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Role of sanitation in preventing faecal contamination of the domestic environment and protecting health: An observational study.

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Declaration

I, Tarique Mohammad Nurul Huda, confirm that the work presented in this thesis is my own. Where information has been derived from other sources, I confirm that this has been indicated in the thesis.

Signed  _____

Date: 31st January, 2016

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Abstract

This thesis assesses the potential public health significance of, sanitation quality and coverage by using microbiological indicator and secondary health outcome data. Sanitation was categorised using The Millennium Development Goal (MDG) definition of improved (private pit latrine with a slab or better) and unimproved (toilets connected to open, pit latrine without a slab, hanging toilet, shared toilets).

A spot check of sanitation facilities was conducted in 460 target houses and 1,784 neighbouring houses. Faecal contamination of the household environment was assessed by looking for evidence of contamination with faecal coliforms on children's hands and on 'sentinel' toys (standardised toy balls provided by the study). An analysis of secondary data was conducted on sanitation and reported diarrhoea among children <5 years of age that had been collected as part of an impact evaluation.

Households with private improved sanitation had lower faecal coliform contamination than households with unimproved sanitation [difference in means: -0.31 log₁₀ colony forming units (CFU)/toy ball; 95% CI: -0.61, -0.01]. Access to 100% private improved sanitation coverage in the neighbourhood was associated with a small but statistically insignificant difference in contamination of sentinel toys (difference in means: -0.09 log₁₀ CFU/toy; 95% CI: -0.56, 0.38). Other household sanitary practices such as cleanliness of latrine, wastewater disposal and disposal of animal faeces were important and statistically significant (P value ≤0.06) determinants of household faecal contamination. Children from households with access to private improved sanitation had a similar prevalence of diarrhoea to those with unimproved sanitation (Prevalence Ratio [PR] =1.00; 95% CI: 0.89, 1.13). Children from households with appropriate solid waste disposal systems had lower prevalence of diarrhoea compared to those without (PR=0.78; 95% CI: 0.65, 0.95).

Improved sanitation infrastructure quality and coverage may have limited roles in preventing transmission of diarrhoea causing enteric pathogens in the study context in which diarrhoea is endemic. Although in this study, private use and cleanliness of latrine were associated reduction in faecal contamination, but these factors were not associated with reduced diarrhoea prevalence. This may be because, firstly data were collected from slightly different contexts and time, secondly indicator organisms are only weakly associated presence of enteric pathogens and thirdly the population in this study context may have developed some degree of immunity to common circulating pathogens. Findings from this observational studies presented in this thesis adds to the evidence base, which do not support the inclusion of shared facilities as improved. There may be other more important source of children's exposure to enteric pathogens that onsite sanitation access cannot prevent. Other sanitation related factors like maintenance of sanitation facility, use by all household members including children and faecal sludge management should be considered while defining improved sanitation for international monitoring. We also need to increase research efforts to integrate sanitation, water quality, handwashing and nutritional interventions and to understand better ways to monitor the impact of these interventions.

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List of Abbreviations

BDHS	Bangladesh Demographic and Health Survey
CFU	Colony Forming Units
CHP	Community Hygiene Promoter
CI	Confidence Interval
CV	Coefficient of Variation
DAG	Directed Acyclic Graph
DFID	Department For International Development
DHS	Demographic and Health Survey
DPHE	Department of Public Health Engineering
EC	<i>Escherichia coli</i>
ECVG	<i>E. coli Virulence Genes</i>
ERC	Ethical Review Committee
EPA	Environmental Protection Agency
FC	Faecal Coliform
FIB	Faecal Indicator Bacteria
GBP	Great Britain Pound
GEE	Generalised Estimating Equation
GIS	Geographic Information System
GLS	Generalised Least Squares
GoB	Government of Bangladesh
GPS	Global Positioning System
HH	Household
icddr,b	International Centre for Diarrhoeal Disease Research Bangladesh
IGME	Inter-agency Group for child mortality estimation
JMP	WHO/UNICEF Joint Monitoring Programme for Water Supply and Sanitation
LSHTM	London School of Hygiene and Tropical Medicine
MDD	Minimum Detectable Difference
MDG	Millennium Development Goal

