Disposal of child faeces: practices, determinants and health effects

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Thesis submitted in accordance with the requirements for the degree of

Doctor of Philosophy, University of London

January 2017

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LONDON SCHOOL OF HYGIENE & TROPICAL MEDICINE

Funded by a grant from the Bill & Melinda Gates Foundation.

Declaration

'I, Fiona Majorin, 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 *Fiona Majorin*__________________ Date: January 2017

Fiona Majorin

Abstract

An estimated 2.4 billion people worldwide lack access to improved sanitation. This includes nearly 1 billion people practicing open defecation, of which around 60% reside in India. Even among households with access to improved sanitation, children's faeces—a potentially important source of disease transmission—are not always disposed of safely (disposal of faeces or defecation into latrine). In India only 20% of child faeces were reportedly disposed of safely in the latest National Family Health Survey (2006).

This research has two overall aims. The first is to summarize existing knowledge of the health impact of safely disposing child faeces. The second is to advance our understanding of the scope and possible reasons for unsafe disposal of child faeces among a population in Eastern India. To achieve these aims a systematic review and cross-sectional study were conducted.

The systematic review summarized the evidence on the effectiveness of interventions to improve child faeces disposal for preventing diarrhoea and soil-transmitted helminth (STH) infections from 46 studies. The evidence suggested that safe child faeces disposal may reduce diarrhoea. However, the evidence was limited and of low quality. Only 2 studies measured effects on STH, neither found a protective effect.

Findings from the cross-sectional study in slums in Odisha, India, were divided into two papers. The first described child faeces management practices and identified potential sources of faecal exposure, highlighting the importance of considering other steps of child faeces management rather than just the place of disposal. The second paper investigated factors associated with being a safe disposal household, where the faeces of all children <5 ended up in a latrine. Significant risk factors were: education and religion of the primary caregiver, number and mobility of children <5 in the household, wealth, type and location of latrine, and defecation behaviours of household members >5.

Acknowledgements

I would like to thank my supervisor, Dr Thomas Clasen, for his advice and guidance during the PhD. I'm very grateful for his flexibility and availability to answer questions or provide advice whenever needed. I thank him for the opportunity of doing a PhD and all of the valuable things I learnt as a result.

Thanks also to my associate supervisor Dr Belen Torondel, for the encouragements throughout the PhD and the helpful practical advice during field work. I'm also enormously grateful for the many hours spent doing the second data extraction for the systematic review and the hours we talked on Skype comparing our extractions!

I would like to thank the wonderful team I had the pleasure of working with in Bhubaneswar. Their experience, enthusiasm and diligence were all key parts in completing the research. I would like to give particular thanks to Parimita Routray for her valuable advice and her availability for questions throughout the process; and Manaswani Rout for all her help in the field work management. Many thanks to the supervisors Munmun Dasmohapatra, Alfred Mohanty and Soumya Nayak for their hard work and the lovely data collection team, Sunita Ray, Sasmita Barik, Puspa Barik, Swarnalata Sahoo, Rajani Barik, Archana Harichandan, Arnapurna Harichandan, Rajashree Nayak and the data entry team Sadasiv Khotia and Sonam Sahoo, and drivers without whom the research would not have been possible.

I would also like to thank my co-authors who contributed to the papers presented in chapters 2, 3, 5 and 6. Firstly, thanks to Belen Torondel, Gabby Ka Seen Chan and Thomas Clasen for their contributions to the Cochrane protocol and review. T. Clasen and I planned the review. I drafted the protocol and all authors provided general advice on the protocol and commented on and revised protocol drafts, and approved the final version. For the full review, I screened all the titles. B. Torondel, G. Ka Seen Chan and I screened abstracts and full texts. I contacted authors for additional information. B. Torondel, G. Ka Seen Chan and I extracted data. I entered the data and B. Torondel checked a sample. I drafted the review and all authors provided comments on it.

Secondly, I would like to thank the authors for the cross-sectional papers: Belen Torondel, Parimita Routray, Manaswini Rout and Thomas Clasen. I drafted the study protocol and data collection tools for the cross-sectional study, with input from study authors. I trained the field staff with the assistance of M. Rout and P. Routray. During the study, M. Rout and I managed the team and coordinated the work and logistics. After data collection, I analysed the data and drafted the manuscripts. All authors read and commented on the manuscript for the paper in chapter 5. B. Torondel and T. Clasen read and commented on the prepared manuscript in chapter 6.

I would also like to thank the many people who provided advice or help at various stages in the PhD: Dr Jeroen Ensink, Dr Monique Hennink, Dr Adam Biran, Dr Wolf-Peter Schmidt, Dr Matthew Freeman, Dr Robert Aunger, Dr Sandy Cairncross, Dr Corey Nagel, Jane Bruce, Aurelie Jeandron, Lyndsey Gray and Christianne Esparza and the CIDG team at Cochrane.

To my colleagues and friends at LSHTM who made the PhD process a lot more enjoyable, Maryann Delea, Lauren D'Mello-Guyett, Ghislaine Rosa, Aurelie Jeandron, Katie Greenland, Sian White, Jessica de Witt Huberts, Miles Kirby, Marieke Heijnen, Sophie Boisson, Gaby Judah and the EHG PhD students.

I'm also very grateful for my friends outside of LSHTM, without whom I would have struggled to keep things in perspective. Special thanks to Dr Leora Feldstein, for sharing her wisdom in the last stretch of the PhD.

Last but not least, this PhD journey would not have been possible without the incredibly supportive family I am lucky to have, especially Chris, without whom I would never have been able to finish in one piece! Thanks for the continuous encouragements, the notes to keep going (and also for keeping me well fed and refilling my teas and coffees). I am looking forward to our post-PhD married life!

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List of Abbreviations

ASHA	Accredited Social Health Activist
AWW	Anganwadi worker
BPL	Below poverty line
CBA	Controlled before-and-after studies
CHC	Community health clubs
CI	Confidence interval
CRCT	Cluster RCT
DHS	Demographic and Health Survey
EED	Environmental Enteric Dysfunction
HAZ	Height for age Z score
JMP	WHO/UNICEF Joint Monitoring Programme for Water and Sanitation
MICS	Multiple Indicator Cluster Survey
MDG	Millennium Development Goals
NRS	Non-randomised studies
NOS	Newcastle Ottawa scale
OR	Odds ratio
RCT	Randomized controlled trial
RR	Risk ratio
SDG	Sustainable development goals
STH	Soil transmitted helminth
TSC	Total Sanitation Campaign
UN	United Nations
UNICEF	United Nations Children's Fund
WASH	Water Sanitation and Hygiene
WAZ	Weight for age Z score
WHO	World Health Organisation
WSP	World Bank Water and Sanitation Program

1. Introduction

1.1. Background

Faecal-oral diseases are transmitted from one person to another via faeces contaminating hands, water, fields, flies or food (figure 1.1) [1]. Faeces contain large amounts of bacteria, viruses, helminth eggs and protozoa, including those that cause diarrhoea [2]. Diarrhoea is responsible for the deaths of an estimated 1.3 million people per year, ranking fourth in the leading causes of years of life lost due to premature mortality [3]. Children below the age of five are most vulnerable with more than 519,000 children dying annually of diarrhoea [3].

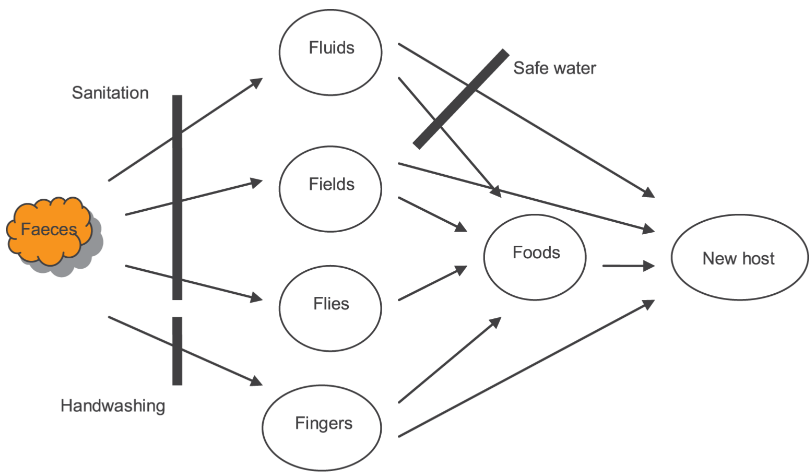

Figure 1.1: F-diagram (Wagner and Lanoix 1958), image source: [4]

Other diseases are also associated with the contamination of the environment with faeces; these include trachoma, with 21.4 million cases of active trachoma worldwide in 2011 [5] and soil-transmitted helminths (STHs), which infected 819 million (*Ascaris lumbricoides*), 464.4 million (*Trichuris trichiura*) and 438.9 million (hookworm) people in 2010 [6]. Schistosomiasis also presents a large burden worldwide with a prevalence of 238.4 million people in 2010 [7]. In addition, substantial ingestion of faecal bacteria may lead to environmental enteropathy, a sub-clinical condition characterized by villous atrophy and intestinal malabsorption leading to under nutrition and stunting [8, 9]. Lack of appropriate sanitation has also been associated with important long-term consequences on cognitive skills and stunting [10, 11].

Sanitation is a primary barrier to environmental contamination by faeces [12], making it an essential mechanism for preventing faecal-oral diseases transmission. Several systematic reviews have linked sanitation with lower risks of diarrhoea [13-17], STH infections [14, 18, 19], schistosomiasis [14, 20] and trachoma [21, 22].

In addition to sanitation, other barriers to faecal-oral diseases are important. These include hand washing following contact with excreta to remove all traces of faecal material, which also constitutes a primary barrier to transmission. Secondary barriers include hand washing before cooking, preventing the contamination of water sources, ensuring children have play areas free of faecal material and reducing flies [12].

1.2. Sanitation coverage

Despite the recognition of the importance of sanitation and large-scale efforts to improve access to facilities, 2.4 billion people still did not have access to improved sanitation in 2015 including nearly 1 billion people practicing open defecation [23].

The coverage is uneven worldwide, with the majority of the people who do not use improved sanitation, living in southern Asia, Sub-Saharan Africa and Eastern Asia [23]. Of the nearly 1 billion practicing open defecation, around 60% reside in India. In addition, there are wide disparities in coverage between urban and rural households (figure 1.2), and even across states and districts [24].

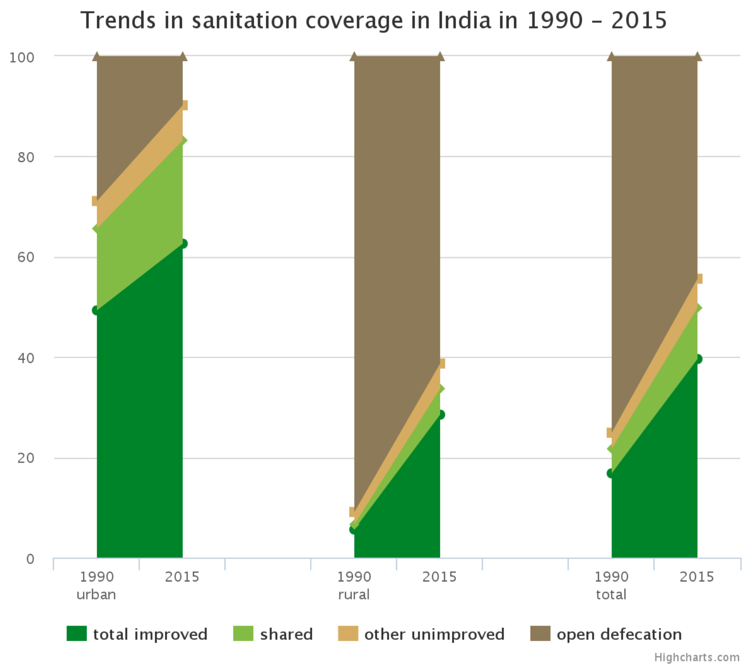

Figure 1.2: Trends in sanitation coverage in India in 1990- 2015. Source: [25]

There is also evidence that even in households with sanitation, these may not be used [26-28]. Another aspect of under-use of sanitation facilities is the improper collection and disposal of child faeces [29-31].

Global estimates on sanitation access are based on the primary sanitation facility of a household. Thus, the disposal of children's faeces is not considered in these estimates [32].

1.3. <u>The potential role of child faeces disposal in public health</u>

Sanitation has been defined as 'the safe disposal of human excreta' and it is recognised that both adult and infants faeces should be included in the definition [4]. There are several reasons, however, why the safe management of children's faeces may deserve even greater priority than those of adults.

Firstly, young children have the highest incidence of enteric infections [33] and their faeces are most likely to contain transmissible pathogens [2]. Secondly, latrines are not designed for, or used by young children [34] and young children tend to defecate in areas where susceptible children could be exposed [35]. Since young children's faeces are often not considered to be dangerous, offensive [36-38] or impure [39], their presence and disposal in the environment is not seen as problematic. Young children are more vulnerable to exposure to faeces due to their immature immune system and the time they spend on the ground carrying exploratory behaviours, which include putting fingers and fomites in their mouths and geophagia [40-42]. Thirdly, diarrhoea is one of the main causes of death of young children making them most vulnerable to faecal exposure [3].

Despite the special risks presented, child faeces disposal has been an under-researched and neglected area of sanitation [4]. In a review and meta-analysis of 10 observational studies published between 1987 and 2001, Gil and colleagues (2004) found that child faeces disposal behaviours considered risky (open defecation, stool disposal in the open, stools not removed from soil, stools seen in household soil, and children seen eating faeces) were associated with a 23% increase in risk of diarrheal diseases (RR 1.23, 95% confidence interval (CI) 1.15 to 1.32); on the other hand, behaviours considered safe (use of latrines, nappies, potties, toilets, washing diapers) were borderline protective (RR 0.93, 95% CI 0.86 to 1.00)[43]. An unpublished update of the systematic review [44] found a further four papers. Two papers found that unsafe disposal of child faeces (not in a latrine) increased the risk of diarrhoea [45, 46]. Of note is that Tumwine and colleagues (2002) found that burying of faeces increased the odds of having diarrhoea by more than three-fold [45]. The other two papers found no significant association between presence of human faeces in the compound and bloody diarrhoea [47] and between potty use and typhoid fever [48].

A study in rural Bangladesh found that the disposal of child faeces in closed spaces such as pit latrines was associated with a 35% reduction in helminthiasis in children under two compared with disposal in open spaces [49], indicating that safe disposal of child faeces may also play a role in the control of enteric infections other than diarrhoea.

As I will describe in chapter 3, I led a team that conducted a Cochrane systematic review of interventions to improve the disposal of child faeces to prevent diarrhoeal diseases and STH infection, providing the first comprehensive summary and analysis of the evidence. Recently, a more limited systematic review on the topic has just been accepted for publication [50]. While the review had limitations described in Chapter 3 below, there were similarities with our review.

1.4. Defining safe child faeces disposal

For global monitoring purposes, safe disposal of child faeces is defined by the World Health Organization (WHO) and United Nations Children's Fund (UNICEF) Joint Monitoring Programme for Water and Sanitation (JMP) as defecation in a latrine, disposal in a latrine or burial of the faeces [51]. UNICEF only considers disposal in a latrine and defecation in a latrine as safe disposal [52]. The World Bank Water and Sanitation Program (WSP) further categorised safe disposal (faeces ending up in a latrine) into 'improved disposal' if the latrine, is considered improved [32].

An expert consultation was conducted to decide whether burial of child faeces or disposal with garbage should be considered as safe or improved. The consultation concluded that neither should be considered safe or improved, due to among other arguments, the proximity of solid waste and burial sites to the house and the children's play areas, and that neither practice would be considered improved for adults [53]. The JMP has not yet published the definition of what will constitute safe child faeces disposal, in the sustainable development goals (SDG) monitoring [54].

These definitions may be poor proxies for the health risks associated with child faeces. Disposing of child faeces in a latrine or burying the faeces deals only with the most visible evidence after a child defecates; it does not remove the microbiological evidence or the potential for exposure. A policy that encourages a child carer to remove and dispose of faeces in a latrine or by burying them could result in greater exposure to the child from the carer's unwashed hands and from the site of defecation. This idea will be explored further in chapter 5, where child faeces management practices will be described in detail.

1.5. Prevalence of safe disposal of child faeces

In a recent report, presenting analysis of data from the latest available Multiple Indicator Cluster Surveys (MICS) and Demographic and Health Surveys (DHS), the WSP observed that safe child faeces disposal was poor worldwide, with 14 out of the 26 locations that they studied, having more than 50% of child (<3 years) faeces being disposed of unsafely (not into a latrine) [32]. An even smaller proportion ending up in improved latrines (figure 1.3). The prevalence of improved disposal was worse than the access to improved sanitation in all but three of the investigated locations [32].

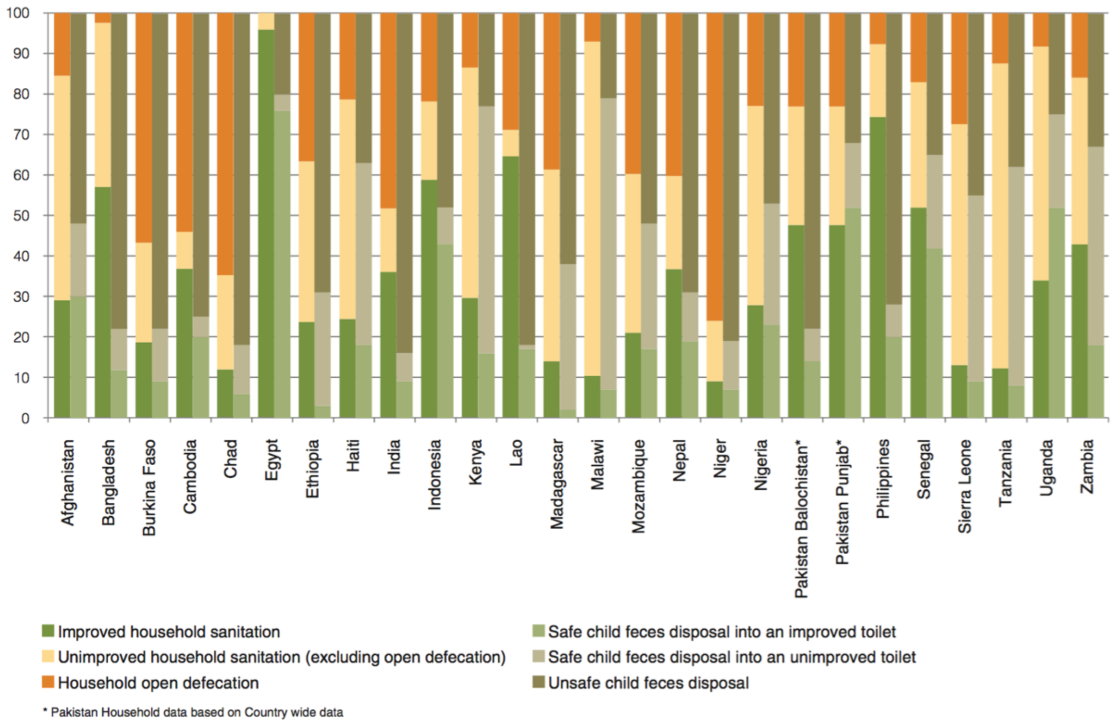

Figure 1.3: Percentage of the population with improved sanitation comparing it with proportion of population practicing safe faeces disposal of their youngest child <3. Source: [32].
For each country shown in the figure, the left bar is showing the type of household sanitation facilities (improved, unimproved, open defecation) and the right bar is showing the child faeces disposal practice of the household (improved disposal, safe disposal or unsafe disposal).

The country of India and the Eastern State of Odisha represent some of the major challenges in the disposal of child faeces. According to the latest National Family Health Survey (2005-2006), nationally 78.9% of child (<5) faeces were disposed of unsafely with the majority of the faeces being left in the open (44%) and disposed of in the garbage (25.6%)[55]. Nationally, safe disposal was found to be more prevalent in urban areas (47.2%) compared to rural areas (11.4%). The main practices reported in urban areas were the child used the toilet/ latrine (26.8%), the faeces were left in the open (24.6%) and the faeces were put in a toilet/ latrine (20.1%). In rural areas, the main practices were the faeces were left in the open (51.1%) and throwing the faeces in the garbage (28.8%)[55]. The State of Odisha had one of the country's lowest percentages of safe disposal with only 7% of the faeces being safely disposed (includes defecation and disposal in a latrine as well as burial of faeces); again, the main disposal sites were leaving the faeces in the open (53.7%) and throwing them in the garbage (32.3%). The child faeces management data presented for Odisha, is not presented separately for urban and rural areas but it can be assumed that the prevalence of safe disposal is higher in urban areas, as this is the case nationally. Furthermore, access to sanitation facilities within premises is higher in urban areas of Odisha than rural areas [24], facilitating safe disposal of child faeces.

Nationally, for children younger than three, 16% of faeces were disposed of in any sanitation facility, and 9% ended up in improved facilities (see figure 1.4) [56].

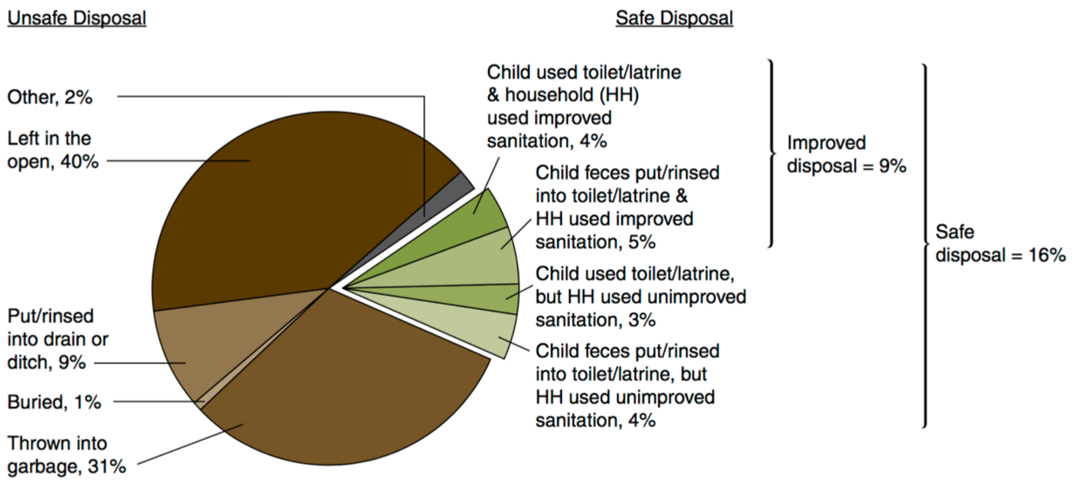

Figure 1.4: Percentage of households reporting child faeces practices for their youngest child under 3 in India (survey 2005-2006). Source: [56]

1.6. Previous research in Odisha and context for PhD field work

A large study on sanitation has been taking place in rural Odisha since 2010. This includes a randomized controlled trial (RCT) assessing the health impact of sanitation [26] and other studies, including MSc projects. I conducted my MSc project in 2012 in the district of Puri, in Odisha, in villages where the Total Sanitation Campaign (TSC) had been implemented at least 3 years before. The aim of my MSc project was to gain an understanding of child faeces disposal practices in Odisha and the cultural and contextual factors associated with those practices. I used a mixed-methods approach to data collection and collected data through a cross-sectional survey (I included 7 questions in a survey conducted in 20 rural villages by another MSc student to assess latrine use), in-depth interviews with mothers, anganwadi workers and NGO workers, and focus group discussions. The findings from the cross-sectional survey, were published and can be found in Appendix 1 [29].

The study gathered data on 145 children from 136 households in Puri district and found that 81.4% of child faeces were disposed of unsafely, with the majority of faeces reported to being deposited in the garbage. Even though safe disposal of child faeces only occurred in households with latrines, the majority of the faeces were still disposed of elsewhere [29].

Additionally, findings from my MSc thesis were used to formulate questions to evaluate the impact of the TSC on child faeces disposal practices, the resulting paper from that study that I assisted [30] appears in Appendix 2. The study found that the intervention increased the safe disposal of child faeces from 1.1% at baseline to 10.4% in intervention households compared to 3.1% in the control households (RR: 3.34; 95% CI: 1.99-5.59). However, this increase in safe child faeces disposal was directly related to increases in latrine coverage in the intervention communities and not from a change in underlying behaviours. Indeed, intervention households with latrines were no more likely than households with latrines in the control to dispose of their children's faeces safely (RR: 1.10; 95% CI:0.66-1.82) [30].

The understanding I gained from my MSc research also informed the type of information that I thought would be important to collect in the field work for my

PhD. For my PhD, I wanted to study practices of child faeces management in urban slums in order to gather data on practices in urban contexts, which are different environments and may present different risks of exposure, and also to have a comparison to practices studied in rural areas.

1.7. Aim and objectives of the PhD

There were two overall aims of this research. The first was to summarize existing knowledge of the health impact of safely disposing of child faeces. The second was to advance our understanding of the scope and possible reasons for unsafe disposal of child faeces among a population in Eastern India.

The specific objectives of the research were:

1. To conduct a systematic review of evidence of the effectiveness of interventions to improve child faeces disposal for preventing diarrhoea and soil-transmitted helminth infections (Paper I).
2. To conduct a cross-sectional study to gather information on the current child faeces disposal behaviours (Paper II) and factors related to child defecation and disposal practices in urban settings in Odisha (Paper III).

1.8. Thesis components

This thesis is presented using a paper-style format and consists of 9 chapters, which are summarised below.

- **Chapter 1**. Introduction, research aims and objectives
- **Chapter 2**. Systematic review: protocol
  This chapter presents the published protocol for the systematic review presented in chapter 3.
- **Chapter 3**. Systematic review: Interventions to improve disposal of child faeces for preventing diarrhoea and soil-transmitted helminth infection

This chapter presents the findings from a systematic review of the literature on health impacts of child faeces disposal.

- **Chapter 4**. Methods of cross-sectional study

  Describes the study site and methods for the cross-sectional study in urban slums of Odisha.

- **Chapter 5**. Identifying potential sources of exposure along the child faeces management pathway: a cross-sectional study among urban slums in Odisha, India

  This chapter presents a paper submitted for publication, describing child faeces management practices and possible sources of exposure.

- **Chapter 6**. Determinants of disposal of child faeces in latrines in urban slums of Odisha, India: a cross-sectional study

  This chapter presents a paper prepared for submission, investigating factors associated with safe child faeces disposal.

- **Chapter 7**. Additional findings from the cross-sectional study

  This chapter presents unpublished results from the cross-sectional study, using a formative research framework to describe the findings and identify questions for further research.

- **Chapter 8**. Discussion and Reflections

  This chapter discusses the findings of the research, reflects on things I would do differently were I to do the same study again, and suggests areas for future research.

- **Chapter 9**. Conclusions

  This final chapter summarizes the overall contributions from my PhD research and how these relate to the research aims.

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2. **Systematic review: protocol**

This chapter presents the published protocol for the Cochrane systematic review of interventions to improve the disposal of child faeces for preventing diarrhoea and soil-transmitted helminth infection.

In this review and for the field work, presented in later chapters, the focus is on children younger than 5 years old. This is because children of this age group spend most of their time at home, unless they attend pre-school, and they are also assumed not to be able to use a latrine (especially for children under 3), thus they need other sanitation solutions compared to other household members. Since most sanitation interventions tend to focus on increasing access to sanitation facilities, this age group is also mostly overlooked.

2.1. Cover sheet for research paper included in thesis

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SECTION A – Student Details

Student	Fiona Majorin
Principal Supervisor	Thomas Clasen
Thesis Title	Disposal of child faeces: practices, determinants and health effects

If the Research Paper has previously been published please complete Section B, if not please move to Section C

SECTION B – Paper already published

Where was the work published?	Cochrane Database of Systematic Reviews		
When was the work published?	Majorin F, Torondel B, Ka Seen Chan G, Clasen TF		
If the work was published prior to registration for your research degree, give a brief rationale for its inclusion	NA		
Have you retained the copyright for the work?*	**No** *	Was the work subject to academic peer review?	**Yes**

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For multi-authored work, give full details of your role in the research included in the paper and in the preparation of the paper. (Attach a further sheet if necessary)	I submitted the title registration and drafted the protocol, with input from co-authors.

Student Signature: Fiona Majorin **Date:** 11/09/2016

Supervisor Signature: **Date:** 11/09/2016

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Interventions to improve disposal of child faeces for preventing diarrhoea and soil-transmitted helminth infection (Protocol)

Majorin F, Torondel B, Ka Seen Chan G, Clasen TF

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[Intervention Protocol]

Interventions to improve disposal of child faeces for preventing diarrhoea and soil-transmitted helminth infection

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Editorial group: Cochrane Infectious Diseases Group.
Publication status and date: New, published in Issue 4, 2014.

Citation: Majorin F, Torondel B, Ka Seen Chan G, Clasen TF. Interventions to improve disposal of child faeces for preventing diarrhoea and soil-transmitted helminth infection. *Cochrane Database of Systematic Reviews* 2014, Issue 4. Art. No.: CD011055. DOI: 10.1002/14651858.CD011055.

ABSTRACT

This is the protocol for a review and there is no abstract. The objectives are as follows:

To assess the effectiveness of interventions to improve the disposal of child faeces for preventing diarrhoea and STH infections.

BACKGROUND

Epidemiology and transmission of diarrhoeal disease and soil-transmitted helminth infection

Despite advances in prevention and treatment, diarrhoea and soil-transmitted helminth (STH) infections still represent a large disease burden, particularly in low-income countries. Diarrhoeal diseases account for an estimated 1.4 million deaths worldwide and rank fourth globally for leading causes of years of life lost due to premature mortality (Lozano 2013). Among children under the age of five, diarrhoea kills more than 700,000 children annually, making it the second leading cause of mortality after pneumonia (Walker 2013). Over five billion people worldwide, including one billion school-aged children (aged five to 14 years), are at risk of infection with at least one STH species (Pullan 2012). The three STHs responsible for most infections are *Ascaris lumbricoides*, *Trichuris trichiura* and hookworms (*Ancylostoma duodenale* or *Necator americanus)*, with 819 million, 464.6 million and 438.9 million people infected in 2010 respectively (Pullan 2014). The pathogens that cause diarrhoea are mainly transmitted via the faecal-oral route (Byers 2001). Pathogens from contaminated faeces can be passed on to a new susceptible host via contaminated hands, drinking water, soil, flies, or by ingesting contaminated food (Wagner 1958). The settings, pathogens and their prevalence in different populations will determine the importance of each transmission route (Brown 2013). The symptoms of diarrhoea and course of disease vary with age, nutritional and immune status of the infected person, and the causative pathogens (Clasen 2010). The main characteristics of infection are changes in stool consistency, increases in volume or fluidity, and increased frequency of defecation (Thapar 2004). The three clinical presentations of diarrhoea are: (1) acute watery diarrhoea lasting several hours or days, (2) acute bloody diarrhoea (dysentery) and (3) persistent diarrhoea lasting 14 days or more (Heymann 2008). The direct threat from acute watery diarrhoea is dehydration, loss of fluids and electrolytes. Severe dehydration can result in death if untreated (Keusch 2006).

STHs are transmitted via ingestion of STH eggs (*A. lumbricoides* and *T. trichiura*) or larvae (*A. duodenale*), or via penetration of third stage larvae (hookworms) (Bethony 2006). The larvae go through several developmental stages in the human host and depending on the species, the adult parasites can settle in different parts of the gastrointestinal (GI) tract, where they can live several years, mating and producing eggs that are passed in the faeces (Bethony 2006). The eggs (*A. lumbricoides* and *T. trichiura*) and larvae (hookworm) can survive in the soil for several months or several weeks, respectively, depending on the environmental conditions, including humidity, soil moisture and temperature (Brooker 2006). Morbidity caused by STHs is linked to the intensity of infection, which is the number of worms per human host measured by the number of eggs per gram of faeces (Bethony 2006). STHs infections can have several clinical features, which can be classified into acute manifestations linked to larval migrations through the skin and intestines, and acute and chronic manifestations associated with parasite presence in the GI tract (Bethony 2006).

In addition to the direct health consequences of diarrhoeal diseases and STHs infections, they have longer term impacts on human development due to malabsorption and malnutrition (resulting in stunting and chronic anaemia), and on capacity (via lower cognition, school absenteeism and inability to work); which in turn can have impacts on development and poverty (Harhay 2010). STHs are believed to be one of the main causes of physical and intellectual growth retardation in the world (Bethony 2006).

Sanitation and disposal of child faeces

As the aetiological agents associated with diarrhoea and STHs are transmitted through faeces, the safe collection and disposal of human excreta has the potential to significantly reduce exposure and disease. When readers of the *British Medical Journal* were asked to vote on the "greatest medical advance" since 1840, they chose the sanitary revolution (the introduction of clean water and sewage disposal) over antibiotics, anaesthesia, vaccines and germ theory (Ferriman 2007). Large scale efforts have been made to increase coverage of improved sanitation, most recently as part of the Millennium Development Goal (MDG) sanitation target of halving the proportion of the population without access to basic sanitation by 2015 (United Nations 2013). However, this target is far from being met; 2.5 billion people were still without improved sanitation by the end of 2011 including more than one billion people who were practicing open defecation (WHO/UNICEF 2013).

A series of published systematic reviews have consistently concluded that sanitation interventions are effective in preventing diarrhoea and STH infections. Esrey 1991 reported a 22% median reduction in diarrhoea from 11 observational studies and 36% from the five rigorous studies. They also reported reduction in *Ascaris* and hookworm from water supply and sanitation interventions, especially on the reduction in disease intensity (egg counts). Fewtrell 2005 reported a pooled estimate risk on diarrhoea of 0.68 (95% confidence interval (CI) 0.53 to 0.87) from two intervention studies. Waddington 2009 reported a pooled estimate of 0.63 (95% CI 0.43 to 0.93) from six controlled studies among children. Clasen 2010 found a consistent protective effect against diarrhoea among 13 intervention studies but noted that nearly all involved water or hygiene interventions in addition to sanitation. Norman 2010 reported that sewerage led to a 30% reduction in diarrhoea (RR 0.70, 95% CI 0.58 to 0.85) among 17 observational studies. Ziegelbauer 2012 reported that sanitation interventions were protective against *Ascaris*, *Trichuris* and hookworm.

All of these reviews, however, focused on interventions to improve coverage, use or functionality of sanitation facilities; none specifically addressed the disposal of child faeces, another source of exposure even among households with improved sanitation. Actually, the unsafe disposal of child faeces may represent a more significant health risk than that of adults. This is because young children have the highest incidence of enteric infections (Walker 2012), and their faeces are most likely to contain infectious agents (Feachem 1983). Young children are more likely to defecate in places where susceptible children could be exposed (Lanata 1998). This exposure is worse for other young children due to the amount of time they spend on the ground and their exploratory behaviours including putting fingers and fomites in their mouths, and common behaviours such as geophagia (intentional consumption of earth) (Moya 2004; Ngure 2013; Young 2011). Perhaps for these reasons, World Health Organization (WHO) and United Nations Children's Fund (UNICEF) Joint Monitoring Programme for Water Supply and Sanitation (JMP), which is charged with assessing progress toward the MDG sanitation target, treats disposal of child faeces that are not deposited in a latrine or buried as unsanitary (WHO/UNICEF 2006).

An additional risk of contamination of the environment with faeces, including those of children, is that it may result in extended exposure of children to faecal pathogens which may lead to enteropathy, a disorder of the small intestine that is characterised by villous atrophy, crypt hyperplasia, inflammatory cell infiltrate, increased permeability and malabsorption (Humphrey 2009). Enteropathy is thought to lead to under nutrition and growth faltering (Humphrey 2009; Lin 2013).

We are unaware of any published, peer-reviewed study summarizing the evidence on the impact of child faeces disposal on human health. In an unpublished review and meta-analysis of 10 observational studies published between 1987 and 2001, Gil 2004 found that child faeces disposal behaviours considered risky (open defecation, stool disposal in the open, stools not removed from soil, stools seen in household soil and children seen eating faeces) were associated with a 23% increase in risk of diarrhoeal diseases (RR 1.23, 95% CI 1.15 to 1.32); on the other hand, behaviours considered safe (use of latrines, nappies, potties, toilets, washing diapers) were borderline protective (RR 0.93, 95% CI 0.86 to 1.00). In a study in rural Bangladesh, it was found that the disposal of child faeces in closed spaces such as pit latrines resulted in a 35% reduction in helminthiasis in children under two compared with disposal in open space (Roy 2011) indicating that safe disposal of child faeces may also play a role in the control of STH infections.

O B J E C T I V E S

To assess the effectiveness of interventions to improve the disposal of child faeces for preventing diarrhoea and STH infections.

M E T H O D S

Criteria for considering studies for this review

Types of studies

We will include randomized controlled trials (RCTs) that are individually- or cluster-RCT and the following non-randomized controlled studies (NRS): quasi-RCTs, non-RCTs, controlled before-and-after studies, interrupted-time-series studies, historically controlled studies, case-control studies, cohort studies, and cross-sectional studies (see definitions in Appendix 1). We will include NRS as based on a previous review (Gil 2004) we assume that there will be no or very few RCTs assessing the effect of improved disposal of child faeces for preventing diarrhoea and STH infection. We will exclude non-controlled studies, such as case reports or case series, due to the importance of control groups to determine the effect of the intervention on the outcomes of interest.

Types of participants

Adults and children.

Types of interventions

Intervention:

All interventions aiming to improve the safe collection or disposal of faeces of children aged below five years in order to decrease direct or indirect human contact with such faeces. For NRS, we will include interventions that have occurred in the course of usual healthcare or daily life, or those that have been deliberately introduced. This will include, but not be limited to, safe disposal practices as defined by the JMP, namely direct defecation into a latrine, disposal of stools in a latrine, or burying of stools (WHO/UNICEF 2006). Interventions can include the provision of hardware (for example, nappies (diapers), potties, faecal collection devices, cleaning products to hygienically remove faeces, child-friendly squatting slabs or latrines used by children), software (for example, promotion of safe disposal practices), or both. We will include interventions that combine the safe disposal of child faeces with other interventions, such as hygiene promotion interventions, and employ subgroup analysis to investigate the impact of these additional interventions.

Control:

Participants that continue their usual practices of child faeces disposal instead of the intervention, or who received a different type of intervention (for example, a heath promotion intervention).

Types of outcome measures

Primary outcomes

- Diarrhoea episodes among individuals, whether or not confirmed by microbiological examination.

We will define an episode according to the case definitions used in each reviewed study. This includes the WHO definition, which is the passage of three or more loose or liquid stools per day or more than usual for the individual (WHO 2013). We will treat this outcome as dichotomous; whether an individual has had one or more episodes of diarrhoea.

- Infection with one or more species of STHs (*Ascaris lumbricoides*, *Trichuris trichiura*,*Ancylostoma duodenale* or*Necator americanus*). We will define infection as the presence of eggs, or juvenile nematodes, or both in the stools of the participants. We will include any accepted diagnostic techniques.

Secondary outcomes

- Dysentery
- Severe diarrhoea
- Persistent diarrhoea
- Clinical visits for diarrhoea
- Intensity of STH infection (number of eggs per gram of stool)
- Presence of pathogenic microbes in stool assays
- Anthropometry (weight-for-age and height-for-age)
- Serology
- Other markers of infection and disease
- Mortality
- Use and adoption of the intervention (behaviour change)
- Adverse events

Search methods for identification of studies

We will attempt to identify all relevant studies regardless of language or publication status (published, unpublished, in press and ongoing).

Electronic searches

We will search the following databases using the search terms detailed in Appendix 2: CIDG Specialized Register; Cochrane Central Register of Controlled Trials (CENTRAL), published in *The Cochrane Library;* EMBASE; MEDLINE; Global Health; Web of Science; LILACS; and POPLINE. Also, we will examine Chinese-language databases available in the China National Knowledge Infrastructure and the Wan Fang Portal using the search terms detailed in Appendix 2 or their Chinese language equivalents. We will search the *meta*Register of Controlled Trials (*m*RCT), clinicaltrials.gov and International Clinical Trials Registry Platform Search Portal (www.who.int/trialsearch) using "sanitation" and "hygiene" as search terms, as well as an index to theses in the United Kingdom (http://ethos.bl.uk). We will search Open Grey (http://www.opengrey.eu) database for grey literature.

Searching other resources

Conference proceedings

We will search the following organizations' conference proceedings: International Water Association and Water, Engineering and Development Centre, Loughborough University, UK.

Researchers and organisations

We will contact individuals working in the field, and contact or search websites of the following organizations for other potential published and unpublished studies: Water, Sanitation and Health Programme of the WHO; World Bank Water and Sanitation Program; UNICEF Water, Environment and Sanitation; Environmental Health Project (USAID); IRC International Water and Sanitation Centre; Global Water, Sanitation and Hygiene (CDC); International Centre for Diarrhoeal Disease Research, Bangladesh (ICDDR,B); US Agency for International Development (USAID); UK Department for International Development (DFID); Asian Development Bank (ADB); WASHplus (http://www.washplus.org/); sustainable sanitation alliance (http://www.susana.org/); community-led total sanitation (CLTS); the sanitation updates blog (http://sanitationupdates.wordpress.com/); and the STEPS Centre at the Institute of Development Studies University of Sussex (http://steps-centre.org).

Reference lists

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

Data collection and analysis

Selection of studies

Fiona Majorin (FM) and Belen Torondel (BT) will independently examine titles and abstracts of all identified studies and select all potentially eligible studies based on the inclusion criteria. If a title or abstract cannot be rejected with certainty due to lack of information, we will obtain the full text of the article for further assessment. Gabrielle Ka Seen Chan (GC) will review the results of the Chinese database search, undertake the same process as FM and BT, and summarize the potentially eligible articles in English. We will obtain full copies of all studies agreed by either author to potentially fall within the inclusion criteria. FM and BT will independently determine whether each study meets the inclusion criteria using a form. We will check study reports to ensure that multiple publications of the same study are only included once. When we agree, we will either include or exclude the study. If we are unable to agree, we will consult Thomas Clasen (TC) who will make the final decision. FM will correspond with authors in case data needed to assess eligibility is not obvious in the study or if data is missing from the report. Any studies that FM or BT suggest to include but which are ultimately excluded through discussion or by TC will be presented with the reason for exclusion in the 'Characteristics of excluded studies'.

Data extraction and management

FM and BT will independently extract data from the included studies using a data extraction form after it has been piloted (items included in the form are presented in Appendix 3). In case of discrepancy, we will discuss the data and consult TC, if necessary, who will make the final decision. FM will enter and analyse the agreed data into Review Manager (RevMan) and BT will independently cross-check a sample of the data.

Type of data to be extracted

RCTs randomized by individual

For each RCT we will extract the number of participants randomized and the numbers analysed in each treatment group for each outcome. For dichotomous outcomes, we will extract the number of participants experiencing the outcome and the number of participants in each treatment group. For continuous outcomes, we will extract the means, standard deviations and number of participants in each group.

RCTs randomized by cluster

For cluster RCTs we will extract the number of participants randomized and the number analysed in each treatment group for each outcome. When the cluster RCT has been adjusted for clustering in the analysis, we will extract the measures of effect that have been adjusted for clustering and the CIs. When the cluster RCT has not adjusted for clustering in the analysis, we will extract measures of effect and CIs, as well as average cluster sizes and intra-cluster correlation coefficients (ICC) to approximate correct analysis that account for clustering using the inflating standard error method (Higgins 2011a).

NRS

For NRS, we will extract details on the features of the design, the confounding factors considered in the study, methods used to control for confounding, data on the risk of bias specific for NRS (see Assessment of risk of bias in included studies), the total numbers of participants included in the study and in each comparison group, the measures of effect and CIs.

Assessment of risk of bias in included studies

Two authors will independently apply the risk of bias criteria using an assessment form. In case of disagreement we will discuss the issue and if necessary consult a third author, TC, to make the final decision. If there's any missing data required to assess the risk of bias, FM will contact the authors for additional information. For each study, we will justify reasons for the level of risk of bias and include it in the 'Risk of bias' table.

For RCTs randomized by individuals and by cluster, we will use the Cochrane Collaboration tool (Higgins 2011b) to assess the risk of bias, which includes methods of random sequence generation, allocation concealment, blinding of participants, personnel and outcome assessment, incomplete outcome data and selective reporting. For each domain, we will follow the definitions of low risk, unclear risk and high risk described in Higgins 2011b.

For cluster RCTs we will also assess the risk of bias specific to this study design:

- Recruitment bias. We will qualify the study as high risk of bias in case the participants and staff were aware of which cluster was the intervention or control; unclear risk in case the information was not collected or reported; or low risk of bias if clusters are not known to be intervention or control during participant recruitment.
- Baseline imbalance. We will assess a study as high risk of bias when large differences in baseline characteristics were present and they were not adjusted for in the analysis; low risk of bias in case statistical methods are used to match the clusters at the design stage or to adjust for imbalances in the analysis, or in case no substantial differences in baseline characteristics are observed; or unclear risk if it is not mentioned in the report.
- Loss of clusters. We will qualify studies as high in case > 10% of clusters are lost to follow-up; low risk of bias if < 10% of clusters are lost to follow-up; or unclear if loss to follow-up is not mentioned.
- Incorrect analyses. We will assess studies as high risk of bias if they did not analyse the data adjusting for clustering; low risk of bias in case there are no unit-of analysis errors in the study and if clustering is adjusted for in the analysis; or unclear risk if it's not reported in the study. We will calculate estimate corrections to adjust for clustering when analysing these high risk of bias studies.
- Comparability with individually randomized RCTs. We will analyse cluster-RCTs separately to individually randomized RCTs as it is likely that community effects of improved child faeces disposal are observed in cluster RCTs.

We will use the EPOC criteria (EPOC 2013) to assess the risk of bias of the included quasi-RCTs, non-RCTs, controlled before-and-after studies, historically-controlled studies and controlled interrupted-time-series studies (ITS), controlled cohort and cross-sectional studies. For all study designs except ITS, this tool includes random sequence generation, allocation concealment, incomplete outcome data, selective outcome reporting and other biases that are similar to the RCT risk of bias tool, as well as the following additional domains:

- Similarity of baseline characteristics. Important baseline characteristics for this study include: access and type of sanitation facilities, water access and quality, age, wealth and hygiene practices. We will qualify the studies as high in case there are substantial differences; low risk of bias if baseline characteristics are reported and there is no substantial difference; or unclear if it's not reported or unknown.
- Similarity of baseline outcome measurements. We will give high risk of bias scores when large differences were present and they were not adjusted for in the analysis; low risk of bias scores to studies if participant outcomes were measured prior to the intervention and there were no substantial differences; or unclear risk if it is not mentioned in the report.
- Adequate protection against contamination? We will qualify the study as high risk if it is likely that the control group received the intervention; low risk if it is unlikely that the control group received the intervention; or unclear in case it is possible contamination could have occurred.
- Adequate allocation of intervention concealment during the study. We will classify studies as high risk if the outcomes were not assessed blindly; low risk of bias if the authors explicitly report that the primary outcomes were assessed blindly or the outcomes are objective; or unclear if it's not specified in the paper.

For ITS, the tool includes seven domains, for which we will use the definitions of high risk, low risk and unclear risk suggested by EPOC: intervention independent from other changes, pre-specified shape of the intervention, whether the intervention was likely to affect the data collection, whether knowledge of the allocated interventions was adequately prevented, incomplete outcome data, selective outcome reporting and other biases (EPOC 2013).

We will also add a domain to assess whether the studies appropriately adjusted for confounders. The following confounders related to child faeces disposal and diarrhoea or STHs infections are considered important for this review: access to or ownership of a sanitation facility, type of sanitation facility (improved or unimproved according to the JMP classification (WHO/ UNICEF 2014), use of sanitation facility, wealth, age, water access, season, water quality, animal ownership, household size, educational level, attendance to school or pre-school by the children, shoe-wearing and hygiene practices. We will classify studies as low risk if they control for at least one of the listed confounders in the design (for example, matching) or the analysis (for example, multivariable statistical modelling). We will classify studies as high risk if no adjustment for confounding variables is conducted and unclear in case it is not mentioned in the paper.

For case-control studies we will assess the quality of the studies using the Newcastle Ottawa scale (NOS) (Wells 2013). The scale is divided into eight items grouped into three domains: selection, comparability and ascertainment of exposure. For each item in the selection and exposure ascertainment domains a total of one 'star' can be awarded to a study; in the comparability domain two stars can be awarded. For one star in the comparability domain, the study will control for access to or ownership of a sanitation facility. For two stars, the study will have to control for at least one other important confounding variable, such as type of sanitation facility (improved or unimproved) use of sanitation facility, wealth, age, water access, season, water quality, animal ownership, household size, educational level, attendance to school or pre-school by the children, shoe-wearing and hygiene practices.

Measures of treatment effect

For RCTs with dichotomous outcomes, we will calculate the risk ratios (RR) with 95% CIs in case the raw data are available. If not we will use the effect measures reported including rate ratios or risk ratios, along with the 95% CI. For continuous variables, we will extract the mean differences or the standardized mean difference (SMD) in case different studies use different measures. We will calculate or extract standard errors and 95% CI from these studies. For NRS studies, we will report measures of effect adjusted for confounders from the studies. If several adjusted estimates are reported, we will use the estimate adjusting for the most confounders. We will specify the confounders that were adjusted for in the study and how that was done whether it was in the design or in the analysis. In case the effect measures extracted are expressed in different metrics, we will convert them into a common measure, RR, to pool them if possible; if they are all the same, we will combine them using the effect measure used in the reports. If no adjusted measures can be obtained from the studies, we will use unadjusted measures reported in the study or calculate RR and 95% CI from the raw data.

Unit of analysis issues

We will consider individually RCTs and cluster-RCTs. For the latter, we will assess whether clustering was properly accounted for in the analysis and use the adjusted measure of effect reported. We will analyse cluster-RCTs and individually RCTs separately.

Dealing with missing data

If studies have missing data needed for assessment of eligibility or analysis, FM will contact authors and attempt to obtain the data. We will report on the number of participants in each study and the number of participants that were lost to follow-up.

Assessment of heterogeneity

We will assess heterogeneity by visually examining the CIs in the forest plot and by using the Chi^2 test and I^2 statistic (Higgins 2003). We will consider a significance level of < 0.1 for Chi^2 test to be significant and indicate potential heterogeneity. To estimate the degree of heterogeneity, we will classify an estimate of I^2 > 50% to indicate substantial heterogeneity and > 75% to indicate considerable heterogeneity (Deeks 2011). If there are sufficient studies (> 10) and substantial heterogeneity, we will investigate causes of heterogeneity using subgroup analysis and meta-regression where appropriate, specifically to investigate the effects of the study designs, study quality and types of intervention.

Assessment of reporting biases

We will try to minimise reporting bias by using a comprehensive search strategy including published and unpublished studies. If study protocols are available, we will compare the study protocol with the published results to check if all planned outcomes are reported on. If not, we will compare the outcomes listed in the methods and those reported in the results sections. We will assess the potential of publication bias using funnel plots in case we find sufficient studies (> 10) and they are of different sizes.

Data synthesis

We will analyse the data using Review Manager (RevMan). If there is more than one study with comparable participants, interventions and outcomes, and there isn't considerable heterogeneity between the studies (I^2 statistic value > 75%) we will conduct a meta-analysis to estimate a pooled measure of effect. We will use a random-effects model to pool the data. The comparisons made

will be between those with the intervention and those without or with a different intervention. Due to differences in potential risk of bias of different study designs (Reeves 2011), we will only pool results of similar study designs.
In case the studies included have varying degrees of risk of bias, we will conduct stratified analysis according to the level of risk of bias of the studies.
If there are not enough similar studies to pool them together, we will show the individual study results on the forest plot without displaying a pooled estimate and we will conduct a systematic description of the results. The studies will be organized by type of intervention and study design when described.

Summary of findings table

Two review authors (BT and FM) will assess the methodological quality of each outcome across the included studies using GRADE guidelines (Guyatt 2011). In case of discrepancy, a third author (TC) will assess the methodological quality. We will summarize the 'Summary of findings' table using GRADEpro.
The following outcomes will be presented in the 'Summary of findings' table:

- Diarrhoea episodes;
- Infections with one or more species of STHs.

Subgroup analysis and investigation of heterogeneity

We will conduct meta-analyses of studies with comparable participants, interventions and outcomes such as:

- The effects of different types of interventions, such as software versus hardware, collection versus disposal, burying faeces versus disposal or defecation in a latrine, use of different faeces collection tools such as potties versus diapers;
- The effects of single versus combined interventions (for example, in combination with improved water supply, hygiene, or improved sanitation).

Then, within each of these meta-analyses, if there are sufficient comparisons (> 10) included in the review, we will conduct subgroup analyses to investigate:

- The effects of different methods to ascertain use of the intervention (for example, observations versus survey questionnaire reporting on child faeces disposal method);
- The effects of different levels of baseline/end line coverage and compliance with the intervention;
- The effects of different study designs;
- The effects of the intervention site (urban versus rural);
- The effects of the intervention settings (low, middle or high income country);
- The effect of safe child faeces disposal on infections with different STHs species (for example, *A. lumbricoides* versus hookworms);
- The effect of safe child faeces disposal on outcomes in different age groups, children aged < 5 years versus children aged > 5 years.

Sensitivity analysis

We will conduct sensitivity analyses in case there are disagreements with eligibility criteria and to check robustness of the choice of analysis method (random-effects model versus fixed-effect). If there are sufficient studies, we will perform sensitivity analyses comparing inclusion of studies with different methodological quality. Where there are other debated decisions during the review process, we will conduct other sensitivity analyses investigating these issues when possible.

ACKNOWLEDGEMENTS

The editorial base for the Cochrane Infectious Diseases Group is funded by the UK Department for International Development (DFID) for the benefit of developing countries.

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* *Indicates the major publication for the study*

APPENDICES

Appendix 1. Study design definitions (from the Cochrane Handbook for Systematic Reviews of Interventions)

- Quasi-RCT: A study with an experimental design where participants are allocated to different interventions using a quasi-random method, such as date of birth, alternation, and medical record number.
- Non-RCT: A study with an experimental design where participants are allocated to different interventions using a non-random method.
- Controlled before-and-after study: A study where observations are made in a control and intervention group, before and after the implementation of an intervention.
- Interrupted-time-series study: A study in which observations are done at multiple time points before and after an intervention (interruption). The design of the study enables to see if the intervention has an effect that is significantly greater than underlying trend over time.
- Historically controlled study: A study comparing a group of participants receiving an intervention with a similar group from the past that didn't.
- Cohort study: A study that follows a defined group of people (cohort) over a period of time to examine interventions received and subsequent outcomes. A 'prospective' cohort study recruits participants before an intervention and follows them whereas a 'retrospective' cohort study recruits participants from the past using records from the past that describe the interventions received and follows them in the past using the records.
- Case-control study: A study that compares participants with a certain outcome (cases) with people from the same source population without the outcome (controls) and examines the associations between the outcome and prior exposures (for example, receiving an intervention).
- Cross-sectional study: A study where information on past or current interventions and health outcomes are collected for a group of people at a particular time point in order to study associations between outcomes and exposure to interventions.

Appendix 2. Detailed search strategy

Search set	CIDG SR[1]	CENTRAL	MEDLINE	EMBASE	Global Health	Web of Science	LILACS	POPLINE
1	feces OR faeces OR faecal OR fecal OR stool* OR excreta* OR excrement OR diarrhoea OR diarrhea OR defeacation OR defecation OR human waste	feces OR faeces OR faecal OR fecal OR stool* OR excreta* OR excrement OR diarrhoea OR diarrhea OR defeacation OR defecation OR human waste	(f?eces or f?ecal or stool$ or excreta$ or excrement or diarrh?ea or defe?cation or human waste) adj3 (management or dispos$ or remov$ or cleansing or cleaning or washing))	(f?eces or f?ecal or stool$ or excreta$ or excrement or diarrh?ea or defe?cation or human waste) adj3 (management or dispos$ or remov$ or cleansing or cleaning or washing))	(f?eces or f?ecal or stool* or excreta* or excrement or diarrh?ea or defe?cation or human waste) adj3 (management or dispos*or remov* or cleansing or cleaning or washing))	F$eces OR f$ecal OR stool* OR excreta* OR excrement OR diarrh$ea OR defe$cation OR human waste	feces or faeces or fecal or faecal or stool$ or excreta$ or excrement or diarrhea or diarrhoea or defecation or defeacation or human waste	feces OR faeces OR faecal OR fecal OR stool* OR excreta* OR excrement OR diarrhea OR diarrhoea OR defeacation OR defecation OR human waste

(Continued)

2	management OR dispos*OR remov* OR cleansing OR cleaning OR washing	management OR dispos*OR remov* OR cleansing OR cleaning OR washing	sanitation or potty or potties or diaper$ or nappy or nappies or latrine$ or toilet$ or cloth$ diaper$ or swaddle or wrap$	sanitation or potty or potties or diaper$ or nappy or nappies or latrine$ or toilet$ or cloth$ diaper$ or swaddle or wrap$	sanitation or potty or potties or diaper* or nappy or nappies or latrine* or toilet* or cloth* or diaper* or swaddle or wrap*	management OR dispos*OR remov* OR cleansing OR cleaning OR washing	management or dispos$ or remov$ or cleansing or cleaning or washing	management OR dispos* OR remov* OR cleansing OR cleaning OR washing
3	1 AND 2	1 AND 2	1 or 2	1 or 2	1 or 2	1 AND 2	1 AND 2	1 AND 2
4	sanitation OR potty OR potties OR diaper* OR nappy OR nappies OR latrine* OR toilet* OR cloth* OR diaper* OR swaddle OR wrap*	sanitation OR potty OR potties OR diaper* OR nappy OR nappies OR latrine* OR toilet* OR cloth* OR diaper* OR swaddle OR wrap*	exp Sanitation/	exp sanitation/ or exp environmental sanitation/	exp sanitation/	sanitation OR potty OR potties OR diaper* OR nappy OR nappies OR latrine* OR toilet* OR cloth OR diaper* OR swaddle OR wrap*	child$ or babies or baby or infant$ or toddler$ or neonate$ or preschool or pre-school	sanitation OR potty OR potties OR diaper* OR nappy OR nappies OR latrine* OR toilet* OR cloth OR diaper* OR swaddle OR wrap*
5	3 OR 4	3 OR 4	3 or 4	3 or 4	3 or 4	3 OR 4	3 AND 4	3 OR 4
6	child* OR babies OR baby OR infant* OR toddler* OR neonate* OR preschool OR pre-school	[Sanitation]	child$ or babies or baby or infant$ or toddler$ or neonate$ or pre?school	child$ or babies or baby or infant$ or toddler$ or neonate$ or pre?school	child* or babies or baby or infant* or toddler* or neonate* or pre?school	child* OR babies OR baby OR infant* OR toddler* OR neonate* OR preschool OR pre$school		Keywords : sanitation OR Hygiene
7	5 and 6	5 OR 6	exp child/ or exp child, preschool/ or exp infant/	exp child/	exp children/	5 AND 6		5 OR 6

(*Continued*)

8		child* OR babies OR baby OR infant* OR toddler* OR neonate* OR preschool OR pre-school	6 or 7	6 or 7	Exp infants/			child* OR babies OR baby OR infant* OR toddler* OR neonate* OR preschool OR pre-school
9		[child]	5 and 8	5 and 8	6 or 7 or 8			Keywords : child OR infant
10		[infant]			5 and 9			8 OR 9
11		8 OR 9 OR 10						7 AND 10
12		7 AND 11						

[1] Cochrane Infectious Diseases Group Specialized Register.

Appendix 3. Items for data extraction

Study data
Person extracting data
Date of extraction
Study ID
Report ID (if different from study ID)
Reference citation
Study author details
Publication type
Publication status
Notes (for example, questions for authors, statistical concerns)

(*Continued*)

Study eligibility: (if answer no to one of the criteria, exclude)
Type of study: RCT or NRS with control group (quasi-RCTs, non-RCTs, controlled before-and-after studies, interrupted time series studies, historically controlled studies, case-control studies, cohort studies and cross-sectional studies)
Participants: adults or children
Type of intervention: hardware or software interventions that reduce the direct or indirect contact with child (aged < 5 years) faeces?
Type of comparison: no intervention or other intervention?
Type of outcome: diarrhoea episodes; infections with one or more species of STHs; intensity of infection with one or more species of STH; dysentery; severe diarrhoea; persistent diarrhoea; clinical visits for diarrhoea; presence of pathogenic microbes in stools; anthropometry; serology; other markers of infection and disease; adverse events; mortality; or behaviour change?
If excluded, reasons for exclusion:
Characteristics of included studies
Country and district, state, or town
Setting (hospital, school, community, urban, or rural)
Season
Design
Description of design
Was it a multicentre study?
Funding source
Duration of study (start and end date of study)
Duration of participation (start of recruitment until last follow-up time point)
Ethical approval if needed
Missing data and reasons
Unit of randomization and whether the analysis adjusted for clustering if cluster design
Participants:
Population demographics

(*Continued*)

Study inclusion criteria
Study exclusion criteria
Method of participant recruitment
Total number of participants recruited
Withdrawals, exclusions, loss to follow-up
Age
Sex
Household size
Education level
Socio-economic level
Pre- and post-intervention water quality
Sanitation type and coverage
Hygiene practices
Type of water supply and coverage
Baseline child faeces disposal sites
Prevalence of open defecation
Deworming history in the study population
Solid waste disposal practices
Animal ownership
School or pre-school attendance
Shoe wearing practices
Intervention group
Description of intervention
Number of participants

(*Continued*)

Co-interventions?
Who delivered the intervention?
Format and timing of delivery?
Coverage and uptake of child faeces collection and disposal practices
Compliance to intervention
Control group
Description of control
Number of participants
Co-intervention?
Outcomes
Case definition for health outcomes
Measuring/diagnosis method (if self-reported include recall period)
Time points measured
Effect estimate and 95% CI and raw numbers (for NRS record adjusted and unadjusted measures with confounders adjusted for; for cluster RCT specify if effect estimate is adjusted for clustering)
List of outcomes measured in study
Key conclusions of authors
Explanations of unexpected findings
Risk of bias assessment
- RCTs (high, low, or unclear risk)
Random sequence generation?
Allocation concealment?
Blinding of participants and personnel?
Blinding of outcome assessment?
Incomplete outcome data?

(*Continued*)

Selective reporting?
Other risks of bias?
- Cluster RCTs (high, low, or unclear risk)
Recruitment bias?
Baseline imbalance?
Loss of clusters?
Incorrect analyses?
- NRS except case-control and ITS (high, low, or unclear risk)
Random sequence generation?
Allocation concealment?
Baseline outcome measures similar?
Baseline characteristics similar?
Incomplete outcome data?
Adequate allocation of intervention concealment?
Adequate protection against contamination?
Selective reporting?
Other risks of bias?
Confounders adequately adjusted for in analysis or design? (describe adjustment method)
Methods to identify and measure confounders
List all confounders considered in study
- ITS (high, low, or unclear risk)
- Intervention independent from other changes?
- Pre-specified shape of the intervention?
- Intervention likely to affect the data collection?

(*Continued*)

- Knowledge of the allocated interventions was adequately prevented?
- Incomplete outcome data?
- Selective outcome reporting?
- Other risk of bias?
- Case control studies
- Selection
Is the case definition adequate?
Representativeness of the cases
Selection of controls
Definition of controls
- Comparability
Comparability of cases and controls on the basis of the design or analysis
- Exposure
Ascertainment of exposure
Same method of ascertainment for cases and controls
Non-response rate

CONTRIBUTIONS OF AUTHORS

TC and FM planned the review. FM drafted the protocol. All authors provided general advice for the protocol, commented on and revised protocol drafts, and approved the final version.

DECLARATIONS OF INTEREST

None known.

SOURCES OF SUPPORT

Internal sources

- No sources of support supplied

External sources

- This research is supported in part by a grant from the Bill & Melinda Gates Foundation, USA.

3. **Systematic review: Interventions to improve disposal of child faeces for preventing diarrhoea and soil-transmitted helminth infection**

In this chapter I present the findings from the systematic review which was conducted according to the protocol presented in the previous chapter. This is a draft and pre-peer review version of a Cochrane Review. Upon completion and approval, the final version is expected to be published in the Cochrane Database of Systematic Reviews (www.cochranelibrary.com).

3.1. Cover sheet for research paper included in thesis

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RESEARCH PAPER COVER SHEET

PLEASE NOTE THAT A COVER SHEET MUST BE COMPLETED FOR EACH RESEARCH PAPER INCLUDED IN A THESIS.

SECTION A – Student Details

Student	Fiona Majorin
Principal Supervisor	Thomas Clasen
Thesis Title	Disposal of child faeces: practices, determinants and health effects

If the Research Paper has previously been published please complete Section B, if not please move to Section C

SECTION B – Paper already published

Where was the work published?			
When was the work published?			
If the work was published prior to registration for your research degree, give a brief rationale for its inclusion			
Have you retained the copyright for the work?*	Choose an item.	Was the work subject to academic peer review?	Choose an item.

**If yes, please attach evidence of retention. If no, or if the work is being included in its published format, please attach evidence of permission from the copyright holder (publisher or other author) to include this work.*

SECTION C – Prepared for publication, but not yet published

Where is the work intended to be published?	Cochrane Database of Systematic Reviews
Please list the paper's authors in the intended authorship order:	Majorin F, Torondel B, Ka Seen Chan G, Clasen TF
Stage of publication	**Undergoing revision**

SECTION D – Multi-authored work

For multi-authored work, give full details of your role in the research included in the paper and in the preparation of the paper. (Attach a further sheet if necessary)	I drafted the review, with input from co-authors.I screened articles, abstracts and full texts (with BT, LG and GC). I contacted authors. I extracted data with BT and GC.I entered the data.

Student Signature: Fiona Majorin **Date:** 25/01/17

Supervisor Signature: Thomas Cl **Date:** 25/01/17

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Interventions to improve disposal of child faeces for preventing diarrhoea and soil- transmitted helminth infection

Fiona Majorin, Belen Torondel, Gabrielle Ka Seen Chan, Thomas F Clasen

ABSTRACT

Background

Worldwide, diarrhoea and soil-transmitted helminth (STH) infections represent a large disease burden, particularly in low-income countries. As the aetiological agents associated with diarrhoea and STHs are transmitted through faeces, the safe containment and management of human excreta has the potential to significantly reduce exposure and disease. While systematic reviews have looked at the association between sanitation and diarrhoea or STH infection, no published, peer-reviewed study has specifically addressed the disposal of child faeces, an important source of potential exposure even among households with improved sanitation.

Objectives

To assess the effectiveness of interventions to improve the disposal of child faeces for preventing diarrhoea and STH infections.

Search methods

We searched the CIDG Specialized Register (14/11/2014), Cochrane Central Register of Controlled Trials (CENTRAL), published in The Cochrane Library (07/11/2014), EMBASE (7/11/2014), MEDLINE (7/11/2014), Global Health (7/11/2014), Web of Science (7/11/2014), LILACS (14/11/2014), and POPLINE (7/11/2014). We also examined Chinese-language databases, China National Knowledge Infrastructure (25/01/2015) and the Wan Fang Portal (11/01/2015). We searched the *meta*Register of Controlled Trials (*m*RCT), International Clinical Trials Registry Platform Search Portal, an index to theses in the United Kingdom (http://ethos.bl.uk) (9/06/2015) and Open Grey database for grey literature (9/06/2015). We also searched relevant

conference proceedings, contacted researchers and searched websites for organizations, and checked references from identified studies.

Selection criteria

We included randomized controlled trials (RCTs) and non-randomized controlled studies (NRS), comparing interventions aiming to improve the disposal of faeces of children aged below five years in order to decrease direct or indirect human contact with such faeces with no intervention or a different intervention in children and adults.

Data collection and analysis

Two reviewers selected eligible studies, extracted data and assessed the risk of bias. We used meta-analyses to estimate pooled measures of effect where appropriate, or described the study results qualitatively. We investigated potential sources of heterogeneity using subgroup analyses. We assessed the quality of evidence using the GRADE approach.

Main results

Forty-six studies covering more than 82 100 participants were included in this review. Eleven studies were cluster RCTs, 3 were controlled before-and-after studies (CBA) and 32 were NRS (25 case-control studies, 2 controlled cohort studies and 5 controlled cross-sectional studies). Most studies were conducted in low- or lower middle-income settings. Among studies using experimental study designs, most interventions included child faeces disposal messages along with other health education messages or other water, sanitation or hygiene (WASH) components. Among observational studies, the main risk factors relevant to this review were safe disposal of faeces in the latrine or defecation of <5s in a latrine.

The 2 RCTs that evaluated education-only interventions reduced diarrhoea by about 20% (RR 0.83, 95% CI 0.73 to 0.94, *very low quality evidence*). Interventions that aimed to end open defecation by all household members had no effect on diarrhoea (RR 0.93, 95% CI 0.83 to 1.04, 4 studies, *low quality evidence*). The 2 CBAs evaluating interventions including other WASH components reduced diarrhoea by about a quarter (RR 0.77, 95%CI 0.71 to 0.84, *very low quality*).

Pooled results from case-control studies that presented data for child faeces disposal indicate that disposal of faeces in the latrine decreased the odds of diarrhoea by about a quarter among all ages (OR 0.76, 95%CI: 0.66 to 0.88, 22 comparisons, *very low evidence*) and children <5 (OR 0.77, 95%CI: 0.66 to 0.89, 19 comparisons). Pooled results from case-control studies that presented data for children defecating in the latrine indicates that children using the latrine reduces the odds of diarrhoea by about half in all ages (OR 0.54, 95% CI: 0.33 to 0.90, 7 studies, *very low quality evidence*); the corresponding pooled estimate for children <5 is the same but is not statistically significant (OR: 0.54, 95%CI: 0.28 to 1.07, 5 studies).

The 2 cross-sectional studies that compared 2-week diarrhoea prevalence in "model" and "non model" households of the health extension package in Ethiopia, which includes the promotion of safe disposal of child faeces (disposal in a latrine and burial of faeces) among other messages in the health packages found that being a model family decreased the odds of having diarrhoea by about three quarters (OR 0.26, 95%CI 0.16 to 0.42, *very low quality evidence*).

Only 2 RCTs reported on the impact of the interventions on STHs. Both reported no effect on any STH infection (pooled RR 1.03, 95% CI 0.78 to 1.37, *very low quality evidence*).

Authors' conclusions

Evidence suggests that the safe disposal of child faeces is effective in preventing diarrhoea. However, the evidence is limited and of low quality. The limited evidence on soil-transmitted helminth infections provides no evidence that interventions to improve safe disposal of child faeces are effective in preventing such STH infection.

There is a compelling need for RCTs and other rigorous studies to assess the effectiveness and sustainability of different hardware and software interventions to improve the safe disposal of faeces of children of different age groups. Such research will help to clarify the effectiveness of specific interventions in preventing child faeces from entering the environment and contribute more evidence on the role of such interventions in preventing faecal exposure and preventing disease.

PLAIN LANGUAGE SUMMARY

<u>Interventions to improve child faeces disposal and prevent diarrhoea and soil-transmitted helminths</u>

Worldwide, diarrhoea and soil-transmitted helminth (STH) infections affect millions of people particularly in low-income countries. Diarrhoea and STHs are transmitted through human faeces so the safe containment and management of human excreta has the potential to significantly reduce exposure and disease. An often neglected source of exposure is from the unsafe disposal of child faeces. Research has shown that even in settings with improved sanitation, child faeces are thrown into refuse piles or elsewhere and not disposed of in latrines as considered safe by the World Health Organization. We sought to assess the impact of improved disposal of child faeces on diarrhoea and STH infection.

This review includes 46 studies covering more than 82 100 people. Most of the studies were conducted in low- and middle- income countries. We identified 14 studies with experimental designs and 32 observational studies that met our review's inclusion criteria. Results from studies using experimental study designs suggest that promotional interventions that included child faeces disposal messages may reduce diarrhoea by about a fifth (*very low quality evidence*). Interventions that addressed safe disposal of child faeces as part of a wider water, sanitation or hygiene interventions may reduce diarrhoea by about a quarter (*very low quality evidence*). However, more generalized interventions that addressed child faeces only as part of a wider intervention aimed at ending open defecation by all household members had no effect on diarrhoea (*low quality evidence*).

Pooled results from case-control studies that presented data for child faeces disposal indicate that disposal of faeces in the latrine may decrease the odds of diarrhoea by about a quarter among all ages (*very low quality evidence*). Children using the latrine to defecate may reduce the odds of diarrhoea by about half in all ages (*very low quality evidence*).

Only two experimental studies reported on the impact of the interventions promoting the safe disposal of child faeces on STHs. Neither found an effect on any STH infection (*very low quality evidence*).

More research is needed to study the health impact of different types of interventions to improve child faeces disposal.

SUMMARY OF FINDINGS TABLE

Child faeces disposal intervention compared with no intervention for diarrhoea/ STH						
Patient or population: adults and children **Settings:** all settings **Intervention:** child faeces disposal intervention **Comparison:** no intervention						
Outcomes	**Illustrative comparative risks* (95% CI)**		**Relative effect (95% CI)**	**No of Participants (studies)**	**Quality of the evidence (GRADE)**	**Comments**
	Assumed risk	**Corresponding risk**				
	No intervention	**Improved child faeces disposal**				
Diarrhoea episodes Cluster RCTs: hygiene education only	**3 episodes per person per year**	**2.49 episodes per person per year** (2.19 to 2.82)	**RR 0.83** (0.73 to 0.94)	**3114** (2 studies)	⊕⊖⊖⊖ **very low** [2,3,4,5]	
Diarrhoea episodes Cluster RCTs: sanitation interventions	**3 episodes per person per year**	**2.79 episodes per person per year** (2.49 to 3.12)	**RR 0.93** (0.83 to 1.04)	**16033** (4 studies)	⊕⊕⊖⊖ **low** [2,4,5,6]	
Diarrhoea episodes CBAs: WASH interventions	**3 episodes per person per year**	**2.31 episodes per person per year** (2.13 to 2.52)	**RR 0.77 (** 0.71 to 0.84)	**1028** (2 studies)	⊕⊖⊖⊖ **very low** [2,5,6,7]	
Diarrhoea episodes Cohort studies: SHEWA,B intervention	**3 episodes per person per year**	**2.73 episodes per person per year** (1.92 to 3.84)	**RR 0.91** (0.64 to 1.28)	**~2000** (2 studies)	⊕⊖⊖⊖ **very low** [2,7,8,9]	

Diarrhoea episodes Case-control studies: disposal in latrine	**3 episodes per person per year**	**2.28 episodes per person per year** (1.98 to 2.64)[1]	**OR 0.76** (0.66 to 0.88)	**32360** (16 studies)	⊕⊖⊖⊖ **very low** [5,10,11,12]	
Diarrhoea episodes Case-control studies: defecation in latrine	**3 episodes per person per year**	**1.62 episodes per person per year** (0.99 to 2.70)[1]	**OR 0.54** (0.33 to 0.90)	**2996** (7 studies)	⊕⊖⊖⊖ **very low** [5,10,13,14]	
Diarrhoea episodes Cross-sectional studies: HEP intervention	**3 episodes per person per year**	**0.78 episodes per person per year** (0.48 to 1.26)[1]	**OR 0.26** (0.16 to 0.42)	**1660** (2 studies)	⊕⊖⊖⊖ **very low** [5,6,7,10]	
STH infection (any helminth) Cluster RCTs	**4.8 out of 100 persons with any helminths**	**4.9 out of 100 persons with any helminths** (3.74 to 6.58)	**RR 1.03** (0.78 to 1.37)	**3480** (2 studies)	⊕⊖⊖⊖ **very low** [6,9,15,16]	

*The assumed risk for diarrhoea is taken from Walker 2012 and represents an estimated average for the incidence of diarrhoea in low- and middle-income countries. The assumed risk for any helminth in stool is an average of the control group risks of Cameron 2013 INA (control group risk: 3.9%) Patil 2014 IND (control group risk; 5.6%). The **corresponding risk** (and its 95% confidence interval) is based on the assumed risk in the comparison group and the **relative effect** of the intervention (and its 95% CI).
CI: Confidence interval; **OR**: Odds Ratio

GRADE Working Group grades of evidence
High quality: Further research is very unlikely to change our confidence in the estimate of effect.
Moderate quality: Further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate.
Low quality: Further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate.
Very low quality: We are very uncertain about the estimate.

Footnotes

1. Calculated using the OR as an approximation for RR.

2. Downgraded by 1 for serious risk of bias: the outcome was measured as self-reported episodes of diarrhoea, and is susceptible to bias as all studies were unblinded.
3. Downgraded by 1 for serious inconsistency: statistical heterogeneity was very high (I^2 statistic = 80%).
4. Downgraded by 1 for indirectness: only a few studies (2 education-only and 4 sanitation) that included child faeces disposal only as a component.
5. No serious imprecision.
6. No serious inconsistency.
7. Downgraded by 2 for indirectness: only 2 studies that included child faeces disposal as a component among other WASH intervention. In addition both studies were conducted in the same country.
8. Downgraded by 1 for inconsistency: statistical heterogeneity was very high (I^2 statistic = 55%).
9. Downgraded by 1 for imprecision: small sample size and large confidence intervals which include important effects in both directions
10. Downgraded by 1 for serious risk of bias: the studies are observational and thus the differences in diarrhoea between groups could be due to other factors
11. Downgraded by 1 for serious inconsistency: statistical heterogeneity was very high (I^2 statistic = 63%).
12. No serious indirectness: these studies are from a range of settings, including rural and urban sites, in different income levels.
13. Downgraded by 1 for serious inconsistency: statistical heterogeneity was very high (I^2 statistic = 68%).
14. Downgraded by 1 for indirectness: there are only 7 studies and they are mostly from urban sites.
15. No serious risk of bias: the 2 studies are cluster RCTs and although assessors and participants were not blinded to the intervention, the outcome is objective.
16. Downgraded by 2 for serious indirectness: only 2 studies that included child faeces disposal as part of its components assessed the impact on STH. Both studies were conducted in Asia (in Indonesia and India).

BACKGROUND

Epidemiology and transmission of diarrhoeal disease and soil-transmitted helminth infection

Despite advances in prevention and treatment, diarrhoea and soil-transmitted helminth (STH) infections still represent a large disease burden, particularly in low-income countries. Diarrhoeal diseases account for an estimated 1.26 million deaths worldwide and rank fourth globally for leading causes of years of life lost due to premature mortality (GBD 2015). Among children under the age of five, diarrhoea kills more than 700,000 children annually, making it the second leading cause of mortality after pneumonia (Walker 2013). Over five billion people worldwide, including one billion school-aged children (aged five to 14 years), are at risk of infection with at least one STH species (Pullan 2012). The three STHs responsible for most infections are *Ascaris lumbricoides*, *Trichuris trichiura* and hookworms (*Ancylostoma duodenale* or *Necator americanus)*, with 819 million, 464.6 million and 438.9 million people infected in 2010 respectively (Pullan 2014).

The pathogens that cause diarrhoea are mainly transmitted via the faecal-oral route (Byers 2001). Pathogens from contaminated faeces can be passed on to a new susceptible host via contaminated hands, drinking water, soil, flies, or by ingesting contaminated food (Wagner 1958). The settings, pathogens and their prevalence in different populations will determine the importance of each transmission route (Brown 2013). The symptoms of diarrhoea and course of disease vary with age, nutritional and immune status of the infected person, and the causative pathogens (Clasen 2010). The main characteristics of infection are changes in stool consistency, increases in volume or fluidity, and increased frequency of defecation (Thapar 2004). The three clinical presentations of diarrhoea are: (1) acute watery diarrhoea lasting several hours or days, (2) acute bloody diarrhoea (dysentery) and (3) persistent diarrhoea lasting 14 days or more (Heymann 2008). The direct threat from acute watery diarrhoea is dehydration, loss of fluids and electrolytes. Severe dehydration can result in death if untreated (Keusch 2006).

STHs are transmitted via ingestion of STH eggs (*A. lumbricoides* and *T. trichiura*) or larvae (*A. duodenale*), or via penetration of third stage larvae (hookworms) (Bethony 2006). The larvae go through several developmental stages in the human host and depending on the species, the adult parasites can settle in different parts of the gastrointestinal (GI) tract, where they can live several years, mating and producing eggs that are passed in the faeces (Bethony 2006). The eggs (*A. lumbricoides* and *T. trichiura*) and larvae (hookworm) can survive in the soil for several months or several weeks, respectively, depending on the environmental conditions, including humidity, soil moisture and temperature (Brooker 2006). Morbidity caused by STHs is linked to the intensity of infection, which is the number of worms per human host measured by the number of eggs per gram of faeces (Bethony 2006). STHs infections can have several clinical features, which can be classified into acute manifestations linked to larval migrations through the skin and intestines, and acute and chronic manifestations associated with parasite presence in the GI tract (Bethony 2006).

