁରୋଧ କରନ୍ତୁ ।	YES	NO
	01	02

Activities before collecting sample (circle the appropriated one) ନମୁନା ସଂଗ୍ରହ କରିବା ପୂର୍ବର କାର୍ଯ୍ୟ	
HR1 What were you doing where we arrived? ଆମେ ପହଁଚିଲା ବେଳେ ଆପଣ କଣ କରୁଥିଲେ ?	
Preparing food for cooking/cooking (Peeling, cutting, sorting, washing ଖାଇବା ତିଆରି କରିବା	1
Eating food ଖାଦ୍ୟ ଖାଇବା	2
Cleaning house ଘର ସଫା	3
Washing dishes, pots, pans or clothes ବାସନ, ମାଠିଆ ଏବଂ କପଡା ସଫା	4
Defecating in latrine ପାଇଖାନାରେ ଝାଡା	5
Defecating in open place ଖୋଲା ପଡିଆରେ ଝାଡା କରିବା	6
Urinating ପରିସ୍ରା କରିବା	7
Cleaning child after defecation ଝାଡା ଫେରିବା ପରେ ଛୁଆକୁ ସଫା କରିବା	8
Bathing (self or child) ଗାଧୋଇବା	9
Caring for animal (please specify which type of animal) ପଶୁର ଯତ୍ନ ନେବା (କେଉଁ ପ୍ରକାର ପଶୁ ଦୟାକରି ଚିହ୍ନଟ କର)	10
Other, specify ଅନ୍ୟାନ୍ୟ ଲେଖନ୍ତୁ	11
HR2 When did you last wash your hands? ଶେଷଥର ପାଇଁ ଆପଣ କେତେବେଳେ ହାତ ସଫା କରିଥିଲେ ?	
Today, less than 30 minutes ago ଆଜି ୩୦ ମିନିଟ୍ ଭିତରେ	1
Today, more than 30 minutes ago ଆଜି ୩୦ ମିନିଟ୍ ପରେ	2
Yesterday ଗତ କାଲି	3
I can't remember ମୋର ମନେ ନାହିଁ	4
HR3 What did you use to wash your hands the last time?ଶେଷଥର ହାତ ଧୋଇବା ପାଇଁ ଆପଣ କଣ ବ୍ୟବହାର କରିଥିଲେ ?	
Water only କେବଳ ପାଣି	1
Water and soap ପାଣି ଏବଂ ସାବୁନ	2
Water and ash ପାଣି ଏବଂ ପାଉଁଶ	3
Water and mud ପାଣି ଏବଂ ମାଟି	4
Other ଅନ୍ୟାନ୍ୟ	5

HOUSEHOLD QUESTIONNAIRE- Private latrine- Section C

PLEASE STAPLE WITH RELEVANT SECTION OF SECTION A

PL100	Where is your toilet facility located? ପାଇଖାନା ବ୍ୟବସ୍ଥା କେଉଁଠି ଅଛି ?	In own dwelling or attached to own dwelling ନିଜ ଅଗଣା ବା ଅଗଣା ସହ ଲାଗିଛି	01	
		In own compound ନିଜ ପରିସରରେ	02	
		Inside neighbor's dwelling or attached to neighbor's dwelling ପଡିଶା ଅଗଣା ବା ପଡିଶା ଅଗଣା ସହ ଲାଗିଛି	03	Skip to PL109
		Inside neighbors' compound ପଡିଶା ପରିସର ଭିତରେ	04	
		Other ଅନ୍ୟ କିଛି	05	
PL101	Does your household share this facility with other households? ଆପଣ ଘରେ ପାଇଖାନା ଅନ୍ୟମାନେ ବ୍ୟବହାର କରନ୍ତି କି ?	Yes ହଁ	01	
		No ନାଁ	02 (skip to PL104)	
PL102	If YES, how many other households use this toilet facility? ଯଦି ହଁ ତେବେ କେତେ ପରିବାର ବ୍ୟବହାର କରନ୍ତି ?	☐☐ Households ଘର		
PL103	Do the other households pay to use this toilet facility? ଅନ୍ୟ ଘର ଆପଣଙ୍କ ପାଇଖାନା ବ୍ୟବହାର କରିଲେ କିଛି ମୂଲ୍ୟ ଦିଅନ୍ତି କି ?	Yes, they pay for	☐ Use ବ୍ୟବହାର	
			☐ Sweeper ଝାଡୁଦାର	
			☐ Electricity ବିଦ୍ୟୁତ୍	
			☐ Water ପାଣି	
			☐ Pit emptying ଗାତ ଖାଲିକରିବା	
			☐ Other ଅନ୍ୟାନ୍ୟ	
		No they do not pay ନା, ମୂଲ୍ୟ ଦିଅନ୍ତି ନାହିଁ	☐	
		Don't Know ଜାଣି ନାହିଁ	☐	
PL104	Did you receive any materials, cash or labor support from the government or NGO for construction of the toilet facility? ସରକାରୀ କି ବେସରକାରୀ ଦ୍ୱାରା କିଛି ଜିନିଷ, ପଇସା କିମ୍ବା ଶ୍ରମ ସାହାଯ୍ୟ ପାଇଖାନା ସୁବିଧା ପାଇଁ ପାଇଥିଲେ କି ?	Yes ହଁ	01	
		No ନାଁ	02	
		Don't Know ଜାଣି ନାହିଁ	03	
PL105	How much money did your household spend to build your facility? ପାଇଖାନା ତିଆରି କରିବା ପାଇଁ ଘର ଲୋକ କେତେ ଖର୍ଚ୍ଚ କରିଥିଲେ ?	☐☐☐☐☐ Rupees		
		Don't Know ☐		
PL106	How long ago was this facility constructed? କେତେବର୍ଷ ହେଲା ଆପଣଙ୍କ ପାଇଖାନା ତିଆରି ହେଲାଣି ?	☐☐ Years		