MST	Microbial Source Tracking
PAF	Population Attributable Fraction
PB	Primary Barrier
PCA	Principal Component Analysis
PR	Prevalence Ratio
OR	Odds Ratio
SB	Secondary Barrier
SD	Standard Deviation
SDG	Sustainable Development Goal
SHARE	Sanitation and Hygiene Applied Research for Equity
SHEWA-B	Sanitation Hygiene Education and Water Supply in Bangladesh Programme
SOP	Standard Operating Procedures
TNTC	Too Numerous To Count
TTC	Thermo-Tolerant Coliform
UK	United Kingdom
UN	United Nations
UNICEF	United Nations Children's Fund
US	United States
USEPA	US Environmental Protection Agency
VIF	Variance Inflation Factor
VIP	Ventilated Improved Pit Latrine
Vs.	Versus
WATSAN	Water Sanitation and Hygiene
WHO	World Health Organisation

Chapter 1: Background and literature review

1.1 Background

1.1.1. Burden of diarrhoeal diseases

Globally, deaths due to diarrhoea among children under five years of age fell by more than 50% in 2013 in comparison to 1990 [1]. Despite these substantial reductions diarrhoea is still one of the leading causes of mortality [1, 2] and morbidity [3] among children under five. According to the UN Inter-agency Group for Child Mortality Estimation (IGME), worldwide an estimated 6.3 million children younger than five years died in 2013. About 9% (0.448-0.750 million) of these deaths were caused by diarrhoea [2, 4]. The incidence of diarrhoea declined, from 3.4 episodes/child per year in 1990, to 2.9 episodes/child per year in 2010. However, there were still 1.7 billion episodes of diarrhoea in 2010, in 139 low and middle income countries [3]. In the South East Asian region of the WHO, there were 2.4 episodes of diarrhoea per child year in 2010 [3].

Diarrhoea is also found to be a risk factor for pneumonia [5]. Moreover repeated episodes of early childhood diarrhoea have a lasting influence on physical growth, [6] cognitive function [7], school performance [6-10], obesity associated comorbidities [10] and reduced economic productivity [11]. So, for the health and development of the children of low and middle income countries, the cost of diarrhoea remains high, and interventions to reduce child mortality and morbidity due to diarrhoeal diseases need to be given a high priority [3, 12].

1.1.2. Transmission of infectious diarrhoea

Most cases of diarrhoea are transmitted through the faecal-oral route [13]. The agents causing diarrhoea, including viruses, bacteria, protozoa and parasitic worms can transmit from one host to another through several pathways, via the environment [14]. The pathways, through which diarrhoea causing enteric pathogens can be transmitted from faeces, through the environment to a new host, are illustrated in the 'F diagram' (Figure 1) [14-16]. In the environment, the

pathogens can be transmitted through contaminated food and drink, person to person contact, contact with objects and flies (either through contaminated food and utensils or landing directly on children) [17]. The transmission can occur in the context of both the domestic and public domain [18].