In addition to the direct health consequences of diarrhoeal diseases and STHs infections, they have longer term impacts on human development due to malabsorption and malnutrition (resulting in stunting and chronic anaemia), and on capacity (via lower cognition, school absenteeism and inability to work), which in turn can have impacts on development and poverty (Harhay 2010). STHs are believed to be one of the main causes of physical and intellectual growth retardation in the world (Bethony 2006).

Sanitation and disposal of child faeces

As the aetiological agents associated with diarrhoea and STHs are transmitted through faeces, the safe collection and disposal of human excreta has the potential to significantly reduce exposure and disease. When readers of the *British Medical Journal* were asked to vote on the "greatest medical advance" since 1840, they chose the sanitary revolution (the introduction of clean water and sewage disposal) over antibiotics, anaesthesia, vaccines and germ theory (Ferriman 2007). Large scale efforts have been made to increase coverage of improved sanitation, most recently as part of the Millennium Development Goal (MDG) sanitation target of halving the proportion of the population without access to basic sanitation by 2015 (United Nations 2013). However, this target was missed by almost 700 million people and 2.4 billion people were still without improved sanitation in 2015 including almost one billion people practicing open defecation (WHO/UNICEF 2015). The post-2015 sustainable development goals (SDGs) include a goal to "[e]nsure availability and sustainable management of water and sanitation for all" with target 6.2 aiming, by 2030, to "achieve access to adequate and equitable sanitation and hygiene for all and end open defecation, paying special attention to the needs of women and girls and those in vulnerable situations" (United Nations 2016).

A series of published systematic reviews have consistently concluded that sanitation interventions are effective in preventing diarrhoea and STH infections. Esrey 1991 reported a 22% median reduction in diarrhoea from 11 observational studies and 36% from the five rigorous studies. They also reported reduction in *Ascaris* and hookworm from water supply and sanitation interventions, especially on the reduction in disease intensity (egg counts). Fewtrell 2005 reported a pooled risk ratio for diarrhoea of 0.68 (95% confidence interval (CI) 0.53 to 0.87) from two intervention studies. Waddington 2009 reported a pooled risk ratio for diarrhoea of 0.63 (95% CI 0.43 to 0.93) from six controlled studies among children. Clasen 2010 found a consistent protective effect against diarrhoea among 13 intervention studies but noted that nearly all involved water or hygiene interventions in addition to sanitation. Norman 2010 reported that sewerage led to a 30% reduction in diarrhoea (RR 0.70, 95% CI 0.58 to 0.85) among 17 observational studies. Ziegelbauer 2012 reported that sanitation interventions were protective against *Ascaris*, *Trichuris* and hookworm, while Strunz 2014 found that access to sanitation was associated with reduced odds of infection with any STH, *Ascaris and Trichuris* but not hookworm.

All of these reviews, however, focused on interventions to improve coverage, use or functionality of sanitation facilities; none specifically addressed the disposal of child faeces, another source of exposure even among households with improved sanitation. Actually, the unsafe disposal of child faeces may represent a more significant health risk to children, caregivers and other community members than that of adults. This is because young children have the highest incidence of enteric infections (Walker 2012), and their faeces are most likely to contain infectious agents (Feachem 1983). Young children are more likely to defecate in places where susceptible children could be exposed (Lanata 1998). This exposure is worse for other young children due to the amount of time they spend on the ground and their exploratory behaviours including putting fingers and fomites in their mouths, and common behaviours such as geophagia (intentional consumption of earth) (Moya 2004; Young 2011;Ngure 2013). Perhaps for these reasons, World Health Organization (WHO) and United Nations Children's Fund (UNICEF) Joint Monitoring Programme for Water Supply and Sanitation (JMP), which was charged with assessing progress toward the MDG sanitation targets, treated disposal of child faeces that are not deposited in a latrine or buried as unsanitary (WHO/UNICEF 2006). The JMP which will also monitor progress towards SDGs, has not yet published what child faeces disposal methods will be considered hygienic in this next phase of monitoring (WHO/ UNICEF 2015).

An additional risk of contamination of the environment with faeces, including those of children, is that it may result in extended exposure of children to faecal pathogens which may lead to environmental enteric dysfunction (EED), a disorder of the small intestine that is characterised by villous atrophy, crypt hyperplasia, inflammatory cell infiltrate, increased permeability and malabsorption (Humphrey 2009; Mbuya 2015). EED is thought to lead to under nutrition and growth faltering (Humphrey 2009; Lin 2013; Mbuya 2015).

We are unaware of any published, peer-reviewed study summarizing the evidence on the impact of child faeces disposal on human health. In an unpublished review and meta-analysis of 10 observational studies published between 1987 and 2001, Gil 2004 found that child faeces disposal behaviours considered risky (open defecation, stool disposal in the open, stools not removed from soil, stools seen in household soil and children seen eating faeces) were associated with a 23% increase in risk of diarrhoeal diseases (RR 1.23, 95% CI 1.15 to 1.32); on the other hand, behaviours considered safe (use of latrines, nappies, potties, toilets, washing diapers) were borderline protective (RR 0.93, 95% CI 0.86 to 1.00).

Prevalence of safe child faeces disposal

Safe disposal of child faeces has been defined in different ways, predominantly involving disposal of the faeces in a latrine (UNICEF 2012, WSP 2015) but also sometimes involving burying (WHO/UNICEF 2006). However, it was deemed that burying of faeces or throwing faeces in garbage should not be considered safe or improved disposal in an expert consultation (Bain 2015). Another definition of safe disposal of child faeces categorized safe disposal (disposal into any latrine) further into improved disposal if the latrine in which the faeces end up is considered improved (WSP 2015). None of these definitions are supported by strong evidence. The definitions of safe disposal of child faeces involve the child if the child defecates in a latrine directly or involves the caregiver disposing the faeces of the child safely into a latrine. The caregiver thus plays an important role, especially for younger children who are too young to be able to use a latrine, both to dispose of the faeces and also to train the child to use a latrine.

Worldwide safe disposal of child faeces is sub-optimal, a report by the WSP presenting analysis from the latest available MICS/DHS surveys found that in 15 out of 26 locations more than 50 percent of households reported that the faeces of their youngest child under three years were disposed of unsafely (not into a latrine) (WSP 2015) and the percentage of faeces ending up in improved latrines was even lower. Worldwide child faeces disposal was found to be safer in urban settings, in households with improved sanitation, for older children and in richer households (WSP 2015).

OBJECTIVES

To assess the effectiveness of interventions to improve the disposal of child faeces for preventing diarrhoea and STH infections.

METHODS

Criteria for considering studies for this review

Types of studies

We included randomised controlled trials (RCTs) that were individually- or cluster-randomised, together with the following non-randomized controlled studies (NRS): quasi-RCTs, non-RCTs, controlled before-and-after studies, interrupted-time- series studies, historically controlled studies, case-control studies, cohort studies, and cross-sectional studies (see definitions in Appendix 1, page 204). We included NRS as based on a previous review (Gil 2004) we assumed that there would be no or very few RCTs assessing the effect of improved disposal of child faeces for preventing diarrhoea and STH infection. We excluded non-controlled studies, such as case reports or case series, due to the importance of control groups to determine the effect of the intervention on the outcomes of interest.

Types of participants

Adults and children.

Types of interventions

Intervention:

All interventions aiming to improve the safe collection or disposal of faeces of children aged below five years in order to decrease direct or indirect human contact with such faeces. For NRS, this extended to interventions that occurred in the course of usual healthcare or daily life, or those that were deliberately introduced. This included, but was not limited to, safe disposal practices as defined by the JMP, namely direct defecation into a latrine, disposal of stools in a latrine, or burying of stools (WHO/UNICEF 2006). Interventions could include the provision of hardware (for example, nappies (diapers), potties, faecal collection devices, cleaning products to remove faeces, child-friendly squatting slabs or latrines used by children), software (for example, promotion of safe disposal practices), or both. We included interventions that combined the safe disposal of child faeces with other interventions, such as hygiene promotion interventions, and employed subgroup analysis to investigate the impact of these additional interventions.

Control:

Participants that continued their usual practices of child faeces disposal instead of the intervention, or who received a different type of intervention (for example, a health promotion intervention).

Types of outcome measures

Primary outcomes

- Diarrhoea episodes among individuals, whether or not confirmed by microbiological examination.

We defined an episode according to the case definitions used in each reviewed study. This includes the WHO definition, which is the passage of three or more loose or liquid stools per day or more than usual for the individual (WHO 2013). We treated this outcome as dichotomous, whether an individual had one or more episodes of diarrhoea.

- Infection with one or more of the following species of STHs: *Ascaris lumbricoides (round worm)*, *Trichuris trichiura (whip worm)*, *Ancylostoma duodenale* or *Necator americanus (hookworm*). We defined infection as the presence of eggs, or juvenile nematodes, or both in the stools of the participants. We included any accepted diagnostic techniques.

Secondary outcomes

- Dysentery
- Severe diarrhoea
- Persistent diarrhoea
- Clinical visits for diarrhoea
- Intensity of STH infection (number of eggs per gram of stool)
- Presence of pathogenic microbes in stool assays
- Anthropometry (weight-for-age and height-for-age)

- Serology
- Other markers of infection and disease
- Mortality
- Use and adoption of the intervention (behaviour change)
- Adverse events

Search methods for identification of studies

We attempted to identify all relevant studies regardless of language or publication status (published, unpublished, in press and ongoing).

Electronic searches

We searched the following databases using the search terms detailed in Appendix 2 (page 205): CIDG Specialized Register (14/11/2014); Cochrane Central Register of Controlled Trials (CENTRAL), published in *The Cochrane Library* (07/11/2014); EMBASE (7/11/2014) ; MEDLINE (7/11/2014); Global Health (7/11/2014); Web of Science (7/11/2014); LILACS (14/11/2014); and POPLINE (7/11/2014). Also, we examined Chinese-language databases available in the China National Knowledge Infrastructure (25/01/2015) and the Wan Fang Portal (11/01/2015) using the search terms detailed in Appendix 2 or their Chinese language equivalents. We searched the *meta*Register of Controlled Trials (*m*RCT), clinicaltrials.gov and International Clinical Trials Registry Platform Search Portal (www.who.int/trialsearch) using "sanitation" and "hygiene" as search terms, as well as an index to theses in the United Kingdom (http://ethos.bl.uk) (9/06/2015). We searched Open Grey http://www.opengrey.eu) database for grey literature (9/06/2015).

Searching other resources

Conference proceedings

We searched the following organizations' conference proceedings: International Water Association and Water, Engineering and Development Centre, Loughborough University, UK.

Researchers and organisations

We contacted individuals working in the field, and contacted or searched websites of the following organizations for other potential published and unpublished studies: Water, Sanitation and Health Programme of the WHO; World Bank Water and Sanitation Program; UNICEF Water, Environment and Sanitation; Environmental Health Project (USAID); IRC International Water and Sanitation Centre; Global Water, Sanitation and Hygiene (CDC); International Centre for Diarrhoeal Disease Research, Bangladesh (ICDDR,B); US Agency for International Development (USAID); UK Department for International Development (DFID); Asian Development Bank (ADB); WASHplus (http://www.washplus.org/); sustainable sanitation alliance (http://www.susana.org/); community-led total sanitation (CLTS); the sanitation updates blog (http://sanitationupdates.wordpress.com/); and the STEPS Centre at the Institute of Development Studies University of Sussex (http://steps-centre.org).

Reference lists

We checked the reference lists of studies identified by the above methods.

Data collection and analysis

Selection of studies

Fiona Majorin (FM) examined titles of all identified studies removing those that were clearly ineligible and off-topic. Two reviewers (FM and Lyndsey Gray (LG) for database searches and Belen Torondel (BT) for other resources) independently examined abstracts and selected all potentially eligible studies based on the inclusion criteria. If a title or abstract could not be rejected with certainty due to lack of information, we obtained the full text of the article for further assessment. Gabrielle Ka Seen Chan (GC) reviewed the results of the Chinese database search, undertaking the same process as FM, LG and BT. We obtained full copies of all studies agreed by either author to potentially fall within the inclusion criteria. FM and LG or BT independently determined whether each study met the inclusion criteria using a form. When we agreed, we either included or excluded the study. If we were unable to agree, we consulted Thomas Clasen (TC) who made the final decision. FM corresponded with authors in case data needed to assess eligibility was not obvious in the study or if data was missing from the report. Any studies that FM or the second reviewer (LG or BT) suggested to include but which was ultimately excluded through discussion or by TC is presented with the reason for exclusion in the 'Characteristics of excluded studies' (page 158). We checked study reports to ensure that multiple publications of the same study were only included once.

Data extraction and management

FM and BT independently extracted data from the included studies using a data extraction form after it had been piloted (items included in the form are presented in Appendix 3, page 207). In case of discrepancy, we discussed the data and consulted TC, if necessary, who made the final decision. FM entered and analysed the agreed data into Review Manager (RevMan) and BT independently cross-checked a sample of the data.

Type of data extracted

RCTs randomized by cluster

For cluster RCTs, when the data was available, we extracted the number of participants enrolled and the number analysed in each treatment group for each outcome. We noted whether or not the authors reported adjusting for clustering in the analysis.

NRS

For NRS, we extracted details on the features of the design, the confounding factors considered in the study, methods used to control for confounding, data on the risk of bias specific for NRS (see Assessment of risk of bias in included studies, next page), the total numbers of participants included in the study and in each comparison group, the measures of effect and CIs.

Assessment of risk of bias in included studies

Two authors (FM and BT) independently applied the risk of bias criteria using an assessment form. In case of disagreement we discussed the issue to make the final decision. For each study, we justified reasons for the level of risk of bias and included it in the 'Risk of bias' table.

For RCTs we used the Cochrane Collaboration tool (Higgins 2011b) to assess the risk of bias, which includes methods of random sequence generation, allocation concealment, blinding of participants, personnel and outcome assessment, incomplete outcome data and selective reporting. For each domain, we followed the definitions of low risk, unclear risk and high risk described in Higgins 2011b.

For cluster RCTs we also assessed the risk of bias specific to this study design:

- Recruitment bias. We qualified the study as high risk of bias in case the participants and staff were aware of which cluster was the intervention or control; unclear risk in case the information was not collected or reported; or low risk of bias if clusters were not known to be intervention or control during participant recruitment.
- Baseline imbalance. We assessed a study as high risk of bias when large differences in baseline characteristics were present and they were not adjusted for in the analysis; low risk of bias in case statistical methods were used to match the clusters at the design stage or to adjust for imbalances in the analysis, or in case no substantial differences in baseline characteristics were observed; or unclear risk if it was not mentioned in the report.
- Loss of clusters. We qualified studies as high in case > 10% of clusters were lost to follow-up; low risk of bias if < 10% of clusters were lost to follow-up; or unclear if loss to follow-up was not mentioned.
- Incorrect analyses. We assessed studies as high risk of bias if they did not analyse the data adjusting for clustering; low risk of bias in case there were no unit-of

analysis errors in the study and if clustering was adjusted for in the analysis; or unclear risk if it was not reported in the study.

- Comparability with individually randomized RCTs. We analysed cluster-RCTs separately from other study designs.

For controlled before-and-after studies, controlled cohort and cross-sectional studies, we used the EPOC criteria (EPOC 2013) to assess the risk of bias. This tool includes random sequence generation, allocation concealment, incomplete outcome data, selective outcome reporting and other biases that are similar to the RCT risk of bias tool, as well as the following additional domains:

- Similarity of baseline characteristics. Important baseline characteristics for this study include: access and type of sanitation facilities, water access and quality, age, wealth and hygiene practices. We qualified the studies as high in case there were substantial differences; low risk of bias if baseline characteristics were reported and there was no substantial difference; or unclear if it was not reported or unknown.
- Similarity of baseline outcome measurements. We gave high risk of bias scores when large differences were present and they were not adjusted for in the analysis; low risk of bias scores to studies if participant outcomes were measured prior to the intervention and there were no substantial differences; or unclear risk if it was not mentioned in the report.
- Adequate protection against contamination? We qualified a study as high risk if it was likely that the control group received the intervention; low risk if it was unlikely that the control group received the intervention; or unclear in case it was possible contamination could have occurred.
- Adequate allocation of intervention concealment during the study. We classified studies as high risk if the outcomes were not assessed blindly; low risk of bias if the authors explicitly reported that the primary outcomes were assessed blindly or the outcomes were objective; or unclear if it was not specified in the paper.

We also added a domain to assess whether the studies appropriately adjusted for confounders. The following confounders related to child faeces disposal and diarrhoea or STHs infections were considered important for this review: access to or ownership of a sanitation facility, type of sanitation facility (improved or unimproved according to the JMP classification (WHO/UNICEF 2014), use of sanitation facility, wealth, age, water access, season, water quality, animal ownership, household size, educational level, attendance to school or pre-school by the children, shoe-wearing and hygiene practices. We classified studies as low risk if they controlled for at least one of the listed confounders in the design (for example, matching) or the analysis (for example, multivariable statistical modelling). We classified studies as high risk if no adjustment for confounding variables was conducted and unclear in case it was not mentioned in the paper.

For case-control studies we assessed the quality of the studies using the Newcastle Ottawa scale (NOS) (Wells 2013). The scale is divided into eight items grouped into three domains: selection, comparability and ascertainment of exposure. For each item in the selection and exposure ascertainment domains a total of one 'star' can be awarded to a study; in the comparability domain two stars can be awarded. For one star in the comparability domain, the study had to control for access to or ownership of a sanitation facility. For two stars, the study had to control for at least one other important confounding variable, such as type of sanitation facility (improved or unimproved) use of sanitation facility, wealth, age, water access, season, water quality, animal ownership, household size, educational level, attendance to school or pre-school by the children, shoe-wearing and hygiene practices.

Measures of treatment effect

For RCTs with dichotomous outcomes, we calculated risk ratios (RR) with 95% CIs in case the raw data were available. If not we used the effect measures reported, along with the 95% CI. For continuous variables, we extracted the mean differences. We calculated or extracted standard errors and 95% CI from these studies.

For NRS, we report measures of effect adjusted for confounders from the studies. If several adjusted estimates are reported, we used the estimate adjusting for the most confounders. We specified the confounders that were adjusted for in the study and whether it was done in the design or in the analysis. In case the effect measures extracted were expressed in different metrics, we converted them into a common measure, RR for controlled cohorts and cross-sectional studies and OR for case-control studies; if they were all the same, we combined them using the effect measure used in the reports. If no adjusted measures could be obtained from the studies, we used unadjusted measures reported in the study or calculated RR or OR (for case-controls) and 95% CI from the raw data.

Unit of analysis issues

We searched for both individually- and cluster-randomized RCTs, however we identified no individually-randomized RCTs that met our inclusion criteria. For cluster RCTs, we assessed whether clustering was properly accounted for in the analysis and used the adjusted measure of effect reported or used the unadjusted measure of effect and specified it in the text.

Dealing with missing data

If studies had missing data needed for assessment of eligibility or analysis, FM attempted to contact authors to obtain the data. We report on the number of participants in each study and the number of participants that were lost to follow-up.

Assessment of heterogeneity

We assessed heterogeneity by visually examining the CIs in the forest plot and by using the Chi^2 test and I^2 statistic (Higgins 2003). We considered a significance level of < 0.1 for Chi^2 test to be significant and indicate potential heterogeneity. To estimate the degree of heterogeneity, we classified an estimate of I^2 > 50% to indicate substantial heterogeneity and > 75% to indicate considerable heterogeneity (Deeks 2011). We prespecified that if there are sufficient studies and substantial heterogeneity, we would investigate causes of heterogeneity using subgroup analysis.

Assessment of reporting biases

We tried to minimise reporting bias by using a comprehensive search strategy including published and unpublished studies. We compared the outcomes listed in the methods and those reported in the results sections. We assessed the potential of publication bias using funnel plots of case-control studies included in the analysis of safe disposal of child faeces (Figure 1, page 202).

Data synthesis

We analysed the data using Review Manager (RevMan). If there was more than one study with comparable participants, interventions and outcomes, we conducted a meta-analysis to estimate a pooled measure of effect. We used random-effects models to pool the data. The comparisons made were between those with the intervention and those without or with a different intervention. Due to differences in potential risk of bias of different study designs (Reeves 2011), we only pooled results of similar study designs.

We stratified the case-control analyses according to the level of quality of the studies, according to the numbers of stars it received.

When there were not enough similar studies to pool them together, we described them in the text organising them by type of intervention, outcome and study design.

Summary of findings table

One reviewer assessed the methodological quality of each outcome across the included studies using GRADE guidelines (Guyatt 2011). We summarized the methodological quality in the ‘Summary of findings table’.

The following outcomes are presented in the 'Summary of findings' table:

- Diarrhoea episodes;

- Infections with one or more species of STHs.

Subgroup analysis and investigation of heterogeneity

In the case-control analyses, we conducted subgroup analyses to investigate:

- The effect of safe child faeces disposal on outcomes in different age groups, children aged < 5 years versus all ages.
- The effects of different case-definitions;
- The effects of the intervention site (urban versus rural);
- The effects of the intervention settings (low, middle or high income country)
- The effects of different methods to ascertain child faeces disposal behaviour: observations vs survey questionnaire

Sensitivity analysis

We conducted sensitivity analyses to check robustness of the choice of analysis method (random-effects model versus fixed- effect).

RESULTS

Description of studies

Results of the search

The searches identified 33540 records, 29927 from English databases, 3613 from Chinese databases, and 885 from other sources. We screened the titles and abstracts and obtained 572 full texts, of which 51 reports on 46 studies ultimately were deemed to meet our inclusion criteria. See Figure 2 (page 203).

Included studies

Study designs

The 46 studies included in this review covered at least 82,243 participants (see Characteristics of included studies, page 112). Of these studies, 11 were cluster RCTs, 3 were CBAs and 32 were NRS (25 case-control studies, 2 controlled cohort studies and 5 controlled cross-sectional studies). Out of the 14 CRCTs and CBAs, 6 were education-only interventions that included child faeces disposal instructions exclusively (Yeager 2002 PER) or among other targeted behaviours (Ahmed 1993 BGD; Barrios 2008 PHI; Haggerty 1994 DRC; Jinadu 2007 NGR; Stanton 1987 BGD) and 6 included child faeces disposal among other WASH components. Of these 6 multi-component interventions, 4 focused on ending open defecation throughout the target community, including adults as well as children (Pickering 2015 MLI, Briceño 2015 TAN; Cameron 2013 INA; Patil 2014 IND). The others included instruction for children to use toilets constructed in its WASH intervention (Aziz 1990 BGD) or included child faeces disposal messaging in their health education component along with providing hand pumps (Alam 1989 BGD). Two studies included child faeces disposal in their multi-component interventions in day care centres (Butz 1990 USA; Kotch 2007 USA).

In the case-control studies, 3 studies included 2 risk factors related to child faeces disposal and one study Baker 2016 BGD had 7 different study sites, thus making a total of 29 comparisons. Five studies (Arvelo 2009 USA; Chiang 2005 TWN; Daniels 1990 LES; Menon 1990 USA; Nanan 2003 PAK) could not be included in the analyses as they either had insufficient or no data or could not be compared to the other case-control studies.

Two cross-sectional studies compared "model" and "non-model" families from the Ethiopian Health Extension Package (HEP) (Berhe 2014 ETH; Gebru 2014 ETH), 2 studied the behaviour change as a result of community health clubs (Mathew 2004 ZIM; Waterkeyn 2005 ZIM), and 1 studied the behaviour change and health effect of the BRAC WASH programme (Fisher 2011 BGD). Two controlled-cohort studies evaluated the SHEWA-B intervention in Bangladesh which included child faeces disposal in its hygiene education component (Huda 2012 BGD; Luby 2014 BGD).

Nine of the included studies had insufficient information or had no comparable studies to be included in the quantitative analysis. These are described in this review but not included in the analyses. Twenty-six authors of included studies were contacted for additional details on their study, of which 14 replied.

Study participants and settings

RCTs and CBAs

Most studies were conducted in low- or lower middle-income settings, apart from Butz 1990 USA and Kotch 2007 USA, which were conducted in day care centres in the USA and Yeager 2002 PER which was conducted in urban Peru.

Ahmed 1993 BGD, Alam 1989 BGD; Aziz 1990 BGD were conducted in rural Bangladesh and Stanton 1987 BGD in urban Bangladesh, Barrios 2008 PHI in rural Philippines, Cameron 2013 INA in rural Indonesia, Patil 2014 IND in rural India. Briceño 2015 TAN was conducted in rural Tanzania, Haggerty 1994 DRC in rural Democratic Republic of Congo (DRC); Jinadu 2007 NGR in rural Nigeria and Pickering 2015 MLI in rural Mali.

Apart from Stanton 1987 BGD which collected diarrhoea morbidity data in children <6 years old, Jinadu 2007 NGR which collected data on ≤5 year olds and Butz 1990 USA which included children between 1 month and 7 years old in day care centres, all other studies collected data for children <5.

NRS

Case-control studies

Most of the case-control studies occurred in low- or lower middle- income countries, apart from Chompook 2006 THA; Genthe 1996 SAF; Heller 2003 BRA; Knight 1992 MAL; Strina 2012 BRA which were in upper middle income countries and Abalkhail 1995 KSA; Arvelo 2009 USA; Chiang 2005 TWN; Menon 1990 USA which were in high-income countries.

In general, included studies considered cases and controls only <5 or younger. The exceptions were Arvelo 2009 USA which did not specify the age of the children in the day care centres, Chompook 2006 THA which included all ages (median age: 5 years in cases and controls), Clemens 1987 BGD included children <6 years old, Cummings 2012 UGA which only collected data on cases and controls >10 years old (median age in cases: 26 years, in controls: 33 years), Genthe 1996 SAF which included pre-school children (age range 0.2-67.2 months), Nanan 2003 PAK who considered cases and controls between 4- 71 months, Oketcho 2012 TAN between 6-60 months and Strina 2012 BRA <10 years old.

The majority (11 studies) of the case-control studies recruited cases from health care settings and controls from the community (Menon 1990 USA; Mertens 1992 SRI; Traore 1994b BUR had both community and hospital controls), 8 recruited cases and controls from health-care settings, 5 recruited cases and controls from the community and Arvelo 2009 USA recruited cases and controls from among licensed day care centres.

Cohort studies

Both cohort studies were conducted in Bangladesh. Huda 2012 BGD included only rural populations while Luby 2014 BGD included both urban and rural areas. Both studies studied outcomes in children below 5.

Cross-sectional studies

Berhe 2014 ETH and Gebru 2014 ETH were conducted in rural Ethiopia and measured outcomes in children <5. Mathew 2004 ZIM and Waterkeyn 2005 ZIM were conducted in rural Zimbabwe and did not specify the age of the children whose defecation or faeces disposal behaviour were collected. Fisher 2011 BGD covered children <5 in rural Bangladesh.

Interventions

RCTs and CBAs

The 6 education-only interventions included different messages on child faeces disposal (Characteristics of included studies, page 112).

Yeager 2002 PER focused on promoting use of a potty for children 15-47 months and to keep the home environment free of faeces and was promoted through the routine health service. Although the intervention describes what messages were promoted to train children to defecate in potties, no details are given in the paper as to where faeces should be cleared away from the potties.

Ahmed 1993 BGD generated the intervention messages through participation with the community and thus contained a large amount of target behaviours including the use of dirt thrower to immediately remove child or animal faeces from the compound and to construct a pit to dispose of faeces and other dirty material from the compound. Barrios 2008 PHI focused its intervention messages on hand washing and stool disposal aiming to ensure the sanitary disposal of faeces in a latrine or burying in case no latrine was available, regardless of where the child defecated. Haggerty 1994 DRC promoted the disposal of animal faeces, hand washing at different key moments and disposal of children's faeces, emphasising digging or improving pit latrines. Jinadu 2007 NGR promoted the hygienic disposal of children's faeces by educating mothers to use chamber pots for disposal (although no details on final disposal site are provided in the paper), discouraging children from defecating around households and also promoting the construction of ventilated improved pit (VIP) latrines and educating mothers to wash their hands after using the toilet and cleaning up children's faeces. Stanton 1987 BGD promoted proper hand washing before food preparation, defecation away from the house and in a proper site, and suitable disposal of waste and faeces, again the final disposal site for child faeces was not specified in the paper.

Briceño 2015 TAN; Cameron 2013 INA; Patil 2014 IND and Pickering 2015 MLI focused on ending open defecation including by children in their intervention using community led total sanitation (CLTS). CLTS aims to change the behaviour in a community through stimulating a collective sense of disgust and shame that triggers the whole community to stop practicing open defecation; once communities succeed in ending open defecation, they are rewarded open defecation free (ODF) certification (Kar 2008). Briceño 2015 TAN; Cameron 2013 INA; Patil 2014 IND also had other components to increase demand for sanitation as part of the total sanitation marketing (TSSM) project, and in India the total sanitation campaign also included subsidies for latrine construction (Patil 2014 IND). In the criteria for ODF certification in Mali, among other indicators is that 'all family members must use the latrine or a child potty' (Pickering 2015 MLI).

Aziz 1990 BGD included the provision of water and sanitation infrastructure as well as hygiene education which included the need for children to use the toilets constructed. Alam 1989 BGD provided hand pumps to communities as well as health education on use of hand pump water, improvement of water handling and storage practices, disposal of child's faeces soon after defecation (with no details on how or where), washing hands before handling food.

Of the 2 studies in day care centres in the USA, Butz 1990 USA included advice on hand washing and diaper changing practices and instructions to dispose of gloves, disposable pads and diapers in plastic bags and centres were given supplies (gloves, diaper changing pads, hand rinse solution). Kotch 2007 USA provided diapering, hand-washing, and food- preparation equipment with impermeable, seamless surfacing and automatic faucets and foot-activated, roll-out waste bins for diaper disposal.

Controlled cohort and cross-sectional studies

The SHEWA,B (Huda 2012 BGD, Luby 2014 BGD), community health clubs (CHC) (Mathew 2004 ZIM, Waterkeyn 2005 ZIM) and BRAC (Fisher 2011 BGD) programs promote the disposal of children’s faeces into hygienic latrines among other messages in their educational component. SHEWA,B also promoted the importance of everyone in the household, including children, to use the latrine.

In the HEP program in Ethiopia (Berhe 2014 ETH, Gebru 2014 ETH), education on child faeces disposal is included in the maternal and child health package, emphasising cleaning faeces and disposing of them in a pit latrine or burying the faeces (HEP 2003). The HEP includes health promotion and education on 16 packages in four main categories: family health services, disease prevention and control, hygiene and environmental sanitation and health education and communication.

Case-control studies

Among the case-control studies, child faeces disposal variables were categorised into safe and unsafe disposal differently (Characteristics of included studies, page 112). The most used categorisation of child faeces disposal was disposal into a latrine vs elsewhere (10 comparisons of which 1 included both disposal in a latrine after defecation elsewhere and defecation in a latrine). In some studies, the authors also classify the defecation in a latrine as well as disposal in a latrine as safe in the same variable, whereas other studies presented separate variables for disposal in a latrine and defecation in a latrine. Thus, we pooled together studies that had variables of safe disposal into a latrine (which in some cases included defecation into a latrine) and separately pooled studies with variables of defecation into a latrine.

Some definitions of safe disposal are more specific, including only certain disposal places as safe, such as Baker 2016 BGD only considered certain types of latrines in which the faeces are disposed of as safe: hanging latrines and bucket latrines were considered open disposal. Baltazar 1989 PHI defined sanitary disposal as child defecated in a nappy and faeces were thrown away in washing, child used chamber pot/piece of paper and faecal matter was thrown in the toilet or child used the toilet, whereas unsanitary was when the faeces were deposited elsewhere than latrine or the child defecated outside (regardless of where faecal matter was finally thrown away). Mertens 1992 SRI defined unsanitary stool disposal as stools passed, or disposed of, in or out of the yard without being disposed within a day in a latrine or in a covered rubbish pit, while proper disposal was stools passed in a potty and later disposed of in a latrine or in a covered pit.

Ghosh 1994 IND, Ghosh 1997 IND did not define what they considered indiscriminate disposal of stools and Strina 2012 BRA did not define what they considered to be inadequate/adequate disposal of excreta of children.

In the studies with variables including defecation in a latrine, Chompook 2006 THA categorised data into children always using latrines vs not/sometimes using latrines. Clemens 1987 BGD considered the latrine or some other specially designated place vs open defecation. Knight 1992 MAL grouped defecation in a nappy and latrine as safe, whereas Maung 1992a MYA and Traore 1994b BUR categorised data into defecation in pots and latrines vs elsewhere. Mediratta 2010b ETH; Oketcho 2012 TAN categorised defecation into 2 categories: into the latrine or elsewhere.

In Arvelo 2009 USA, the risk factor relevant to this review was whether day care centres had lined, lidded bins for diaper disposal (the unit of analysis was the day-care centre). In Chiang 2005 TWN the risk factor relevant to the review was open defecation of children <5 but the reference category was not provided. Daniels 1990 LES collected data on disposal of child faeces in latrines in cases and controls but did not provide data separately for both groups. In Menon 1990 USA the risk factor of interest was whether households had dirty diapers in the yard, Nanan 2003 PAK studied whether cases and controls were from WASEP villages, which included in its intervention education on the safe disposal of faeces (adult, child and household animals). Thus these 5 studies could not be compared with the other case-control studies and were excluded from the analyses.

Primary outcome measures

Diarrhoea

For diarrhoea, the majority of studies (14 studies) used the WHO's definition (passage of three or more loose or liquid stools per day or more than usual for the individual) for the case definition of diarrhoea (Characteristics of included studies, page 112). Other studies defined diarrhoea as: softer than usual, 1-5 stools; watery, 1-5 stools; softer than usual, 5-10 stools; watery, 5-10 stools; watery more than 10 stools per day; or dysentery (Ahmed 1993 BGD), 3 or more soft liquid stools within 12 hours or a single soft or liquid stool with blood, pus or mucus (Abalkhail 1995 KSA), 3 or more loose/watery stools in a 24 hour period or having a stool with blood or mucus (Briceño 2015 TAN, Cameron 2013 INA; Mertens 1992 SRI; Patil 2014 IND), occurrence of loose, unformed bowel movements at twice the normal frequency (infants, one to two stools per day; and older children, one stool per day) (Butz 1990 USA), passage of at least 3 liquid, watery mucoid stools with or without blood during the past 24hrs. For infants up to 3 months, an increase in the frequency and a change in the consistency of stools which was of concern to mothers (Ghosh 1997 IND), mother's own definition using local term to describe diarrhoea (Haggerty 1994 DRC), any loose, watery stool that if contained would assume the shape of the container (Kotch 2007 USA), caretaker reported increase in the stool fluidity and frequency of passing stool for at least 2 days (Oketcho 2012 TAN) or as reported by the mother and examined by a doctor (Traore 1994a BUR).

Baker 2016 BGD included criteria qualifying the episode to be moderate or severe. Cummings 2012 UGA used acute watery diarrhoea in an area with laboratory-confirmed cholera cases.

Other definitions required lab-testing to confirm shigella (Arvelo 2009 USA; Chiang 2005 TWN; Chompook 2006 THA) or rotavirus (Menon 1990 USA; Strina 2012 BRA). Maung 1992a MYA used persistent diarrhoea and protein energy malnutrition.

Baltazar 1989 PHI; Berhe 2014 ETH; Dikassa 1993 DRC; Gebru 2014 ETH; Ghosh 1994 IND; Godana 2013 ETH; Heller 2003 BRA did not provide a case definition for diarrhoea.

Soil-transmitted infections

Cameron 2013 INA; Patil 2014 IND both assessed the presence of STH in stool samples using the Kato-Katz technique.

Excluded studies

The studies that were discussed but subsequently excluded are described in Characteristics of excluded studies (page 158). Three studies appear to meet our inclusion criteria but are still ongoing are presented in Characteristics of ongoing studies (page 158).

Risk of bias in included studies

The risk of bias of trials and non-randomised studies apart from case-control studies are summarized in Table 1 (page 185) and in Characteristics of included studies (page 112).

Allocation (selection bias)

The random sequence generation was classified as 'low risk' in 5 of the cluster RCTs and unclear in the other 6. Concealment was classified as 'low' in 3 studies and 'unclear' in 8. All CBAs, cohort and cross-sectional studies were classified as ‘high’ risk.

Blinding (performance bias and detection bias)

All cluster RCTs were classified as 'high' risk for blinding participants and personnel. Apart from 1 'unclear' studies, all other RCTs were rated as 'high' risk for blinding of outcome assessment.

Incomplete outcome data (attrition bias)

Barrios 2008 PHI was qualified as 'high' risk for incomplete outcome data, 4 studies were qualified as 'unclear' and the remaining 6 as 'low' risk.
Two CBAs were rated as unclear while Alam 1989 BGD was qualified as ‘low’ risk. The 2 cohort studies were classified as ‘unclear’. Of the cross-sectional studies, 1 was classified as ‘unclear’ and 4 as ‘low’.

Selective reporting (reporting bias)

Two RCTs (Barrios 2008 PHI; Haggerty 1994 DRC) were classified as 'high' risk of selective bias, while the other 9 RCTs were classified as 'low' risk.
All CBAs, cohorts and cross-sectional studies were qualified as ‘low’ risk apart from Mathew 2004 ZIM, which was classified as ‘unclear’.

Risk of bias specific to cluster RCTs

8 CRCTs were classified as 'high' risk and the remaining 3 as 'low' risk for recruitment bias. For baseline imbalance, 3 CRCTs were classified as 'high' risk, Jinadu 2007 NGR as unclear and the rest as 'low' risk. For loss of clusters, 2 studies, Stanton 1987 BGD and Yeager 2002 PER, were classified as unclear and all other CRCTs were classified as 'low' risk. For incorrect analysis, 5 CRCTs were classified as 'high' risk, while the remaining 6 were classified as 'low'.

Risk of bias specific to NRS (except case-control studies)

For similarity of baseline outcome measurements, Ahmed 1993 BGD was qualified as 'high' risk, Alam 1989 BGD as 'unclear' and Aziz 1990 BGD as 'low'. The cohort and cross-sectional studies were classified as 'unclear'. For similarity of baseline characteristics, Ahmed 1993 BGD was rated as 'high' risk while the 2 other CBAs were 'unclear'. The cohort studies were classified as 'low' and the 5 cross-sectional studies as 'unclear'. For adequate allocation of intervention concealment, the 3 CBAs and 2 cohorts were rated as 'high' risk. Three of the cross-sectional studies were high risk, Gebru 2014 ETH was classified as 'unclear' and Berhe 2014 ETH as 'low'. For adequate protection against contamination, Alam 1989 BGD was classified as 'high' while the 2 other CBAs were considered as 'low' risk. The 2 cohorts studies were classified as 'low' risk. Berhe 2014 ETH and Gebru 2014 ETH as 'high' risk, while Fisher 2011 BGD and Mathew 2004 ZIM were classified as 'unclear' and Waterkeyn 2005 ZIM as 'low'. For adequate adjustment for confounders, the 3 CBAs were classified as 'high' risk, the cohort studies and 3 cross-sectional studies were classified as 'high' risk. Berhe 2014 ETH and Gebru 2014 ETH were classified as 'low' risk.

Risk of bias of the case-control studies

The case-control studies risk of bias are presented in Table 2 (page 187).

Effects of interventions

See: summary of findings table (page 53).

Diarrhoea

RCTs and CBAs

Neither Barrios 2008 PHI, Jinadu 2007 NGR or Yeager 2002 PER reported on the health impact of the intervention.

The 2 CRCTs that evaluated education only interventions were found to reduce diarrhoea by about 20% (RR 0.83, 95% CI 0.73 to 0.94, Analysis 1.1, page 166). These studies were not adjusted for clustering. Ahmed 1993 BGD only presented trends in daily diarrhoea prevalence in the intervention and control groups in graphs and it seems that although for a portion of the intervention the prevalence of diarrhoea was lower in the intervention, by the end of the study the prevalence was similar between groups.

The pooled effect of the sanitation interventions that aimed to end open defecation by all household members found no effect on diarrhoea (RR 0.93, 95% CI 0.83 to 1.04, Analysis 2.1, page 167) Only the estimates for Pickering 2015 MLI are adjusted for clustering. Pickering 2015 MLI found no difference in child diarrhoea prevalence between intervention and control groups with either a 2-day (22.5% vs 24.1%, p=0.486) or 2-week recall period (31.2% vs 32.0%, p=0.787). Patil 2014 IND found no difference in diarrhoea prevalence (7 day recall) between the intervention and control (7.4% vs 7.7%; p= 0.687). Briceño 2015 TAN found a decrease in diarrhoea in the sanitation and handwashing combined arm (12.5% vs 16.8% for 14 days recall) but in the sanitation only arm there was no significant decrease. Diarrhoea symptoms in the past 7 days between either treatment (TSSM and HWWS combined or just TSSM) and control groups also showed no significant difference. Cameron 2013 INA found that the intervention group had lower diarrhoea prevalence compared to control children (2.4% vs 3.8%, p=0.07 for 7 day recall and 1.6% vs

3.1%, p=0.025 for 2 day recall). The impact of children using the latrine cannot be deduced from this overall measure of effect.

Interventions including other WASH components were found to reduce diarrhoea by about a quarter (RR 0.77, 95%CI 0.71 to 0.84, 2 studies, Analysis 3.1, page 170). However, it is not possible from these studies to ascertain the specific contribution of the child faeces disposal component of the intervention.

Two interventions were conducted in day care centres in the USA. Butz 1990 USA found that symptoms of diarrhoea were significantly reduced in intervention day care centres (OR 0.715, 95%CI: 0.54 to 0.72). Kotch 2007 USA found that children in the intervention day care centres had fewer episodes of diarrhoea (0.90 vs 1.58 diarrhoea illnesses per 100 child-days, p<0.001) compared to the control group.

Controlled-cohort studies

The SHEWA-B evaluation (Luby 2014 BGD) found no difference in diarrhoea prevalence in children <5 (recall 2 days) during the first 24 months of the evaluation (10.5% vs 10.3%, p=0.67). In the last 18 months of the evaluation, they found that children in the intervention had less diarrhoea (9% vs 12%, RR=0.80, p=0.033) in rural areas, however the evaluation found no impact in the urban slums exposed to the intervention compared to control slums (7% vs 6%, RR= 1.12, p=0.348). The pooled effect shows no difference in diarrhoea between intervention and control areas (RR 0.91, 95% CI 0.64 to 1.28, Analysis 4.1, page 170).

Case-control studies

Pooled results from case-control studies that presented data for child faeces disposal indicated that disposal of faeces in the latrine significantly decreased the odds of diarrhoea by about a quarter among all ages (OR 0.76, 95%CI: 0.66 to 0.88, 22 comparisons) and children <5 (OR 0.77, 95%CI: 0.66 to 0.89, 19 comparisons) (Analysis 5.1, page 172). See Table 3 (page 197) for more information on those studies.

Pooled results from case-control studies that presented data for children defecating in the latrine indicates that children using the latrine reduces the odds of diarrhoea by about half in all ages (OR 0.54, 95% CI: 0.33 to 0.90, 7 studies); the corresponding pooled estimate for children <5 is the same but is not statistically significant (OR: 0.54, 95%CI: 0.28 to 1.07, 5 studies) (Analysis 6.1, page 178). See Table 4 (page 201) for more information on those studies.

Arvelo 2009 USA found no significant difference in lidded bins for diaper disposal between case and control LIDCs (OR 2.0, 95%CI: 0.5 to 8.1). Chiang 2005 TWN found that open defecation of children increased the odds of being a case (OR 6.32, 95%CI: 0.7 to 54.5, adjusted for ethnicity and living residence). Daniels 1990 LES found that among both the cases and controls, 50% of latrine owners reported that they disposed of the child's stools in the latrine, however this was not shown separately for cases and controls. Menon 1990 USA observed more dirty diapers in the yards of case households compared to controls but not significantly (OR 3.5, 95%CI: 0.88 to 13.93); Nanan 2003 PAK found that cases were more likely to come from non-WASEP villages than controls (OR 1.33, 95%CI: 1.0 to 1.8).

Controlled cross-sectional studies

Fisher 2011 BGD found that among households in the BRAC villages 5 children had diarrhoea during the month preceding data collection compared to 6 in the control village, which was significantly less but provided no additional data (p=0.027). Mathew 2004 ZIM; Waterkeyn 2005 ZIM did not report the health impact of the community health clubs.

Berhe 2014 ETH; Gebru 2014 ETH both studied difference in 2-week diarrhoea prevalence in model and non model households of the health extension package and found that being a model family decreased the odds of having diarrhoea by about three quarters (OR 0.26, 95%CI 0.16 to 0.42, Analysis 7.1, page 182).

Soil-transmitted helminths

RCTs and CBAs

Only 2 RCTs reported on the impact of the interventions on STHs and found no effect on any STH infection (RR 1.03, 95% CI 0.78 to 1.37, Analysis 2.2, page 167) nor on *A. lumbricoides* (RR 1.01, 95% CI 0.74 to 1.39, Analysis 2.3, page 168). Neither study estimates are adjusted for clustering. Patil 2014 IND found no difference in helminth prevalence between intervention and control groups (any helminth 5.9% vs 5.6%; *A. lumbricoides* 4.3% vs 4.4%). Cameron 2013 INA found no significant difference in the probability of having any helminth between the children in the treatment and control groups (4.0% vs 3.9%, p=0.889), *A. lumbricoides* (3.4% vs 3.3%, p=0.881)*, T. Trichuris* (0% vs 0.1%, p=0.319) or hookworm (0.6% vs 0.5%, p=0.733).

NRS

No case-control or controlled cross-sectional study on STHs infection was included in this review.

Dysentery

Pickering 2015 MLI found no difference in prevalence of blood in stool between intervention and control groups using a 2-day (1.2% vs 1.4%, p=0.481) recall period but the 2 week prevalence was lower in the intervention than control villages (prevalence ratio: 0.68, 95%CI: 0.48 to 0.97, p=0.031). Cameron 2013 INA found lower prevalence of mucus or blood in stool (7 day prevalence) in intervention vs control (0.8% vs 2%, p=0.034). Overall the pooled effect showed no effect of the intervention (RR 0.63, 95% CI 0.31 to 1.30, Analysis 2.4, page 168).
Aziz 1990 BGD found that children had 27% less dysentery in the intervention than controls (IDR=0.73, 95%CI: 0.61-0.88).

Severe diarrhoea

Ahmed 1993 BGD only presents trends in daily severe diarrhoea prevalence in the intervention and control sites and it seems that although for a portion of the intervention the prevalence of severe diarrhoea was lower in the intervention, by the end of the study the prevalence was similar between groups.

Persistent diarrhoea

Aziz 1990 BGD found that children had 40% less persistent diarrhoea in the intervention than controls (IDR=0.58, 95%CI:0.52 to 0.65). Maung 1992a MYA found no significant difference in child faeces disposal in cases with persistent diarrhoea and controls (OR 0.53, 95% CI 0.17 to 1.68) but found that defecation in a pot or latrine decreased the odds of being a case (OR 0.27, 95% CI 0.12 to 0.60) (Maung 1992b MYA).

Clinical visits for diarrhoea

No RCT or CBA reported clinic visits for diarrhoea.

Intensity of STH infection (number of eggs per gram of stool)

Patil 2014 IND did not report on STH infection intensity. Cameron 2013 INA found no significant difference in infection intensity between intervention and control groups.

Presence of pathogenic microbes in stool assays

Patil 2014 IND found no significant difference in prevalence of any protozoan present in intervention and control (21.7% vs 25.7%) or *entamoeba histolytica* (3.3% vs 2.5%). They found lower prevalence of *Giardia Lamblia* (18.4% vs 23.2%, mean difference: 4.8%, p= 0.047).

Anthropometry

Patil 2014 IND and Cameron 2013 INA reported no significant differences in the intervention and controls groups on anthropometry. Pickering 2015 MLI found that children <5 in intervention villages were taller than in control villages by a mean of

0·17 in height for age Z (HAZ) score (95% CI: 0.04 to 0.31) and found no differences in weight for age Z (WAZ) scores (mean 0.09 WAZ score, 95% CI: -0.03 to 0.20), when restricting the analysis to younger children a larger effect was found on HAZ. Briceño 2015 TAN found a decrease in weight for age by 0.075 standard deviations off an average WAZ-score of -1.03 ($p<0.05$) and weight for height by 0.097 standard deviations from an average WHZ-score of 0.055 ($p<0.05$) in the combined arm of the intervention (hand washing with soap and sanitation) compared to the control groups. No difference was observed between the sanitation only arm and the control group. The pooled effect on HAZ (MD 0.05, 95% CI -0.07 to 0.17, 3 studies with usable data) and WAZ scores (MD 0.02, 95% CI -0.06 to 0.09) showed no significant effect (Analysis 2.5; Analysis 2.6, page 169).

Stanton 1987 BGD also reported no significant differences in the intervention and controls groups on anthropometry. Ahmed 1993 BGD reported that percentages of severely malnourished children (-3 SD WAZ) reduced over time in the intervention compared to the control site (at end line the percentage of children -3 SD WAZ score was approximately 21.5% in the intervention and 35.5% in the control group, $p<0.0001$). Aziz 1990 BGD and Luby 2014 BGD found no difference in nutritional status in the intervention and control groups.

Serology and other markers of infection and disease

No included study reported on these outcomes.

Mortality

Stanton 1987 BGD reported that rates of child and infant death were similar in the intervention and control groups.

Pickering 2015 MLI found no difference in all-cause mortality between intervention and control groups but fewer households in the intervention reported to have a diarrhoeal-related death (16 total diarrhoeal deaths in intervention vs 34 in control, prevalence ratio (PR) 0.46, 95%CI: 0.26 to 0.83) and child diarrhoeal deaths (11 child diarrhoea deaths in intervention vs 23 in control, PR 0.47, 95%CI: 0.23 to 0.98) than controls. Briceño 2015 TAN found no difference in the mortality of children <5 in control and intervention groups.

Behaviour change

CRCTs and CBAs

Ten studies reported on behavioural outcomes after their intervention. For three studies it was the main outcome (Barrios 2008 PHI; Jinadu 2007 NGR; Yeager 2002 PER) while for Briceño 2015 TAN; Cameron 2013 INA; Patil 2014 IND; Pickering 2015 MLI; Stanton 1987 BGD it was as intermediate outcomes of their intervention. Alam 1989 BGD and Aziz 1990 BGD did not present data in a format that could be used. Different behaviours related to child faeces disposal were measured in the different interventions.

Analysis 8.1 (page 182) shows the effects of the interventions on open defecation by <5 children. The 3 sanitation interventions reported a significant increase in no open defecation by children <5, Stanton 1987 BGD reported no difference. Analysis 8.2 (page 182) shows how latrine use by children <5 increased as a result of the interventions. Jinadu 2007 NGR reported an increase in latrine use by children 25-60 months, while Yeager 2002 PER reported no effect on latrine use by children 15-47 months. Analysis 8.3 (page 183) presents data on potty use of children after the intervention, which increased significantly in Jinadu 2007 NGR and Pickering 2015 MLI but showed no difference between intervention and control households in Yeager 2002 PER. Analysis 8.4 (page 183) shows the impacts of interventions on child faeces disposal behaviours (the data for Cameron 2013 INA is not in a usable format). Safe child faeces disposal practices improved in Briceño 2015 TAN (safe disposal also improved in the hand washing and sanitation combination arm) and Patil 2014 IND but not in Yeager 2002 PER. Analysis 8.5 (page 183) shows changes in faeces observed in the yard after the intervention. Barrios 2008 PHI found no effect on faeces visible in the yard, Jinadu 2007 NGR reported an increase in no child faeces observed in the yard.

It is important to note that while some studies report increase use of a potty, this does not necessarily mean the faeces will end up in the latrine and be safely disposed of. Jinadu 2007 NGR also reports on households that were observed to use chamber pots for sanitary disposal of children faeces (58% in intervention vs 26.9% in the control communities, p<0.05, shown in Analysis 8.3); Yeager 2002 PER also reports on faeces not left in a potty or put in a safe place (this data is shown in Analysis 8.4).

It's also important to note that studies observing fewer faeces in the yard, might also not necessarily be an indicator of increased safe disposal as the child faeces may not have been disposed of in a latrine but rather been thrown elsewhere.

Controlled-cohort studies

Huda 2012 BGD and Luby 2014 BGD found no impact on child faeces disposal behaviour at midline and end line of the SHEWA-B intervention compared to controls (Analysis 4.2, page 171).

Controlled cross-sectional studies

Berhe 2014 ETH; Fisher 2011 BGD; Gebru 2014 ETH all found an increase in safe disposal of child faeces in the intervention areas compared to the control (Analysis 9.1, page 184). Although Gebru 2014 ETH did not specify what they considered to be safe disposal, it is assumed that their definition includes burying of faeces as well as disposal in the latrines as that is what is promoted in the HEP. Thus when calculating the risk of safe disposal for Berhe 2014 ETH the same classification of safe disposal was used, although restricting the definition of safe disposal to just defecation in a latrine and disposal in a latrine, also showed that intervention significantly increased safe disposal.

Mathew 2004 ZIM found that in community health club (CHC) areas a lower percentage of children were not using a latrine compared to control areas (approximately 54% vs 83%, however no statistical analysis is conducted and insufficient data is provided to do analysis).

In Waterkeyn 2005 ZIM no significant difference was found in observing child faeces in the yard in CHC households vs control households (4% vs 0% in Tsolotsho, p=0.0807; 16% vs 23% in Makoni, p=0.0972).

Adverse events

No study reported adverse events from the interventions.

DISCUSSION

Summary of main results

While numerous studies met the review's inclusion criteria, we consider the evidence linking the safe disposal of child faeces with diarrhoea or STH infection to be limited. Few studies focused solely on interventions aimed at improving the collection or disposal of child faeces. Of the 11 RCTs and 3 CBAs included in the review, only 1 focused exclusively on improving child faeces disposal behaviour, and that study only measured behaviour change. Five other studies included child faeces disposal as one of the messages in their hygiene promotion intervention, only 3 of those included health outcomes. Of the other RCTs and CBAs, 4 measured the health impacts of their intervention to end open defecation of the whole community including children as well as child faeces disposal behaviour change indicators, 2 included other WASH components and 2 were based in day care facilities. The health impacts of the child faeces disposal component of these interventions can thus not be measured.

The 2 cohort and 5 cross-sectional studies included in the review also measured the health effect of combined interventions (5 studies), while 2 only measured the behaviour change after the community health club (CHC) intervention.

Thus the best available evidence of the association between child faeces disposal in a latrine and diarrhoea come from the case-control studies. 25 case-control studies were included, with 20 of them being used in the quantitative analyses. The evidence from these studies suggests that disposing of child faeces in a latrine is associated with reduced odds of diarrhoea (OR 0.76, 95% CI 0.66 to 0.88, *very low quality evidence*). These studies also suggest that children defecating in a latrine rather than elsewhere is associated with reduced odds of diarrhoea (OR 0.54, 95% CI 0.33 to 0.90, *very low quality evidence*).

Only 2 studies (both RCTs) reported impacts of safe disposal of child faeces on STH infection. Both were interventions aiming to stop open defecation generally (not safe disposal of child faeces specifically) and neither study found a health impact on helminth infection. Both studies reported reduction in open defecation of children and Patil 2014 IND reported improved disposal of child faeces in the intervention arm. However, Patil 2014 IND found that the intervention led to a small increase in latrine construction accompanied with a small decrease of open defecation and that these improvements were not sufficient to see an improvement in health outcomes (both diarrhoea and STH). In Cameron 2013 INA , the intervention led to a moderate increase in toilet construction, with associated decreases in open defecation in households that did not have access to sanitation at baseline, which suggested an improvement in behaviour due to the toilet construction. While, the intervention was associated with lower diarrhoea prevalence in the intervention communities, there was no significant effect on STH infection. This could be because diarrhoea prevalence was measured through self-reports, which could have been biased due to non-blinding while the STH infections were diagnosed from stool, thus a more objective measure. Alternatively, as STH eggs can survive longer in the environment than diarrhoea-causing pathogens, it may take longer to observe an impact on STH.

Overall completeness and applicability of evidence

Most of the included studies were conducted in low or lower middle income countries, while some were done in upper middle or high income countries. The majority of the study sites were in rural areas (57%).

Few studies investigated specific hardware for safe child faeces disposal. Potties were promoted in Jinadu 2007 NGR and Yeager 2002 PER, and were one of the criteria of the ODF certification in CLTS in Mali (all family members had to use the latrine or a child potty) (Pickering 2015 MLI). However, it is unclear how much focus there is on safe disposal of child faeces as part of the triggering of activities in the paper. Ahmed 1993 BGD included messaging to use a dirt thrower to dispose of child faeces. Butz 1990 USA and Kotch 2007 USA included some diaper changing equipment in their intervention and instructions to dispose of diapers in plastic bags (Butz 1990 USA) and roll-out waste bins for diaper disposal (Kotch 2007 USA). No other included study had a hardware component and none encompassed different hardware solutions for different age groups.

Quality of the evidence

The quality of evidence of the RCTs were either very low or low due to the risk of bias, the indirectness of the evidence and heterogeneity. The CBAs, cohort studies and cross-sectional studies were all very low quality evidence due to risk of bias and indirectness (Summary of findings table, page 53).

The quality of evidence for case-control studies was very low due to the bias intrinsic to NRS and due to heterogeneity.

Potential biases in the review process

We endeavoured to identify all eligible studies for the review by conducting extensive searches with no time or language restrictions. The high number of studies resulting from the search criteria meant that it was not possible for 2 reviewers to check the titles, so only 1 author went through all titles excluding those that were clearly irrelevant.

Agreements and disagreements with other studies or reviews

The only previous review on the safe disposal of child faeces was conducted more than a decade ago (Gil 2004). That study included 10 observational studies and no intervention studies. It reported that child faeces disposal behaviours considered risky (open defecation, stool disposal in the open, stools not removed from soil, stools seen in household soil, and children seen eating faeces) were associated with a 23% increase in risk of diarrhoea (RR 1.23, 95%CI: 1.15 to 1.32); on the other hand, behaviours considered safe (use of latrines, nappies, potties, toilets, washing diapers) were borderline protective (RR 0.93, 95% CI 0.86 to 1.00). An unpublished update of that systematic review (Scott 2008) found a further 4 papers. Two papers found that unsafe disposal of child faeces (not in a latrine) increased the risk of diarrhoea (Tumwine 2002 and Heller 2003 BRA), while two papers found no significant association between presence of human faeces in the compound and bloody diarrhoea (Brooks 2003) and between potty use and typhoid fever (Ram 2007). Although we identified and included substantially more studies in our review, the results are not inconsistent with this previous research. Both found safe disposal of child faeces to be protective against diarrhoea.

Our results are also generally consistent with recent reviews of the effects of sanitation generally against diarrhoeal disease. Freeman and colleagues reported improved sanitation to reduce the odds of diarrhoeal disease by 13% compared to unimproved sanitation (OR 0.87, 95%CI 0.65 to 0.84, n=28 studies; when restricted to intervention studies, the protective effect doubled to 28% (OR 0.72, 95% CI 0.62 to 0.83) (Freeman 2016).

AUTHORS' CONCLUSIONS

Implications for practice

Very low quality evidence suggests that children should be encouraged to use latrines and that child faeces should be disposed in a latrine.

Implications for research

RCTs that study the health impact of different hardware and software interventions to improve the disposal of child faeces of different age groups will help to clarify the potential for child faeces disposal interventions to prevent diarrhoea and soil-transmitted helminth infections. These studies should be conducted in different settings so the evidence is applicable to various settings. This will improve the quality of the evidence due to indirectness. Additionally, measuring the health outcomes using objective measures rather than self-report, such as pathogens in stool or anthropometry, will also improve quality. The RCTs should include intermediate measures to study the impact of the intervention on possible transmission routes, such as contamination of water, soil and hands, to increase the plausibility of the findings.

ACKNOWLEDGEMENTS

The editorial base for the Cochrane Infectious Diseases Group is funded by the UK Department for International Development (DFID) for the benefit of developing countries.

The authors would like to thank Aurelie Jeandron for assessing the eligibility of the Russian literature, Lyndsey Gray for doing abstract and full text eligibility assessments, Christianne Esparza and her colleagues for the help in finding difficult articles.

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CHARACTERISTICS OF STUDIES

Characteristics of included studies

Abalkhail 1995 KSA

Methods	Case-control study
Participants	Cases: <3 years old children admitted to 20 primary health centres for primary diagnosis of diarrhoea with infectious origin, n=319 (after excluded 3), mean age= 13.1 months, 45.3% female Controls: <3 years old children with no history of hospitalisation due to diarrhoeal diseases, selected randomly from the nearest residential neighbours, n=312 (after excluded 13). mean age= 19.2 months, 52.6% female
Interventions	Risk factor of interest: disposal of child faeces elsewhere vs in the latrine
Outcomes	Diarrhoea (3 or more soft liquid stools within 12 hours or a single soft or liquid stool with blood, pus or mucus)
Notes	Location: Urban Makkah area, 20 primary health care centres, Saudi Arabia Length of recruitment: 3 months (October 1994- January 1995) Publication status: Journal

Risk of bias table- see table 2 (page 187)

Ahmed 1993 BGD

Methods	Controlled before-and-after study
Participants	Number: 370 families (after lost 17: 9 deaths and 8 left the study area) Inclusion criteria: families with a child <19 months In intervention group, mean age of children=8.8 months and 51% were female. In control mean age=8.9 months and 56% were female.

Interventions	1 intervention site (5 contiguous villages): Participatory behaviour change intervention, campaign called "*Porichchhanna Jibon*" (clean life). The campaign was developed in partnership with the community. The intervention involved teaching the germ theory of disease then encouraging mothers to identify their problems and to find solutions through group participation and discussion. These are the interventions developed, implemented and adopted by community: - Theme I: Ground Sanitation-keeping babies from touching and eating disease- causing matter on the dirt surface of the compound Sweep the baby’s play area four times a day. Use a dirt thrower (similar to a flat garden trowel provided by the project at US $0.30) to immediately remove the baby’s or animal faeces from the compound surface, so that the crawling baby could not be contaminated by faeces from the ground. Construct a faeces pit to dispose of faeces and other filthy matter from the compound. The faeces pit was about 2 ft deep, with a narrow neck. Wash babies in a particular place after defecation so that germ-contaminated water did not spread everywhere. Keep crawling babies in a playpen (locally constructed, provided by the project at a cost of US $1.0) instead of permitting them to crawl in the dirt. Theme II: Personal hygiene- reducing the transmission of germs from defecation and other personal hygiene behaviours (hand washing with ashes or soap, anal cleaning, clean baby after defecation, cut nails, clean rag to dry hands, clean baby rug/mat) Theme III: Food hygiene-reducing the transmission of germs during supplementary and bottle feeding (do not use any feeding bottle if possible, clean bottle, prepare small amount, use tube well water for drinking and baby food, wash hands before eating, cover food, don't eat leftovers, store plates and pans upside down, cover water pitchers) 1 control site (5 contiguous villages) where a structured observation study was taking place.
Outcomes	- Diarrhoea daily prevalence and severe diarrhoea daily prevalence. Mothers were asked to recall the presence or absence of diarrhoea according to their own perceptions day-by-day. If diarrhoea was reported, the mother was asked if the stool was: softer than usual, 1-5 stools; watery, 1-5 stools; softer than usual, 5-10 stools; watery, 5-10 stools; watery more than 10 stools per day; or dysentery. Diarrhoea was re-categorized into two levels: any diarrhoea and severe diarrhoea (all reported watery stools and dysentery). Severe diarrhoea= all reported watery stools and dysentery. Daily prevalence= number of children sick with diarrhoea over total children observed. - Anthropometry (weight for age), - Awareness, understanding and adoption of each message. - Cleanliness observations
Notes	Location: 10 rural villages, Bangladesh Length of study: 9 months (October 1985 - July 1986) Publication status: Journal

Risk of bias table

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	High risk	No randomisation, researchers chose the community for intervention as the poorer, less hygienic site
Allocation concealment (selection bias)	High risk	Investigators could foresee assignment
Blinding of participants and personnel (performance bias)	Unclear risk	NA
Blinding of outcome assessment (detection bias)	Unclear risk	NA
Incomplete outcome data (attrition bias)	Unclear risk	not specified how many child days are missing in analysis
Selective reporting (reporting bias)	Low risk	report on all outcomes specified in methods
Other bias	Unclear risk	_
Similarity of baseline outcome measurements	High risk	there were baseline imbalances in all outcomes and the study did not adjust for it in analysis
Similarity of baseline characteristics	High risk	there were baseline imbalances in crowding, mother and father education, father occupation, land and animal ownership and the study did not adjust for it in analysis
Adequate allocation of intervention concealment during the study	High risk	outcomes were not assessed blindly
Adequate protection against contamination	Low risk	unlikely that the control group received the intervention "The intervention site was 5 km away from the control site and accessible by a 2-hr boat ride most of the year, and by foot over narrow foot paths in about 1.5hr during the driest months" and the intervention was delivered by members of the community so likely they would know participants
Confounders adequately adjusted for in analysis/design	High risk	no adjustments for any confounders
Recruitment bias	Unclear risk	NA
Baseline imbalance	Unclear risk	NA
Loss of clusters	Unclear risk	NA
Incorrect analysis	Unclear risk	NA

Alam 1989 BGD

Methods	CBA
Participants	Number: 623 children (after excluded 27 in intervention and 50 in control) Inclusion criteria: households with children aged 6 to 23 months, with more than 6 months observations per year
Interventions	Intervention site (3 sub-units): hand pumps were provided with a ratio of 4-6 households (3 times more than control) + health education (main objectives: promotion of consistent and exclusive use of hand pump water, improvement of water handling and storage practices, disposal of child's faeces soon after defecation, washing hands before handling food and rubbing hands in ash or using soap after defecation) Control site (2 sub-units): no project input
Outcomes	- Incidence of diarrhoea among children aged 6 to 23 months. Diarrhoea: three or more loose motions in 24-hour period whether or not blood was present. An episode was considered new if there was an interval of at least 48 hours between symptoms (recall= 7 days) -observed sources of water, faeces visible in the yard, handwashing before food & after defecation
Notes	Location: 5 subunits (paras) in a village in rural Bangladesh Length: 3 years (July 1980-June 1983) Publication status: journal

Risk of bias table

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	High risk	Allocation not random
Allocation concealment (selection bias)	High risk	no allocation concealment
Blinding of participants and personnel (performance bias)	Unclear risk	NA
Blinding of outcome assessment (detection bias)	Unclear risk	NA
Incomplete outcome data (attrition bias)	Low risk	similar number of child-periods excluded in the analysis in both groups (54 vs 55)
Selective reporting (reporting bias)	Low risk	report on outcomes pre-specified in methods
Other bias	Unclear risk	-
Similarity of baseline outcome measurements	Unclear risk	no mention of baseline risk
Similarity of baseline characteristics	Unclear risk	the intervention and control "populations were comparable in terms of education, household size and sanitation conditions" (but not data is presented)

Adequate allocation of intervention concealment during the study	High risk	"workers' knowledge of which area was intervention and control"
Adequate protection against contamination	High risk	allocation by community- adjacent paras and in the control group some households installed hand pumps. "Over the years of the project some households in the control area purchased their own hand pumps privately"
Confounders adequately adjusted for in analysis/design	High risk	No analysis adjusting for confounders
Recruitment bias	Unclear risk	NA
Baseline imbalance	Unclear risk	NA
Loss of clusters	Unclear risk	NA
Incorrect analysis	Unclear risk	NA

Arvelo 2009 USA

Methods	Case-control study
Participants	Case licensed daycare centre (LDC): daycare centre with a secondary attack rate of shigellosis ≥2% (median, 5%; range, 2%–25%), n=18 Control LDCs: LDC with a secondary attack rate <2% (median, 0; range, 0%–1.2%), n=21
Interventions	Risk factor of interest: no lined, lidded bins for diaper disposal vs lined, lidded bins
Outcomes	Daycare centre with a secondary attack rate of shigellosis (shigellosis case was defined as a person with any Shigella species isolated from stool) ≥2%
Notes	Location: 39 LDCs in Kansas city metropolitan area, USA Length: 2 months (October - November 2005) Publication status: journal

Risk of bias table-see table 2 (page 187)

Aziz 1990 BGD

Methods	Controlled before-and-after
Participants	Number: exact numbers not presented, on average complete data available for 405 children Inclusion criteria: households with children aged <5 years

Interventions	Intervention (2 villages): 148 new hand pumps (1 pump: 30 persons on average) + free maintenance, 92% of HHs received a double pit water sealed latrine, hygiene education emphasising exclusive use of the pump water for all personal and domestic use and the need for all members of the household, including young children to use the latrines. Control (3 villages): no intervention provided. ORS was given to sick children + referral to hospital if sick
Outcomes	- Diarrhoea incidence, case definition: 3/more loose motions in a 24hr period. Recall period= 7 days, an episode was considered complete after 2 diarrhoea free days - Dysentery incidence, case definition: blood was present in the stools. - Persistent diarrhoea incidence, case definition: episodes of duration more than 14 days - Days of diarrhoea - Anthropometry (weight for age, height for age, weight for height) (Hasan 1989) - Hand pump distance and use, defecation of children or disposal of their faeces in latrine (only reported in intervention arm)
Notes	Location: 5 villages in rural Bangladesh Length: 3 years (January 1984- December 1987) Publication status: journal

Risk of bias table

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	High risk	not randomised allocation
Allocation concealment (selection bias)	High risk	no allocation concealment
Blinding of participants and personnel (performance bias)	Unclear risk	NA
Blinding of outcome assessment (detection bias)	Unclear risk	NA
Incomplete outcome data (attrition bias)	Unclear risk	no total number of children reported nor mention of loss to follow up.
Selective reporting (reporting bias)	Low risk	report on outcomes prespecified in methods
Other bias	Unclear risk	-
Similarity of baseline outcome measurements	Low risk	diarrhoea and anthropometry measures were similar at baseline
Similarity of baseline characteristics	Unclear risk	"the two areas were comparable with respect to most socio-demographic and economic characteristics although the control area was slightly better off in terms of female education and socio-economic level" but no data is presented.
Adequate allocation of intervention concealment during the study	High risk	" project staff and the community under investigation knew that the aim of the study was to decrease the diarrhoea incidence"

Adequate protection against contamination	Low risk	the 2 areas were 5 km apart
Confounders adequately adjusted for in analysis/design	High risk	no adjustments in the analysis.
Recruitment bias	Unclear risk	NA
Baseline imbalance	Unclear risk	NA
Loss of clusters	Unclear risk	NA
Incorrect analysis	Unclear risk	NA

Baker 2016 BGD

Methods	Case-control study (prospective, age-stratified, matched)
Participants	Case: 0–59 months old child belonging to the demographic surveillance system population at the site, not currently enrolled as a case (previously enrolled and pending 60-day visit) seeking care at health centre with moderate to severe diarrhoea, n=1374 (1.4% LTFU compared to all cases enrolled at site) Control: child with no diarrhoea in the previous 7 days, residing in demographic surveillance system area, matched to the case for age (±2 months for 0–11 and 12-23 months, ±4 months for 24–59 months, not exceeding the stratum boundaries of the case), sex, residence (lives in the same or nearby village/neighbourhood as the case) and time (enrolled within 14 days of presentation of the case), n=2428 (1.5% LTFU compared to all controls enrolled at site)
Interventions	Risk factor of interest: disposal of child faeces in the open vs disposal in any type of latrine with a pit or sewer. Hanging latrines and bucket latrines were considered open disposal.
Outcomes	diarrhoea: ≥3 abnormally loose stools in the previous 24 h. Diarrhoea episode had to be acute (onset within 7 d of study enrolment) and be a new episode (onset after ≥7 diarrhoea-free days) Moderate-to-severe: child met at least 1 of the following criteria: Sunken eyes, confirmed by parent/primary caretaker as more than normal Loss of skin turgor (determined by abdominal skin pinch (slow return [≤2 s] or very slow return [>2 s]) • Intravenous rehydration administered or prescribed • Dysentery (visible blood in a loose stool) • Hospitalized with diarrhoea or dysentery
Notes	Location: 1 rural sentinel health centre, Mirzapur, Bangladesh Length: 3 years (1 December 2007 - 3 March 2011) Publication status: in press

Risk of bias table- see table 2 (page 187)

Baker 2016 GMB

Methods	Case-control study (prospective, age-stratified, matched)
Participants	case and control definitions are the same as Baker 2015 BGD. cases n=910 (11.6% LTFU), controls n=1456 (7.2% LTFU)
Interventions	same as Baker 2015 BGD
Outcomes	same as Baker 2015 BGD
Notes	Location: 5 rural sentinel health centres, Basse, The Gambia Length: 3 years (1 December 2007 - 3 March 2011) Publication status: in press

Risk of bias table – see table 2 (page 187)

Baker 2016 IND

Methods	Case-control study (prospective, age-stratified, matched)
Participants	case and control definitions are the same as Baker 2015 BGD. cases n=1505 (4% LTFU), controls n=1967 (2.3% LTFU)
Interventions	same as Baker 2015 BGD
Outcomes	same as Baker 2015 BGD
Notes	Location: 2 urban sentinel health centres, Kolkata, West Bengal, India Length: 3 years (1 December 2007 - 3 March 2011) Publication status: in press

Risk of bias table- see table 2 (page 187)

Baker 2016 KEN

Methods	Case-control study (prospective, age-stratified, matched)
Participants	case and control definitions are the same as Baker 2015 BGD. cases n=1419 (3.9% LTFU), controls n=1841 (2.2% LTFU)
Interventions	same as Baker 2015 BGD
Outcomes	same as Baker 2015 BGD
Notes	Location: 11 rural sentinel health centres, Nyanza Province, Kenya Length: 3 years (1 December 2007 - 3 March 2011) Publication status: in press

Risk of bias table – see table 2 (page 187)

Baker 2016 MLI

Methods	Case-control study (prospective, age-stratified, matched)
Participants	case and control definitions are the same as Baker 2015 BGD. cases n=1786 (12.1% LTFU), controls n=1891 (8.4% LTFU)
Interventions	same as Baker 2015 BGD
Outcomes	same as Baker 2015 BGD
Notes	Location: 9 urban sentinel health centres, Bamako, Mali, Length: 3 years (1 December 2007 - 3 March 2011) Publication status: in press

Risk of bias table – see table 2 (page 187)

Baker 2016 MOZ

Methods	Case-control study (prospective, age-stratified, matched)
Participants	case and control definitions are the same as Baker 2015 BGD. cases n=602 (11.6%), controls n=1182 (8.8% LTFU)
Interventions	same as Baker 2015 BGD
Outcomes	same as Baker 2015 BGD
Notes	Location: 5 rural sentinel health centres, Manhiça, Mozambique Length: 3 years (1 December 2007 - 3 March 2011) Publication status: in press

Risk of bias table – see table 2 (page 187)

Baker 2016 PAK

Methods	Case-control study (prospective, age-stratified, matched)
Participants	case and control definitions are the same as Baker 2015 BGD. cases n=996 (20.8% LTFU), controls n=1625 (11.6% LTFU)
Interventions	same as Baker 2015 BGD
Outcomes	same as Baker 2015 BGD
Notes	Location: 7 peri-urban sentinel health centres, Karachi (Bin Qasim Town), Pakistan Length: 3 years (1 December 2007 - 3 March 2011) Publication status: in press

Risk of bias table – see table 2 (page 187)

Baltazar 1989 PHI

Methods	case-control study
Participants	Cases: children <2 yrs old brought to clinic for diarrhoea , n=275 (after excluded 6, couldn't find 4 and 4 refused), 68% were <1 year old Controls: children <2 yrs old brought to clinic for ARI without diarrhoea in past 24hours, n=381 (after excluded 3 and 19 refused to participate), 73% were <1 year old
Interventions	Risk factor of interest: unsanitary vs sanitary disposal of stools. sanitary: child defecated in a nappy and faeces were thrown away in washing, child used chamber pot/piece of paper and fecal matter was thrown in the toilet or child used the toilet unsanitary: faecal matter was deposited elsewhere than latrine/ child defecated outside (regardless of where faecal matter was finally thrown away)
Outcomes	Diarrhoea (no case definition). Also obtained rectal swabs for diagnosis of diarrhoea pathogens and carried out a sub- group analysis for lab-confirmed cases.
Notes	Location: 16 clinics, Cebu area (urban and rural), Philippines Length of recruitment: 5 months (June-October 1985) Publication status: Journal

Risk of bias table – see table 2 (page 187)

Barrios 2008 PHI

Methods	Cluster RCT
Participants	Number: 495 respondents (enrolment rate=90%) Inclusion criteria: households with children <5 years
Interventions	Interventions (2 barangays (smallest local government unit)): hygiene promotion program that focused on improving hand washing and stool disposal behaviours. Midwives and barangay health workers delivered the educational sessions in small group meetings and in home visits. Activities to promote the behaviours included demonstrations of proper hand washing, a drawing activity with a brief story-board of the negative effects of improper stool disposal. For the disposal of child faeces, caretakers were encouraged to use toilets (any type) as the final site of faeces disposal. When a toilet was not available, burying faeces at least ten meters away from water sources and living areas was discussed. The main message was the sanitary disposal of faeces, regardless of where a child defecated. Control intervention (2 barangays): caregivers received education on signs and symptoms of dehydration and the importance of oral re-hydration during diarrhoea Control with no contact (2 barangays): no contact, no treatment
Outcomes	- diarrhoea (measured but not reported on) - handwashing behaviour - stool disposal behaviour: observed faeces in the yard - knowledge, attitudes, beliefs on hand washing and stool disposal

Notes	Location: 6 rural barangays in Basista, Phillipines - Length of study: 2 months - Publication status: PhD thesis

Risk of bias table

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Low risk	"Random assignment to one of three experimental conditions was achieved by a simple sample draw with replacement"
Allocation concealment (selection bias)	Unclear risk	no details
Blinding of participants and personnel (performance bias)	High risk	not possible to blind to the intervention although one of the control groups had a placebo intervention, the other control to which behaviours are compared received no intervention
Blinding of outcome assessment (detection bias)	High risk	midwives who delivered the intervention also collected data on outcomes
Incomplete outcome data (attrition bias)	High risk	no details on loss to follow up and not reporting data on both control groups at endline
Selective reporting (reporting bias)	High risk	collected data on diarrhoea but no results presented
Other bias	Unclear risk	_
Similarity of baseline outcome measurements	Unclear risk	NA
Similarity of baseline characteristics	Unclear risk	NA
Adequate allocation of intervention concealment during the study	Unclear risk	NA
Adequate protection against contamination	Unclear risk	NA
Confounders adequately adjusted for in analysis/design	Unclear risk	NA
Recruitment bias	High risk	participants were recruited once the clusters had been randomly allocated
Baseline imbalance	High risk	only 3 demographic variables presented
Loss of clusters	Low risk	no mention of loss of barangays
Incorrect analysis	High risk	no adjustments for clustering

Berhe 2014 ETH

Methods	controlled cross-sectional study
Participants	Number: 650 households (866 <5s) (model households had 1% non-response) Inclusion criteria: households that had at least one <5 children in 12 gotts. For model families (intervention): households that fully implemented the health extension package (HEP). For non-model families (control): households that did not fully implement the health extension package
Interventions	Intervention (327 respondents): households who have implemented the HEP packages fully. The HEP is implemented by full-time female health extension workers, who train households to implement packages. The packages include interventions in 4 main categories: family health services, infectious disease prevention and control, hygiene and environmental sanitation and health education and communication. The maternal and child health package (in the family health services category) includes safe child stool disposal (the stool should be cleaned and disposed in a pit latrine, or shall be covered with a leaf or paper and be buried)(HEP 2003). Control (323 respondents): non model-families
Outcomes	- two week diarrhoea prevalence (having diarrhoea in the two weeks prior to the interview, no additional details on case definition) - WASH and nutritional behaviours including child stool disposal method
Notes	Location: 12 gotts, Tula sub city, Ethiopia Length of study: 1 month (January 2012) Publication status: Journal

Risk of bias table

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	High risk	non random allocation to model or non model HHs
Allocation concealment (selection bias)	High risk	non random allocation to model or non model HHs
Blinding of participants and personnel (performance bias)	Unclear risk	NA
Blinding of outcome assessment (detection bias)	Unclear risk	NA
Incomplete outcome data (attrition bias)	Low risk	99% response rate in model HHs and 100% in non-model HHs
Selective reporting (reporting bias)	Low risk	report on main outcomes specified in methods
Other bias	Unclear risk	_
Similarity of baseline outcome measurements	Unclear risk	NA, no baseline
Similarity of baseline characteristics	Unclear risk	NA, no baseline

Adequate allocation of intervention concealment during the study	Low risk	"data collectors were blinded regarding whether each household was model or non model in order to reduce interviewer bias."
Adequate protection against contamination	High risk	" the absence of clear demarcation between model and non model with reference to distance (closeness of model and non model) may have created information contamination as well as diarrheal disease transmission to the model HH members and vice versa."
Confounders adequately adjusted for in analysis/design	Low risk	multivariate analysis
Recruitment bias	Unclear risk	NA
Baseline imbalance	Unclear risk	NA
Loss of clusters	Unclear risk	NA
Incorrect analysis	Unclear risk	NA

Briceño 2015 TAN

Methods	Cluster RCT (factorial design)
Participants	Number: 3619 households (5768 <5s) (97.2% response rate) Inclusion criteria: household was present during the period of listing; had been living in the village since the beginning of 2009 or earlier; and had at least one child under the age of five.
Interventions	Interventions: 3 arms (TSSM only, hand-washing promotion only, combined TSSM and handwashing with soap (HWWS)) - Total Sanitation and Sanitation Marketing (TSSM) (43 wards): uses Community Led Total Sanitation (CLTS) (triggering of community to increase demand for improved sanitation and promote open defecation free communities) and sanitation marketing to increase demand for improved sanitation. Also strengthens the supply of sanitation goods and services to local markets to make these products more affordable and accessible. Sanitation marketing messages concentrated on positive aspirational messages rather than shame tactics. No subsidies were used. - TSSM and HWWS (47 wards): TSSM intervention + provision of intensive social marketing interventions and technical assistance to build handwashing stations with local materials (tippy tap) - Control (46 wards): no intervention
Outcomes	- access to an improved latrine and open defecation practice - caregiver hand washing practices - diarrhoea (7 and 14 day recall): 3 or more loose/watery stools in a 24 hour period or having a stool with blood or mucus - anaemia - anthropometry (weight for age, height for age, weight for height, head circumference) - abrasions, bruising, scrapes
Notes	Location: 181 rural wards, in 10 districts, Tanzania Length of study: 46 months (February 2009-December 2012) Publication status: report

Risk of bias table

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	no details apart from "randomly assigned"
Allocation concealment (selection bias)	Unclear risk	no details
Blinding of participants and personnel (performance bias)	High risk	no blinding
Blinding of outcome assessment (detection bias)	High risk	" ensured interviewers were blinded to the intervention status of each village" but not possible to completely blind
Incomplete outcome data (attrition bias)	Low risk	" 3,619 completed interviews from 3,724 attempted (97.2% response rate)."
Selective reporting (reporting bias)	Low risk	report on pre-specified outcomes in methods
Other bias	Unclear risk	_
Similarity of baseline outcome measurements	Unclear risk	NA
Similarity of baseline characteristics	Unclear risk	NA
Adequate allocation of intervention concealment during the study	Unclear risk	NA
Adequate protection against contamination	Unclear risk	NA
Confounders adequately adjusted for in analysis/design	Unclear risk	NA
Recruitment bias	High risk	recruited participants after their villages had received intervention/ not (no baseline)
Baseline imbalance	High risk	no baseline
Loss of clusters	Low risk	9 wards (<10%) were reassigned and lost after they were randomised
Incorrect analysis	Low risk	" Standard errors are clustered at the ward level. "

Butz 1990 USA

Methods	Cluster RCT
Participants	Number: 114 children (1month-7 years) attending 24 family day care homes (FDCHs) Inclusion criteria: all children attending FDCHs In intervention group, 69% ≤36months and 57% were female. In control 62% ≤36months and 42% were female.