PL107	Have you made any improvements to this latrine since it was constructed? ଯେବେଠାରୁ ପାଇଖାନା ତିଆରି କରିଛନ୍ତି ଆପଣମାନେ କିଛି ପ୍ରକାର ଉନ୍ନତି କରିଛନ୍ତି ?	Yes ହଁ No ନା	01 02 (skip to PL109)
PL108	What changes/improvements did you make? କଣ ଉନ୍ନତି/ପରିବର୍ତ୍ତନ କରିଛନ୍ତି ?	Please note down response_____ ଦୟାକରି ମନ୍ତବ୍ୟ ଲେଖନ୍ତୁ	
PL109	Where does the waste from the latrine go? ପାଇଖାନାରୁ ମଇଳା ଆବର୍ଜନା କେଉଁଠିକୁ ଯାଏ ?	Septic tank Sewage system Canal/gutter କେନାଲ No disposal/waste remains Other	01 02 (skip to PL114) 03 04 05 Skip to PL116
PL110	Have you had the latrine emptied since it was constructed? ତିଆରି ଠାରୁ ଆପଣ କେବେ ପାଇଖାନା ଖାଲି କରିଛନ୍ତି କି ?	Yes ହଁ No ନା Don't know ଜଣା ନାହିଁ	01 02 (skip to PL116) 03
PL111	How was it emptied? କିପରି ଖାଲି କରିଲେ ?	Manually ହାତରେ Vacuum pump Other ଅନ୍ୟାନ୍ୟ	01 02 03
PL112	Did you have to pay to have it emptied? ଖାଲି କରିବା ପାଇଁ କିଛି ମୂଲ୍ୟ ଦେଇଥିଲେ କି ?	Yes ହଁ No ନା Don't know ଜଣା ନାହିଁ	01 02 03
PL113	How much do you pay to have the pit emptied? ଟାଙ୍କି ଖାଲି କରିବା ଲାଗି କିଛି ମୂଲ୍ୟ ଦିଅନ୍ତି କି ?	☐☐☐☐ Rupees ଟଙ୍କା No sewage connection ସିଓଏଜ୍ କନେକ୍ସନ	Per Month ପ୍ରତି ମାସ ☐ 01 Per Week ପ୍ରତି ସପ୍ତାହ ☐ 02 Per Year ପ୍ରତି ବର୍ଷ ☐ 03 Occasion ବେଳେବେଳେ ☐ 04 Other ଅନ୍ୟାନ୍ୟ _____ 05 No payment ବିନା ମୂଲ୍ୟରେ 77 Don't Know ଜାଣି ନାହିଁ 88 → (skip PL116)
PL114	Do you pay for your sewage connection? ସିଓଏଜ୍ କନେକ୍ସନ୍ ପାଇଁ କିଛି ମୂଲ୍ୟ ଦିଅନ୍ତି କି ?	Yes ହଁ No ନା	01 02 (skip to PL116)
PL115	How much do you pay for your sewage connection? ସିଓଏଜ୍ କନେକ୍ସନ୍ ପାଇଁ କେତେ ମୂଲ୍ୟ ଦିଅନ୍ତି ?	☐☐☐☐ Rupees ଟଙ୍କା	Per Month ପ୍ରତି ମାସ ☐ 01 Per Week ପ୍ରତି ସପ୍ତାହ ☐ 02 Per Year ପ୍ରତି ବର୍ଷ ☐ 03 Occasion ବେଳେବେଳେ ☐ 04 No payment ବିନା ମୂଲ୍ୟରେ 77 Don't Know ଜାଣି ନାହିଁ 88 Other ଅନ୍ୟାନ୍ୟ _____

PL116	Is there water at the facility? ପାଣିର ସୁବିଧା ଅଛି କି ?	Yes, just outside the latrine ହଁ ପାଇଖାନା ବାହାରେ	01
		Yes, inside the cubicle ହଁ ପାଇଖାନା ଭିତରେ	02 (skip to PL119)
		No,everyone brings their own water ନା, ସମସ୍ତେ ନିଜର ପାଣି ନେଇଯାଆନ୍ତି	03
PL117	Where water is collected that is used to flush the toilet? ପାଇଖାନା ସଫା ପାଇଁ କେଉଁଠାରୁ ପାଣି ସଂଗ୍ରହ କରନ୍ତି ?	From source in compound ପାଣିର ଉତ୍ସଟି ଘର ପରିସରରେ	01
		From community source ଗୋଷ୍ଠି ଉତ୍ସରୁ	02
		Other ଅନ୍ୟାନ୍ୟ.....	03
PL118	How far do you have to carry the water to the latrine? ଆପଣଙ୍କୁ କେତେ ଦୂରରୁ ପାଣି ବୋହିକି ପାଇଖାନାକୁ ଯିବାକୁ ପଡେ ?	Please approximate distance from latrine to water source in meters ପାଇଖାନାରୁ ପାଣି ଉତ୍ସର ହାରାହାରି ଦୂରତା କେତେ ମିଟର ଦୟାକରି କୁହନ୍ତୁ	☐☐
PL119	The last time you defecated, where did you defecate? କେଉଁଠି ଶେଷଥର ଆପଣ ଝାଡା ଯାଇଥିଲେ ?	In facility located in compound or dwelling ବ୍ୟବସ୍ଥା ଘର ପରିସର ଭିତରେ	01
		In facility located out of Compound ବ୍ୟବସ୍ଥା ଘର ପରିସର ବାହାରେ	02
		Community latrine ଗୋଷ୍ଠି ପାଇଖାନା	03 [verify if this is a regular event- if YES, fill Section B for Communal Sanitation] ଯଦି ଗୋଷ୍ଠୀ ପାଇଖାନା ସବୁବେଳେ ବ୍ୟବହାର କରନ୍ତି ତେବେ ସେକ୍ସନ ବି କୁ ଯାଆନ୍ତୁ
		In open area, field ଖୋଲା ପଡିଆ	04
PL120	Where do the female adults usually defecate? ସାଧାରଣତଃ ସ୍ତ୍ରୀ ଲୋକମାନେ କେଉଁଠି ଝାଡା ଯାଆନ୍ତି ?	In facility located in compound or dwelling ନିଜ ଘର ପରିସରରେ	01
		In facility located out of compound ବାହାରେ ଥିବା ବ୍ୟବସ୍ଥା	02
		In open area, field ଖୋଲା ପଡିଆ	03
PL121	Where do the male adults usually defecate? ସାଧାରଣତଃ ପୁରୁଷମାନେ କେଉଁଠି ଝାଡା ଯାଆନ୍ତି ?	In facility located in compound or dwelling ନିଜ ଘର ପରିସରରେ	01
		In facility located out of compound ବାହାରେ ଥିବା ବ୍ୟବସ୍ଥା	02
		In open area, field ଖୋଲା ପଡିଆ	03
PL122	Is there an open defecation site in the community? ଗୋଷ୍ଠି ପାଖରେ କୌଣସି ଖୋଲା ପଡିଆ ଅଛି କି ?	Yes ହଁ	01
		No ନାଁ	02 (skip to PL124)
PL123	How long does it take you to go to open defecation site from your house? (Please write '999' for don not go to open defecation) ଆପଣଙ୍କୁ କେତେ ସମୟ ଲାଗେ ଘରୁ ଖୋଲା ପଡିଆକୁ ଯିବା ପାଇଁ ?	☐☐☐ minutes	

OPEN ENDED QUESTIONS: ଖୋଲା ପ୍ରଶ୍ନାବଳୀ

Please ask the respondent the following questions, and write down the answer and completely as possible. Take the time you need. ଦୟାକରି ଉତର ଦାତାଙ୍କୁ ନିମ୍ନଲିଖିତ ପ୍ରଶ୍ନ ଗୁଡିକ ପଚରନ୍ତୁ । ଯେତେଦୂର ସମ୍ଭବ ଦରକାର ହିସାବରେ ସମୟ ନିଅନ୍ତୁ ।

PL124 What did you do/use before if you did not have a private latrine? ଘରୋଇ ପାଇଖାନା ବ୍ୟବହାର କରିବା ପୂର୍ବରୁ କଣ କରୁଥିଲେ ?

_____
_____
_____
_____

PL125 Have you always had a private latrine? [*for example, if you used a community toilet, or went for open defecation before, what motivated you to build your own latrine?]*

ଆପଣଙ୍କ ପାଖରେ ସବୁବେଳେ ଘରୋଇ ପାଇଖାନାର ବ୍ୟବସ୍ଥା ଥିଲା କି ? ପାଇଖାନା ତିଆରି କରିବା ପାଇଁ ଆପଣଙ୍କୁ କଣ ଉତ୍ସାହିତ କରିଥିଲା ? ସାଧାରଣ ସ୍ୱରୂପ (ଯଦି ଆପଣ ଗୋଷ୍ଠୀ ପାଇଖାନା ବ୍ୟବହାର କଲେ ? କି ଖୋଲା ପଡିଆ ଯିବା ପୂର୍ବରୁ)

_____
_____
_____
_____

PL126 Do some members of your household go for open defecation? [probe: times of day, times of year, which members, primary reason] ଆପଣଙ୍କ ଘରର କୌଣସି ବ୍ୟକ୍ତି ଖୋଲା ପଡିଆକୁ ଯାଆନ୍ତି କି ?