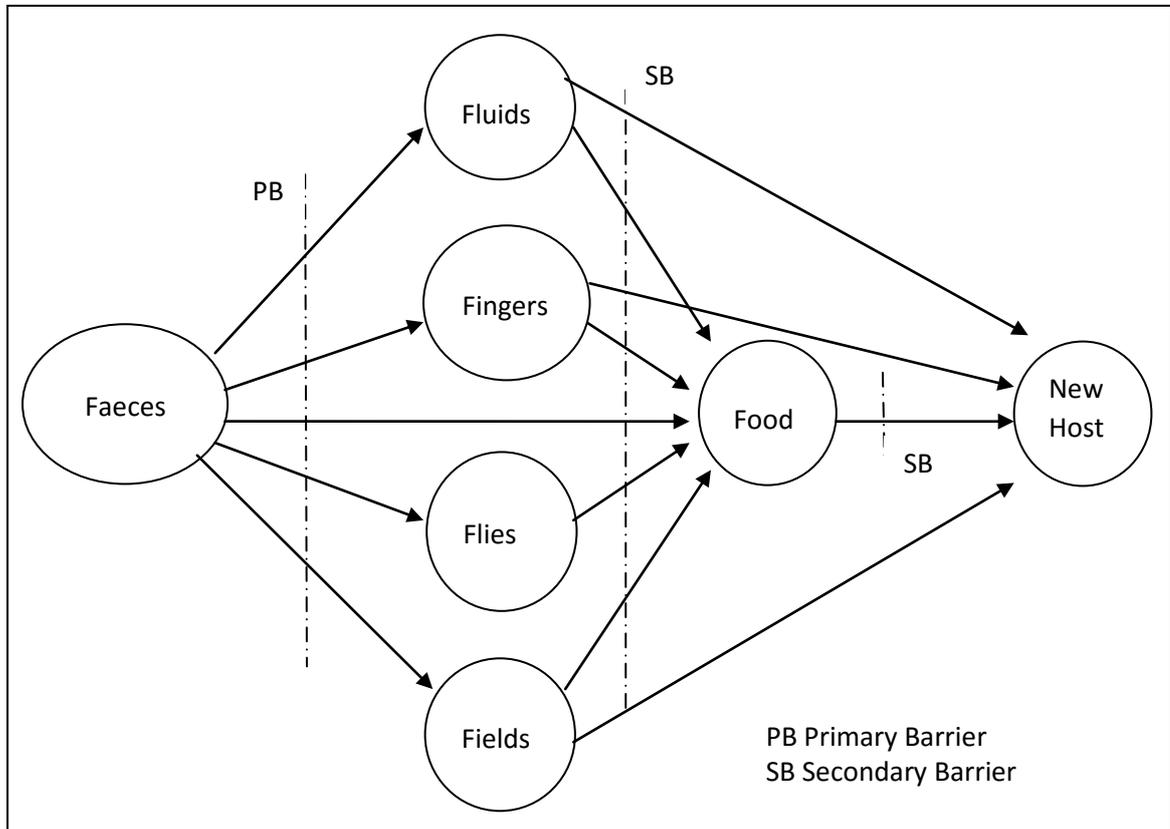


Figure 1.1: The F diagram showing transmission pathways of infectious diarrhoea [15, 16]

1.1.3. Diarrhoea prevention strategy

As shown in the Figure 1.1, there are several potential points for intervention in the environment that may reduce transmission of diarrhoea causing pathogens. Interventions to improve sanitation create a primary barrier. In contexts with suboptimal sanitation, additional environmental interventions may be needed as secondary barriers. WHO and UNICEF recommend five strategies to reduce diarrhoea that include environmental and non-environmental interventions. The strategies include 1) rotavirus and measles vaccinations; 2) promotion of early and exclusive breastfeeding; and vitamin A supplementation; 3) promotion of handwashing with soap; 4) improved water supply (quantity and quality), including

treatment and safe storage of household water; and 5) community-wide sanitation promotion [19, 20].

1.1.4 Definition of sanitation

In the broadest sense the term sanitation may refer to the safe collection, storage, treatment and disposal, reuse, or recycling of human excreta (faeces and urine); as well as the drainage, disposal, recycling and reuse of household wastewater and storm water; along with management of household, industrial and hazardous solid waste [21]. According to the World Health Organisation “sanitation generally refers to the provision of facilities and services for the safe disposal of human urine and faeces” [22]. This definition ignores the disposal of sullage or wastewater. In most epidemiological studies sanitation is usually referred to safe disposal of human excreta [23, 24]. In this thesis the term sanitation refers to the disposal of human excreta.

1.1.5 Classification of sanitation used for international monitoring

International monitoring of sanitation helps to understand a country’s needs, it can inform policy and facilitates the implementation of policies to improve services. Worldwide there is a wide variety of sanitation technologies [25]. Demographic and Health Surveys (DHS) have identified over 400 different sanitation classifications in countries in which the surveys have been undertaken[26]. Contextual factors such as geographical location, population density, wealth, availability of materials, water level, acceptability and traditional practices determine the type of sanitation technologies that are suitable and available. Most of the sanitation facilities that are suitable in rural areas of low-income countries are onsite (pit latrines, septic tanks and other household level technologies that do not involve sewerage). Globally, as of 2010, 60% of urban residents reported using facilities linked to sewers compared to only 12% in rural areas. Sixty four percent of the rural population reported using onsite sanitation facilities [25].