Interventions	Intervention (12 FDCHs): instruction to day care providers on modes of transmission of pathogens, instructions of handwashing, use of vinyl gloves and disposable diaper changing pads at each diaper change. Providers were instructed to dispose of gloves, disposable pads and diapers in plastic bags and given supplies (gloves, diaper changing pads, hand rinse solution) Control (12 FDCHs): no education but received biweekly nurse visits for symptom data collection
Outcomes	-Diarrhoea longitudinal prevalence (diarrhoea symptom days/child care days). Diarrhea: occurrence of loose, unformed bowel movements at twice the normal frequency (infants, one to two stools per day; and older children, one stool per day). Symptoms recorded daily. - Longitudinal prevalence of vomiting and runny nose - Asbsence from day care home (reasons for absenteeism not recorded)
Notes	Location: 24 FDCHs in urban Baltimore, USA Length of study: 12 months (4 January 1988 - 31 December 1988) Publication status: Journal

Risk of bias table

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Unclear risk	"FDCHs were randomly assigned to control or intervention group"
Allocation concealment (selection bias)	Unclear risk	no details
Blinding of participants and personnel (performance bias)	High risk	day care providers were aware that the intervention program was being tested in certain homes
Blinding of outcome assessment (detection bias)	High risk	"day care providers recorded the symptoms " and they were not blinded
Incomplete outcome data (attrition bias)	Unclear risk	10.6% of missing/ absent days excluded in analysis, with no information on whether they were from intervention or control FDCHs.
Selective reporting (reporting bias)	Low risk	report on main outcomes
Other bias	Unclear risk	-
Similarity of baseline outcome measurements	Unclear risk	NA
Similarity of baseline characteristics	Unclear risk	NA
Adequate allocation of intervention concealment during the study	Unclear risk	NA
Adequate protection against contamination	Unclear risk	NA
Confounders adequately adjusted for in analysis/design	Unclear risk	NA
Recruitment bias	High risk	staff were aware of which cluster were intervention and control

Baseline imbalance	Low risk	no significant baseline imbalances
Loss of clusters	Low risk	only 2 clusters lost (1 C and 1 I)=8.3%.
Incorrect analysis	High risk	not adjusted for clustering in analyses

Cameron 2013 INA

Methods	Cluster RCT
Participants	Number: 2500 households at endline Inclusion criteria: households with children under 2 years (and HH with children under 5 in case too few HH with <2 were found)
Interventions	Intervention (80 sub-villages): Total Sanitation and Sanitation Marketing (TSSM) which includes Community Led Total Sanitation (CLTS) to stop open defecation, social sanitation marketing to increase availability of products and services and strengthening the enabling environment at policy and institutional levels. Control (80 sub-villages): no intervention
Outcomes	- changes in perceptions of consequences of poor sanitation - sanitation improvements (toilet construction and access to improved sanitation) - open defecation practices - diarrhoea prevalence (2, 7 or 14 day recall): three or more stools per day and the stools were loose or watery, or blood and/or mucus is visible in the stool - Symptoms: nausea, vomiting, water or soft stools, mucus or blood in stool, refusal to eat, bruising, abrasion, itchy skin or scalp - intestinal parasite infections (Ascaris, Trichuris, hookworm infections) - anthropometry (stunting and wasting) - iron-deficiency anaemia - cognitive and motor development (communication skills, mobility skills and social- personal skills for age) - water source - hand washing practices - acute respiratory infections
Notes	Location: 160 rural sub-villages, East Java, Indonesia Length of study: 30 months (August 2008-February 2011) Publication status: report

Risk of bias table

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	"using a random number generator in STATA, the IE team randomly selected 10 treatment and 10 control villages in each district"
Allocation concealment (selection bias)	Low risk	"Once the IE team received the sub-village lists from the district offices for all 20 villages, they told district offices which villages were in the treatment group and which were in the control group."

Blinding of participants and personnel (performance bias)	High risk	no blinding
Blinding of outcome assessment (detection bias)	High risk	no blinding
Incomplete outcome data (attrition bias)	Low risk	"179 could not be contacted (86 households in the control group and 93 households in the treatment group)" (8.5% LTFU).
Selective reporting (reporting bias)	Low risk	report on all outcomes specified in methods
Other bias	Unclear risk	_
Similarity of baseline outcome measurements	Unclear risk	NA
Similarity of baseline characteristics	Unclear risk	NA
Adequate allocation of intervention concealment during the study	Unclear risk	NA
Adequate protection against contamination	Unclear risk	NA
Confounders adequately adjusted for in analysis/design	Unclear risk	NA
Recruitment bias	High risk	seems the baseline data collection occurred after assignment to intervention and control
Baseline imbalance	Low risk	"For the key outcome variables (household water and sanitation condition, as well as children's health variables), balance is achieved. ""demographic and socio-economic characteristics are also similar across treatment and control groups"
Loss of clusters	Low risk	no loss of clusters reported
Incorrect analysis	Low risk	in multivariate analysis adjust for clustering

Chiang 2005 TWN

Methods	Case-control study
Participants	Cases: children under 5 in Hualian County with shigellosis (confirmed by laboratory test) from hospitals and clinics. n=46, 50% F Controls: children <5 who visited the same hospitals/ clinics +/- 10 days of the cases, for vaccination (excluding those with diarrhoea symptoms or fever within 10 days of house visit/ survey), matched for age group (0-1, 1-3, 3-5 years). n=92, 41.3% F
Interventions	Risk factor of interest: - Open defecation of children (no definition of comparison)

Outcomes	Shigella: symptoms of diarrhoea, abdominal pain, fever, nausea, mucous stool, tenesmus etc, and tested positive for Group B or D Shigella
Notes	Location: hospital and clinics in Hualien County, Taiwan Length of recruitment: 10 months (1 Aug 2001 till 31 May 2002) Publication status: Journal

Risk of bias table- see table 2 (page 187)

Chompook 2006 THA

Methods	case-control study (matched)
Participants	Cases: attended health facility with diarrhoea and *shigella* isolated from rectal swab, n=139 (after 53 not enrolled: not resident, not found, moved away, died or time- constraints), median age= 5 years, 57 % female Controls: Individuals free from diarrhoea or dysentery during the four weeks prior to recruitment, matched for sex and age with the cases (within 3 months for <2 years; within 6 months <5 years; within 12 months <16 years old; and within 5 years for ≥16 years), randomly selected from the population list of the health centre where the case resided. n= 264 (after 7 moved and 2 refused), median age= 5 years, 58 % female
Interventions	Risk factors of interest: - children not/ sometimes using latrine vs using latrine - child excreta disposal method (no data presented)
Outcomes	Diarrhoea (three or more loose stools, or at least one watery, bloody, or mucoid stool in the 24 hours prior to visiting the health facility) with isolated *Shigella*
Notes	Location: semi-urban, Kaengkhoi District, Saraburi Province, Thailand Length of recruitment: 2 years surveillance for Shigella (2000- 2002) Publication status: Journal and PhD thesis

Risk of bias table – see table 2 (page 187)

Clemens 1987 BGD

Methods	case-control study (community-based, cases and control selected from families in diarrhoea surveillance)
Participants	Case families: sentinel families with diarrhoea rate 1.7 times expected rate for similar aged children during 3 month observation, n= 45. Control families: sentinel families without any episodes of childhood diarrhoea during the 3 month period of observation, n=53.
Interventions	Risk factor of interest: Open defecation of ambulatory children (<6) in family living area vs in latrine or specially designated place

Outcomes	Diarrhoea: at least three unformed stools in any 24-hour period during the two week interval. Stipulated that a child could have a maximum of one episode in any one recall period and a new episode began only after a round without diarrhoea (or in the first round) and ended with the next diarrhoea-free round (data collected fortnightly).
Notes	Location: Dhaka slums, Bangladesh Length of recruitment: 3 months fortnightly histories of diarrhoea + observations in sentinel families (October 1984- January 1985) Publication status: Journal

Risk of bias table – see table 2 (page 187)

Cummings 2012 UGA

Methods	case-control study (unmatched)
Participants	Cases: individuals >10 years old who met the UMOH's outbreak case definition, were admitted to a cholera treatment centre in Moroto during April–June 2010; and resided in one of the 15 selected villages in Nadunget, n=99, median age=26 years, 64.6% female Controls: individuals >10 years old that had not experienced any form of diarrhoea from April 2010 to the time of investigation, resided in one of the 15 selected villages in Nadunget, n=99, median age=33 years, 51.5% female
Interventions	Risk factor of interest: not disposing of child faeces in latrine vs using latrine to dispose of faeces (unclear what the age of the children whose faeces are disposed, referred to as younger children in the household)
Outcomes	Cholera: acute watery diarrhoea in an area with laboratory-confirmed cholera cases
Notes	Location: rural Karamoja sub region, north east, Uganda Length of recruitment: 3 months (April-June 2010) Publication status: Journal

Risk of bias table- see table 2 (page 187)

Daniels 1990 LES

Methods	case-control study (clinic-based)
Participants	Cases: children less than 5 years of age who presented to the participating health facilities with diarrhoea, n=803 (after excluded 3), 43.5% <12months, 48.8% female Controls: the same age range who reported with either respiratory infections or trauma, but without diarrhoea. Children also had to meet the following selection criteria: be accompanied by a parent or guardian who had been responsible for the child for the previous 3 months, be living in a household within Mohale's Hoek district, not be suffering from a congenital abnormality or chronic illness and the accompanying adult had to consent to his or her child's inclusion in the study, n=810 (after excluded 4). 54.6% <12months, 52.4% female

Interventions	Risk factor of interest: child faeces disposed in latrine vs not (no usable data, data reported for cases and controls jointly)
Outcomes	Diarrhoea: as defined by the mother, with a minimum requirement of three or more loose or watery stools in the previous 24 hours
Notes	Location: 4 health facilities in rural Mohale's Hoek district, Lesotho Length of recruitment: 6 months (8 December 1987 - 6 June 1988) Publication status: Journal

Risk of bias table – see table 2 (page 187)

Dikassa 1993 DRC

Methods	case-control study (matched)
Participants	Cases: children <3 admitted to hospital and admission for primary diagnosis of diarrhoea of infectious origin, n=107 (after excluded 6), mean age= 11.9 months, 39.3% female Controls: age-matched children who were the nearest residential neighbours of the cases recruited for the study and who had no history of hospitalisation for diarrhoeal disease, n=107 (after excluded 6), mean age= 10.5 months, 41.1% female
Interventions	Risk factor of interest: not disposing of child faeces in latrine vs using latrine for disposal
Outcomes	Severe diarrhoea, all cases were identified by the first author (no case definition). The severity of diarrhoea was assessed based on evident dehydration of the child requiring hospitalisation.
Notes	Location: 2 hospitals, urban Kinshasa, DRC Length of recruitment: 8 months (March-November 1988) Publication status: Journal

Risk of bias table – see table 2 (page 187)

Fisher 2011 BGD

Methods	controlled cross-sectional study
Participants	Number: 107 respondents (1.8% non-response) Inclusion criteria: caregivers of a child below 5
Interventions	Intervention (2 villages, 80 respondents): BRAC hygiene education intervention, trained field workers provide water, sanitation and hygiene education to separate clusters of men, women, adolescents and children at least once every three months. The education uses pictorial flip chart with a total of 39 messages covering multiple aspects of cleanliness, clean water and sanitation. Villagers are also encouraged to learn the ‘19 Messages to Remember’, concerning hand-washing, sanitation (includes child faeces disposal in latrine) and safe water. Control (1 village, 27 respondents): no BRAC intervention

Outcomes	- Diarrhoea in previous month: three or more loose or watery stools within a 24-hour period (WHO definition) - Behaviour change: comparison between disposal of child faeces in latrine (child used latrine + faeces disposed in latrine) vs elsewhere for the last time the child defecated - Knowledge and practices covered in BRAC
Notes	Location: 3 rural villages, Mymensingh District, Bangladesh Length of study: not specified. Publication status: Journal

Risk of bias table

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	High risk	intervention was not allocated randomly
Allocation concealment (selection bias)	High risk	no details on concealment
Blinding of participants and personnel (performance bias)	Unclear risk	NA
Blinding of outcome assessment (detection bias)	Unclear risk	NA
Incomplete outcome data (attrition bias)	Low risk	only 1.8% non-response
Selective reporting (reporting bias)	Low risk	report on outcomes from methods
Other bias	High risk	small sample size with only 1 control village.
Similarity of baseline outcome measurements	Unclear risk	NA, no baseline
Similarity of baseline characteristics	Unclear risk	NA, no baseline
Adequate allocation of intervention concealment during the study	High risk	allocation to intervention occurred prior to study and the interviews were conducted by BRAC field workers (presumably aware of allocation of intervention)
Adequate protection against contamination	Unclear risk	control village was 7km away from the other 2 villages but unclear whether it was nearby to another BRAC village
Confounders adequately adjusted for in analysis/design	High risk	no analysis controlling for confounders
Recruitment bias	Unclear risk	NA
Baseline imbalance	Unclear risk	NA
Loss of clusters	Unclear risk	NA
Incorrect analysis	Unclear risk	NA

Gebru 2014 ETH

Methods	controlled cross-sectional study
Participants	Number: 794 respondents (96.2% response rate) Inclusion criteria: households that had at least one <5 children in 11 randomly selected kebeles. For model families (intervention): all households graduated (trained) health extension programme (HEP). For non-model families (control): all non-graduated households
Interventions	Intervention (265 respondents): health promotion and education, female and male household heads who have graduated as model families after being given basic training on the 16 HEP packages for 96 hours (maternal and child health package includes safe child stool disposal HEP 2003). Control (529 respondents): non model-families
Outcomes	- two week diarrhoea prevalence (adapted WHO questionnaire but no additional details on case definition) - possible environmental and behavioural risk factors for diarrhoea, including proper vs improver child stool disposal method (no definition of proper disposal)
Notes	Location: 11 rural kebeles, Sheko district, South West Ethiopia Length of study: 1 month (31 January to 29 February 2012) Publication status: Journal

Risk of bias table

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	High risk	the model households weren't allocated to the intervention at random
Allocation concealment (selection bias)	High risk	no allocation concealment
Blinding of participants and personnel (performance bias)	Unclear risk	NA
Blinding of outcome assessment (detection bias)	Unclear risk	NA
Incomplete outcome data (attrition bias)	Low risk	96.2% response rate
Selective reporting (reporting bias)	Low risk	report on outcomes from methods
Other bias	Unclear risk	_
Similarity of baseline outcome measurements	Unclear risk	NA, no baseline
Similarity of baseline characteristics	Unclear risk	NA, no baseline
Adequate allocation of intervention concealment during the study	Unclear risk	allocation to intervention occurred prior to study but no mention of whether data collectors were blind to whether household was model/ non model

Adequate protection against contamination	High risk	no specification about whether the model and non model households were in the same kebeles
Confounders adequately adjusted for in analysis/design	Low risk	analysis of diarrhoea risk factors controls for wealth, education and handwashing
Recruitment bias	Unclear risk	NA
Baseline imbalance	Unclear risk	NA
Loss of clusters	Unclear risk	NA
Incorrect analysis	Unclear risk	NA

Genthe 1996 SAF

Methods	case-control study
Participants	Cases: a sample was drawn from pre-school children who were brought to the day hospitals with diarrhoea, n=169, median age= 12 months , 50.6% female Controls: selected according to age (±6 months) and type of water supply from the immediate neighbourhood of the case and who had not suffered from diarrhoea during the preceding 14 days of the visit. Controls were matched for the time of occurrence of the case as well as the dates for interviews and observational studies, n=166. median age= 18 months, 47.3% female
Interventions	Risk factor of interest: open disposal of stools vs dispose of the stools into any form of sanitation system (private or communal toilet)
Outcomes	Diarrhoea: three or more loose or watery stools in a period of 24 hours (WHO definition)
Notes	Location: 2 day hospitals, urban townships, Kliayelitsha, Cape Flats, South Africa Length of recruitment: two 3-month periods (wet and dry seasons) in 1993-4 Publication status: report

Risk of bias table – see table 2 (page 187)

Ghosh 1994 IND

Methods	case-control study (nested in a community longitudinal study following up of children <3 with twice a week active surveillance for diarrhoea)
Participants	Cases: families with a child (<3 years) with diarrhoea, n= 105 (initially 76 but 29 controls developed diarrhoea and became a case) Controls: families with an age-matched child (<3 years) without diarrhoea in neighbourhood , n= 47 (initially 76 but 29 controls developed diarrhoea and became a case)
Interventions	Risk factor of interest: indiscriminate child stool disposal (no definition of indiscriminate)

Outcomes	Diarrhoea (no case definition), data collected twice per week
Notes	Location: rural West Bengal, India Length of recruitment: 12 months Publication status: Journal

Risk of bias table – see table 2 (page 187)

Ghosh 1997 IND

Methods	case-control study (nested in a community longitudinal study following up of children <4 with twice a week active surveillance for diarrhoea)
Participants	Cases: families with a child (<4 years) with diarrhoea, n=108 (initially 90 but 18 control families became cases) Controls: neighbourhood families with a study child of similar age but without diarrhoea within preceding 7 months (if control family developed diarrhoea in following 6 months it became a case family instead of a control family), n=72 (initially 90 but 18 control families became cases)
Interventions	Risk factors of interest: - indiscriminate disposal of child stools (no definition) - mothers who dispose of child faeces indiscriminately without knowledge compared to mothers who have knowledge of risk of indiscriminate child faeces disposal and do not practice indiscriminate child faeces disposal (no definition of indiscriminate disposal) (Gosh 1998)
Outcomes	Diarrhoea: passage of at least 3 liquid, watery mucoid stools with or without blood during the past 24hrs. For infants up to 3 months, an increase in the frequency and a change in the consistency of stools which was of concern to mothers.
Notes	Location: 3 rural villages in West Bengal, India Length of recruitment: 24 months (July 1992-June 1994) Publication status: Journal

Risk of bias table – see table 2 (page 187)

Godana 2013 ETH

Methods	case-control study (community based, unmatched)
Participants	Cases: a child under-five years of age, resident in a Derashe rural area, with a report of diarrhoea by mother and/caretaker in the 2 weeks preceding the survey, n=199 (after 5 non-responders), 57.8% <12months Controls: a child under-five years of age without diarrhoea in the preceding two weeks, randomly chosen from the resident population in the rural kebele, n=393 (after 15 non- responders), 57.5% <12months
Interventions	Risk factor of interest: disposal of infant faeces elsewhere vs in latrine

Outcomes	Diarrhoea: report of diarrhoea by mother and/caretaker in the 2 weeks preceding survey
Notes	Location: 5 rural kebeles, Derashe District, Southern Nations Nationalities and Peoples Region, Ethiopia Length of recruitment: 2 months (January – February 2012) Publication status: Journal

Risk of bias table – see table 2 (page 187)

Haggerty 1994 DRC

Methods	Cluster RCT
Participants	Number: 1764 (after excluding 190 children with <9 weeks diarrhoea morbidity data) Inclusion criteria: children 3-35 months
Interventions	Intervention (9 villages): education intervention to improve personal and domestic hygiene behaviour including: disposal of animal faeces, hand washing before meal preparation and after defecation/washing hands and buttocks of young children after defecation, disposal of children's faeces (emphasised digging or improving pit latrines). The messages were delivered by female community volunteers in village-wide meetings and small group discussions. Control (9 villages): education to continue breastfeeding and give rice water during diarrhoea by community volunteers selected and trained in the same way as intervention.
Outcomes	- diarrhoea incidence, duration of diarrhoeal episodes, number of diarrhoea days. Weekly visit (7 day recall). The mother's own definition of diarrhoea was used, employing the local word ('pulu-pulu") to describe diarrhoea. For each day that diarrhoea occurred, the mother was asked if the child was febrile, whether there was blood in the stool and what (if any) treatment was used. A gap of ≥2 diarrhoea free days was used to define a new episode of diarrhoea - observed hygiene practices (data not presented) - child growth (data not presented)
Notes	Location: 18 rural villages, in Bandundu province, DRC Length of study: 14 months (October 1987-December 1988) Publication status: Journal

Risk of bias table

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Unclear risk	"Following the baseline diarrhoeal and observational studies, all sites were ranked from lowest to highest according to age-adjusted mean days of diarrhoea [...] and then one in each pair was chosen at random to receive the intervention, the other to serve as a control."
Allocation concealment (selection bias)	Unclear risk	no details
Blinding of participants and personnel (performance bias)	High risk	control sites also received a placebo intervention but the intervention was clearly different

Blinding of outcome assessment (detection bias)	High risk	not specified
Incomplete outcome data (attrition bias)	Low risk	<10% had < 9 complete weeks of diarrhoea data
Selective reporting (reporting bias)	High risk	did not report on behaviour change in the study although it was specified in methods
Other bias	Unclear risk	_
Similarity of baseline outcome measurements	Unclear risk	NA
Similarity of baseline characteristics	Unclear risk	NA
Adequate allocation of intervention concealment during the study	Unclear risk	NA
Adequate protection against contamination	Unclear risk	NA
Confounders adequately adjusted for in analysis/design	Unclear risk	NA
Recruitment bias	Low risk	clusters are not known to be intervention or control during participant recruitment
Baseline imbalance	Low risk	matched clusters according to mean days of diarrhoea
Loss of clusters	Low risk	No reported loss of clusters
Incorrect analysis	Low risk	clusters are adjusted for in analysis

Heller 2003 BRA

Methods	case-control study
Participants	Cases: <5 yo children resident in Betim area attending a health centre for diarrhoea, n=997, mean age= 1.72 years , 47.1% female Controls: <5 yo children resident in Betim area chosen randomly from a register (used by municipality with purpose of housing taxes), n=999, mean age= 2.63 years, 49.75% female
Interventions	Risk factors of interest: - faeces disposal from swaddle disposed elsewhere vs in toilet/ latrine
Outcomes	Diarrhoea: The attendant physician diagnosis of diarrhoea was assumed as the case definition.
Notes	Location: 29 health centres in urban area of Betim in Minais Gerais State in South East Brazil Length of recruitment: 5 months (November 1993 – April 1994) Publication status: Journal

Risk of bias table – see table 2 (page 187)

Huda 2012 BGD

Methods	Controlled cohort study
Participants	Number: 1699 HHs for structured observations and 1000 HHs for diarrhoea surveillance Inclusion criteria: household with a child <5 years and a guardian of the child agreed to participate in the study
Interventions	Intervention (50 communities): Sanitation Hygiene Education and Water Supply in Bangladesh (SHEWA-B), a large-scale hygiene promotion intervention which engages local residents to develop their own community action plans, including targets for improvements in latrine coverage and use, access to arsenic-free water and improved hygiene practices. Community hygiene promoters are trained to deliver 11 key messages including "use hygienic latrine by all family members including children" and "dispose of children's faeces into hygienic latrines" using household visits, courtyard meetings and different activities e.g. hygiene fairs, village theatre, group discussions in tea stalls. Promoters used flip charts and flash cards. Control (50 communities): no major water, sanitation, hygiene programme ongoing.
Outcomes	- diarrhoea prevalence. Diarrhoea: the passage of 3 or more loose or watery stools in 24 h period. Monthly visits to ask about episodes of diarrhoea in previous 2 days. - acute respiratory illness - observed hygiene behaviours including child faeces disposal, considered appropriate if faeces were observed to be disposed in a toilet or in a specific pit.
Notes	Location: 100 rural villages across Bangladesh Length of study: 24 months (October 2007 to September 2009) Publication status: Journal

Risk of bias table

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	High risk	intervention not randomly allocated
Allocation concealment (selection bias)	High risk	intervention communities were allocated prior to enrolment
Blinding of participants and personnel (performance bias)	Unclear risk	NA
Blinding of outcome assessment (detection bias)	Unclear risk	NA
Incomplete outcome data (attrition bias)	Unclear risk	numbers of respondents is not reported for the health outcomes
Selective reporting (reporting bias)	Low risk	report on all outcomes prespecified in the methods
Other bias	Unclear risk	_
Similarity of baseline outcome measurements	Unclear risk	from figure it looks as though the baseline diarrhoea prevalence was a bit different but no data presented

Similarity of baseline characteristics	Low risk	no major differences at baseline
Adequate allocation of intervention concealment during the study	High risk	although the community monitors were not aware of the hypothesis, they were aware of allocation to intervention/ control group
Adequate protection against contamination	Low risk	selected sub districts in which "Department of Public Health Engineering of the Government of Bangladesh, who were responsible for implementing SHEWA-B and confirmed that there was no similar intervention ongoing."
Confounders adequately adjusted for in analysis/design	High risk	no confounders adjusted for in analyses
Recruitment bias	Unclear risk	NA
Baseline imbalance	Unclear risk	NA
Loss of clusters	Unclear risk	NA
Incorrect analysis	Unclear risk	NA

Jinadu 2007 NGR

Methods	Cluster RCT
Participants	Number: 514 Inclusion criteria: mothers of children below 5 In intervention group, 65.8% ≤12 months. In control 65.9% ≤12 months
Interventions	Intervention (5 villages): educational intervention programme to promote the hygienic disposal of children's faeces: 1- Educating mothers about the hygienic use of chamber- pots for the disposal of children faeces. 2- Discouraging children from defecation around households. 3- Educating the heads of households about the construction and use of cheap, affordable ventilated improved latrines by members of the communities. 4- Educating mothers to wash hands with soap and water after going to toilet and after cleaning up children's faeces. Control (5 villages): no health promotion activities
Outcomes	- hygienic behaviours: child defecation pattern, households with sanitary latrines, HH use chamber pots, HH where mothers HWWS after cleaning child faeces and defecation, HH without children faeces lying around
Notes	Location: 10 rural villages in Osun State, Nigeria Length of study: 12 months Publication status: Journal

Risk of bias table

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Unclear risk	no description
Allocation concealment (selection bias)	Unclear risk	no description

Blinding of participants and personnel (performance bias)	High risk	no mention of blinding
Blinding of outcome assessment (detection bias)	High risk	no mention of blinding and no mention of relation of interviewers in relation to trial
Incomplete outcome data (attrition bias)	Unclear risk	no data on loss to follow up
Selective reporting (reporting bias)	Low risk	present outcomes pre-specified in the methods
Other bias	Unclear risk	_
Similarity of baseline outcome measurements	Unclear risk	NA
Similarity of baseline characteristics	Unclear risk	NA
Adequate allocation of intervention concealment during the study	Unclear risk	NA
Adequate protection against contamination	Unclear risk	NA
Confounders adequately adjusted for in analysis/design	Unclear risk	NA
Recruitment bias	High risk	clusters were known to be intervention or control during participant recruitment (only selected participants to measure outcomes after intervention had been implemented)
Baseline imbalance	Unclear risk	no baseline
Loss of clusters	Low risk	no reported loss of villages
Incorrect analysis	High risk	no correction for clustering

Knight 1992 MAL

Methods	case-control study (matched)
Participants	Cases: a child aged 4-59 months resident in Tumpat, who presented at a health centre with 3 or more loose stools in 24 hours and duration of diarrhoea less than 2 weeks (and without measles, malaria, UTI, ARI, acute otitis media, or antibiotics use in the previous 2 weeks), n=98 (after 2 left area) Controls: randomly selected from children resident in Tumpat, registered at a health centre usually within a week of their respective case child, with a condition other than diarrhoea, and age (±6 weeks for <1 year,± 3 months for child age 1 year, ±6 months for child ≥2 years) and sex matched to case child and who did not have skin infection, conjunctivitis or worm infestation as their provisional diagnosis, n=98
Interventions	Risk factor of interest: indiscriminate child defecation (anywhere other than a toilet or nappy)

Outcomes	Diarrhoea: three or more loose stools in 24 hours
Notes	Location: 5 health centres, Tumpat rural district, Malaysia Length of recruitment: 2 months (February-March 1989) Publication status: Journal

Risk of bias table- see table 2 (page 187)

Kotch 2007 USA

Methods	Cluster RCT
Participants	Number: 388 children Inclusion criteria: children were expected to remain in the classroom throughout the 7- month study period and be 36 months of age at the end of data collection and that at least 1 family contact could participate in a telephone survey in English. Siblings were allowed to participate when they also attended the study centre and met the eligibility criteria. In intervention group, mean age of children= 21.26 months and 6.39 boys per class. In control mean age=21.41 months and 3.61 boys per class.
Interventions	Intervention (23 child care centres): staff were trained using the 'Keep It Clean' training module to improve and standardize the hand-washing, sanitation, diapering, and food- preparation procedures. Diapering, hand-washing, and food-preparation equipment with impermeable, seamless surfacing for food preparation, diaper-changing, and hand-washing were provided. In addition, automatic faucets and foot-activated, roll-out waste bins for diaper disposal were provided. Control (23 child care centres): staff were trained using the 'Keep It Clean' training module but received no equipment.
Outcomes	- severe diarrhoea incidence: any loose, watery stool that if contained would assume the shape of the container. A separate episode of diarrhoea was defined by an interval of 7 diarrhoea-free days. Survey every 2 weeks. - number of days sick - number of days child absent for centre because of illness - number of days parents missed work because of child illness - sick days of caregivers in centres - diapering and food preparations practices
Notes	Location: 46 child care centres in 21 counties, North Carolina, USA Length of study: 7 months follow up (December 2002- July 2003) Publication status: Journal

Risk of bias table

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	no details, "from each pair 1 centre was randomly selected as intervention centre"
Allocation concealment (selection bias)	Unclear risk	no details

Blinding of participants and personnel (performance bias)	High risk	no blinding
Blinding of outcome assessment (detection bias)	Unclear risk	no blinding specified although as the outcome was assessed by phone by the survey research unit at UNC- could have been blind
Incomplete outcome data (attrition bias)	Low risk	121 children LTFU from 388 children in total (31% LTFU) but the numbers were similar in intervention and control groups (59 control and 62 intervention LTFU, NS)
Selective reporting (reporting bias)	Low risk	report on prespecified outcomes in paper
Other bias	Unclear risk	_
Similarity of baseline outcome	Unclear risk	NA
Similarity of baseline characteristics	Unclear risk	NA
Adequate allocation of intervention concealment during the study	Unclear risk	NA
Adequate protection against contamination	Unclear risk	NA
Confounders adequately adjusted for in analysis/design	Unclear risk	NA
Recruitment bias	High risk	seems the directors recruiting the children were aware of which cluster the centre was in
Baseline imbalance	High risk	baseline imbalances in mean classroom enrolment, mean number of children participating in the study per classroom, mean number of boys enrolled in the classroom, and mean number of boys participating in the study per classroom. Because the direction of the differences, more boys and more total children in intervention classrooms and did not adjust in analysis
Loss of clusters	Low risk	no loss of centres reported
Incorrect analysis	Low risk	adjusted for clustering at class level by adding random effect

Luby 2014 BGD

Methods	controlled cohort study
Participants	Number: 1000 urban households and 1000 rural households for diarrhoea surveillance, 1000 households for anthropometry and 1000 households for structured observations Inclusion criteria: household with a child <5 years and a guardian of the child agreed to participate in the study

Interventions	Intervention: SHEWA-B, improved from findings in Huda 2012 BGD. Changes in the intervention included a mass media campaign including radio spots across 6 regional channels from November 2011 to February 2012 encouraging HWWS before food, after defecation and after cleaning a child and video spots on 5 TV stations (Nov-Feb 2012) encouraging HWWS, using sanitary latrines for defecation and discarding child faeces and keeping latrines clean to reduce bad smells and flies. A second series of videos encouraged testing tube-wells for arsenic and using arsenic free water for cooking and drinking. The intervention target population also expanded to include urban households. Control: no major water, sanitation, hygiene programme ongoing.
Outcomes	- diarrhoea prevalence. Diarrhoea: the passage of 3 or more loose or watery stools within 24 h period. Monthly visits to ask about episodes of diarrhoea in previous 2 days. - acute respiratory illness - anthropometry - observed hygiene and sanitation behaviours including child faeces disposal, considered appropriate if faeces were observed to be disposed in a toilet or in a specific pit. - water quality
Notes	Location: rural villages and urban slums across Bangladesh Length of study: 60 months in total (October 2007 to September 2012). For this study report from 2011 to 2012. Publication status: report

Risk of bias table

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	High risk	intervention not randomly allocated
Allocation concealment (selection bias)	High risk	intervention communities were allocated prior to enrolment
Blinding of participants and personnel (performance bias)	Unclear risk	NA
Blinding of outcome assessment (detection bias)	Unclear risk	NA
Incomplete outcome data (attrition bias)	Unclear risk	numbers of respondents is not reported for the health outcomes
Selective reporting (reporting bias)	Low risk	report on all outcomes prespecified in methods
Other bias	Unclear risk	_
Similarity of baseline outcome measurements	Unclear risk	in figure it looks like the baseline diarrhoea prevalence was different but no data presented
Similarity of baseline characteristics	Low risk	no major differences at baseline, however the control and intervention households at follow up are different

Adequate allocation of intervention concealment during the study	High risk	were aware of allocation to intervention/ control group
Adequate protection against contamination	Low risk	selected sub districts in which "Department of Public Health Engineering of the Government of Bangladesh, who were responsible for implementing SHEWA-B and confirmed that there was no similar intervention ongoing."
Confounders adequately adjusted for in analysis/design	High risk	no confounders adjusted for in analyses
Recruitment bias	Unclear risk	NA
Baseline imbalance	Unclear risk	NA
Loss of clusters	Unclear risk	NA
Incorrect analysis	Unclear risk	NA

Mathew 2004 ZIM

Methods	controlled cross-sectional study
Participants	Number: 115 respondents Inclusion criteria: no details
Interventions	Intervention (2 villages): Community Health Clubs (CHCs)- structured weekly course of participatory health education classes. 15 health topics covered using PHAST techniques, within the hygiene lesson cover disposal of toddler's faeces in a latrine. Control (2 villages): no CHCs
Outcomes	-knowledge of risks and practices including: percentage of children (<5) present at the time of observations not using a latrine
Notes	Location: 4 rural villages, Bikita district, Zimbabwe Length of study: not specified Publication status: PhD thesis

Risk of bias table

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	High risk	intervention not randomly allocated
Allocation concealment (selection bias)	High risk	allocation not concealed
Blinding of participants and personnel (performance bias)	Unclear risk	NA
Blinding of outcome assessment (detection bias)	Unclear risk	NA

Incomplete outcome data (attrition bias)	Unclear risk	no non response data reported
Selective reporting (reporting bias)	Unclear risk	tool for observations is not available
Other bias	Unclear risk	_
Similarity of baseline outcome measurements	Unclear risk	NA, not relevant to design
Similarity of baseline characteristics	Unclear risk	NA, not relevant to design
Adequate allocation of intervention concealment during the study	High risk	no blinding
Adequate protection against contamination	Unclear risk	no details about distance or possibility for contamination
Confounders adequately adjusted for in analysis/design	High risk	no adjustments for any confounders
Recruitment bias	Unclear risk	NA
Baseline imbalance	Unclear risk	NA
Loss of clusters	Unclear risk	NA
Incorrect analysis	Unclear risk	NA

Maung 1992a MYA

Methods	case-control study
Participants	Cases: children 1-59 months admitted to paediatric wards of North Okkalapa General Hospital, or presented at the urban health centre or at the Emergency Department of North Okkalapa General Hospital, for persistent diarrhoea and protein- energy malnutrition (PEM), n= 67 Controls: age- and sex-matched apparently healthy children within the neighbourhood of the case children (usually within the same street, selected from houses with structural appearances similar to that of the cases). The control children had no diarrhoea or PEM in the last 2 months, n=67
Interventions	Risk factor of interest: - faeces were disposed of around house vs latrine (assume this is reporting data on child faeces disposal as the risk factors are all related to child defecation but it's not stated in the paper)
Outcomes	Persistent diarrhoea: passage of watery or loose stools (with or without mucus) >3 times/day on most days lasting at least 14 days during the last 2 months, with an interval of not more than 6 days during which loose motions were <3 times/day PEM: children with kwashiorkor, marasmic kwashiorkor or marasmus, or children with weight-for-age <2 SD below the median National Centre for Health Statistics reference

Notes	Location: town hospital and urban health centre, Yangon region, Myanmar Length of recruitment: not specified Publication status: Journal

Risk of bias table – see table 2 (page 187)

Maung 1992b MYA

Methods	case-control study
Participants	same as above
Interventions	Risk factors of interest: - child defecated on the floor vs in pot/latrine
Outcomes	As above
Notes	As above

Risk of bias table – see table 2 (page 187)

Mediratta 2010a ETH

Methods	case-control study (clinic based)
Participants	Cases: children <5 with acute diarrhoea were consecutively enrolled from the outpatient department and inpatient paediatric ward, n=220, mean age=1.57 years , 35% female Controls: selected from children with other conditions who did not present with acute diarrhoea for at least 14 days before the date of interview. Match the cases with 1:1 ratio for age (within 6-months), sex, within 2 weeks from the date of the case visit and the same ward, n=220. mean age= 1.51 years, 35% female
Interventions	Risk factors of interest: - disposal of stools elsewhere (thrown in garbage, buried, left on ground) vs in latrine (child used latrine + put into latrine)
Outcomes	Diarrhoea: three or more liquid stools within a 24-hour period. Acute diarrhoea: having diarrhoea for less than 14 days.
Notes	Location: University of Gondar Referral and Teaching Hospital in the North Gondar Zone, Ethiopia Length of recruitment: 6 months (July 2007- January 2008) Publication status: Journal

Risk of bias table – see table 2 (page 187)

Mediratta 2010b ETH

Methods	case-control study (clinic based)

Participants	Same as above
Interventions	Risk factors of interest: - place of child's last defecation was elsewhere (ground, small bucket (popo), underclothes) vs latrine
Outcomes	As above
Notes	As above

Risk of bias table – see table 2 (page 187)

Menon 1990 USA

Methods	case-control study
Participants	Cases: Apache children <2 years residing on the White Mountain reservation, seen at the Whiteriver Indian Hospital with rotavirus diarrhoea, n=45 (after 1 refused, 27 respondents were not available and 5 cases were dropped as had no matched control) Hospital controls: children <2 years residing on the White Mountain reservation, matched for sex and age within 2 months, chosen from outpatient and inpatient records for a variety of other non-diarrhoeal illnesses, and visited the hospital within two weeks of the date of diagnosis of the case, n=45 Neighbourhood controls: children <2 within same age group, same sex and neighbourhood (area served by same water supply system), n=24
Interventions	Risk factor of interest: dirty diapers on ground in yard vs none
Outcomes	Rotavirus diarrhoea: 3 or more loose or watery stools during the previous 24 hours which tested positive (2+) for rotavirus antigen by the ELISA assay
Notes	Location: 1 hospital on White Mountain reservation in East-central Arizona, USA Length of recruitment: 7 months (1 May - 15 December 1985) Publication status: Journal

Risk of bias table – see table 2 (page 187)

Mertens 1992 SRI

Methods	case-control study
Participants	Cases: all children below 5 years of age presenting with diarrhoea to one of five hospitals, n= 2458 (only visited 1415), mean age= 20.6 months, 45.6% female Hospital controls: children suffering from a control disease, frequency matched for age with the cases (within a range of 5 months), n=4140 (only visited household of 2279), mean age= 23.3 months, 48.8% female Community controls: a random sample of children <5 years was recruited from the community in the catchment areas of the hospitals, using multistage sampling, and applying the same exclusion criteria as the clinic controls, n=1659, mean age=25.8 months, 47.6% female.

Interventions	Risk factor of interest: unsanitary disposal (stools passed, or disposed of, in or out of the yard without being later (within a day) disposed of in a latrine or in a covered rubbish pit) vs sanitary disposal (stools passed in a potty and later disposed of in a latrine or in a covered pit).
Outcomes	Diarrhoea: Diarrhoea was defined as three or more loose or watery stools in the previous 24 hours, or as stools with blood or mucus
Notes	Location: 5 rural hospitals and community, district of Kurunegala, Sri Lanka Length of recruitment: 14 months (January 1987- March 1988) Publication status: Journal

Risk of bias table- see table 2 (page 187)

Nanan 2003 PAK

Methods	case-control study (clinic based)
Participants	cases: children 4– 71 months with diarrhoea (episode-based) that attended the recruitment centres during the study period, had been resident in the same village for the previous 2 weeks, and were accompanied by a parent or guardian who was willing to participate in the study, n=454 (after 54 excluded), 63% <24 months, 45% female controls: children 4– 71 months with any complaint other than diarrhoea and without a skin condition or worm infestation that attended the recruitment centres during the study period, had been resident in the same village for the previous 2 weeks, and were accompanied by a parent or guardian who was willing to participate in the study, frequency matched on the health centre of recruitment and time of diagnosis (selected within 24 hours of a case), n=349 (after 125 excluded), 49% <24 months, 38% female
Interventions	Risk factor of interest: non Water and Sanitation Extension Programme (WASEP) village vs WASEP village. WASEP (Aga Khan Development Network) aimed to improve potable water supply at village and household levels, sanitation facilities and their use, and awareness and practices about hygiene behaviour. WASEP delivered water supply, water quality, drainage, sanitation and school and community-based hygiene education. The hygiene education contained information on safe disposal of faeces (adult, child and household animals), and use and maintenance of a latrine (if the household possessed a latrine).
Outcomes	Diarrhoea: 3 or more loose, watery stools in the last 24 hours
Notes	Location: 6 Aga Khan Health services, Pakistan (AKHS,P) centres, Ghizer and Gilgit districts, Pakistan Length of recruitment: 2 months (July – September 2001) Publication status: Journal

Risk of bias table – see table 2 (page 187)

Oketcho 2012 TAN

Methods	case-control study (clinic-based)

Participants	Cases: children (6-60 months) admitted to the paediatric infectious diseases ward and the caretaker reported increase in the stool fluidity and frequency of passing stool for at least 2 days, n=151 Controls: children (6-60 months) admitted to the ward for management of non infectious diseases, without diarrhoea within the previous 2 weeks . All children meeting the case and control criteria admitted at the same time of the same age group and residing in Morogoro region were included in the study, n=152
Interventions	Risk factor of interest: child use toilet vs defecate elsewhere
Outcomes	Diarrhoea: caretaker reported increase in the stool fluidity and frequency of passing stool for at least 2 days
Notes	Location: urban, Morogoro Regional Hospital, Tanzania Length of recruitment: 8 months (January to September 2011) Publication status: Journal

Risk of bias table- see table 2 (page 187)

Patil 2014 IND

Methods	Cluster RCT
Participants	Number: 3039 HHs (5209 <5) (after 15.3% LTFU) Inclusion criteria: household with at least one child <24 months at enrolment, for follow- up, the household had to have at least 1 child between 21 and 45 months and were living in the village at the time of baseline In intervention group, mean age= 21.9 months. In control mean age= 22.1 months
Interventions	Intervention (40 villages): India Total Sanitation Campaign (TSC) (subsidies and promotion of individual household latrines) and Nirmal Vatika (additional subsidies) and support from WSP through TSSM project, which included creation of enabling environment + capacity building to implement community led total sanitation (CLTS) based behaviour change methods Control (40 villages): no intervention
Outcomes	- toilet coverage, defecation behaviours (including daily open defecation by children (<5), hygienic child faeces disposal) - diarrhoea: ≥3 loose or watery stools in 24 hours or a single stool with blood/ mucus. 7 day recall in questionnaire at baseline and at end line. - highly credible gastrointestinal illness (HCGI) - acute lower respiratory illness - bruising/abrasions and itchy skin/scalp (negative control outcomes) - anthropometry (weight for age, height for age, weight for height, mid-upper arm circumference) - anaemia - water quality - child stool parasitology (including helminth present in stool, *A. lumbricoides* present in stool)
Notes	Location: 80 rural villages in 2 neighbouring districts in Madhya Pradesh, India Length of study: 23 months (25 May 2009- 25 April 2011) Publication status: Journal

Risk of bias table

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	used public lottery to assign villages to arms
Allocation concealment (selection bias)	Low risk	used public lottery to assign villages to arms
Blinding of participants and personnel (performance bias)	High risk	no blinding of participants possible but outcomes are self reported so could be affected by lack of blinding
Blinding of outcome assessment (detection bias)	High risk	"Field interviewers were not informed of group assignment, but it was possible for them to identify intervention villages during interviews of Block officers or the village secretary" so incomplete blinding
Incomplete outcome data (attrition bias)	Low risk	attrition was not differential by randomised group and no missing values for main outcomes
Selective reporting (reporting bias)	Low risk	report on main outcomes
Other bias	Unclear risk	_
Similarity of baseline outcome measurements	Unclear risk	NA
Similarity of baseline characteristics	Unclear risk	NA
Adequate allocation of intervention concealment during the study	Unclear risk	NA
Adequate protection against contamination	Unclear risk	NA
Confounders adequately adjusted for in analysis/design	Unclear risk	NA
Recruitment bias	High risk	follow-up data which is the data used for analysis was measured in newly recruited households that belonged to either intervention or control arms
Baseline imbalance	Low risk	no major imbalance and the analysis adjusted for the 3 characteristics that had slight imbalance between groups
Loss of clusters	Low risk	no loss of clusters
Incorrect analysis	Low risk	adjusted for clustering in the analyses

Pickering 2015 MLI

Methods	Cluster RCT

Participants	Number: 6319 children <5 at end line (4031 HHs) (after 11.1% LTFU) Inclusion criteria: households with at least one child <10
Interventions	Interventions (60 villages, 2365 households): Community Led Total Sanitation (CLTS) which uses participatory methods to eliminate the practice of open defecation in rural households and promote building of toilets. No hardware or subsidies is provided to households. Control (61 villages, 2167 households): no intervention
Outcomes	- diarrhoea (2 days and 2 week prevalence): three or more loose or watery stools per 24 hours - symptoms: loose stool by chart, blood in stool, vomit, fever, cough, congestion, difficulty breathing, earache and bruising (negative controls) - anthropometry (height for age, weight for age) - self reported all cause and cause-specific mortality - sanitation access and defecation behaviours (including open defecation by children and use of potty) - drinking water quality - hand hygiene
Notes	Location: 121 villages in Koulikoro district, Mali Length of study: 24 months (April 2011- May 2013) Publication status: published

Risk of bias table

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Low risk	" One of the study investigators (MLA) used a computer-generated algorithm that randomly assigned villages (1:1) to treatment and control groups"
Allocation concealment (selection bias)	Low risk	"The algorithm generated a random number for each village, which was then used to sort villages and assigned the first 60 to the intervention group and the remaining 61 to the control group. "
Blinding of participants and personnel (performance bias)	High risk	" masking of participants was not possible because of the nature of the intervention"
Blinding of outcome assessment (detection bias)	High risk	"Field staff were not informed of village treatment status, but could have inferred this during the follow-up from the presence of signage showing village certification of an open defecation free status."
Incomplete outcome data (attrition bias)	Low risk	similar percentage lost to follow up (11.8% of households in control and 10.4% in intervention)
Selective reporting (reporting bias)	Low risk	all outcomes pre-specified in methods are reported on
Other bias	Unclear risk	_
Similarity of baseline outcome measurements	Unclear risk	NA

Similarity of baseline characteristics	Unclear risk	NA
Adequate allocation of intervention concealment during the study	Unclear risk	NA
Adequate protection against contamination	Unclear risk	NA
Confounders adequately adjusted for in analysis/design	Unclear risk	NA
Recruitment bias	Low risk	the participants were unaware on whether they would be randomised to CLTS or control villages
Baseline imbalance	Low risk	no substantial differences in baseline characteristics were observed "access to sanitation and an improved water source were similar across groups. Baseline diarrhoeal and respiratory illness symptoms were at higher prevalence in villages assigned to the CLTS intervention"
Loss of clusters	Low risk	no loss of villages reported
Incorrect analysis	Low risk	in the analysis used "robust standard errors (the Huber-White Sandwich estimator) to account for correlated outcomes at the village level"

Stanton 1987 BGD

Methods	Cluster RCT
Participants	Number: 1923 families, 1350 with <6 years child (after 0.8 % emigrated) Inclusion criteria: families with children <6
Interventions	Intervention (25 slums): educational intervention emphasizing 3 messages- proper hand washing before food preparation, defecation away from the house and in a proper site, and suitable disposal of waste and faeces. The intervention was delivered in the community over 8 weeks through small group discussions, larger demonstrations, community wide planning and action meeting, posters, games, pictorial stories, flexi flans (flannel board with movable characters). Control (26 slums): community health workers continued to provide the primary health care services
Outcomes	- diarrhoea incidence in 6 months following intervention and 1 year following intervention. Diarrhea: at least three unformed stools in any 24-hour period during the 2 week interval. stipulated that a child could have a maximum of one episode in any one recall period, and that a new episode began only after a round without diarrhoea (or in the first round) and ended with the next diarrhoea-free round. - nutritional status (weight for age, height for age, weight for height) (Stanton 1988) - hygiene behaviour change: hand washing before serving food, child defecate in living area, garbage and faeces seen in living area, child observed to put garbage in mouth
Notes	Location: Dhaka slums, Bangladesh Length of study: 18 months (October 1984- March 1986). Publication status: Journal

Risk of bias table

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	use of a random number table
Allocation concealment (selection bias)	Unclear risk	no detail on how allocation was concealed
Blinding of participants and personnel (performance bias)	High risk	" This study was not performed in a double-blinded fashion"
Blinding of outcome assessment (detection bias)	High risk	" This study was not performed in a double-blinded fashion"
Incomplete outcome data (attrition bias)	Unclear risk	similar attrition in both groups "equivalent percentages of intervention and control communities immigrated (19% in intervention vs. 23% in control) or emigrated (38% in intervention vs. 37% in control) but unclear number of children who provided full histories of diarrhoea
Selective reporting (reporting bias)	Low risk	report on all outcomes
Other bias	Unclear risk	-
Similarity of baseline outcome measurements	Unclear risk	NA
Similarity of baseline characteristics	Unclear risk	NA
Adequate allocation of intervention concealment during the study	Unclear risk	NA
Adequate protection against contamination	Unclear risk	NA
Confounders adequately adjusted for in analysis/design	Unclear risk	NA
Recruitment bias	Low risk	participants were recruited in clusters prior to randomisation
Baseline imbalance	Low risk	similar baseline characteristics and matched at design stage "grouped the ordered communities into 25 adjacent pairs and one remaining community…within each stratum (pair), one community was assigned to intervention and one to control"
Loss of clusters	Unclear risk	no mention of loss of clusters, although don't present the single control slum that was not matched
Incorrect analysis	High risk	although report on analysis using cluster as individuals- don't present data and quote unadjusted data as final

Strina 2012 BRA

Methods	case-control study (clinic-based)
Participants	Cases: children (<10 years) presenting with diarrhoea as a main complaint in five health facilities of Salvador and tested positive for rotavirus in stool sample, n=390, 39.0% <12 months, 43.3% female Controls: children without diarrhoea selected from children attending the same health facilities, at well-baby consultations or because of other health problems not related to diarrhoea, such as orthopaedic procedures or evaluation before a surgical operation. Controls were frequency matched to cases by age and health insurance, n=1674, 31.2% <12 months, 47.5% female
Interventions	Risk factor of interest: inadequate disposal of excreta of children ≤2 years old vs adequate (no definition)
Outcomes	Rotavirus diarrhoea: children with diarrhoea who tested positive for rotavirus in stool
Notes	Location: urban, 5 health facilities, Salvador, Brazil Length of recruitment: 21 months (November 2002 – August 2004) Publication status: Journal

Risk of bias table- see table 2 (page 187)

Traore 1994a BUR

Methods	case-control study
Participants	Cases: child aged ≤36 months, resident in Bobo-Dioulasso and admitted to hospital at Sanou Souro Hospital during the period of the study, with symptoms which included diarrhoea or dysentery, or both, as reported by the mother, n=757 (1056 cases in total but 28% LTFU), 49% <12 months, 45% female Hospital controls: Any child aged ≤36 months, resident in Bobo-Dioulasso and admitted to hospital at Sanou Souro Hospital during the period of the study without symptoms of diarrhoea or dysentery, n=631 (72% follow up), 40% <12 months, 46% female Neighbourhood controls: These were neighbours of children admitted to hospital with symptoms of diarrhoea or dysentery, or both, matched for age group, n=1405, 47% <12 months, 53% female
Interventions	Risk factors of interest: - disposing of children faeces elsewhere vs latrine - Stools visible in yard (not used in the review)
Outcomes	Diarrhoea: as reported by mother and examined by a doctor, dysentery: bloody or mucoid stools
Notes	Location: urban Bobo-Dioulasso, Burkina Faso Length of recruitment: 2.5 months (15 January 1990 to 31 March 1991) Publication status: Journal

Risk of bias table- see table 2 (page 187)

Traore 1994b BUR

Methods	case-control study
Participants	Same as above
Interventions	Risk factors of interest: - defecation elsewhere vs. in pots/latrine
Outcomes	As above
Notes	As above

Risk of bias table- see table 2 (page 187)

Waterkeyn 2005 ZIM

Methods	controlled cross-sectional study
Participants	Number: 908 respondents Inclusion criteria: intervention survey respondents had to be members of health clubs, control group respondents came from areas with no health clubs matched with regard to demography, cultural practices, levels of sanitation and water coverage.
Interventions	Intervention (382 respondents from Makoni and 354 from Tsholotsho): Community Health Clubs (CHCs)- structured weekly course of participatory health education classes. The training materials used for health promotion consisted of 14 sets of illustrated cards. The different topics were reflected in a 'membership card' which provided an outline of the syllabus: 1 Mapping of Village, 2 Disease Identification, 3 Balanced Diet, 4 Nutrition Plans, 5 Diarrhoea, 6 Salt Sugar Solution, 7 Home Hygiene, 8 Water Sources, 9 Drinking Water, 10 Water Storage, 11 Hand Washing, 12 Bilharzia, 13 Skin and Eye Diseases, 14 Worms, 15 Sanitation Ladder 16 Sanitation Story, 17 Malaria, 18 Respiratory Diseases, 19 Tuberculosis, 20 AIDs and STDs. Within the hygiene lesson cover: Disposal of toddler's faeces in a latrine Control (113 respondents from Makoni and 59 from Tsholotsho): no CHCs
Outcomes	- 20 observable indicators of behaviour change including child faeces in yard
Notes	Location: rural wards in Makoni (21 intervention wards) and Tsholotsho districts (3 intervention wards), Zimbabwe Length of study: 7 months (August 2000- March 2001) Publication status: Journal

Risk of bias table

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	High risk	intervention not randomly allocated
Allocation concealment (selection bias)	High risk	allocation not concealed
Blinding of participants and personnel (performance bias)	Unclear risk	NA

Blinding of outcome assessment (detection bias)	Unclear risk	NA
Incomplete outcome data (attrition bias)	Low risk	it seems they observed hygiene indicators in all households
Selective reporting (reporting bias)	Low risk	behaviours pre-specified are reported on
Other bias	Unclear risk	_
Similarity of baseline outcome measurements	Unclear risk	NA, not relevant to design
Similarity of baseline characteristics	Unclear risk	NA, not relevant to design
Adequate allocation of intervention concealment during the study	High risk	no blinding
Adequate protection against contamination	Low risk	control areas were " far removed from health clubs areas (typically 30-50km away)"
Confounders adequately adjusted for in analysis/design	High risk	no adjustments for any confounders
Recruitment bias	Unclear risk	NA
Baseline imbalance	Unclear risk	NA
Loss of clusters	Unclear risk	NA
Incorrect analysis	Unclear risk	NA

Wijewardene 1992 SRI

Methods	case-control study (community-based)
Participants	Cases: families with a child <5 having acute diarrhoea in previous 6 months (identified through community visits), n=100 Controls: families with at least one <5 child that did not have a single episode of diarrhoea during the previous 6 months, matched for age of child, occupation and ethnic group of father, n=100
Interventions	Risk factor of interest: not disposing of children's faeces in latrine vs disposing of it in latrine
Outcomes	Acute diarrhoea for children >1: 3/more loose stools in 24 hours for a period not lasting more than 7 days
Notes	Location: Urban, Galle municipality, Sri Lanka Length of recruitment: no details Publication status: Journal

Risk of bias table- see table 2 (page 187)

Yeager 2002 PER

Methods	Cluster RCT
Participants	Number: 722 households (post intervention) Inclusion criteria: household had to have an eligible child (15-47months)
Interventions	Intervention (4 clusters): hygiene promotion for potty use & keeping the home environment free from faeces. The intervention was delivered through routine health services, and using video presentations, leaflets including 4 steps to potty training and counselling by health staff during consultations. Control (4 clusters): no intervention
Outcomes	-observed behaviours: use of potties, defecation behaviour of children, hygiene behaviours afterwards, disposal behaviour of faeces
Notes	Location: San Juan de Lurigancho district, Lima, Peru Length of study: 17 months (October 1996-March 1998) Publication status: Journal

Risk of bias table

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Unclear risk	not described "One of these groups was then selected at random as the intervention group."
Allocation concealment (selection bias)	Unclear risk	not described
Blinding of participants and personnel (performance bias)	High risk	no blinding
Blinding of outcome assessment (detection bias)	High risk	no blinding
Incomplete outcome data (attrition bias)	Unclear risk	no details of non-response
Selective reporting (reporting bias)	Low risk	report on main outcomes
Other bias	Unclear risk	_
Similarity of baseline outcome measurements	Unclear risk	NA
Similarity of baseline characteristics	Unclear risk	NA
Adequate allocation of intervention concealment during the study	Unclear risk	NA
Adequate protection against contamination	Unclear risk	NA
Confounders adequately adjusted for in analysis/design	Unclear risk	NA
Recruitment bias	High risk	for end line data collection field workers would have known allocation of cluster

Baseline imbalance	Low risk	the implementers had matched the zones
Loss of clusters	Unclear risk	no loss of clusters reported
Incorrect analysis	High risk	no statistical calculations

Characteristics of excluded studies

Study	Reason for exclusion
Assefa 2010	the study design was not eligible
Blum 1990	unclear whether child faeces disposal or use of latrines by children was included in the intervention
Dumba 2013	unclear whether child faeces disposal or use of latrines by children was included in the intervention
Gorter 1998	The study design and intervention were not eligible
Gungoren 2007	unclear whether child faeces disposal or use of latrines by children was included in the intervention
Hunter 2004	risk factor is contact with toileting child or changing diaper (yes vs no) not about the disposal of the faeces & where the faeces end up
IOB/UNICEF 2011	insufficient detail provided on whether child faeces disposal or use of latrines by children was included in the intervention whether there was a control group
JDC/ IHI 2012	unclear whether child faeces disposal was included in the intervention
Messou 1997	unclear whether child faeces disposal or use of latrines by children was included in the intervention
Taha 2000	intervention and outcome were not eligible

Characteristics of ongoing studies

SHINE, Zimbabwe

Study name	Sanitation, Hygiene, Infant Nutrition Efficacy Project (SHINE)
Methods	Cluster RCT
Participants	Estimated: 5272

Interventions	1. WASH: Standard care interventions, provision of household ventilated pit latrine, water treatment solution, and monthly liquid soap, two hand-washing facilities and protected infant play space. Provision of interpersonal communication interventions promoting faeces disposal in a latrine, hand washing with soap, drinking water treatment, hygienic weaning food preparation, and preventing babies from putting dirt and animal faeces in their mouths. 2. Nutrition: Standard care interventions, provision of 20 g/d Nutributter from 6-18 months. Provision of interpersonal communication interventions promoting optimal use of locally available foods for complementary feeding after 6 months, continued breastfeeding and feeding during illness. 3. WASH and nutrition combined
Outcomes	Primary outcomes: 1.Infant length at 18 months 2.Infant haemoglobin at 18 months Secondary outcomes: 1.Infant environmental enteric dysfunction (measured at 1, 3, 6, 12 and 18 months of age) 2.Infant weight, mid-upper arm circumference and head circumference (at 18 months, and (with length) at intermediate time-points of 1, 3, 6 and 12 months) 3.Infant diarrhoea prevalence, incidence and severity (1 month to 18 months of age) Assessed by 7-day morbidity history in all infants, and by daily morbidity diary in a subgroup of infants 4. Process and intermediate outcomes
Starting date	November 2012
Contact information	Jean Humphrey, Johns Hopkins Bloomberg School of Public Health
Notes	Location: Harare, Zimbabwe Trial registration number: NCT01824940

WASH-B, Bangladesh

Study name	WASH Benefits Bangladesh: A Cluster Randomized Controlled Trial of the Benefits of Water, Sanitation, Hygiene Plus Nutrition Interventions on Child Growth
Methods	Cluster RCT
Participants	Estimated: 5040

Interventions	1. Water quality: chlorine tablets (Aquatabs; NaDCC) and a safe storage vessel to treat and store drinking water. Behaviour change messaging to treat drinking water for all children <36 months 2. Sanitation: provision of free child potties, sani-scoop hoes to remove faeces from household environments, and latrine upgrades to a dual pit latrine. For promotion, local promoters will visit study compounds to deliver behavior change messages on the use of latrines for defecation and the removal of human and animal faeces from the compound. 3. Hand washing: hand washing stations, soapy water bottles, detergent soap to supply soapy water. Behavior change messages will focus on handwashing with soap at critical times around food preparation, defecation, and contact with faeces. 4. Combined WASH: water quality, sanitation and hand washing components. 5. Nutrition: Lipid-based Nutrient Supplement (LNS) given twice daily for children 6-24 months. Behavior change messages based on those recommended in the Guiding Principles for Complementary Feeding of the Breastfed Child and the recent UNICEF Program Guide for Infant and Young Child Feeding Practices. 6. Nutrition + combined WASH
Outcomes	Primary outcomes: 1.Length-for-Age Z-scores (measured 24 months after intervention) 2.Diarrhea Prevalence (defined as 3+ loose or watery stools in 24 hours or 1+ stools with blood in 24 hours. Diarrhea will be measured in interviews using caregiver- reported symptoms with 2-day and 7-day recall, measured 12 and 24 months after intervention) Secondary outcomes: 1.Length-for-Age Z-scores (measured 12 months after intervention) 2.Stunting Prevalence (measured 24 months after intervention) 3.Enteropathy Biomarkers (measured 12- and 24 months after intervention) 4.Ages and Stages Questionnaire Child Development Scores (measured 24 months after intervention)
Starting date	May 2012
Contact information	International Centre for Diarrhoeal Disease Research, Bangladesh
Notes	Trial registration number: NCT01590095 Location: Bangladesh

WASH-B, Kenya

Study name	WASH Benefits Kenya: A Cluster Randomized Controlled Trial of the Benefits of Sanitation, Water Quality, Handwashing, and Nutrition Interventions on Child Health and Development
Methods	Cluster RCT
Participants	Estimated: 8000

Interventions	1.Water quality: chlorine dispensers provided for free at communal water sources and behaviour change messaging to treat drinking water for all children living in the household 2.Sanitation: provision of free child potties, sani-scoop hoes to remove faeces from household environments, and new or upgraded pit latrine for each study compound. For promotion, local promoters will visit study compounds to deliver behavior change messages on the use of latrines for defecation and the removal of human and animal faeces from the compound. 3.Hand washing: "dual tippy tap" stations, including jugs for clean and for soapy water, stocked with soap for the duration of the trial. Behavior change messages will focus on handwashing with soap at critical times around food preparation, defecation, and contact with faeces. 4. Combined WASH: water quality, sanitation and hand washing components. 5. Nutrition: Lipid-based Nutrient Supplement (LNS) given twice daily for children 6-24 months. Behavior change messages based on those recommended in the Guiding Principles for Complementary Feeding of the Breastfed Child and the recent UNICEF Program Guide for Infant and Young Child Feeding Practices. 6. Nutrition + combined WASH
Outcomes	Primary outcomes: 1. Length-for-Age Z-scores (measured 24 months after intervention) 2. Diarrhea Prevalence (defined as 3+ loose or watery stools in 24 hours or 1+ stools with blood in 24 hours. Diarrhea will be measured in interviews using caregiver- reported symptoms with 2-day and 7-day recall, measured 12 and 24 months after intervention) Secondary outcomes: 1. Length-for-Age Z-scores (measured 12 months after intervention) 2. Stunting Prevalence (measured 24 months after intervention) 3. Enteropathy Biomarkers (measured 12- and 24 months after intervention) 4. Ages and Stages Questionnaire Child Development Scores (measured 24 months after intervention)
Starting date	September 2012
Contact information	Innovations for Poverty Action, Kenya
Notes	Trial registration number: NCT01704105 Location: Kenya

DATA AND ANALYSES

Comparison 1. CRCTs: Hygiene education vs control

Outcome or Subgroup	Studies	Participants	Statistical Method	Effect Estimate
1.1 diarrhoea	2		Risk Ratio(IV, Random, 95% CI)	0.83 [0.73, 0.94]

Comparison 2. CRCTs: Sanitation intervention vs control

Outcome or Subgroup	Studies	Participants	Statistical Method	Effect Estimate
2.1 diarrhoea	4		Risk Ratio(IV, Random, 95% CI)	0.93 [0.83, 1.04]
2.2 any helminth	2		Risk Ratio(IV, Random, 95% CI)	1.03 [0.78, 1.37]
2.3 *Ascaris lumbricoides* present	2		Risk Ratio(IV, Random, 95% CI)	1.01 [0.74, 1.39]
2.4 Dysentery	2		Risk Ratio(IV, Random, 95% CI)	0.63 [0.31, 1.30]
2.5 Anthropometry: HAZ	4		Mean Difference(IV, Random, 95% CI)	0.05 [-0.07, 0.17]
2.6 Anthropometry: WAZ	4		Mean Difference(IV, Random, 95% CI)	0.02 [-0.06, 0.09]

Comparison 3. CBA: WASH interventions vs control

Outcome or Subgroup	Studies	Participants	Statistical Method	Effect Estimate
3.1 diarrhoea	2		Risk Ratio(IV, Random, 95% CI)	0.77 [0.71, 0.84]

Comparison 4. controlled cohort studies: SHEWA-B vs control

Outcome or Subgroup	Studies	Participants	Statistical Method	Effect Estimate
4.1 diarrhoea	2		Risk Ratio(IV, Random, 95% CI)	0.91 [0.64, 1.28]
4.2 safe vs unsafe child faeces disposal	2		Risk Ratio(IV, Random, 95% CI)	1.10 [0.72, 1.67]

Comparison 5. Case-control studies: disposal of child faeces in latrine vs elsewhere

Outcome or Subgroup	Studies	Participants	Statistical Method	Effect Estimate
5.1 Diarrhoea (including severe and cholera):	22		Odds Ratio(IV, Random, 95% CI)	0.77 [0.69, 0.85]

subgrouped by age group				
5.1.1 All ages	22		Odds Ratio(IV, Random, 95% CI)	0.76 [0.66, 0.88]
5.1.2 ≤5 years	19		Odds Ratio(IV, Random, 95% CI)	0.77 [0.66, 0.89]
5.2 Diarrhoea (including severe and cholera): subgrouped by country income level	22		Odds Ratio(IV, Random, 95% CI)	0.76 [0.66, 0.88]
5.2.1 low	8		Odds Ratio(IV, Random, 95% CI)	0.68 [0.43, 1.09]
5.2.2 lower middle	10		Odds Ratio(IV, Random, 95% CI)	0.82 [0.70, 0.96]
5.2.3 upper middle	3		Odds Ratio(IV, Random, 95% CI)	0.75 [0.60, 0.94]
5.2.4 high	1		Odds Ratio(IV, Random, 95% CI)	0.68 [0.48, 0.97]
5.3 Diarrhoea (including severe and cholera): subgrouped by type of diarrhoea	22		Odds Ratio(IV, Random, 95% CI)	0.76 [0.66, 0.88]
5.3.1 Persistent diarrhoea	1		Odds Ratio(IV, Random, 95% CI)	0.53 [0.17, 1.68]
5.3.2 Moderate to severe diarrhoea	7		Odds Ratio(IV, Random, 95% CI)	0.96 [0.83, 1.11]
5.3.3 Acute (possibly) bloody diarrhoea	4		Odds Ratio(IV, Random, 95% CI)	0.67 [0.56, 0.81]
5.3.4 Acute watery diarrhoea	5		Odds Ratio(IV, Random, 95% CI)	0.76 [0.48, 1.22]
5.3.5 No case definition	5		Odds Ratio(IV, Random, 95% CI)	0.54 [0.39, 0.75]
5.4 Diarrhoea (including severe and cholera): subgrouped by study quality	22		Odds Ratio(IV, Random, 95% CI)	0.76 [0.66, 0.88]
5.4.1 4 stars	7		Odds Ratio(IV, Random, 95% CI)	0.96 [0.83, 1.11]
5.4.2 5 stars	7		Odds Ratio(IV, Random, 95% CI)	0.65 [0.52, 0.82]
5.4.3 6 stars	3		Odds Ratio(IV, Random, 95% CI)	0.71 [0.38, 1.33]
5.4.4 7+ stars	5		Odds Ratio(IV, Random, 95% CI)	0.66 [0.51, 0.84]
5.5 Diarrhoea (including severe and cholera): subgrouped by setting	22		Odds Ratio(IV, Random, 95% CI)	0.76 [0.66, 0.88]
5.5.1 Rural	9		Odds Ratio(IV, Random, 95% CI)	0.72 [0.55, 0.94]
5.5.2 Urban	10		Odds Ratio(IV, Random, 95% CI)	0.74 [0.61, 0.90]
5.5.3 Peri-urban/urban and rural	3		Odds Ratio(IV, Random, 95% CI)	0.98 [0.70, 1.38]

5.6 Diarrhoea (including severe and cholera): subgrouped by method of data collection	22		Odds Ratio(IV, Random, 95% CI)	0.76 [0.66, 0.88]
5.6.1 questionnaire	18		Odds Ratio(IV, Random, 95% CI)	0.80 [0.69, 0.93]
5.6.2 observation	2		Odds Ratio(IV, Random, 95% CI)	0.48 [0.29, 0.79]
5.6.3 unclear	2		Odds Ratio(IV, Random, 95% CI)	0.67 [0.48, 0.94]

Comparison 6. Case-control studies: defecation of children in latrine vs elsewhere

Outcome or Subgroup	Studies	Participants	Statistical Method	Effect Estimate
6.1 Diarrhoea: case-control studies: subgrouped by age group	7		Odds Ratio(IV, Random, 95% CI)	0.56 [0.39, 0.80]
6.1.1 All ages	7		Odds Ratio(IV, Random, 95% CI)	0.54 [0.33, 0.90]
6.1.2 ≤5 years	5		Odds Ratio(IV, Random, 95% CI)	0.54 [0.28, 1.07]
6.2 Diarrhoea: case-control studies: subgrouped by country income level	7		Odds Ratio(IV, Random, 95% CI)	0.54 [0.33, 0.90]
6.2.1 low	3		Odds Ratio(IV, Random, 95% CI)	0.61 [0.23, 1.60]
6.2.2 lower middle	2		Odds Ratio(IV, Random, 95% CI)	0.23 [0.11, 0.48]
6.2.3 upper middle	2		Odds Ratio(IV, Random, 95% CI)	0.78 [0.53, 1.14]
6.3 Diarrhoea: case-control studies: subgrouped by type of diarrhoea	7		Odds Ratio(IV, Random, 95% CI)	0.54 [0.33, 0.90]
6.3.1 Other	1		Odds Ratio(IV, Random, 95% CI)	0.14 [0.03, 0.52]
6.3.2 Persistent diarrhoea	1		Odds Ratio(IV, Random, 95% CI)	0.27 [0.12, 0.60]
6.3.3 Acute (possibly) bloody diarrhoea	2		Odds Ratio(IV, Random, 95% CI)	0.85 [0.65, 1.12]
6.3.4 Acute watery diarrhoea	3		Odds Ratio(IV, Random, 95% CI)	0.58 [0.20, 1.65]
6.4 Diarrhoea: case-control studies: subgrouped by study quality	7		Odds Ratio(IV, Random, 95% CI)	0.54 [0.33, 0.90]
6.4.1 4 stars	2		Odds Ratio(IV, Random, 95% CI)	0.13 [0.05, 0.37]
6.4.2 5 stars	1		Odds Ratio(IV, Random, 95% CI)	0.27 [0.12, 0.60]

6.4.3 6 stars	3		Odds Ratio(IV, Random, 95% CI)	0.82 [0.57, 1.17]
6.4.4 7 stars	1		Odds Ratio(IV, Random, 95% CI)	0.91 [0.64, 1.29]
6.5 Diarrhoea: case-control studies: subgrouped by setting	7		Odds Ratio(IV, Random, 95% CI)	0.54 [0.33, 0.90]
6.5.1 rural	1		Odds Ratio(IV, Random, 95% CI)	0.75 [0.29, 1.93]
6.5.2 semi-urban	1		Odds Ratio(IV, Random, 95% CI)	0.79 [0.52, 1.19]
6.5.3 Urban	5		Odds Ratio(IV, Random, 95% CI)	0.40 [0.17, 0.94]
6.6 Diarrhoea: case-control studies: subgrouped by by method of data collection	7		Odds Ratio(IV, Random, 95% CI)	0.54 [0.33, 0.90]
6.6.1 questionnaire	5		Odds Ratio(IV, Random, 95% CI)	0.75 [0.50, 1.13]
6.6.2 observation	1		Odds Ratio(IV, Random, 95% CI)	0.13 [0.02, 0.66]
6.6.3 unclear	1		Odds Ratio(IV, Random, 95% CI)	0.27 [0.12, 0.60]

Comparison 7. controlled cross-sectional: HEP model households vs non-model

Outcome or Subgroup	Studies	Participants	Statistical Method	Effect Estimate
7.1 diarrhoea	2		Odds Ratio(IV, Random, 95% CI)	0.26 [0.16, 0.42]

Comparison 8. Trials: behaviour change after intervention

Outcome or Subgroup	Studies	Participants	Statistical Method	Effect Estimate
8.1 No open defecation by children <5	4		Risk Ratio(IV, Random, 95% CI)	1.56 [0.76, 3.20]
8.2 Latrine use by children	2		Risk Ratio(IV, Random, 95% CI)	1.69 [0.26, 11.04]
8.3 Potty use by children	3		Risk Ratio(IV, Random, 95% CI)	1.85 [0.81, 4.23]
8.4 Safe disposal of child faeces	4		Risk Ratio(IV, Random, 95% CI)	1.19 [1.01, 1.40]
8.5 faeces not observed in yard/ HH	2		Risk Ratio(IV, Random, 95% CI)	1.09 [0.61, 1.94]

Comparison 9. controlled cross-sectional studies: behaviour change

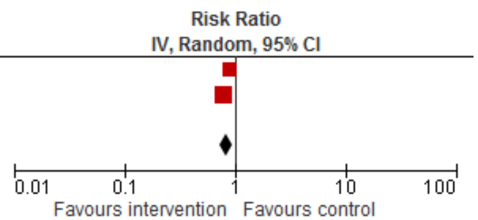
Outcome or Subgroup	Studies	Participants	Statistical Method	Effect Estimate
9.1 safe vs unsafe child faeces disposal	3		Risk Ratio(IV, Random, 95% CI)	1.57 [1.12, 2.20]
9.1.1 BRAC	1		Risk Ratio(IV, Random, 95% CI)	4.25 [1.91, 9.46]
9.1.2 HEP	2		Risk Ratio(IV, Random, 95% CI)	1.36 [0.98, 1.89]

Analysis 1.1. Comparison 1. CRCTs: Hygiene education vs control, Outcome 1 diarrhoea.

1.1 diarrhoea

Study or Subgroup	log[Risk Ratio]	SE	Weight	Risk Ratio IV, Random, 95% CI
Haggerty 1994 DRC	-0.1195	0.0501	45.1%	0.89 [0.80, 0.98]
Stanton 1987 BGD (1)	-0.2485	0.0296	54.9%	0.78 [0.74, 0.83]
Total (95% CI)			**100.0%**	**0.83 [0.73, 0.94]**

Heterogeneity: Tau² = 0.01; Chi² = 4.91, df = 1 (P = 0.03); I² = 80%
Test for overall effect: Z = 2.97 (P = 0.003)



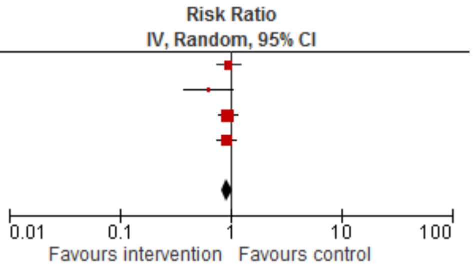
Footnotes
(1) Used 1 year follow up data (Stanton 1988)

Analysis 2.1. Comparison 2. CRCTs: Sanitation intervention vs control, Outcome 1 diarrhoea

2.1 diarrhoea

Study or Subgroup	log[Risk Ratio]	SE	Weight	Risk Ratio IV, Random, 95% CI
Briceño 2015 TAN	-0.0417	0.1229	23.5%	0.96 [0.75, 1.22]
Cameron 2013 INA (1)	-0.4512	0.263	5.1%	0.64 [0.38, 1.07]
Patil 2014 IND	-0.0424	0.097	37.8%	0.96 [0.79, 1.16]
Pickering 2015 MLI (2)	-0.0726	0.103	33.5%	0.93 [0.76, 1.14]
Total (95% CI)			**100.0%**	**0.93 [0.83, 1.04]**

Heterogeneity: Tau² = 0.00; Chi² = 2.23, df = 3 (P = 0.53); I² = 0%
Test for overall effect: Z = 1.23 (P = 0.22)



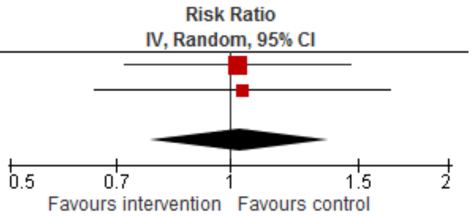
Footnotes
(1) Effect measures for Briceno 2015, Cameron 2013 and Patil 2014 are not adjusted for clustering. The denominators for Cameron...
(2) data for 2-day recall

Analysis 2.2. Comparison 2. CRCTs: Sanitation intervention vs control, Outcome 2 any helminth.