_____
_____
_____

WATER SAMPLING			
		YES	NO
W71	**HOUSEHOLD SELECTED FOR WATER SAMPLING?** ପାଣିର ନମୁନା ପାଇଁ ଘରଟି ଚିହ୍ନଟ କରନ୍ତୁ	01	02
		PROCEED	**END**

		YES	NO
W1	If your child/household wanted a drink of water right now, which water would you give him/her? Can you show me your child's drinking water storage container? May I take a sample of this water? ଯଦି ଆପଣଙ୍କ ପିଲା ଏବେ ପାଣି ପିଇବାପାଇଁ ମାଗେ, ତାଙ୍କୁ ଆପଣ କେଉଁଠାରୁ ପାଣି ଦେବେ ? ମୁଁ ତାହା ଦେଖିପାରିବି କି ? ମୁଁ ଏହି ପାଣିର ନମୁନା ନେଇପାରିବି କି ?	01	02
W2	Household sample collected ଘର ପାଣିର ନମୁନା ସଂଗ୍ରହ *Take sample from designated drinking water storage container.* ବ୍ୟବହାର କରୁଥିବା ପାତ୍ରରୁ ପାଣି ନିଅନ୍ତୁ । *Mark Household id and **'H'** for household* ଘରରୁ ନମୁନା ନିଆଯାଉଥିବା ଓରିଲ୍ ପ୍ୟାକ୍ ବ୍ୟାଗରେ ଘରର ନମ୍ବର ଓ 'ଏଚ୍' ଚିହ୍ନଟ କରନ୍ତୁ ।	01	02

HAND RINSES

	YES	NO
HR4 Please request a hand rinse from the primary caregiver of children, or the primary person responsible for cleaning and cooking in the household ଦୟାକରି ଘରକୁ ସଫାସୁତୁରା କରୁଥିବା ଲୋକ ବା ପିଲାର ଯତ୍ନ ନେଉଥିବା ଲୋକ ବା ଘରେ ରୋଷେଇ କରୁଥିବା ଲୋକକୁ ହାତ ଧୋଇବା ପାଇଁ ଅନୁରୋଧ କରନ୍ତୁ ।	01	02

Activities before collecting sample (circle the appropriated one) ନମୁନା ସଂଗ୍ରହ କରିବା ପୂର୍ବର କାର୍ଯ୍ୟ

HR1 What were you doing where we arrived? ଆମେ ପହଁଚିଲା ବେଳେ ଆପଣ କଣ କରୁଥିଲେ ?

Preparing food for cooking/cooking (Peeling, cutting, sorting, washing ଖାଇବା ତିଆରି କରିବା	1
Eating food ଖାଦ୍ୟ ଖାଇବା	2
Cleaning house ଘର ସଫା	3
Washing dishes, pots, pans or clothes ବାସନ, ମାଠିଆ ଏବଂ କପଡା ସଫା	4
Defecating in latrine ପାଇଖାନାରେ ଝାଡା	5
Defecating in open place ଖୋଲା ପଡିଆରେ ଝାଡା କରିବା	6
Urinating ପରିସ୍ରା କରିବା	7
Cleaning child after defecation ଝାଡା ଫେରିବା ପରେ ଝୁଆକୁ ସଫା କରିବା	8
Bathing (self or child) ଗାଧୋଇବା	9
Caring for animal (please specify which type of animal) ପଶୁର ଯତ୍ନ ନେବା (କେଉଁ ପ୍ରକାର ପଶୁ ଦୟାକରି ଚିହ୍ନଟ କର)	10
Other, specify	11

HR2 When did you last wash your hands? ଶେଷଥର ପାଇଁ ଆପଣ କେତେବେଳେ ହାତ ସଫା କରିଥିଲେ ?

Today, less than 30 minutes ago ଆଜି ୩୦ ମିନିଟ୍ ଭିତରେ	1
Today, more than 30 minutes ago ଆଜି ୩୦ ମିନିଟ୍ ପରେ	2
Yesterday ଗତ କାଲି	3
I can't remember ମୋର ମନେ ନାହିଁ	4

HR3 What did you use to wash your hands the last time?ଶେଷଥର ହାତ ଧୋଇବା ପାଇଁ ଆପଣ କଣ ବ୍ୟବହାର କରିଥିଲେ ?

Water only କେବଳ ପାଣି	1
Water and soap ପାଣି ଏବଂ ସାବୁନ	2
Water and ash ପାଣି ଏବଂ ପାଉଁଶ	3
Water and mud ପାଣି ଏବଂ ମାଟି	4
Other ଅନ୍ୟାନ୍ୟ	5

Latrine survey: Private latrine_ section D

LS100	What type of latrine is this? ଏଇଟା କେଉଁ ପ୍ରକାର ପାଇଖାନା ?	Private latrine ବ୍ୟକ୍ତିଗତ ପାଇଖାନା	01	
		Private latrine shared with other households ବ୍ୟକ୍ତିଗତ ପାଇଖାନା ଅନ୍ୟ ଘର ସହିତ	02	Please complete latrine survey E
		Public latrine/sulabh latrine ସର୍ବସାଧାରଣ/ସୁଲଖ	03	
		Community latrine ଗୋଷ୍ଠି ପାଇଖାନା	04	
		Other, please specify_____ ଅନ୍ୟାନ୍ୟ	05	
LS101	How long does it take to walk here from the household? ଆପଣଙ୍କୁ ଘରୁ ଏଠାକୁ ଆସିବାକୁ କେତେ ସମୟ ଲାଗେ ?	☐☐ minutes ମିନିଟ୍		
		No time, as latrine is in the house	55	
LS102	Observe what type of facility is this? ନିରିକ୍ଷଣ: ଏହା କେଉଁ ପ୍ରକାରର ବ୍ୟବସ୍ଥା ?	Flush or pour flush toilet (ପାଣି ଢାଳିବା)	01	
		Pit latrine without slab/open pit ଖୋଲା ପିଟ୍	02	
		Other, ଅନ୍ୟାନ୍ୟ please describe_____	03	
LS103	How many seats are available in the facility? କେତୋଟି ବସିବା ସ୍ଥାନ ଏଠି ଉପସ୍ଥିତ ଅଛି ?	☐☐ seats ବସିବା ସ୍ଥାନ		
LS104	How many seats are in use/functional? କେତୋଟି ବସିବା ସ୍ଥାନ ବ୍ୟବହାର ହୁଏ ?	☐☐ seats ବସିବା ସ୍ଥାନ		
LS105	Is the latrine used by	Men ପୁରୁଷ ☐ Women ସ୍ତ୍ରୀ ☐ Children ଛୋଟ ପିଲା ☐		
		No distinctions made କିଛି ଅନ୍ତର ନାହିଁ	66	
LS106	Is there a space for bathing? ଗାଧୋଇବା ପାଇଁ ସ୍ଥାନ ଅଛି ?	Yes ହଁ	01	
		No ନା	02 (Skip to LS108)	
LS107	Where is the space for bathing? କେଉଁଠି ଗାଧୋଇବା ପାଇଁ ସ୍ଥାନ ଅଛି ?	Inside latrine ଘର ଭିତରେ	01	
		Next to latrine ପାଇଖାନା ପାଖରେ	02	
		Away from house or out of compound ଘର କିମ୍ବା ପରିସର ଠାରୁ ବାହାରେ	03	

LS108	Is the pipe from the pan to the pit intact? ପାଶିରୁ ଟାଙ୍କି ପର୍ଯ୍ୟନ୍ତ ପାଇପ୍ ଠିକ୍ ଅଛି ?	Yes ହଁ	01
		No ନା	02
		Not visible ଦେଖା ଯାଉନାହିଁ	03
		Not applicable ଉପଯୁକ୍ତ ନୁହେଁ	04
LS109	Is there a cover over the pit? ଟାଙ୍କିର ଘୋଡଣୀ ଅଛି କି ?	Yes ହଁ	01
		No ନା	02
		Not visible ଦେଖା ଯାଉନାହିଁ	03
		Not applicable ଉପଯୁକ୍ତ ନୁହେଁ	04
LS110	Is there a place for hand washing? ହାତ ଧୋଇବା ପାଇଁ ସ୍ଥାନ ଅଛି କି ?	Yes ହଁ	01
		No ନା	02 (skip to LS112A)
LS111	Is there soap/ash/soil/detergent for hand washing at the place for hand washing? ହାତ ଧୋଇବା ପାଇଁ ସାବୁନ୍ / ପାଉଁଶ / ଡିଟରଜେଂଟ୍ ଅଛି କି ?	Soap ସାବୁନ୍	01
		Ash ପାଉଁଶ	02
		Detergent ଡିଟରଜେଂଟ୍	03
		More than one of the options କୌଣସି ଗୋଟେରୁ ଅଧିକ	04
		None କିଛି ନୁହେଁ	05

PLEASE FILL OUT ONE ROW FOR EACH INDIVIDUAL SEAT IN THE LATRINE. PLEASE TICK THE BOX WHICH IS APPLICABLE. IF THERE IS NO DISTINCTION BETWEEN SEATS FOR MALES OR FEMALES, PLEASE LEAVE THE BOX BLANK												
Seat nr ବସିବା ସ୍ଥାନ	Water inside cubicle (tap or bucket)? ପାଇଖାନା ଭିତରେ ପାଣି ଟ୍ୟାପ ବା ବାଲ୍‌ଟି	Door or screen up to 1 meter? କବାଟ କିମ୍ବା ପରଦା ଏକ ମିଟର ପର୍ଯ୍ୟନ୍ତ	Pan in working order ପ୍ୟାନ୍‌ର ଅବସ୍ଥା	Does the cubicle have a roof? ପାଇଖାନାର ଛାତ ଅଛି କି ?	Floor wet? ଚଟାଣ ଓଦା ଅଛି କି ?	Dry leaves or rubbish inside the pan? ଶୁଖିଲା ପତର ବା ଅସନା ପ୍ୟାନରେ ଅଛି କି ?	Is there any colour change in the pan? (yellowish) ପ୍ୟାନର ରଙ୍ଗ ବଦଳିଛି କି ? (ହଳଦିଆ)	Is there standing water in the pan? ପ୍ୟାନ ଭିତରେ ପାଣି ଅଛି କି ?	Are there faeces in the cubicle? ପାଇଖାନା ରେ ଝାଡା ଅଛି କି ?	Are there flies in the cubicle? ପାଇଖାନାରେ ମଶା ମାଛି ଅଛି କି ?	Smell in the cubicle? Note: Strong smell= detectable from outside the door ପାଇଖାନରେ ଗନ୍ଧ ହେଉଛି କି ? ଅଧିକ ଗନ୍ଧେଇବା ଯାହା କବାଟ ବାହାରୁ ବାସିବା	Cubicle used for storage in a way that prevents defecation ? ବର୍ଗାଗାର ଘର ଯାହା ଝାଡା ଯିବା ପାଇଁ ପ୍ରତିବନ୍ଧକ ଦିଏ
LS112A	Y☐ N☐	Y☐ N☐	Y☐ N☐	Y☐ N☐	Y☐ N☐	Y☐ N☐	Y☐ N☐	Y☐ N☐	Y☐ N☐	☐Some (<5) ☐Many (5+) ☐None	☐No smell ☐ smell inside ☐ strong smell detectable	Y☐ N☐
LS112B	Y☐ N☐	Y☐ N☐	Y☐ N☐	Y☐ N☐	Y☐ N☐	Y☐ N☐	Y☐ N☐	Y☐ N☐	Y☐ N☐	☐Some (<5) ☐Many (5+) ☐None	☐No smell ☐ smell inside ☐ strong smell detectable	Y☐ N☐

Latrine survey: Community latrine_ section E

LS100	What type of latrine is this? ଏଇଟା କେଉଁ ପ୍ରକାର ପାଇଖାନା ?	Private latrine ବ୍ୟକ୍ତିଗତ ପାଇଖାନା	01 (→ latrine survey for private latrine)
		Private latrine shared with other households ବ୍ୟକ୍ତିଗତ ପାଇଖାନା ଅନ୍ୟ ଘର ସହିତ	02
		Public latrine/sulabh latrine ସର୍ବସାଧାରଣ/ସୁଲଖ	03
		Community latrine ଗୋଷ୍ଠି ପାଇଖାନା	04
		Other, please specify_____ ଅନ୍ୟାନ୍ୟ	05
LS101	How long does it take to walk here from the household? ଆପଣଙ୍କୁ ଘରୁ ଏଠାକୁ ଆସିବାକୁ କେତେ ସମୟ ଲାଗେ ?	☐☐ minutes ମିନିଟ୍	
LS102	Observe: what type of facility is this? ପର୍ଯ୍ୟବେକ୍ଷଣ: ଏହା କେଉଁ ପ୍ରକାରର ବ୍ୟବସ୍ଥା ?	Flush or pour flush toilet ପାଣି ଢାଳିବା	01
		Pit latrine without slab/open pit latrine ଖୋଲା ପିଟ୍	02
		Other, please describe_____ ଅନ୍ୟାନ୍ୟ	03
LS103	How many seats are available in the facility? କେତୋଟି ବସିବା ସ୍ଥାନ ଏଠି ଉପସ୍ଥିତ ଅଛି ?	☐☐ seats ବସିବା ସ୍ଥାନ	
LS104	How many seats are available for କେତୋଟି ବସିବା ସ୍ଥାନ ଅଛି	Men ପୁରୁଷ ☐☐	
		Women ସ୍ତ୍ରୀ ☐☐	
		Children ଛୋଟ ପିଲା ☐☐	
		No distinctions made କିଛି ଅନ୍ତର ନାହିଁ →	66
LS105	How many seats are used/functional? କେତୋଟି ବସିବା ସ୍ଥାନ ବ୍ୟବହାର ହୁଏ ?	☐☐ seats ବସିବା ସ୍ଥାନ	
LS106	How many of the seats which are in use/functional are for: କେତୋଟି ବସିବା ସ୍ଥାନ ବ୍ୟବହାର ହେଉଛି	Men ପୁରୁଷ ☐☐	
		Women ସ୍ତ୍ରୀ ☐☐	
		Children ଛୋଟ ପିଲା ☐☐	
		No distinctions made କିଛି ଅନ୍ତର ନାହିଁ →	66
LS107	Is there a space for bathing? ଗାଧୋଇବା ପାଇଁ ସ୍ଥାନ ଅଛି ?	Yes ହଁ	01
		No ନା	02 (skip to LS109)