2.2 any helminth

Study or Subgroup	log[Risk Ratio]	SE	Weight	Risk Ratio IV, Random, 95% CI
Cameron 2013 INA (1)	0.0253	0.1814	63.5%	1.03 [0.72, 1.46]
Patil 2014 IND	0.0398	0.2391	36.5%	1.04 [0.65, 1.66]
Total (95% CI)			**100.0%**	**1.03 [0.78, 1.37]**

Heterogeneity: Tau² = 0.00; Chi² = 0.00, df = 1 (P = 0.96); I² = 0%
Test for overall effect: Z = 0.21 (P = 0.83)



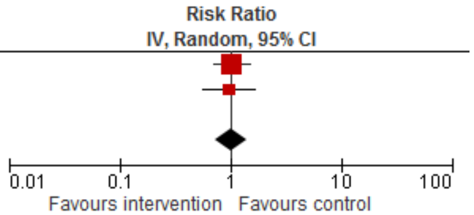
Footnotes
(1) estimated using proportions and p-value reported in paper

Analysis 2.3. Comparison 2. CRCTs: Sanitation intervention vs control, Outcome 3 *Ascaris lumbricoides* present

2.3 *Ascaris lumbricoides* present

Study or Subgroup	log[Risk Ratio]	SE	Weight	Risk Ratio IV, Random, 95% CI
Cameron 2013 INA (1)	0.0299	0.1994	65.8%	1.03 [0.70, 1.52]
Patil 2014 IND	-0.0209	0.2766	34.2%	0.98 [0.57, 1.68]
Total (95% CI)			**100.0%**	**1.01 [0.74, 1.39]**

Heterogeneity: Tau² = 0.00; Chi² = 0.02, df = 1 (P = 0.88); I² = 0%
Test for overall effect: Z = 0.08 (P = 0.94)



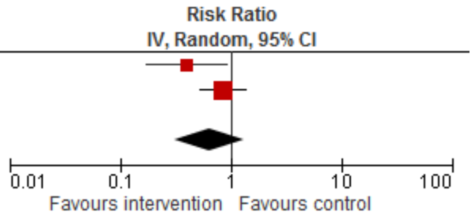
Footnotes
(1) calculated using RR estimate and reported p-value

Analysis 2.4. Comparison 2. CRCTs: Sanitation intervention vs control, Outcome 4 Dysentery

2.4 Dysentery

Study or Subgroup	log[Risk Ratio]	SE	Weight	Risk Ratio IV, Random, 95% CI
Cameron 2013 INA (1)	-0.9163	0.4249	39.1%	0.40 [0.17, 0.92]
Pickering 2015 MLI (2)	-0.1625	0.2372	60.9%	0.85 [0.53, 1.35]
Total (95% CI)			**100.0%**	**0.63 [0.31, 1.30]**

Heterogeneity: Tau² = 0.17; Chi² = 2.40, df = 1 (P = 0.12); I² = 58%
Test for overall effect: Z = 1.24 (P = 0.21)



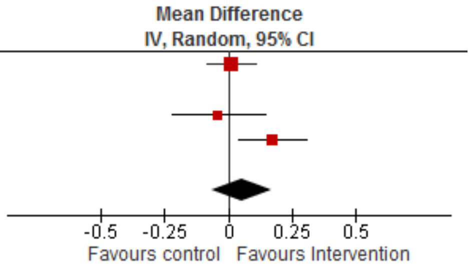
Footnotes
(1) The denominators for Cameron 2013 are estimated using available data. Not adjusted for clustering.
(2) 2 day prevalence

Analysis 2.5. Comparison 2. CRCTs: Sanitation intervention vs control, Outcome 5 Anthropometry: HAZ

2.5 Anthropometry: HAZ

Study or Subgroup	Mean Difference	SE	Weight	Mean Difference IV, Random, 95% CI
Briceño 2015 TAN	0.0104	0.0496	41.8%	0.01 [-0.09, 0.11]
Cameron 2013 INA (1)	0	0		Not estimable
Patil 2014 IND	-0.04	0.0936	24.7%	-0.04 [-0.22, 0.14]
Pickering 2015 MLI	0.174	0.0684	33.6%	0.17 [0.04, 0.31]
Total (95% CI)			**100.0%**	**0.05 [-0.07, 0.17]**

Heterogeneity: Tau² = 0.01; Chi² = 4.85, df = 2 (P = 0.09); I² = 59%
Test for overall effect: Z = 0.86 (P = 0.39)



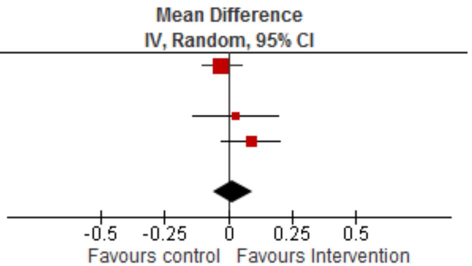
Footnotes
(1) not enough data to calculate the measure of effect

Analysis 2.6. Comparison 2. CRCTs: Sanitation intervention vs control, Outcome 6 Anthropometry: WAZ

2.6 Anthropometry: WAZ

Study or Subgroup	Mean Difference	SE	Weight	Mean Difference IV, Random, 95% CI
Briceño 2015 TAN	-0.0278	0.0396	51.8%	-0.03 [-0.11, 0.05]
Cameron 2013 INA (1)	0	0		Not estimable
Patil 2014 IND	0.0286	0.0868	16.9%	0.03 [-0.14, 0.20]
Pickering 2015 MLI	0.089	0.0587	31.4%	0.09 [-0.03, 0.20]
Total (95% CI)			**100.0%**	**0.02 [-0.06, 0.09]**

Heterogeneity: Tau² = 0.00; Chi² = 2.77, df = 2 (P = 0.25); I² = 28%
Test for overall effect: Z = 0.47 (P = 0.63)



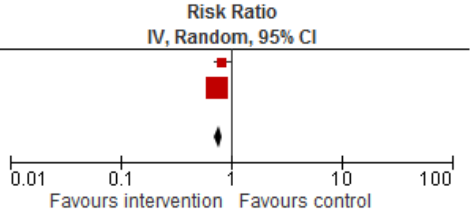
Footnotes
(1) not enough data to calculate the measure of effect

Analysis 3.1. Comparison 3. CBA: WASH interventions vs control, Outcome 1 diarrhoea

3.1 diarrhoea

Study or Subgroup	log[Risk Ratio]	SE	Weight	Risk Ratio IV, Random, 95% CI
Alam 1989 BGD	-0.1863	0.0797	25.1%	0.83 [0.71, 0.97]
Aziz 1990 BGD	-0.2877	0.0352	74.9%	0.75 [0.70, 0.80]
Total (95% CI)			**100.0%**	**0.77 [0.71, 0.84]**

Heterogeneity: Tau² = 0.00; Chi² = 1.35, df = 1 (P = 0.24); I² = 26%
Test for overall effect: Z = 5.96 (P < 0.00001)

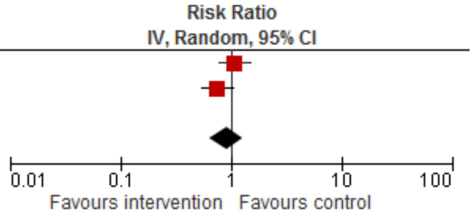


Analysis 4.1. Comparison 4. Controlled cohort studies: SHEWA-B vs control, Outcome 1 diarrhoea

4.1 diarrhoea

Study or Subgroup	log[Risk Ratio]	SE	Weight	Risk Ratio IV, Random, 95% CI
Huda 2012 BGD	0.077	0.1647	50.5%	1.08 [0.78, 1.49]
Luby 2014 BGD (1)	-0.2744	0.1687	49.5%	0.76 [0.55, 1.06]
Total (95% CI)			**100.0%**	**0.91 [0.64, 1.28]**

Heterogeneity: Tau² = 0.03; Chi² = 2.22, df = 1 (P = 0.14); I² = 55%
Test for overall effect: Z = 0.55 (P = 0.58)



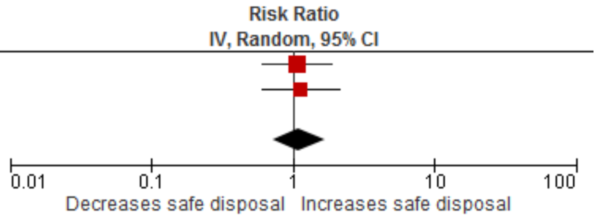
Footnotes
(1) only data for rural households

Analysis 4.2. Comparison 4. Controlled cohort studies: SHEWA-B vs control, Outcome 2 safe vs unsafe child faeces disposal

4.2 safe vs unsafe child faeces disposal

Study or Subgroup	log[Risk Ratio]	SE	Weight	Risk Ratio IV, Random, 95% CI
Huda 2012 BGD	0.062	0.2878	55.9%	1.06 [0.61, 1.87]
Luby 2014 BGD	0.1335	0.3238	44.1%	1.14 [0.61, 2.16]
Total (95% CI)			**100.0%**	**1.10 [0.72, 1.67]**

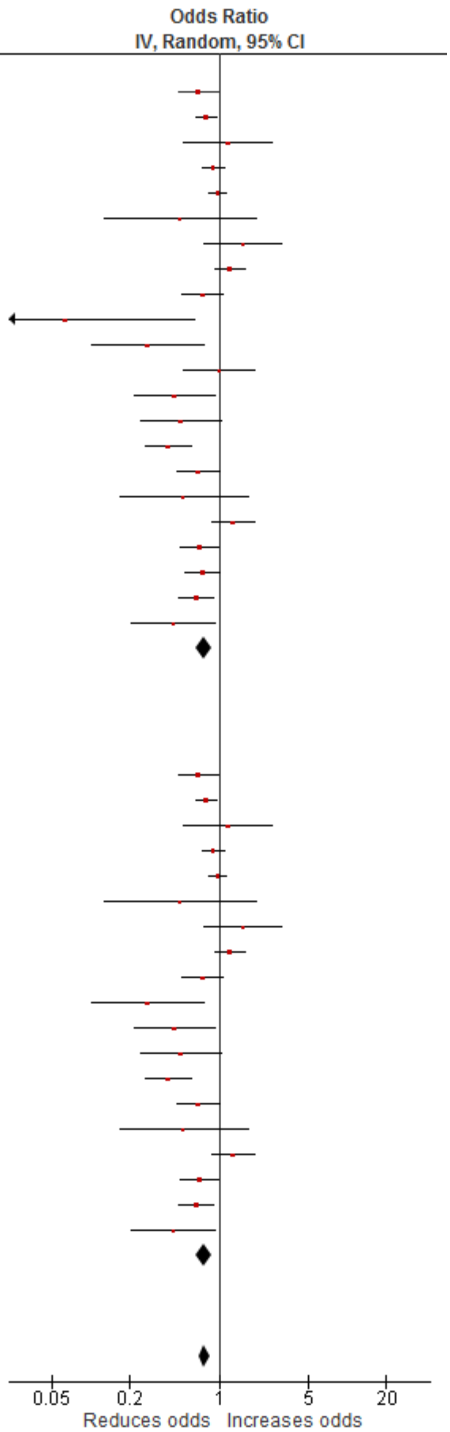
Heterogeneity: Tau² = 0.00; Chi² = 0.03, df = 1 (P = 0.87); I² = 0%
Test for overall effect: Z = 0.43 (P = 0.66)



Analysis 5.1. Comparison 5. Case-control studies: disposal of child faeces in latrine vs elsewhere, Outcome 1 Diarrhoea (including severe and cholera): subgrouped by age group

5.1 Diarrhoea (including severe and cholera): subgrouped by age group

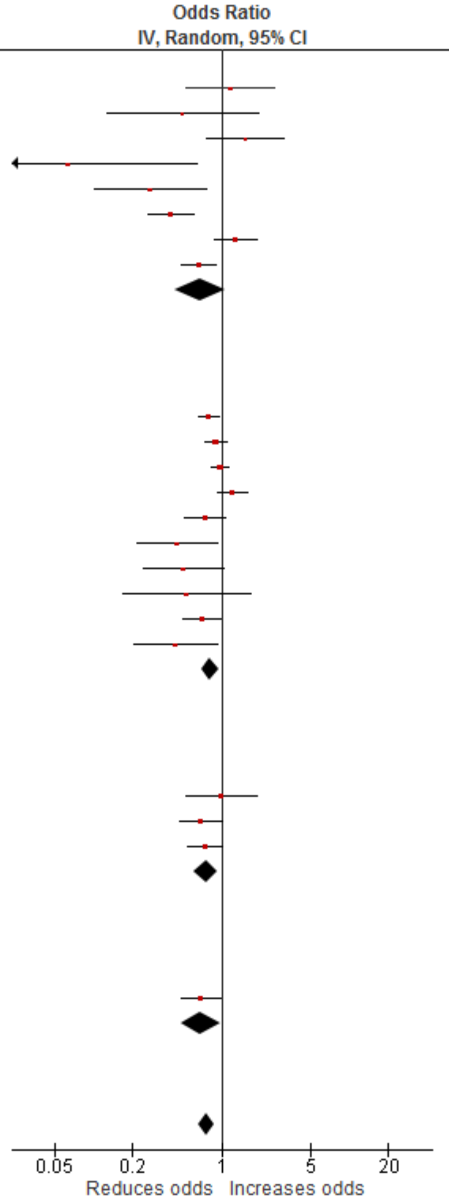
Study or Subgroup	log[Odds Ratio]	SE	Weight	Odds Ratio IV, Random, 95% CI
5.1.1 All ages				
Abalkhail 1995 KSA	-0.3784	0.18	3.1%	0.68 [0.48, 0.97]
Baker 2016 BGD	-0.2311	0.0945	4.3%	0.79 [0.66, 0.96]
Baker 2016 GMB	0.1625	0.4054	1.2%	1.18 [0.53, 2.60]
Baker 2016 IND	-0.1044	0.0981	4.3%	0.90 [0.74, 1.09]
Baker 2016 KEN	-0.0198	0.0812	4.5%	0.98 [0.84, 1.15]
Baker 2016 MLI	-0.6966	0.694	0.5%	0.50 [0.13, 1.94]
Baker 2016 MOZ	0.4308	0.3552	1.5%	1.54 [0.77, 3.09]
Baker 2016 PAK	0.1985	0.1345	3.8%	1.22 [0.94, 1.59]
Baltazar 1989 PHI	-0.2927	0.1842	3.1%	0.75 [0.52, 1.07]
Cummings 2012 UGA	-2.7577	1.1864	0.2%	0.06 [0.01, 0.65]
Dikassa 1993 DRC	-1.2837	0.5122	0.8%	0.28 [0.10, 0.76]
Genthe 1996 SAF	0	0.322	1.7%	1.00 [0.53, 1.88]
Ghosh 1994 IND	-0.798	0.3671	1.4%	0.45 [0.22, 0.92]
Ghosh 1997 IND	-0.6881	0.3666	1.4%	0.50 [0.24, 1.03]
Godana 2013 ETH	-0.9109	0.213	2.7%	0.40 [0.26, 0.61]
Heller 2003 BRA	-0.3716	0.1947	2.9%	0.69 [0.47, 1.01]
Maung 1992a MYA	-0.6337	0.5872	0.7%	0.53 [0.17, 1.68]
Mediratta 2010a ETH	0.2452	0.1945	3.0%	1.28 [0.87, 1.87]
Mertens 1992 SRI	-0.35	0.1712	3.3%	0.70 [0.50, 0.99]
Strina 2012 BRA	-0.2927	0.1596	3.4%	0.75 [0.55, 1.02]
Traore 1994a BUR	-0.4055	0.1629	3.4%	0.67 [0.48, 0.92]
Wijewardene 1992 SRI	-0.8242	0.3775	1.4%	0.44 [0.21, 0.92]
Subtotal (95% CI)			**52.7%**	**0.76 [0.66, 0.88]**
Heterogeneity: Tau² = 0.06; Chi² = 57.36, df = 21 (P < 0.0001); I² = 63%				
Test for overall effect: Z = 3.69 (P = 0.0002)				
5.1.2 ≤5 years				
Abalkhail 1995 KSA	-0.3784	0.18	3.1%	0.68 [0.48, 0.97]
Baker 2016 BGD	-0.2311	0.0945	4.3%	0.79 [0.66, 0.96]
Baker 2016 GMB	0.1625	0.4054	1.2%	1.18 [0.53, 2.60]
Baker 2016 IND	-0.1044	0.0981	4.3%	0.90 [0.74, 1.09]
Baker 2016 KEN	-0.0198	0.0812	4.5%	0.98 [0.84, 1.15]
Baker 2016 MLI	-0.6966	0.694	0.5%	0.50 [0.13, 1.94]
Baker 2016 MOZ	0.4308	0.3552	1.5%	1.54 [0.77, 3.09]
Baker 2016 PAK	0.1985	0.1345	3.8%	1.22 [0.94, 1.59]
Baltazar 1989 PHI	-0.2927	0.1842	3.1%	0.75 [0.52, 1.07]
Dikassa 1993 DRC	-1.2837	0.5122	0.8%	0.28 [0.10, 0.76]
Ghosh 1994 IND	-0.798	0.3671	1.4%	0.45 [0.22, 0.92]
Ghosh 1997 IND	-0.6881	0.3666	1.4%	0.50 [0.24, 1.03]
Godana 2013 ETH	-0.9109	0.213	2.7%	0.40 [0.26, 0.61]
Heller 2003 BRA	-0.3716	0.1947	2.9%	0.69 [0.47, 1.01]
Maung 1992a MYA	-0.6337	0.5872	0.7%	0.53 [0.17, 1.68]
Mediratta 2010a ETH	0.2452	0.1945	3.0%	1.28 [0.87, 1.87]
Mertens 1992 SRI	-0.35	0.1712	3.3%	0.70 [0.50, 0.99]
Traore 1994a BUR	-0.4055	0.1629	3.4%	0.67 [0.48, 0.92]
Wijewardene 1992 SRI	-0.8242	0.3775	1.4%	0.44 [0.21, 0.92]
Subtotal (95% CI)			**47.3%**	**0.77 [0.66, 0.89]**
Heterogeneity: Tau² = 0.06; Chi² = 51.84, df = 18 (P < 0.0001); I² = 65%				
Test for overall effect: Z = 3.46 (P = 0.0005)				
Total (95% CI)			**100.0%**	**0.77 [0.69, 0.85]**
Heterogeneity: Tau² = 0.05; Chi² = 109.22, df = 40 (P < 0.00001); I² = 63%				
Test for overall effect: Z = 5.13 (P < 0.00001)				
Test for subgroup differences: Chi² = 0.00, df = 1 (P = 0.99), I² = 0%				



Analysis 5.2. Comparison 5. Case-control studies: disposal of child faeces in latrine vs elsewhere, Outcome 2 Diarrhoea (including severe and cholera): subgrouped by income level

5.2 Diarrhoea (including severe and cholera): subgrouped by country income level

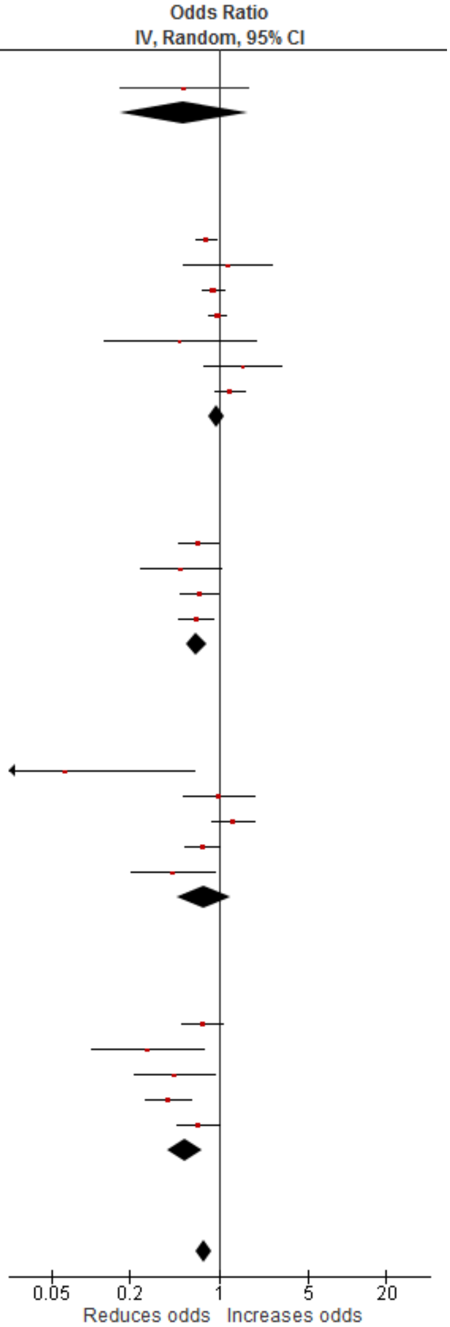
Study or Subgroup	log[Odds Ratio]	SE	Weight	Odds Ratio IV, Random, 95% CI
5.2.1 low				
Baker 2016 GMB	0.1625	0.4054	2.4%	1.18 [0.53, 2.60]
Baker 2016 MLI	-0.6966	0.694	1.0%	0.50 [0.13, 1.94]
Baker 2016 MOZ	0.4308	0.3552	2.9%	1.54 [0.77, 3.09]
Cummings 2012 UGA	-2.7577	1.1864	0.4%	0.06 [0.01, 0.65]
Dikassa 1993 DRC	-1.2837	0.5122	1.7%	0.28 [0.10, 0.76]
Godana 2013 ETH	-0.9109	0.213	5.2%	0.40 [0.26, 0.61]
Mediratta 2010a ETH	0.2452	0.1945	5.6%	1.28 [0.87, 1.87]
Traore 1994a BUR	-0.4055	0.1629	6.4%	0.67 [0.48, 0.92]
Subtotal (95% CI)			**25.5%**	**0.68 [0.43, 1.09]**
Heterogeneity: Tau² = 0.29; Chi² = 30.34, df = 7 (P < 0.0001); I² = 77%				
Test for overall effect: Z = 1.61 (P = 0.11)				
5.2.2 lower middle				
Baker 2016 BGD	-0.2311	0.0945	8.1%	0.79 [0.66, 0.96]
Baker 2016 IND	-0.1044	0.0981	8.0%	0.90 [0.74, 1.09]
Baker 2016 KEN	-0.0198	0.0812	8.4%	0.98 [0.84, 1.15]
Baker 2016 PAK	0.1985	0.1345	7.1%	1.22 [0.94, 1.59]
Baltazar 1989 PHI	-0.2927	0.1842	5.9%	0.75 [0.52, 1.07]
Ghosh 1994 IND	-0.798	0.3671	2.8%	0.45 [0.22, 0.92]
Ghosh 1997 IND	-0.6881	0.3666	2.8%	0.50 [0.24, 1.03]
Maung 1992a MYA	-0.6337	0.5872	1.3%	0.53 [0.17, 1.68]
Mertens 1992 SRI	-0.35	0.1712	6.2%	0.70 [0.50, 0.99]
Wijewardene 1992 SRI	-0.8242	0.3775	2.7%	0.44 [0.21, 0.92]
Subtotal (95% CI)			**53.2%**	**0.82 [0.70, 0.96]**
Heterogeneity: Tau² = 0.03; Chi² = 21.19, df = 9 (P = 0.01); I² = 58%				
Test for overall effect: Z = 2.51 (P = 0.01)				
5.2.3 upper middle				
Genthe 1996 SAF	0	0.322	3.3%	1.00 [0.53, 1.88]
Heller 2003 BRA	-0.3716	0.1947	5.6%	0.69 [0.47, 1.01]
Strina 2012 BRA	-0.2927	0.1596	6.5%	0.75 [0.55, 1.02]
Subtotal (95% CI)			**15.4%**	**0.75 [0.60, 0.94]**
Heterogeneity: Tau² = 0.00; Chi² = 0.98, df = 2 (P = 0.61); I² = 0%				
Test for overall effect: Z = 2.45 (P = 0.01)				
5.2.4 high				
Abalkhail 1995 KSA	-0.3784	0.18	6.0%	0.68 [0.48, 0.97]
Subtotal (95% CI)			**6.0%**	**0.68 [0.48, 0.97]**
Heterogeneity: Not applicable				
Test for overall effect: Z = 2.10 (P = 0.04)				
Total (95% CI)			**100.0%**	**0.76 [0.66, 0.88]**
Heterogeneity: Tau² = 0.06; Chi² = 57.36, df = 21 (P < 0.0001); I² = 63%				
Test for overall effect: Z = 3.69 (P = 0.0002)				
Test for subgroup differences: Chi² = 1.23, df = 3 (P = 0.75), I² = 0%				



Analysis 5.3. Comparison 5. Case-control studies: disposal of child faeces in latrine vs elsewhere, Outcome3 Diarrhoea (including severe and cholera): subgrouped by type of diarrhoea

5.3 Diarrhoea (including severe and cholera): subgrouped by type of diarrhoea

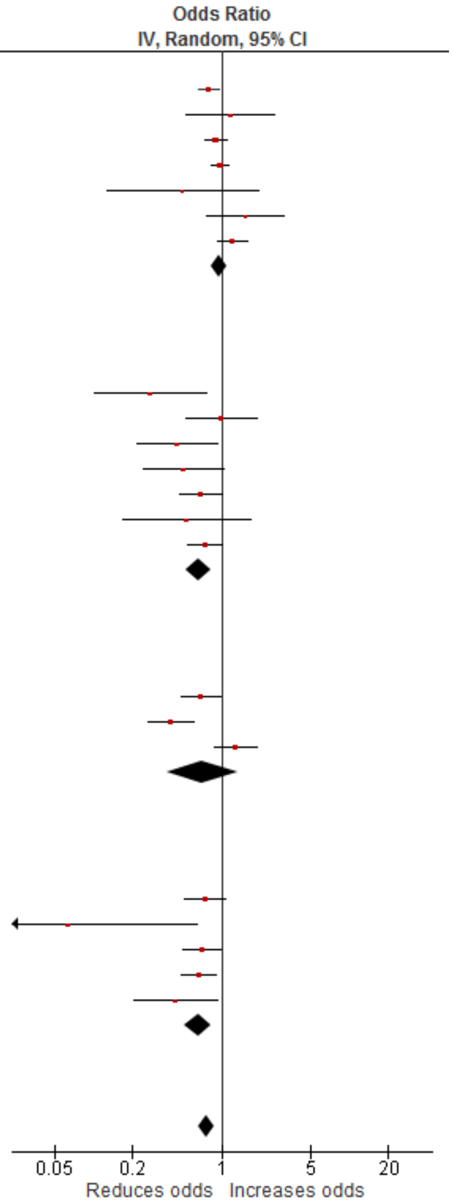
Study or Subgroup	log[Odds Ratio]	SE	Weight	Odds Ratio IV, Random, 95% CI
5.3.1 Persistent diarrhoea				
Maung 1992a MYA	-0.6337	0.5872	1.3%	0.53 [0.17, 1.68]
Subtotal (95% CI)			**1.3%**	**0.53 [0.17, 1.68]**
Heterogeneity: Not applicable				
Test for overall effect: Z = 1.08 (P = 0.28)				
5.3.2 Moderate to severe diarrhoea				
Baker 2016 BGD	-0.2311	0.0945	8.1%	0.79 [0.66, 0.96]
Baker 2016 GMB	0.1625	0.4054	2.4%	1.18 [0.53, 2.60]
Baker 2016 IND	-0.1044	0.0981	8.0%	0.90 [0.74, 1.09]
Baker 2016 KEN	-0.0198	0.0812	8.4%	0.98 [0.84, 1.15]
Baker 2016 MLI	-0.6966	0.694	1.0%	0.50 [0.13, 1.94]
Baker 2016 MOZ	0.4308	0.3552	2.9%	1.54 [0.77, 3.09]
Baker 2016 PAK	0.1985	0.1345	7.1%	1.22 [0.94, 1.59]
Subtotal (95% CI)			**37.9%**	**0.96 [0.83, 1.11]**
Heterogeneity: Tau² = 0.01; Chi² = 10.47, df = 6 (P = 0.11); I² = 43%				
Test for overall effect: Z = 0.51 (P = 0.61)				
5.3.3 Acute (possibly) bloody diarrhoea				
Abalkhail 1995 KSA	-0.3784	0.18	6.0%	0.68 [0.48, 0.97]
Ghosh 1997 IND	-0.6881	0.3666	2.8%	0.50 [0.24, 1.03]
Mertens 1992 SRI	-0.35	0.1712	6.2%	0.70 [0.50, 0.99]
Traore 1994a BUR	-0.4055	0.1629	6.4%	0.67 [0.48, 0.92]
Subtotal (95% CI)			**21.3%**	**0.67 [0.56, 0.81]**
Heterogeneity: Tau² = 0.00; Chi² = 0.72, df = 3 (P = 0.87); I² = 0%				
Test for overall effect: Z = 4.20 (P < 0.0001)				
5.3.4 Acute watery diarrhoea				
Cummings 2012 UGA	-2.7577	1.1864	0.4%	0.06 [0.01, 0.65]
Genthe 1996 SAF	0	0.322	3.3%	1.00 [0.53, 1.88]
Mediratta 2010a ETH	0.2452	0.1945	5.6%	1.28 [0.87, 1.87]
Strina 2012 BRA	-0.2927	0.1596	6.5%	0.75 [0.55, 1.02]
Wijewardene 1992 SRI	-0.8242	0.3775	2.7%	0.44 [0.21, 0.92]
Subtotal (95% CI)			**18.4%**	**0.76 [0.48, 1.22]**
Heterogeneity: Tau² = 0.17; Chi² = 13.16, df = 4 (P = 0.01); I² = 70%				
Test for overall effect: Z = 1.13 (P = 0.26)				
5.3.5 No case definition				
Baltazar 1989 PHI	-0.2927	0.1842	5.9%	0.75 [0.52, 1.07]
Dikassa 1993 DRC	-1.2837	0.5122	1.7%	0.28 [0.10, 0.76]
Ghosh 1994 IND	-0.798	0.3671	2.8%	0.45 [0.22, 0.92]
Godana 2013 ETH	-0.9109	0.213	5.2%	0.40 [0.26, 0.61]
Heller 2003 BRA	-0.3716	0.1947	5.6%	0.69 [0.47, 1.01]
Subtotal (95% CI)			**21.1%**	**0.54 [0.39, 0.75]**
Heterogeneity: Tau² = 0.06; Chi² = 8.17, df = 4 (P = 0.09); I² = 51%				
Test for overall effect: Z = 3.76 (P = 0.0002)				
Total (95% CI)			**100.0%**	**0.76 [0.66, 0.88]**
Heterogeneity: Tau² = 0.06; Chi² = 57.36, df = 21 (P < 0.0001); I² = 63%				
Test for overall effect: Z = 3.69 (P = 0.0002)				
Test for subgroup differences: Chi² = 15.97, df = 4 (P = 0.003), I² = 75.0%				



Analysis 5.4. Comparison 5. Case-control studies: disposal of child faeces in latrine vs elsewhere, Outcome 4 Diarrhoea (including severe and cholera): subgrouped by study quality.

5.4 Diarrhoea (including severe and cholera): subgrouped by study quality

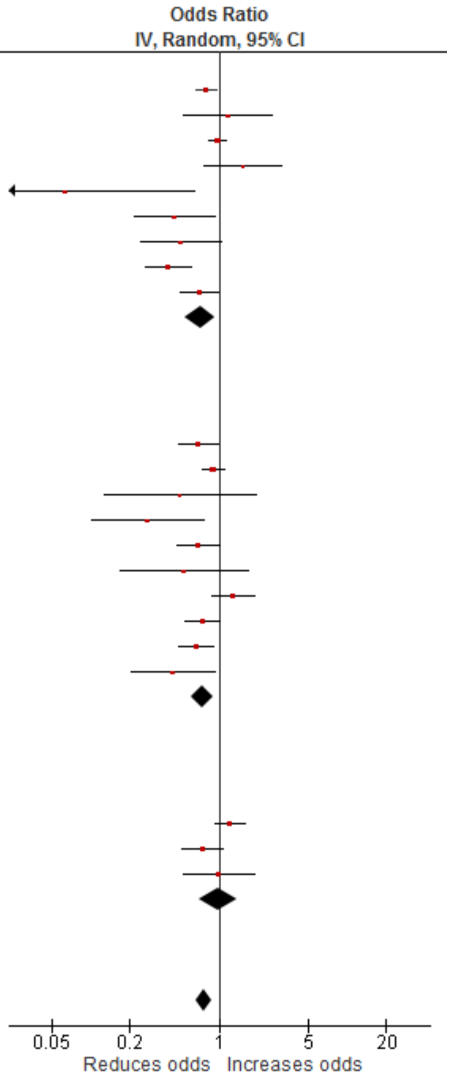
Study or Subgroup	log[Odds Ratio]	SE	Weight	Odds Ratio IV, Random, 95% CI
5.4.1 4 stars				
Baker 2016 BGD	-0.2311	0.0945	8.1%	0.79 [0.66, 0.96]
Baker 2016 GMB	0.1625	0.4054	2.4%	1.18 [0.53, 2.60]
Baker 2016 IND	-0.1044	0.0981	8.0%	0.90 [0.74, 1.09]
Baker 2016 KEN	-0.0198	0.0812	8.4%	0.98 [0.84, 1.15]
Baker 2016 MLI	-0.6966	0.694	1.0%	0.50 [0.13, 1.94]
Baker 2016 MOZ	0.4308	0.3552	2.9%	1.54 [0.77, 3.09]
Baker 2016 PAK	0.1985	0.1345	7.1%	1.22 [0.94, 1.59]
Subtotal (95% CI)			**37.9%**	**0.96 [0.83, 1.11]**
Heterogeneity: Tau² = 0.01; Chi² = 10.47, df = 6 (P = 0.11); I² = 43%				
Test for overall effect: Z = 0.51 (P = 0.61)				
5.4.2 5 stars				
Dikassa 1993 DRC	-1.2837	0.5122	1.7%	0.28 [0.10, 0.76]
Genthe 1996 SAF	0	0.322	3.3%	1.00 [0.53, 1.88]
Ghosh 1994 IND	-0.798	0.3671	2.8%	0.45 [0.22, 0.92]
Ghosh 1997 IND	-0.6881	0.3666	2.8%	0.50 [0.24, 1.03]
Heller 2003 BRA	-0.3716	0.1947	5.6%	0.69 [0.47, 1.01]
Maung 1992a MYA	-0.6337	0.5872	1.3%	0.53 [0.17, 1.68]
Strina 2012 BRA	-0.2927	0.1596	6.5%	0.75 [0.55, 1.02]
Subtotal (95% CI)			**23.9%**	**0.65 [0.52, 0.82]**
Heterogeneity: Tau² = 0.01; Chi² = 6.94, df = 6 (P = 0.33); I² = 14%				
Test for overall effect: Z = 3.64 (P = 0.0003)				
5.4.3 6 stars				
Abalkhail 1995 KSA	-0.3784	0.18	6.0%	0.68 [0.48, 0.97]
Godana 2013 ETH	-0.9109	0.213	5.2%	0.40 [0.26, 0.61]
Mediratta 2010a ETH	0.2452	0.1945	5.6%	1.28 [0.87, 1.87]
Subtotal (95% CI)			**16.8%**	**0.71 [0.38, 1.33]**
Heterogeneity: Tau² = 0.27; Chi² = 16.25, df = 2 (P = 0.0003); I² = 88%				
Test for overall effect: Z = 1.07 (P = 0.29)				
5.4.4 7+ stars				
Baltazar 1989 PHI	-0.2927	0.1842	5.9%	0.75 [0.52, 1.07]
Cummings 2012 UGA	-2.7577	1.1864	0.4%	0.06 [0.01, 0.65]
Mertens 1992 SRI	-0.35	0.1712	6.2%	0.70 [0.50, 0.99]
Traore 1994a BUR	-0.4055	0.1629	6.4%	0.67 [0.48, 0.92]
Wijewardene 1992 SRI	-0.8242	0.3775	2.7%	0.44 [0.21, 0.92]
Subtotal (95% CI)			**21.4%**	**0.66 [0.51, 0.84]**
Heterogeneity: Tau² = 0.02; Chi² = 5.64, df = 4 (P = 0.23); I² = 29%				
Test for overall effect: Z = 3.41 (P = 0.0006)				
Total (95% CI)			**100.0%**	**0.76 [0.66, 0.88]**
Heterogeneity: Tau² = 0.06; Chi² = 57.36, df = 21 (P < 0.0001); I² = 63%				
Test for overall effect: Z = 3.69 (P = 0.0002)				
Test for subgroup differences: Chi² = 11.92, df = 3 (P = 0.008), I² = 74.8%				



Analysis 5.5. Comparison 5. Case-control studies: disposal of child faeces in latrine vs elsewhere, Outcome 5 Diarrhoea (including severe and cholera): subgrouped by setting.

5.5 Diarrhoea (including severe and cholera): subgrouped by setting

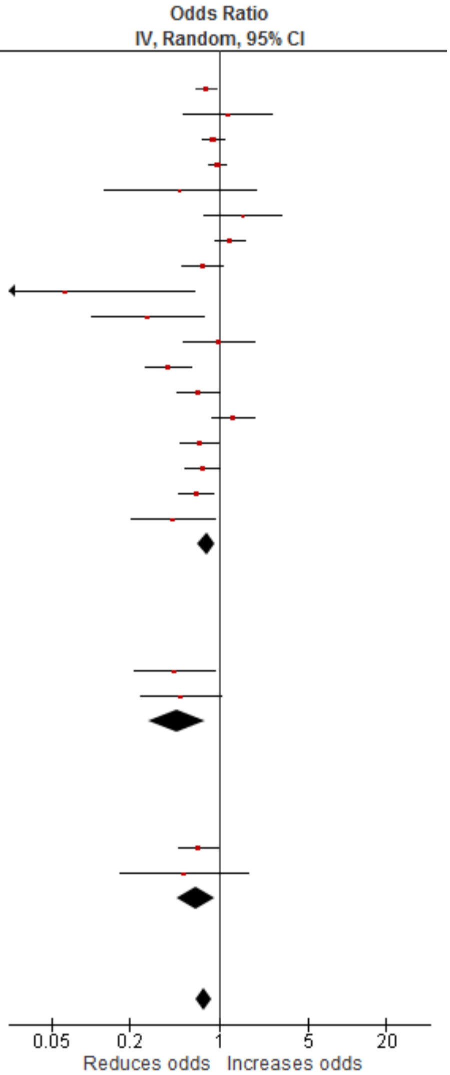
Study or Subgroup	log[Odds Ratio]	SE	Weight	Odds Ratio IV, Random, 95% CI
5.5.1 Rural				
Baker 2016 BGD	-0.2311	0.0945	8.1%	0.79 [0.66, 0.96]
Baker 2016 GMB	0.1625	0.4054	2.4%	1.18 [0.53, 2.60]
Baker 2016 KEN	-0.0198	0.0812	8.4%	0.98 [0.84, 1.15]
Baker 2016 MOZ	0.4308	0.3552	2.9%	1.54 [0.77, 3.09]
Cummings 2012 UGA	-2.7577	1.1864	0.4%	0.06 [0.01, 0.65]
Ghosh 1994 IND	-0.798	0.3671	2.8%	0.45 [0.22, 0.92]
Ghosh 1997 IND	-0.6881	0.3666	2.8%	0.50 [0.24, 1.03]
Godana 2013 ETH	-0.9109	0.213	5.2%	0.40 [0.26, 0.61]
Mertens 1992 SRI	-0.35	0.1712	6.2%	0.70 [0.50, 0.99]
Subtotal (95% CI)			**39.1%**	**0.72 [0.55, 0.94]**
Heterogeneity: Tau² = 0.09; Chi² = 29.97, df = 8 (P = 0.0002); I² = 73%				
Test for overall effect: Z = 2.44 (P = 0.01)				
5.5.2 Urban				
Abalkhail 1995 KSA	-0.3784	0.18	6.0%	0.68 [0.48, 0.97]
Baker 2016 IND	-0.1044	0.0981	8.0%	0.90 [0.74, 1.09]
Baker 2016 MLI	-0.6966	0.694	1.0%	0.50 [0.13, 1.94]
Dikassa 1993 DRC	-1.2837	0.5122	1.7%	0.28 [0.10, 0.76]
Heller 2003 BRA	-0.3716	0.1947	5.6%	0.69 [0.47, 1.01]
Maung 1992a MYA	-0.6337	0.5872	1.3%	0.53 [0.17, 1.68]
Mediratta 2010a ETH	0.2452	0.1945	5.6%	1.28 [0.87, 1.87]
Strina 2012 BRA	-0.2927	0.1596	6.5%	0.75 [0.55, 1.02]
Traore 1994a BUR	-0.4055	0.1629	6.4%	0.67 [0.48, 0.92]
Wijewardene 1992 SRI	-0.8242	0.3775	2.7%	0.44 [0.21, 0.92]
Subtotal (95% CI)			**44.7%**	**0.74 [0.61, 0.90]**
Heterogeneity: Tau² = 0.04; Chi² = 17.75, df = 9 (P = 0.04); I² = 49%				
Test for overall effect: Z = 3.08 (P = 0.002)				
5.5.3 Peri-urban/urban and rural				
Baker 2016 PAK	0.1985	0.1345	7.1%	1.22 [0.94, 1.59]
Baltazar 1989 PHI	-0.2927	0.1842	5.9%	0.75 [0.52, 1.07]
Genthe 1996 SAF	0	0.322	3.3%	1.00 [0.53, 1.88]
Subtotal (95% CI)			**16.3%**	**0.98 [0.70, 1.38]**
Heterogeneity: Tau² = 0.05; Chi² = 4.64, df = 2 (P = 0.10); I² = 57%				
Test for overall effect: Z = 0.10 (P = 0.92)				
Total (95% CI)			**100.0%**	**0.76 [0.66, 0.88]**
Heterogeneity: Tau² = 0.06; Chi² = 57.36, df = 21 (P < 0.0001); I² = 63%				
Test for overall effect: Z = 3.69 (P = 0.0002)				
Test for subgroup differences: Chi² = 2.39, df = 2 (P = 0.30), I² = 16.2%				



Analysis 5.6. Comparison 5. Case-control studies: disposal of child faeces in latrine vs elsewhere, Outcome 6 Diarrhoea (including severe and cholera): subgrouped by method of data collection

5.6 Diarrhoea (including severe and cholera): subgrouped by method of data collection

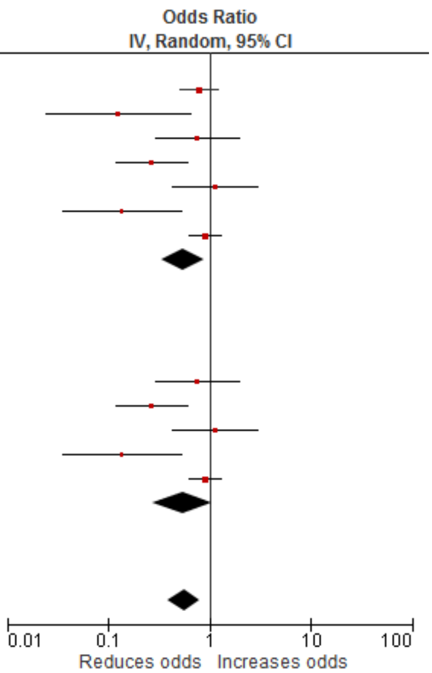
Study or Subgroup	log[Odds Ratio]	SE	Weight	Odds Ratio IV, Random, 95% CI
5.6.1 questionnaire				
Baker 2016 BGD	-0.2311	0.0945	8.1%	0.79 [0.66, 0.96]
Baker 2016 GMB	0.1625	0.4054	2.4%	1.18 [0.53, 2.60]
Baker 2016 IND	-0.1044	0.0981	8.0%	0.90 [0.74, 1.09]
Baker 2016 KEN	-0.0198	0.0812	8.4%	0.98 [0.84, 1.15]
Baker 2016 MLI	-0.6966	0.694	1.0%	0.50 [0.13, 1.94]
Baker 2016 MOZ	0.4308	0.3552	2.9%	1.54 [0.77, 3.09]
Baker 2016 PAK	0.1985	0.1345	7.1%	1.22 [0.94, 1.59]
Baltazar 1989 PHI	-0.2927	0.1842	5.9%	0.75 [0.52, 1.07]
Cummings 2012 UGA	-2.7577	1.1864	0.4%	0.06 [0.01, 0.65]
Dikassa 1993 DRC	-1.2837	0.5122	1.7%	0.28 [0.10, 0.76]
Genthe 1996 SAF	0	0.322	3.3%	1.00 [0.53, 1.88]
Godana 2013 ETH	-0.9109	0.213	5.2%	0.40 [0.26, 0.61]
Heller 2003 BRA	-0.3716	0.1947	5.6%	0.69 [0.47, 1.01]
Mediratta 2010a ETH	0.2452	0.1945	5.6%	1.28 [0.87, 1.87]
Mertens 1992 SRI	-0.35	0.1712	6.2%	0.70 [0.50, 0.99]
Strina 2012 BRA	-0.2927	0.1596	6.5%	0.75 [0.55, 1.02]
Traore 1994a BUR	-0.4055	0.1629	6.4%	0.67 [0.48, 0.92]
Wijewardene 1992 SRI	-0.8242	0.3775	2.7%	0.44 [0.21, 0.92]
Subtotal (95% CI)			**87.2%**	**0.80 [0.69, 0.93]**
Heterogeneity: Tau² = 0.06; Chi² = 50.58, df = 17 (P < 0.0001); I² = 66%				
Test for overall effect: Z = 2.89 (P = 0.004)				
5.6.2 observation				
Ghosh 1994 IND	-0.798	0.3671	2.8%	0.45 [0.22, 0.92]
Ghosh 1997 IND	-0.6881	0.3666	2.8%	0.50 [0.24, 1.03]
Subtotal (95% CI)			**5.5%**	**0.48 [0.29, 0.79]**
Heterogeneity: Tau² = 0.00; Chi² = 0.04, df = 1 (P = 0.83); I² = 0%				
Test for overall effect: Z = 2.86 (P = 0.004)				
5.6.3 unclear				
Abalkhail 1995 KSA	-0.3784	0.18	6.0%	0.68 [0.48, 0.97]
Maung 1992a MYA	-0.6337	0.5872	1.3%	0.53 [0.17, 1.68]
Subtotal (95% CI)			**7.3%**	**0.67 [0.48, 0.94]**
Heterogeneity: Tau² = 0.00; Chi² = 0.17, df = 1 (P = 0.68); I² = 0%				
Test for overall effect: Z = 2.33 (P = 0.02)				
Total (95% CI)			**100.0%**	**0.76 [0.66, 0.88]**
Heterogeneity: Tau² = 0.06; Chi² = 57.36, df = 21 (P < 0.0001); I² = 63%				
Test for overall effect: Z = 3.69 (P = 0.0002)				
Test for subgroup differences: Chi² = 4.15, df = 2 (P = 0.13), I² = 51.8%				



Analysis 6.1. Comparison 6. Case-control studies: defecation of children in latrine vs elsewhere, Outcome 1 Diarrhoea: subgrouped by age group

6.1 Diarrhoea: case-control studies: subgrouped by age group

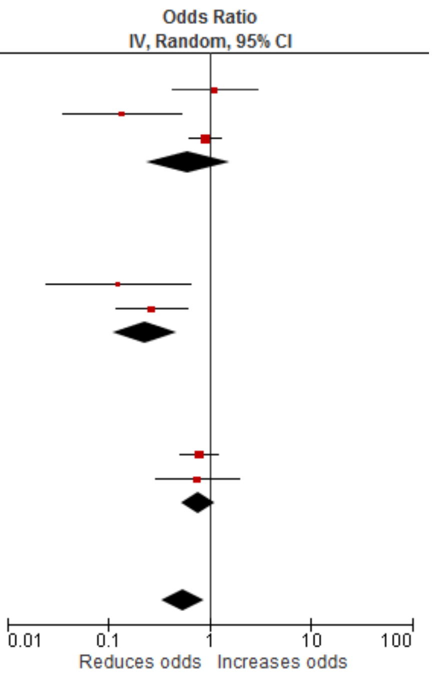
Study or Subgroup	log[Odds Ratio]	SE	Weight	Odds Ratio IV, Random, 95% CI
6.1.1 All ages				
Chompook 2006 THA	-0.2407	0.2136	12.7%	0.79 [0.52, 1.19]
Clemens 1987 BGD	-2.0794	0.8466	3.7%	0.13 [0.02, 0.66]
Knight 1992 MAL	-0.2852	0.4821	7.5%	0.75 [0.29, 1.93]
Maung 1992b MYA	-1.3246	0.4114	8.7%	0.27 [0.12, 0.60]
Mediratta 2010b ETH	0.1225	0.4955	7.3%	1.13 [0.43, 2.99]
Oketcho 2012 TAN	-1.9988	0.6908	4.9%	0.14 [0.03, 0.52]
Traore 1994b BUR	-0.0989	0.1801	13.3%	0.91 [0.64, 1.29]
Subtotal (95% CI)			**58.2%**	**0.54 [0.33, 0.90]**
Heterogeneity: Tau² = 0.26; Chi² = 18.61, df = 6 (P = 0.005); I² = 68%				
Test for overall effect: Z = 2.40 (P = 0.02)				
6.1.2 ≤5 years				
Knight 1992 MAL	-0.2852	0.4821	7.5%	0.75 [0.29, 1.93]
Maung 1992b MYA	-1.3246	0.4114	8.7%	0.27 [0.12, 0.60]
Mediratta 2010b ETH	0.1225	0.4955	7.3%	1.13 [0.43, 2.99]
Oketcho 2012 TAN	-1.9988	0.6908	4.9%	0.14 [0.03, 0.52]
Traore 1994b BUR	-0.0989	0.1801	13.3%	0.91 [0.64, 1.29]
Subtotal (95% CI)			**41.8%**	**0.54 [0.28, 1.07]**
Heterogeneity: Tau² = 0.40; Chi² = 14.17, df = 4 (P = 0.007); I² = 72%				
Test for overall effect: Z = 1.77 (P = 0.08)				
Total (95% CI)			**100.0%**	**0.56 [0.39, 0.80]**
Heterogeneity: Tau² = 0.23; Chi² = 32.78, df = 11 (P = 0.0006); I² = 66%				
Test for overall effect: Z = 3.15 (P = 0.002)				
Test for subgroup differences: Chi² = 0.00, df = 1 (P = 0.99), I² = 0%				



Analysis 6.2. Comparison 6. Case-control studies: defecation of children in latrine vs elsewhere, Outcome 2 Diarrhoea: subgrouped by country income level.

6.2 Diarrhoea: case-control studies: subgrouped by country income level

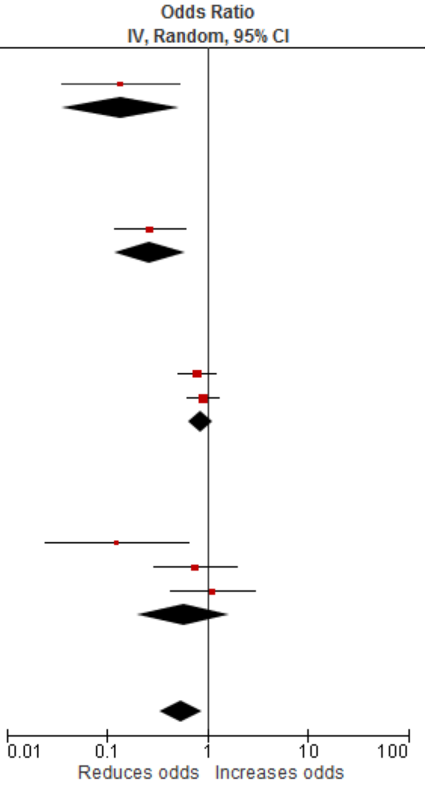
Study or Subgroup	log[Odds Ratio]	SE	Weight	Odds Ratio IV, Random, 95% CI
6.2.1 low				
Mediratta 2010b ETH	0.1225	0.4955	12.8%	1.13 [0.43, 2.99]
Oketcho 2012 TAN	-1.9988	0.6908	8.8%	0.14 [0.03, 0.52]
Traore 1994b BUR	-0.0989	0.1801	22.3%	0.91 [0.64, 1.29]
Subtotal (95% CI)			**43.8%**	**0.61 [0.23, 1.60]**
Heterogeneity: Tau² = 0.51; Chi² = 7.51, df = 2 (P = 0.02); I² = 73%				
Test for overall effect: Z = 1.00 (P = 0.32)				
6.2.2 lower middle				
Clemens 1987 BGD	-2.0794	0.8466	6.6%	0.13 [0.02, 0.66]
Maung 1992b MYA	-1.3246	0.4114	15.1%	0.27 [0.12, 0.60]
Subtotal (95% CI)			**21.7%**	**0.23 [0.11, 0.48]**
Heterogeneity: Tau² = 0.00; Chi² = 0.64, df = 1 (P = 0.42); I² = 0%				
Test for overall effect: Z = 3.97 (P < 0.0001)				
6.2.3 upper middle				
Chompook 2006 THA	-0.2407	0.2136	21.3%	0.79 [0.52, 1.19]
Knight 1992 MAL	-0.2852	0.4821	13.2%	0.75 [0.29, 1.93]
Subtotal (95% CI)			**34.4%**	**0.78 [0.53, 1.14]**
Heterogeneity: Tau² = 0.00; Chi² = 0.01, df = 1 (P = 0.93); I² = 0%				
Test for overall effect: Z = 1.27 (P = 0.20)				
Total (95% CI)			**100.0%**	**0.54 [0.33, 0.90]**
Heterogeneity: Tau² = 0.26; Chi² = 18.61, df = 6 (P = 0.005); I² = 68%				
Test for overall effect: Z = 2.40 (P = 0.02)				
Test for subgroup differences: Chi² = 8.52, df = 2 (P = 0.01), I² = 76.5%				



Analysis 6.3. Comparison 6. Case-control studies: defecation of children in latrine vs elsewhere, Outcome 1 Diarrhoea: subgrouped by type of diarrhoea

6.3 Diarrhoea: case-control studies: subgrouped by type of diarrhoea

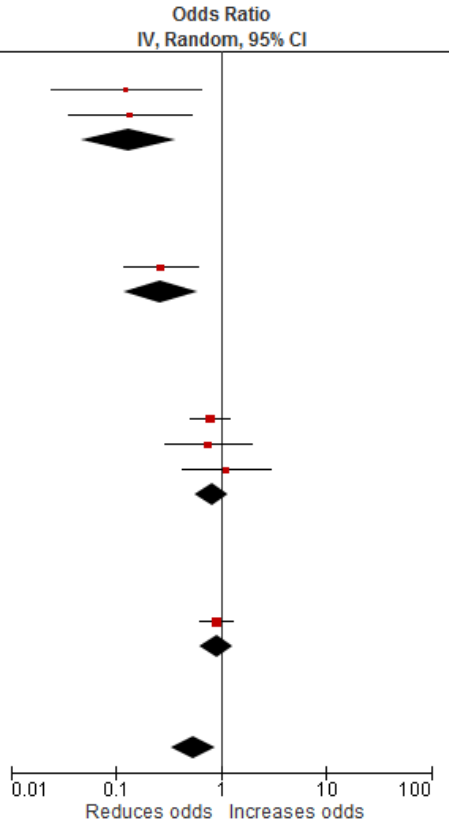
Study or Subgroup	log[Odds Ratio]	SE	Weight	Odds Ratio IV, Random, 95% CI
6.3.1 Other				
Oketcho 2012 TAN	-1.9988	0.6908	8.8%	0.14 [0.03, 0.52]
Subtotal (95% CI)			**8.8%**	**0.14 [0.03, 0.52]**
Heterogeneity: Not applicable				
Test for overall effect: Z = 2.89 (P = 0.004)				
6.3.2 Persistent diarrhoea				
Maung 1992b MYA	-1.3246	0.4114	15.1%	0.27 [0.12, 0.60]
Subtotal (95% CI)			**15.1%**	**0.27 [0.12, 0.60]**
Heterogeneity: Not applicable				
Test for overall effect: Z = 3.22 (P = 0.001)				
6.3.3 Acute (possibly) bloody diarrhoea				
Chompook 2006 THA	-0.2407	0.2136	21.3%	0.79 [0.52, 1.19]
Traore 1994b BUR	-0.0989	0.1801	22.3%	0.91 [0.64, 1.29]
Subtotal (95% CI)			**43.5%**	**0.85 [0.65, 1.12]**
Heterogeneity: Tau² = 0.00; Chi² = 0.26, df = 1 (P = 0.61); I² = 0%				
Test for overall effect: Z = 1.15 (P = 0.25)				
6.3.4 Acute watery diarrhoea				
Clemens 1987 BGD	-2.0794	0.8466	6.6%	0.13 [0.02, 0.66]
Knight 1992 MAL	-0.2852	0.4821	13.2%	0.75 [0.29, 1.93]
Mediratta 2010b ETH	0.1225	0.4955	12.8%	1.13 [0.43, 2.99]
Subtotal (95% CI)			**32.6%**	**0.58 [0.20, 1.65]**
Heterogeneity: Tau² = 0.52; Chi² = 5.10, df = 2 (P = 0.08); I² = 61%				
Test for overall effect: Z = 1.02 (P = 0.31)				
Total (95% CI)			**100.0%**	**0.54 [0.33, 0.90]**
Heterogeneity: Tau² = 0.26; Chi² = 18.61, df = 6 (P = 0.005); I² = 68%				
Test for overall effect: Z = 2.40 (P = 0.02)				
Test for subgroup differences: Chi² = 13.40, df = 3 (P = 0.004), I² = 77.6%				



Analysis 6.4. Comparison 6. Case-control studies: defecation of children in latrine vs elsewhere, Outcome 4 Diarrhoea: subgrouped by study quality

6.4 Diarrhoea: case-control studies: subgrouped by study quality

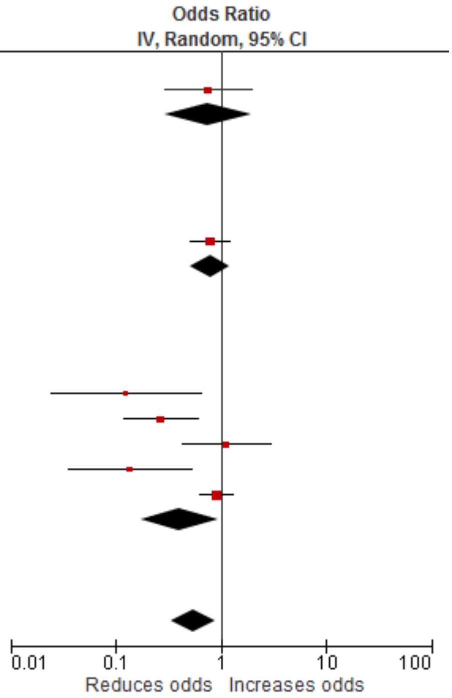
Study or Subgroup	log[Odds Ratio]	SE	Weight	Odds Ratio IV, Random, 95% CI
6.4.1 4 stars				
Clemens 1987 BGD	-2.0794	0.8466	6.6%	0.13 [0.02, 0.66]
Oketcho 2012 TAN	-1.9988	0.6908	8.8%	0.14 [0.03, 0.52]
Subtotal (95% CI)			**15.4%**	**0.13 [0.05, 0.37]**
Heterogeneity: Tau² = 0.00; Chi² = 0.01, df = 1 (P = 0.94); I² = 0%				
Test for overall effect: Z = 3.79 (P = 0.0001)				
6.4.2 5 stars				
Maung 1992b MYA	-1.3246	0.4114	15.1%	0.27 [0.12, 0.60]
Subtotal (95% CI)			**15.1%**	**0.27 [0.12, 0.60]**
Heterogeneity: Not applicable				
Test for overall effect: Z = 3.22 (P = 0.001)				
6.4.3 6 stars				
Chompook 2006 THA	-0.2407	0.2136	21.3%	0.79 [0.52, 1.19]
Knight 1992 MAL	-0.2852	0.4821	13.2%	0.75 [0.29, 1.93]
Mediratta 2010b ETH	0.1225	0.4955	12.8%	1.13 [0.43, 2.99]
Subtotal (95% CI)			**47.3%**	**0.82 [0.57, 1.17]**
Heterogeneity: Tau² = 0.00; Chi² = 0.49, df = 2 (P = 0.78); I² = 0%				
Test for overall effect: Z = 1.09 (P = 0.28)				
6.4.4 7 stars				
Traore 1994b BUR	-0.0989	0.1801	22.3%	0.91 [0.64, 1.29]
Subtotal (95% CI)			**22.3%**	**0.91 [0.64, 1.29]**
Heterogeneity: Not applicable				
Test for overall effect: Z = 0.55 (P = 0.58)				
Total (95% CI)			**100.0%**	**0.54 [0.33, 0.90]**
Heterogeneity: Tau² = 0.26; Chi² = 18.61, df = 6 (P = 0.005); I² = 68%				
Test for overall effect: Z = 2.40 (P = 0.02)				
Test for subgroup differences: Chi² = 18.11, df = 3 (P = 0.0004), I² = 83.4%				



Analysis 6.5. Comparison 6. Case-control studies: defecation of children in latrine vs elsewhere, Outcome 5 Diarrhoea: subgrouped by setting

6.5 Diarrhoea: case-control studies: subgrouped by setting

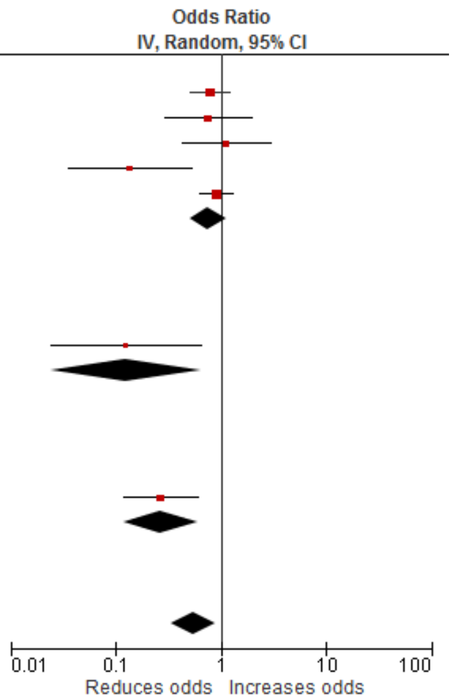
Study or Subgroup	log[Odds Ratio]	SE	Weight	Odds Ratio IV, Random, 95% CI
6.5.1 rural				
Knight 1992 MAL	-0.2852	0.4821	13.2%	0.75 [0.29, 1.93]
Subtotal (95% CI)			**13.2%**	**0.75 [0.29, 1.93]**
Heterogeneity: Not applicable				
Test for overall effect: Z = 0.59 (P = 0.55)				
6.5.2 semi-urban				
Chompook 2006 THA	-0.2407	0.2136	21.3%	0.79 [0.52, 1.19]
Subtotal (95% CI)			**21.3%**	**0.79 [0.52, 1.19]**
Heterogeneity: Not applicable				
Test for overall effect: Z = 1.13 (P = 0.26)				
6.5.3 Urban				
Clemens 1987 BGD	-2.0794	0.8466	6.6%	0.13 [0.02, 0.66]
Maung 1992b MYA	-1.3246	0.4114	15.1%	0.27 [0.12, 0.60]
Mediratta 2010b ETH	0.1225	0.4955	12.8%	1.13 [0.43, 2.99]
Oketcho 2012 TAN	-1.9988	0.6908	8.8%	0.14 [0.03, 0.52]
Traore 1994b BUR	-0.0989	0.1801	22.3%	0.91 [0.64, 1.29]
Subtotal (95% CI)			**65.6%**	**0.40 [0.17, 0.94]**
Heterogeneity: Tau² = 0.66; Chi² = 18.25, df = 4 (P = 0.001); I² = 78%				
Test for overall effect: Z = 2.10 (P = 0.04)				
Total (95% CI)			**100.0%**	**0.54 [0.33, 0.90]**
Heterogeneity: Tau² = 0.26; Chi² = 18.61, df = 6 (P = 0.005); I² = 68%				
Test for overall effect: Z = 2.40 (P = 0.02)				
Test for subgroup differences: Chi² = 1.95, df = 2 (P = 0.38), I² = 0%				



Analysis 6.6. Comparison 6. Case-control studies: defecation of children in latrine vs elsewhere, Outcome 6 Diarrhoea: subgrouped by method of data collection

6.6 Diarrhoea: case-control studies: subgrouped by by method of data collection

Study or Subgroup	log[Odds Ratio]	SE	Weight	Odds Ratio IV, Random, 95% CI
6.6.1 questionnaire				
Chompook 2006 THA	-0.2407	0.2136	21.3%	0.79 [0.52, 1.19]
Knight 1992 MAL	-0.2852	0.4821	13.2%	0.75 [0.29, 1.93]
Mediratta 2010b ETH	0.1225	0.4955	12.8%	1.13 [0.43, 2.99]
Oketcho 2012 TAN	-1.9988	0.6908	8.8%	0.14 [0.03, 0.52]
Traore 1994b BUR	-0.0989	0.1801	22.3%	0.91 [0.64, 1.29]
Subtotal (95% CI)			**78.3%**	**0.75 [0.50, 1.13]**
Heterogeneity: Tau² = 0.09; Chi² = 7.58, df = 4 (P = 0.11); I² = 47%				
Test for overall effect: Z = 1.37 (P = 0.17)				
6.6.2 observation				
Clemens 1987 BGD	-2.0794	0.8466	6.6%	0.13 [0.02, 0.66]
Subtotal (95% CI)			**6.6%**	**0.13 [0.02, 0.66]**
Heterogeneity: Not applicable				
Test for overall effect: Z = 2.46 (P = 0.01)				
6.6.3 unclear				
Maung 1992b MYA	-1.3246	0.4114	15.1%	0.27 [0.12, 0.60]
Subtotal (95% CI)			**15.1%**	**0.27 [0.12, 0.60]**
Heterogeneity: Not applicable				
Test for overall effect: Z = 3.22 (P = 0.001)				
Total (95% CI)			**100.0%**	**0.54 [0.33, 0.90]**
Heterogeneity: Tau² = 0.26; Chi² = 18.61, df = 6 (P = 0.005); I² = 68%				
Test for overall effect: Z = 2.40 (P = 0.02)				
Test for subgroup differences: Chi² = 8.47, df = 2 (P = 0.01), I² = 76.4%				

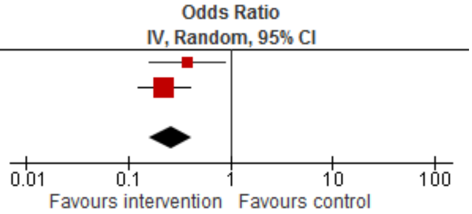


Analysis 7.1. Comparison 7. controlled cross-sectional: HEP model households vs non-model, Outcome 1 Diarrhoea

7.1 diarrhoea

Study or Subgroup	log[Odds Ratio]	SE	Weight	Odds Ratio IV, Random, 95% CI
Berhe 2014 ETH	-0.9727	0.4408	31.0%	0.38 [0.16, 0.90]
Gebru 2014 ETH	-1.5041	0.2954	69.0%	0.22 [0.12, 0.40]
Total (95% CI)			**100.0%**	**0.26 [0.16, 0.42]**

Heterogeneity: Tau² = 0.00; Chi² = 1.00, df = 1 (P = 0.32); I² = 0%
Test for overall effect: Z = 5.45 (P < 0.00001)

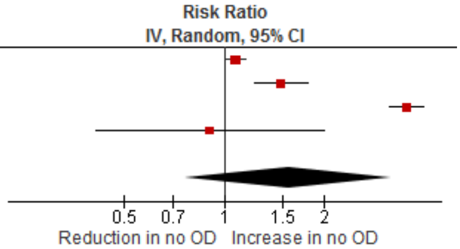


Analysis 8.1. Comparison 8. Trials: behaviour change after intervention, Outcome 1 No open defecation by children <5

8.1 No open defecation by children <5

Study or Subgroup	log[Risk Ratio]	SE	Weight	Risk Ratio IV, Random, 95% CI
Cameron 2013 INA	0.0791	0.0365	26.8%	1.08 [1.01, 1.16]
Patil 2014 IND	0.3982	0.0941	26.4%	1.49 [1.24, 1.79]
Pickering 2015 MLI	1.2721	0.0589	26.7%	3.57 [3.18, 4.00]
Stanton 1987 BGD	-0.1001	0.4053	20.2%	0.90 [0.41, 2.00]
Total (95% CI)			**100.0%**	**1.56 [0.76, 3.20]**

Heterogeneity: Tau² = 0.50; Chi² = 298.00, df = 3 (P < 0.00001); I² = 99%
Test for overall effect: Z = 1.21 (P = 0.23)

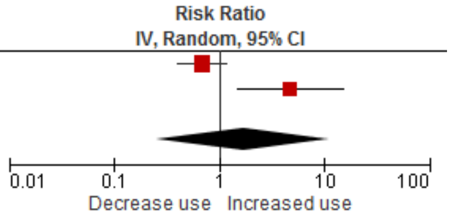


Analysis 8.2. Comparison 8. Trials: behaviour change after intervention, Outcome 2 Latrine use by children

8.2 Latrine use by children

Study or Subgroup	log[Risk Ratio]	SE	Weight	Risk Ratio IV, Random, 95% CI
Yeager 2002 PER	-0.3682	0.2732	53.7%	0.69 [0.41, 1.18]
Jinadu 2007 NGR (1)	1.5539	0.5869	46.3%	4.73 [1.50, 14.94]
Total (95% CI)			**100.0%**	**1.69 [0.26, 11.04]**

Heterogeneity: Tau² = 1.64; Chi² = 8.82, df = 1 (P = 0.003); I² = 89%
Test for overall effect: Z = 0.55 (P = 0.59)



Footnotes
(1) data for 25-60 months children

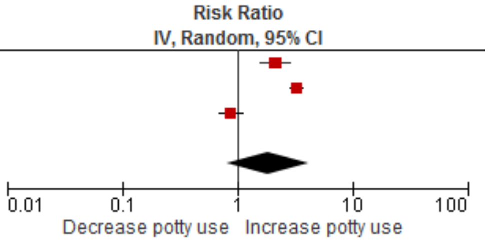
Analysis 8.3. Comparison 8. Trials: behaviour change after intervention, Outcome 3 Potty use by children

8.3 Potty use by children

Study or Subgroup	log[Risk Ratio]	SE	Weight	Risk Ratio IV, Random, 95% CI
Jinadu 2007 NGR (1)	0.7684	0.1535	32.8%	2.16 [1.60, 2.91]
Pickering 2015 MLI	1.1879	0.0627	34.0%	3.28 [2.90, 3.71]
Yeager 2002 PER	-0.1253	0.1273	33.2%	0.88 [0.69, 1.13]
Total (95% CI)			**100.0%**	**1.85 [0.81, 4.23]**

Heterogeneity: Tau² = 0.52; Chi² = 86.64, df = 2 (P < 0.00001); I² = 98%

Test for overall effect: Z = 1.45 (P = 0.15)



Footnotes

(1) used observations of HHs that used chamber pots for sanitary disposal of children faeces

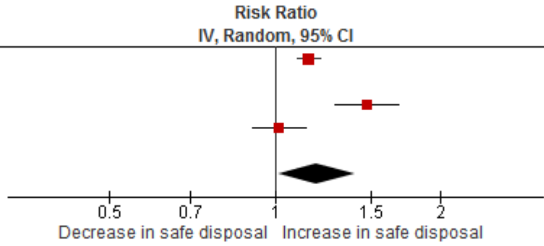
Analysis 8.4. Comparison 8. Trials: behaviour change after intervention, Outcome 4 Safe disposal of child faeces

8.4 Safe disposal of child faeces

Study or Subgroup	log[Risk Ratio]	SE	Weight	Risk Ratio IV, Random, 95% CI
Briceño 2015 TAN	0.1431	0.0259	37.0%	1.15 [1.10, 1.21]
Cameron 2013 INA	0	0		Not estimable
Patil 2014 IND	0.385	0.0685	30.5%	1.47 [1.28, 1.68]
Yeager 2002 PER	0.0175	0.0565	32.6%	1.02 [0.91, 1.14]
Total (95% CI)			**100.0%**	**1.19 [1.01, 1.40]**

Heterogeneity: Tau² = 0.02; Chi² = 17.34, df = 2 (P = 0.0002); I² = 88%

Test for overall effect: Z = 2.11 (P = 0.04)



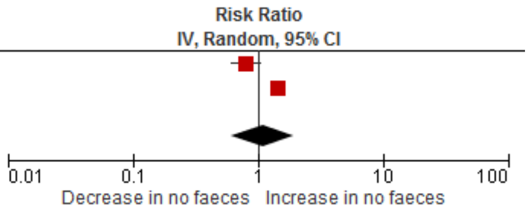
Analysis 8.5. Comparison 8. Trials: behaviour change after intervention, Outcome 5 Faeces not observed in yard/ HH

8.5 faeces not observed in yard/ HH

Study or Subgroup	log[Risk Ratio]	SE	Weight	Risk Ratio IV, Random, 95% CI
Barrios 2008 PHI	-0.2194	0.1338	48.0%	0.80 [0.62, 1.04]
Jinadu 2007 NGR	0.368	0.0662	52.0%	1.44 [1.27, 1.65]
Total (95% CI)			**100.0%**	**1.09 [0.61, 1.94]**

Heterogeneity: Tau² = 0.16; Chi² = 15.48, df = 1 (P < 0.0001); I² = 94%

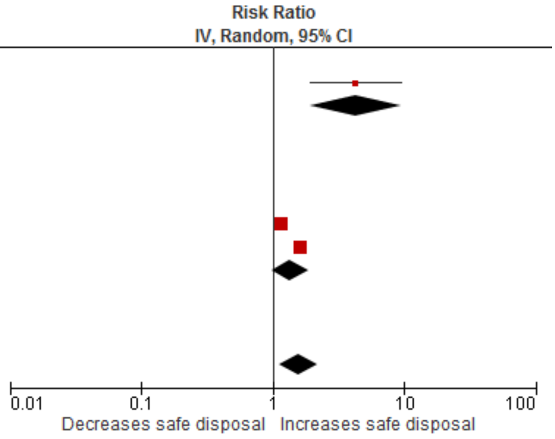
Test for overall effect: Z = 0.29 (P = 0.77)



Analysis 9.1. Comparison 9. Controlled cross-sectional studies: behaviour change, Outcome 1 safe vs unsafe child faeces disposal

9.1 safe vs unsafe child faeces disposal

Study or Subgroup	log[Risk Ratio]	SE	Weight	Risk Ratio IV, Random, 95% CI
9.1.1 BRAC				
Fisher 2011 BGD	1.4475	0.4078	12.7%	4.25 [1.91, 9.46]
Subtotal (95% CI)			**12.7%**	**4.25 [1.91, 9.46]**
Heterogeneity: Not applicable				
Test for overall effect: Z = 3.55 (P = 0.0004)				
9.1.2 HEP				
Berhe 2014 ETH	0.1369	0.044	43.6%	1.15 [1.05, 1.25]
Gebru 2014 ETH	0.4738	0.0405	43.7%	1.61 [1.48, 1.74]
Subtotal (95% CI)			**87.3%**	**1.36 [0.98, 1.89]**
Heterogeneity: Tau² = 0.05; Chi² = 31.74, df = 1 (P < 0.00001); I² = 97%				
Test for overall effect: Z = 1.82 (P = 0.07)				
Total (95% CI)			**100.0%**	**1.57 [1.12, 2.20]**
Heterogeneity: Tau² = 0.07; Chi² = 39.35, df = 2 (P < 0.00001); I² = 95%				
Test for overall effect: Z = 2.63 (P = 0.009)				
Test for subgroup differences: Chi² = 6.70, df = 1 (P = 0.010), I² = 85.1%				



ADDITIONAL TABLES

Table 1. Summary of risk of bias of prospective studies

Study ID	Study design [a]	Random sequence generation (selection bias)[b]	Allocation concealment (selection bias)	Blinding of participants and personnel (performance bias)	Blinding of outcome assessment (detection bias)	Incomplete outcome data (attrition bias)	selective reporting (reporting bias)	Other bias	Similarity of baseline outcome measurements	Similarity of baseline characteristics	Adequate allocation of intervention concealment	Adequate protection against contamination	Confounders adequately adjusted for in analysis/ design	Recruitment bias	Baseline imbalance	Loss of clusters	Incorrect analysis
Ahmed 1993	CBA	H	H	_	_	U	L	_	H	H	H	L	H	_	_	_	_
Alam 1989	CBA	H	H	_	_	L	L	_	U	U	H	H	H	_	_	_	_
Aziz 1990	CBA	H	H	_	_	U	L	_	L	U	H	L	H	_	_	_	_
Barios 2008	CRCT	L	U	H	H	H	H	_	_	_	_	_	_	H	H	L	H
Briceño 2015	CRCT	U	U	H	H	L	L	_	_	_	_	_	_	H	H	L	L
Butz 1990	CRCT	U	U	H	H	U	L	_	_	_	_	_	_	H	L	L	H
Cameron 2013	CRCT	L	L	H	H	L	L	_	_	_	_	_	_	H	L	L	L
Haggerty 1994	CRCT	U	U	H	H	L	H	_	_	_	_	_	_	L	L	L	L

Jinadu 2007	CRCT	U	U	H	H	U	L	_	_	_	_	_	_	H	U	L	H
Kotch 2007	CRCT	U	U	H	U	L	L	_	_	_	_	_	_	H	H	L	L
Patil 2014	CRCT	L	L	H	H	L	L	_	_	_	_	_	_	H	L	L	L
Pickering 2015	CRCT	L	L	H	H	L	L	_	_	_	_	_	_	L	L	L	L
Stanton 1987	CRCT	L	U	H	H	U	L	_	_	_	_	_	_	L	L	U	H
Yeager 2002	CRCT	U	U	H	H	U	L	_	_	_	_	_	_	H	L	U	H
Huda 2012	CO	H	H	_	_	U	L	_	U	L	H	L	H	_	_	_	_
Luby 2014	CO	H	H	_	_	U	L	_	U	L	H	L	H	_	_	_	_
Berhe 2014	XS	H	H	_	_	L	L	_	U	U	L	H	L	_	_	_	_
Fisher 2011	XS	H	H	_	_	L	L	H	U	U	H	U	H	_	_	_	_
Gebru 2014	XS	H	H	_	_	L	L	_	U	U	U	H	L	_	_	_	_
Matthew 2004	XS	H	H	_	_	U	U	_	U	U	H	U	H	_	_	_	_
Watekeyn 2006	XS	H	H	_	_	L	L	_	U	U	H	L	H	_	_	_	_

Footnotes

[a]CBA: controlled before and after, CRCT: cluster RCT, CO: cohort, XS: cross-sectional study.

[b]H: high risk of bias, L: low risk of bias, U: unclear risk of bias.