LS108	Where is the space for bathing? କେଉଁଠି ଗାଧୋଇବା ପାଇଁ ସ୍ଥାନ ଅଛି ?	Inside the latrine ଘର ଭିତରେ	01	
		Within the structure of the community latrine ଗୋଷ୍ଠି ପାଇଖାନା ଭିତରେ	02	
		Outside the community latrine ଗୋଷ୍ଠି ପାଇଖାନା ବାହାରେ	03	
		Other ଅନ୍ୟାନ୍ୟ	04	
LS109	Is water available? ପାଣିର ବ୍ୟବସ୍ଥା ଅଛି କି ?	Yes, piped water outside of cubicles ହଁ, ପାଇପ୍ ପାଣି ଘର ବାହାରେ	01	
		Yes, piped water inside cubicles ହଁ, ପାଇପ୍ ପାଣି ଘର ଭିତରେ	02	
		Water tank ପାଣି ଟାଙ୍କି	03	
		Standpipe ନଳ କୂପ	04	
		Other, specify _____ ଅନ୍ୟାନ୍ୟ	05	
LS110	Is the pipe from the pan to the pit intact? ପ୍ୟାନରୁ ଟାଙ୍କି ପର୍ଯ୍ୟନ୍ତ ପାଇପ୍ ଠିକ୍ ଅଛି କି ?	Yes ହଁ	01	
		No ନା	02	
		Not visible ଦେଖା ଯାଉନାହିଁ	03	
		Not applicable ଉପଯୁକ୍ତ ନୁହେଁ	04	
LS111	Is there a cover over the pit? ଟାଙ୍କିର ଘୋଡଣା ଅଛି କି ?	Yes ହଁ	01	
		No ନା	02	
		Not visible ଦେଖା ଯାଉନାହିଁ	03	
		Not applicable ଉପଯୁକ୍ତ ନୁହେଁ	04	
LS112	Is there a place for hand washing? ହାତ ଧୋଇବା ପାଇଁ ସ୍ଥାନ ଅଛି କି ?	Yes ହଁ	01	
		No ନା	02	skip LS114A
LS113	Is there soap/ash/soil/detergent for hand washing? ହାତ ଧୋଇବା ପାଇଁ ସାବୁନ୍ / ପାଉଁଶ / ଡିଟରଜେଂଟ୍ ଅଛି କି ?	Soap ସାବୁନ୍	01	
		Ash ପାଉଁଶ	02	
		Detergent ଡିଟରଜେଂଟ୍	03	
		Mud ମାଟି	04	
		More than one of the options କୌଣସି ଗୋଟେରୁ ଅଧିକ	05	
		None କିଛି ନୁହେଁ	06	

Seat nr ବସିବା ସ୍ଥାନ	IF NO DISTINCTION MADE, PLEASE LEAVE BLANK ଯଦି ପାର୍ଥକ୍ୟ ନାହିଁ ତେବେ ଖାଲି ଛାଡି ଦିଅ	Water inside cubicle (tap or bucket)? ପାଇଖାନା ଭିତରେ ପାଣି ଟ୍ୟାପ ବା ବାଲ୍‌ଟି	Door or screen up to 1 meter? କବାଟ କିମ୍ବା ପରଦା ଏକ ମିଟର ପର୍ଯ୍ୟନ୍ତ	Pan in working order ପ୍ୟାନ୍‌ର ଅବସ୍ଥା	Does the cubicle have a roof? ପାଇଖାନାର ଛାତ ଅଛି କି ?	Floor wet? ଚଟାଣ ଓଦା ଅଛି କି ?	Dry leaves or rubbish inside the pan? ଶୁଖିଲା ପତ୍ର ବା ଅସନା ପ୍ୟାନ୍‌ରେ ଅଛି କି ?	Is there any colour change in the pan? (yellowish/ blackish) ପ୍ୟାନର ରଙ୍ଗ ବଦଳିଛି କି ? (ହଳଦିଆ)	Is there standing water in the pan? ପ୍ୟାନ ଭିତରେ ପାଣି ଅଛି କି ?	Are there faeces in the cubicle? ପାଇଖାନାରେ ଝାଡା ଅଛି କି ?	Are there flies in the cubicle? ପାଇଖାନାରେ ମଶା ମାଛି ଅଛି କି ?	Smell in the cubicle? Note: Strong smell= detectable from outside the door ପାଇଖାନରେ ଗନ୍ଧ ହେଉଛି କି ? ଅଧିକ ଗନ୍ଧେଇବା ଯାହା କବାଟ ବାହାରୁ ବାସିବା	Cubicle used for storage in a way that prevents defecation ? ବର୍ଗାଗାର ଘର ଯାହା ଝାଡା ଯିବା ପାଇଁ ପ୍ରତିବନ୍ଧକ ଦିଏ
LS114A	M☐F☐	Y☐ N☐	Y☐N☐	Y☐N☐	Y☐N☐	Y☐N☐	Y☐ N☐	Y☐ N☐	Y☐ N☐	Y☐N☐	☐Some ☐ (<5) ☐Many (5 or more) ☐None	☐No smell ☐ smell inside ☐ strong smell detectable	Y☐ N☐
LS114B	M☐F☐	Y☐ N☐	Y☐N☐	Y☐N☐	Y☐N☐	Y☐N☐	Y☐ N☐	Y☐ N☐	Y☐ N☐	Y☐N☐	☐Some ☐ (<5) ☐Many (5 or more) ☐None	☐No smell ☐ smell inside ☐ strong smell detectable	Y☐ N☐
LS114C	M☐F☐	Y☐ N☐	Y☐N☐	Y☐N☐	Y☐N☐	Y☐N☐	Y☐ N☐	Y☐ N☐	Y☐ N☐	Y☐N☐	☐Some ☐ (<5) ☐Many (5 or more) ☐None	☐No smell ☐ smell inside ☐ strong smell detectable	Y☐ N☐
LS114D	M☐F☐	Y☐ N☐	Y☐N☐	Y☐N☐	Y☐N☐	Y☐N☐	Y☐ N☐	Y☐ N☐	Y☐ N☐	Y☐N☐	☐Some ☐ (<5) ☐Many (5 or more) ☐None	☐No smell ☐ smell inside ☐ strong smell	Y☐ N☐

												detectable	
LS114E	M☐F☐	Y☐ N☐	Y☐N☐	Y☐N☐	Y☐N☐	Y☐N☐	Y☐ N☐	Y☐ N☐	Y☐ N☐	Y☐N☐	☐Some ☐ (<5) ☐Many (5 or more) ☐None	☐No smell ☐ smell inside ☐ strong smell detectable	Y☐ N☐
LS114F	M☐F☐	Y☐ N☐	Y☐N☐	Y☐N☐	Y☐N☐	Y☐N☐	Y☐ N☐	Y☐ N☐	Y☐ N☐	Y☐N☐	☐Some ☐ (<5) ☐Many (5 or more) ☐None	☐No smell ☐ smell inside ☐ strong smell detectable	Y☐ N☐
LS114G	M☐F☐	Y☐ N☐	Y☐N☐	Y☐N☐	Y☐N☐	Y☐N☐	Y☐ N☐	Y☐ N☐	Y☐ N☐	Y☐N☐	☐Some ☐ (<5) ☐Many (5 or more) ☐None	☐No smell ☐ smell inside ☐ strong smell detectable	Y☐ N☐
LS114H	M☐F☐	Y☐ N☐	Y☐N☐	Y☐N☐	Y☐N☐	Y☐N☐	Y☐ N☐	Y☐ N☐	Y☐ N☐	Y☐N☐	☐Some ☐ (<5) ☐Many (5 or more) ☐None	☐No smell ☐ smell inside ☐ strong smell detectable	Y☐ N☐
LS114I	M☐F☐	Y☐ N☐	Y☐N☐	Y☐N☐	Y☐N☐	Y☐N☐	Y☐ N☐	Y☐ N☐	Y☐ N☐	Y☐N☐	☐Some ☐ (<5) ☐Many (5 or more) ☐None	☐No smell ☐ smell inside ☐ strong smell detectable	Y☐ N☐
LS114J	M☐F☐	Y☐ N☐	Y☐N☐	Y☐N☐	Y☐N☐	Y☐N☐	Y☐ N☐	Y☐ N☐	Y☐ N☐	Y☐N☐	☐Some ☐ (<5) ☐Many (5 or more) ☐None	☐No smell ☐ smell inside ☐ strong smell	Y☐ N☐

												detectable	
LS114K	M☐F☐	Y☐ N☐	Y☐N☐	Y☐N☐	Y☐N☐	Y☐N☐	Y☐ N☐	Y☐ N☐	Y☐ N☐	Y☐N☐	☐Some ☐ (<5) ☐Many (5 or more) ☐None	☐No smell ☐ smell inside ☐ strong smell detectable	Y☐ N☐
LS114K	M☐F☐	Y☐ N☐	Y☐N☐	Y☐N☐	Y☐N☐	Y☐N☐	Y☐ N☐	Y☐ N☐	Y☐ N☐	Y☐N☐	☐Some ☐ (<5) ☐Many (5 or more) ☐None	☐No smell ☐ smell inside ☐ strong smell detectable	Y☐ N☐
LS114L	M☐F☐	Y☐ N☐	Y☐N☐	Y☐N☐	Y☐N☐	Y☐N☐	Y☐ N☐	Y☐ N☐	Y☐ N☐	Y☐N☐	☐Some ☐ (<5) ☐Many (5 or more) ☐None	☐No smell ☐ smell inside ☐ strong smell detectable	Y☐ N☐
LS114M	M☐F☐	Y☐ N☐	Y☐N☐	Y☐N☐	Y☐N☐	Y☐N☐	Y☐ N☐	Y☐ N☐	Y☐ N☐	Y☐N☐	☐Some ☐ (<5) ☐Many (5 or more) ☐None	☐No smell ☐ smell inside ☐ strong smell detectable	Y☐ N☐
LS114N	M☐F☐	Y☐ N☐	Y☐N☐	Y☐N☐	Y☐N☐	Y☐N☐	Y☐ N☐	Y☐ N☐	Y☐ N☐	Y☐N☐	☐Some ☐ (<5) ☐Many (5 or more) ☐None	☐No smell ☐ smell inside ☐ strong smell detectable	Y☐ N☐
LS114O	M☐F☐	Y☐ N☐	Y☐N☐	Y☐N☐	Y☐N☐	Y☐N☐	Y☐ N☐	Y☐ N☐	Y☐ N☐	Y☐N☐	☐Some ☐ (<5) ☐Many (5 or more) ☐None	☐No smell ☐ smell inside ☐ strong smell	Y☐ N☐

												detectable	
LS114P	M☐F☐	Y☐ N☐	Y☐N☐	Y☐N☐	Y☐N☐	Y☐N☐	Y☐ N☐	Y☐ N☐	Y☐ N☐	Y☐N☐	☐Some ☐ (<5) ☐Many (5 or more) ☐None	☐No smell ☐ smell inside ☐ strong smell detectable	Y☐ N☐
LS114Q	M☐F☐	Y☐ N☐	Y☐N☐	Y☐N☐	Y☐N☐	Y☐N☐	Y☐ N☐	Y☐ N☐	Y☐ N☐	Y☐N☐	☐Some ☐ (<5) ☐Many (5 or more) ☐None	☐No smell ☐ smell inside ☐ strong smell detectable	Y☐ N☐
LS114R	M☐F☐	Y☐ N☐	Y☐N☐	Y☐N☐	Y☐N☐	Y☐N☐	Y☐ N☐	Y☐ N☐	Y☐ N☐	Y☐N☐	☐Some ☐ (<5) ☐Many (5 or more) ☐None	☐No smell ☐ smell inside ☐ strong smell detectable	Y☐ N☐
LS114S	M☐F☐	Y☐ N☐	Y☐N☐	Y☐N☐	Y☐N☐	Y☐N☐	Y☐ N☐	Y☐ N☐	Y☐ N☐	Y☐N☐	☐Some ☐ (<5) ☐Many (5 or more) ☐None	☐No smell ☐ smell inside ☐ strong smell detectable	Y☐ N☐

APPENDIX 5

EPI method- Shared sanitation research Bhubaneswar- Cuttack

DEFINITIONS FOR DATA COLLECTION

Shared facility: A facility used by other members of the community or by other households

Private facility: A facility which is used **ONLY** by the respondent household.

IF SLUM CONSISTS OF ONE AREA: select a central starting point for data collection on Day 1. On Day 2, select a different starting point, for example, on the opposite side of the slum.

IF SLUM CONSISTS OF SEVERAL AREAS: Select a starting point in each area. Allow for approximate even numbers of questionnaires in each section (ie. Three sections, conduct 6-7 questionnaires in each section. Two sections, conduct 10 questionnaires in each section.

DATA COLLECTION -**Day 1**

1. Select a central point in the slum to start (intersection/meeting area)

2. Take GPS coordinates. Note down.
[use only one GPS machine for all data points to prevent overlap in numbers]

3. Spin pencil /toss coin to determine starting direction
if there are only two possible directions, tossing a coin is acceptable

4. Select every second household on the left. Conduct questionnaire and take gps.

If the HH is locked/ does not want to participate, select the NEXT house

5. Continue collecting information from each 2nd house on the left

If there are only two directions, tossing a coin is acceptable. Before tossing the coin, determine what the outcome will indicate: i.e. If it is heads, we go right'

Spin the pencil on clipboard if there is no even ground or if the ground is wet

If there are no houses on the left, continue until the end of the path/road and turn around to start sampling every second house on the left. If there are no houses or no 'front doors' on the left, the enumerators will automatically return to the central point, where a new direction can be randomly chosen]

If 4 consecutive questionnaires result in the same type of sanitation (shared-shared-shared-shared or private-private-private-private) return to starting point to randomly choose a new direction

Day 2

6. Follow steps 1-5, as done on Day 1 until 20 questionnaires have been completed (Ideally 10 shared-10 private)
   Different starting point from day 1

All the same guidelines apply.

If on day 2 you encounter an area which was covered on day 1, toss a coin/spin pencil if there are uncovered routes. If there are no uncovered routes, return in the direction from which you came, selecting every 2nd household on the left

The process changes ONLY when one type of facility becomes over-represented [ie. 12 questionnaires of households sharing, or 12 questionnaires of households with private latrines]

If you reach 12 questionnaires using **shared** facilities

STOP collecting data on **shared** facilities

Spend 30 minutes (note time) searching only for HHs using **private facilities**, using the prescribed methodology (steps 1-5 from day 1)

If you reach 12 questionnaires using **private** facilities

STOP collecting data on **private** facilities

Spend 30 minutes (note time) searching only for HHs using **shared facilities**, using the prescribed methodology (steps 1-5 from day 1)

If after 30 minutes, no HH can be found through the prescribed methodology, spend the remainder of the field-day asking individuals in the slum if they know anyone with a private/shared altrine9as required). It is important to ask different people in different areas. If this methodology is used, please note on the Slum Overview Form.