Table 2. Risk of bias of case-control studies

Study ID	Selection				Comparability of cases and controls on the basis of the design or analysis[a]	Exposure			Total number of stars	
	case definition adequate	Representativeness of cases	Selection of Controls	Definition of controls		Ascertainment of exposure	Same method of ascertainment for cases and controls?	Non-Response rate		
Abalkhail 1995 KSA	*yes physician at health centre	* cases were incident cases during the study period	*controls selected from residential neighbours of cases	* controls had no history of hospitalisation for diarrhoeal diseases	* analysis adjusted for maternal education, child and maternal age and family size.	no mention of blinding of interviewers to case/control status	* yes structured questionnaire and observations	cases= 7 no response for child faeces disposal, controls=17 no response for child faeces disposal	6	
Arvelo 2009 USA	* yes lab confirmed then calculated attack rate	11% of LIDCs did not participate in investigation- no reason described	LDCs controls selected from LDCs	lower attack rate <2%	no control in analysis or design	no detail of blinding	* yes interviews and inspections	* for exposure of interest, no non response	3	
Baker 2016 BGD; Baker 2016 GMB; Baker 2016 IND; Baker 2016 KEN; Baker 2016 MLI; Baker	* yes, GEMS clinician	"each site restricted enrolment to about the first nine eligible cases per age stratum per fortnight to maintain a	* community controls	* " No diarrhoea in the previous 7 days"	* matched for age and adjusted for wealth	"Case enrolment interviews took place at the SHC whereas control caretakers were interviewed at	no, initial interview was in health centre for cases and in home for controls, although at 60	unclear what the non-response rate for child faeces disposal was	4	

2016 MOZ; Baker 2016 PAK		manageable work flow throughout the study"				home." so assume knew status	days, also did a HH visit to both			
Baltazar 1989 PHI	*cases were brought to the clinic	*"All cases seen at the clinics on a "morbidity day" during the recruitment period that satisfied this definition were included in the study"	"children aged <2 years who were brought to the clinic because of an acute respiratory infection"	*had not had diarrhoea during the previous 24 hours.	* adjusted for toilet facilities) and * water supply, sex, education of head of HH and mother, feeding practices, level of health service utilisation, number of children under 5 in HH	didn't specify if they were blinded to status of case/control	*yes, structured questionnaire	* no missing values for child faeces disposal	7	
Chiang 2005 TWN	*cases were confirmed by lab test	no details on how the cases were selected	hospital/ clinic control	*children who went to the clinics for vaccination and showing no symptoms of diarrhoea or fever	*matched for age	didn't specify if they were blinded to status of case/control	*yes, semi-structured questionnaire	no details on missing values for child defecation variable	4	
Chompook 2006 THA	* yes lab diagnosis	"All shigellosis cases ascertained from the population-based surveillance study	* community control " For each case enrolled, two matched	*" individuals free from diarrhoea or dysentery during the	*study controls for age in design.	" un-blinded status of the investigator visiting the households and	* yes, questionnaire and observations	* no missing values for child defecation variable	6	In the thesis report that child faeces disposal

		were eligible to be included in a matched case-control study. However, during the peak of the shigellosis season in June 2001, only 14 of the 50 shigellosis cases were recruited into the study"	controls were randomly selected from the population list of the health centre where the case resided"	four weeks prior to recruitment were eligible to participate in the study as controls"		conducting interviews to the case/control status of the participant"				was insignificant but no data is presented
Clemens 1987 BGD	self reports	potential for selection bias- not all cases and based on reported diarrhoea incidence	* community controls	*no history of diarrhoea in the 3 months	Study didn't control in design or analysis for any of the confounders	* structured observations blinded to history of diarrhoea	* yes questionnaire and observations	defecation of ambulatory children was only observed in 15 case and 15 control families	4	
Cummings 2012 UGA	* medical records	not stated if consecutive/ representative	*community however not described how they selected them	* had not experienced diarrhoea from April till time of investigation	*sanitation included in analysis and * controls for age, gender, water treatment practices	didn't specify if health workers were blind to case/control status	* yes, questionnaire	* no non response rate reported	7	
Daniels 1990 LES	*hospital nurse	* consecutive cases recruited	hospital controls with ARI/trauma	* no diarrhoea at recruitment	*sanitation is main exposure,	interview not blinded as nurse did	* yes, questionnaire and for sub	no information on non	6	

					*age, education of mother	interview at hospital	sample second interview at home with observations of facilities	response		
Dikassa 1993 DRC	* hospital	incident case identified at hospital - no details on whether it was consecutive	*community however not described how they selected them	*no history of hospitalisation for diarrhoea	no statistical difference in sanitation but it wasn't matched for in design. * matches for education in analysis and age of child in design.	not specified that interviewers were blinded to case/control status	*yes, structured interview and observations	numbers not described- no information about non respondents	5	
Genthe 1996 SAF	* yes hospital staff	no detail on how "a sample was drawn from pre-school children who were brought to the day hospitals with diarrhoea."	* community controls	* "Children who suffered from diarrhoea during the preceding 14 days at the time of the visit were excluded as controls."	* study controlled for age in design	" it was not possible to blind the interviewer to the disease status of the child under study"	*yes, interviews and spot check observations	non respondents not described	5	
Ghosh 1994 IND	self reports to surveillance worker	not stated how chose the case families out of the 980 study families	*neighbouring families	*no history of diarrhoea in the study period	*adjusted for age in matching when	not specified that interviewers were blinded to	* yes, observations	*no missing data for indiscriminate disposal	5	

					selected controls	case/control				
Ghosh 1997 IND	self reports to surveillance worker	not stated how chose the 90 case families out of the 1027 study families	*neighbouring families	*no history of diarrhoea in the study period	*adjusted for age in matching when selected controls	not specified that interviewers were blinded to case/control	* yes, observations	*no missing data for indiscriminate disposal	5	
Godana 2013 ETH	self report	*appropriate sample selected at random	*community controls	* no diarrhoea in previous 2 weeks	* controls for latrine ownership , * controls for source of water and whether treat water	no mention of blinding	* yes, questionnaire	different rates of non-response for infant faeces disposal (33.7% missing in cases vs 20.4% missing in controls)	6	
Heller 2003 BRA	*physician at health centre	all cases diagnosed during study period were included (although 29% couldn't be found)	*community controls	no mention of history of outcome	*adjust in analysis for: child's age, ownership of fridge, water reservoir	*double masked interviews were planned but in some situations the participant status was obvious for the respondent	*yes, home interviews	Not known how many missing answers for child faeces disposal	5	

Knight 1992 MAL	* doctor/ health assistant	* register each child with diarrhoea or other illness	hospital controls with ARI mainly	* no diarrhoea	* controlled for SES, educational level of main caregiver, recruitment health centre, interviewer, birth order and number of people living in house.	* interviewing team were unaware of the case/control status of the child	* yes, questionnaire, direct observations and water quality testing	no information on non respondents for child faeces disposal	6	
Maung 1992a MYA	*yes, seen at hospital/ health centre	cases were selected from among admitted children but doesn't say how they were selected	* community control	*no diarrhoea in past 2 months and no PEM	*matched for age and sex in selection	interview not blinded to case/ control status	*yes, house interviews and observations	non responders are different for child defecation variable (13 missing in cases and 7 missing for controls)	5	
Mediratta 2010a ETH	* assessed at outpatient department in hospital	* "Cases with acute diarrhoea were consecutively en-rolled from the OPD and inpatient paediatric ward."	controls selected from outpatient and inpatient ward	* "did not present with acute diarrhoea for at least 14 days before the date of interview"	* study controls for age in the design of the study	structure interview not blind " the clinical presentation of illness, food and fluid intake, and treatment given by	* yes, structured questionnaire	* no missing respondents for child faeces disposal variable	6	

						physicians were recorded for all the cases."				
Menon 1990 USA	* nurses and ELISA confirmation of rectal swabs	* 'The nursing staff at the outpatient department and emergency room were instructed to obtain a rectal swab from every child less than two years of age who presented with diarrhoea.'	*hospital and community controls but only a few community controls (n=24) so using hospital controls in primary analyses.	* controls who had diarrhoea during the 2 week period were excluded.	* study matched for age and sex	interview but no mention of blinding	* yes, interviews and observations	* no non responses for diapers.	7	
Mertens 1992 SRI	* medical professional s	* all children <5 presenting to hospitals	*hospital and community controls but- use hospital controls for main analysis	* controls suffered from a control disease: acute conditions including respiratory tract infections, malaria, fever of unknown origin and otitis	* controls for age, hand washing, water source & distance	* structured interview blinded to status	* yes, questionnaire s and observations	rate of non-response for child excreta disposal behaviour is different and not described (94 responses (6.6%) missing for cases and 40 (1.8%) for controls	7	

Nanan 2003 PAK	* diagnosed at health centre	* all eligible cases recruited within time of recruitment.	health centre controls	* no diarrhoea	* study controls for age	* structured interview blind to exposure "Interviewers at the health centre were blinded to the exposure status of cases and controls, and staff from WASEP were blinded as to whether a village included in the study was associated with a case or a control. "	* yes structured interview	* no missing data for WASEP variable	7	
Oketcho 2012 TAN	* admission to paediatric infectious disease ward and caretaker reported increase in stool fluidity	* Consecutive "all children meeting the case criteria and those meeting control criteria admitted at the same time of the same age group and residing in Morogoro region were included in the study"	hospital controls	* no history of diarrhoea in the previous 2 weeks	no control in design or analysis	structure interview, no mention of blinding and improbable as interview took place at hospital	* yes, structured interview	no description of non-responders for child defecation	4	

Strina 2012 BRA	* stool lab examination	* seems that all confirmed rotavirus diarrhoea were cases	hospital controls	* no history of diarrhoea in the preceding 3 weeks	* study adjusts for age and gender in design.	structured interview but infer not blind " information about the house and the peridomestic environment was collected by direct observation, together with information, for cases, about the episode itself"	* yes (interview with caregiver at hospital and home visit for another interview + observations)	different rates of no children <2 in the household (33% missing in controls vs 21% missing in cases)	5	
Traore 1994a BUR	*yes caregiver and doctor	all cases presenting to hospital with diarrhoea/ dysentery/ both but 28% couldn't be found for interview	* community and hospital controls. Main analysis using community control	* not admitted to hospital /and for those at hospital no diarrhoea/ Dysentry	* controls for age, water source, SES (radio ownership), household size	* interviewers were not blind to whether child had been to hospital but were blind to whether had diarrhoea/not	* yes, questionnaire and spot checks	* in cases only 2 answers missing for disposal (0.3%) and 3 missing for defecation (0.4%) and 0 missing for community controls	7	

Wijewardene 1992 SRI	* yes (says in the limitations that all children were clinically examined and cross-checked for recent visits to doctor, and child welfare cards available were examined)	* "the first hundred consecutive families with children <5 with an acute episode of diarrhoea"	*community cases and controls	*no diarrhoea episode in last 6 months	* controls for use of shared/public latrines vs private and * controlled for age in matching and other relevant confounders in regression	no mention of blinding	* yes, questionnaire and observations of the facilities	* from table 1, appears there are no missing values for child faeces disposal	8	

Footnotes

[a] risk factors listed in the column are those relevant to the review (pre-specified in the protocol). For a full list of confounders adjusted for in the analysis, see table 3 and 4.

Table 3. Case-control studies: disposal elsewhere vs latrine

Study ID	age group	outcome	specific comparison	Adjusted/crude	Measure of effect	value	lower CI	Upper CI	What is it adjusted for
Abalkhail 1995 KSA	<3	diarrhoea	disposal of child faeces elsewhere vs in latrine	adjusted	OR	1.46	1.03	2.08	paternal education, child and maternal age and family size
Baker 2016 BGD	<5	MSD	disposes of child faeces in the open vs disposal in any type of latrine with a pit or sewer. Hanging latrines and bucket latrines were considered open disposal	adjusted	OR	1.26	1.05	1.52	adjusted for wealth quintiles and the presence of both parents in the home
Baker 2016 GMB	<5	MSD	disposal of child faeces in the open vs in any type of latrine with pit/sewer	adjusted	OR	0.85	0.38	1.88	adjusted for wealth quintiles and the presence of both parents in the home
Baker 2016 IND	<5	MSD	disposal of child faeces in the open vs in any type of latrine with pit/sewer	adjusted	OR	1.11	0.92	1.35	adjusted for wealth quintiles and the presence of both parents in the home
Baker 2016 KEN	<5	MSD	disposal of child faeces in the open vs in any type of latrine with pit/sewer	adjusted	OR	1.02	0.87	1.2	adjusted for wealth quintiles and the presence of both parents in the home
Baker 2016 MLI	<5	MSD	disposal of child faeces in the open vs in any type of latrine with pit/sewer	adjusted	OR	2.01	0.51	7.82	adjusted for wealth quintiles and the presence of both parents in the home
Baker 2016 MOZ	<5	MSD	disposal of child faeces in the open vs in any type of latrine with pit/sewer	adjusted	OR	0.65	0.32	1.3	adjusted for wealth quintiles and the presence of both parents in the home
Baker 2016 PAK	<5	MSD	disposal of child faeces in the open vs in any type of latrine with pit/sewer	adjusted	OR	0.82	0.63	1.07	adjusted for wealth quintiles and the presence of both parents in the home

Baltazar 1989 PHI	<2	diarrhoea	unsanitary vs sanitary disposal of child faeces (sanitary=child defecated in a nappy and faeces were thrown away in washing, child used chamber pot/piece of paper and fecal matter was thrown in the toilet or child used the toilet)	adjusted	OR	1.34	0.93	1.92	water supply, toilet facilities , sex, education of head of HH and mother, feeding practices, level of health service utilisation, number of children under 5 in HH
Cummings 2012 UGA[a]	>10	cholera	not disposing of child faeces in latrine vs using latrine to dispose of faeces in cases vs control	adjusted	OR	15.76	1.54	161.25	reside in HH with another case, doesn't use chlorine tablet to disinfect water, eats roadside food, gender female, age group (10-17yo), no latrine in HH, doesn't wash hands after defecation, doesn't store water in sealed container, eats mostly cold meals and drinks local alcoholic beverage.
Dikassa 1993 DRC	<3	diarrhoea	not disposing of child faeces in latrine vs using latrine to dispose of faeces	adjusted	OR	3.61	1.32	9.85	garbage disposal, caretaker hygiene, maternal education
Genthe 1996 SAF	pre-school children	diarrhoea	open disposal of stools vs disposal into any form of sanitation.	unadjusted	OR	1	0.53	1.88	
Ghosh 1994 IND	<3	diarrhoea case families	indiscriminate disposal of child stools	unadjusted	OR	2.22	1.08	4.56	
Ghosh 1997 IND	<4	diarrhoea case families	indiscriminate disposal of child stools	adjusted	OR	1.99	0.97	4.08	bottle feeding, cleaning feeding container without soap, using pond water for cleaning feeding container, storing drinking water in wide mouthed vessel (bucket)

Godana 2013 ETH[b]	<5	acute diarrhoea	child faeces disposal elsewhere vs in latrine	crude (calc)	OR	2.49	1.64	3.77	
Heller 2003 BRA	<5	diarrhoea	faeces disposal from swaddle elsewhere vs in toilet/ latrine	adjusted	OR	1.45	0.99	2.12	fruit & green hygiene, mother's religion, superficial presence of wastewater in street, refuse storage, domestic reservoir (2 categories), child's age, refuse disposal, number of children, near stream existence, own a fridge, cockroach presence, flooding in lot, mosquito presence, refuse collection frequency, domestic water reservoir (3 categories), faeces disposal from swaddle (no swaddle use vs latrine/toilet) + interaction terms for wastewater in street* refuse storage, domestic reservoir (no storage vs covered+ clean)*cockroach, domestic reservoir (vessel storage vs covered+ clean)*cockroach, domestic water storage (3 different categories)* cockroach, cockroach*mosquito
Maung 1992 MYA-A	1-59 m	persistent diarrhoea + PEM	faeces were disposed of around house vs latrine	unadjusted	OR	1.88	0.6	5.96	
Mediratta 2010 ETH-1	<5	acute diarrhoea	disposal of stool elsewhere (garbage, buried, left on ground) vs in latrine	unadjusted	OR	0.78	0.53	1.15	
Mertens 1992 SRI	<5	diarrhoea	unsanitary vs sanitary disposal. Unsanitary stool disposal= stools	adjusted	OR	1.42	1.01	1.98	child's age, recruitment clinic, the distance from the home to the clinic,

			passed, or disposed of, in or out of the yard without being later (within a day) disposed of in a latrine or in a covered rubbish pit. Proper= Stools passed in a potty and later disposed of in a latrine or in a covered pit						handwashing before a meal, water quantity, occupation of the head of the household, main type of water source used, and distance to the water source
Strina 2012 BRA	<10	rotavirus diarrhoea	inadequate vs adequate disposal of excreta of children ≤2 y (no def)	adjusted	OR	1.34	0.98	1.83	age and gender
Traore 1994 BUR-A	<3	diarrhoea / dysentery	disposal elsewhere vs in latrines	adjusted	OR	1.5	1.09	2.06	age, mother's religion, father's occupation, source of drinking water, possession of a radio-cassette, whether the child was reported to eat soil, whether the mother practised "lavements" (anal purging) on the child, number of people in the household.
Wijewardene 1992 SRI	<5	acute diarrhoea	children's faeces not disposed in latrine in cases vs controls	adjusted	OR	2.28	1.09	4.78	HH size, source of water, disposal of garbage, adult defecation site, mother's education, mother's lack of knowledge regarding infectivity of diarrhoea, mother's lack of knowledge of mode of spread of diarrhoea, families that keep cooked food, feeding bottle and children's drinking cups uncovered.

Footnotes: [a]Cummings reported a confidence interval of 1.54 to 161.25, however the closest we could enter was 161.26. [b]Calculated a crude odds ratio as could not obtain as narrow confidence intervals as what was reported in the paper.

Table 4. case-control studies: defecation elsewhere vs in latrine

Study ID	age group	outcome	specific comparison	Adjusted/crude	Measure of effect	value	lower CI	Upper CI	What is it adjusted for
Chompook 2006 THA	all	shigellosis	child not/sometimes using latrine vs using latrine	unadjusted	OR	1.27	0.84	1.93	
Clemens 1987 BDG	<6	diarrhoea at least 1.7 times rate expected	open defecation in the family living area rather than latrine or some other specially designated place in cases vs controls	unadjusted	OR	8	1.52	42.04	
Knight 1992 MAL	4-59m	diarrhoea	indiscriminate defecation of child (not in latrine or nappy) vs defecation in nappy/latrine	adjusted	OR	1.33	0.52	3.42	SES, educational level of main caregiver, health centre of recruitment, interviewer, birth order of child and number of people living in house.
Maung 1992 MYA-B	1-59 m	persistent diarrhoea + PEM	child defecated on the floor vs in pot/latrine	unadjusted	OR	3.76	1.68	8.42	
Mediratta 2010 ETH-B	<5	acute diarrhoea	defecation elsewhere vs in latrines	unadjusted	OR	0.88	0.33	2.34	
Oketcho 2012 TAN	6-60 m	diarrhoea	use of latrine by children vs defecation elsewhere	unadjusted	OR	7.38	1.91	28.58	
Traore 1994 BUR-B	<3	diarrhoea / dysentery	defecation elsewhere vs in pots/latrines	adjusted	OR	1.1	0.78	1.57	age, mother's religion, father's occupation, source of drinking water, possession of a radio-cassette, whether the child was reported to eat soil, whether the mother practised "lavements" (anal purging) on the child, number of people in the household.

FIGURES

Figure 1: Funnel plot of comparison: 4 Case-control studies: disposal of child faeces in latrine vs elsewhere, outcome: 4.1 Diarrhoea (including severe and cholera): subgrouped by age group.

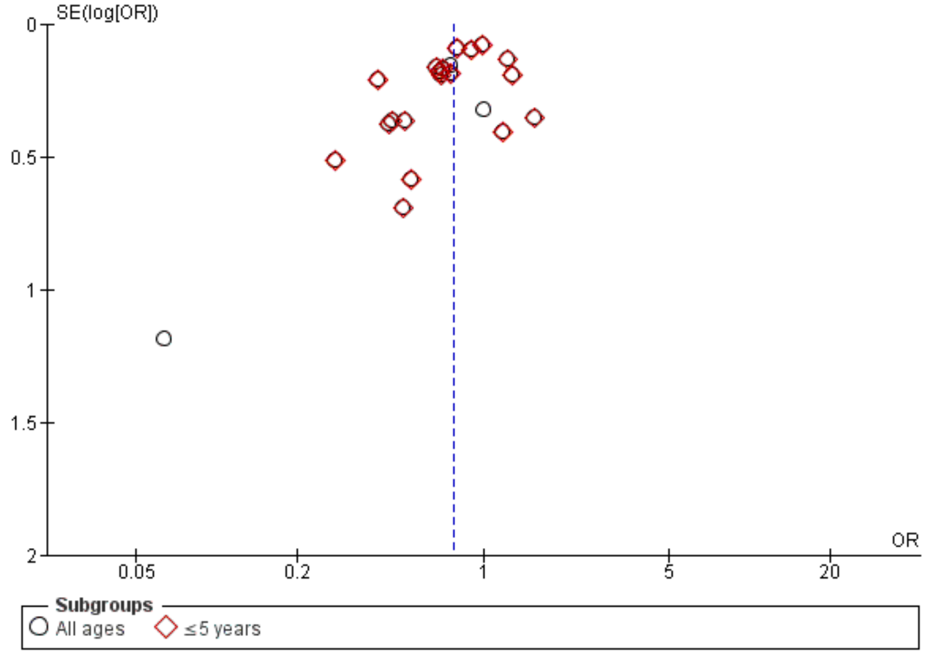
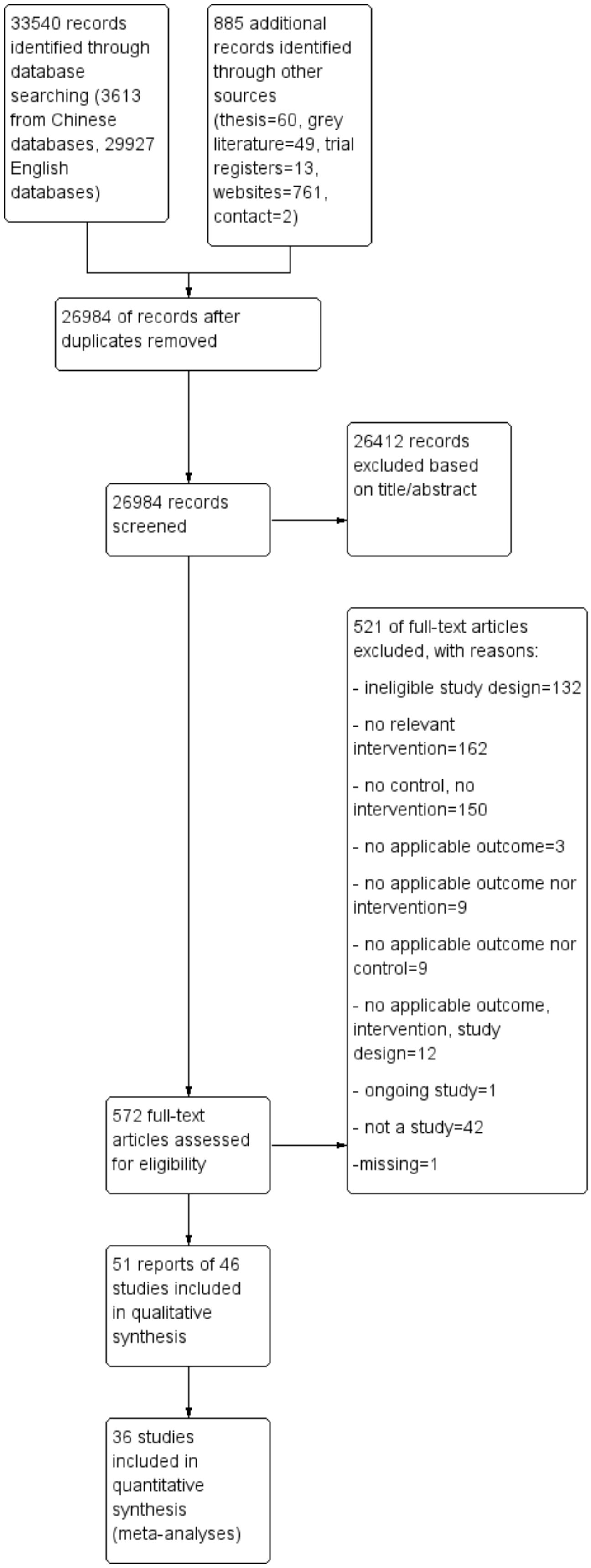


Figure 2: study flow diagram



APPENDICES

Appendix 1. Study design definitions (from the Cochrane Handbook for Systematic Reviews of Interventions)

- Quasi-RCT: A study with an experimental design where participants are allocated to different interventions using a quasi- random method, such as date of birth, alternation, and medical record number.
- Non-RCT: A study with an experimental design where participants are allocated to different interventions using a non- random method.
- Controlled before-and-after study: A study where observations are made in a control and intervention group, before and after the implementation of an intervention.
- Interrupted-time-series study: A study in which observations are done at multiple time points before and after an intervention (interruption). The design of the study enables to see if the intervention has an effect that is significantly greater than underlying trend over time.
- Historically controlled study: A study comparing a group of participants receiving an intervention with a similar group from the past that didn't.
- Cohort study: A study that follows a defined group of people (cohort) over a period of time to examine interventions received and subsequent outcomes. A 'prospective' cohort study recruits participants before an intervention and follows them whereas a 'retrospective' cohort study recruits participants from the past using records from the past that describe the interventions received and follows them in the past using the records.
- Case-control study: A study that compares participants with a certain outcome (cases) with people from the same source population without the outcome (controls) and examines the associations between the outcome and prior exposures (for example, receiving an intervention).
- Cross-sectional study: A study where information on past or current interventions and health outcomes are collected for a group of people at a particular time point in order to study associations between outcomes and exposure to interventions.

Appendix 2 Detailed search strategy

Search set	CIDG SR[a]	CENTRAL	MEDLINE	EMBASE	Global Health	Web of Science	LILACS	POPLINE
1	feces OR faeces OR faecal OR fecal OR stool* OR excreta* OR excrement OR diarrhoea OR diarrhea OR defeacation OR defecation OR human waste	feces OR faeces OR faecal OR fecal OR stool* OR excreta* OR excrement OR diarrhoea OR diarrhea OR defeacation OR defecation OR human waste	(f?eces or f?ecal or stool$ or excreta$ or excrement or diarrh?ea or defe?cation or human waste) adj3 (management or dispos$ or remov$ or cleansing or cleaning or washing))	(f?eces or f?ecal or stool$ or excreta$ or excrement or diarrh?ea or defe?cation or human waste) adj3 (management or dispos$ or remov$ or cleansing or cleaning or washing))	(f?eces or f?ecal or stool* or excreta* or excrement or diarrh?ea or defe?cation or human waste) adj3 (management or dispos*or remov* or cleansing or cleaning or washing))	F$eces OR f$ecal OR stool* OR excreta* OR excrement OR diarrh$ea OR defe$cation OR human waste	feces or faeces or fecal or faecal or stool$ or excreta$ or excrement or diarrhea or diarrhoea or defecation or defeacation or human waste	feces OR faeces OR faecal OR fecal OR stool* OR excreta* OR excrement OR diarrhea OR diarrhoea OR defeacation OR defecation OR human waste
2	management OR dispos*OR remov* OR cleansing OR cleaning OR washing	management OR dispos*OR remov* OR cleansing OR cleaning OR washing	sanitation or potty or potties or diaper$ or nappy or nappies or latrine$ or toilet$ or cloth$ diaper$ or swaddle or wrap$	sanitation or potty or potties or diaper$ or nappy or nappies or latrine$ or toilet$ or cloth$ diaper$ or swaddle or wrap$	sanitation or potty or potties or diaper* or nappy or nappies or latrine* or toilet* or cloth* or diaper* or swaddle or wrap*	management OR dispos*OR remov* OR cleansing OR cleaning OR washing	management or dispos$ or remov$ or cleansing or cleaning or washing	management OR dispos* OR remov* OR cleansing OR cleaning OR washing
3	1 AND 2	1 AND 2	1 or 2	1 or 2	1 or 2	1 AND 2	1 AND 2	1 AND 2
4	sanitation OR potty OR potties OR diaper* OR nappy OR nappies OR	sanitation OR potty OR potties OR diaper* OR nappy OR nappies OR	exp Sanitation/	exp sanitation/ or exp environmental sanitation/	exp sanitation/	sanitation OR potty OR potties OR diaper* OR nappy OR nappies OR	child$ or babies or baby or infant$ or toddler$ or neonate$ or	sanitation OR potty OR potties OR diaper* OR nappy OR nappies OR

	latrine* OR toilet* OR cloth* OR diaper* OR swaddle OR wrap*	latrine* OR toilet* OR cloth* OR diaper* OR swaddle OR wrap*				latrine* OR toilet* OR cloth OR diaper* OR swaddle OR wrap*	preschool or pre-school	latrine* OR toilet* OR cloth OR diaper* OR swaddle OR wrap*
5	3 OR 4	3 OR 4	3 or 4	3 or 4	3 or 4	3 OR 4	3 AND 4	3 OR 4
6	child* OR babies OR baby OR infant* OR toddler* OR neonate* OR preschool OR pre-school	[Sanitation]	child$ or babies or baby or infant$ or toddler$ or neonate$ or pre?school	child$ or babies or baby or infant$ or toddler$ or neonate$ or pre?school	child* or babies or baby or infant* or toddler* or neonate* or pre?school	child* OR babies OR baby OR infant* OR toddler* OR neonate* OR preschool OR pre$school		Keywords : sanitation OR Hygiene
7	5 and 6	5 OR 6	exp child/ or exp child, preschool/ or exp infant/	exp child/	exp children/	5 AND 6		5 OR 6
8		child* OR babies OR baby OR infant* OR toddler* OR neonate* OR preschool OR pre-school	6 or 7	6 or 7	Exp infants/			child* OR babies OR baby OR infant* OR toddler* OR neonate* OR preschool OR pre-school
9		[child]	5 and 8	5 and 8	6 or 7 or 8			Keywords : child OR infant
10		[infant]			5 and 9			8 OR 9
11		8 OR 9 OR 10						7 AND 10
12		7 AND 11						

[a]Cochrane Infectious Diseases Group Specialized Register.

Appendix 3. Items for data extraction

Study data
Person extracting data
Date of extraction
Study ID
Report ID (if different from study ID)
Reference citation
Study author details
Publication type
Publication status
Notes (for example, questions for authors, statistical concerns)
Study eligibility: (if answer no to one of the criteria, exclude)
Type of study: RCT or NRS with control group (quasi-RCTs, non-RCTs, controlled before-and-after studies, interrupted time series studies, historically controlled studies, case-control studies, cohort studies and cross-sectional studies)
Participants: adults or children
Type of intervention: hardware or software interventions that reduce the direct or indirect contact with child (aged < 5 years) faeces?
Type of comparison: no intervention or other intervention?
Type of outcome: diarrhoea episodes; infections with one or more species of STHs; intensity of infection with one or more species of STH; dysentery; severe diarrhoea; persistent diarrhoea; clinical visits for diarrhoea; presence of pathogenic microbes in stools; anthropometry; serology; other markers of infection and disease; adverse events; mortality; or behaviour change?
If excluded, reasons for exclusion:
Characteristics of included studies
Country and district, state, or town
Setting (hospital, school, community, urban, or rural)
Season
Design
Description of design
Was it a multicentre study?
Funding source
Duration of study (start and end date of study)
Duration of participation (start of recruitment until last follow-up time point)

Ethical approval if needed
Missing data and reasons
Unit of randomization and whether the analysis adjusted for clustering if cluster design
Participants:
Population demographics
Study inclusion criteria
Study exclusion criteria
Method of participant recruitment
Total number of participants recruited
Withdrawals, exclusions, loss to follow-up
Age and Sex
Household size
Education level
Socio-economic level
Pre- and post-intervention water quality
Sanitation type and coverage
Hygiene practices
Type of water supply and coverage
Baseline child faeces disposal sites
Prevalence of open defecation
Deworming history in the study population
Solid waste disposal practices
Animal ownership
School or pre-school attendance
Shoe wearing practices
Intervention group
Description of intervention
Number of participants
Co-interventions?
Who delivered the intervention?
Format and timing of delivery?

Coverage and uptake of child faeces collection and disposal practices
Compliance to intervention
Control group
Description of control
Number of participants
Co-intervention?
Outcomes
Case definition for health outcomes
Measuring/diagnosis method (if self-reported include recall period)
Time points measured
Effect estimate and 95% CI and raw numbers (for NRS record adjusted and unadjusted measures with confounders adjusted for; for cluster RCT specify if effect estimate is adjusted for clustering)
List of outcomes measured in study
Key conclusions of authors
Explanations of unexpected findings
Risk of bias assessment
- RCTs (high, low, or unclear risk)
Random sequence generation?
Allocation concealment?
Blinding of participants and personnel?
Blinding of outcome assessment?
Incomplete outcome data?
Selective reporting?
Other risks of bias?
- Cluster RCTs (high, low, or unclear risk)
Recruitment bias?
Baseline imbalance?
Loss of clusters?
Incorrect analyses?
- NRS except case-control and ITS (high, low, or unclear risk)
Random sequence generation?

Allocation concealment?
Baseline outcome measures similar?
Baseline characteristics similar?
Incomplete outcome data?
Adequate allocation of intervention concealment?
Adequate protection against contamination?
Selective reporting?
Other risks of bias?
Confounders adequately adjusted for in analysis or design? (describe adjustment method)
Methods to identify and measure confounders
List all confounders considered in study
- ITS (high, low, or unclear risk)
- Intervention independent from other changes?
- Pre-specified shape of the intervention?
- Intervention likely to affect the data collection?
- Knowledge of the allocated interventions was adequately prevented?
- Incomplete outcome data?
- Selective outcome reporting?
- Other risk of bias?
- Case control studies
- Selection
Is the case definition adequate?
Representativeness of the cases
Selection of controls
Definition of controls
- Comparability
Comparability of cases and controls on the basis of the design or analysis
- Exposure
Ascertainment of exposure
Same method of ascertainment for cases and controls
Non-response rate

CONTRIBUTIONS OF AUTHORS

TC and FM planned the review. FM drafted the protocol. FM screened titles. FM, LG, BT and GC screened abstracts and full texts. FM contacted authors for additional information. FM, BT and GC extracted data. FM entered the data and BT checked a sample. FM drafted the review. All authors provided comments on the review.

DECLARATIONS OF INTEREST

None known.

SOURCES OF SUPPORT

Internal sources

No sources of support provided

External sources

This research is supported in part by a grant from the Bill & Melinda Gates Foundation, USA

DIFFERENCES BETWEEN PROTOCOL AND REVIEW

When cluster RCTs had not adjusted for clustering in the analysis, we extracted measures of effect and CIs, we did not have sufficient data to calculate adjusted confidence intervals using the inflating standard error method (Higgins 2011a). Instead, we reported in the text which studies were adjusted for clustering.

We had prespecified that if there are sufficient studies (>10) we would investigate causes of heterogeneity using subgroup analysis but we investigated causes of heterogeneity using subgroup analysis, even when there were <10 studies.

We pooled comparable studies together if there was more than one study even when I^2 statistic value > 75%.

BT did not also GRADE the quality of the evidence of included studies, instead only one reviewer assessed the quality of the evidence.

3.2. Notes on the review

I am working on comments on the review from the peer reviewers received the week before my viva. Consistent with Cochrane Collaboration requirements, the literature search for this review needs to be updated before it is published (the date of the search was November 2014).

Our Cochrane review varies significantly from the recent by Morita et al. (2016)[50]. First, it used different inclusion criteria to our review, resulting in far fewer studies (n= 8) compared to our 46 studies. This review included one study, which would be eligible for our review, but that was published after our search [57]. The study by Christensen *et al.* (2015) measured the behaviour change resulting from a pilot intervention of the WASH Benefit study in Kenya, and found that the combined WASH intervention resulted in a 47 percentage points (95%CI 37.2-57.1) increase in child faeces disposal (no definition of appropriate disposal), but the single sanitation intervention arm resulted in no significant change. In addition, the Morita review included an unpublished report [58] that included more details on one of the studies included in our review, finding that the intervention implemented had an impact on the prevalence of ascariasis, however no control arm was included in that analysis and it would thus not have been eligible for our review.

The findings of the Morita review agreed with ours in that none of the included studies that reported health outcomes focused exclusively on improving child faeces disposal and that there is a need for RCTs to evaluate the health impact of safe child faeces disposal interventions.

Chapter references

50. Morita, T., S. Godfrey, and C.M. George, *Systematic Review of Evidence on the Effectiveness of Safe Child Feces Disposal Interventions.* Tropical Medicine & International Health, 2016. **21**(11): p. 1403-1419.
57. Christensen, G., et al., *Pilot cluster randomized controlled trials to evaluate adoption of water, sanitation, and hygiene interventions and their combination in rural western Kenya.* Am J Trop Med Hyg, 2015. **92**(2): p. 437-47.
58. Aziz KMA, H.B., Huttly S, Minnatullah KM, Hasan KZ, Patwary Y, et al. , *Mirzapur Handpump Project. Final Report.* 1989.

4. Methods of cross-sectional study

In this chapter I introduce the study site and provide additional details on the methods for the cross-sectional study, the results of which are presented in the following 3 chapters.

4.1. Description of the study site

The study was conducted in Odisha in slums in the cities of Bhubaneswar and Cuttack. As described in chapter 1, colleagues have been conducting research in Odisha on sanitation since 2010. The reason for initially conducting sanitation research in Odisha was the low sanitation coverage at the time of designing the study, in Puri district in 2008 it was estimated at 15% in rural areas [59]. Since then, the research infrastructure has enabled several studies to take place.

Odisha is a state bordering the East coast of India (Figure 4.1), divided into 30 districts which are further divided into 58 subdivisions, 317 tehsils and 314 blocks [60]. The state's capital is Bhubaneswar. The climate is tropical with a monsoon season from July to September.

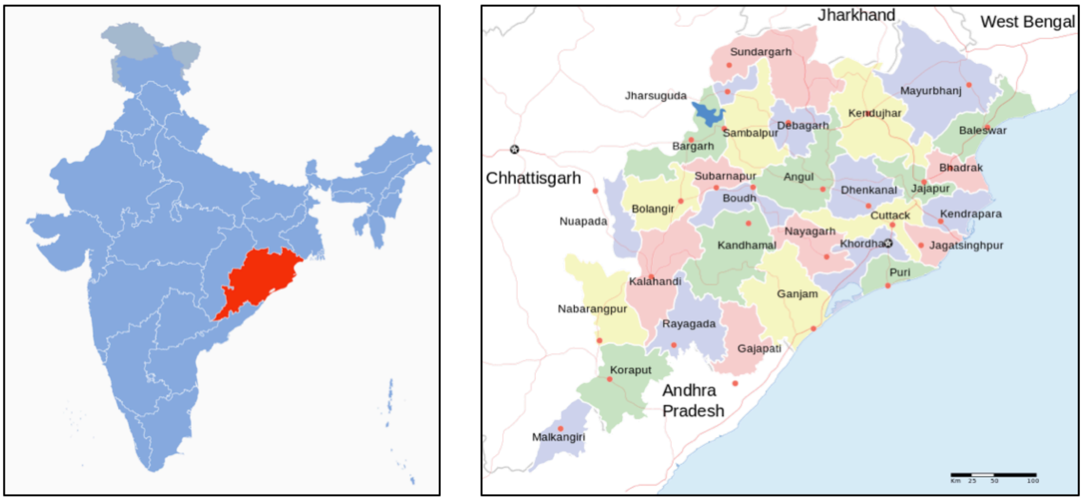


Figure 4.1: Maps of Odisha (Wikipedia commons)

The latest census (2011), reported that Odisha had a total population of 41,947,358 people, with the majority living in rural areas (83.3%) although like the rest the country, the urban population is growing [61].

In 2011, the percentage of households (n=9,661,085) in Odisha that had a latrine facility within the premises was 22.0% overall, 14.1% in rural areas and 64.8% in urban areas. The large majority of people still defecate in the open, with 84.7% of the rural households defecating in the open and 33.2% in urban areas. Compared to other states in India, Odisha and Jharkhand had the lowest proportions (22.0%) of households with a latrine facility available within the premises in 2011 [24]. The main sources of drinking water in rural areas were hand pumps (46.8%) and tube well/boreholes (20.2%); in urban areas it was taps (48.0%) and tube well/boreholes (18.9%) [62].

In the 2011 Census of India, three types of slums were recorded: notified slums, recognized slums and identified slums. Notified slums are those that are notified by state, Union territories administration or Local government under any act; recognized slums are areas recognized by State, Union territories administration or local government, housing and slum boards, which have not been notified formally under any act; identified slums are those identified to be a compact area of at least 300 people or 60-70 households with poorly built housing, unhygienic environments with inadequate infrastructure and lacking proper sanitation and drinking water facilities [63]. According to the census, there are no notified slums in Odisha but 812,737 recognized slums and 747,566 identified slums [63].

Bhubaneswar has 436 slums, which include a total population of 301,611 people in 80,665 households [64]. Cuttack, the second largest city in the state, has 264 identified slums, which include 129,720 people [65]. I am not aware of any representative data available on the type of sanitation facilities provided and used by slum dwellers in Bhubaneswar and Cuttack. However, previous research in slums in these two cities, has documented that there are households that use private, shared or communal/ public facilities. This research found that the users of the private and shared facilities (including communal) tended to be different, with households relying on shared sanitation being poorer and less educated than households relying on private sanitation facilities. In addition, shared facilities tended to be less functional, less clean and had more faeces and flies observed during spot-checks [66].

4.1.1. Previous sanitation research in Odisha

As described in chapter 1, previous research has been conducted in Odisha. A RCT assessing the health impact of the TSC was carried out in Puri district [26], which enabled further research to take place in the area. This includes a study by Heijnen (2015), who conducted research on shared sanitation in 30 slums in Bhubaneswar and Cuttack in 2013 [66, 67]. My field work in 2014 was conducted using the pool of slums used by Heijnen, which enabled research and logistical efficiencies, including continuity of staff with extensive data collection experience.

4.2. Detailed methods

4.2.1. Study design

The study followed a cross-sectional design using a questionnaire, spot checks and demonstrations of child faeces management practices as data collection tools. The data collection took place in July and August 2014.

4.2.2. Slum Selection

As mentioned earlier, the slums used for this research were selected from lists of potentially eligible slums (23 in Cuttack and 39 slums in Bhubaneswar), which had been provided to a colleague by the municipal authorities and NGOs for her previous work [66, 67]. Heijnen required slums to have a minimum of 10 households accessing a shared, communal, or public sanitation facility [66, 67].

Using the provided lists, I created a pool of potential slums for this study using the following criteria: they were required to have at least 33 households based on Heijnen that found 62.5% of households with children below 5 [66]), with access to either individual household latrines or functional community latrines [66, 67]. I excluded leprosy colonies from our list of eligible slums as well as slums in which pilot activities were previously conducted. This selection process resulted in 20 eligible slums in Cuttack and 28 eligible slums in Bhubaneswar.

4.2.3. Sample size calculation

The primary outcome for this study is the proportion of children <5 whose faeces are disposed of safely (defined in this study as defecation in a latrine or disposal in a latrine). Based on previous studies, the sample size was calculated using the average of 30% safe disposal (table 4.1). Using simple random sampling, the average of 30% safe disposal of child faeces led to a sample size of 323 households (assuming 1 child per household) (95% confidence) [68]. The sample size calculation was adjusted to account for clustering, with an intra-cluster correlation coefficient (ICC) of 0.06 based on previous work in rural Odisha in rural villages [26]. Based on the different sample size calculations in different scenarios, 20 households in 35 clusters (a total of 700 households) was chosen to be the best logistical option (table 4.2). The study was not specifically powered for two locations but for 35 slums in total.

Table 4.1: Percentage of safe disposal of child faeces in different studies undertaken in Odisha or nearby states in India.

Author (year)[1]	State	Area	How data was collected	N	% safe disposal (defecate in latrine or disposed in a latrine)
Majorin (2014)	Odisha	Rural	Reported	114[2]	22.8
Freeman (unpublished)	Odisha	Rural	Reported	136[3]	25.7
DHS (2006)	Odisha	Rural & urban	Reported	4540[4]	5.6
TARU (2008)[5]	West Bengal	Rural	Reported	-	25.0
TARU (2008)	Chhattisgarh	Rural	Reported	-	37.0
TARU (2008)	Andrha Pradesh	Rural	Reported	-	62.0
Average					**29.68**

[1] [29, 55, 69]
[2] Among households with latrines
[3] In intervention villages, where the TSC was being implemented.
[4] Number of women interviewed in Odisha. Not necessarily the number of women with children.
[5] Data of number of respondents per state unavailable

Table 4.2: Different sample size calculations using the simple random sampling sample size estimate of 323 (95% Confidence level) and an ICC of 0.06.

Average number of households with at least 1 child below 5 per cluster	Design effect	Effective sample size	Number of clusters
5	1.24	400.52	80
10	1.54	497.42	50
15	1.84	594.32	40
20	2.14	691.22	35
25	2.44	788.12	32
30	2.74	885.02	30
35	3.04	981.92	28
40	3.34	1078.82	27

The lists of slums for each city were randomly ordered using STATA version 12 (StataCorp, College Station, Texas, United States) in order to select the first 35 to be visited. It was not always possible to recruit 20 eligible households in each selected slum due to the varying sizes of the slums and the number of households with children under five that were in the slum and available at the time of visit, so we continued visiting slums in the order in which they had been randomised until the target sample size of 700 households was reached. This resulted in the data being collected in 42 slums: 22 in Bhubaneswar and 20 in Cuttack.

4.2.4. Household selection

Households eligible for inclusion in the study were required to meet the following eligibility criteria: (i) have at least one child below the age of five years with a primary caregiver older than 18 years old, and (ii) the primary caregiver reported having access to sanitation facilities (individual household latrines, shared or communal facilities) or belonged to a slum with communal sanitation facilities. Households that otherwise met such eligibility criteria were nevertheless excluded from the study if the primary caregiver was an ASHA (Accredited Social Health Activist), *anganwadi* (government sponsored child-care and mother-care centre) worker or a person who had worked for health promotion campaigns.

As a sampling frame I had initially envisaged using lists of under-five year old children managed by *anganwadi* workers in their respective slums. Two supervisors, collected data from the registered lists and entered them into excel. I then planned on randomly selecting 20 households with children <5 in each slum and find these in the slums and recruit them into the study. However, this method was found not to be feasible during a pilot, due to issues with finding the randomly selected households in the slum.

Instead participating households were selected through systematic sampling using an adaptation of the Extended Program on Immunization (EPI) sampling method [27, 66, 70]. This method involved the supervisor spinning a pen in a central location of the slum to determine the direction in which each enumerator would select households. Prior to data collection, the supervisors had visited all the slums and drawn approximate maps delimiting the slums so that appropriate central points could be chosen to spin the pen. The four enumerators enrolled every other household on the left that fit the eligibility criteria in that direction until they each had collected data from 5 households, the slum boundary was reached or it was the end of the field day. The pen was spun for each enumerator, if the pen spun twice in the same direction, the next enumerator would enrol every second house on the right. At every intersection the pen was spun again to determine the direction in which the enumerators would continue enrolling households. When the enumerators reached the slum boundary before having collected data from 5 households, they would go back to the last intersection or the central point (if no intersections were met) and start the process again (see Appendix 4).

The number of participating households in each slum varied due to the varying sizes of the slums and the number of households with children under five that were in the slum and available at the time of visit. Respondents were the primary caregivers (defined as ‘the one who usually cares for the child’) of the youngest child under five in each household. Households that were locked, where the primary caregiver was not available at the time of visit, that did not fit the eligibility criteria or that refused to participate were not enrolled and the enumerators would go to the next household on the left until they found one that met the eligibility criteria.

4.2.5. Data collection tools

A conceptual model of factors that may influence child faeces disposal behaviour was developed (Figure 4.2). This model was used to generate questions for inclusion in the survey, which were later refined. Relevant questions from the Odisha trial [26] survey tools and from the cross-sectional in rural areas [29] were used to ensure the data collected in this study was comparable to existing data. The survey was initially piloted twice by two supervisors in slums nearby the field office. The questions were amended according to the pilot findings. The revised questionnaire was used to train the enumerators.

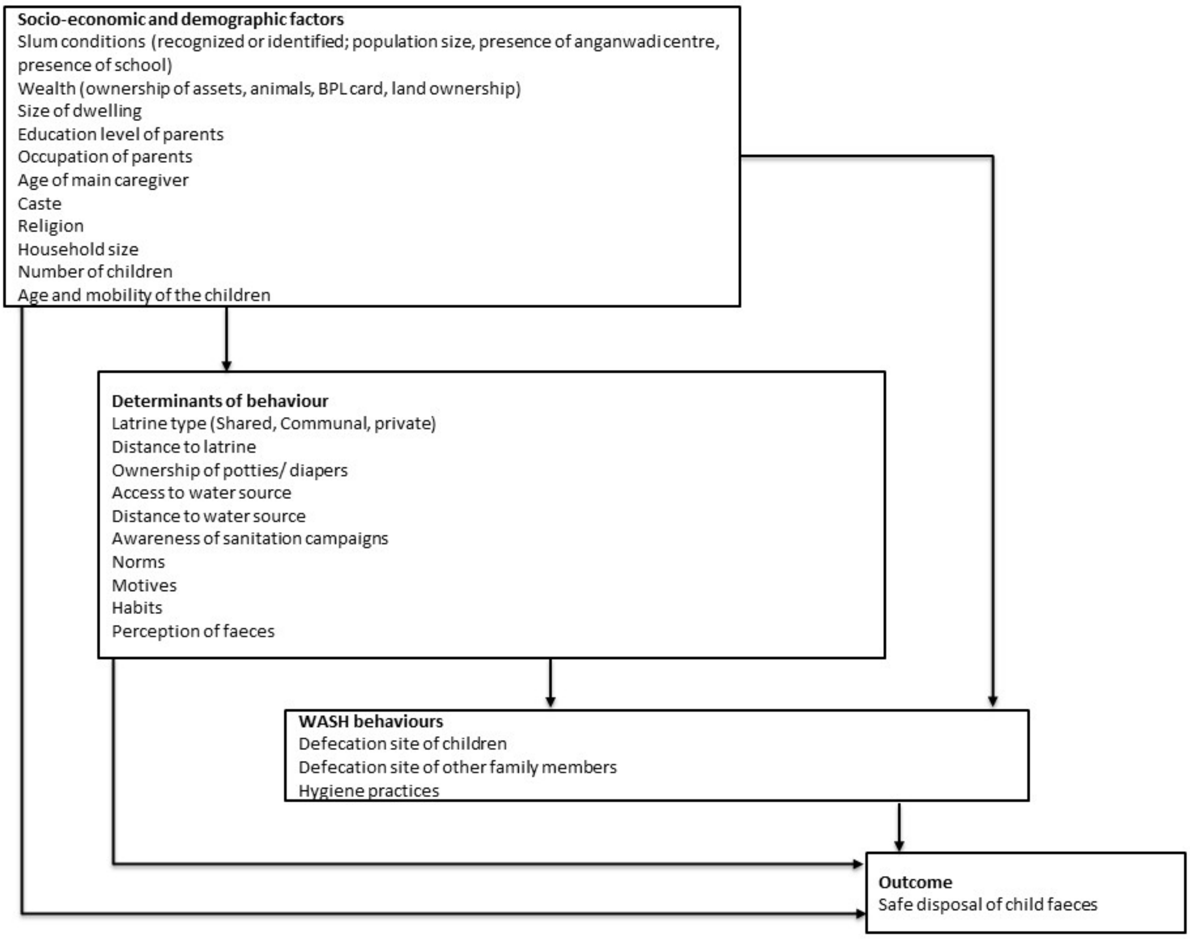


Figure 4.2: Conceptual model of factors that may influence child faeces disposal behaviour

During the two-day training, each question was explained as well as practiced. Any question that required further clarification or that the team felt were in an illogical order or could be improved were raised and the questionnaire was edited accordingly. Following the training, the enumerators piloted the questionnaire in 2 slums, the first time this included testing of the *anganwadi* list sampling strategy. After the first pilot it was decided that that sampling method would not work, and enumerators were retrained. The final data collection tool can be found in appendix 5 and is described in the next chapter. Briefly, it was consisted of the following 13 sections:

Section 1. Collected data on the public or communal sanitation facilities in the slums if there were any. This section was filled once per slum, when the team arrived in the slum. It included spot checks of the latrine seats/ cubicles for males, females and children, if there were separate child-specific latrines (figure 4.3).

Section 2. Checked the eligibility of the household.

Section 3. Consisted of survey detail information, including the date of visit, the slum code and full survey ID of the household.

Section 4. Collected data on socio-economic and demographics of the household.

Section 5. Collected data on the water, sanitation and hygiene of the household.

Section 6. Collected data about the defecation practices for each member of the household over five.

Section 7. Collected data about the defecation and faeces disposal practices for each child below five in the household. Including data on each child's gender, age, mobility, *anganwadi* or pre-school attendance, nutrition (whether the child was breastfed or fed other foods, or a mix of breastfeeding and other foods), the consistency of the stools the last time the child defecated, the place where the child defecated the last time, on what he/ she defecated (ground/floor directly or something else), what was done to dispose of the stools and what was used to dispose of the stools.

Section 8. Collected data on demonstrations (using plastic faeces) of what a caregiver would do if the child defecated (figure 4.4).

Section 9: Collected additional data on child faeces management practices, including information on toilet training and anal hygiene.

Section 10. Consisted of agree/disagree questions, which included questions on beliefs around defecation, disease transmission via faeces, perceptions of faeces and of using latrines for defecation by children and to dispose of child faeces.

Section 11. Gathered data on communication channels for information about child health and hygiene/sanitation. Also collected data on decision making for health care, household purchases and child latrine training.

Section 12. Consisted of questions and spot checks of potties if the household owned one, hand washing facilities, presence of stools, of children wearing diapers, and of the private or shared latrine facilities used by the household.

Section 13. Was a section available to make observations of child faeces management in case a child defecated during the visit.

Figure 4.3: Unused and non-functional child-specific latrines at a communal latrine in a slum

Figure 4.4: Caregivers demonstrating child faeces management practices

4.2.6. Field Procedures

The field team collected data from 2 slums per day (1 in Cuttack and 1 in Bhubaneswar) as far as possible and weather permitting (data collection occurred during the monsoon season). The field team was divided into two teams of four female enumerators and supervised by one or two field supervisors (2 males and 1 female) depending on the size of the slum that was visited (figure 4.5).

When the team arrived at a slum they would start by visiting the community latrine(s) if present, where they would conduct spot checks of the latrines to record the type of facility, the number of seats/cubicles and whether they looked used (if there was smell or the pan was wet or there were stains of urine/faeces) and functional (if the latrine had any cover, it was not used for storage, the pan was not broken, blocked or full of leaves/ dust, and the pit was completed) [26] (section 1). After the spot checks, the team would go to the central point picked by the supervisor, where the supervisor would spin the pen to determine the directions in which the enumerators would enrol households.

The field supervisors checked on the enumerators to ensure they were following the sampling rules and also occasionally accompanied them into households to ensure they were asking the questions correctly. After data collection, the supervisors checked the data collection forms for missing values and contradictory answers. In addition, I checked most of the forms every day and clarified any issues with the field supervisors and enumerators when needed. Weekly meetings were held between the supervisors and I to ensure the team was on track and to discuss any logistical or data collection issues.

4.2.1. *Ethics and consent*

Ethics approval was obtained from the London School of Hygiene and Tropical Medicine and the School of Medicine of the Kalinga Institute of Industrial Technology (KIIT) (India). Prior to enrolment, the enumerators read an information sheet describing the study, answered any questions and asked for written consent to participate (see Appendix 6). The survey was conducted with primary caregivers who were available and willing to participate in the survey. The survey topic is neither considered a taboo or uncomfortable to discuss. The study participants received no compensation for their participation and were free to withdraw from the study at any time. Anonymity was ensured through the use of household and participant identification numbers. The survey data was entered in 2 password protected laptops located in an office in the Xavier Institute of Management, Bhubaneswar (XIMB). The data was sent to me via email and kept on my password protected laptop and desktop computer, on which I conducted the analyses.

Figure 4.5: Three enumerators ready for data collection

Figure 4.6: Child defecating in a drain

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5. Identifying potential sources of exposure along the child feces management pathway: a cross-sectional study among urban slums in Odisha, India

5.1. Cover sheet for research paper included in thesis

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SECTION A – Student Details

Student	Fiona Majorin
Principal Supervisor	Thomas Clasen
Thesis Title	Disposal of child faeces: practices, determinants and health effects

If the Research Paper has previously been published please complete Section B, if not please move to Section C

SECTION B – Paper already published

Where was the work published?			
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Where is the work intended to be published?	The American Journal of Tropical Medicine and Hygiene
Please list the paper's authors in the intended authorship order:	Majorin F, Torondel B, Routray P, Rout M, Clasen TF
Stage of publication	**Undergoing revision**

SECTION D – Multi-authored work

For multi-authored work, give full details of your role in the research included in the paper and in the preparation of the paper. (Attach a further sheet if necessary)	I drafted the study protocol and study tools, with input from co-authors. I analysed the results and drafted the manuscript.

Student Signature: Fiona Majorin **Date:** 25/01/2017

Supervisor Signature: Thomas Cl **Date:** 25/01/2017

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Identifying potential sources of exposure along the child feces management pathway: a cross-sectional study among urban slums in Odisha, India

Fiona Majorin, Belen Torondel, Parimita Routray, Manaswini Rout, Thomas Clasen

Abstract

Child feces represent a particular health risk due to physiological and behavioral factors that are particular to children. The safe management of such feces, however, presents a significant challenge, not only for the 2.4 billion who lack access to improved sanitation, but also due to unhygienic feces collection, disposal and subsequent hand washing practices. We sought to assess potential sources of fecal exposure by documenting child feces management practices in a cross-sectional study of 851 children < 5 from 694 households in 42 slums in 2 cities in Odisha, India. We identified several sources of fecal exposure from children's feces. No pre-ambulatory children and only 27.4% of ambulatory children defecated directly in the latrine. Children that did not use a latrine mainly defecated directly on the ground, whether they were pre-ambulatory or ambulatory. Use of diapers (1.2%) or potties (2.8%) was low. If the feces were removed from the ground, the defecation area was usually cleaned, if at all, only with water. Most children's feces were disposed of in surrounding environment, with only 6.5% deposited into any kind of latrine, including unimproved. Hand washing of the caregiver after child feces disposal and child anal cleaning with soap following defecation was also uncommon. While proper disposal of child feces in an improved latrine still represents a major challenge, control of the risks presented requires attention to the full range of exposures associated to the management of child feces, and not simply the place of disposal.

Introduction

Worldwide 2.4 billion people did not have access to improved sanitation in 2015, including nearly 1 billion people that practiced open defecation [1]. India represents a particular challenge, as 44% of its population practiced open defecation and only 40% used improved facilities [1].

Poor sanitation is a major cause of fecal-oral diseases, including diarrhea which is responsible for more than 1.2 million deaths annually [2]. Several systematic reviews have linked improved sanitation with lower risks of diarrhea [3-8], soil-transmitted helminth infections [3, 9, 10], schistosomiasis [3, 11], and trachoma [12, 13].

The unsafe disposal of child feces represents a particular challenge for preventing transmission of fecal-oral diseases, particularly among young children. First, young children have the highest incidence of enteric infections [14] and their feces are most likely to contain transmissible pathogens [15]. Second, young children tend to defecate in areas where other susceptible children could be exposed [16]. This exposure is worse for young children due to their higher vulnerability which is a function of the time they spend on the ground and exploratory behaviors including geophagia [17, 18], as well as their immature immune system [19]. Third, diarrhea is one of the main causes of death of young children making them most vulnerable to fecal exposure [2].

A recent systematic review suggests that safe disposal of child feces may also play a role in preventing diarrhea (Majorin, F., submitted). However, most of the evidence was of low quality and no studies of high quality that measured health outcomes focused on improving child feces disposal only. Recent evidence from a cohort study in rural Bangladesh found that children from households that disposed of their children's feces unsafely had higher scores of enteropathy, a disorder of the small intestine which is thought to lead to undernutrition and growth faltering, and greater odds of being wasted [20]. The same study found increased contamination of the soil with *Escherichia coli* in the areas where study children played, supporting the hypothesis that unsafe child feces disposal may increase the risk of exposure to enteric pathogens [20].

Even in settings with improved sanitation (or "basic sanitation" under the proposed SDG sanitation ladder [21]), householders often do not dispose of child feces in latrines [22, 23]. A recent report by the World Bank Water and Sanitation Program (WSP) presenting analysis from the latest available Multiple Indicator Cluster surveys (MICS) and Demographic and Health Surveys (DHS) (survey years: 2006-2012) found that in 15 out of 26 locations more than 50% of households reported disposing of their youngest under 3 year old child's feces unsafely (not into a latrine); and the percentage of feces ending up in improved sanitation facilities was even lower [24]. In India, the latest DHS (2005-2006) found that only 20.3% of child feces ended up in a latrine (child defecated in latrine (11.5%) and 8.8% were disposed in the latrine), and 0.8% was buried [25]. A cross-sectional study of child feces disposal practices among rural households in villages in the State of Odisha where the Total Sanitation Campaign (TSC) had been implemented at least 3 years before, found that 81.4% of child feces were disposed of unsafely, with the majority of feces reported to being deposited with the solid waste. Safe disposal of child feces only occurred in households with latrines, but the majority of the feces were disposed of elsewhere [23].

While the Government of India has endeavored to improve sanitation through a series of initiatives aimed at reducing open defecation, studies have reported no significant impact of the interventions on diarrhea, soil-transmitted helminth infection or nutrition [26, 27]. In one such evaluation, the intervention increased the safe disposal of child feces from 1.1% at baseline to 10.4% in intervention households compared to 3.1% in the control households (RR: 3.34; 95% CI: 1.99-5.59) [22]. However, this increase in safe child feces disposal was directly related to increases in latrine coverage in the intervention communities and not from a change in underlying behaviors.

We undertook this cross-sectional study in order to describe the child feces management practices of children under 5 in urban slums in Odisha, India. The study is a complement to our previous work in rural villages [23]. While the DHS and MICS surveys collect limited data on child feces disposal behaviors, such surveys do not always cover informal settlements such as urban slums [1]. In addition, since they only have one question on child feces disposal practices ("The last time [name of youngest child] passed stools, what was done to dispose of the stools?") [28], they do not describe the range of child feces management behaviors. We sought to describe a more comprehensive range of intermediary behaviors that may cause exposure to child feces, including where the child defecates, where the feces are disposed of, and any associated hygiene behaviors.

Materials and Methods

Study design and setting

The study followed a cross-sectional design using a questionnaire, spot checks, and demonstrations of child feces management practices as data collection tools. The data collection took place in July and August 2014.

Slum Selection

The informal settlements (slums) were selected from lists of 23 slums in Cuttack and 39 slums in Bhubaneswar in which other sanitation-related work has been conducted [29, 30]. The selection criteria for the slums was that they had at least 33 households with access to either individual household latrines or functional community latrines [29, 30]. We excluded 3 leprosy colonies from our list of eligible slums as well as slums in which pilot activities were previously conducted. This selection process resulted in 20 eligible slums in Cuttack and 28 eligible slums in Bhubaneswar. These slums were randomly ordered for each city using STATA version 12 (StataCorp, College Station, Texas, United States).

Sample size calculation

The primary outcome for this cross-sectional study is the proportion of children < 5 whose feces are disposed of safely (defined here as defecation or disposal in a latrine). Based on previous studies, the sample size was calculated using the average of 30% safe disposal. Using simple random sampling, the average of 30% safe disposal of child feces led to a sample size of 323 people (95% confidence) [31]. The sample size calculation was adjusted to account for clustering, with an intra-cluster correlation coefficient (ICC) of 0.06 based on previous work in rural Odisha [26]. Based on the different sample size calculations in different scenarios, 20 households in 35 clusters (a total of 700 households) was chosen to be the best logistical option. The study was not separately powered for each city but for 35 slums in total. As it was not always possible to find 20 eligible households in each selected slum, we continued selecting slums in the order in which they had been randomly ordered until we reached our target sample size of 700 households. This resulted in the data being collected in 42 slums: 22 in Bhubaneswar and 20 in Cuttack.

Household selection

In the selected slums households eligible for inclusion in the study were required to meet the following eligibility criteria: (i) have at least one child < 5 years with a primary caregiver older than 18 years old, and (ii) the primary caregiver reported having access to sanitation facilities (individual household latrines, shared or communal facilities) or belonged to a slum with communal sanitation facilities. Households that otherwise met such eligibility criteria were nevertheless excluded from the study if the primary caregiver was an ASHA (Accredited Social Health Activist), *anganwadi* (government sponsored child-care and mother-care center) worker or a person who had worked for health promotion campaigns.

As a sampling frame we initially envisaged using lists of < 5 years old children managed by *anganwadi* workers in their respective slums. This method was not feasible due to issues with finding the randomly selected households in the slum. Instead participating households were selected through systematic sampling using an adaptation of the Extended Program of Immunization (EPI) sampling method [32].

This method involved the supervisor spinning a pen in a central location of the slum to determine the direction in which each enumerator would select households. The four enumerators enrolled every other household on the left that fit the eligibility criteria in that direction until they each had collected data from 5 households, the slum boundary was reached or it was the end of the field day. When the enumerators reached the slum boundary before having collected data from 5 households, they would go back to the last intersection or the central point (if no intersections were met) and start the process again.

The number of participating households in each slum varied due to the varying sizes of the slums and the availability of households with children < 5 at the time of visit. Respondents were the primary caregivers (defined as 'the one who usually cares for the child') of the youngest child < 5 in each household. Households that were locked, where the primary caregiver was unavailable at the time of visit, that did not meet the eligibility criteria or that refused to participate, were not enrolled and the enumerators would go to the next household on the left until they found one that met the eligibility criteria.

Data collection tools

Data collection tools included a structured survey, which included questions on socio-economic and demographic factors, access to sanitation, water and hygiene facilities, availability of potties and diapers, exposure to messages about child sanitation or hygiene, and agree or disagree statements. Questions about defecation place and feces disposal method for the last time each child < 5 defecated [23] were included using wording as per the core questions of the WHO/UNICEF Joint

Monitoring Programme on Water and Sanitation (JMP) [28]. Questions were also asked to know ‘on what’ the child defecated (if directly on the ground or on paper or polythene, etc.) and ‘what’ was used to dispose of the stools. The age and mobility capacity (whether the child can or cannot walk) of the children, whether they were exclusively breastfed and the consistency of their feces (solid, liquid, semi-liquid) the last time they defecated, were also recorded. Data was also collected on the age, marital status and usual defecation places of each family member over the age of 5 [33].

Spot-checks were done to determine the type of the latrine (flush/pour flush with pit/ closed sewer system, flush/pour flush without pit/ open sewer system, pit latrine with slab, or other), reported by the households as the one used the majority of the time and whether it looked used (if there was smell or the pan was wet or there were stains of urine/feces) [26], to check the presence of a potty in the household, whether children were wearing a diaper, and to check the availability of soap and water at the specific place identified by participants to be used for hand washing after disposal of child feces. The primary caregiver was also asked to demonstrate (using plastic feces) how s/he would manage the stool if that child defecated at the time of visit. The enumerators would prompt the caregiver to explain and/or show all the steps from the moment the child defecated.

The questions on defecation and disposal practices for the last time the children defecated were asked for all the children < 5 in each household (defined as sharing the same cooking pot). As such, data could be collected on children that were cousins or siblings, as long as they lived in the same house and the parents shared the same cooking pot.

The disposal sites/places were recorded so that the place where most feces ended up was recorded, e.g. if the child defecated in his pants and the pants were washed in water, the disposal site was recorded as washed with water. If on the other hand the caregiver first put the feces in the latrine or garbage and then washed the pants, which might have contained some remains of feces, the disposal site was recorded as latrine or garbage.

The questionnaire, information sheet and consent forms were written in English and then translated into Odia, the local language. A researcher bilingual in Odia and English evaluated the translation. All the enumerators who conducted the surveys were fluent Odia speakers. During the development of the questionnaire, the field supervisors piloted the questions in a slum and the questions were amended accordingly.

Field Procedures

Following training and piloting in 2 slums with retraining after the first pilot, the field team collected data from 2 slums per day (1 in Cuttack and 1 in Bhubaneswar) as far as possible and weather permitting (data collection occurred during the monsoon season). The field team was divided into 2 teams of 4 female enumerators and supervised by one or 2 field supervisors (2 males and 1 female) depending on the size of the slum that was visited. When the team arrived at a slum they would start by visiting the community latrine(s) if there were one or several, where they would conduct spot checks of the latrines. After the spot checks, the team would go to the central point identified by the supervisor, where the supervisor would spin the pen to determine the directions in which the enumerators would enroll households. The supervisors checked on the enumerators to ensure they followed the sampling rules and also occasionally accompanied them into households to ensure they were asking the questions correctly and checked the data collection forms for missing values and contradictory answers.

Ethics and consent

Ethics approval was obtained from the London School of Hygiene and Tropical Medicine and the School of Medicine of the Kalinga Institute of Industrial Technology (KIIT) (India). Prior to enrolment, the enumerators read an information sheet describing the study, answered any questions and asked for written consent to participate. The study participants received no compensation for their participation and were free to withdraw from the study at any time. Anonymity was ensured through the use of household identification numbers.

Data entry and analysis

Data were double entered using EpiData 3.1 (EpiData Association, Odense, Denmark) and analyzed using STATA version 14 (StataCorp, College Station, Texas, United States). The description of child feces management behaviors was stratified according to the mobility category of the children. Child feces disposal was categorized as safe if children's feces ended up in a latrine and improved if the latrine was considered improved according to the JMP (flush/pour flush with pit/

closed sewer and pit latrine with slab) [24]. The data used for describing the behaviors was from questions on the last time the child defecated, which was collected for each child under 5 in the household. This was complemented with data collected at the household level on handwashing and latrine training, etc., which was only asked once per household about the youngest child in the household if there were more than one child.

Results

A total of 694 households, with 852 children < 5, were enrolled from 42 slums. There was an average of 16.5 respondents per slum (range: 3-20). The primary caregiver of the youngest child in the household who was the respondent for the survey, was mostly the mother of the child (96.3%) (table 1) and most did not work (90.9%, data not shown).

The latrines reported to be used by the household the majority of the time were mostly private latrines (of any type improved/ unimproved) (38.0%), followed by communal latrines (29.1%) and shared (26.4%). 45 households (6.5%) reported not using any sanitation facility, despite having access to communal sanitation. Among the 40 communal latrines that the participating households reported using, 3 had separate latrines specifically for children (2 with 6 ‘seats’ and 1 with 9 ‘seats’), of which only 1 latrine looked used.

While 45.4% of caregivers had heard of potties (referred to as ‘plastic latrines’), only 7.6% owned one (53/694) and of those 86.8% (46/53) showed it at the time of visit. 47.3% (328/694) of caregivers reported that they or other members of the household sometimes purchased diapers, of those 90.5% (297/328) agreed that diapers were too expensive to be used daily and only in 2.4% (8/328) of those households was there a child observed to be wearing a diaper at the time of visit.

Caregivers reported that the median age to train their child to use a latrine was 3 years (interquartile range (IQR): 2.0, range: 1-14 years, 5 said never) with median age being lowest for users of private latrines (median: 3, IQR:2.0, range: 1-8) and shared latrines (median: 3, IQR:2.0, range; 1-10), followed by communal latrines (median: 4, IQR: 2.0, range; 1-14) and households where no one uses sanitation facilities (median: 5, IQR:1.0, range; 2-8). Caregivers expected their child to use a latrine by themselves by the median age of 5 years (IQR:2.0, range: 1-14 years, 3 said never), this again increased according to the household sanitation facilities (median for private and shared latrine users: 5, median for communal latrine users and households were no one uses latrines: 6).

Complete data on defecation behaviors were available for 851 children, of which 631 could walk (ambulatory) and 220 were pre-ambulatory. Overall, 25.5% (95%CI: 22.7-28.5) of the 851 children's feces were reported to end up in the latrine the last time they defecated; 20.3% (95%CI:17.8-23.2) defecated directly into latrine while the others had feces deposited there after defecating elsewhere. Only 13.5% (95%CI: 11.4-16.0) ended up in improved latrines (improved disposal). No household reported burying their child's feces.

No pre-ambulatory children defecated directly into a latrine. The main defecation place was on the ground inside the household (40.9%) followed by on the ground in the compound (27.3%), and the main disposal sites were the garbage (30.0%) and the canal or drain (25.0%) (table 2). 34.6% of pre-ambulatory children were reported to have their feces washed with water (13.2%) or with water and soap (21.4%), mostly in bathing areas that tend to be directly connected to the open drains, or at water sources (e.g. river, canal, near hand pumps, near wells or tube wells); however we did not specifically collect data on the disposal of the contaminated water. Only 5% of the pre-ambulatory children's feces ended up in the latrine the last time they defecated.

For ambulatory children, 27.4% defecated into a latrine, of which 49.1% were improved latrines; most defecated on the ground in the compound (28.5%) (table 3). While 32.6% of ambulatory children's feces were reported to end up in the latrine, only 7.2% of defecation events that occurred elsewhere than the latrine the last time the child defecated (n=458) resulted in feces being disposed in the latrine. Ambulatory children's feces were also reported to be disposed of in garbage (25.0%) and the canal or drain (20.9%).

The main tool used to pick up and dispose of the stools for pre-ambulatory children was cloth (45.5%, 100/220), mostly after the child had defecated on it (67%, 67/100) followed by paper (37.7%, 83/220), mostly after the child had defecated on the ground (66.3%, 55/83). For ambulatory children, paper was the main disposal tool (68.8%, 260/378), either after the child had defecated on it (33.1%, 86/260) or just used to pick up after the child defecated on the ground (66.5%, 173/260) or oil cloth (0.4%, 1/260).

After defecation, caregivers reported washing their child's bottom, however this was mostly with water only (53.1% for pre-ambulatory and 78.5% for ambulatory children). After disposing of child feces, 99.6% of caregivers (529/531) reported washing their hands, 69.9% (370/529) reported to have a specific place to wash their hands and in 62.2% (230/370) of households soap and water was observed to be available at that place (100/150 pre-ambulatory and 130/220 ambulatory).

Our research shows other points during child feces management when fecal pathogens enter the environment causing the potential for exposure. Figure 1 illustrates these potential sources of exposure both for pre-ambulatory and ambulatory children. First, the child may defecate on the ground directly as opposed to on paper or plastic. Indeed, of the defecation events on the ground, 62.3% were directly on the ground for pre-ambulatory and 75.3% for ambulatory children. Second, the feces may not be picked up (12.7% for ambulatory children) or not be picked up efficiently leaving some pathogens at the defecation place. Third, the feces may be picked with a tool that may not efficiently prevent hand contamination, such as a cloth or paper. The ground may then not be cleaned with anything (7.0% for pre-ambulatory and 11.9% for ambulatory children) or with water only (53.5% pre-ambulatory and 58.1% ambulatory) or cow dung, creating the potential for adding pathogens on the floor [34]. Finally, most caregivers did not have a specific place to wash their hands after disposing of their child's feces (30.1%) or had a facility but there was no soap and water available at that place (26.5%), and most caregivers used only water for anal cleaning of their child following defecation (71.8%). Each of these represents a critical control point that simple monitoring of the place of disposal does not currently address.

Discussion

In this paper we describe defecation and feces disposal practices for children living in slums in Bhubaneswar and Cuttack. We attempted to describe the child feces management process to show the multiple pathways in which child feces may enter the environment.

Most of the feces ended up in the household waste and in open drains. Disposal of child feces with garbage was considered neither safe nor improved in an expert consultation due to the proximity of the garbage to the domestic environment among other reasons [35]. The defecation of children and the disposal of their stools in drains, may further contaminate the drains with fecal microbes, a possibly important source of exposure when children have contact with the drains [36].

While we collected data from households that had access to a latrine (any type), we found that the majority of feces ended up in the environment and few were disposed of safely in a latrine, even fewer into an improved latrine. Safe disposal mostly took place where ambulatory children defecated directly in the latrine. On few occasions when the child defecated elsewhere than the latrine were the feces disposed of in the latrine. This is a finding similar to what we saw in rural areas [22, 23]. Qualitative research in rural Odisha has described sanitation rituals that prohibit safe disposal in a latrine since it might require a change or wash of clothes after entering the latrine to dispose of children’s feces [37].

While 5% of pre-ambulatory and 32.6% of ambulatory children’s feces were reported to end up in the latrine, even this may overstate the extent to which these feces are safely managed. Research shows that large amounts of feces that end up in the latrine are actually returned to the environment during leaks in the entire fecal sludge management chain (fecal waste flow diagram [21]).

In addition to the defecation and disposal elsewhere than the latrine, there are several points during the child feces management process that may create exposure to feces. This suggests that current monitoring of child feces—which is limited to the place of disposal—may not be adequate to address the risks presented by child feces. A “Child Feces Safety Plan”, modelled after the WHO’s water safety plans [38] and recent sanitation safety planning [39] may be helpful in highlighting the hazardous control points in the management of child feces.

Capturing all such potential sources of exposure would obviously complicate international monitoring. Further research may help quantify the risk of the different child feces management practices and thus identify key practices that may have the highest impact on health. There may be some practices that may present more protection from others in terms of contamination. For example, is using pants or cloth nappies more safe than the child defecating on the ground before being disposed, even if pants and cloth nappies may not be completely leak-proof? And how do cloth nappies compare to disposable diapers considering the diapers are often disposed of in the garbage whereas cloth nappies are mostly washed with the water ending up in the environment?

Moreover, practices vary by age, which is reflected in the differences in child feces management between pre-ambulatory and ambulatory children. Younger pre-ambulatory children may be the major priority since they are unable to use the latrines directly, few of them use potties/ diapers, and they defecate closer to the domestic environment and mostly on the floor or cloth. Additionally, they spend more time in the household environment, thus potentially creating exposure for other household members, particularly children. Since children are taught how to use a latrine at about 3.8 years of age, the main gap is before that age.

Limitations

There may be other behaviors that were not quantified in our research or were not captured accurately, for example hand washing of the children after defecation, which has been found to be poor in rural Bangladesh [20]. This aspect should be investigated for children being trained to use the toilet. We did not collect data on whether the tool used for child feces disposal/ removal was cleaned afterwards, which is also a step of child feces management that may create a potential risk for exposure [40]. What happens with the water when the main disposal was washed with water or with water and soap is unclear, but it’s assumed to end up in the environment where the cloth/ nappy, etc. is washed. Future research should quantify where the water ends up as well as the other feces management steps. While we collected data on the consistency of the feces the last time the child defecated this does not indicate whether the child was sick with diarrhea but it was used to understand whether there were differences in disposal when feces are more liquid. This is, however, an important research question as presumably diarrhea feces may pose a more significant threat as they may contain more pathogens, thus the disposal of diarrhea feces may be an important question to ask. The temporality of events was not captured in the questionnaire and it may be relevant to know how long child feces remain at the defecation place before being disposed of etc. How consistent the disposal behavior is, would also be interesting as this has not been found to be the case in other studies [22, 40].

This study was intended to explore fecal management practices and not to estimate the prevalence of those practices in a particular community. In addition, it has been found that participants over-report "desirable" behaviors of child feces disposal when data is collected using questionnaires compared to structured observations [41, 42]. We tried to minimize this by using questions about the last time children defecated [28] and ask participants to demonstrate what they would do if their youngest child defecated at the time of visit. In addition, recent evidence suggests that reported and observed behavior were very similar [20].

Acknowledgements

We would like to thank the survey participants for their participation, and also the field team Munmun Dasmohapatra, Alfred Mohanty, Soumya Nayak, Sunita Ray, Sasmita Barik, Puspa Barik, Swarnalata Sahoo, Rajani Barik, Archana Harichandan, Arnapurna Harichandan, Rajashree Nayak and the data entry team Sadasiv Khotia and Sonam Sahoo.

Financial support

The research described in this paper was funded by a grant from the Bill & Melinda Gates Foundation (Grant number: OPP1008048).

Conflicts of interest

None known.

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Table 1. Household characteristics

	N	%	Median [IQR]	Min-Max
Demographics				
Gender of head of HH	**694**			
Male	567	81.7		
Female	127	18.3		
Number of persons per household	**694**		5 [3.0]	2-17
Caregiver's relationship to youngest child	**694**			
Mother of the child	668	96.3		
Other (father, grandmother, aunt, sister)	26	3.7		
Religion	**694**			
Hindu	654	94.2		
Muslim	32	4.6		
Christian	8	1.2		
Age of caregiver	**694**		26 [6.0]	18-75
Education of caregiver	**694**			
Illiterate	55	7.9		
Literate without formal schooling	57	8.2		
Some/completed primary school	135	19.5		
Completed secondary school	350	50.4		
Any higher level of education	97	14.0		
Type of household construction[1]	**694**			
Pucca	495	71.3		
Semi-pucca	152	21.9		
Kuchha	47	6.8		
Own a BPL/ AYY card[2]	**694**			
Yes	179	25.8		
No	506	72.9		
DK	9	1.3		
Type of latrine[3]	**694**			
Private	264	38.0		
Shared	183	26.4		
Communal	202	29.1		
Not using a latrine	45	6.5		
Water Source location (98.8% improved)	**693**			
In dwelling	221	31.9		
In compound	135	19.5		
Outside compound	337	48.6		
Number of children < 5 per household	**852**		1 [0.0]	1-4
Gender of child	**852**			
Male	418	49.1		
Female	434	50.9		
Age of child (months)	**852**			
0-11	155	18.2		
12-23	191	22.4		
24-35	162	19.0		
36-47	175	20.5		
48-59	169	19.8		

[1]Pucca =concrete walls, floors and roof or corrugated roof; Kuccha =mud, dung, plastic, wood (non-durable materials); Semi-pucca=mix of pucca and kuchha.[2]BPL=below poverty line, AYY= Antyodaya (extreme poverty) ration cards.[3]Of any type: improved/ unimproved

Table 2. Frequency of feces disposal sites of pre-ambulatory children by site of defecation and on what they defecated (n =220)[1].