APPENDIX 6

Slum code:
Date of visit:
Questionnaires conducted at the same time Y/N? :

Boundary map:
GPS waypoints range from _____ to _____

Population:
Approximate population according to 3 different respondents (*different areas of the slum*)
Person 1: _____HH/People/Family
Person 2: _____HH/People/Family
Person 3: _____HH/People/Family

Sanitation
Nr of public or communal latrine facilities in the slum

Nr of open defecation sites used by slum inhabitants

Mark the GPS coordinates of each OD area (central) and note down
OD area 1 visible faeces yes/no
OD area 2 visible faeces yes/no
OD area 3 visible faeces yes/no
OD area 4 visible faeces yes/no

Are there streetlights in the slum? YES/NO
Are they functional _____

Solid waste management:
Where do you put your rubbish/household waste?
Designated area_____
Open space_____
Other_____

Waste collected by Municipality? YES/NO

Slum Characterisation

Water:
Nr of public water points in the slum:

Sl. No.	Code the water points	Availability 24/7 Yes/ No	Different types of water sources	No. of the source
1			Piped water	1
2			Tap	2
3			Shallow tube well (popular 6)	3
4			Deep borehole fitted with handpump (India Mark II/III)	4
5				
6			Protected dug well	5
7			Unprotected dug well	6
8			Surface water: River/ lake/ pond / canal	7
9				
10				
11				
12				
13				
14				
15				
16				
17				
18				
19				
20				

Additional remarks

APPENDIX 7

Information sheet and consent form

ସୂଚନା ପତ୍ର ଓ ସହମତି ପତ୍ର

Focus Group Discussions on sanitation facilities in urban slums in Bhubaneswar and Cuttack, Odisha

ଭୁବନେଶ୍ୱର ଓ କଟକରେ ଥିବା ବସ୍ତି ଗୁଡିକର ଗୋଷ୍ଠି ଆଲୋଚନା ସମ୍ବନ୍ଧୀୟ ସୂଚନାବଳୀ, ଓଡ଼ିଶା

ଗବେଶଣାକାରୀ –

Researcher: Marieke Heijnen (marieke.heijnen@lshtm.ac.uk)
Project supervisor: Belen Torondel (belen.torondel@lshtm.ac.uk)

Good morning/afternoon, my name is .....

ଶୁଭ ସକାଳ / ଶୁଭ ଓପରବେଳା,ମୋ ନାମ ----------

I work at the London School of Hygiene and Tropical Medicine. The London School of Hygiene and Tropical Medicine is currently collaborating with the Xavier Institute of Management, Bhubaneswar to conduct research on 'shared sanitation' in the slums of Cuttack and Bhubaneswar.

ମୁଁ ଲଣ୍ଡନ ସ୍କୁଲ ଅଫ ହାଇଜିନ୍ ଏବଂ ଟ୍ରପିକାଲ ମେଡିସିନ୍‌ରେ କାମ କରେ । ଲଣ୍ଡନ ସ୍କୁଲ ଅଫ ହାଇଜିନ୍ ଏବଂ ଟ୍ରପିକାଲ ମେଡିସିନ୍ ଏବଂ ଜାଭିଅର ଇନ୍‌ଷ୍ଟିଚ୍ୟୁଟ୍ ଅଫ ମ୍ୟାନେଜମେ , ଭୁବନେଶ୍ୱର ଏହି ଗବେଷଣା "shared sanitation" କଟକ ଓ ଭୁବନେଶ୍ୱର ଥିବା ବସ୍ତି ଉପରେ ପରିଚାଳନା କରୁଛି ।

Why are we inviting you to participate in Focus Group Discussion?

ଆମେ ଆପଣମାନଙ୍କୁ ଏ ଗୋଷ୍ଠି ଆଲୋଚନାରେ କାହିଁକି ନିମନ୍ତ୍ରଣ କରୁଛ ?

In this research, we are hoping to learn more about sanitation facilities in slums of Bhubaneswar and Cuttack city. We are approaching the slum dwellers to participate and share their experiences on the subject of our research. Therefore, we would like you to participate and share your views on this subject.

ଏହି ଗବେଶଣାରେ ଆମେ ଭୁବନେଶ୍ୱର ଓ କଟକ ସହରରେ ଥିବା ବସ୍ତି ପରିମଳ ବ୍ୟବସ୍ଥା ସିଖିବା ପାଇଁ ଚାହୁଁଛୁ । ସେଥିପାଇଁ ବସ୍ତିରେ ବସବାସ କରୁଥିବା ଲୋକମାନଙ୍କର ଏ ଗବେଶଣାରେ ଭାଗ ନେବାକୁ ସାହାଯ୍ୟ ଲୋଡୁଛୁ ।

Risks & Benefits **କ୍ଷତି ଓ ସୁବିଧା** –:There are no risks involved with your participation in this study. We would only request for your time. Your participation is voluntary as there is no monetary compensation for taking part in this study. Instead, we (researchers) will be benefitted from your views, experiences and opinions as it will help fill the knowledge gaps.

ଏହି ଅନୁଧାନରେ ଭାଗ ନେବା ଆପଣଙ୍କ ଉପରେ କୌଣସି ବିପଦ ସହିବା ପାଇଁ ପଡିବ ନାହିଁ । ଆପଣଙ୍କ ଯୋଗଦାନ ସଂପୂର୍ଣ୍ଣ ଆପଣଙ୍କ ଉପରେ ନିର୍ଭର କରେ ଓ ଏଥିରେ ଭାଗ ନେବା ପାଇଁ ଆପଣମାନଙ୍କୁ କିଛି ପଇସା ଆକାରରେ ମିଳିବ ନାହିଁ । ଅତେବ, ଆପଣମାନେ ଦେଇଥିବା ବ୍ୟକ୍ତିଗତ ମନ୍ତବ୍ୟ ଓ ମତାମତ ଆମ ପାଇଁ ଅତି ଲାଭ ଜନକ ହେବ । ଯାହାକି ଆମ ଗବେଷଣାରେ ଆମକୁ ବହୁତ ସାହାଯ୍ୟ କରିବ ।

Privacy, anonymity and confidentiality

ଗୋପନୀୟ

All the information we collect will be kept confidential and will be used only for the purpose of the study. Though we will ask all participants to maintain a similar level of confidentiality about what was said during the discussion, we cannot guarantee all participants will do so.

ଆପଣମାନଙ୍କ ଦ୍ୱାରା ଦିଆଯାଇଥିବା ତଥ୍ୟକୁ ଗୋପନୀୟ ରଖାଯିବ ଏବଂ କେବଳ ଆମର ଗବେଶଣାରେ ବ୍ୟବହାର କରାଯିବ । ଯଦିବା ଆମେ ଏହି ଆଲୋଚନାରେ ଅଂଶଗ୍ରହଣକାରୀଙ୍କୁ ମଧ୍ୟ ଶୁଣାଉଛୁ ଯେ ସେମାନଙ୍କ ଓ ଅନ୍ୟମାନଙ୍କର ଦିଆଯାଇଥିବା ମନ୍ତବ୍ୟକୁ ଗୋପନୀୟ ରଖାଯିବ । ତଥାପି ଆମେ ଆପଣଙ୍କୁ guarantee ଦେଇପାରିବୁ ଯେ ସମସ୍ତେ ଆମ ଅନୁରୋଧ ରକ୍ଷା କରିବେ ।

Right not to participate and withdraw

ଅଂଶ ଗ୍ରହଣ ନ କରିବା ବା ଓହରିଯିବା -:

Taking part in the study is completely voluntary. You may choose not to answer any or all of the questions that will ask. You can drop out of this study at any time, even in the middle of the discussion.

ଆପଣମାନଙ୍କ ଯୋଗଦାନ କରିବାର ନିଷ୍ପତି ଆପଣମାନଙ୍କର ଉପରେ ସଂପୂର୍ଣ୍ଣ ନିର୍ଭର କରେ । ଆପଣ କୌଣସି ପ୍ରଶ୍ନର ଉ ର ଦେବା ପାଇଁ ମନା କରିପାରନ୍ତି ଓ ଅଧ୍ୟୟନର ଯେକୌଣସି ସମୟରେ ଓହରି ଯାଇ ପାରନ୍ତି ।

Persons to contact:

ଯୋଗାଯୋଗ କରିବା ଠିକଣା –

If you have any questions, you can ask me any time. If you have additional questions about the focus group discussions, you may contact Belen Torondel, based at XIM, Bhubaneswar.
If at any time during the study, you have questions or you wish to know more about your rights as a participant in a research study, you may speak to any of the investigators. Investigators may be contacted through the school or at the following address:-

ଆପଣଙ୍କର ଯଦି କୌଣସି ପ୍ରଶ୍ନ ଅଛି, ତେବେ ଆପଣ ଆମକୁ ଯେକୌଣସି ସମୟରେ ପଚରି ପାରିବେ । ଯଦି ଆପଣଙ୍କ ପାଖରେ ଅଧିକ ପ୍ରଶ୍ନ ଅଛି ଏହି ଗୋଷ୍ଠି ଆଲୋଚନାକୁ ନେଇ ତା ହେଲେ ଆପଣ ବେଲେନ ତୋରନଡେଲଙ୍କୁ ଯୋଗାଯୋଗ କରିପାରିବେ ଯେ କି ଏକ୍ସ.ଆଇ.ଏମ୍. ଭୁବନେଶ୍ୱରରେ ଅବସ୍ଥିତ । ଯଦି ଅଧ୍ୟୟନ ସମୟରେ ଆପଣଙ୍କ ମନରେ ଅଧ୍ୟୟନ କିମ୍ବା ଅଧିକାର ସମ୍ବନ୍ଧୀୟ କୌଣସି ପ୍ରଶ୍ନ ଉଠେ, ତାହେଲେ ଆପଣ ଯେକୌଣସି ଅନୁସନ୍ଧାନକାରୀଙ୍କୁ ପଚରିପାରିବେ । ଅନୁସନ୍ଧାନକାରୀକୁ ଲଣ୍ଡନ ସ୍କୁଲ ମାଧ୍ୟମରେ ଯୋଗାଯୋଗ କରିପାରିବେ ନହେଲେ ନିମ୍ନଲିଖିତ ଠିକଣା

Prof. Subhajyoti Ray
Xavier Institute of Management,
Xavier Square,
Bhubaneswar – 751 013

Consent Form

ଯୋଗଦାନ ଚୁକ୍ତି -:

The above description of the research project was read to me by .....

Anything I did not understand was explained to me by him/her. , and any questions I had were answered by him/her. I understand that at any time I may withdraw from this study without giving a reason and without repercussions. I agree to take part in this study.

ଉପରୋକ୍ତ ବର୍ଣ୍ଣନୀୟ ଗବେଷଣା ଜନିତ ବିବରଣୀକୁ ପଢ଼ାଯାଇଥିଲା ----------ଙ୍କ ଦ୍ୱାରା । ଯେଉଁ ଉକ୍ତି ଗୁଡିକ ମୁଁ ବୁଝିପାରି ନଥିଲି, ତାହା ମୋତେ ବର୍ଣ୍ଣନା କରାଗଲା ଏବଂ ଯେଉଁ ପ୍ରଶ୍ନଗୁଡିକର ଉ ର ମୁଁ ଦେଇ ନଥିଲି ତାହାର ଉ ର ମଧ୍ୟ ମୁଁ ଜାଣି ପାରିଲି । ମୁଁ ଜାଣି ପାରିଲି ଯେ ମୁଁ ଯେକୌଣସି ସମୟରେ ଏ ଆଲୋଚନାରୁ ଓହରି ଯାଇ ପାରିବି । ମୁଁ ସ୍ୱଇଚ୍ଛାରେ ଏହି ଗବେଷଣାରେ ଯୋଗ ଦେବା ପାଇଁ ସଂପୂର୍ଣ୍ଣ ଭାବରେ ଏକମତ ।

Sl No	Name of person giving consent ସ୍ୱୀକୃତି ଦେବା ବ୍ୟକ୍ତିର ନାମ	DATE ତାରିଖ	Signature ସ୍ୱାକ୍ଷର

Name of the person taking consent .....

ସ୍ୱୀକୃତି ନେବା ବ୍ୟକ୍ତିର ନାମ

Signature .....

ସ୍ୱାକ୍ଷର

DATE

ତାରିଖ

Slum details

ବସ୍ତିର ବିବରଣୀ :

Focus Group Discussion Guide_ Sanitation in Urban Slums Bhubaneswar/Cuttack_Separate discussions for women and men

Questions:

OVERALL

1. Let's start the discussion by talking about what sanitation options- what types of toilets- are available to you for use when you are at home?

    a) Community latrine?
    b) Do people have private latrines?
    c) Do people go for OD?

2. Which type of facility to most of you here use?

COMMUNITY LATRINE

3. How long has the community latrine been in use?
    a) Do you know who constructed it?
    b) Do you know when it was constructed?
    c) Have you made any changes/improvements to it since it was constructed?

4. Do you always use this toilet?
    a) Do you sometimes use other means (OD, different latrine etc.)
    b) Different times of the day?
    c) Different times of the year?

5. What are the good things about these toilets?
    a) Water available?
    b) Clean?
    c) Privacy?
    d) Accessible?
    e) Space for bathing?

6. What are some of the things that aren't so good about these toilets?
    a) Crowded?
    b) Cost?
    c) Opening times?
    d) Dirty?
    e) Nonfunctional?

INDIVIDUAL HOUSEHOLD LATRINE

7. What about the people who have private, household latrines in the community?
    a) Did they self-finance the construction? –how many people
    b) Were there subsidies?- who subsidized, how much?
    c) Do the people who have a private latrine use it all the time?

CLEANING & MAINTENANCE

8. How do you arrange the cleaning of the community toilet?
    a) Is there a sweeper or do the users clean?
    b) How often does the sweeper come?
    c) How often do the users clean?
    d) How much is the sweeper paid?

    e) If you as the users clean, how do you arrange it? Is there a rotation? Or are there some households which clean more often than others?
    f) How do you purchase of materials for cleaning? (harpic, broom etc.). do you have a communal fund for this?
    g) Are you happy with the cleanliness of the facility?
    h) If not what could you do about it?

    i) What about if something breaks? Or needs replacement? How do you arrange this within the community? *Alternative question: have you had any problems with the latrine? Ie. That you could no longer use it? If so, what did you do to fix it?*
9. Bathing
    a) Where do people usually go for bathing? Is this different for men and women?
    b) Where do people usually go for bathing after defecation? Men/women/children?

WASTE MANAGEMENT

10. Do you know where the waste from the latrine go?
    a) Septic tank?
    b) Sewer connection?
    c) If it's a septic tank, do you pay to have it emptied?- how much? How often? Who empties? (manual labour? Municipality? Other private organization?)
    d) If it's a sewer connection, do you pay the municipality?
    e) What about the people with a private latrine, how do they deal with the waste? –where does it go, does it take payment, how is it emptied?

MOTIVATION

11. Have you considered building your own toilet?
    a) What is stopping you?
    b) Or what options are available to you?

12. How do you feel about people who go for OD?

WOMEN & CHILDREN

13. What about the young children, do they use the shared facility?
14. Do the women use the community latrine? Do you prefer the community latrine or do you prefer other options (such as OD). Why? Why not?
    Probe: privacy? Safe to go at night?
15. If you could change one thing about your sanitation situation (whatever you use, OD/comm lat/private lat), what would you change?

APPENDIX 8: PERMISSIONS FROM COPYRIGHT HOLDERS FOR MANUSCRIPT USE

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TMIH

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