	Disposal site													
	Thrown in garbage[2]		**Thrown into canal/drain**		**Washed with water+soap[3]**		**Washed with water only**		**Thrown outside[4]**		**Put/rinsed into latrine**		**Total**	
Defecation site	n	(%)	n	(%)	n	(%)	n	(%)	n	(%)	n	(%)	n	(%)
on ground inside household	26	(39.4)	29	(52.7)	17	(36.2)	8	(27.6)	7	(58.3)	3	(27.3)	90	(40.9)
directly on ground	17	(25.8)	22	(40.0)	3	(6.4)	2	(6.9)	5	(41.7)	3	(27.3)	52	(23.6)
on cloth	1	(1.5)	1	(1.8)	14	(29.8)	5	(17.2)	2	(16.7)	0	(0.0)	23	(10.5)
on paper	5	(7.6)	6	(10.9)	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)	11	(5.0)
on polythene/oilcloth/plank	3	(4.5)	0	(0.0)	0	(0.0)	1	(3.4)	0	(0.0)	0	(0.0)	4	(1.8)
on ground in compound	28	(42.4)	18	(32.7)	5	(10.6)	5	(17.2)	3	(25.0)	1	(9.1)	60	(27.3)
directly on ground	21	(31.8)	15	(27.3)	3	(6.4)	1	(3.4)	2	(16.7)	0	(0.0)	42	(19.1)
on cloth	0	(0.0)	0	(0.0)	1	(2.1)	4	(13.8)	0	(0.0)	0	(0.0)	5	(2.3)
on paper	6	(9.1)	3	(5.5)	0	(0.0)	0	(0.0)	1	(8.3)	1	(9.1)	11	(5.0)
on polythene/oilcloth/plank	1	(1.5)	0	(0.0)	1	(2.1)	0	(0.0)	0	(0.0)	0	(0.0)	2	(0.9)
on bed	2	(3.0)	5	(9.1)	22	(46.8)	11	(37.9)	1	(8.3)	4	(36.4)	45	(20.5)
on cloth	2	(3.0)	3	(5.5)	21	(44.7)	11	(37.9)	1	(8.3)	4	(36.4)	42	(19.1)
on paper	0	(0.0)	0	(0.0)	1	(2.1)	0	(0.0)	0	(0.0)	0	(0.0)	1	(0.5)
on polythene/oilcloth/plank	0	(0.0)	2	(3.6)	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)	2	(0.9)
in cloth nappy/pants	1	(1.5)	1	(1.8)	3	(6.4)	5	(17.2)	0	(0.0)	1	(9.1)	11	(5.0)
in diaper	8	(12.1)	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)	1	(9.1)	9	(4.1)
in potty	0	(0.0)	2	(3.6)	0	(0.0)	0	(0.0)	1	(8.3)	1	(9.1)	4	(1.8)
on ground in latrine cubicle	1	(1.5)	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)	1	(0.5)
on paper	1	(1.5)	0	(0.0)	0	(0.0)	0	(0.0)		(0.0)	0	(0.0)	1	(0.5)
Total	66	(30.0)	55	(25.0)	47	(21.4)	29	(13.2)	12	(5.5)	11	(5.0)	220	(100.0)

[1]The table is organized descending from the main defecation and disposal sites.

[2]at house compound, at dump, in dustbin, sweeper van; [3]includes dettol/ detergent; [4]open field, rail tracks, outside compound, pond, roadside

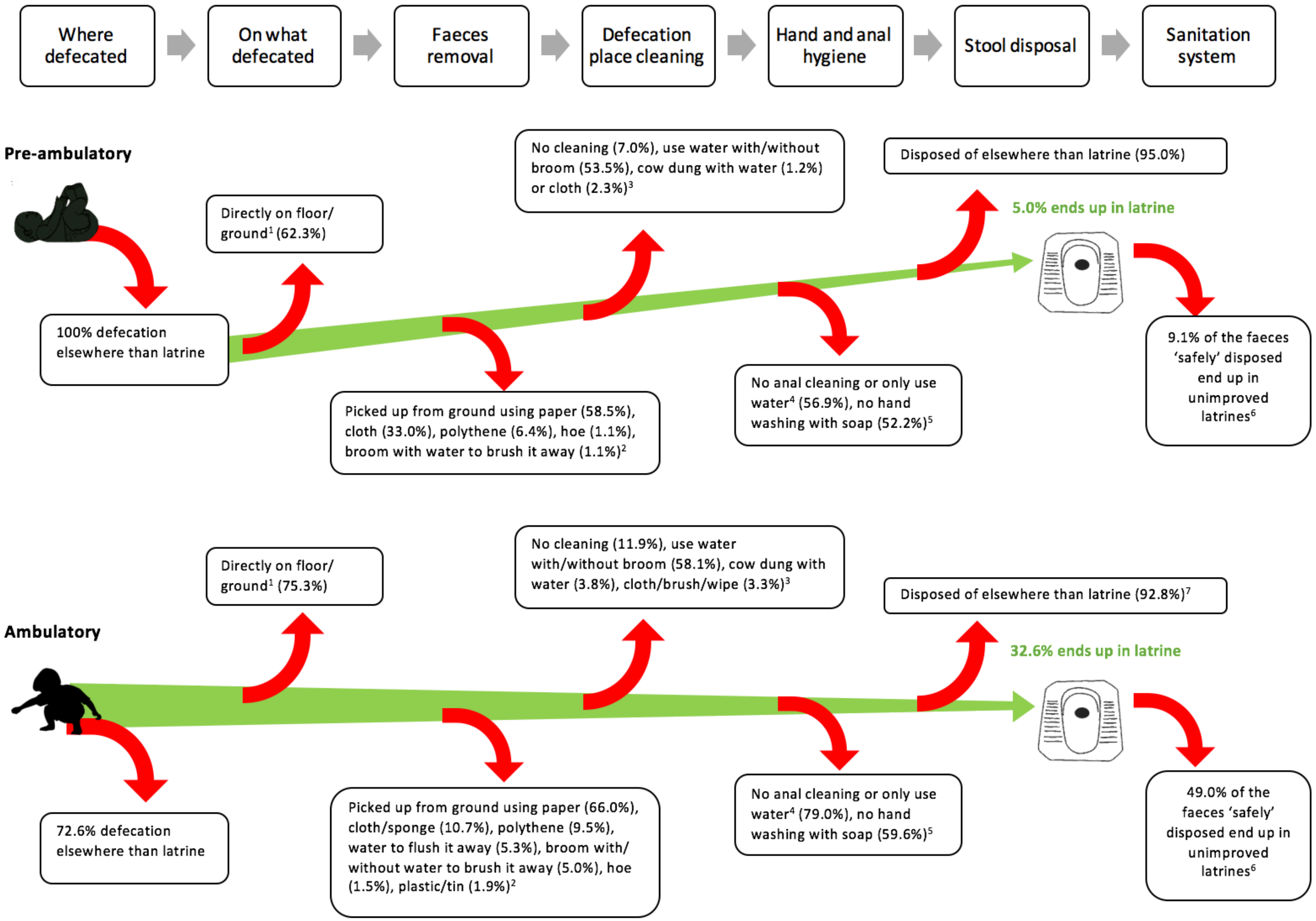
Table 3. Frequency of feces disposal sites of ambulatory children by site of defecation and on what they defecated (n =631)[1]

	Disposal site															
	Put/rinsed into latrine		**Thrown in garbage[2]**		**Thrown into canal/drain**		**Left in the open**		**Thrown outside[3]**		**Washed with water only**		**Washed water +soap[4]**		**Total**	
Defecation site	n	(%)	n	(%)	n	(%)	n	(%)	N	(%)	n	(%)	n	(%)	n	(%)
on ground in compound	7	(3.4)	70	(44.3)	80	(60.6)	1	(1.3)	21	(45.7)	1	(16.7)	0	(0.0)	180	(28.5)
directly on ground	4	(1.9)	46	(29.1)	54	(40.9)	1	(1.3)	20	(43.5)	1	(16.7)	0	(0.0)	126	(20.0)
on paper	3	(1.5)	23	(14.6)	26	(19.7)	0	(0.0)	1	(2.2)	0	(0.0)	0	(0.0)	53	(8.4)
on polythene/oilcloth/plank	0	(0.0)	1	(0.6)	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)	1	(0.2)
directly into latrine	173	(84.0)	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)	173	(27.4)
side path	2	(1.0)	56	(35.4)	24	(18.2)	0	(0.0)	14	(30.4)	0	(0.0)	0	(0.0)	96	(15.2)
directly on ground	1	(0.5)	43	(27.2)	20	(15.2)	0	(0.0)	12	(26.1)	0	(0.0)	0	(0.0)	76	(12.0)
on paper	1	(0.5)	12	(7.6)	4	(3.0)	0	(0.0)	1	(2.2)	0	(0.0)	0	(0.0)	18	(2.9)
on polythene/oilcloth/plank	0	(0.0)	1	(0.6)	0	(0.0)	0	(0.0)	1	(2.2)	0	(0.0)	0	(0.0)	2	(0.3)
in drain	0	(0.0)	0	(0.0)	0	(0.0)	68	(85.0)	0	(0.0)	0	(0.0)	0	(0.0)	68	(10.8)
on ground inside household	3	(1.5)	25	(15.8)	21	(15.9)	0	(0.0)	7	(15.2)	1	(16.7)	0	(0.0)	57	(9.0)
directly on ground	3	(1.5)	18	(11.4)	15	(11.4)	0	(0.0)	4	(8.7)	1	(16.7)	0	(0.0)	41	(6.5)
on paper	0	(0.0)	7	(4.4)	5	(3.8)	0	(0.0)	3	(6.5)	0	(0.0)	0	(0.0)	15	(2.4)
on polythene/oilcloth/plank	0	(0.0)	0	(0.0)	1	(0.8)	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)	1	(0.2)
in potty	7	(3.4)	4	(2.5)	3	(2.3)	0	(0.0)	4	(8.7)	1	(16.7)	1	(33.3)	20	(3.2)
on ground in latrine cubicle[5]	13	(6.3)	1	(0.6)	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)	14	(2.2)
roadside/riverside/field[5]	0	(0.0)	1	(0.6)	0	(0.0)	11	(13.8)	0	(0.0)	0	(0.0)	0	(0.0)	12	(1.9)
bathroom[5]	0	(0.0)	0	(0.0)	3	(2.3)	0	(0.0)	0	(0.0)	2	(33.3)	0	(0.0)	5	(0.8)
on bed	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)	1	(16.7)	2	(66.7)	3	(0.5)
on cloth	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)	1	(16.7)	2	(66.7)	3	(0.5)
in cloth nappy/pants	1	(0.5)	0	(0.0)	1	(0.8)	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)	2	(0.3)
in diaper	0	(0.0)	1	(0.6)	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)	1	(0.2)
Total	206	(32.6)	158	(25.0)	132	(20.9)	80	(12.7)	46	(7.3)	6	(1.0)	3	(0.5)	631	(100.0)

[1]The table is organized descending from the main defecation and disposal sites.

[2]at house compound, at dump, in dustbin, sweeper van; [3]open field, rail tracks, outside compound, pond, roadside;[4]includes dettol/ detergent; [5]all directly on ground

Figure 1. Child Feces Exposure Pathway



1 – if child defecated on ground (n= 151 pre-ambulatory and 364 ambulatory children), i.e. on ground in latrine cubicle, on the roadside, on the path near the house, in the household, in the household compound, in a field, by the river, in the bathroom floor.
2- if child defecated elsewhere than latrine and if the feces were not left in the open (i.e. not disposed of) and the child defecated directly on the ground (n=94 pre-ambulatory and 262 ambulatory children)
3- estimated using demonstration data for youngest child (total= 211 pre-ambulatory (4 missing) and 483 ambulatory children (3 missing)), when the child was reported to defecate on the ground directly of the latrine cubicle, path near the house, in the household, in the household compound, bathroom (n= 86 pre-ambulatory and 210 ambulatory).
4- does the caregiver wash the bottom of the child after defecation, using data on whether youngest child was ambulatory or not (only 1 response per household) (n= 211 pre-ambulatory and 483 ambulatory children). For 3 ambulatory children, the caregiver said the child cleans his/her bottom by themselves so there is no data on those children.
5- based on caregivers not washing hands (only 2 pre-ambulatory), not having a specific place to wash their hands or there being a hand washing facility but with no water & soap, if caregivers demonstrated/reported disposing of their children's feces (i.e. the question was asked if the feces were not left in the open, or children didn't directly defecate in the latrine) (n= 211 pre-ambulatory and 324 ambulatory but data is missing for 2 pre-ambulatory and 2 ambulatory children).
6- 1/ 11 safely disposed feces of pre-ambulatory feces end up in unimproved latrines, 101/ 206 safely disposed feces of ambulatory children end up in unimproved latrines.
7- if child defecated elsewhere than latrine (n=458)

6. Determinants of disposal of child faeces in latrines in urban slums of Odisha, India: a cross-sectional study

6.1. Cover sheet for research paper included in thesis

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SECTION A – Student Details

Student	Fiona Majorin
Principal Supervisor	Thomas Clasen
Thesis Title	Disposal of child faeces: practices, determinants and health effects

If the Research Paper has previously been published please complete Section B, if not please move to Section C

SECTION B – Paper already published

Where was the work published?			
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Where is the work intended to be published?	Transactions of the Royal Society of Tropical Medicine & Hygiene
Please list the paper's authors in the intended authorship order:	Majorin F, Torondel B, Routray P, Rout M, Clasen TF
Stage of publication	**Not yet submitted**

SECTION D – Multi-authored work

For multi-authored work, give full details of your role in the research included in the paper and in the preparation of the paper. (Attach a further sheet if necessary)	I drafted the study protocol and study tools, with input from co-authors. I analysed the results and drafted the manuscript.

Student Signature: Fiona Majorin **Date:** 25/01/17

Supervisor Signature: **Date:** 25/01/17

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Determinants of disposal of child faeces in latrines in urban slums of Odisha, India: a cross-sectional study

Fiona Majorin, Belen Torondel, Parimita Routray, Manaswini Rout, Thomas Clasen

Abstract

Background

Worldwide an estimated 2.4 billion people lack access to improved sanitation. Even among households that have access to improved sanitation, children's faeces—a potentially important source of disease transmission—often do not end up in a latrine, the international criterion for safe disposal of child faeces.

Methods: We collected data on possible determinants of safe child faeces disposal in a cross-sectional study of 851 children under five from 694 households in 42 slums in two cities in Odisha, India. Caregivers were asked about defecation and faeces disposal practices for all the children under five in the household, as well as potential risk factors.

Results: Only a quarter (25.5%) of the 851 children were reported to have their faeces disposed in the latrine (child defecating in latrine directly or faeces being subsequently disposed in latrine). Even fewer (22.3%) of the 694 households reported all the <5 children's faeces ended up in the latrine the last time the child defecated, and 71.2% reported none of their children's faeces ended in the latrine. Factors associated with being a safe disposal household were: education and religion of the primary caregiver, number of children <5 in the household, wealth, type and location of latrine, defecation behaviours of the household members >5 and the mobility of children in the house.

Conclusions: Few households reported disposing of all of their children's faeces in a latrine. Increasing latrine access closer to the households and specific behaviour change interventions may improve this practice.

Introduction

Poor sanitation is a major cause of faecal-oral diseases, including diarrhoea which is responsible for more than 1.2 million deaths annually [1]. In 2015, 2.4 billion people did not have access to improved sanitation worldwide, including nearly 1 billion people that practiced open defecation [2]. In India 44% of its population practiced open defecation and only 40% used improved facilities [2].

Even in settings with improved sanitation (or "basic sanitation" under the proposed SDG sanitation ladder [3]), householders often do not dispose of child faeces in latrines [4-6], creating a potentially important source of exposure to faecal pathogens. A recent report by the World Bank Water and Sanitation Programme (WSP) presenting analysis from the latest available Multiple Indicator Cluster surveys (MICS) and Demographic and Health Surveys (DHS) (survey years: 2006-2012) found that in 15 out of 26 locations more than 50% of households reported disposing of their youngest under three year old child's faeces unsafely (not into a latrine); and the percentage of faeces ending up in improved sanitation facilities was even lower [6]. In India, the latest DHS (2005-2006) found that only 20.3% of child faeces ended up in a latrine (child defecated in latrine (11.5%) and 8.8% were disposed in the latrine) and 0.8% was buried [7]. A cross-sectional study of child faeces disposal practices among rural households in villages in the State of Odisha where the Total Sanitation Campaign (TSC) had been implemented at least 3 years before, found that 81.4% of child faeces were disposed of unsafely, with the majority of faeces reported being deposited with the solid waste. Safe disposal of child faeces only occurred in households with latrines, but the majority of the faeces were disposed of elsewhere [5].

While the Government of India has endeavoured to improve sanitation through a series of initiatives aimed at reducing open defecation, evaluations of these have found limited impacts on child faeces disposal practices. In one such evaluation, the intervention increased the safe disposal of child faeces from 1.1% at baseline to 10.4% in intervention households compared to 3.1% in the control households (RR: 3.34; 95% CI: 1.99-5.59) [4]. In another study, the intervention also resulted in an increase of safe child faeces disposal by 9 percentage points (27% intervention vs. 18% control; $p<0.001$)[8]. While these studies showed some improvements in child faeces disposal, the majority of faeces still ended up in the environment. Studying factors that are associated with child faeces disposal may help in understanding reasons for the low prevalence as well as potential ways to improve the behaviours.

Factors that have previously been found to be associated with disposal of child faeces into a latrine include: (i) child characteristics and practices (mobility category, defecation site of the child, child age); (ii) factors related to the water and sanitation access and use (number of years of latrine ownership, access to a toilet in the compound, type of latrine, consistency of adult latrine use, presence of child faeces management tools in the latrine, and type of water source); and (iii) socio-economic and demographic characteristics (urban residence, household wealth, household head's education, number of children <5 in the household, mother's education, caregiver/mother age, attendance to health education sessions, media exposure, religion, caste/tribe of head of household) [4-6, 9-13].

Our research suggests that there are multiple sources of exposure from child faeces beyond the disposal in a latrine (Majorin 2016, submitted). These include unhygienic collection of faeces or cleaning of surfaces when children defecate on the floor or ground (diapers and potties being rare in many low-income settings) and inadequate handwashing after disposing of the faeces. However, international monitoring currently defines "safe disposal" of child faeces solely on the basis of whether the faeces ended up in a latrine, either because the child defecated in a latrine or the faeces were subsequently deposited there. While acknowledging the potential shortcoming of this limited criterion, we report here on associations between disposal of faeces in the latrine ("safe") and possible determinants in urban slums in Odisha, India.

Methods

Study design and setting

Details of the study have been described in an accompanying paper that has already been submitted elsewhere (Majorin 2016, submitted). Briefly, the study followed a cross-sectional design using a questionnaire, spot checks and demonstrations of child faeces management practices as data collection tools. The data collection took place in July and August 2014. Households were selected using an adaptation of the Extended Program of Immunization (EPI) sampling method [14]. Households eligible for inclusion in the study were required to meet the following eligibility criteria: (i) have at least one child < 5 years with a primary caregiver older than 18 years old, and (ii) the primary caregiver reported having access to sanitation facilities (individual household latrines, shared or communal facilities) or belonged to a slum with communal sanitation facilities. Households that otherwise met such eligibility criteria were nevertheless excluded from the study if the primary caregiver was an ASHA (Accredited Social Health Activist), *anganwadi* (government sponsored child-care and mother-care centre) worker or a person who had worked for health promotion campaigns. The number of participating households in each slum varied due to the varying sizes of the slums and the availability of households with children under five at the time of visit. Respondents were the primary caregivers (defined as 'the one who usually cares for the child') of the youngest child under five in each household. Households that were locked, where the primary caregiver was unavailable at the time of visit, that did not meet the eligibility criteria or that refused to participate, were not enrolled and the enumerators would go to the next household on the left until they found one that met the eligibility criteria.

Slum Selection

The informal settlements (slums) were selected from lists of 23 in Cuttack and 39 slums in Bhubaneswar in which other sanitation-related work has been conducted [15]. The selection criteria for the slums was that they had at least 33 households with access to either individual household latrines or functional community latrines [15, 16]. We excluded 3 leprosy colonies from our list of eligible slums as well as slums in which pilot activities were previously conducted. This selection process resulted in 20 eligible slums in Cuttack and 28 eligible slums in Bhubaneswar. These slums were randomly ordered using STATA version 12 (StataCorp, College Station, Texas, United States).

Sample size calculation

The primary outcome for this cross-sectional study is the proportion of children <5 whose faeces are disposed of safely (defined here as defecation or disposal in a latrine). Based on previous studies, the sample size was calculated using the average of 30% safe disposal. Using simple random sampling, the average of 30% safe disposal of child faeces led to a sample size of 323 people (95% confidence) [17]. The sample size calculation was adjusted to account for clustering, with an intra-cluster correlation coefficient (ICC) of 0.06 based on previous work in rural Odisha [18]. Based on the different sample size calculations in different scenarios, 20 households in 35 clusters (a total of 700 households) was chosen to be the best logistical option. The study was not separately powered for each city but for 35 slums in total. As it was not always possible to find 20 eligible households in each selected slum, we continued selecting slums in the order in which they had been randomly ordered until we reached our target sample size of 700 households. This resulted in the data being collected in 42 slums: 22 in Bhubaneswar and 20 in Cuttack.

Data collection tools

Data collection tools included a structured survey, which included questions on socio-economic and demographic factors, access to sanitation, water and hygiene facilities, availability of potties and diapers, exposure to messages about child sanitation or hygiene, and agree or disagree statements. Questions about defecation place and faeces disposal method for the last time each child under five defecated [5] were included using wording as per the core questions of the WHO/UNICEF Joint Monitoring Programme on Water and Sanitation (JMP)[19]. The age and mobility capacity (whether the child can or cannot walk) of the children, whether they were exclusively breastfed and the consistency of their faeces (solid, liquid, semi-solid) the last time they defecated, were also recorded. The questions on defecation and disposal practices for the last time the children defecated were asked for all the children under five in each household (defined as sharing the same cooking pot). Data was also collected on the age, marital status and usual defecation places of each family member over the age of five [20].

Spot-checks were done to determine the type of the latrine (flush/pour flush with pit/ closed sewer system, flush/pour flush without pit/ open sewer system, pit latrine with slab, or other) reported by the households as the one used the majority of the time, to check the presence of a potty in the household, whether children were wearing a diaper, and to check the availability of soap and water at the specific place identified by participants to be used for hand washing after disposal of child faeces.

The questionnaire, information sheet and consent forms were written in English and then translated into Odia, the local language. A researcher bilingual in Odia and English evaluated the translation. All the enumerators who conducted the surveys were fluent Odia speakers.

Ethics and consent

Ethics approval was obtained from the London School of Hygiene and Tropical Medicine and the School of Medicine of the Kalinga Institute of Industrial Technology (KIIT) (India). Prior to enrolment, the enumerators read an information sheet describing the study, answered any questions and asked for written consent to participate. The study participants received no compensation for their participation and were free to withdraw from the study at any time. Anonymity was ensured through the use of household identification numbers.

Data entry and analysis

Data were double entered using EpiData 3.1 (EpiData Association, Odense, Denmark) and analysed using STATA version 14 (StataCorp, College Station, Texas, United States). Child faeces disposal was categorized as safe if children's faeces ended up in the latrine (defecation or disposal in any latrine, improved or unimproved as per the JMP [19]). The analysis was performed at the household level, whether a household practiced safe disposal of all the children's faeces 'safe disposal household' or not 'unsafe disposal household' (none or only a portion of the children's faeces were disposed of in a latrine).

An asset index was created by combining household information on numbers of rooms to sleep, household construction type and ownership of items (watch/ clock, pressure cooker, radio, TV, dish antenna, fridge, mobile phone, mattress, bed/cot, chair, table, sewing machine, bicycle, motorbike, car, computer/ tablet) using principal component analysis [21]. The wealth score was divided into tertiles. Numbers of room to sleep in was missing 2 values, these were replaced by the average value for households with the same number of total rooms. The type of latrine (improved or unimproved) and location of latrine were combined into a variable with three levels: unimproved outside compound, unimproved inside compound or in/attached to dwelling and improved latrine (of which 7 were outside the compound).

Bivariate analyses were conducted, to assess the association of safe disposal households with each of the possible covariates collected. Polychoric correlations were used to check correlations between all variables and collinearity diagnostics were checked. All variables with a p-value <0.25 (Wald) in the bivariate analysis were considered for inclusion in the multivariate analysis. Variables that were not significant (p<0.1) in the full model were removed one at a time, while checking the ORs in the model did not change >20%. This was conducted until all insignificant variables were excluded from the model. Variables initially excluded after the bivariate were then checked for significance and included if p<0.1. Finally, interactions were investigated between wealth and latrine type. [22]. Generalised estimating equations with robust standard errors were used to calculate odds ratios, and accounted for clustering at the slum level using an exchangeable correlation matrix. As safe child faeces disposal was only possible in households with access to a latrine, the multivariate analysis excluded households that reported not using sanitation facilities.

Results

A total of 694 households, with 852 children < 5, were enrolled from 42 slums. There was an average of 16.5 respondents per slum (range: 3-20). Most households had just one child <5 (554/694, 79.8%) while 140 households had more children (18.0% had 2, 1.7% had 3 and 0.4% had 4). Complete data on defecation behaviours were available for 851 children, the missing child belonged to a household with 3 children, and thus it is considered as a household with 2 children.

Overall, 25.5% (95%CI: 22.7-28.5) of the 851 children were reported to have their faeces end up in the latrine the last time they defecated (faeces of 217 children from 200 households). Most of these (20.3%, 95%CI:17.8-23.2) defecated directly into latrine while the others had faeces deposited there after defecating elsewhere. Only 13.5% (95%CI: 11.4-16.0) ended up in improved latrines (improved disposal).

At the household level, 22.3% of households disposed of all the <5 children' faeces in the latrine the last time the child defecated (155/694, 142 households had 1 child, 13 households had 2), 6.5% (45/694) of households disposed of some of the children's faeces in the latrine (38 with 1 out 2 faeces ending up in the latrine and 4 with 2 out of 3 faeces disposed in latrine and 3 with 1 out of 3 faeces ending up in the latrine), 71.2% (494/694) disposed of none of the children's faeces in the latrine (412 with 1 child, 75 with 2 children, 4 with 3 children, 3 with 4 children).

In the bivariate analysis the following factors were found to be associated with safe disposal households (Wald p<0.25): education, age, religion and occupation of the primary caregiver, number of children <5 in the household, wealth, location of the drinking water source, type and location of latrine, having heard or seen a message about child sanitation or hygiene, use of the latrine by household members over 5 years old, mobility of the children in the household (table 1). Certain other variables were also associated with safe disposal (attendance to *anganwadi*, breastfeeding and age), but these were excluded due to their collinearity with mobility (Supplementary table 1). Having a place to wash hands with soap and water was excluded as the question was only asked to caregivers who disposed of their child's faeces (i.e. the child didn't defecate directly in the latrine and faeces weren't left in the open); what is used to wash a child's bottom was also excluded due to lack of reported data. Whether the defecation place of children <5 was improved or not was also associated with the outcome. However, this was not included in the multivariate analysis because it excluded the 114 households in which all children used the latrine. As safe child faeces disposal was only possible in households with access to a latrine, the multivariate analysis excluded the 55 children from the 45 households that didn't use sanitation facilities, resulting in a sample of 796 children in 649 households.

The multivariate analysis resulted in the following variables being significantly associated with being a safe disposing household: education and religion of the primary caregiver, number of children <5 in the household, type and location of latrine, defecation behaviours of the household members >5, the mobility of children in the house and the interaction between wealth and latrine type and location (table 2). A caregiver with higher education than secondary school was associated with increased odds of being a safe disposing household compared to caregivers who were illiterate or had no formal schooling (AOR: 2.05, 95%CI:1.01-4.19). Being Muslim or Christian increased the odds of being a safe disposing household (AOR:2.82, 95%CI:1.07-7.44). Having only one child increased the odds of being a safe disposing household (AOR:2.20, 95%CI:1.09-4.47). Using an unimproved latrine in the compound or in/attached to the dwelling (AOR:2.86, 95%CI:1.15-7.11) and using an improved latrine increased the odds of being a safe disposing household (AOR: 5.98, 95%CI:1.86-19.29) compared to households using unimproved latrines outside the compound. Households where all the members > 5 were reported to use the latrine always, had higher odds of being a safe disposal household (AOR: 8.09, 95%CI: 1.75-37.33). Households where all the children <5 were ambulatory had 8.46 times the odds of being a safe disposing household (AOR: 8.46, 95%CI: 4.25-16.85). In all categories of wealth, using an improved latrine increased the odds of being a safe disposing household.

Discussion

While we have defined and studied factors associated with safe child faeces disposal, defined here as ending in any latrine (improved or unimproved), we would not recommend this classification of safe. Children's faeces should at least be treated to be as risky as those of adults and thus treated in the same way with regards to disposal. Furthermore, as we have described in a previous study (Majorin 2016, submitted), child faeces management contains several critical points beyond the final disposal place that need to be mitigated to avoid exposure including the place of defecation, cleaning of that place as well as hygiene behaviours.

The factors found to be associated with being a safe disposing household are similar to previous studies. Azage and colleagues (2015) found that increase in caregiver education and a lower number of children in the household were associated with safer disposal [9]. The consistency of adult toilet use has also been found to be associated with safe disposal in another recent study [11].

Being a Christian or Muslim was associated with higher odds of safe disposal. This was also found in a recent study analysing the latest India DHS data, which found that Muslim households and 'other religion' households had lower odds of unsafe disposal than Hindu households [13]. This finding may be explained by Hindu religious rituals that may prevent safe disposal in a latrine, such as cleaning of clothes after entering the latrine [23]. The SQUAT survey also found that religion was associated with use of the latrine, with Muslims using their latrine more than Hindus [24, 25].

In this study we found that being from a wealthier household was borderline associated with poorer child faeces disposal practices, which is contrary to other studies [6, 9, 13]. This may be due to mediating factors between wealth and the outcome, such as the type of latrine used by the household and maybe other factors that were not measured in the study. Indeed, the type of latrine was an effect modifier of wealth, with improved latrines increasing the odds of safe disposal within each wealth category. Another possibility is that the assets used to generate the wealth categories don't represent wealth accurately.

The strong association of being a safe disposing household with using an improved latrine has been found in other studies [6, 9, 12, 13]. Additionally, in this study we sub grouped unimproved latrines by distance and found that unimproved latrine users were more likely to being a safe disposing household if the latrine they used was nearer to their dwelling, which may be due to the convenience of disposing of faeces or training children to use a latrine if it's closer to the house. We have previously described that the age of latrine training was younger for children in households with private and shared latrines compared to communal latrine users (Majorin 2016, submitted). In addition, for communal latrine user households, it may not be seen as adequate for children to use them. A recent study in Accra in Ghana, found that children were unlikely to use public toilets [26].

The mobility of children is strongly associated to safe disposal, because most of the safe disposal is due to ambulatory children directly defecating in the latrine. This has also been found in previous studies in rural Odisha [4, 5]. Similarly, increase in safe disposal with increasing age of the children has been found in other studies [6, 9-11, 13]. This suggests that there is a need to design interventions for younger children who are defecating elsewhere than the latrine.

Limitations

This paper is only focusing on associations between households that dispose of all of the children's faeces in a latrine and possible determinants. However, disposing of children's faeces in a latrine is only one risky aspect of child faeces management. Furthermore, the study quantified safe disposal using questions about the last time each child defecated, this behaviour is likely to change and has not been found to be consistent in other studies [4, 11]. In addition, this study was conducted in the rainy season and thus behaviours may differ from other seasons.

The results of this study are only generalizable to the population included in the study. In addition, it has been found that participants over-report "desirable" behaviours of child faeces disposal when data is collected using questionnaires compared to structured observations [27, 28]. We tried to minimise this by using questions about the last time children defecated [19]. In addition, recent evidence suggests that reported and observed behaviour were very similar [29].

Conclusions and recommendations

Few households reported disposing of all of their children's faeces in a latrine. Factors associated with being a safe disposal household were: education and religion of the primary caregiver, number of children <5 in the household, wealth, type and location of latrine, defecation behaviours of the household members >5 and the mobility of children in the house. Based on these findings, potential candidates for improving disposal of child faeces into a latrine include improving latrine use of all the members of the household as well as finding safe disposal methods for children who are not ambulatory as little safe disposal is observed in this age group. Improving latrine use by ambulatory children is also key as many of them still do not use the latrines despite their physical ability to do so.

Acknowledgements

We would like to thank the survey participants for their participation, and also the field team Munmun Dasmohapatra, Alfred Mohanty, Soumya Nayak, Sunita Ray, Sasmita Barik, Puspa Barik, Swarnalata Sahoo, Rajani Barik, Archana Harichandan, Arnapurna Harichandan, Rajashree Nayak and the data entry team Sadasiv Khotia and Sonam Sahoo.

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Table 1. Bivariate analysis assessing association between risk factors and safe disposal households

	Safe disposing household						
Variables	**N**	**Total**	**%**	**OR**	**lower CI**	**upper CI**	**P-value***
Education of primary caregiver	**694**						
Illiterate/no formal schooling	14	112	12.5	Ref			
Some/ completed primary school	13	135	9.6	0.66	0.34	1.30	0.229
Completed secondary school	86	350	24.6	1.63	0.95	2.80	0.078
Any level of higher education	42	97	43.3	3.59	1.95	6.60	<0.001
Age of primary caregiver	**694**						
18-24	48	264	18.2	Ref			
25-29	57	257	22.2	1.24	0.81	1.89	0.330
30+	50	173	28.9	1.77	1.11	2.84	0.017
Religion of primary caregiver	**694**						
Hindu	140	654	21.4	Ref			
Muslim/ Christian[1]	15	40	37.5	2.30	0.84	6.25	0.104
Caregiver has a job	**694**						
No	139	632	22.0	ref			
Yes[2]	16	62	25.8	1.58	1.04	2.40	0.032
Number of children <5 in household	**694**						
2-4	13	140	9.3	ref			
1	142	554	25.6	2.83	1.73	4.60	<0.001
Number of people >5 living in household							
1-2	39	165	23.6	ref			
3-4	53	253	21.0	0.89	0.56	1.42	0.63
5-6	32	157	20.4	0.93	0.64	1.35	0.706
7-16	31	119	26.1	1.23	0.72	2.09	0.452
Wealth	**694**						
Poorest	38	233	16.3	ref			
Middle	45	231	19.5	1.08	0.62	1.86	0.789
Least poor	72	230	31.3	1.96	1.20	3.20	0.007
Gender of head of HH	**694**						
Female	22	127	17.3	Ref			
Male	133	567	23.5	1.28	0.83	1.99	0.269
Owner/ tenant of house	**694**						
Owner	110	506	21.7	Ref			
Tenant	45	188	23.9	1.02	0.73	1.42	0.921
Time in household	**692**						
<1 year	11	43	25.6	Ref			
1- 5years	30	115	26.1	1.00	0.45	2.24	0.998
5+ years	114	534	21.4	0.94	0.50	1.76	0.836
Location of drinking water (98.8% improved)	**693**						
Outside compound	49	337	14.5	ref			
In compound	37	135	27.4	1.83	1.09	3.09	0.023
In dwelling	69	221	31.2	2.34	1.45	3.77	<0.001
Type of latrine[3]	**649**						
Unimproved latrine outside compound	26	248	10.5	ref			
Unimproved latrine in compound	36	160	22.5	2.21	1.23	3.96	0.008
Improved	93	241	38.6	4.73	2.77	8.10	<0.001
Ownership of a potty	**694**						
No/ unable to show[4]	141	648	21.8	ref			
Yes observed	14	46	30.4	1.34	0.69	2.59	0.391
Buy diapers sometimes	**694**						
No/DK	79	366	21.6	ref			
Yes	76	328	23.2	0.89	0.57	1.39	0.604

Table 1 (continued)

Variables	N	Total	%	OR	lower CI	upper CI	P-value*
Hand washing place[5]	**535**						
No specific place	8	159	5.0	ref			
Hand washing facility	2	140	1.4	0.25	0.037	1.68	0.154
Hand washing facility with soap and water	33	230	14.4	2.62	1.29	5.33	0.008
Wash child's bottom[6]	**681**						
Use water	102	489	20.9	ref			
Use water and soap	44	125	35.2	2.01	1.38	2.92	<0.001
Use cloth/ wipe/ paper	4	67	6.0	0.19	0.06	0.59	0.004
In the last 6 months heard/seen any messages about child sanitation/ hygiene[7]	**694**						
No	95	477	19.9	ref			
Yes	60	217	27.7	1.38	1.01	1.91	0.046
Ever heard of a program promoting the use of latrines by children?	**694**						
No/DK	143	642	22.3	ref			
Yes	12	52	23.1	0.92	0.39	2.18	0.847
>5 summary variables per HH							
All >5 members of HH use latrine always	**649**						
No	5	116	4.3	ref			
yes	150	533	28.1	5.84	1.81	18.83	0.003
<5 summary variables per HH							
Proportion of male and female <5 per HH	**694**						
Female >=Male	86	385	22.3	ref			
Female < Male	69	309	22.3	1.03	0.74	1.43	0.864
Proportion of mobility category in HH	**694**						
All/some pre-ambulatory	11	211	5.2	ref			
All ambulatory	144	483	29.8	7.07	3.55	14.08	<0.001
Defecation site of <5	**580**						
All/some unimproved[8]	24	384	6.3	ref			
All semi-improved[9]	7	137	5.1	0.67	0.25	1.78	0.421
All improved[10]	8	34	23.5	3.93	1.60	9.62	0.003
Mixed semi/improved/use latrine	2	25	8.0	1.31	0.33	5.24	0.701
Proportion of solid feces[11]	**462**						
All liquid	1	44	2.3	ref			
All solid	31	333	9.3	5.22	0.57	47.76	0.144
All semi solid	3	64	4.7	2.89	0.23	36.26	0.41
Some liquid/ solid/ semi	0	19	0	dropped			
All DK/didn't see	0	2	0	dropped			

*Wald p-value

1. 8 muslim, 32 christians
2. Mostly day labour (44/62), private job(10/62), gvt job (4/62), business (4/62)
3. Excludes 45 HH who practice open defecation, none are safely disposing households. Outside compound, includes in neighbour's compound or dwelling, inside compound includes attached/in dwelling, improved latrines include 7 that were out of the compound.
4. Seven households did not show the potty,
5. Only for those who disposed of faeces (i.e.child didn't defecate in latrine or faeces weren't left in the open) 4 missing, 2 reported no hand washing.
6. Only for those who wash (3 said the child washed himself and 10 said they didn't clean). Water includes water and powder; soap includes dettol; cloth includes cloth with dettol or water or coconut oil.
7. On tv, radio, poster, newspaper, or other
8. On ground in lat cubicle, roadside, riverside, field, side path, in compound, household, drain, bathroom
9. On paper, polythene, cloth, oil cloth, or plank
10. In Potty, nappy, pants or diaper
11. Only for those households in which none of the children defecated in the latrine, drain or were left in the open. Thus the safe disposing hosueholds only include those where the faeces of all the chilldren in the HH were deposited in the latrine when the child defecated elsewhere (n=35).

Table 2. Ajusted associations between risk factors and safe disposal households (n=649)

Variables	AOR	lower CI	upper CI	P-value (Wald)
Education of primary caregiver				
Illiterate/no formal schooling	Ref			
Some/ completed primary school	0.68	0.30	1.51	0.341
Completed secondary school	1.20	0.64	2.25	0.574
Any level of higher education	2.05	1.01	4.19	0.047
Religion of primary caregiver				
Hindu	Ref			
Muslim/ Christian	2.82	1.07	7.44	0.036
Number of children <5 in household				
2-4	Ref			
One	2.20	1.09	4.47	0.028
Wealth				
Poorest	Ref			
Middle	0.95	0.39	2.29	0.908
Least poor	0.19	0.03	1.19	0.076
Type of latrine				
Unimproved latrine outside compound	Ref			
Unimproved latrine in compound	2.86	1.15	7.11	0.024
Improved	5.98	1.86	19.29	0.003
All >5 members of HH use latrine always				
No	Ref			
yes	8.09	1.75	37.33	0.007
Proportion of mobility category in HH				
All/some pre-ambulatory	Ref			
All ambulatory	8.46	4.25	16.85	<0.001
Interaction between wealth and latrine				
Middle* unimproved in compound	0.48	0.15	1.55	0.221
Middle* improved	0.55	0.15	2.05	0.373
Least poor * unimproved but in compound	2.67	0.30	24.04	0.381
Least poor * improved	2.77	0.32	23.82	0.353

Supplementary table 1: Additional variables from the bivariate analysis, assessing association between risk factors and safe disposal households

Variables	N	Total	%	OR	lower CI	upper CI	P-value[2]
Age composition	**694**						
Some/ all are infants	9	151	6.0	ref			
None are infants (<1 yo)	146	543	26.9	5.90	2.80	12.44	<0.001
Proportion of <5 who go to *anganwadi*	**694**						
all/some never attend	77	513	15.01	ref			
all attend (always/sometimes)	78	177	44.1	4.59	3.01	6.98	<0.001
missing	0	4	0	_			
Proportion exclusively breastfed	**694**						
All/some exclusively breastfed	2	58	3.5	ref			
Some mixed and some not breastfed	8	93	8.6	2.99	0.75	11.97	0.122
All mixed food (breastfeeding and other)	47	311	15.1	4.54	1.14	18.08	0.032
All other than breastfed	98	231	42.4	18.22	4.58	72.53	<0.001
Missing	0	1	0	_			

7. **Additional findings from the cross-sectional study**

In this chapter, I will describe additional results from the cross-sectional study, which were not included in the papers prepared for publication. My intention at the outset of the PhD was to conduct some formative research to develop an intervention to improve child faeces disposal. Thus in the cross-sectional survey, I included some questions that could be used for that purpose, and I was planning to conduct some qualitative research to complement the quantitative findings. However, this was not possible within the PhD. In this chapter I present the additional data from the survey using a formative research framework to structure the findings and highlight areas that require qualitative research to complete the formative research.

The evidence from the systematic review, presented in chapter 3, suggests that child faeces disposal may play a role in preventing diarrhoea transmission and thus designing an intervention to improve child faeces disposal practices may be of public health importance.

In order to plan an effective behaviour change intervention, it is essential to understand predominant behaviours and the determinants for these behaviours [38]. This is achieved through formative research[36, 71-74].

According to Curtis and colleagues (1997), formative research should set out to answer five questions in order to plan an intervention [72]:

1. Which practices put children at risk of infection?
2. What are the practices that are a priority for intervention?
3. Who are the target audiences?
4. What can motivate behaviour change?
5. What communication channels and materials are likely to be effective?

For the first question, I focus on unsafe child faeces management in the domestic environment. As hardware is likely to be important in enabling the safe disposal of child faeces, whether it consists of a potty, faeces removal or collection devices, cleaning product or a way to adapt a latrine for child use, an important aspect of the formative research should include describing the hardware currently used and investigate possible hardware solutions.

In line with the formative research questions outlined above and the behaviour of interest of improving child faeces disposal in the domestic environment, I developed the following research questions which may be useful to understand the determinants of child faeces management practices and to design a behaviour change intervention to improve child faeces disposal:

1. How are developmental stages of children below five defined in the local population and how do they relate to defecation practices, toilet training and faeces disposal practices?
2. How are children's faeces disposed of?
3. Who is involved in child faeces disposal?
4. What is the setting in which child faeces disposal takes place?
5. What are the channels of communication used in the research population?
6. Why do people use their current child faeces disposal practices and what influences those practices?
7. What are the available hardware for child faeces disposal and how could the use and adoption of hardware that can improve child faeces disposal be increased?

As I mentioned above, in order to answer some of these questions, some qualitative and ethnographic methods would be required [71, 72]. These would also be useful to triangulate the quantitative findings from the cross-sectional study. However, some of the data collected during the cross-sectional study can provide a start to answer these questions. I will therefore present the additional results thematically according to these questions. This will also highlight remaining research gaps that require qualitative research. Question 1 requires some qualitative research, which was beyond the scope of this PhD. Question 2 has been described in Chapter 5, thus I focus on questions 3-7 here.

Question 3. Who is involved in child faeces disposal?

In order to target the intervention to the correct audience, it is important to know who is involved in child faeces disposal (table 7.1). The large majority is the mother (96.1%), but other relatives are also involved, including the grandmother of the child, the father, aunt and older sibling. Similar household members are involved in teaching the child to use a latrine and in caring for the child in case the primary caregiver has a job and leaves the house for work. Decision making on purchasing of diapers are a combination of the caregiver and partner, while latrine training is mostly the decision of the primary caregiver.

Table 7.1: Who is involved in child faeces disposal

	N	%
Who usually disposes of child faeces[1]	**533**	
Mother	512	96.1
Father	2	0.4
Grandmother	13	2.4
Aunt	4	0.8
Older sibling	1	0.2
Mother & father	1	0.2
Who usually teaches the child to use a latrine	**694**	
Mother	675	97.3
Father	1	0.1
Grandmother	8	1.2
Aunt	2	0.3
Older sibling	3	0.4
Mother + other (father/ grandmother)	4	0.6
Learn on his own	1	0.1
Caretaker of the child while main caregiver is at work[2]	**59**	
Caregiver takes the child to work	5	8.5
Father of the child	10	17.0
Grandmother of the child	14	23.7
Aunt	5	8.5
Neighbour	2	3.4
Older sibling	13	22.0
Mother of the child	8	13.6
Child goes to school while the caregiver works	1	1.7
Uncle	1	1.7
Who usually makes decisions about making purchases for diapers	**694**	
Respondent	152	21.9
Partner	154	22.2
Respondent and partner jointly	53	7.6
Male head of HH	1	0.1

Grandmother in law	5	0.7
NA	255	36.7
Someone else (aunt, child's mother, father or neighbour)	7	1.0
DK	67	9.7
Who usually makes decisions about teaching the child to use a latrine	**694**	
Respondent	632	91.1
Partner	19	2.7
Respondent and partner jointly	24	3.5
Male head of HH	1	0.1
Grandmother in law	7	1.0
NA	2	0.3
Someone else (child's mother, friends)	7	1.0
DK	2	0.3

[1]if caregiver reported/ demonstrated disposing of child faeces, i.e. the faeces were not left in the open or the child didn't use the latrine directly. 2 missing values.
[2]62 caregivers with a job, 59 leave the house for work

Question 4. What is the setting in which child faeces disposal takes place?

An important aspect of the setting in which child faeces disposal takes place is the type of sanitation infrastructure to which households have access (table 7.2). Indeed, safe child faeces disposal is only possible for households with latrines and as discussed in Chapter 6, the type of facility is associated with safe disposal behaviour.

Table 7.2: Sanitation facilities and practices of members of household

SANITATION	N	%	Median [IQR]	Range
Main latrine used by household	**694**			
Private	264	38.0		
Shared	183	26.4		
Communal	202	29.1		
No member of HH uses a latrine	45	6.5		
Private latrines				
Median number of years ago latrine was built	**161**		6 [8.0]	0-40
Don't know how long ago latrine was built	103	39.0		
Type of latrine	**264**			
Flush/ pour flush with pit/closed sewerage system	228	86.4		
Flush/ pour flush without pit/ open sewerage system	23	8.7		
Pit latrine with slab	13	4.9		
Latrines functional (If have any cover; not used for storage; pan not broken, not blocked or not full of leaves or dust; pit completed)[1]	**241**			
Yes	221	91.7		
No	20	8.3		
Latrines Used (if either smell, pan wet or stains of	**264**			

urine/faeces)				
Yes	263	99.6		
No	1	0.4		
Shared latrines	**N**	**%**	**Median [IQR]**	**Range**
Median number of years ago latrine was built	55		7 [12.0]	0-40
Don't know how long ago latrine was built	128	70.0		
Pay to use latrine	**16**	8.7		
Median price per month	9		20 [34.0]	10-300
Median price per week	1		5 [-]	5
Median price per year	6		250 [200.0]	10-1800
Type of latrine	**183**			
Flush/ pour flush with pit/closed sewerage system	139	76.0		
Pit latrine with slab	12	6.6		
Flush/ pour flush without pit/ open sewerage system	28	15.3		
Other unimproved	2	1.1		
Missing- latrine not shown	2	1.1		
Latrines functional (If have any cover; not used for storage; pan not broken, not blocked or not full of leaves or dust; pit completed)[1]	**151**			
Yes	126	83.4		
No	25	16.6		
Latrines used (if smell/pan wet/ stain (faeces/urine)	**181**			
Yes	179	98.9		
No	1	0.6		
Missing	1	0.6		
Communal latrines	**N**	**%**	**Median [IQR]**	**Range**
Median number of years ago latrine was built	53		10 [10.0]	1-40
Don't know how long ago latrine was built	149	73.8		
Pay to use latrine	**108**	53.5		
Median price per month	45		20 [15.0]	5-90
Median price per week	7		20 [10.0]	10-20
Median price per use	40		2 [1]	1-10
Median price per year	15		100 [150.0]	10-400
Latrine open all day and all night	**161**	**79.7**		
Spot checks data				
Slums with community latrines	**36**	**85.7**		
Slums with caregivers reporting CL as main latrine	**33**			
Number of community latrines (33 slums)	**40**			
Type of latrines	**40**			
Flush/ pour flush with pit/closed sewerage system	35	87.5		
Flush/ pour flush without pit/ open sewerage system	5	12.5		
Median no of seats per community latrine				
For males	24		5.0 [7.0]	1-23
For females	24		5.5 [7.0]	1-23
Unisex	16		3.5 [2.0]	2-8
For children	3		6.0 [3.0]	6-9

Reasons for not using a latrine for households who did not use a sanitation facility	N	%	Median [IQR]	Range
CL not affordable	4	8. 9		
CL too far	6	13.3		
CL further than OD site	1	2.2		
No private facility so go outside	5	11.1		
CL is dirty	2	4.4		
CL too far & mostly used by men	2	4.4		
Don't have habit	1	2.2		
Habit to go OD	1	2.2		
CL too far & not clean	1	2.2		
CL is far & no water facility avail	1	2.2		
CL is far & no water facility avail & unclean	1	2.2		
Too many people use the CL	2	4.4		
Prefer going to riverside as CL is dirty	3	6. 7		
Not allowed due to fear of jamming CL	1	2. 2		
Other cluster/colony in slum doesn't allow them to use CL	10	22.2		
Private latrine is blocked	1	2. 2		
Don't know where the CL is	1	2. 2		
Prefer OD	1	2. 2		
No interest in using the CL	1	2. 2		
Defecation site of members of household >5				
Number of HH members over 5 years old	**3062**			**1-16**
Gender of over 5 year olds in the households	**3062**			
Male	1499	49.0		
Female	1563	51.0		
Median age of over 5 year olds in the households	**3048**		28.0 [18.0]	5-93
DK age	14	0.5		
Marital status	**3062**			
Unmarried	835	27.3		
Married	2055	67.1		
Widowed	167	5.5		
Divorced	5	0.2		
Defecation place	**3062**			
Latrine always	2652	86.6		
Latrine usually	24	0.8		
Latrine sometimes	87	2.8		
Always open defecation	296	9.7		
Paralyzed/ can't move so defecate in bed	2	0.1		
Missing	1	0.03		

[1]if latrine is improved

An important aspect of the shared and communal facilities is how many users they have. Ascertaining this via the questionnaire was deemed unreliable, though shared latrine users tended to report lower numbers of households sharing the latrine than communal latrine users.

Important traits of a latrine include its location (figure 7.1) and cleanliness (figure 7.2). Another important characteristic of communal latrines is having to pay to use them (figure 7.3), which just over half of the using households reported having to do. This cost may be considered burdensome in case of several children, as has been found in slums in Ghana [75]. This cost may mean open defecation is the only option for households that can't afford to use them. An additional factor to be considered is whether the communal latrines are open all the time, 20% of households reported that their communal latrine was not. This can be problematic for 'out of hours' defecation needs. While I didn't collect data on this, an additional concern for households using communal latrines and to some extent shared latrines may be safety concerns, including poor lighting [76]. This lack of safety may be a barrier to women caregivers going to the communal latrine to dispose of their child's faeces or taking their child to the latrine to defecate.

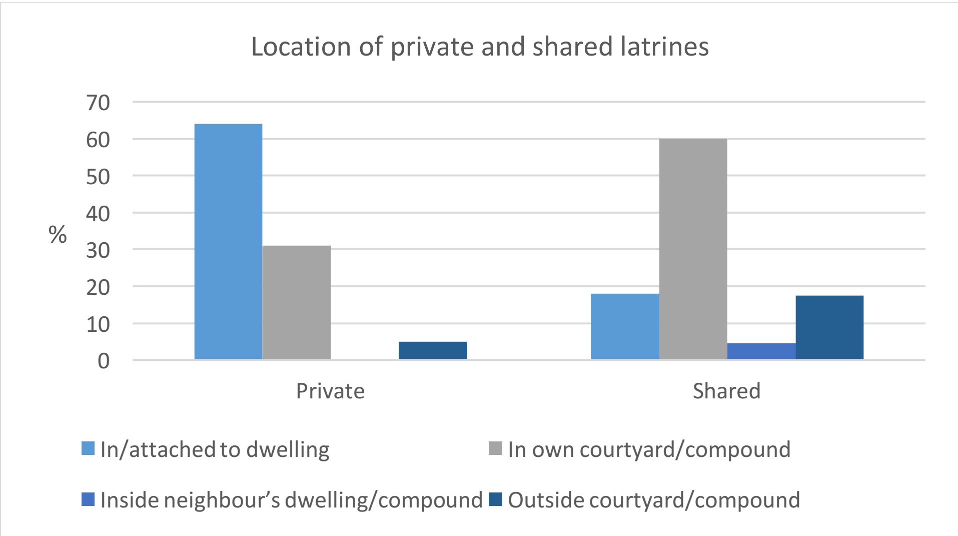


Figure 7.1 Location of private and shared latrines

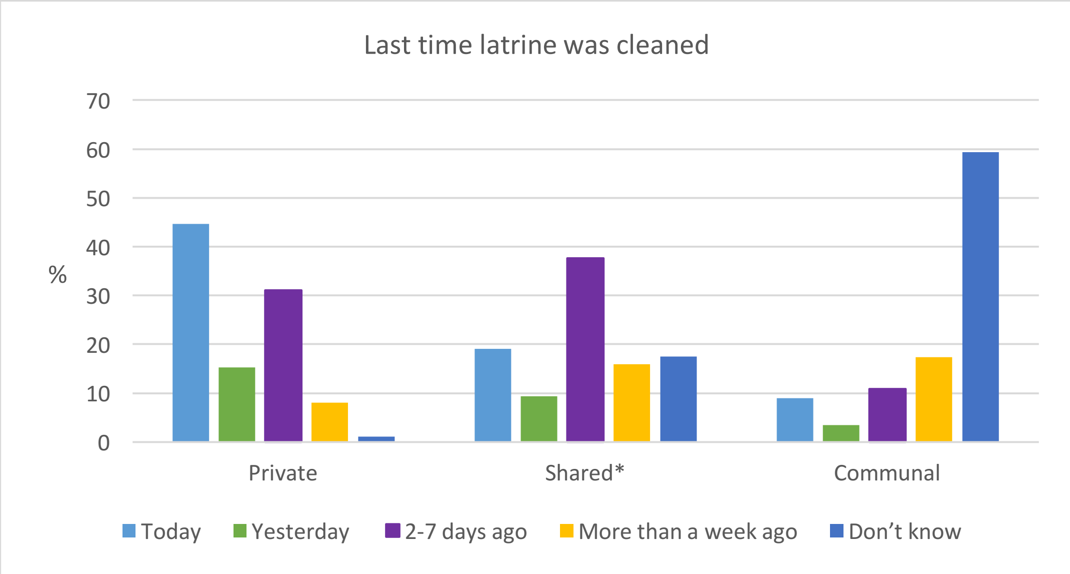


Figure 7.2 Last time latrine was cleaned, by type of sanitation facility.

*1 missing

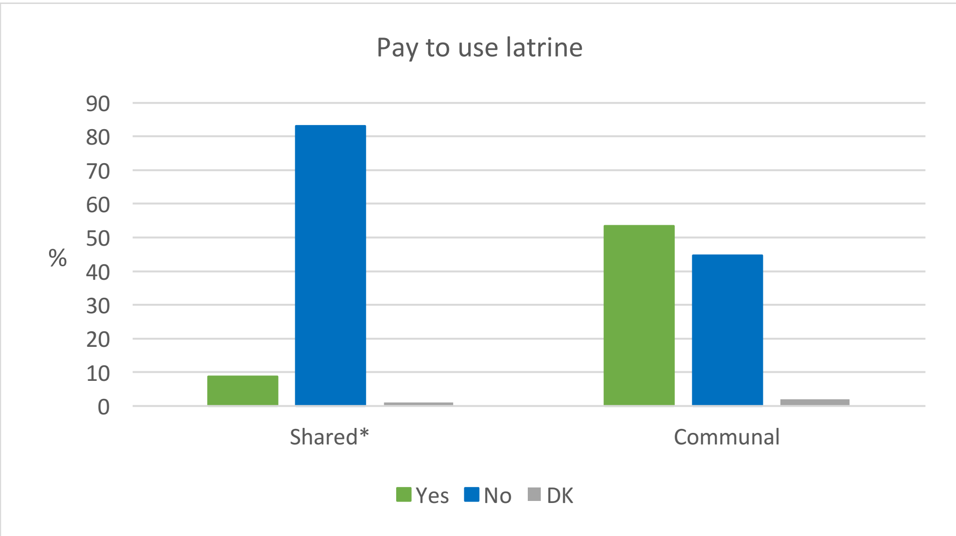


Figure 7.3 Pay to use latrine by type of sanitation facility.

*13 missing

The reasons given by the 45 households who practice open defecation all the time is useful in understanding reasoning but in order to solve these issues, large scale sanitation programmes are required. Reasons included issues of affordability, distance, cleanliness of the facilities, habit and preferences and community issues (certain parts of the slum not being allowed to use the community latrine (CL)).

Question 5. What are the channels of communication used in the research population?

Table 7.3 presents data on channels of communication reported by caregivers as a source of information for child health, care, hygiene or sanitation. Most caregivers reported to seek advice on care and child health from the doctor, although it's not clear whether that advice would include child faeces management. TV was the main media through which caregivers reporting having heard of a child sanitation or hygiene messaging, although most couldn't name the programme. 7.5% of caregivers reported that they had heard of a program promoting the use of latrines by children, although most did not know or remember the name of the program, for those that did, most said it was an *anganwadi*, TV or NGO program. The majority of households had TVs, dish antennas and mobiles, which could thus be used for communication.

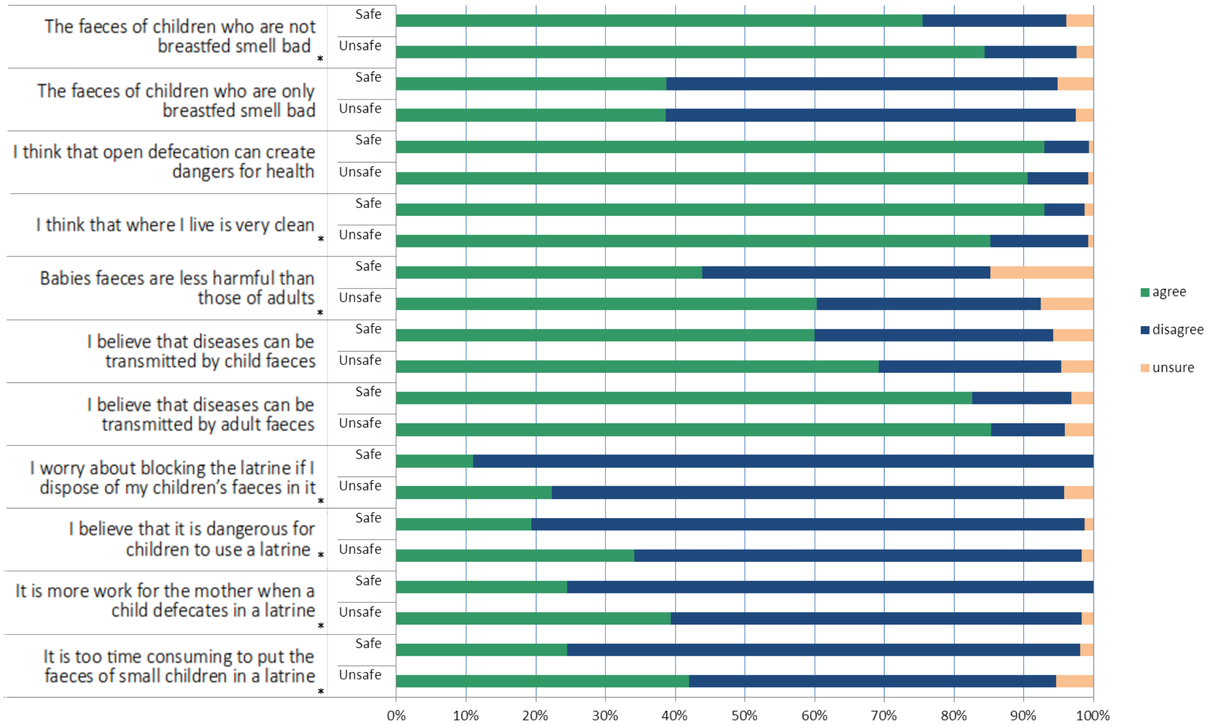
Table 7.3: Existing channels of communication and campaigns

	N	%
Professional advice for child health or care	**694**	
Anganwadi worker (AWW)	16	2.3
ASHA	4	0.6
Doctor	666	96.0
Medical store/Pharmacy	4	0.6
AWW + ASHA/ doctor	2	0.3
Medical store + doctor	1	0.1
Missing	1	0.1
Heard/ seen messages about child sanitation or hygiene in the last 6 months		
On radio	3	0.4
On TV	199	28.7
In newspapers/magazines	14	2.0
On wall painting/ posters	13	1.9
Other (AWW/ NGOs)	16	2.3
Heard of a program promoting the use of latrines by children	**52**	**7.5**
AWW	7	13.5
students	2	3.8
NGO	4	7.7
TV	5	9.6
Other	2	3.8
DK	32	61.5

Items owned by household	n	%
HH owns a radio	58	8.4
HH owns a TV	564	81.3
HH owns a dish antenna	535	77.1
HH owns a mobile	645	92.9
HH owns a computer/tablet	39	5.6

Question 6. Why do people use their current child faeces disposal practices and what influences those practices?

In Chapter 6, the analysis focused on determinants of being a household that disposes of all the children's faeces in a latrine. Another reason why households manage their children's faeces in certain ways may be due to their perceptions or beliefs regarding faeces, defecation and disposal practices (figure 7.4). Fewer caregivers agreed with the statement that children's faeces could transmit diseases than agreed with the statement that adult faeces could. More than half of the caregivers agreed that babies' faeces were less harmful than those of adults, with fewer safe disposing households agreeing with this statement. Over 30% of caregivers agreed that it was too time consuming to put the faeces of small children in a latrine, and a similar percentage agreed that it was more work for the mother when a child defecates in the latrine. Both statements were agreed with more in unsafe disposing households. A larger proportion of unsafe disposing households agreed that they worry about blocking the latrine if they dispose of their children's faeces in it, and that it is dangerous for children to use a latrine. A larger proportion of caregivers in safe disposing households agreed that where they live is very clean.



*Chi Square p-value <0.05

Figure 7.4: Agree/ disagree statements by safe and unsafe disposing households

Further research is needed to understand psychological determinants, such as motives for safe child faeces disposal, which can make the behaviour more rewarding [71, 77]. I attempted to collected data on norms through the agree/ disagree statements [78], but the wordings of the questions were not understood well by the caregivers and thus the answers have not been considered, however, this should also be explored further.

Another important factor to consider with regards to child faeces management is toilet training. Table 7.4 presents data on the age at which children are trained to use a latrine and why. The main reason reported by caregivers to start training a child at a particular age was that he/she would understand instructions.

Table 7.4: Latrine training

	N	%	Median [IQR]	Min-Max
Median age to start training child to use latrine (years)	689		3 [2.0]	1-14
Never	5	0.7		
Why at that age (can tick multiple reasons)	**689**			
He can understand and grasp instructions	460	66.8		
He will not fall into latrine	201	29.2		
He can stand on his own	83	12.0		
He's not scared of the latrine	87	12.6		
Other	19	2.8		
Because/ before child goes to school	4	21.1		
CL not allowed for young children	1	5.3		
To habituate/ habit	5	26.3		
For practice	1	5.3		
He can squat by himself	1	5.3		
Insufficient space + child would get infected if goes to drain	1	5.3		
It's more work for the mother if make child use latrine	1	5.3		
Mother feels bad to clean the faeces	1	5.3		
No open defecation space	1	5.3		
Have no latrine	2	10.5		
"we all use latrine so trained child to use latrine"	1	5.3		
Median age expect child to use latrine on his own (years)	**691**		5 [2.0]	1-14
Never	3	0.4		

Question 7. What are the available hardware for child faeces disposal and how could the use and adoption of hardware that can improve child faeces disposal be increased?

Just under half of the caregivers, reported that the household sometimes bought diapers, and for all except 2 cases, these were disposable diapers (table 7.5). Only 45.4% of households had heard of potties, of those only 16.8% had a potty. Only 28% of households owned a hoe, which is a tool that could be adapted to collect and dispose of faeces [79].

Table 7.5: Existing hardware used or available in some households

	N	%
Do you or other members of your HH sometimes buy diapers/ nappies?	**694**	
Yes	328	47.3
No	364	52.5
Don't know	2	0.3
Can the diapers/nappies be reused?	**328**	
Disposable/ single use	324	98.8
Reusable/ multi use	2	0.6
Missing	2	0.6
Ever heard of potties	**315**	**45.4**
Ownership of potty	**53**	**16.8**
HH owns a hoe	**194**	**28.0**

Discussion

A summary table of the main findings and what the implications are for the design of a behaviour change program is presented below. Where appropriate, this has been separated for pre-ambulatory and ambulatory children.

	Pre-ambulatory	**Ambulatory**
		
Key practices	Having described child faeces management in detail, it's clear there is a need to target the full child faeces management pathway. Improving the defecation place to a safer place (e.g. nappy or potty or the latrine directly), may reduce the number of steps involved in child faeces management (e.g. cleaning of defecation place and disposal of the faeces if the child defecates in a latrine). The hygiene (hand and anal) steps need to be targeted specifically for both mobility categories.	
	Target: to collect and dispose of child faeces safely into a latrine. -For very young children, cloth nappies could be promoted, and safe practices with solutions for disposal of the contaminated water should be proposed. -Previous research has found that children are actually trained to defecate when they	Target: Improve use of latrines by ambulatory children and/or promote use of potties or other collection device to dispose of faeces in latrine. - for private latrine users, the interventions may focus on changing the perceptions of the caregivers with regards to use of

	are younger [39], by sitting on the mother's feet. A possibility would be to target this practice and improve it, by adding a potty or another 'leak-proof' receptacle to collect the faeces. Then promoting the disposal of the contents of the receptacle into a latrine.	latrines by children, maybe adaptations of the latrine to make it more child-friendly would be useful. - For shared and communal latrines, the perceptions of the wider community need to be targeted so it is acceptable for them to use the latrines. One issue is probably the distance from the latrine, making it difficult to train children to use a latrine, and safely disposing of stools in the latrines (although arguably this should not be considered safe since it's shared but until everyone has access to improved private latrines at home, it's the only adequate solution). - Perhaps creating a safe disposal place at the house level, e.g. sealed bins that could be used to safely dispose of faeces during the day, and be emptied in the latrine once a day/ couple of days. Challenges would be to ensure no access to these by the children, and that it was easy to dispose of the contents in the latrines.
Target audience	- Mothers of the children are the main target but it's important to also include fathers and grandmothers, aunts and siblings who are involved in some households. - Involving the community as a whole to change the perceptions and norms around child faeces, such as the norm for children to defecate in drains or in public as well as increasing the perception that child faeces are able to transmit diseases, would be important too.	
What can motivate behaviour change? **what is the setting in which the child faeces management takes place?**	- It was only possible to gain a small insight into this using the cross-sectional study and further qualitative research is required for this. - Exploring further some of the findings from the statements, such as the perceived danger of children using a latrine. Additionally, investigating ways to overcome perceived barriers such as the required work when a child uses a latrine, the worry of blocking the latrine and the time it takes to dispose of faeces in a latrine, would be important. - Settings-wise, it is clear that the type of sanitation the population has access to will play an important role in an intervention and should be considered in the planning stages. However, more ethnographic research to study the domestic environment where child defecation and disposal takes place, would be required too.	

<table>
<tr><td>Communication channels</td><td colspan="2">- Some caregivers had heard of child sanitation/hygiene messaging on TV, which might be a possible media avenue since most households had TVs. Media campaign through mobiles, may also be feasible since most caregivers reported their household owned one.
- Some programming seems to already be delivered in the community via anganwadis, NGOs and students. Enhancing those existing channels may be an effective way to intervene.
- Doctors were reported to be the main person where caregivers would seek professional advice on child health or care, thus it would be a good channel to use for an intervention. Anganwadi workers were second and thus also worth investigating as possible channels.</td></tr>
<tr><td>Hardware</td><td>Investigating the feasibility of reusable diapers, could be useful, since disposable diapers are considered too expensive for daily use and disposing of the contents of disposable diapers in a latrine seems impractical for an intervention.</td><td>- Few households used potties but it might be a possible hardware to target.

- Investigating adaptations to existing latrines to make them more child friendly might be a possible intervention.

- 3 of the communal latrines used by the respondents had child-specific latrines, these only appeared to be used in 1 slum. Investigating whether use of these could be increased, should be considered.</td></tr>
<tr><td></td><td colspan="2">Few households owned a hoe, which has been adapted as a sani-scoop in some interventions being conducted in Kenya and Bangladesh. This hardware option could also be adapted and should be investigated.

Depending on the affordability of the hardware options preferred by the households, investigating ways to reduce the cost may be relevant.

For the hand and anal hygiene steps, increasing access to soap and hand washing stands should be improved.</td></tr>
</table>

Remaining gaps:

Additional formative research is needed to understand what can motivate improved child faeces disposal and to understand more about the setting in which child faeces management takes place. Further research around the hardware used and available is also needed. Additionally, as mentioned, it would be helpful to understand more about how child developmental stages are defined and how that affects child faeces management practices. Specific tools that could be used for further research include:

- In-depth interviews with positive deviants, who are conducting safe disposal, as well as observations of their settings to see how they differ from non-deviants.
- In-depth interviews with community members who may play a role in improving child faeces disposal, including communal latrine guardians, anganwadi workers and school teachers.
- Focus group discussions to understand how stages of childhood are defined in the target population. FGDs should also be used to understand reasons for safe child faeces disposal, including motives, using tools such as motive mapping [71].
- Surveys of markets to explore locally available hardware for child faeces management could be conducted. The available tools could then be discussed with caregivers to understand their perceptions of these.
- Trials of improved practice (TIPS) to test specific interventions for a set period and subsequently using interviews to assess the experience and how it could be improved. TIPs would enable us to gain information on barriers and preferences for different interventions and to learn whether they are acceptable and feasible or how they could be improved [80]

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8. Discussion and Reflections

Previous chapters of this thesis included a systematic review, and methods and findings from primary research conducted in slums in Odisha. This chapter will review the findings from previous chapters, propose an agenda for future research and reflect on the methodology used in the presented research.

8.1. Discussion of the main findings

The systematic review included significantly more studies on the disposal of child faeces than were previously identified, and many more than were included even in a review published in 2016 by Morita and colleagues [50]. However, the quality of the included studies was low or very low. Most of the included studies were non-randomised studies. The interventions evaluated in the experimental studies (CBAs and RCTs), included child faeces disposal only as one component among other health education messages or WASH components. The contribution of the child faeces disposal component on the health outcome following these interventions are thus not possible to estimate. Only one study evaluated the impact of an intervention focused only on behaviour change to increase the use of potties for child (15-47 months) defecation, but found no impact on behaviour change [74]. This study did not measure health impacts, nor did it specifically describe the final destination of the child stools recommended as part of the intervention. There was considerable variation in the interventions and the outcome definitions among the included studies. The best available health impact estimate was from the case-control studies, which indicated that disposal of faeces in a latrine and defecation in a latrine may decrease the odds of diarrhoea. Only two of the included studies, which only comprised child faeces disposal as a component to their larger interventions to end open defecation, assessed the impact on STH infection, neither found an impact.

The cross-sectional study in slums in Odisha found a low prevalence of faeces being disposed in a latrine. The study also described several points during child faeces management that should be considered as a source of exposure. Indeed, safe management involves many more critical control points. These include where the child defecates, on what the child defecates (if directly on the ground or something), what is used to remove the faeces, whether the ground is cleaned afterwards, whether there was anal cleaning after defecation and what hand washing practices are used, and lastly the disposal site of the faeces. Finally, the type of latrine in which child faeces are disposed into, may not prevent the contamination of the environment if it is not improved. The current definition for safe child faeces disposal, which is used for monitoring of practices only considers the final destination of the faeces [51]. While this is a useful indicator, it is likely to underestimate the risks of the practices involved.

Chapter 6 identified the following factors to be important risk factors for child faeces disposal: education and religion of the primary caregiver, number of children <5 in the household, wealth, type and location of latrine, defecation behaviours of the household members >5 and the mobility of children in the house. In order to improve chid faeces disposal in a latrine, some factors identified through this study are difficult to change, including improving education of caregivers and increasing latrine access closer to the households. Potential candidates for improving disposal into a latrine based on these findings include improving latrine use behaviours of all the members in the household as well as focusing on finding safe disposal methods for children who are not ambulatory as in that group very little safe disposal is observed. In addition, identifying ways to improve latrine use by ambulatory children is important as many of them still do not use the latrines.

The findings reiterate the importance of improving access to improved sanitation. This has also been found to be key determinant of safe child faeces disposal in studies analysing DHS and MICS survey data [32, 81, 82]. This still requires large improvement in India where only 40% of the population had access to improved latrines in 2015 [23]. A large national sanitation strategy to eliminate open defecation is underway with the *Swachh Bharat Mission*, some of the child relevant components of the strategy include improving access to toilets in *anganwadis* and using children as change agents. There is mention of prioritising access to categories of people that are unable to access and use safe sanitation facilities, which includes children [83]. Thus, there may be some opportunity to improve child faeces management in the campaign. However, the campaign is likely to take time and in the interim, interventions should be designed to facilitate safe child faeces management for households using unimproved sanitation as well as improved sanitation.

Chapter 7 contained additional findings from the cross-sectional study that were used to describe components to consider in the design of a child faeces disposal intervention in the slums of Odisha. Mothers should be the main target for intervention messaging in interventions, but other family members were also involved in child faeces management and should also be considered. Existing channels of communications could be used to deliver behaviour change intervention messaging. Chapter 7 also highlighted areas that required further research.

8.2. Agenda for future research

While the systematic review in Chapter 3 provides the evidence base for the health impact of safe disposal of child faeces, there is a need for research to inform practical guidance to householders in low-income settings about how to manage child faeces. This should involve reviewing existing literature from published and unpublished sources to summarize existing practices and any available recommendations for the management of child faeces and propose evidence-based suggestions on the safe management of child faeces as well as more defined research questions based on the identified gaps.

In addition, more primary research is essential. As suggested by the systematic review, there is an urgent need for RCTs to assess the effectiveness of different interventions to improve child faeces disposal for children in different age groups. These should assess the effectiveness on behaviour change and measure health impacts. Process evaluations along the intervention would also be crucial to understand whether the intervention worked as intended.

While Chapter 5 highlighted the complexities of child faeces management behaviour, further research is needed to quantify the risk of the different child faeces management practices and thus identify key practices that may have the highest impact on health. There may be some practices that may present more risk from others in terms of contamination. Quantitative Microbial Risk Assessment (QMRA) may be useful in understanding key behaviours and practices that should be targeted for future interventions and policies [84]. This should include structured observations to better understand the instances when children are exposed to unsafe child faeces management practices. One interesting aspect of this would be to quantify the risks of the common practices identified in this study, such as the disposal of faeces with garbage, in the drain, and the practice of washing away faeces and whether this creates risks. Particularly, it would be interesting to see whether the use of soap or detergent helps in reducing the risk of the contaminated wastewater.

As described in Chapter 7, additional research is needed to complete the formative research in order to design an intervention to improve child faeces disposal in Odisha. Filling the remaining gaps will require additional qualitative and ethnographic research. Research is particularly needed to understand what can motivate improved child faeces disposal and other psychological determinants of child faeces disposal. Investigating more about the setting in which child faeces management takes place would be useful, particularly reasons other than distance for safer disposal in improved latrines vs unimproved latrine. In addition, qualitative research into the reasons why caregivers with access to improved sanitation do or don't dispose of their children's faeces safely would be important. Further research around the hardware used and available is also needed, and to test whether for example potties could improve behaviour. Investigating experiences of existing users of potties and using TIPs to see whether they could be used as a likely intervention would be useful. Many households had never heard of potties. Thus if the TIPs prove successful, investigating ways to increase their availability would be needed.

8.3. Reflections on what could have been done to improve the research presented

The research presented here represents my best effort. However, I have learned much over the three years during which this research was conducted. Reflecting back, there are several areas in which it might have been improved.

- Systematic review

Due to the large number of studies identified in the systematic review literature search, it was not possible for two reviewers to independently assess the inclusion of studies based on the titles. Instead, I removed the clearly irrelevant titles before a colleague and myself assessed the abstracts and full texts. The very inclusive search strategy produced a large amount of studies and a thorough summary of the literature to date, however it was very time-consuming. The inclusion of 'exclusion' search terms in the search strategy may have helped in reducing the amount of clearly irrelevant studies.

The inclusion criteria were perhaps too inclusive. For example, studies that only included child faeces as one of the components of their intervention were included in the review, although it's not possible to distinguish what the effect of the child faeces disposal component had on the health outcomes.

- Cross-sectional study

For the cross-sectional study, a few things could have been improved in both the design and data collection phase.

Firstly, obtaining a sampling frame through a census of the slums would have allowed making more generalizable comments on the findings. However, given methodological complexities of conducting censuses in slums, this could have proved complex. In addition, given the limited evidence-base for child faeces management, this study allowed for exploration of practices and possible risk factors and was appropriate for that purpose.

The tools used in the study could have been improved in several ways. Firstly, more consideration of the variables to be included in the analysis should have been given during the data collection tool development since some questions measured very similar data that were not included in the analysis. Secondly, additional piloting would have narrowed down the 'other' response categories, which were time consuming to analyse. Thirdly, while the translation of the questionnaire was evaluated by a fluent Odia speaker and the enumerators trained on the tools, some issues with translation persisted, for example spot checks were intended to see whether the household potty looked dusty, and thus likely not used regularly, was translated in a way that could mean dusty or dirty and thus was considered to not be a reliable indicator. Back-translation of the questionnaire could have prevented this issue.

For caregivers reporting to dispose of faeces through washing with water, or water and soap, there was a space in the questionnaire for the enumerator to specify where the washing was done, however, it was a free text option and thus the data was inconsistent and complicated to use. The inclusion of some categories of where the washing takes place and where the wastewater ends up would be a useful improvement to the questionnaire. While there was space for the enumerators to write additional comments in the questionnaire, some of the more complex behaviours were maybe not adequately captured, e.g. if a child defecated in a potty and the faeces were disposed of using the potty and a broom to empty the potty, this may not have been captured unless the enumerator wrote this in the comments section. Again, additional answer options could have improved this. Data was not collected on the cleaning of the disposal tool, which is also a step of child feces management that may create a potential risk for exposure [31]. This should be considered in future studies.

Since the results of the demonstrations and the reported behaviours for the last time the child defecated were very similar, the additional demonstrations probably did not add much information. The additional step about ground cleaning included in the demonstration data could be added to the questions on the last time the child defecated, especially in settings such as this where there is no inhibition over reporting child faeces disposal behaviours. Previous research has found that caregivers are unaware that they should dispose of children's faeces in a latrine [39]. On the other hand, demonstrations may be a useful complement if perhaps videoing was conducted to obtain a clearer description of the sequence of child faeces management steps. Use of videoing for such a large sample may not be practical. However, piloting this technique for formative research may be useful. A particular limitation of the way in which the demonstration data was collected was that the enumerators were instructed to let the participant demonstrate or describe what they would do if their child defecated at the time of visit and thus depended on the participants demonstrating or explaining all of the steps, with the enumerator prompting the caregiver to ask about what they would do after. This may have led to some caregivers not reporting cleaning the floor but maybe they did and just didn't demonstrate or report it. In addition, in the survey, options for what was used to clean the floor only included whether this was water, water and soap, water and dettol/ phenyl or water and cow dung. The enumerators added comments in 'other' category to add detail if this included a cloth or a broom, but this was probably not done consistently and additional categories would have been more useful. This is however unlikely to play a large role in the risks presented by the behaviours.

For the indicators of functionality and use of the latrine, a combined spot check question was used, rather than individual indicators, which could then later have been aggregated into a composite score. The latter option would have been more useful in seeing whether latrines were functional as the definition of a functional latrine, which included having a completed pit, was intrinsically linked to whether the latrine was improved or not (pour flush without a pit/open sewerage system), thus a series of indicators that could have been compared across improved and unimproved latrines would have been better.

The data collected for each child (nutrition, attendance to pre-school and mobility) were all related to how old the children are and thus were not all used in the analysis. The collection of age was done by asking the caregiver the age of the child in months, or the enumerator calculating the age in months, however I found that this led to clustering around half and full year intervals, which brought into question the accuracy of the data especially for older children. Collecting the dates of birth of the children, using vaccination cards for example, rather than ask enumerators and caregivers to calculate the age of the children in months, would have been better.

The collection of data on assets to estimate socio-economic status of households may have been hindered by the reluctance of the respondents to give this information due to lack of trust since these questions are usually used to assess eligibility for ration cards. However, there was an association between wealth categories generated through PCA of the assets and the type of latrine the households used, indicating a level of reliability.

Following on from the description of the many steps involved in child faeces disposal, a more conservative definition of safe disposal would ideally have been used in the analysis by creating a scale of what constitutes a safe disposing household. However, more research is needed to characterise epidemiologically and microbiologically the critical points so an evidenced-based definition for the scale is used. In addition, the small number of safe disposing households would have been further reduced, making analysis of risk factors not possible. While the definition of safe disposal includes both the defecation and the disposal of child faeces into a latrine, the determinants of a child using a latrine and a caregiver picking up and disposing of the faeces may be different. Particularly for a child using a latrine, a big determinant is their age and capacity to use it. For a caregiver to pick up the faeces of children around the environment and put them in a latrine may be driven by different determinants. This would be an interesting question to study, although in our sample the large majority of the safe disposal was due to direct defecation of children in a latrine and thus would require a much larger sample size in order to look at determinants for disposal behaviour.

The data was collected during the rainy season and being a cross-sectional study, data was only collected at one time point. It is likely that child faeces disposal behaviours change from season to season, and it could be that on the days when there were very heavy rains, the reported behaviours took place more often inside the households, however this was not investigated. Additionally, I had included a question to gage consistency of disposal behaviour, by asking if the caregiver always used the same method to manage their child's faeces, but I found the question created confusion. This was partly due to the wording of child faeces management, rather than specific behaviours, such as whether the child always defecates in the same place or the caregiver always disposes of the faeces in the same manner. In addition, inconsistencies between different elements of the questionnaire (demonstrations and the last time the child defecated), with caregivers saying they used the same method for child faeces management, made me question the usefulness of the data. Carrying out additional qualitative research using in-depth interviews and focus group discussions would have allowed to understand better the consistency of the behaviours and would have enabled the triangulation of the findings from the research, as well as a deeper understanding of the practices and determinants of the reported behaviours.

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9. **Conclusions**

My PhD had the following aims:

1) To summarize existing knowledge of the health impact of safely disposing of child faeces. 2) To advance our understanding of the scope and possible reasons for unsafe disposal of child faeces among a population in Eastern India.

The first aim was achieved through the completion of a Cochrane systematic review. The review is the most comprehensive summary and analysis of the evidence available on this topic. The review found that:

- The quality of the 46 included studies was low or very low. Most of the included studies were non-randomised studies. Most interventions evaluated in the experimental studies (CBAs and RCTs), included child faeces disposal only as one component among other health education messages or WASH components. The contribution of the child faeces disposal component on the health outcome following these interventions were thus not possible to estimate.
- There was considerable variation in the interventions and the outcome definitions among the included studies. The best available health impact estimate was from the case-control studies, which indicated that disposal of faeces in a latrine and defecation in a latrine may decrease the odds of diarrhoea.
- Only two of the included studies, which only included child faeces disposal as a component to their larger interventions to end open defecation, assessed the impact on STH infection, neither found an impact.

The second aim was achieved through a cross-sectional study in urban slums of Odisha. The study:

- described several points during child faeces management that should be considered as a potential source of exposure to faecal pathogens. Indeed, safe management involves many more critical control points than just the site of disposal. These include where the child defecates, on what the child defecates (if directly on the ground or something), what is used to remove the faeces, whether the ground is cleaned afterwards, whether there was anal cleaning after defecation and what hand washing practices are used, and finally the disposal site of the faeces. Finally, the type of latrine in which child faeces are disposed into, may not prevent the contamination of the environment if it is not improved. Currently in global monitoring, only the disposal site of the faeces is recorded.

- Found low percentages (25.5%) of child faeces being disposed of in latrines, and even lower percentages of faeces ending up in improved latrines.
- Even fewer (22.3%) of the 694 households reported all the <5 children's faeces ended up in the latrine the last time the child defecated, and 71.2% reported none of their children's faeces ended in the latrine. The following factors were identified to be risk factors for being a safe disposing household (disposing of all of the children's faeces in the latrine): education and religion of the primary caregiver, number of children <5 in the household, wealth, type and location of latrine, defecation behaviours of the household members >5 and the mobility of children in the house.

In conclusion, child faeces disposal is an overlooked area of sanitation and more research is needed. Studies in different settings should be conducted to see whether findings from this research are similar in other places. Research is needed to quantify the microbial risks of different practices as well as health impacts of interventions to improve child faeces disposal. Considerations of what constitutes safe child faeces management are needed as well as practical guidelines of what should be considered safe disposal.

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Appendix 1: Child feces disposal practices in rural Orissa: a cross sectional study

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Child Feces Disposal Practices in Rural Orissa: A Cross Sectional Study

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Abstract

Background: An estimated 2.5 billion people worldwide lack access to improved sanitation facilities. While large-scale programs in some countries have increased latrine coverage, they sometimes fail to ensure optimal latrine use, including the safe disposal of child feces, a significant source of exposure to fecal pathogens. We undertook a cross-sectional study to explore fecal disposal practices among children in rural Orissa, India in villages where the Government of India's Total Sanitation Campaign had been implemented at least three years prior to the study.

Methods and Findings: We conducted surveys with heads of 136 households with 145 children under 5 years of age in 20 villages. We describe defecation and feces disposal practices and explore associations between safe disposal and risk factors. Respondents reported that children commonly defecated on the ground, either inside the household (57.5%) for pre-ambulatory children or around the compound (55.2%) for ambulatory children. Twenty percent of pre-ambulatory children used potties and nappies; the same percentage of ambulatory children defecated in a latrine. While 78.6% of study children came from 106 households with a latrine, less than a quarter (22.8%) reported using them for disposal of child feces. Most child feces were deposited with other household waste, both for pre-ambulatory (67.5%) and ambulatory (58.1%) children. After restricting the analysis to households owning a latrine, the use of a nappy or potty was associated with safe disposal of feces (OR 6.72, 95%CI 1.02–44.38) though due to small sample size the regression could not adjust for confounders.

Conclusions: In the area surveyed, the Total Sanitation Campaign has not led to high levels of safe disposal of child feces. Further research is needed to identify the actual scope of this potential gap in programming, the health risk presented and interventions to minimize any adverse effect.

Citation: Majorin F, Freeman MC, Barnard S, Routray P, Boisson S, et al. (2014) Child Feces Disposal Practices in Rural Orissa: A Cross Sectional Study. PLoS ONE 9(2): e89551. doi:10.1371/journal.pone.0089551

Editor: Jeremy D. Goldhaber-Fiebert, Stanford University, United States of America

Received August 15, 2013; **Accepted** January 21, 2014; **Published** February 20, 2014

Funding: This work was supported by the Bill & Melinda Gates Foundation. The funders had no role in study design, data collection and analysis, decision to publish, or preparation of the manuscript.

Competing Interests: The authors have declared that no competing interests exist.

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Introduction

Millennium Development Goal (MDG) target 7c includes the reduction by half of the proportion of the population without sustainable access to basic sanitation by 2015 [1]. This MDG is far off track from being met; indeed 2.5 billion people were still without access to improved sanitation by the end of 2011 [2]. In India, sanitation represents a particular challenge, as 50% of the population still practice open defecation (which, by definition, includes disposals with solid waste) and only 35% of the population uses improved sanitation [2].

This gap in access to improved sanitation has led to large-scale interventions to increase sanitation coverage, in some cases without a corresponding focus on use. The largest rural sanitation campaign is the Nirmal Bharat Abhiyan in India, previously known as the Total Sanitation Campaign (TSC), a subsidy-based approach that seeks to create demand and provide subsidies to below the poverty line (BPL) households towards construction of individual household latrines [3]. The TSC reported building one latrine per 10 rural people in India between 2001 and 2011, and there is some evidence that this has resulted in health gains [4]. There is also evidence, however, that actual use of the latrines is suboptimal, and in many cases is isolated to the adult female members of the household [5–8]. Yet both coverage and use of sanitation are necessary to reduce the exposure to feces in the environment and yield reductions in enteric diseases [9].

Another aspect of suboptimal sanitation is the improper collection and disposal of child feces. While there are few published studies, the evidence suggests that in many low-income settings, nappies (i.e. diapers or cloth) and potties are rarely available or used, making the hygienic collection of young children's feces difficult; if collected, such feces are often disposed of in a manner that does not prevent further exposure to household members or contamination of water sources [10].

In fact, the unsanitary disposal of child feces may present a greater health risk than that of adults. First, young children represent the highest incidence of enteric infections [11], and their feces are most likely to contain agents [12]. Second, young children tend to defecate in areas where susceptible children could be exposed [13]. Third, young children who are also most at risk of mortality and the serious sequelae associated with enteric infection [14,15] are most likely to be exposed to these ambient agents due to the time they spend on the ground, their tendency to put fingers and fomites in their mouths, and common behaviors such as geophagia [16,17]. In a meta-analysis of 10 observational studies published between 1987 and 2001, Gil et al. (2004) found that child feces disposal behaviors considered risky (open defecation, stool disposal in the open, stools not removed from soil, stools seen in household soil, and children seen eating feces) were associated with a 23% increase in risk of diarrheal diseases (RR 1.23, 95%CI 1.15–1.32); behaviors considered safe (use of latrines, nappies, potties, toilets, washing diapers) were borderline protective (RR 0.93, 95%CI 0.86–1.00) [10]. In addition, improved disposal of child feces could have an impact on enteric infections other than diarrhea; a study in rural Bangladesh found that the disposal of child feces in closed spaces such as pit latrines resulted in a 35% reduction in helminthiasis in children under 2 compared with disposal in open space [18].

In connection with a large scale trial to assess the effectiveness of rural sanitation in Orissa State [9], we undertook this study to describe the practices with respect to the disposal of feces of children under 5 years old in rural villages where the TSC had been implemented at least 3 years prior to this study.

Methods

Study design and setting

The study followed a cross-sectional design. It was conducted in June and July 2012 in Puri District, a coastal region of the State of Orissa in Eastern India. A sample of 20 villages was selected randomly from a list of 35 villages where the TSC had been implemented by a partner NGO of WaterAid India (the implementer of the large scale trial) at least 3 years prior to the study. This study was a component of a larger study on latrine coverage and use by adults which contains further details on the study setting [7].

Household selection

In the selected villages, all households were eligible for inclusion in the study. For logistical reasons, we targeted 20 households in each of the 20 villages that were selected in a larger study assessing latrine coverage and use [7]. The sample size was chosen for logistical reasons without conducting power calculations. Households eligible for inclusion in this study were required to have at least one child under five years old, which led to a sample of 136 households out of the 447 households that were surveyed in the larger study [7]. Households were selected using systematic sampling following the method described by the Extended Program on Immunization (EPI) [19]. This approach consists of spinning a pen in a central location of the village to determine the direction in which the enumerator would sample households. Each of three enumerators enrolled every other household in that direction until they reached their quota of 7 households or the village boundary was reached. In the case when the village boundary was reached before the quota was met, the enumerator would start the process again from the central location. The actual number of households enrolled varied slightly among villages due to logistical constraints. Households were enrolled only after receiving all the details concerning the study and consenting to participate. Respondents were female heads of household or, if unavailable, male heads of households or an adult over 18 years of age. Households where no adults were present at the time of visit or that did not consent to participate in the study were not enrolled.

Survey tool

Data collection tools included a structured survey and spot-checks of household latrines looking for indicators of use and of the compound looking for the presence of human stools. The survey was developed in English, translated to Oriya (the local language) and then back-translated to assess accuracy. Fluent Oriya speakers conducted the survey, which included questions on demographics, type of household construction, education level of heads of households, ownership of a latrine and distance to nearest water source to use in the latrine. The outcomes of interest were defecation sites of children under 5 and feces disposal sites. We assessed child feces disposal practices based on the wording used in the core questions of the WHO/UNICEF Joint Monitoring Programme on Water and Sanitation (JMP) [20]: "The last time this child [youngest child in mobility category] passed stools, what was done to dispose of the stools?" The questions on defecation and disposal practices were asked for the youngest child in each household in each of the two mobility categories: pre-ambulatory children (worded as "child that cannot yet walk" in the questionnaire) and ambulatory children (worded as "child that can walk"). As such, data from a total of two children per household were possible.

Data analysis

Data were entered using EpiData 3.1 (EpiData Association, Odense, Denmark) and analyzed using STATA version 12 (StataCorp, College Station, Texas, United States). For univariate descriptive statistics, analysis was stratified by mobility category. Feces disposal was recoded into a binary outcome, "safe" and "unsafe," based on whether the reported behavior was expected to be associated with the fecal contamination of the environment [21]. We used the JMP definition of safe disposal (defecation into a latrine, disposal of stools in a latrine or buried) to categorize behaviors as "safe" [20]. Seven values were missing for disposal site when the site of defecation of the child was an open field or roadside; these unknowns were categorized into the unsafe disposal category.

Bivariate analysis between safe feces disposal and defecation site, household characteristics and latrine ownership were conducted using logistic regression. Since not owning a latrine predicts failure to safely dispose feces (only those households with a latrine reported safe disposal of child feces), we restricted subsequent regression analyses quantifying the relationship between potential determinants and safe disposal of child feces to households owning a latrine. In order to adjust for clustering of children within households, we used generalized estimating equations with robust standard errors. Due to the small sample size, it was not possible to conduct multivariate analysis to adjust for potential confounders.

Ethics Statement

This study was approved by the Ethics Committees of the London School of Hygiene and Tropical Medicine (United Kingdom) and Xavier Institute of Management, Bhubaneswar (India), who also approved the consent procedures. Prior to enrollment, field workers fluent in Oriya read an information sheet describing the study, answered any questions and asked for written consent to participate, The study participants received no compensation for their participation. Anonymity was ensured through the use of household identification numbers and no names were recorded.

Results

Although a total of 447 households were enrolled into the larger study [7], only 136 households reported to have a child below the age of five and thus met the eligibility criteria to participate in this sub study. A total of 145 children from 136 households are reported on in this study, of these forty (27.6%) were pre-ambulatory. Thirty-three (82.5%) pre-ambulatory children and 81 (77.1%) ambulatory children came from a household with a latrine (table 1).

The defecation and disposal sites reported for the last time the children defecated are listed in tables 2 and 3. Most children were reported to defecate on the ground, either inside the home (57.5%) or compound (20.0%) for pre-ambulatory children, or inside the compound for ambulatory children (55.2%). Twenty percent of pre-ambulatory children used potties (17.5%) and nappies (2.5%), while 20.0% of ambulatory children defecated in a latrine. The defecation sites of children were categorized as improved if the child defecated in a potty or nappy or unimproved if they defecated on paper, roadside, inside compound, inside household or in an open field.

The feces of most children ended up in the household's solid waste disposal site typically located outside at the rear of the compound ("garbage"), both for pre-ambulatory (67.5%) and

Table 1. Household characteristics of participating pre-ambulatory and ambulatory children.

Characteristics	Pre-ambulatory (n = 40)		Ambulatory (n = 105)	
	N	%	N	%
Ownership of a latrine				
Yes	33	83	81	77
No	7	18	24	23
Water access to use in latrine[1]				
Water on premise	28	70	67	64
Water not on premise	5	13	13	12
Number of persons per household				
1–3	0	0	3	3
4–6	18	46	50	48
7–9	9	23	33	31
10+	12	31	19	18
Religion				
Hindu	40	100	101	97
Muslim	0	0	3	3
Education of male head of household				
Illiterate	3	8	9	9
Literate no formal schooling	2	5	13	13
Some or completed primary school	7	18	23	22
Some or completed secondary school	25	63	45	43
Any level of higher education	3	8	9	9
Education of female head of household				
Illiterate	8	20	27	26
Literate no formal schooling	6	15	13	13
Some or completed primary school	10	25	25	24
Some or completed secondary school	12	30	32	31
Any level of higher education	4	10	5	5
Type of house construction[2]				
Pucca	27	68	57	54
Semi-Pucca	10	25	29	28
Kuchha	3	8	19	18
Own a BPL card				
Yes[3]	30	81	62	65
No	7	19	34	35

[1]only among households with latrines.
[2]Pucca = concrete; Kuccha = mud and dung.
[3]checked or reported.
doi:10.1371/journal.pone.0089551.t001

Table 2. Frequency of feces disposal sites of pre-ambulatory children by site of defecation (n = 40).

	Defecation sites					
	Potty	Nappy	On paper	Ground in compound	Ground inside household	Total
Disposal sites	7 (18)	1 (3)	1 (3)	8 (20)	23 (58)	40 (100)
Latrine	1 (14)	0 (0)	0 (0)	1 (13)	2 (9)	4 (10)
Garbage	6 (86)	1 (100)	0 (0)	6 (75)	14 (61)	27 (68)
Field	0 (0)	0 (0)	0 (0)	0 (0)	1 (4)	1 (3)
Left in the open	0 (0)	0 (0)	1 (100)	1 (13)	2 (9)	4 (10)
Washed*	0 (0)	0 (0)	0 (0)	0 (0)	3 (13)	3 (8)
Roadside	0 (0)	0 (0)	0 (0)	0 (0)	1 (4)	1 (3)

*Includes: washing, washing clothes, and cleaning it in water.
doi:10.1371/journal.pone.0089551.t002

ambulatory (58.1%) children. Overall, the feces of only 10.0% of pre-ambulatory children and 21.9% of ambulatory children were reported to have been safely disposed of, which was defined as either directly defecating in a latrine or feces being rinsed/put in a latrine or buried [20]. Although 84 (80.0%) defecation events of ambulatory children occurred outside of the latrine, the feces were only disposed of in a latrine once (1.2%) and buried once (1.2%).

Safe disposal of child feces only occurred in households that owned latrines (n = 106). As such, it was not possible to conduct analysis on determinants of safe disposal in non-latrine households. However, latrine ownership was no guarantee of safe disposal of child feces: the feces of only 27 (23.7%) children from 26 (24.5%) households with latrines were reported to be safely disposed of. In households with latrines that reported safely disposing of their children's feces, no human stools were observed in the compound during spot check observations. In households with latrines that reported safely disposing of their children's feces, 19 (73.1%) had wet floors in the latrine and 18 (69.2%) had cleaning products in their latrines, both of which are positive indicators of latrine use.

In the crude bivariate analysis (data not presented in tables) one variable was found to be associated with safe child feces disposal: defecation in a potty or nappy (Odds Ratio [OR] 7.91, 95% confidence interval [CI] 1.24–50.41). This may be linked to household education level, household wealth/socioeconomic status, and/or local availability of potties or nappies, but these could not be controlled for in multivariate analysis due to small sample size. After restricting the analysis to households owning a latrine, defecation by children into a potty or nappy remained associated with safe stool disposal (Table 4). While safe disposal of child feces was higher when children used potties or nappies (OR 6.72, 95%CI 1.02–44.38), the feces of the majority (75%) of children defecating in potties or nappies were still not safely disposed and the observed association could be due to confounders which could not be adjusted for in the analysis.

Safe stool disposal was weakly associated with ambulatory mobility category, owning a latrine for more than 5 years compared to less than 3 years and water on premise to use in latrine. The safe disposal of child feces was higher in ambulatory children than in pre-ambulatory children after restricting the analysis to households owning a latrine (OR 3.21, 95%CI 1.00–10.31) due to ambulatory children defecating directly into a latrine. The feces of ambulatory children that defecated outside of the latrine were only safely disposed of twice (2.4%) compared to four (10.0%) pre-ambulatory children's feces being disposed of safely. Households that had a latrine for more than five years were more likely to dispose of their child's feces safely than households that built their latrines less than three years ago (OR 3.77, 95%CI 0.99–14.33). Having owned a latrine for between 3 and 5 years was not associated with safer stool disposal (OR 0.74, 95%CI 0.13–4.09). Most of the children whose feces were reported to being safely disposed came from households (96.0%) with water on the premises. Water on the premises increased the

Table 3. Frequency of feces disposal sites of ambulatory children by site of defecation (n = 105).

	Defecation sites							
	Latrine	Potty	On paper	Roadside	Ground in compound	Ground inside household	Open field	Total
Disposal sites	21 (20)	1 (1)	4 (4)	9 (9)	58 (55)	5 (5)	7 (7)	105 (100)
Latrine	21 (100)	1 (100)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	22 (21)
Garbage	0 (0)	0 (0)	2 (50)	6 (67)	49 (84)	4 (80)	0 (0)	61 (58)
Field	0 (0)	0 (0)	0 (0)	1 (11)	1 (2)	0 (0)	1 (14)	3 (3)
Buried	0 (0)	0 (0)	1 (25)	0 (0)	0 (0)	0 (0)	0 (0)	1 (1)
Left in the open	0 (0)	0 (0)	1 (25)	1 (11)	8 (14)	1 (20)	0 (0)	11 (10)
Unknown	0 (0)	0 (0)	0 (0)	1 (11)	0 (0)	0 (0)	6 (86)	7 (7)

doi:10.1371/journal.pone.0089551.t003

Table 4. Bivariate analysis assessing association between household characteristics and safe disposal of child feces among households with a latrine (n = 114 children from 106 households).

	N	Total	%	OR	95% CI	P-value[1]
Mobility Category						
Pre-ambulatory	4	33	12	Ref.	-	-
Ambulatory	23	81	28	3.21	1.00–10.31	0.05
Defecation site						
Unimproved[2]	4	85	5	Ref.	-	-
Improved[3]	2	8	25	6.72	1.02–44.38	0.05
When the latrine was built						
<3 years ago	3	23	13	Ref.	-	-
3–5 years ago	3	31	10	0.74	0.13–4.09	0.73
>5 years	21	58	36	3.77	0.99–14.33	0.05
Water access to use in latrine						
Water not on premise	1	18	6	Ref.	-	-
Water on premise	26	94	28	6.16	0.76–49.72	0.09
Number of persons per household						
10+	6	25	24	Ref.	-	-
7–9	10	33	30	1.40	0.43–4.61	0.58
4–6	10	53	19	0.77	0.25–2.36	0.65
1–3	1	2	50	3.25	0.18–60.29	0.43
Religion						
Hindu	25	111	23	Ref.	-	-
Muslim	2	3	67	6.92	0.59–80.56	0.12
Education of male head of household[4]						
Illiterate [5]	0	8	0	-	-	-
Literate no formal schooling	2	10	20	Ref.	-	-
Some or completed primary school	4	24	17	0.80	0.12–5.21	0.82
Some or completed secondary school	15	56	27	1.46	0.27–7.85	0.66
Any level of higher education	5	11	45	3.33	0.47–23.72	0.23
Education of female head of household						
Illiterate	5	25	20	Ref.	-	-
Literate no formal schooling	2	12	17	0.81	0.13–4.91	0.82
Some or completed primary school	9	26	35	2.12	0.58–7.73	0.25
Some or completed secondary school	8	41	20	1.00	0.29–3.47	1.00
Any level of higher education	3	9	33	2.02	0.37–10.99	0.42
Type of house construction						
Pucca	19	70	27	Ref.	-	-
Semi-Pucca	4	31	13	0.40	0.12–1.33	0.13
Kuchha	4	13	31	1.15	0.33–4.03	0.83
Own a BPL card						
Yes[6]	17	79	22	Ref.	-	-
No	9	27	33	1.95	0.73–5.22	0.18

[1]Wald test.
[2]Paper, roadside, inside compound, inside household, in open field.
[3]Potty, nappy.
[4]used robust standard errors without GEE as not possible.
[5]dropped from analysis.
[6]checked or reported.
Note 1: Denominators vary as not all respondents answered all questions.
Note 2: Due to the small sample size of the study and the rare occurrence of safe feces disposal, it was not possible to conduct multivariate analysis beyond restricting the analysis to households owning a latrine, therefore these crude odds ratios should be interpreted cautiously.
doi:10.1371/journal.pone.0089551.t004

odds of safe disposal (OR 6.16, 95%CI 0.76–49.72), although not significantly.

Discussion

We describe reported defecation and disposal practices of 145 children under five years old from 136 households in rural Orissa, together with factors associated with these practices. We found that most child feces are disposed of unsafely even among households with latrines.

Most child feces ended up in the household waste disposal site. Such disposal is considered "open defecation" under the definitions used by the JMP [2]. In these communities, household waste is generally collected in piles or pits and mostly located in the backyard of the house and according to qualitative research it is sometimes burned. This practice could create a source of pathogen exposure, either directly through leaching or dispersion with the rains or indirectly via animals and mechanical vectors (flies), and its proximity to households may increase the risk compared to the more typically distant open defecation sites. However, the actual risk that this practice presents has not been quantified.

In this study population, safe disposal of child feces was limited almost exclusively to latrine use by ambulatory children. Few caregivers collected and disposed of stools around the compound safely. As data was not collected on the age of the children within the mobility categories, it is not possible to know whether there was an association between age and latrine use, which may explain the ambulatory children that did not use the latrine for defecation. Defecation in potties or nappies, though uncommon, was associated with safe disposal of the feces even though the majority of the feces collected in potties or nappies were still disposed of unsafely. Studies in Burkina Faso and Peru where defecation in a potty was more common in the study population also found that defecation into a potty was associated with safe disposal of the stools into a latrine [21,22].

Longer-term adoption of a latrine by households (>5 years) was weakly associated with safer stool disposal. It is possible that these households built their latrines themselves as it was in the early stages of the TSC and so they may attach more priority to sanitation generally, it seems likely that household investment in sanitation would increase use of the latrine. Alternatively, households may take more time to adopt safe child feces disposal practices after they own their latrines, though the possible association could be due to other confounders not explored or adjusted for in this paper such as wealth, exposure to sanitation messages and use of the latrine by other members of the family.

Access to water within the compound was found to be associated with safe child feces disposal in Burkina Faso [21]. While our findings were suggestive of an association, our sample size may have been too small to achieve statistical significance. Curtis and colleagues hypothesized that this association was maybe due to mothers in households with improved water sources wanting to conform to better standards of hygiene behavior or due to increased time to carry out safer behaviors [21].

The study involved a small sample from a single, non-randomly selected district in Orissa State, and thus cannot be generalized beyond the study population itself. Nevertheless, our findings are similar to those from large-scale surveys in India. The latest Demographic and Health Survey (DHS) for India (2005–2006) reported that nationally, 79.0% percent of child feces were disposed of unsafely [23] compared to our finding of 81.4%. In that DHS survey, Orissa was found to have one of the lowest percentages in the country of safe child stool disposal, with only 7.0% of the stools being disposed of safely [23]. The main disposal methods in Orissa were found to be leaving the feces in the open (53.7%) or disposing of them in the garbage (32.3%). These methods were also among the ones found to be most common in our study. A more recent but smaller study conducted in 6 states in India (not including Orissa), reported 55.0% safe stool disposal practices [5].

India may present a particular challenge for the safe disposal of child feces owing to the continuing widespread practice of open defecation in the country [2]. However, our results are largely consistent with previous research in other countries, particularly in Asia [10]. Studies analyzed by Gil and colleagues (2004) found low use of direct defecation into latrines and of potties and diapers as defecation sites in Asia. The review authors also reported that the disposal of child feces in latrines was uncommon in studies from Asia (three studies with a prevalence of <25%). In Africa or Latin America, the behavior is more widespread with a prevalence of child feces disposal in latrines of more than 50% [10].

Although we present data on pre-ambulatory and ambulatory children, there were notably fewer data on pre-ambulatory children than ambulatory children, as the latter category encompasses more possible ages under five. This limits the conclusions that can be inferred from this data about the different mobility categories. In future studies, the sampling procedure should take this into account as well as record the actual ages of the children. Moreover, in accordance with practices in this setting, we targeted the survey to the female head of household but accepted responses from the male head if she was not available. Future surveys may wish to explore targeting the child's principal caregiver.

Like the DHS survey, we relied on reported practices via a survey rather than direct observation, although surveys are susceptible to courtesy and recall bias [24,25]. Gil and colleagues found greater precision among studies employing spot checks and structured observations rather than questionnaires [10] so our study survey results should be interpreted with some caution. However, direct observation of sanitation practices has been shown to be subject to reactivity (Hawthorne effect) in the study population [9]. Like the DHS survey, we endeavored to minimize reporting bias by enquiring about the "last time" rather than a usual practice for disposal of child feces [24]. While we cannot rule out courtesy bias, adjustment for an exaggeration of positive (safe) behaviors would further reduce the already low level of safe feces disposal that we report here. Due to the small sample size of the study and the rare occurrence of safe feces disposal, it was not possible to conduct multivariate analysis beyond restricting the analysis to households owning a latrine, which is an important determinant of safe feces disposal [26–29]. The associations that were found in the bivariate analysis should thus be interpreted cautiously as they are likely to be confounded by other variables.

Despite these limitations, this study draws attention to unsafe disposal of child feces in this area of India and adds to a growing body of evidence raising questions about the effectiveness of sanitation strategies focused on expanding coverage without a corresponding emphasis on optimizing use. The larger study in the same households as those investigated here, reported low levels of latrine use by many adults [7]. These and other studies reporting on deficiencies in latrine use in India [5,8] suggest that current sanitation campaigns in rural India may be more effective in addressing coverage than securing the behavior change necessary to ensure the safe disposal of feces of all members of the household in a manner that minimizes exposure to human feces—a condition to optimizing health gains.

Acknowledgments

The authors would like to thank the participants of this study for donating their valuable time, and also the study field team Rajashree Nayak, Rajani Barik, Swarnalata Sahoo, Alfred Mohanty, Anisha Mitra and Munmun Dasmohapatra for collecting the data.

Author Contributions

Conceived and designed the experiments: FM S. Barnard MF PR S. Boisson TC. Performed the experiments: FM S. Barnard PR. Analyzed the data: FM MF TC. Contributed reagents/materials/analysis tools: FM MF S. Boisson S. Barnard. Wrote the paper: FM MF TC.

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Appendix 2: The impact of a rural sanitation programme on safe disposal of child faeces: a cluster randomized trial in Odisha, India

Trans R Soc Trop Med Hyg 2016; **110**: 386–392
doi:10.1093/trstmh/trw043

ORIGINAL ARTICLE

The impact of a rural sanitation programme on safe disposal of child faeces: a cluster randomised trial in Odisha, India

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Received 13 May 2016; revised 16 June 2016; accepted 20 June 2016

Background: Unsafe disposal of child faeces is persistent and may lead to considerable impact on the health of young children. Research is limited on the impact of sanitation or hygiene interventions to improve child faeces disposal practices.

Methods: In the context of a randomised controlled trial to assess the health impact of a programme in Odisha, India, to promote rural sanitation under the Government of India's Total Sanitation Campaign, we explored whether the intervention affected the safe disposal of faeces of children under-5 years of age.

Results: At baseline, 1.1% of households practised 'safe' disposal of child faeces, either disposing it in a toilet or by burial. The intervention increased safe disposal of child faeces to 10.4% in intervention households, compared to 3.1% in the control households (RR 3.34; 95% CI 1.99–5.59). This increase in safe disposal is attributable to increases in latrine presence in the intervention communities; the intervention did not change safe disposal practices above and beyond the increase in latrine coverage.

Conclusions: The very modest increase in safe disposal, while statistically significant, is not likely to have consequential health benefit. To achieve open defecation free communities, sanitation interventions will need to develop behaviour change approaches to explicitly target safe disposal behaviours.

Keywords: Child faeces, Diarrhoea, Faecal exposure, India, Sanitation, WASH

Introduction

Nearly 1 billion people still practise open defecation globally, and a further 1.4 billion use unimproved toilet facilities.[1] The problem is especially severe in India, where 44% of the population still practise open defecation and only 40% of the population use improved sanitation.[1] In response, the Government of India launched a series of initiatives, including the Total Sanitation Campaign (TSC) (1999–2012), Nirmal Bharat Abhiyan (2012–2014) and most recently Swachh Bharat Abhiyan.[2,3] While these programmes have been successful in expanding sanitation coverage, the use of these facilities has been found to be poor.[4–7] Despite evidence of the positive health impact of improved sanitation generally,[8,9] rigorous evaluation programmes implementing the TSC have shown no effect on diarrhoea, soil-transmitted helminth infection or nutritional status.[4,7]

Compounding the low use among adolescents and adults is that even among households with access to improved sanitation, the faeces of children may not end up in the latrine.[10] In the latest demographic health survey in India, just 20% of child faeces ended in latrines—either the child defecated in the latrine, or it was placed there by a caregiver—the last time the child defecated.[11] Less than 1% was buried, a method currently characterised by the WHO/UNICEF Joint Monitoring Programme on Water Supply and Sanitation (JMP) as safe disposal.[12] However, a recent expert review deemed burial to be unsafe because of the thought among others that burial sites could be near the home and children's play areas and that the practice would not be acceptable for adults.[13] In children under 3 years, 16% of faeces were disposed of in any sanitation facility,[14] about half of which (9%) were improved facilities.[15] In a cross-sectional study in rural Odisha, India, among households with a latrine in villages households with a latrine in villages where the

TSC had been implemented at least 3 years before, less than a quarter of the children's faeces ended up in a latrine.[10]

Despite the common perception that they are less 'unclean' or harmful than those of adults,[16] child faeces may present more of a health risk. Young children have the highest incidence of enteric infections[17] and are more likely to have pathogens in their stools.[18] A review in 2004 found that risky practices related to child faeces disposal resulted in a 23% increase in the risk of diarrhoea.[16] A 2016 study in Indonesia using data from demographic and health surveys, found unsafe disposal of child faeces to be strongly associated with child diarrhoea.[19] Children tend to defecate in areas where other children[20] and animals, such as dogs,[21] may come in contact with the faeces. Since children spend considerable time exploring their environment and practise behaviours such as geophagia,[22] they are more exposed to the contaminated soil, a potential risk factor for environmental enteropathy and stunting.[23]

In this paper we report on whether the implementation of the TSC among rural households in Puri District in the State of Odisha impacted child faeces disposal behaviours. We also explored whether demographic or other characteristics of the study population predict safe disposal practices.

Methods

Background

This study was nested within a village cluster-randomised controlled trial in Odisha between 2010 and 2013. Details of the study have been published elsewhere, including the study design,[24] process evaluation[25] and main health impacts.[4] Briefly, 100 villages selected to receive the TSC were randomised following baseline: half to receive a standard intervention delivered by WaterAid—an international non-governmental organisation—and its implementing partners, and the other half to serve as controls. A government subsidy covered most of the costs of materials and masonary support to construct a pour flush pit latrine with 1.5 m walls and a door. Householders were required to contribute labour, such as digging the pit, and if they wished to raise the latrine walls then they provided sand and bricks or stone for the walls. Although the intervention included mobilisers to encourage householders to participate, it did not include any significant behaviour change messages about toilet use, and no specific child faeces disposal behaviour change component. The baseline, conducted in the last quarter of 2010, showed latrine coverage in subsequently randomised to intervention and control groups of 9% and 8%, respectively. By March 2012, one year after the start of construction activities, 63% of households in the intervention communities had complete latrines compared to 12% in control villages.[25]

Data collection

Data on child faeces disposal practices were collected at baseline (October 2010) and endline (October 2013) as part of a survey administered to households in both the intervention and control villages by a separate team that conducted health surveillance.[26] We included all villages chosen for the randomised trial and surveyed all households enrolled under health surveillance. A structured questionnaire was conducted in Oriya by enumerators trained in research ethics. Maternal heads of household were asked about the walking ability of their youngest child under 5 years old. Caregivers were asked about where that child typically defecated, and if the child did not defecate in the toilet, what they did, if anything, to dispose of the faeces. Additional demographic information was recorded, as well as water, sanitation and hygiene conditions at the home.

Data management and analysis

Data were recorded on paper surveys and entered using EpiData 3.1 (EpiData Association, Odense, Denmark). Data were cleaned and analysed using STATA v. 13 (StataCorp, College Station, TX, USA). We compared child defecation behaviours using generalised estimating equations to calculate risk ratios, and accounted for clustering at the village level using an exchangeable correlation matrix. We analysed ambulatory and non-ambulatory children separately, since the child's ability to walk is a likely indicator of toilet use.[5,27] We used data collected during baseline to assess associations with safe disposal practices at endline. Disposal was considered 'safe' only if the faeces ended up in the latrine either because a child defecated in a latrine, or it was placed there by a caregiver or it was buried.[28] Models covariates were determined a priori and included the gender of the household head, if the main source of drinking water for the household was 'improved' as defined by the JMP,[29] if the water source was located in the compound, an observed household toilet in the compound, and an observed place for handwashing that included water and soap. Education of the household head was coded and categorised into 'no or some primary education' and 'completed at least primary education.' For assessments at endline, we included the intervention as a covariate. A wealth score was derived using principal component analysis from an asset index that included standardised variables.[30,31] However, the score accounted for only 13% of the total variation and failed to converge in models, so it was dropped from multivariable models.

Results

Study participants

During the baseline survey, data from two villages were lost due to data collection error. Within 98 villages with available data, 7872 households were surveyed, of which 1958 were eligible for the study and consented: 1831 households had a child under 4 years of age and 288 had women in the third trimester of pregnancy (87 had both). An additional six households were eligible for the study but did not consent to the survey. We analysed a total of 1816 households with complete data. During the follow-up survey to assess child faeces disposal, we interviewed 2563 female caregivers. Among 2463 households interviewed with complete data, only 1780 (72%) with a child under 5 years old and complete data were analysed. In our assessment of determinants of faecal exposure behaviours at endline, we included only households that could be matched for both data collection rounds with children under 5 years old at endline (n=1092).

Baseline disposal practices

At baseline, 45/1816 (2.5%) had a movable potty for use by children and 180/1816 (9.9%) had toilets. Few mothers (78/1816; 4.3%) reported that their youngest child defecated in a nappy, in a toilet (11/1816; 0.6%) or a potty (3/1816; 0.2%); the remainder reported defecation on the ground (1472/1816; 81.1%) or in their clothes (222/1816; 12.2%), and 30/1816 (1.7%) did not know. Among those whose child did not defecate in the toilet, 6/1805 (0.3%) placed it in the latrine, while 650/1805 (36.0%) put the faeces in the garbage or compost pit and 3/1805 (0.2%) buried it. The remaining left it out or did not move the faeces. As a result, 20/1816 (1.1%) practised safe disposal of child faeces; an equivalent number in the intervention (8/886; 0.9%) and control (9/930; 1.0%), p=0.89. At the time of this data collection, burial was considered 'safe' disposal. Using this definition of 'safe', 51/886 (5.8%) households in the intervention practised safe disposal, compared to 46/930 (5.0%) households in the control (p=0.43).

Endline disposal practices

At endline, among households with children under 5 years, 634/970 (65.4%) in the intervention group had an observed toilet compared to 153/810 (18.9%) in the control group. Among households with children under 5 years, 92/970 (9.5%) of intervention households had children that defecated in the toilet compared to control 22/810 (2.8%) households (RR 3.45; 95% CI 1.99–6.00; Table 1). The percent of caregivers that reported that the youngest child less than 5 years old defecated within the compound, was comparable between intervention (740/960; 77.1%) and control (623/800; 77.9%) households, but those that left the compound for open defecation, perhaps accompanied by the mother or an older sibling, was (155/800; 19.4%) in controls and (128/960; 13.3%) in the intervention households. Few households where children did not defecate in the toilet reported disposing of the faeces in the toilet in either the intervention (9/960; 0.9%) or control households (3/800; 0.3%); only one household buried the faeces. In the intervention villages, households with children under 5 were 3.3 times more likely to practise safe disposal of child faeces of their youngest child compared to households in control communities (RR 3.34; 95% CI 1.99–5.59).

Table 1. Child defecation and faeces disposal practices at follow-up

	Intervention		Control		RR (95% CI)[a]	p value
	n	%	n	%		
Any child	n=970		n=810			
Defecation						
In toilet[b]	92	9.5	22	2.7	3.45 (1.99–6.00)	<0.001
In house or in compound	740	77.1	623	77.9	ref[d]	NA[e]
Outside compound	128	13.3	155	19.4	ref	NA
Disposal						
Safe disposal[c]	102	10.5	25	3.1	3.34 (1.99–5.59)	<0.001
Thrown in latrine	9	0.9	3	0.3	-[c]	NA
Buried	1	0.1	0	0.0	-[c]	NA
Unsafe disposal						
Left where defecation occurred (left in open)	87	9.1	98	11.1	ref	NA
Thrown away inside compound	152	15.8	103	11.7	ref	NA
Thrown away outside compound	521	54.3	475	54.0	ref	NA
Washed away	63	6.6	56	6.4	ref	NA
Ambulatory children	n=770		n=642			
Safe faeces disposal	97	12.6	23	3.6	3.50 (2.06–5.94)	<0.001
Non-ambulatory children	n=195		n=168			
Safe faeces disposal	3	1.5	2	1.2	1.30 (0.22–7.67)	NS[f]
Among those with a toilet						
Safe faeces disposal	98	15.5	22	14.4	1.10 (0.65–1.82)	NS

[a] Risk ratios (RR) and 95% CI calculated using generalised estimating equations (GEE), with standard errors adjusted for clustering at the village level.
[b] Comparison between defecation in toilet and defecation elsewhere.
[c] Comparison between safe disposal in toilet (either defecation or disposal in toilet) or buried and all other unsafe disposal behaviors.
[d] Ref refers to the referent groups for the risk ratio calculations.
[e] NA: not applicable as p-values are only calculated for a single estimate of the risk ratio.
[f] NS: not significant at p<0.05.

Parents reported that 79.3% of children (1412/1780) were ambulatory and 363/1780 (20.4%) could not walk; data on mobility was missing for 5/1780 (0.3%). Among children under 5 who were not ambulatory, few households practised safe disposal of child faeces. Only 3/195 (1.5%) households in the intervention group and 2/168 (1.2%) in the control group practised safe disposal of child faeces (RR 1.30; 95% CI 0.22–7.67). Among children under 5 who were ambulatory in the intervention households, 97/770 (12.6%) practised safe disposal practices, which primarily consisted of use of the latrine (91; 11.9%). Safe disposal in intervention communities was 3.5 times higher compared to the control communities where 23/642 (3.6%) had safe faeces disposal (RR 3.50; 95% CI 2.06–5.94).

Of the 126 households that practised safe disposal of child faeces, 120 (95.2%) had a toilet. For the subset of the households with a toilet, the percentage of households that had safe child faeces disposal practices—typically use of the toilet by an ambulatory child—was similar between households within the intervention (98/634; 15.5%) and control (22/153; 14.4%) villages (RR 1.10; 95% CI 0.66–1.82). In other words, those in the intervention communities with a toilet were no more likely than those with toilets in the control to safely dispose of the child faeces.

Associations with safe disposal practices at endline

Intervention status alone was a strong predictor of safe faeces disposal practices (RR 3.26; 95% CI 1.85–5.76, data not shown). However, in multivariable analysis, intervention status was not associated with the safe disposal of child faeces (RR 1.11; 95% CI 0.67–1.82; Table 2). The presence of a toilet was strongly associated with safe disposal (RR 31.5; 95% CI 9.45–104), as was education of the household head (RR 1.82; 95% CI 1.07–3.11); water in the compound was weakly associated with safe faeces disposal (RR 1.45; 95% CI 0.95–2.22). An improved drinking water source was associated with poorer safe disposal practices (RR 0.57; 95% CI 0.35–0.95).

Discussion

Unsafe disposal of child faeces is persistent,[32] yet few sanitation and hygiene programmes, even those that focus on promotion of open defecation free communities, have focused on safe disposal of child faeces. However, a considerable proportion of both symptomatic and asymptomatic children shed pathogens in their stool,[33] and contamination of the environment with child faeces represents a considerable potential risk to health. In accordance with the JMP definition, we defined safe disposal as depositing faeces in a latrine or burying. However, this does not guarantee that the faeces will not contaminate the environment if waste stream from the latrines is not properly managed. In addition, a recent Delphi consultation concluded that burial should not constitute ‘safe’ disposal, due to the proximity of burial sites to children’s play areas and that a similar practice would not be appropriate for adults.[13] Practices like disposal with a solid waste service may be a better option for households without toilets than just leaving it in the yard or washing it into a water source, though while this approach would not pose immediate risks to the household directly, it would not be considered safe due to the risk of environmental contamination.

We explored whether an intervention in Odisha to promote rural sanitation under the Government of India’s TSC impacted the safe disposal of faeces of children under 5 years, within the context of a randomised controlled trial to assess health impact. Safe disposal was rare, with only 1% of study households following the practice prior to the introduction of the intervention. This low level was not surprising, since open defecation was common in this population at baseline, with less than 10% of study households having a latrine that would have allowed them to safely dispose of their children’s faeces.

While the intervention increased latrine coverage in study villages to 63% (65% in the full trial population[25]), this may be insufficient to yield health gains even assuming full use, including for disposal of child faeces. However, we found that among intervention households at endline, only 10.4% of mothers reported that child faeces ended up safely disposed in latrines.

Table 2. Adjusted associations between household demographics and conditions and safe disposal of child faeces

	Endline			
	Unsafe disposal (n=997)	Safe disposal (n=95)	RR (95% CI)[a]	*p*
Male head of household	942 (94.5%)	92 (96.8%)	0.70 (0.24–2.07)	NS
Household head completed at least primary school	685 (68.7%)	81 (85.3%)	1.82 (1.07–3.11)	0.03
Drinking water source is improved	852 (85.5%)	79 (83.2%)	0.57 (0.35–0.95)	0.03
Water in compound	268 (26.9%)	48 (50.3%)	1.45 (0.95–2.22)	NS
Access to a toilet in compound	376 (37.7%)	92 (96.8%)	31.5 (9.45–104)	<0.001
Presence of place for handwashing with water and soap	105 (10.5%)	26 (27.4%)	1.25 (0.80–1.94)	NS
Intervention	511 (51.2%)	75 (79.0%)	1.11 (0.67–1.82)	NS

[a] Risk ratios (RR) and 95% confidence intervals calculated using generalized estimating equations (GEE), with standard errors adjusted for clustering at the village level.
NS: not significant at p<0.05.

Moreover, this change from baseline in safe disposal was solely due to an increase in the number of households with latrines; at endline, intervention households with toilets were no more likely than those with toilets in the control to safely dispose of the child faeces. Thus, beyond increasing latrine coverage, we did not find evidence that the intervention had any impact on safe disposal of child faeces.

While the increase in child faeces disposal over baseline was substantial, evidence suggests that it would be insufficient to result in health gains. Community latrine coverage may need to exceed 75% in order to see significant reductions in diarrhoeal disease.[34] Improvements in community defecation practices may result in commensurate declines in childhood stunting, but the effects of the communities practices exceeds the influence of the household practices.[35]

Access to a latrine is a necessary but clearly insufficient condition of practising safe disposal of child faeces; most households with latrines still do not follow the practice. At endline, safe disposal was associated weakly with having a water point within the compound, but inversely related to having an 'improved' water source for drinking. Having a water point within the compound is strongly related to household water availability, which is strongly linked with latrine usage in Odisha[27] and may explain the relationship with safe disposal of child faeces. However, having an 'improved' drinking water source is not indicative of increased water availability, potentially explaining the counter intuitive results. Other studies have found safe disposal to be associated with household wealth, mother's education, child age, years of latrine ownership, caregiver age, consistency of adult latrine use and presence of child faeces management tools in the latrine.[36,37] Our results are consistent with other studies that report poor and inconsistent use of latrines for disposal of child faeces.[10,36,37] They are also consistent with other findings regarding sub-optimal use of latrines constructed under the TSC,[4,5,7] which did not include explicit behaviour change elements that focused on either toilet use or safe disposal of child faeces.

Challenges in achieving correct, consistent use of latrines in India have been documented elsewhere.[27,38] However, there are additional obstacles to overcome to increase safe disposal of child faeces. Perhaps chief among these is the perception that child faeces do not present a risk to human health.[27] This knowledge barrier is consistent with findings by others and us that safe disposal is associated with parents' education and caregiver awareness.[23] On the other hand, research has suggested that in the area of personal hygiene, the development of healthfully habits, such as handwashing after defecation, is not motivated by knowledge but on other motivators or structural facilitators of behaviour change.[39–41] Recent research in Cambodia suggests a need for a more comprehensive understanding of the barriers to safe disposal of child faeces, and for specific hardware interventions, such as reusable diapers, child-friendly potties and latrine seats that offer child safety.[37]

There is increasing acknowledgement that interventions that increase latrine coverage do not necessarily ensure latrine use—a clear condition to achieving health gains from sanitation. To optimise health impacts, it is also important that such use also includes the safe disposal of child faeces. Both require specific efforts that are informed by a deeper understanding of barriers to adopting the targeted behaviours and that are supported by policies that encourage programmatic efforts to overcome them.

There were several limitations to this study. First, we relied on caregiver self-report for our key outcomes, a potential source of bias in the context of an intervention study where treatment status was not blinded. Direct observation may be more objective, but are also prone to bias.[42] Second, we only assessed behaviour at a single time point. Our pilot data collected among a subset of households in October 2013 found safe disposal of child faeces in the intervention group of 26%, and 5% in the control households (data not shown). Additional data collection at a different season or time following implementation may have revealed different findings. Third, the intervention did not include any specific behaviour change component, let alone a focus on disposal of child faeces. The purpose of this study was to assess the impact of the TSC as it was implemented. Future research should focus on optimising the effectiveness of sanitation and hygiene interventions to improve child faeces disposal practices.

Conclusions

We found that while safe disposal of child faeces increased considerably from baseline, and was significantly different between intervention and control, the increase in safe disposal was directly related to commensurate increases in latrine presence in the intervention communities. The intervention did not substantially change behaviours above and beyond the expected change associated with greater latrine coverage. The very modest increase in safe disposal, while statistically significant, is not likely to have consequential health benefit as it likely did not mitigate community or household exposure to faecal pathogens.[35] To achieve open defecation free communities, sanitation interventions will need to develop behaviour change approaches to explicitly target safe child faeces behaviors.

Authors' contributions: MCF, SB and TC conceived this study; SB, TC, MCF, PR and BT designed the study protocol; SB, PR and BT carried out data collection and ensured data quality; MCF analysed the data; MCF, FM and TC wrote the initial draft; all authors revised the manuscript and approved the final draft. MCF and TC are the guarantors of the paper.

Acknowledgements: We thank WaterAid, United Artists Association and their collaborating implementers; the Xavier Institute of Management Bhubaneswar, and our dedicated study teams.

Funding: The study was funded by the Bill & Melinda Gates Foundation, the International Initiative for Impact Evaluation (3ie), UK aid from the Department for International Development (DFID) as part of the SHARE Research Programme (www.SHAREResearch.org). However, the views expressed do not necessarily reflect the Department's official policies.

Competing interests: None declared.

Ethical approval: Ethical approval for this study was provided by the London School of Hygiene and Tropical Medicine (London, UK) and Xavier

Institute of Management (Odisha, India). Heads of household provided oral consent to participate and were not compensated for their contribution to the survey. Anonymity was ensured through the use of household identification numbers; no unique identifiers were recorded in the database. The trial is registered with ClinicalTrials.gov [no. NCT01214785].

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Appendix 4: Cross-sectional study sampling instructions

IF SLUM CONSISTS OF ONE AREA: select a central starting point for data collection. All enumerators should start from this point.

IF SLUM CONSISTS OF SEVERAL AREAS: Select a starting point in each area. An even number of enumerators should start from each central point. So if there are 2 areas- 2 enumerators should start from each central point.

IF SLUM CONSISTS OF ONE LONG ROAD WITH HOUSES ON BOTH SIDES: Select 2 starting points at about ¼ and ¾ of the road and divide the team so that 2 enumerators start from each starting point. Flip a coin to decide in which direction the enumerator will go from each point. Before tossing the coin, determine what the outcome will indicate: i.e. If it is heads, we go left. Each enumerator then visits every second house on the left.

IF SLUM CONSISTS OF ONE LONG ROAD WITH HOUSES ON ONE SIDE: Select 2 starting points at about ¼ and ¾ of the road and divide the team so that 2 enumerators start from each starting point. Flip a coin to decide in which direction the enumerator will go from each point. Before tossing the coin, determine what the outcome will indicate: i.e. If it is heads, we go left. Each enumerator then visits every second house on the side with houses.

Step 1: go to starting point(s), which was decided while visiting and mapping the slums.

- Take a picture from the starting point.

If the pen spins twice in the same direction- the first enumerator should visit every second house on the left and the other enumerator- every second household on the right.

Step 2: spin the pen to decide the direction in which the enumerators will go visit the households. The order of the enumerators IDs should be used to determine who goes first.

If there are no more houses on the side the enumerator is visiting / the enumerator has reached the boundary of the slum, return to the last point at which the pen was spun (last intersection) OR the central starting point (in case there have been no intersections), where a new direction can be randomly chosen.

OR if it is one road with houses on both sides- the enumerator should turn around and visit every second house on the left going back to the starting point.

OR if it is one road with houses only one side- the enumerator should notify the supervisor who will check if the other parts of the road (visited by the other enumerators still have unvisited houses).

Step 3: The enumerator should go to every second house on the left (unless the pen spun twice in the same direction) and ask eligibility criteria and if we are still in the correct slum.

If the HH is locked/ does not want to participate/ does not fit the selection criteria, select the NEXT house.

Step 4: the enumerator should keep visiting every second household until they have each collected data from 5 households OR it is the end of the field day (3.30 PM).

If get back to a crossroad and all the roads but one have been done- then the enumerator has to go to the last option.

If they reach a crossing the pen is again spun (by the supervisor) to determine which direction to continue sampling.

If all the roads have been visited from the initial central point but there still are other parts of the slum which have not been visited- select a new central point and spin the pen from there.

Appendix 5: Cross-sectional study questionnaire

URBAN SLUM HOUSEHOLD SURVEY ବସ୍ତି ପରିବାରର ସର୍ବେକ୍ଷଣ			
SECTION 1: SLUM CHARACTERISTICS (SUPERVISORS - TO FILL IN ONCE WHEN VISIT EACH SLUM) ବସ୍ତିର ବୈଶିଷ୍ଟ୍ୟ(ବସ୍ତିରେ କିଛି ସମୟ ବୁଲି ଏହି ତଥ୍ୟ ଗୁଡିକୁ ପୁରଣ କରନ୍ତୁ) *Walk around the slum upon arrival at the slum and fill in the following information*			
	Questions	**Response selections (CIRCLE OR WRITE RESPONSE WHEN PROMPTED)**	
S01	Name of the slum ବସ୍ତିର ନାମ		
S02	Presence of one/ several public/communal latrines? ଗୋଟିଏ/ଅଧିକା ସରକାରୀ / ଗୋଷ୍ଠୀ ପାଇଖାନାର ଉପସ୍ଥିତି ?	01. Yes	02. No => SKIP to 201
S03	How many public/communal latrines blocks are there? କେତୋଟି ସରକାରୀ / ଗୋଷ୍ଠୀ ପାଇଖାନାର ବିଭାଗ ଅଛି ?	*Write the number* ସଂଖ୍ୟା ଲେଖନ୍ତୁ ___________	
S04	Are there separate toilets for adults and children? ବଡଲୋକ ଏବଂ ଛୋଟ ପିଲାଙ୍କ ପାଇଁ ଅଲଗା ଅଲଗା ପାଇଖାନା ର ସୁବିଧା ଅଛି କି ?	01. Yes	02. No
S05-S16	*For each community latrine, write name, number of seats per block(male and female), number of seats that are functional and used, type of facility, whether there are separate toilets for men, women and children, if there is space for bathing and hand washing, if the blocks are accessible to be used all day and the times when they are accessible.* ପ୍ରତ୍ୟେକ ପାଇଖାନା ବିଭାଗ ପାଇଁ ନାମ, ବିଭାଗ ପିଛା ପାଇଖାନା ସଂଖ୍ୟା, କେତୋଟି ପାଇଖାନା କାର୍ଯ୍ୟକ୍ଷମ ଓ ବ୍ୟବହୃତ, କେଉଁ ପ୍ରକାରର ବ୍ୟବସ୍ଥା, ସେଠାରେ ଛୋଟ ପିଲା, ସ୍ତ୍ରୀ ଲୋକ ଓ ପୁରୁଷ ଲୋକଙ୍କ ପାଇଁ ଅଲଗା ପାଇଖାନା ଅଛି କି ? ସେଠାରେ ଗାଧୋଇବା ଓ ହାତ ଧୋଇବା ପାଇଁ ଅଲଗା ଜାଗା ଅଛି କି ଲେଖନ୍ତୁ । ବିଭାଗ ଗୁଡିକୁ ଦିନର ସବୁ ସମୟରେ ଯାଇ ବ୍ୟବହାର କରି ହେଉଥିବ ଏବଂ କେଉଁ ସମୟରେ ନୁହେଁ ଲେଖନ୍ତୁ ।		

S05. Latrine no. ପାଇଖାନା ସଂଖ୍ୟା	S06. Community latrine name ପାଇଖାନାର ନାମ *Write clearly name of latrine* ସ୍ପଷ୍ଟ ଭାବେ ପାଇଖାନା ନାମ ଲେଖନ୍ତୁ ।	S07. Was the community latrine built by the government,NGO or other? ଗୋଷ୍ଠୀ ପାଇଖାନାଟି କାହା ଦ୍ୱାରା ନିର୍ମିତ ? 01. GVT ସରକାର 02.NGO ଏନ୍.ଜି.ଓ 88.Other, specify ଅନ୍ୟ କିଛି, ବିବରଣୀ କରନ୍ତୁ	S08. Number of seats କେତୋଟି ପାଇଖାନା ବସିବା ସ୍ଥାନ *Write total number of seats per block.* ବିଭାଗ ପିଛା କେତୋଟି ସିଟ୍			S09.How many seats are functional**? କେତୋଟି ପାଇଖାନା ବସିବା ସ୍ଥାନ କାର୍ଯ୍ୟକ୍ଷମ			S10.How many seats are used***? ବ୍ୟବହୃତ ପାଇଖାନା ବସିବା ସ୍ଥାନ			S11. What type of facility are the public/ communal latrines? ସରକାରୀ / ଗୋଷ୍ଠୀ ପାଇଖାନାରେ କେଉଁ ପ୍ରକାରର ବ୍ୟବସ୍ଥା ରହିଛି ? 01. Pour flush with pit/closed sewerage system ଗର୍ତ ଥିବା ପାଣି ଢଳା ପାଇଖାନା 02. Pour flush without pit/open sewerage system ଗର୍ତ ନଥିବା ପାଣି ଢଳା ପାଇଖାନା 03. Pit latrine with slab ଉଠା ପାଇଖାନା 88. Other, specify ଅନ୍ୟ କିଛି, ବିବରଣୀ କରନ୍ତୁ			S12. Is there a place for bathing? ଗାଧୋଇବା ପାଇଁ ସେଠାରେ ଯାଗା ଅଛି କି ? 01. Yes 02. No			S13. Is there a place for hand washing? ହାତ ଧୋଇବା ପାଇଁ ସେଠାରେ ଯାଗା ଅଛି କି ? 01. Yes 02. No			S14. Is there a fee to use the toilets? ପାଇଖାନା କୁ ବ୍ୟବହାର କରିବା ପାଇଁ କିଛି ଶୁଳ୍କ ଅଛି କି ? 01. Yes 02. No			S15. Are the latrines accessible to be used all day and night? ପାଇଖାନା ଗୁଡିକୁ କଣ ଦିନ ରାତି ସବୁ ସମୟରେ ବ୍ୟବହାର କରିବା ପାଇଁ ଯାଇପାରିବେ 01.Yes =>SKIP to 201 02.No			S16. When are the latrines accessible? କେବେ ପାଇଖାନା କୁ ଯାଇ ହେବ(ଯିବା ର ସମୟ ସୀମା ଲେଖନ୍ତୁ) *Write times when accessible (e.g. 5am-10pm)*		
			M	F	C	M	F	C	M	F	C	M	F	C	M	F	C	M	F	C	M	F	C	M	F	C	M	F	C
01																													
02																													
03																													

** **Seat is functional** If **ALL** of this **'YES'**, then enter **'YES'.** ଯଦି ସମସ୍ତେ 'ହଁ' ହୁଏ, ତେବେ 'ହଁ' ଲେଖନ୍ତୁ । : 1. **ANY COVER** ଯେକୌଣସି ଘୋଡ଼ଣି 2. Not used for storage ସଂରକ୍ଷଣ ପାଇଁ ବ୍ୟବହାର ହେଉନଥିବ 3. Pan not broken, not blocked or not full of leaves/dust ପ୍ୟାନ ଟି ଭାଙ୍ଗି ନ ଥିବ,ପତ୍ର ଓ ଧୂଳି ଦ୍ୱାରା ବନ୍ଦ ହୋଇନଥିବ 4. Pit completed ଗର୍ତଟି ସମ୍ପୂର୍ଣ ତିଆରି ହୋଇଥିବ

***Seat is used** If **ONE** of this **'YES'**, then enter **'YES'.** ଯଦି ଏହା ଭିତରୁ ଗୋଟେ ବି 'ହଁ ' ହୁଏ, ତେବେ 'ହଁ 'ଲେଖନ୍ତୁ । 1. Smell ଗନ୍ଧ 2. Pan wet ପ୍ୟାନଟି ଓଦା 3. Stain (faeces, urine) ଦାଗ (ମଳ,ମୂତ୍ର)

1

URBAN SLUM HOUSEHOLD SURVEY ବସ୍ତି ପରିବାରର ସର୍ବେକ୍ଷଣ		
SECTION 2: HOUSEHOLD ELIGIBILITY ଘରର ଯୋଗ୍ୟତା		
	Questions	**Response selections**
201	Do you have at least one child below 5 years old (up to 4 years and 11 months/ 59 months)? ଆପଣଙ୍କର, ୫ ବର୍ଷରୁ କମ୍ ବୟସର ପିଲା ଅଛନ୍ତି କି ? (୪ ବର୍ଷ ଏବଂ ୧୧ ମାସ ପର୍ଯ୍ୟନ୍ତ/୫୯ ମାସ)	01. Yes → eligible ଯୋଗ୍ୟ 02. No → STOP
202	Is the primary caregiver of the <u>youngest child below 5</u> (the one who usually cares for the child) available to answer questions? ୫ ବର୍ଷ ରୁ କମ୍ ବୟସର ସବୁଠାରୁ ସାନ ପିଲାର ପ୍ରାଥମିକ ଦେଖାଶୁଣା(ଯିଏ ପ୍ରାୟତଃ ପିଲାଟିର ଦେଖାରେଖା କରୁଥିବେ) କରୁଥିବା ବ୍ୟକ୍ତି ଉତର ଦେବା ପାଇଁ ଉପସ୍ଥିତ କି ?	01. Yes → eligible - *ask <u>primary caregiver</u> the questions* ଯୋଗ୍ୟ- ପ୍ରାଥମିକ ଦେଖାଶୁଣା କରୁଥିବା ବ୍ୟକ୍ତିଙ୍କୁ ପ୍ରଶ୍ନ ପଚାରନ୍ତୁ 02. No → STOP
203	Do you have access to sanitation facilities (individual household latrines, shared or communal facilities)? ଆପଣଙ୍କର ପରିମଳ ସୁବିଧା କିଛି ଅଛି କି ?(ବ୍ୟକ୍ତିଗତ ପାଇଖାନା,୧ ରୁ ଅଧିକ ଘର ବ୍ୟବହୃତ ପାଇଖାନା ବା ଗୋଷ୍ଠୀ ପାଇଖାନା ର ସୁବିଧା ଅଛି କି)	01. Yes → eligible ଯୋଗ୍ୟ 02. No → STOP
204	Are you an ASHA or *anganwadi* worker or have you worked for health promotion campaigns? ଆପଣ ଜଣେ ଆଶା ବା ଅଙ୍ଗନୱାଡି କର୍ମୀ ବା ଆପଣ କେବେ କୌଣସି ସ୍ୱାସ୍ଥ୍ୟ ଅଭିଯାନରେ କାମ କରିଛନ୍ତି କି ?	01. Yes → STOP 02. No → eligible ଯୋଗ୍ୟ
205	Is the primary caregiver older than 18 years old? ପିଲାର ପ୍ରାଥମିକ ଦେଖାରେଖା କରୁଥିବା ବ୍ୟକ୍ତି ଜଣକ ୧୮ ବର୍ଷରୁ ଅଧିକ କି ?	01. Yes → eligible – *ask for consent.* ଯୋଗ୍ୟ - ସହମତି ପାଇଁ ପଚାରନ୍ତୁ 02. No → STOP
206	Is the primary caregiver willing to participate after having understood the information on the study? ପ୍ରାଥମିକ ଦେଖା ରେଖା କରୁଥିବା ବ୍ୟକ୍ତି ଜଣକ ଗବେଷଣାରେ ତଥ୍ୟ ଗୁଡ଼ିକ ବୁଝିବା ପରେ ଗବେଷଣାରେ ଯୋଗଦାନ ପାଇଁ ରାଜି ଅଛନ୍ତି କି ?	01. Yes →*Continue survey after consent form is signed.* ସହମତି ପତ୍ର ହସ୍ତାକ୍ଷର ପରେ ସର୍ଭେ ଆରମ୍ଭ କରନ୍ତୁ 02. No → STOP.

SECTION 3: SURVEY DETAILS ସର୍ଭେ ତଥ୍ୟ *Fill in for every household.* ସବୁ ଘର ଗୁଡିକ ପାଇଁ ପୁରଣ କରନ୍ତୁ	
Date of visit ସାକ୍ଷାତକାର ତାରିଖ	_ _DD_ _MM _ _ _ _YYYY
Survey start time ସର୍ଭେ ଆରମ୍ଭ ସମୟ	_ _HH_ _ MM
Survey end time ସର୍ଭେ ଶେଷ ସମୟ	_ _HH_ _ MM
Name of enumerator	______________________
Enumerator ID	_ _
Slum name ବସ୍ତିର ନାମ	______________________
Slum code ବସ୍ତିର କୋଡ୍	_ _ _
Household number ଘରର ସଂଖ୍ୟା	_ _
Full ID (ENUMERATOR ID + SLUM CODE + HOUSEHOLD NUMBER) ସମ୍ପୂର୍ଣ୍ଣ **ID**	_ _ _ _ _ _ _

SECTION 4: SOCIO-ECONOMICS AND DEMOGRAPHICS (*ASK ALL QUESTIONS TO PRIMARY CAREGIVER*) ସାମାଜିକ-ଆର୍ଥିକ ଓ ଜନ ସଂଖିକ(ସମସ୍ତ ପ୍ରଶ୍ନ ପ୍ରାଥମିକ ଦେଖାରେଖା କରୁଥିବା ବ୍ୟକ୍ତିଙ୍କୁ ପଚାରନ୍ତୁ)		
I would like to start by asking you some questions about you and your family. ପ୍ରଥମେ ଆପଣଙ୍କ ପରିବାର ସମ୍ବନ୍ଧୀୟ କିଛିଟା ପ୍ରଶ୍ନ ମୁଁ ଆପଣଙ୍କୁ ପଚାରିବି ।		
	Questions	**Response selections**
401	What is your relationship to the child? ଆପଣଙ୍କର ପିଲା ସହିତ ସର୍ମ୍ପକ କଣ ?	01. Mother of the child ପିଲାର ମାଁ 02. Father of the child ପିଲାର ବାପା 03. Grandmother ଜେଜେ ମାଁ 04. Aunt ମାଉସି/ ପିଉସୀ 88. Other, specify ଅନ୍ୟ କିଛି, ବର୍ଣ୍ଣନା କରନ୍ତୁ_______________
402	What is your relationship to the head of household? (IN RELATION TO THE RESPONDENT) ଆପଣଙ୍କର ଘର ମୁରବି ସହ କଣ ସର୍ମ୍ପକ ? (ଉତରଦାତା ଙ୍କ ସହ ସଂପୃକ୍ତ)	01. Respondent is the head of household ଉତରଦାତା ନିଜେ ଘରର ମୁରବି 02. Wife ସ୍ତ୍ରୀ 03. Daughter-in-law ବୋହୂ 04. Sister ଭଉଣୀ 05. Brother ଭାଇ 06. Sister in-law ନଣନ୍ଦ 07. Mother ମାଁ 88. Other, specify ଅନ୍ୟ କିଛି, ବର୍ଣ୍ଣନା କରନ୍ତୁ_______________
403	What is the gender of the head of HH? ଘରର ମୁରବୀ ଙ୍କ ଲିଙ୍ଗ କଣ ?	01. Male ପୁରୁଷ 02. Female ମହିଳା
404	What is the highest level of education that the head of household has attained? ଘରର ମୁରବିଙ୍କ ସର୍ବାଧିକ ଶିକ୍ଷାଗତ ଯୋଗ୍ୟତା କେତେ ?	01. Illiterate ଅଶିକ୍ଷିତ 02. Literate without formal schooling ଶିକ୍ଷିତ କିନ୍ତୁ ସ୍କୁଲ ଯାଇ ନାହାନ୍ତି 03. Some primary (1-4th year) ପ୍ରାଥମିକ 04. Completed primary (5th year) ପ୍ରାଥମିକ ପାସ୍ 05. Completed secondary (6th-10th year) ଉଚ ମାଧମିକ ପାସ୍ 06. Completed +2 (12th year) +2 ପାସ୍ 07. Completed +3 year (university etc.) +3 ପାସ୍ 99. Don't know ଜଣା ନାହିଁ
405	What is the highest level of education that you (primary caregiver of the child) have attained? (If not head of the HH) ଆପଣଙ୍କର ସର୍ବାଧିକ ଶିକ୍ଷାଗତ ଯୋଗ୍ୟତା କେତେ ?(ଯଦି ଉତରଦାତା ଘରର ମୁରବି ହୋଇନଥିବେ)	01. Illiterate ଅଶିକ୍ଷିତ 02. Literate without formal schooling ଶିକ୍ଷିତ କିନ୍ତୁ ସ୍କୁଲ ଯାଇ ନାହାଁନ୍ତି 03. Some primary (1-4th year) ପ୍ରାଥମିକ 04. Completed primary (5th year) ପ୍ରାଥମିକ ପାସ୍ 05. Completed secondary (6th-10th year) ଉଚ୍ଚ ମାଧମିକ ପାସ୍ 06. Completed +2 (12th year) +2 ପାସ୍ 07. Completed +3 year (university etc) +3 ପାସ୍ 99. Don't know ଜଣା ନାହିଁ
406	How old are you? ଆପଣଙ୍କର ବୟସ କେତେ ?	01. ____________YEARS (approximate) 99. Don't know ଜଣା ନାହିଁ
407	What is your religion? ଆପଣଙ୍କର ଧର୍ମ କଣ ?	01. Hindu 02. Muslim 03. Christian 04. Sikh 05. Buddhist/ neo-buddhist 06. Jain 88. Other, specify ଅନ୍ୟ କିଛି, ବର୍ଣ୍ଣନା କରନ୍ତୁ_________________
408	What is your caste or tribe? ଆପଣଙ୍କର ଜାତି କଣ ?	01. SC 02. ST 03. OBC 04. GEN 05. Not applicable କୌଣସିଟି ନୁହେଁ 99.Don't know 88. Other caste_______________

409	What is your occupation? ଆପଣଙ୍କର ଜୀବିକା କ'ଣ ?	01. Day labour ଦିନ ମୁଲିଆ 02. Private job ବେସରକାରୀ ଚାକିରୀ 03. Government Job ସରକାରୀ ଚାକିରୀ 04. Business ବ୍ୟବସାୟ 05. Housewife ଗୃହିଣୀ => SKIP to 413 88. Other, specify ଅନ୍ୟ କିଛି, ବର୍ଣ୍ଣନା କରନ୍ତୁ ____________________
410	Is it full time or part time? ଏହା ଫୁଲ ଟାଇମ୍ ନା ପାର୍ଟ ଟାଇମ ଅଟେ ?	01. Full time 02. Part time 88. Other, specify ଅନ୍ୟ କିଛି, ବର୍ଣ୍ଣନା କରନ୍ତୁ ____________________
411	Do you leave the house for work? ଆପଣ କାମ ପାଇଁ ଘର ବାହାରକୁ ଯାଆନ୍ତି କି ?	01. Yes 02. No => SKIP to 413
412	Who takes care of your youngest child when you are working? (*IN RELATION TO THE CHILD*) ଯେତେବେଳେ ଆପଣ କାମ କରିବା ପାଇଁ ବାହାରକୁ ଯାଆନ୍ତି ସେତେବେଳେ ଆପଣଙ୍କର ସବୁଠାରୁ ସାନ ପିଲାର ଯତ୍ନ କିଏ ନିଅନ୍ତି	01. Respondent takes the child with him/ her ଉତରଦାତା ପିଲାଟିକୁ ନିଜ ସହିତ ନେଇ ଯାଆନ୍ତି 02. Father of the child ପିଲାର ବାପା 03. Grandmother of the child ପିଲାର ଜେଜେ ମାଁ 04. Aunt ମାଉସି/ ପିଉସୀ 05.Non-relative neighbour ପଡୋଶୀ ଯିଏ କୁଟୁମ୍ବର ନୁହନ୍ତି 88. Other, specify ଅନ୍ୟ କିଛି, ବର୍ଣ୍ଣନା କରନ୍ତୁ ________________
413	Are you the owner of this house or a tenant? ଏହି ଘରଟି ଆପଣଙ୍କର ଅଟେ ନା ଆପଣ ଭଡାଟିଆ ଅଛନ୍ତି ?	01. Owner ମାଲିକ 02. Tenant ଭଡାଟିଆ
414	How long have you lived in this house? ଆପଣ ଏହି ଘରେ ରହିବାର କେତେ ଦିନ ହୋଇ ଗଲାଣି ?	01. Less than 6 months 6 ମାସରୁ କମ୍ 02. 6 months- 1 year 6 ମାସରୁ 1 ବର୍ଷ 03. 1 year- 5 years 1 ବର୍ଷରୁ 5 ବର୍ଷ 04. More than 5 years 5 ବର୍ଷ ରୁ ଅଧିକ
415	How many rooms are there in your home? *Hint: separate rooms with walls* ଆପଣଙ୍କ ଘରେ କେତୋଟି କକ୍ଷ ଅଛି ? *(କକ୍ଷ ଗୁଡିକ କାନ୍ଥ ଦ୍ୱାରା ଅଲଗା ହୋଇଥିବ)*	*Write number* (ସଂଖ୍ୟା ଲେଖନ୍ତୁ) ____________
416	How many rooms are used for sleeping? ଶୋଇବା ପାଇଁ କେତୋଟି କକ୍ଷ ବ୍ୟବହାର କରାଯାଏ ?	*Write number* (ସଂଖ୍ୟା ଲେଖନ୍ତୁ) ____________
417	How many persons live in your household full-time? *Hint: A household is defined as sharing the same cooking pot. A person should live at the house* full-time . ଆପଣଙ୍କ ଘରେ ସବୁବେଳେ କେତେ ଲୋକ ରୁହନ୍ତି ?	*Write number* (ସଂଖ୍ୟା ଲେଖନ୍ତୁ) ____________
418	How many children are under 5 years old? *Hint: 0 to 4 years* ୫ ବର୍ଷରୁ କମ୍ ବୟସ ପିଲା କେତୋଟି ଅଛନ୍ତି ? ୦ ରୁ ୪ ବର୍ଷ	*Write number* (ସଂଖ୍ୟା ଲେଖନ୍ତୁ) ____________
419	How many persons are between 5 and 16 years old? ୫ ବର୍ଷରୁ ୧୬ ବର୍ଷ ମଧ୍ୟରେ କେତୋଟି ପିଲା ଅଛନ୍ତି ?	*Write number* (ସଂଖ୍ୟା ଲେଖନ୍ତୁ) ____________
420	***OBSERVE AND RECORD*** ଦେଖିକି ଲେଖନ୍ତୁ Household construction ଘର କେଉଁ ପ୍ରକାରରେ ନିର୍ମିତ	01. Pucca କୋଠା ଘର 02. Semi-Pucca ଅଧା ପକ୍କା 03. Kuchha ମାଟି ଘର
421	***OBSERVE AND RECORD*** ଦେଖିକି ଲେଖନ୍ତୁ Is there a compound? ଘରର ଅଗଣା ଅଛି କି ?	01. Yes 02. No
422	Does your household own a BPL card or Antyodaya (AYY) card? If so, can I see it? ଆପଣଙ୍କର BPL ବା ଅନ୍ତୋଦୟ କାର୍ଡ ଅଛି କି? ମୁଁ ତାହା ଦେଖିପାରିବି କି ?	01. Yes BPL observed ହଁ BPL କାର୍ଡ ଦେଖିଛି 02. Yes BPL reported ହଁ BPL କାର୍ଡ କୁହାଯାଇଛି 03. Yes AYY observed ହଁ AYY କାର୍ଡ ଦେଖିଛି 04. Yes AYY reported ହଁ AYY କାର୍ଡ କୁହାଯାଇଛି 05. No 99. Don't know ଜଣା ନାହିଁ

423-446	Does your household own the following items? ଆପଣଙ୍କ ଘରେ ନିମ୍ନଲିଖିତ ଜିନିଷ ଗୁଡିକ ଅଛି କି ?	01.Yes	02.No	99. Don't know
423	Watch/ clock? କାନ୍ଥ ଘଣ୍ଟା/ହାତ ଘଣ୍ଟା	01	02	99
424	Pressure cooker? ପ୍ରେସର କୁକର୍	01	02	99
425	Radio? ରେଡିଓ	01	02	99
426	Electricity? ବିଦ୍ୟୁତ ଲାଇନ୍	01	02	99
427	Television? ଟେଲିଭିଜନ	01	02	99
428	Dish antenna? ଡ଼ିସ ଆଣ୍ଟିନା	01	02	99
429	Refrigerator? ଫ୍ରିଜ୍	01	02	99
430	Mobile phone? ମୋବାଇଲ	01	02	99
431	Mattress? ଗଦି/ରଜାଇ	01	02	99
432	Cot/bed? ଖଟିଆ/ଖଟ	01	02	99
433	Chair? ଚୌକି	01	02	99
434	Table? ଟେବୁଲ	01	02	99
435	Electric fan? ଇଲେକଟ୍ରିକ ଫ୍ୟାନ୍	01	02	99
436	Sewing machine? ସିଲେଇ ମେସିନ୍	01	02	99
437	Water pump? ପାଣି ପମ୍ପ	01	02	99
438	Hoe? କୋଦାଳ	01	02	99
439	Bicycle? ସାଇକେଲ	01	02	99
440	Motorcycle/scooter? ବାଇକ୍	01	02	99
441	Trolley (bicycle cart) ଟ୍ରଲି	01	02	99
442	Auto rickshaw ଅଟୋ	01	02	99
443	Car/truck? କାର/ଟ୍ରକ	01	02	99
444	Computer? କମ୍ପୁଟର୍	01	02	99
445	Bathroom? *Hint: Separate room for privacy in the house for bathing* ଗାଧୋଇବା ଘର ? ଅଲଗା ଘର ଗାଧୋଇବା ପାଇଁ	01	02	99
446	Does anyone in your household own poultry/livestock or farm animals? ଆପଣଙ୍କ ଘରେ କୁକୁଡ଼ା ବା ଫାର୍ମ ପଶୁ/ପକ୍ଷୀ ପାଳିଛନ୍ତି କି ?	01. Yes 02. No⇒SKIP to section 5		
447	How many poultry/livestock or farm animals do you have? ଆପଣଙ୍କ ଘରେ କୋଡୋଟି କୁକୁଡ଼ା ବା ଫାର୍ମ ପଶୁ/ପକ୍ଷୀ ପାଳିଛନ୍ତି ?	☐ Buffalo ମଇଁଷି ☐ Goat ଛେଳି ☐ Other ଅନ୍ୟାନ୍ୟ ☐ Cow ଗାଈ ☐ Sheep ମେଣ୍ଢା ---------------------- ☐ Pig ଘୁଷୁରି ☐ Chicken/Duck କୁକୁଡା/ବତକ		

SECTION 5: WATER, SANITATION AND HYGIENE ଜଳ, ପରିମଳ ଏବଂ ସ୍ୱାସ୍ଥ୍ୟ ରକ୍ଷା		
The next questions are about your household's water and sanitation access. ପରବର୍ତ୍ତି ପ୍ରଶ୍ନଗୁଡ଼ିକ ଆପଣଙ୍କ ଘରର ପାଣି ଓ ପରିମଳ ବ୍ୟବସ୍ଥା ଉପରେ ଆଧାରିତ		
	Questions	**Response selections**
501	What is the main source of <u>drinking</u> water for members of your household? ଆପଣଙ୍କ ଘରର ସଦସ୍ୟ ପିଉଥିବା ପାଣିର ମୁଖ୍ୟ ଉତ୍ସ କଣ ?	01. Piped water ପାଇପ୍ ପାଣି 02. Hand pump ନଳକୂପ 03. Protected dug well ସୁରକ୍ଷିତ କୂଅ 04. Unprotected dug well ଅସୁରକ୍ଷିତ କୂଅ 05. Pond ପୋଖରୀ 06. River ନଦୀ 07. Tanker truck ପାଣି ଟ୍ୟାଙ୍କର୍ 88. Other ଅନ୍ୟାନ୍ୟ ____________________

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502	Where is the water located? ସେ ପାଣିର ଉତ୍ସ କେଉଁଠି ?	01. In own dwelling ଘର ଅଗଣାରେ =>SKIP to 504 02. In own compound ଘର ପରିସରରେ =>SKIP to 504 03. Outside compound ଘର ପରିସର ବାହାରେ
503	How long does it take to go there, get water, and come back in one trip? ଆପଣଙ୍କୁ ଥରକରେ ସେଠାକୁ ଯାଇ ପାଣି ଆଣି ଫେରିବା ପାଇଁ କେତେ ସମୟ ଲାଗୁଛି ?	01. _____MINUTES 99. Don't know.
504	Where do the children below 5 in your household usually bathe? ଆପଣଙ୍କ ଘରେ ୫ ବର୍ଷରୁ କମ୍ ପିଲା ସାଧାରଣତଃ କେଉଁଠାରେ ଗାଧୋଇ ଥାନ୍ତି ?	01. In the house/ compound ଘର ଭିତରେ/ଘର ଅଗଣା ମଧ୍ୟରେ => SKIP to 506 02. At a hand pump ନଳକୂପ ପାଖରେ 03. In a Pond ପୋଖରୀରେ 04. Other surface water ଅନ୍ୟାନ୍ୟ ବାହ୍ୟସ୍ତର ପାଣି 05. In the slum communal bathrooms ବସ୍ତିରେ ଥିବା ଗୋଷ୍ଠୀ ଗାଧୁଆ ଘରେ 88. Other, specify ଅନ୍ୟ କିଛି, ବିବରଣ କରନ୍ତୁ __________________
505	How long does it take to go there (one way- excluding bathing time)? ଆପଣଙ୍କୁ ସେଠିକୁ ଯିବା ପାଇଁ କେତେ ସମୟ ଲାଗେ ?	01. _____MINUTES 99. Don't know.
506	Where is the latrine that members of your household use the majority of the time located? ଅଧିକାଂଶ ଥର ଯେଉଁ ପାଇଖାନାଟି ଆପଣଙ୍କ ଘରର ସଦସ୍ୟ ମାନେ ବ୍ୟବହାର କରନ୍ତି ତାହା କେଉଁ ଠାରେ ଅବସ୍ଥିତ ?	01. In/Attached to own dwelling ଘର ଭିତରେ/ଘରକୁ ଲାଗିକି => SKIP to 508 02. In own courtyard/compound ନିଜ ଘର ପରିସରରେ/ ଅଗଣାରେ =>SKIP to 508 03. Inside neighbour's dwelling/compound ପଡିଶାଙ୍କ ଘର ପରିସର ମଧ୍ୟରେ 04. Outside the courtyard/ compound ଘର ପରିସର ବାହାରେ 05. No member of the household uses a latrine ଘରର କେହି ସଦସ୍ୟ ପାଇଖାନା ବ୍ୟବହାର କରନ୍ତି ନାହିଁ =>SKIP to 521 88. Other, specify ଅନ୍ୟ କିଛି, ବିବରଣ କରନ୍ତୁ _________________
507	How long does it take to go to the latrine? ଆପଣଙ୍କୁ କେତେ ସମୟ ଲାଗେ ପାଇଖାନା ଯିବା ପାଇଁ ?	01. _____MINUTES 99. Don't know
508	When was this latrine last cleaned? ଶେଷ ଥର କେବେ ଏହି ପାଇଖାନାଟି ସଫା ହୋଇଥିଲା ?	01. Today ଆଜି 02. Yesterday ଗତକାଲି 03. Between 2-7 days ago ୨ ରୁ ୭ ଦିନ ମଧ୍ୟରେ 04. More than a week ago ଗୋଟେ ସପ୍ତାହ ପୂର୍ବରୁ 99. Don't know ଜଣା ନାହିଁ
509	When was this latrine built? ଏହି ପାଇଖାନାଟି କେବେ ତିଆରି ହୋଇଥିଲା ?	*Number of years ago (e.g. 1=1 year ago). Write 0 if built in the last year.* 01. ____________YEARS AGO ବର୍ଷେ ପୂର୍ବେ 99. Don't know ଜଣା ନାହିଁ
510	Is the toilet facility that members of your household use the majority of the time privately owned or shared or communal? ଆପଣଙ୍କ ଘରର ସଦସ୍ୟ ମାନେ ମୁଖ୍ୟତଃ ଯେଉଁ ପାଇଖାନାଟିକୁ ସବୁବେଳେ ବ୍ୟବହାର କରନ୍ତି ତାହା ବ୍ୟକ୍ତିଗତ ନା, ୧ ରୁ ଅଧିକା ପରିବାର ବ୍ୟବହାର ପାଇଖାନା ନା ଗୋଷ୍ଠୀ ପାଇଖାନା ଅଟେ ?	01. Privately owned ବ୍ୟକ୍ତିଗତ ପାଇଖାନା =>SKIP to 518 02. Shared ୧ ରୁ ଅଧିକା ପରିବାର ବ୍ୟବହାର ପାଇଖାନା => SKIP to 513 03. Communal ଗୋଷ୍ଠୀ ପାଇଖାନା
511	What is the name of the community latrine you use? ଯେଉଁ ଗୋଷ୍ଠୀ ପାଇଖାନାଟି ବ୍ୟବହାର କରୁଛନ୍ତି ତାହାର ନାମ କଣ ?	*Write name* -------------------------

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512	***DO NOT ASK:*** *Check what the code of the latrine is from the first page and write code.* **ପଚାରନ୍ତୁ ନାହିଁ:** ପ୍ରଥମ ପୃଷ୍ଠାରେ ଲେଖାଯାଇଥିବା କୋଡ୍‌କୁ ଯାଚଂ କରନ୍ତୁ ଓ ଲେଖନ୍ତୁ	*Write code* ______
513	How many households share this latrine? କେତୋଟ ଘର ମିଶିକରି ଏହି ପାଇଖାନାଟିକୁ ବ୍ୟବହାର କରନ୍ତି ?	01. _____HOUSEHOLDS ଘର 99. Don't know ଜଣା ନାହିଁ
514	Do you pay to use this latrine? ବ୍ୟବହାର କରିବା ପାଇଁ କିଛି ମୁଲ୍ୟ ଦିଅନ୍ତି କି ?	01. Yes 02. No => SKIP to 516 99. Don't know =>SKIP to 516
515	How much do you pay to use this latrine? କେତେ ଟଙ୍କା ଦିଅନ୍ତି ପାଇଖାନା ଟି ବ୍ୟବହାର କରିବା ପାଇଁ ?	__________________Rs. 01. Per month ପ୍ରତି ମାସ 02. Per week ପ୍ରତି ସପ୍ତାହ 03. Per use ପ୍ରତିଥର ବ୍ୟବହାର ହିସାବରେ 04. Per year ପ୍ରତି ବର୍ଷ
516	Is the latrine open all day and all night? ପାଇଖାନାଟି ଦିନରାତି ଖୋଲା ଥାଏ କି ?	01. Yes => SKIP to section 6 02. No 99. Don't know => SKIP to section 6
517	Please note down exact opening times ପାଇଖାନା ଟି ଖୋଲା ଥିବା ପ୍ରକୃତ ସମୟ ଟିକୁ ଲେଖନ୍ତୁ	______________________ =>GO to section 6 99.Don't know =>SKIP to section 6
ONLY FOR PRIVATE LATRINE		
518	Do you share your latrine with other households? ଅନ୍ୟ ଘର ଆପଣଙ୍କ ପାଇଖାନା ବ୍ୟବହାର କରନ୍ତି କି ?	01. Yes 02. No =>SKIP to section 6
519	The other households who use this latrine, are they family or tenants? ଯେଉଁ ଅନ୍ୟ ଘର ଆପଣଙ୍କ ପାଇଖାନା ବ୍ୟବହାର କରନ୍ତି,ସେ ଆପଣଙ୍କ ଘରର ସଦସ୍ୟ ନା ଭଡ଼ାଟିଆ ?	01. Family ଘରର ସଦସ୍ୟ 02. Tenants ଭଡ଼ାଟିଆ 88. Other ଅନ୍ୟାନ୍ୟ___________________
520	How many households share your latrine? କେତୋଟି ପରିବାର ଆପଣଙ୍କ ପାଇଖାନା ବ୍ୟବହାର କରନ୍ତି ?	01. _____HOUSEHOLDS ଘର =>SKIP TO SECTION 6 99. Don't know ଜଣା ନାହିଁ =>SKIP TO SECTION 6
IF NOBODY IN THE HOUSEHOLD USES LATRINE		
521	Why do you not use a latrine? ଆପଣ ପାଇଖାନା କାହିଁକି ବ୍ୟବହାର କରନ୍ତି ନାହିଁ ?	

SECTION 6: DEFECATION PRACTICES OF MEMBERS OF THE HOUSEHOLD OVER 5 YEARS OLD (IF NEED EXTRA SHEET- GO TO LAST PAGE)
ପାଚଂ ବର୍ଷରୁ ଅଧିକ ବୟସର ବ୍ୟକ୍ତିଙ୍କ ମଳତ୍ୟାଗ ପକ୍ରିୟା (ଅଧିକ ଜାଗା ଦରକାର ହେଲେ ଶେଷ ପୃଷ୍ଠାକୁ ଯାଆନ୍ତୁ)

I would now like to ask you some questions about the defecation practices of your family members. ମୁଁ ଏବେ ଆପଣଙ୍କୁ, ଆପଣଙ୍କ ପରିବାରର ସଦସ୍ୟ ମାନଙ୍କ ମଳତ୍ୟାଗ ଅଭ୍ୟାସ ସମ୍ବନ୍ଧୀୟ କିଛି ପ୍ରଶ୍ନ ପଚାରିବି ।

Please list the gender, ages and where the household member **older than five years old usually** defecate for each household member **starting with the eldest**. ସବୁଠାରୁ ବଡ଼ରୁ ଆରମ୍ଭ କରି ପରିବାରର ପାଚଂ ବର୍ଷଠାରୁ ଉର୍ଦ୍ଧ୍ୱ ପ୍ରତ୍ୟେକ ସଦସ୍ୟର ଲିଙ୍ଗ, ବୟସ ଓ ତାଙ୍କ ମଳତ୍ୟାଗ କରିବା ସ୍ଥାନର ତାଲିକା ବନାନ୍ତୁ ।

601. Household members ଘରର ସଦସ୍ୟ *Do not include names*	**602. Gender** ଲିଙ୍ଗ M	F	**603. Age** ବୟସ *99= don't know* (years)	**604. Marital status** 01= Unmarried ଅବିବାହିତ 02= Married ବିବାହିତ 03= Widowed ବିଧବା 04= Divorced ଛାଡ଼ପତ୍ର ପ୍ରାପ୍ତ				**605. At this present place what is this household member's usual place of defecation?** *Do not read out the answers. If they say latrine- Probe if always/ usually/ sometimes.* ଏହି ଜାଗାରେ, ଏହି ସଦସ୍ୟ ପ୍ରାୟ କେଉଁଠି ମଳତ୍ୟାଗ କରନ୍ତି ? *ଉତର ପଢନ୍ତୁ ନାହିଁ । ଯଦି ଉତରଦାତା ପାଇଖାନା କୁହନ୍ତି, ତା'ହେଲେ ପଚାରନ୍ତୁ ସବୁବେଳେ/ପ୍ରାୟ/ବେଳେ ବେଳେ ।* 01= Latrine always ସବୁବେଳେ ପାଇଖାନା 02= Latrine usually ପ୍ରାୟତଃ ପାଇଖାନା 03= Latrine sometimes ବେଳେବେଳେ ପାଇଖାନା 04= Always open defecation ସବୁବେଳେ ବାହାରେ 88 = Other, please state ଅନ୍ୟାନ୍ୟ				
1.	01	02		01	02	03	04	01	02	03	04	88
2.	01	02		01	02	03	04	01	02	03	04	88
3.	01	02		01	02	03	04	01	02	03	04	88
4.	01	02		01	02	03	04	01	02	03	04	88
5.	01	02		01	02	03	04	01	02	03	04	88
6.	01	02		01	02	03	04	01	02	03	04	88
7.	01	02		01	02	03	04	01	02	03	04	88
8.	01	02		01	02	03	04	01	02	03	04	88
9.	01	02		01	02	03	04	01	02	03	04	88
10.	01	02		01	02	03	04	01	02	03	04	88

SECTION 7: DEFECATION AND FAECES DISPOSAL PRACTICES OF <u>CHILDREN BELOW 5 YEARS OLD.</u> ପାଚଁ ବର୍ଷଠାରୁ କମ୍ ବୟସ ପିଲାମାନଙ୍କ ମଳତ୍ୟାଗ ଓ ମଳ ନିଷ୍କାସନ ସମ୍ବନ୍ଧୀୟ ଅଭ୍ୟାସ ।

The next questions are about the defecation practices and faeces disposal practices of children below 5 in your household. ପରବର୍ତି ପ୍ରଶ୍ନଗୁଡ଼ିକ ଆପଣଙ୍କ ଘରେ ପାଚଁ ବର୍ଷଠାରୁ କମ୍ ବୟସର ପିଲାମାନଙ୍କ ମଳତ୍ୟାଗ ଓ ମଳ ନିଷ୍କାସନ ଅଭ୍ୟାସ ଗୁଡ଼ିକ ଉପରେ ଆଧାରିତ ।

Please list the gender, ages, mobility category, whether this child currently attends an *anganwadi* centre, whether the child is breastfed and defecation site for **<u>each child below five</u> starting with the eldest.** ଦୟାକରି ଲିଙ୍ଗ, ବୟସ, ବୁଲ୍-ଚାଲ୍ କରିବା କ୍ଷମତା ବିଷୟରେ ସୂଚୀ ପୂରଣ କରନ୍ତୁ । ଏହି ପିଲାଟି ବର୍ତମାନ ସମୟରେ ଅଙ୍ଗନବାଡ଼ି କେନ୍ଦ୍ରକୁ ଯାଉଛି ନା ନାହିଁ, ପିଲାଟିକୁ ସ୍ତନ୍ୟପାନ କରାଯାଉଛି କି, ଓ ସଭା ବଡ଼ରୁ ଆରମ୍ଭ କରି ପାଚଁ ବର୍ଷରୁ କମ୍ ବୟସର ପ୍ରତ୍ୟେକ ପିଲାର ମଳତ୍ୟାଗ ସ୍ଥାନ ବିଷୟରେ ସୂଚୀ ପୂରଣ କରନ୍ତୁ ।

701. Child (<5) ପିଲା(<୫)	**702. Gender** ଲିଙ୍ଗ 01=M 02=F	**703. Age** ବୟସ(ମାସ) (Months)	**704. Mobility capacity** ବୁଲ୍-ଚାଲ୍ ଯୋଗ୍ୟତା 01= can walk ଚାଲିବାକୁ ସକ୍ଷମ 02= cannot walk ଚାଲିବାକୁ ଅକ୍ଷମ	**705. Does this child go to the *anganwadi* centre or pre-school ?** ଏହି ପିଲାଟି ଅଙ୍ଗନବାଡ଼ି କେନ୍ଦ୍ର ଯାଉଛି କି ? 01=Always ସବୁବେଳେ 02=Sometimes ବେଳେ ବେଳେ 03=Never କେବେ ନୁହେଁ	**706. Is he/ she breastfed only?** ଏହି ପିଲାଟିକୁ କେବଳ ସ୍ତନ୍ୟପାନ କରାଯାଉଛି ? 01=Breastfed only କେବଳ ସ୍ତନ୍ୟପାନ 02=Breastfed and other than breastfed ସ୍ତନ୍ୟପାନ ସହିତ ଅଲଗା ଖାଦ୍ୟ 03=Other than breastfed ମାଁ କ୍ଷୀର ଛଡ଼ା ଅଲଗା ଖାଦ୍ୟ	**707. The last time this child passed stools were the faeces solid or liquid?** ଗତ ଥର ଯେତେବେଳେ ଏହି ପିଲା ମଳତ୍ୟାଗ କରିଥିଲା ମଳଟା କଠିନ ଥିଲା ନା ତରଳ ? 01=Solid କଠିନ 02=Liquid ତରଳ 03= semi-solid ଆଂଶିକ କଠିନ 99= don't know/ didn't see ଜାଣି ନାହିଁ/ଦେଖିନି	**708. The last time this child passed stools, where did he/she do it?** ଗତ ଥର ଯେବେ ଏହି ପିଲାଟି ମଳତ୍ୟାଗ କରିଥିଲା ସେ କେଉଁଠି କରିଥିଲା ? 01.Child defecated into latrine ପିଲା ପାଇଖାନାରେ ମଳତ୍ୟାଗ କରିଥିଲା- (ପରବର୍ତି ପିଲାକୁ ଯାଆନ୍ତୁ) =>SKIP to next child 02. Child defecated on the ground in latrine cubicle ପିଲା ପାଇଖାନା ଘରର ଚଟାଣ ଉପରେ ମଳତ୍ୟାଗ କରିଥିଲା 03.Child used potty ପିଲାଟି **ପ୍ଲାଷ୍ଟିକ ପାଇଖାନା** ବ୍ୟବହାର କରିଥିଲା => SKIP to 710 04.Child used nappy ପିଲାଟି କନା ପିନ୍ଧିଥିଲା =>SKIP to 710 05. Child defecated on bed. ପିଲାଟି ଖଟ ଉପରେ ଝାଡ଼ା କରିଥିଲା 06.Defecated on the roadside (main road) ରାସ୍ତା କଡ଼ରେ ମଳତ୍ୟାଗ କରିଥିଲା(ମୁଖ୍ୟ ରାସ୍ତା) 07. Defecated on the side of path near the house ଘର ପାଖ ରାସ୍ତା ଉପରେ ମଳତ୍ୟାଗ କରିଥିଲା 08.Defecated on ground in the household compound ଘରର ପରିସରରେ ଭୂମି ଉପରେ ମଳତ୍ୟାଗ କରିଥିଲା 09.Defecated on ground	**709. On what did he/ she defecate?** ସେ କାହା ଉପରେ ମଳତ୍ୟାଗ କରିଥିଲା ? 01.Directly on the ground/ Bed ସିଧା ଭୂମି ଉପରେ/ଖଟ ଉପରେ 02.On paper put on the ground/Bed ଭୂମି/ଖଟ ଉପରେ ରଖାଯାଇଥିବା କାଗଜ ଉପରେ 03.On polythene put on the ground/Bed ଭୂମି/ଖଟ ଉପରେ ରଖାଯାଇଥିବା ଜରି ଉପରେ 04. On cloth put on the ground/bed ଭୂମି/ଖଟ ଉପରେ ରଖାଯାଇଥିବା କପଡ଼ା ଉପରେ	**710. The last time this child (less than 5 years) passed stools, what was done to dispose of the stools?** ଗତ ଥର ଯେବେ ଏହି ପିଲା (ପାଚଁ ବର୍ଷଠାରୁ କମ୍) ମଳତ୍ୟାଗ କରିଥିଲା, ସେହି ମଳର ନିଷ୍କାସନ ପାଇଁ କ'ଣ କରାଯାଇଥିଲା ? 01. Put/rinsed into latrine ପାଇଖାନା ଭିତରେ ପକେଇ ଦିଆଯାଇଥିଲା 02. Thrown into garbage at house/compound ଘରେ ବା ଘର ପରିସରର ଅଳିଆ ଗଦାକୁ ଫୋପଡ଼ା ଦିଆଯାଇଥିଲା 03. Thrown into garbage dump (land) ବାହାର ଅଳିଆ ଗଦାରେ ଫୋପଡ଼ା ଦିଆଯାଇଥିଲା 04. Thrown into open field ଖୋଲା ପଡ଼ିଆରେ ଫୋପଡ଼ା ଯାଇଥିଲା 05. Buried ପୋତା ଯାଇଥିଲା 06. Left in the open ଖୋଲାରେ ଛାଡ଼ି ଦିଆଯାଇଥିଲା (SKIP to next child) 07. Thrown into	**711. What was used to remove and dispose of the stools?** ମଳକୁ କାଢିବା ଓ ତା' ନିଷ୍କାସନ ପାଇଁ କ'ଣ ବ୍ୟବହାର କରାଯାଇଥିଲା ? 01.Recipient or polythene/ paper/ cloth/oil cloth on which child defecated ପିଲା ମଳତ୍ୟାଗ କରିଥିବା ଜରି/ କାଗଜ/କପଡ଼ା/ ଅଏଲ କନା 02. Polythene ଜରି 03. Paper କାଗଜ 04. Cloth କପଡ଼ା 05. Broom ଝାଡ଼ୁ 06. Hoe କୋଦାଳ 88. Other, specify ଅନ୍ୟ କିଛି, ବର୍ଣ୍ଣନା କରନ୍ତୁ

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																inside the household ଘର ଭିତରେ ଚଟାଣ ଉପରେ ମଳତ୍ୟାଗ କରିଥିଲା 10.Defecated in an open field ଖୋଲା ପଡ଼ିଆରେ ମଳତ୍ୟାଗ କରିଥିଲା 11.Defecated in drain ନାଳରେ ମଳତ୍ୟାଗ କରିଥିଲା (SKIP to 710) 12.Defecated in diaper ଡ଼ାଇପର୍‌ରେ ମଳତ୍ୟାଗ କରିଥିଲା (SKIP to 710) 13.Defecated in pants ପ୍ୟାଣ୍ଟରେ ମଳତ୍ୟାଗ କରିଥିଲା (SKIP to 710) 88.Other, specify ଅନ୍ୟ କିଛି, ବର୍ଣ୍ଣନା କରନ୍ତୁ	05.On oil cloth put on the ground/bed ଭୂମି/ଖଟ ଉପରେ ରଖାଯାଇଥିବା ଅଏଲ କନା ଉପରେ 88.On other, specify ଅନ୍ୟ କିଛି, ବର୍ଣ୍ଣନା କରନ୍ତୁ	canal/drain କେନାଲ/ନାଳ ଫୋପାଡିବା 08. Washed with water only,specify where କେବଳ ପାଣିରେ ଧୁଆ ହୋଇଥିଲା, କେଉଁଠି ବର୍ଣ୍ଣନା କରନ୍ତୁ ___________ 09. Washed with water and soap/dettol,specify where ପାଣି ଏବଂ ସାବୁନ/ଡ଼େଟଲ୍ ସହିତ ଧୁଆ ଯାଇଥିବା, କେଉଁଠି ବର୍ଣ୍ଣନା କରନ୍ତୁ___________ 99.Don't know ଜାଣି ନାହିଁ 88.Other, specify ଅନ୍ୟ କିଛି, ବର୍ଣ୍ଣନା କରନ୍ତୁ	
701	**702**		**703**	**704**		**705**			**706**			**707**				**708**	**709**	**710**	**711**
1	01	02		01	02	01	02	03	01	02	03	01	02	03	99				
2	01	02		01	02	01	02	03	01	02	03	01	02	03	99				
3	01	02		01	02	01	02	03	01	02	03	01	02	03	99				
4	01	02		01	02	01	02	03	01	02	03	01	02	03	99				
5	01	02		01	02	01	02	03	01	02	03	01	02	03	99				
6	01	02		01	02	01	02	03	01	02	03	01	02	03	99				

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SECTION 8: DEMONSTRATION ନମୁନା

Now, I would like to ask you to demonstrate what happens when your youngest child defecates. ଏବେ ମୁଁ ଆପଣଙ୍କୁ ପଚାରିବାକୁ ଚାହିଁବୁ ଯେ ଯେତେବେଳେ ଆପଣଙ୍କର ସବୁଠାରୁ ସାନ ସନ୍ତାନ ମଳତ୍ୟାଗ କରେ, ତେବେ କ'ଣ ହୁଏ ?

Could you please demonstrate what you would do if your youngest child defecated right now, starting with showing us where your child would defecate? ଆପଣଙ୍କର ସବୁଠାରୁ ସାନ ସନ୍ତାନ ଯଦି ଏବେ ମଳତ୍ୟାଗ କରିଲା ତେବେ ଆପଣ କ'ଣ କରିବେ, ଝାଡ଼ା ଯିବା ସ୍ଥାନରୁ ଆରମ୍ଭ କରି ଶେଷ ପର୍ଯ୍ୟାୟ ପର୍ଯ୍ୟନ୍ତ, ଆମକୁ ଏକ ନମୁନା କରି ଦେଖେଇପାରିବେ କି ?

PLACE PLASTIC FAECES AT PLACE SHOWN BY PARTICIPANT (ପ୍ଲାଷ୍ଟିକ୍ ମଳଟିକୁ ଅଂଶଗ୍ରହଣକାରୀ ଦେଖାଇଥିବା ଜାଗାରେ ରଖନ୍ତୁ)

	Observation ନିରୀକ୍ଷଣ	**Response selections** ପ୍ରତିକ୍ରିୟା ଚୟନ
801	***OBSERVE AND RECORD*** ନିରୀକ୍ଷଣ କରି ଲେଖନ୍ତୁ Place of defecation ମଳତ୍ୟାଗର ସ୍ଥାନ	01. Directly into latrine =>DO NOT PUT THE PLASTIC FAECES IN THE LATRINE + SKIP TO 809 ସିଧା ପାଇଖାନା ଭିତରେ- ପ୍ଲାଷ୍ଟିକ ମଳକୁ ପାଇଖାନାରେ ପକାନ୍ତୁ ନାହିଁ + 809 କୁ SKIP କରନ୍ତୁ 02. On the ground in latrine cubicle ପାଇଖାନା ଘର ଚଟାଣ ଉପରେ 03. Potty **ପ୍ଲାଷ୍ଟିକ ପାଇଖାନା** => SKIP TO 806 04. In nappy କନା =>SKIP TO 806 05. Child defecated on bed. ପିଲାଟି ଖଟ ଉପରେ ଝାଡ଼ା କରିଥିଲା 06. Roadside (main road) ରାସ୍ତା କଡ଼ରେ(ମୁଖ୍ୟ ରାସ୍ତା) 07. Side of path near the house ଘର ପାଖ ରାସ୍ତା କଡ଼ରେ 08. On ground in the household compound ଭୂମି ଉପରେ ଘର ପରିସରରେ 09. On ground inside the household ଘର ଭିତରେ ଚଟାଣ ଉପରେ 10. In an open field ଖୋଲା ପଡ଼ିଆରେ 11. In drain ନାଳରେ => SKIP TO 806 12. In diaper ଡ଼ାଇପର୍‌ରେ => SKIP TO 806 13. In pants ପ୍ୟାଣ୍ଟରେ =>SKIP TO 806 88. Other, specify ଅନ୍ୟ କିଛି, ବର୍ଣ୍ଣନା କରନ୍ତୁ ____________
802	***OBSERVE AND RECORD*** ନିରୀକ୍ଷଣ କରି ଲେଖନ୍ତୁ Directly on the ground/bed or on paper, Polythene,cloth, oil cloth? ସିଧା ଭୂମି ଉପରେ ନା କାଗଜ, ଜରି,କନା,ଅଏଲ କନା ଉପରେ ?	01.Directly on the ground/ Bed ସିଧା ଭୂମି ଉପରେ/ଖଟ ଉପରେ 02.On paper put on the ground/Bed ଭୂମି/ଖଟ ଉପରେ ରଖାଯାଇଥିବା କାଗଜ ଉପରେ 03.On Polythene put on the ground/Bed ଭୂମି/ଖଟ ଉପରେ ରଖାଯାଇଥିବା ଜରି ଉପରେ 04. On cloth put on the ground/bed ଭୂମି/ଖଟ ଉପରେ ରଖାଯାଇଥିବା କପଡ଼ା ଉପରେ 05. On oil cloth put on the ground/bed ଭୂମି/ଖଟ ଉପରେ ରଖାଯାଇଥିବା ,ଅଏଲ କନା ଉପରେ ଉପରେ 88.On other, specify ଅନ୍ୟ କିଛି, ବର୍ଣ୍ଣନା କରନ୍ତୁ ____________
803	***OBSERVE AND RECORD*** ନିରୀକ୍ଷଣ କରି ଲେଖନ୍ତୁ Tool used for removal କାଢିବା ପାଇଁ ଉପକରଣ	01. Recipient or Polythene/ paper/ cloth/oil cloth on which child defecated ଜରି, କାଗଜ, କପଡ଼ା,ଅଏଲ କନା ବା ଯାହା ଉପରେ ପିଲାଟି ମଳତ୍ୟାଗ କରିଛି 02. Polythene ଜରି 03. Paper କାଗଜ 04. Cloth କପଡ଼ା 05. Broom ଝାଡୁ 06. Hoe କୋଦାଳ 07. Not removed କଢା ଯାଇ ନଥିଲା =>SKIP TO 809 88. Other, specify ଅନ୍ୟ କିଛି, ବର୍ଣ୍ଣନା କରନ୍ତୁ ___________
804	***OBSERVE AND RECORD*** ନିରୀକ୍ଷଣ କରି ଲେଖନ୍ତୁ Is the ground/bed cleaned after? ଭୂମି/ଚଟାଣ ତା'ପରେ ସଫା କରାଯାଉଛି କି ?	01. Yes ହଁ 02. No ନାଁ =>SKIP TO 806

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805	***OBSERVE AND RECORD*** ନିରୀକ୍ଷଣ କରି ଲେଖନ୍ତୁ With what? କେଉଁଥିରେ ?	01. Water only କେବଳ ପାଣି 02. Water and soap ପାଣି ଓ ସାବୁନ୍ 03. Water and dettol/phenyl ପାଣି ଓ ଡ଼େଟଲ୍/ଫିନାଇଲ୍ 04.Water and cow dung ପାଣି ଓ ଗୋବର 88. Other, specify ଅନ୍ୟ କିଛି, ବର୍ଣ୍ଣନା କରନ୍ତୁ__________________
806	***OBSERVE AND RECORD*** ନିରୀକ୍ଷଣ କରି ଲେଖନ୍ତୁ What was done to dispose of the stools? ସେହି ମଳର ନିଷ୍କାସନ ପାଇଁ କ'ଣ କରାଯାଇଥିଲା ?	01. Put/rinsed into latrine ପାଇଖାନା ଭିତରେ ପକେଇ ଦିଆଯାଇଥିଲା => SKIP TO 809 02. Thrown into garbage at house/compound ଘରେ ବା ଘର ପରିସର ଭିତରେ ଅଳିଆ ଗଦାକୁ ପକାଇ ଦିଆଯାଇଥିଲା => SKIP to 809 03. Thrown into garbage dump (land) ବାହାର ଅଳିଆ ଗଦାରେ ପକାଇ ଦିଆଯାଇଥିଲା 04. Thrown into open field ଖୋଲା ପଡ଼ିଆରେ ପକାଯାଇଥିଲା => SKIP TO 809 05. Buried ପୋତା ଯାଇଥିଲା =>SKIP TO 809 06. Left in the open ଖୋଲାରେ ଛାଡ଼ି ଦିଆଯାଇଥିଲା =>SKIP TO 809 07.Thrown into canal/drain କେନାଲ/ନାଳ ରେ ଫୋପାଡିବା=> SKIP TO 809 08. Washed with water only,specify where କେବଳ ପାଣିରେ ଧୁଆ ହୋଇଥିଲା, କେଉଁଠି ବର୍ଣ୍ଣନା କରନ୍ତୁ____________=> SKIP TO 809 09. Washed with water and soap/dettol,specify where ପାଣି ଏବଂ ସାବୁନ/ଡ଼େଟଲ୍ ସହିତ ଧୁଆ ଯାଇଥିବା, କେଉଁଠି ବର୍ଣ୍ଣନା କରନ୍ତୁ ____________=> SKIP TO 809 88.Other, specify ଅନ୍ୟ କିଛି, ବର୍ଣ୍ଣନା କରନ୍ତୁ________________
807	***OBSERVE AND RECORD***: How far is the garbage? ନିରୀକ୍ଷଣ କରି ଲେଖନ୍ତୁ: ଅଳିଆ କେତେ ଦୂର ?	01.________METRES FROM THE HOUSE ଘରଠାରୁ କେତେ ମିଟର
808	***OBSERVE AND RECORD***: Is the garbage nearby houses (within 10 metres)? ନିରୀକ୍ଷଣ କରି ଲେଖନ୍ତୁ: ଅଳିଆ ଗଦାଟି ଘର ପାଖରେ ଅଛି କି(୧୦ ମିଟର ମଧ୍ୟରେ)	01. Yes ହଁ 02. No ନାଁ
809	**ANY OTHER COMMENTS**	

SECTION 9: CHILD FAECES DISPOSAL PRACTICES ଶିଶୁ ମଳ ନିଷ୍କାସନ ଅଭ୍ୟାସ		
I would now like to ask you a few more questions about the way you manage your child's faeces and about latrine training ଏବେ ମୁଁ ଆପଣଙ୍କୁ ପାଇଖାନା ପ୍ରଶିକ୍ଷଣ ଓ ଆପଣଙ୍କ ଶିଶୁର ମଳ ନିଷ୍କାସନ ସମ୍ବନ୍ଧୀୟ ଅଭ୍ୟାସ ଉପରେ କିଛି ପ୍ରଶ୍ନ ପଚାରିବା ପାଇଁ ଚାହିଁବି ।		
	Questions ପ୍ରଶ୍ନ	**Response selections** ପ୍ରତିକ୍ରିୟା ଚୟନ
901	**DO NOT ASK**: did the participant report/ demonstrate disposing of their child's faeces? ପଚାରନ୍ତୁ ନାହିଁ: ଉତରଦାତା ଶିଶୁର ମଳ ନିଷ୍କାସନ ଦେଖାଇଲେ ବା କହିଲେ କି ?	01. Yes ହଁ 02. No ନାଁ=> SKIP to 903
902	Who usually disposes of your child's faeces? (IN RELATION TO YOUNGEST CHILD <5) (ପାଚଁ ବର୍ଷଠାରୁ କମ୍ ବୟସର ସଭା ସାନ ପିଲା ପାଇଁ) ସାଧାରଣତଃ ଆପଣଙ୍କ ଶିଶୁର ମଳ ନିଷ୍କାସନ କିଏ କରନ୍ତି ?	01. Mother ମା' 02. Father ବାପା 03. Grandmother ଜେଜେମା 04. Aunt ମାଉସି/ **ପିଉସୀ** 05. Older sibling ବଡ଼ ଭାଇ/ଭଉଣୀ 88. Other, specify ଅନ୍ୟ କିଛି, ବର୍ଣ୍ଣନା କରନ୍ତୁ _________

903	These days do you always use the same method to manage your child's faeces? ଏହି ଦିନ ମାନଙ୍କରେ ଆପଣ କ'ଣ ଶିଶୁର ଝାଡ଼ାକୁ ସମାନ ପ୍ରଣାଳିରେ ସଫା କରନ୍ତି ? *Hint: at this present age of the child (ଶିଶୁର ବର୍ତ୍ତମାନ ବୟସରେ)*	01. Yes ହଁ =>SKIP to 905 02. No ନାଁ
904	What are the reasons for using a different method of child faeces management? ଶିଶୁର ଝାଡ଼ାକୁ ଅନ୍ୟ କିଛି ପ୍ରଣାଳିରେ ସଫା କରିବାର କାରଣ ସବୁ କ'ଣ ? *Probe: any other reason?* ପ୍ରୁବ୍; ଅନ୍ୟ କିଛି କାରଣ ?	*Tick all that apply* ଯାହା ଯଥାର୍ଥ ସେଥିରେ ଠିକ୍ ଚିହ୍ନ ମାରନ୍ତୁ 01. Season ଋତୁ 02. Place of defecation ମଳତ୍ୟାଗର ସ୍ଥାନ 03. When the child is sick ପିଲା ଯେବେ ରୋଗରେ ପଡ଼େ 88. Other, specify ଅନ୍ୟ କିଛି, ବର୍ଣ୍ଣନା କରନ୍ତୁ _______________
905	At what age would you train your child to use a latrine? ଆପଣ ନିଜ ଶିଶୁକୁ କେଉଁ ବୟସରେ ପାଇଖାନା ବ୍ୟବହାର କରିବାର ପ୍ରଶିକ୍ଷଣ ଦେବେ ? (ଯଦି ସବା ସାନ ଶିଶୁର ପ୍ରଶିକ୍ଷଣ ହୋଇସାରିଛି ତେବେ କେଉଁ ବୟସରେ କରାଯାଇଥିଲା ?) *Hint: if the youngest child is already trained, report age at which child was trained.*	*Write age in years.* ବୟସ ବର୍ଷରେ ଲେଖନ୍ତୁ *01. _________YEARS* ବର୍ଷ 02. Never କେବେ ନୁହେଁ=>SKIP to 907
906	Why at that age? ଏହି ବୟସରେ କାହିଁକି ? *Probe: any other reason?* ପ୍ରୁବ୍; ଅନ୍ୟ କିଛି କାରଣ ?	*Tick all that apply.* ଯାହା ଯଥାର୍ଥ ସେଥିରେ ଠିକ୍ ଚିହ୍ନ ମାରନ୍ତୁ 01. He can understand and grasp instructions ସେ କଥା ବୁଝିପାରିବ ଏବଂ ଗ୍ରହଣ କରିପାରିବ 02. He will not fall into latrine ସେ ପାଇଖାନା ଭିତରେ ପଡ଼ିଯିବ ନାହିଁ 03. He can stand on his own ସେ ନିଜେ ଛିଡ଼ା ହୋଇପାରିବ 04. He is not scared of the latrine ସେ ପାଇଖାନା ଯିବାକୁ ଡ଼ରିବ ନାହିଁ 88. Other, specify ଅନ୍ୟ କିଛି, ବର୍ଣ୍ଣନା କରନ୍ତୁ ___________________________
907	At what age would you expect your child to be able to use a latrine on its own? ଶିଶୁଟି କେତେ ବୟସରେ ନିଜେ ପାଇଖାନା ବ୍ୟବହାର କରିପାରିବା ଆପଣ ଆଶା କରନ୍ତି ?	*Write age in years.* ବୟସ ବର୍ଷରେ ଲେଖନ୍ତୁ *01._________YEARS* ବର୍ଷ 02. Never କେବେ ନୁହେଁ
908	Who usually teaches the child to use a latrine? (IN RELATION TO YOUNGEST CHILD <5) ସାଧାରଣତଃ ଶିଶୁଟିକୁ ପାଇଖାନା ବ୍ୟବହାର କରିବା କିଏ ଶିଖାଏ ?(ପାଚଁ ବର୍ଷଠାରୁ କମ୍ ବୟସ ଶିଶୁ ର ସବା ସାନ ଶିଶୁ ସଂକ୍ରାନ୍ତରେ)	01. Mother ମା' 02. Father ବାପା 03. Grandmother ଜେଜେମା 04. Aunt ମାଉସି/ ପିଃସୀ 05. Older sibling ବଡ଼ ଭାଇ/ଭଉଣୀ 88. Other, specify ଅନ୍ୟ କିଛି, ବର୍ଣ୍ଣନା କରନ୍ତୁ _________________
909	Do you wash your child's bottom after defecation? ମଳତ୍ୟାଗ ପରେ ଆପଣ ନିଜ ଶିଶୁକୁ ଛଅଟାଁଇ ଦିଅନ୍ତି କି ?	01. Yes ହଁ 02. No ନାଁ=>SKIP to 911 03. No the child does it himself/ herself ନାଁ ,ଶିଶୁଟି ନିଜେ କରେ=>SKIP to 911

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910	What do you usually use to wash your child's bottom after defecation? *DO NOT PROBE* ସାଧାରଣତଃ ଆପଣ ନିଜ ଶିଶୁକୁ ଛଅଚାଁଇବା ପାଇଁ କ'ଣ ବ୍ୟବହାର କରନ୍ତି ?	01. Water ପାଣି 02. Water and soap ପାଣି ଓ ସାବୁନ 03. Cloth କପଡ଼ା 88. Other, specify ଅନ୍ୟ କିଛି, ବର୍ଣ୍ଣନା କରନ୍ତୁ ______________________________
911	Do you or other members of your household sometimes buy diapers/ nappies for your children? ଆପଣ କିମ୍ବା ପରିବାରର ସଦସ୍ୟ କେବେ ଆପଣଙ୍କ ଶିଶୁ ପାଇଁ ଡ଼ାଇପର/ନ୍ୟାପି କିଣନ୍ତି କି ?	01. Yes ହଁ 02. No ନାଁ=> SKIP to section 10 99. Don't know ଜାଣି ନାହିଁ =>SKIP to section 10
912	Are they single use or multiple use types? ଡ଼ାଇପର୍‌ଟି ଥରେ ବ୍ୟବହାର କରିଲା ଭଳି ନା ବାରମ୍ବାର ବ୍ୟବହାର ଯୋଗ୍ୟ ?	01. Single use ଥରେ ବ୍ୟବହାର ଯୋଗ୍ୟ 02. Multiple use ବାରମ୍ବାର ବ୍ୟବହାର ଯୋଗ୍ୟ
913	Where do you buy them? ସେଗୁଡ଼ିକୁ ଆପଣ କେଉଁଠୁ କିଣନ୍ତି ?	01. Shop in local market, ସ୍ଥାନୀୟ ମାର୍କେଟର ଦୋକାନରୁ 02. Shop elsewhere, specify ଅନ୍ୟ ଜାଗାରୁ କିଣନ୍ତି, ବର୍ଣ୍ଣନା କରନ୍ତୁ ___________ 88. Other, specify ଅନ୍ୟ କିଛି, ବର୍ଣ୍ଣନା କରନ୍ତୁ ___________ 99. Don't know ଜାଣି ନାହିଁ
914	How much does it cost for 1 diaper? ଗୋଟେ ଡ଼ାଇପରର ମୂଲ୍ୟ କେତେ ?	01. _________*Rs* 99. Don't know ଜାଣି ନାହିଁ

SECTION 10: AGREE AND DISAGREE QUESTIONS ରାଜି ଓ ଅରାଜି ପ୍ରଶ୍ନ

Now I am going to say some statements and I would like to know if you agree, disagree or are unsure. For example, if I said, "Rice is grown in the field, not on a tree," you would say "Agree". If instead I said, "a motorcycle has 4 wheels," you would say "I disagree." Do you have any questions? This is only to understand your beliefs; there is no right or wrong answer. ଏବେ ମୁଁ କିଛି ବାକ୍ୟ କହିବି ଯେଉଁଥିରେ ଆପଣ ରାଜି, ଅରାଜି କି ଅନିଶ୍ଚିତ ଜଣେଇବେ । ଉଦାହରଣ ସ୍ୱରୂପ: ମୁଁ ଯଦି କହେ,"ଧାନ ବିଲରେ କରାଯାଏ, ଗଛରେ ନୁହେଁ," ଆପଣ କହିବେ"ରାଜି" । ମୁଁ ଯଦି କହେ "ମଟର ସାଇକେଲର ଚାରୋଟି ଚକ" ଆପଣଙ୍କ ଉତର ହେବ "ଅରାଜି" ? ଆପଣଙ୍କର କିଛି ପ୍ରଶ୍ନ ଅଛି କି ? ଏଇଟା କେବଳ ଆପଣଙ୍କ ବିଚାର/ଭାବନାକୁ ବୁଝିବା ପାଇଁ; ଏଥିରେ କିଛି ଠିକ୍ ବା ଭୁଲ୍ ଉତର ନାହିଁ ।

	Questions ପ୍ରଶ୍ନ	**Response selections** ପ୍ରତିକ୍ରିୟା ଚୟନ		
		01. Agree ରାଜି	**02. Disagree** ଅରାଜି	**03. Not sure** ଅନିଶ୍ଚିତ
1001	I believe that everyone in my household should defecate in a latrine ମୋ ପରିବାରର ସମସ୍ତେ ପାଇଖାନାରେ ଝାଡ଼ା ଯିବା ଉଚିତ୍ ବୋଲି ମୁଁ ବିଶ୍ୱାସ କରେ	01	02	03
1002	It is too time consuming to put the faeces of small children in a latrine ଛୋଟ ପିଲାଙ୍କ ମଳକୁ ପାଇଖାନାରେ ପକାଇବାରେ ବହୁତ ସମୟ ଲାଗେ	01	02	03
1003	Babies faeces are less harmful than those of adults ପିଲାଙ୍କ ମଳ ବଡ଼ ମାନଙ୍କ ମଳଠାରୁ କମ୍ ହାନିକାରକ	01	02	03
1004	It is more work for the mother when a child defecates in a latrine ମାଁ ପାଇଁ ଅଧିକ କାମ ପଡ଼େ ଯେବେ ପିଲାଟି ପାଇଖାନାରେ ଝାଡ଼ା ଯାଏ	01	02	03
1005	I believe that diseases can be transmitted by child faeces ମୁଁ ବିଶ୍ୱାସ କରେ ଯେ ଶିଶୁ ମଳ ଦ୍ୱାରା ରୋଗ ବ୍ୟାପି ପାରେ	01	02	03
1006	Most people who are important to me approve of the way I manage my child's faeces ମୁଁ ଗୁରୁତ୍ୱ ଦେଉଥିବା ଅଧିକାଂଶ ଲୋକମାନେ, ଶିଶୁ ମଳକୁ ମୁଁ ଯେପରି ସଫା କରେ, ସେଥିରେ ଏକମତ	01	02	03
1007	I believe that it is dangerous for children to use a latrine ମୁଁ ଭାବେ ଯେ ପିଲାମାନେ ପାଇଖାନା ବ୍ୟବହାର କରିବାଟା ଅସୁରକ୍ଷିତ ଅଟେ	01	02	03

		01. Agree ରାଜି	02. Disagree ଅରାଜି	03. Not sure ଅନିଶ୍ଚିତ
1008	Diapers are too expensive to be used daily ସବୁଦିନ ଡ଼ାଇପର୍ ବ୍ୟବହାର ଅତ୍ୟଧିକ ମହଙ୍ଗା	01	02	03
1009	I believe that diseases can be transmitted by adult faeces ମୁଁ ବିଶ୍ୱାସ କରେ କି ବଡ଼ ମାନଙ୍କ ମଳ ଦ୍ୱାରା ରୋଗ ବ୍ୟାପି ପାରେ	01	02	03
1010	The faeces of children who are only breastfed smell bad ଯେଉଁ ପିଲାମାନେ କେବଳ ସ୍ତନ୍ୟପାନ କରନ୍ତି ତାଙ୍କ ମଳ/ଝାଡ଼ା ଦୁର୍ଗନ୍ଧ ହୁଏ ।	01	02	03
1011	I have heard that potties are a good way to collect and dispose of child faeces ମୁଁ ଶୁଣିଛି ଯେ ପ୍ଲାଷ୍ଟିକ ପାଇଖାନା ଗୁଡ଼ିକ ମଳ/ଝାଡ଼ା ସଂଗ୍ରହ ଓ ନିଷ୍କାସନର ଏକ ଭଲ ବାଟ/ଉପାୟ	01	02	03
1012	Most people who are important to me manage their children's faeces the same way that I do ମୁଁ ଗୁରୁତ୍ୱ ଦେଉଥିବା ଅଧିକାଂଶ ଲୋକମାନେ ମଧ ତାଙ୍କ ଶିଶୁର ମଳକୁ ଠିକ୍ ମୋ ଭଳି ହିଁ ସଫା କରନ୍ତି	01	02	03
1013	I worry about blocking the latrine if I dispose of my children's faeces in it ମୋତେ ଚିନ୍ତା ଲାଗେ ପିଲାମାନଙ୍କ ମଳ/ଝାଡ଼ାକୁ ପାଇଖାନାରେ ପକାଇ ଦେଲେ ପାଇଖାନା ଜାମ୍ ହୋଇଯିବ	01	02	03
1014	I think that where I live is very clean ମୁଁ ଭାବେ, ମୋର ବାସ କରୁଥିବା ସ୍ଥାନଟି ବହୁତ ପରିଷ୍କାର	01	02	03
1015	I think that open defecation can create dangers for health ମୁଁ ଭାବୁଛି ଖୋଲାରେ ମଳତ୍ୟାଗ କରିଲେ ସ୍ୱାସ୍ଥ୍ୟ ପ୍ରତି ଭୟ ଉପୁଜିପାରେ	01	02	03
1016	The faeces of children who are not breast fed, smell bad ମା' କ୍ଷୀର ବ୍ୟତୀତ ଅଲଗା ଖାଦ୍ୟ ଖାଉଥିବା ଶିଶୁମାନଙ୍କ ମଳ ଦୁର୍ଗନ୍ଧ ହୁଏ	01	02	03

SECTION 11: COMMUNICATION CHANNEL AND DECISION MAKING ସୂଚନା ମାର୍ଗ ଏବଂ ନିଷ୍ପତି ଗ୍ରହଣ

I will now ask you some questions about where you get information about your child's health and sanitation ମୁଁ ଏବେ ଆପଣଙ୍କୁ କିଛି ପ୍ରଶ୍ନ ପଚାରିବି ଯାହା ଆପଣ ନିଜ ପିଲାମାନଙ୍କର ସ୍ୱାସ୍ଥ୍ୟ ଓ ପରିମଳ ସମ୍ବନ୍ଧୀୟ ସୂଚନା କେଉଁଠାରୁ ପ୍ରାପ୍ତ କରନ୍ତି ତା' ଉପରେ ଆଧାରିତ

	Questions ପ୍ରଶ୍ନ	**Response selections** ପ୍ରତିକ୍ରିୟା ଚୟନ	
1101	If you wanted some professional advice about your child's health or care, who would you talk to? ଯଦି ଆପଣଙ୍କୁ ନିଜ ପିଲାର ସ୍ୱାସ୍ଥ୍ୟ ବା ଯତ୍ନ ବିଷୟରେ ପ୍ରଫେସ୍‌ନାଲ ପରାମର୍ଶ ଦରକାର ଥାଏ, ତେବେ ଆପଣ କାହା ସାଙ୍ଗରେ କଥା ହେବେ ?	01. Anganwadi worker ଅଙ୍ଗନବାଡି କର୍ମୀ 02. ASHA worker ଆଶା କର୍ମୀ 03. Doctor ଡ଼ାକ୍ତର 04. Medical store/ pharmacy ମେଡ଼ିକାଲ୍ ଷ୍ଟୋର/ଫାର୍ମାସି 05. Mid wife ଧାଇ 88. Other, specify ଅନ୍ୟ କିଛି, ବର୍ଣ୍ଣନା କରନ୍ତୁ ____________________	
1102-1106	In the last six months have you heard or seen any messages about child sanitation or hygiene? ଗତ ଛ'ମାସ ଭିତରେ ଆପଣ ଶିଶୁ ପରିମଳ ବା ସ୍ୱଚ୍ଛତା ବା ସ୍ୱାସ୍ଥ୍ୟ ବିଜ୍ଞାନ ସମ୍ବନ୍ଧୀୟ କିଛି ବାର୍ତା ଶୁଣିଛନ୍ତି ବା ଦେଖିଛନ୍ତି କି ?	01-Yes ହଁ	02-No ନାଁ
1102	On the radio? ରେଡ଼ିଓରେ	01. Yes, specify_________	02. No
1103	On television? ଟିଭିରେ	01. Yes, specify_________	02. No
1104	In newspapers or magazines? ଖବରକାଗଜ ବା ପତ୍ରିକାରେ	01. Yes, specify_________	02. No
1105	On wall painting or posters? କାନ୍ଥ ଚିତ୍ର ବା ପୋଷ୍ଟର	01. Yes, specify_________	02. No
1106	Other ଅନ୍ୟାନ୍ୟ	88. specify _________	

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1107	Have you ever heard of a program promoting the use of latrines by children? ପିଲାମାନଙ୍କର ପାଇଖାନା ବ୍ୟବହାର ପାଇଁ ପ୍ରଚାର କରୁଥିବା କୌଣସି ପ୍ରୋଗାମ୍ ବିଷୟରେ ଆପଣ କେବେ ଶୁଣିଛନ୍ତି କି ?	01. Yes ହଁ 02. No ନାଁ=>SKIP to 1109 99. Don't know ଜାଣି ନାହିଁ=>SKIP to 1109							
1108	What was the program? ସେଇଟା କେଉଁ ପ୍ରୋଗାମ୍ ଥିଲା ?	*Write name of program and NGO/ organization* ପ୍ରେଗାମ୍ ଏବଂ ଏନ୍.ଜି.ଓ/ ସଂସ୍ଥାର ନାମ ଲେଖନ୍ତୁ ________________________________ *99.* Don't remember/don't know ମନେ ନାହିଁ/ ଜାଣିନି							
1109-1112	Who usually makes the following decisions: mainly you, mainly your partner (husband/wife), you and your partner jointly, mainly the male head of household (if not partner of respondent), grandmother-in law of the child or someone else? ନିମ୍ନଲିଖିତ ନିଷ୍ପତି ଗୁଡ଼ିକ ସାଧାରଣତଃ କିଏ ନିଅନ୍ତି ? ମୁଖ୍ୟତଃ , ଆପଣ, ମୁଖ୍ୟତଃ ଆପଣଙ୍କ ପାର୍ଟନର (ସ୍ୱାମୀ/ସ୍ତ୍ରୀ), ଆପଣ ଓ ଆପଣଙ୍କ ପାର୍ଟନର ଏକାଠି, ମୁଖ୍ୟତଃ ଗୃହର ମୁଖ୍ୟ ପୁରୁଷ(ଯେଦି ସେ ଉତରଦାତା ପାର୍ଟନର ନୁହେଁ), ପିଲାଟିର ବୁଢ଼ୀ ମା' ବା ଅନ୍ୟ କେହି ?	01. Respondent ଉତରଦାତା 02. Partner ପାର୍ଟନର 03. Respondent and partner jointly ଉତରଦାତା ଓ ତାଙ୍କ ପାର୍ଟନର ଏକାଠି 04. Male head of household ଗୃହର ମୁଖ୍ୟ ପୁରୁଷ 05. Grand mother in-law of child ପିଲାର ବୁଢ଼ୀ ମା' 06. Not applicable କୌଣସିଟି ନୁହେଁ 99. Don't know ଜାଣି ନାହିଁ 88. Someone else, specify ଅନ୍ୟ କେହି, ବର୍ଣ୍ଣନା କରନ୍ତୁ__________							
1109	Decisions about health care for your children? ଆପଣଙ୍କ ପିଲାମାନଙ୍କର ସାସ୍ଥ୍ୟ ସେବା ସମ୍ବନ୍ଧୀୟ ନିଷ୍ପତି ?	01	02	03	04	05	06	99	88___________
1110	Decisions about making major household purchases? ଗୃହର ମୁଖ୍ୟ ଜିନିଷ କିଣିବା ସମ୍ବନ୍ଧୀୟ ନିଷ୍ପତି ?	01	02	03	04	05	06	99	88___________
1111	Decisions about making purchases for diapers? ଡ଼ାଇପର୍ କିଣିବା ପାଇଁ ନିଷ୍ପତି ?	01	02	03	04	05	06	99	88___________
1112	Decisions about teaching your child to use a latrine? ଆପଣଙ୍କ ପିଲାକୁ ପାଇଖାନା ବ୍ୟବହାର କରିବା ଶିଖାଇବା ବିଷୟରେ ନିଷ୍ପତି ?	01	02	03	04	05	06	99	88____________

SECTION 12: SANITATION AND HYGIENE SPOT CHECKS ପରିମଳ ଓ ସ୍ୱଛତା ସ୍ପଟ୍ ଚେକ୍		
I would now like to ask you more questions and see the water and sanitation facilities that members of your household usually use. ମୁଁ ଏବେ ଆପଣଙ୍କୁ ଆହୁରି କିଛି ପ୍ରଶ୍ନ ପଚାରିବାକୁ ଚାହିଁବି ଓ ଆପଣଙ୍କ ଘରର ସଦସ୍ୟ ମାନେ ପ୍ରାୟ ବ୍ୟବହାର କରୁଥିବା ପାଣି ଓ ପରିମଳ ବ୍ୟବସ୍ଥା ଗୁଡ଼ିକ ଦେଖିବି ।		
	Questions	**Response selections**
1201	Have you ever heard of potties? ଆପଣ କେବେ ହେଲେ ପ୍ଲାଷ୍ଟିକ ପାଇଖାନା ବିଷୟରେ ଶୁଣିଛନ୍ତି ?	01. Yes 02. No =>SKIP to 1207
1202	Does your household own a potty ? ଆପଣଙ୍କ ଘରେ ପ୍ଲାଷ୍ଟିକ ପାଇଖାନା ଅଛି କି ?	01. Yes 02. No =>SKIP to 1207
1203	Where did you buy your potty? ଆପଣ କେଉଁଠୁ ପ୍ଲାଷ୍ଟିକ ପାଇଖାନା କିଣି ଥିଲେ ?	01.Shop in local market ସ୍ଥାନୀୟ ବଜାରରେ 02.Shop elsewhere, specify ଆଉକେଉଁଠି ଦୋକାନରେ ___________ 88. Other, specify ଅନ୍ୟାନ୍ୟ___________ 99. Don't know ଜଣା ନାହିଁ
1204	How much did it cost? ଏହାର ମୂଲ୍ୟ କେତେ ?	*01.* _________ *Rs* 99. Don't know ଜଣା ନାହିଁ

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1205	Can you please show me? ଆମକୁ ଦୟା କରି ପ୍ଲାଷ୍ଟିକ ପାଇଖାନା ଦେଖାଇ ପାରିବେ କି ?	01. Yes ହଁ 02. No, specify reason _______________=>SKIP to 1207 ନାଁ , କାରଣ ଲେଖନ୍ତୁ
1206	***OBSERVE AND RECORD*** (ନୀରିକ୍ଷଣ କରି ଲେଖନ୍ତୁ) Does the potty look dusty? ପ୍ଲାଷ୍ଟିକ ପାଇଖାନା ଟି ମଇଳା ଦେଖା ଯାଉଛି କି ?	01. Yes 02. No
1207	**DO NOT ASK**: did the participant report/ demonstrate disposing of their child's faeces? ପଚାରନ୍ତୁ ନାହିଁ: ଉତରଦାତା ଶିଶୁର ମଳ ନିଷ୍କାସନ ଦେଖାଇଲେ ବା କହିଲେ କି ?	01.Yes ହଁ 02.No ନାଁ=> SKIP to 1214
1208	Do you wash your hands after you dispose of your child's faeces? ଛୋଟ ପିଲାର ମଳକୁ ପକାଇବା ପରେ ଆପଣ ହାତ ଧୁଅନ୍ତି କି ?	01. Yes 02. No => SKIP to 1214
1209	With what? କେଉଁଥିରେ ?	01. Water ପାଣି 02. Water and Soap ପାଣି ଓ ସାବୁନ 88. Other specify ଅନ୍ୟାନ୍ୟ ବର୍ଣ୍ଣନା କରନ୍ତୁ _____________________
1210	Do you have a specific place where you usually wash your hands after you dispose of your child's faeces? ମଳ ଫୋପାଡ଼ିଲା ପରେ, ଏପରି କିଛି ନିର୍ଦ୍ଦିଷ୍ଟ ସ୍ଥାନ ଅଛି ଯେଉଁଠି ଆପଣ ନିଜ ହାତ ଧୁଅନ୍ତି ?	01. Yes 02. No=>SKIP to 1214
1211	Can you please show me? ଆପଣ ମୋତେ ସେହି ସ୍ଥାନ ଦେଖାଇ ପାରିବେ କି ?	01. Yes ହଁ 02. No, specify why ନାଁ , କାରଣ __________________=>SKIP to 1214
1212	***OBSERVE AND RECORD*** ଦେଖନ୍ତୁ ଓ ଲେଖନ୍ତୁ Is there any water available for hand washing? ହାତ ଧୋଇବା ପାଇଁ ସେଠାରେ ପାଣି ଉପଲବ୍ଧ ଅଛି କି ?	01. Yes 02. No
1213	***OBSERVE AND RECORD*** ଦେଖନ୍ତୁ ଓ ଲେଖନ୍ତୁ Is there any soap or detergent or ash? ସେଠାରେ କୌଣସି ସାବୁନ କିମ୍ବା ଡ଼ିଟରଜେଣ୍ଟ ଓ ପାଉଁଶ ଅଛି କି ?	01. Yes, soap or detergent ହଁ, ସାବୁନ ଓ ଡ଼ିଟରଜେଣ୍ଟ 02. Yes, ash ହଁ, ପାଉଁଶ 03. No ନାଁ
	HOUSE/ COMPOUND SPOT CHECKS- *OBSERVE AND RECORD* ଘର ଅଗଣା ସ୍ପଟ ଚେକ୍-ଦେଖନ୍ତୁ ଓ ଲେଖନ୍ତୁ	
1214	The presence of human stools inside the house/compound or in front of the house (within 1 meter)? ମଣିଷର ମଳ,ଗୃହ ପରିସରରେ ବା ପରିସର ବାହାରେ(୧ ମିଟର ଭିତରେ) ଅଛି କି ?	01. Yes 02. No
1215	The presence of animal stools inside the house/compound or in front of the house (within 1 meter)? ପଶୁ ର ମଳ, ଗୃହ ପରିସରରେ ବା ପରିସର ବାହାରେ (୧ ମିଟର ଭିତରେ) ଅଛି କି ?	01. Yes 02. No
1216	How many of the children under five have a diaper on at the time of visit? ୫ ବର୍ଷ ଭିତରେ ଥିବା କେତୋଟି ପିଲା ପରିଦର්ଶନ ସମୟରେ ଡ଼ାଇପର ପିନ୍ଧିଛନ୍ତି ?	*Write number (write 0 if none)* ସଂଖ୍ୟା ଲେଖନ୍ତୁ --

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1217	How many children under five are there at the time of visit? ୫ ବର୍ଷ ଭିତରେ ଥିବା କେତୋଟ ପିଲା ପରିଦର୍ଶନ ସମୟରେ ଅଛନ୍ତି ?	*Write number* ସଂଖ୍ୟା ଲେଖନ୍ତୁ ________________
	FOR SHARED AND PRIVATE HOUSEHOLD LATRINES ONLY ବ୍ୟକ୍ତିଗତ ଓ ଅନ୍ୟ ଘର ସହିତ ବ୍ୟବହାର ହେଉଥିବା ପାଇଖାନା	**IF USE A PUBLIC LATRINE- SKIP TO END** ଯଦି ସର୍ବସାଧାରଣ ପାଇଖାନା ବ୍ୟବହାର କରୁଛନ୍ତି,ଶେଷକୁ ଯାଅନ୍ତୁ
1218	Can you please show me the latrine that members of your household usually use? ଆପଣ ମୋତେ ଟିକେ ଆପଣଙ୍କ ଘରର ସଦସ୍ୟମାନେ ବ୍ୟବହାର କରୁଥିବା ପାଇଖାନା ଦେଖାଇପାରିବେ କି ?	01. Yes 02. No, specify why ନାଁ ,କାରଣ _________________________=>SKIP to end ଶେଷକୁ ଯାଅନ୍ତୁ
1219	**OBSERVE AND RECORD:** type of facility ଦେଖନ୍ତୁ ଓ ଲେଖନ୍ତୁ : ଏହା କେଉଁ ପ୍ରକାରର ବ୍ୟବସ୍ଥା	01. Flush or pour flush with pit/closed sewerage system ଗର୍ତ ଥିବା ପାଣି ଢଳା ପାଇଖାନା 02. Flush or pour flush without pit/open sewerage system ଗର୍ତ ନଥିବା ପାଣି ଢଳା ପାଇଖାନା 03. Pit latrine with slab ଉଠା ପାଇଖାନା 88. Other, specify ଅନ୍ୟ କିଛି, ବର୍ଣ୍ଣନା କରନ୍ତୁ_________
1220	**OBSERVE AND RECORD:** Is the latrine functional? ଦେଖନ୍ତୁ ଓ ଲେଖନ୍ତୁ: ପାଇଖାନା ଟି ବ୍ୟବହାର ଯୋଗ୍ୟ କି ନୁହେଁ ? 1. **ANY COVER** ଯେକୌଣସି ଘୋଡ଼ଣି 2. Not used for storage ସଂରକ୍ଷଣ ପାଇଁ ବ୍ୟବହାର ହେଉନଥିବ 3. Pan not broken, not blocked or not full of leaves/dust ପ୍ୟାନ ଟି ଭାଙ୍ଗି ନ ଥିବ,ପତ୍ର ଓ ଧୂଳି ଦ୍ୱାରା ବନ୍ଦ ହୋଇନଥିବ 4. Pit completed ଗର୍ତଟି ସମ୍ପୂର୍ଣ ତିଆରି ହୋଇଥିବ	If **ALL** of this **'YES'**, then enter **'YES'.** ଯଦି ଏହି ସବୁ 'ହଁ' ହୁଏ, ତେବେ 'ହଁ' ଲେଖନ୍ତୁ । 01. Yes 02. No
1221	**OBSERVE AND RECORD:** Is the latrine currently used? ଦେଖନ୍ତୁ ଓ ଲେଖନ୍ତୁ: ବର୍ତମାନ ପାଇଖାନାଟି ବ୍ୟବହାର ହେଉଛି କି ନାହିଁ ? 1. Smell ଗନ୍ଧ 2. Pan wet ପ୍ୟାନଟି ଓଦା 3. Stain (faeces, urine) ଦାଗ (ମଳ,ମୂତ୍ର)	If **ONE** of this **'YES'**, then enter **'YES'.** ଯଦି ଏହା ଭିତରୁ ଗୋଟେ ବି 'ହଁ ' ହୁଏ, ତେବେ 'ହଁ 'ଲେଖନ୍ତୁ । 01. Yes 02. No

THE END, THANK THE PARTICIPANT AND ANSWER ANY QUESTIONS.

INTERVIEWER'S COMMENTS:
ସାକ୍ଷାତକାରୀଙ୍କ ଟିପ୍ପଣୀ/ମନ୍ତବ୍ୟ ;

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SECTION 13: OBSERVATIONS IN CASE CHILD DEFECATES DURING THE VISIT ଗସ୍ତ ବେଳେ ପିଲା ମଳତ୍ୟାଗ କରିଲେ ତା'ର ଟିପ୍ପଣି		
FOR ALL QUESTIONS- OBSERVE AND RECORD ***IF YOU DON'T OBSERVE SOMETHING- WRITE NOT SEEN (00)***ପ୍ରତ୍ୟେକ ପ୍ରଶ୍ନ ପାଇଁ-ଦେଖିକି ଲେଖନ୍ତୁ (ଯଦି ଆପଣ କିଛି ଦେଖୁ ନାହାଁନ୍ତି, ତେବେ ***NOT SEEN(00)*** ଲେଖନ୍ତୁ)		
Observations		**Response selections** ପ୍ରତିକ୍ରିୟା ଚୟନ
1301	How old is the child that defecated? ମଳତ୍ୟାଗ କରିଥିବା ଶିଶୁର ବୟସ କେତେ ?	*Write age in years* __________YEARS
1302	Place of defecation ମଳତ୍ୟାଗ କରିଥିବା ଜାଗା	01. Directly into latrine ସିଧା ପାଇଖାନା ଭିତରେ=>SKIP TO 1311 02. On ground in latrine cubicle ପାଇଖାନା ଘର ଚଟାଣ ଉପରେ 03. Potty **ପ୍ଲାଷ୍ଟିକ ପାଇଖାନା**=>SKIP TO 1308 04. In nappy ନ୍ୟାପି=> SKIP TO 1308 05. Child defecated on bed. ପିଲାଟି ଖଟ ଉପରେ ଝାଡ଼ା କରିଥିଲା 06. Roadside (main road) ରାସ୍ତା କଡ଼ରେ(ମେନ୍ ରୋଡ଼) 07. Side of path near the house ଘର ପାଖରେ ଯାଇଥିବା ରାସ୍ତା କଡ଼ରେ 08. On ground in the household compound ଘର ପରିସର ଭିତରେ ଭୂମି ଉପରେ 09. On ground inside the household ଘର ଭିତରେ ଚଟାଣ ଉପରେ 10. In an open field ଖୋଲା ପଡ଼ିଆରେ 11. In drain ନାଳରେ=> SKIP TO 1308 12. In diaper ଡ଼ାଇପର୍‌ରେ=> SKIP TO 1308 13.In pants ପ୍ୟାଣ୍ଟରେ=> SKIP TO 1308 88. Other, specify ଅନ୍ୟ କିଛି, ବର୍ଣ୍ଣନା କରନ୍ତୁ___________
1303	Directly on the ground/bed or on paper, Polythene,cloth, oil cloth? ସିଧା ଭୂମି ଉପରେ ନା କାଗଜ, ଜରି,କନା,ଅଏଲ କନା ଉପରେ ?	01.Directly on the ground/ Bed ସିଧା ଭୂମି ଉପରେ/ଖଟ ଉପରେ 02.On paper put on the ground/Bed ଭୂମି/ଖଟ ଉପରେ ରଖାଯାଇଥିବା କାଗଜ ଉପରେ 03.On Polythene put on the ground/Bed ଭୂମି/ଖଟ ଉପରେ ରଖାଯାଇଥିବା ଜରି ଉପରେ 04. On cloth put on the ground/bed ଭୂମି/ଖଟ ଉପରେ ରଖାଯାଇଥିବା କପଡ଼ା ଉପରେ 05. On oil cloth put on the ground/bed ଭୂମି/ଖଟ ଉପରେ ରଖାଯାଇଥିବା ,ଅଏଲ କନା ଉପରେ ଉପରେ 88.On other, specify ଅନ୍ୟ କିଛି, ବର୍ଣ୍ଣନା କରନ୍ତୁ___________
1304	Tool used for removal କାଢିବା ପାଇଁ ବ୍ୟବହାର ହୋଇଥିବା ଉପକରଣ	01.Recipient or polythene/ paper/ cloth/oil cloth on which child defecated ପିଲା ମଳତ୍ୟାଗ କରିଥିବା ଜରି/ କାଗଜ/କପଡ଼ା/ ଅଏଲ କନା 02. Polythene ଜରି 03. Paper କାଗଜ 04. Cloth କପଡ଼ା 05. Broom ଝାଡୁ 06. Hoe କୋଦାଳ 07. Not removed କଢା ହୋଇନି 88. Other, specify ଅନ୍ୟ କିଛି, ବର୍ଣ୍ଣନା କରନ୍ତୁ___________
1305	Remains of faeces visible at the site of defecation after removal & disposal? ମଳର କିଛି ଅବଶେଷ ମଳତ୍ୟାଗ ଜାଗାରେ, ମଳ କାଢି ଦେଇ ଫୋପାଡ଼ି ଦେଲା ପରେ ମଧ୍ୟ ନଜରରେ ଆସୁଛି କି ?	01. Yes 02. No

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1306	Is the ground/bed cleaned after? ଭୂମି/ଶେଯ ତା' ପରେ ସଫା କରାଯାଉଛି କି ?	01. Yes 02. No =>SKIP TO 1308
1307	With what? କେଉଁଥିରେ ?	01. Water only କେବଳ ପାଣିରେ 02. Water and soap ପାଣି ଓ ସାବୁନରେ 03. Water and dettol/phenyl ପାଣି ଓ ଡ଼େଟଲ୍/ଫିନାଇଲ୍ 04. Water and cow dung ପାଣି ଓ ଗୋବର 88. Other, specify ଅନ୍ୟ କିଛି, ବର୍ଣ୍ଣନା କରନ୍ତୁ ________________________
1308	What was done to dispose of the stools? ସେହି ମଳର ନିଷ୍କାସନ ପାଇଁ କ'ଣ କରାଯାଇଥିଲା ?	01. Put/rinsed into latrine ପାଇଖାନା ଭିତରକୁ ଫୋପାଡ଼ି ପାଣି ଢାଳି ଦିଆଗଲା=>SKIP TO 1311 02. Thrown into garbage at house/compound ଘରେ ବା ଘର ପରିସର ଭିତରେ ଅଳିଆ ଗଦାକୁ ପକାଇ ଦିଆଯାଇଥିଲା =>SKIP TO 1311 03. Thrown into garbage dump (land) ବାହାର ଅଳିଆ ଗଦାରେ ପକାଇ ଦିଆଯାଇଥିଲା 04. Thrown into open field ଖୋଲା ପଡ଼ିଆକୁ ଫୋପାଡ଼ି ଦିଆଗଲା =>SKIP TO 1311 05. Buried ପୋତା ହୋଇଗଲା =>SKIP TO 1311 06. Left in the open ଖୋଲା ଛାଡ଼ି ଦିଆଗଲା=>SKIP TO 1311 07.Thrown into canal/drain କେନାଲ/ନାଳ ରେ ଫୋପାଡିବା=> SKIP TO 1311 08. Washed with water only,specify where କେବଳ ପାଣିରେ ଧୁଆ ହୋଇଥିଲା, କେଉଁଠି ବର୍ଣ୍ଣନା କରନ୍ତୁ____________ => SKIP TO 1311 09. Washed with water and soap/dettol,specify where ପାଣି ଏବଂ ସାବୁନ/ଡ଼େଟଲ୍ ସହିତ ଧୁଆ ଯାଇଥିବା, କେଉଁଠି ବର୍ଣ୍ଣନା କରନ୍ତୁ ____________=> SKIP TO 1311 88.Other, specify ଅନ୍ୟ କିଛି, ବର୍ଣ୍ଣନା କରନ୍ତୁ________________
1309	How far is the garbage? ଅଳିଆ ଜାଗା କେତେ ଦୂର ?	01. _______________METRES FROM THE HOUSE ମିଟର ଘରଠାରୁ
1310	Is the garbage nearby houses (within 10 metres)? ଅଳିଆ ଜାଗା ଘର ପାଖରେ କି(୧୦ ମିଟର ଭିତରେ) ?	01. Yes 02. No
1311	Anal cleaning of child ପିଲାକୁ ଛଅଚାଁଇବା	01. Yes 02. No =>SKIP to 1313
1312	With what? କେଉଁଥିରେ ?	01. Water ପାଣି 02. Water and soap ପାଣି ଓ ସାବୁନ 03. Cloth କପଡ଼ା 88. Other, specify ଅନ୍ୟ କିଛି, ବର୍ଣ୍ଣନା କରନ୍ତୁ _____________________________________
1313	Hand washing after disposal? ନିଷ୍କାସନ ପରେ ହାତଧୁଆ ?	01. Yes 02. No=> SKIP to end
1314	With soap? ସାବୁନରେ ?	01. Yes 02. No
1315	**ANY OTHER OBSERVATIONS**	

SUPPLEMENTARY SHEET

SECTION 6:EXTRA SHEET DEFECATION PRACTICES OF <u>MEMBERS OF THE HOUSEHOLD OVER 5 YEARS OLD.</u>
ପାଚଂ ବର୍ଷରୁ ଅଧିକ ବୟସର ବ୍ୟକ୍ତିଙ୍କ ମଳତ୍ୟାଗ ପକ୍ରିୟା (ଅଧିକ ଜାଗା ଦରକାର ହେଲେ ଶେଷ ପୃଷ୍ଠାକୁ ଯାଆନ୍ତୁ)

Please list the gender, ages and where the household member **<u>older than five years old usually</u>** defecate for each household member **<u>starting with the eldest</u>.**

601. Household members ଘରର ସଦସ୍ୟ *Do not include names*	**602. Gender** ଲିଙ୍ଗ M	F	**603. Age** ବୟସ *99= don't know* (years)	**604. Marital status** 01= Unmarried ଅବିବାହିତ 02= Married ବିବାହିତ 03= Widowed ବିଧବା 04= Divorced ଛାଡ଼ପତ୍ର ପ୍ରାପ୍ତ				**605. At this present place what is this household member's usual place of defecation?** *Do not read out the answers. If they say latrine- Probe if always/ usually/ sometimes.* ଏହି ଜାଗାରେ, ଏହି ସଦସ୍ୟ ପ୍ରାୟ କେଉଁଠି ମଳତ୍ୟାଗ କରନ୍ତି ? *ଉତର ପଢନ୍ତୁ ନାହିଁ । ଯଦି ଉତରଦାତା ପାଇଖାନା କୁହନ୍ତି, ତା'ହେଲେ ପଚାରନ୍ତୁ ସବୁବେଳେ/ପ୍ରାୟ/ବେଳେ ବେଳେ ।* 01= Latrine always ସବୁବେଳେ ପାଇଖାନା 02= Latrine usually ପ୍ରାୟତଃ ପାଇଖାନା 03= Latrine sometimes ବେଳେବେଳେ ପାଇଖାନା 04= Always open defecation ସବୁବେଳେ ବାହାରେ 88 = Other, please state ଅନ୍ୟାନ୍ୟ				
11.	01	02		01	02	03	04	01	02	03	04	88
12.	01	02		01	02	03	04	01	02	03	04	88
13.	01	02		01	02	03	04	01	02	03	04	88
14.	01	02		01	02	03	04	01	02	03	04	88
15.	01	02		01	02	03	04	01	02	03	04	88
16.	01	02		01	02	03	04	01	02	03	04	88
17.	01	02		01	02	03	04	01	02	03	04	88
18.	01	02		01	02	03	04	01	02	03	04	88
19.	01	02		01	02	03	04	01	02	03	04	88
20.	01	02		01	02	03	04	01	02	03	04	88

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Appendix 6: Cross-sectional study information sheet and consent form

Information Sheet: Child faeces disposal practices survey in urban Odisha

Investigator: Fiona Majorin (Fiona.majorin@lshtm.ac.uk)

Principal Investigator: Thomas Clasen (thomas.clasen@lshtm.ac.uk)

To be translated into Oriya language.

Good morning/afternoon, my name is _____________. I am a student 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 and Kalinga Institute of Industrial Technology to conduct research in the district of Puri and the cities of Bhubaneswar and Cuttack.

Today I am here with some colleagues to learn about child defecation and faeces disposal practices in urban areas of Odisha. As our research is about the defecation practices and child faeces disposal practices of children younger than five years old and we were informed that you have a child younger than five, we selected your house to ask you questions related to child defecation and faeces disposal. There are no direct benefits in taking part in this study. However, this information will help us to understand and make recommendations to improve sanitation programmes in India.

If you agree to participate in this study, we will ask you some questions about the defecation practices of your children below five and faeces disposal practices. We will also collect some information about your household and whether your house has a private latrine or access to a shared or communal facility. We will make observations of your house and on the type of latrine and maintenance of it. Altogether, this should take about 30 minutes. This should only require one visit but if we require some more information or we would like to invite you to participate in a longer interview to understand reasons for your choice of child faeces disposal method, we may come back for a second visit. We may take pictures during the visit of your house if you agree, these will be used to illustrate research findings.

Your decision to take part is completely up to you. If at any time during the study you decide that you no longer wish to take part, you may withdraw with no consequences. If you don't like some of the questions, you don't have to answer them. Participation in this study should not pose any risk to you or your family. There are no correct or incorrect answers to the questions; I would just like to know what you think. All information you give us will be kept confidential to the extent possible. The names of you or your family members will not appear on any report or publication of this project.

Do you have any questions about the study? If at any time during the study you have questions or concerns or you wish to know more about your rights as a participant in a research study, you may contact Fiona Majorin from London School of Hygiene and Tropical Medicine (fiona.majorin@lshtm.ac.uk) or Dr. Mrutyunjay Suar at Kalinga Institute of Industrial Technology (msbiotek@yahoo.com, +91 9437011465).

Informed consent form for survey

Investigator: Fiona Majorin (Fiona.majorin@lshtm.ac.uk)

Principal Investigator: Thomas Clasen (thomas.clasen@lshtm.ac.uk)

Would you like to participate in this study? [If yes]: I am now going to read you some statements, and if you agree to them, I will ask you to sign the paper to confirm your agreement to participate.

Consent Form: Child faeces disposal practices in urban Odisha

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 my participation is voluntary and I am free to withdraw from this study at any time, without giving any reason and without repercussions. I agree to take part in this study.

_______________	_______________	_______________
Name of Participant *(printed)*	Signature/Thumbprint	Date

The participant is unable to sign. As a witness, I confirm that all the information about the study was given and the participant consented to taking part.

_______________	_______________	_______________
Name of Impartial Witness *(if required)*	Signature	Date