Sanitation facilities vary in terms of technology but also in terms of ownership and user profile. These variations can affect not only user experience [27-

29] but also the extent to which faeces are contained, which in turn reduces contamination of the environment and thereby protects health [30]. For international monitoring of sanitation facilities this variation is a challenge. Ideally, for international monitoring, sanitation would be classified on the basis of evidence for its relative effectiveness in delivering both health and non-health benefits, but this evidence base is weak.

Since the 1930s monitoring of sanitation has been carried out in response to international targets [31]. Adopted in 2000, The Millennium Development Goals (MDGs) became the latest framework for doing this. Target 10 of the MDGs aimed to halve by 2015, the proportion of people without sustainable access to safe drinking water and basic sanitation, in comparison to 1990 [21, 32, 33]. The WHO/UNICEF Joint Monitoring Programme (JMP) for water supply and sanitation is the official United Nations mechanism tasked with monitoring towards the MDG related to water and sanitation. Access to sanitation is monitored using the indicator “proportion of population with access to improved sanitation” [33-35]. The terminology used for the MDG target is “basic sanitation” but JMP refers to basic sanitation as “improved sanitation”.

According to the JMP an "improved" sanitation facility is one that hygienically separates human excreta from human contact [36]. The JMP is constrained by the need to ensure that its definition and indicators can be monitored by existing household survey instruments. Moreover, the JMP also needs to make sure that the data used are comparable across countries and time [25]. So the JMP definition is focused on sanitation technology access at a household level in an attempt to strike a workable balance between what is desirable to measure and what is possible [37]. The improved sanitation facilities include pit latrines with slabs, ventilated improved pit latrines and flush/pour-flush latrines (Table 1). For the MDG target, shared facilities are considered unimproved [35, 38]. Throughout this chapter the term ‘improved sanitation’ will be used to refer to the current JMP technology classification definition without considering sharing status. In addition to the basic indicator to measure “access” or “no-access” to improved sanitation, in 2008 the

JMP also proposed the concept of a “sanitation ladder” to provide disaggregated information on access to sanitation [39]. This four rung ladder of sanitation (individual improved, shared improved, unimproved and no facility) outlines a hierarchy of predefined sanitation technologies, allowing the JMP to assess sanitation progress without changing the MDG definition (Figure 1.1). The sanitation technologies that meet the criteria of individual improved or shared improved are assumed to be better at hygienically separating faeces from the environment and thereby reducing health risk [34, 40].

Table 1.1: Definitions of sanitation proposed by WHO/UNICEF Joint monitoring programme for water supply and sanitation (JMP) and the Government of Bangladesh (GoB) [36, 41]

Toilet characteristics	Improved			Hygienic GoB
	JMP technology type	MDG	SDG*	
Sanitation technology				
Flush or pour-flush toilet to Sewerage pipe/Septic tank/Pit	x	x	x	x
Pit toilet with slab and lid/flap	x	x	x	x
Ventilated Improved Pit toilet	x	x	x	x
Composting toilet	x	x	x	x
Pit toilet with slab	x	x	x	
Number of households using toilet facility	Not considered	1	Up to 5	Up to 2

*This was proposed by the working group on sanitation as presented in the JMP 2014 [36] report but later it was decided to continue to consider shared sanitation as unimproved [42]

As the world approached the deadline for the MDGs, new targets for the post 2015-Sustainable Development Goals (SDGs) were proposed and these also include sanitation [42, 43]. The JMP is revising its definitions to monitor progress towards sanitation for the SDGs. There was discussion as to whether to include sanitation facilities shared among no more than five households or 30 persons, whichever is fewer, as improved [36] (Table 1.1). For the MDG target, shared facilities were considered to be unimproved because of concern regarding cleanliness,

maintenance and access [35, 38]. However, the implications of using a shared facility are likely to be different for urban public and rural private facilities. In the crowded, urban areas of most low income countries, shared facilities might be the only viable option, to avoid open defecation. Whereas in rural areas households with family ties often share a facility to keep the cost down [35].

In addition to the definition provided by the JMP countries often have their own definition of sanitation for monitoring progress. For example the Government of Bangladesh (GoB) categorises sanitation as hygienic or unhygienic. The hygienic sanitation facilities exclude pit latrines with a slab (Table 1.1) [41] and allow sharing by a maximum of two households.

Despite the diversity of definitions used globally, there is very limited empirical evidence to judge the extent to which the definitions of sanitation facilities reflect their performance in separating faeces from the environment.

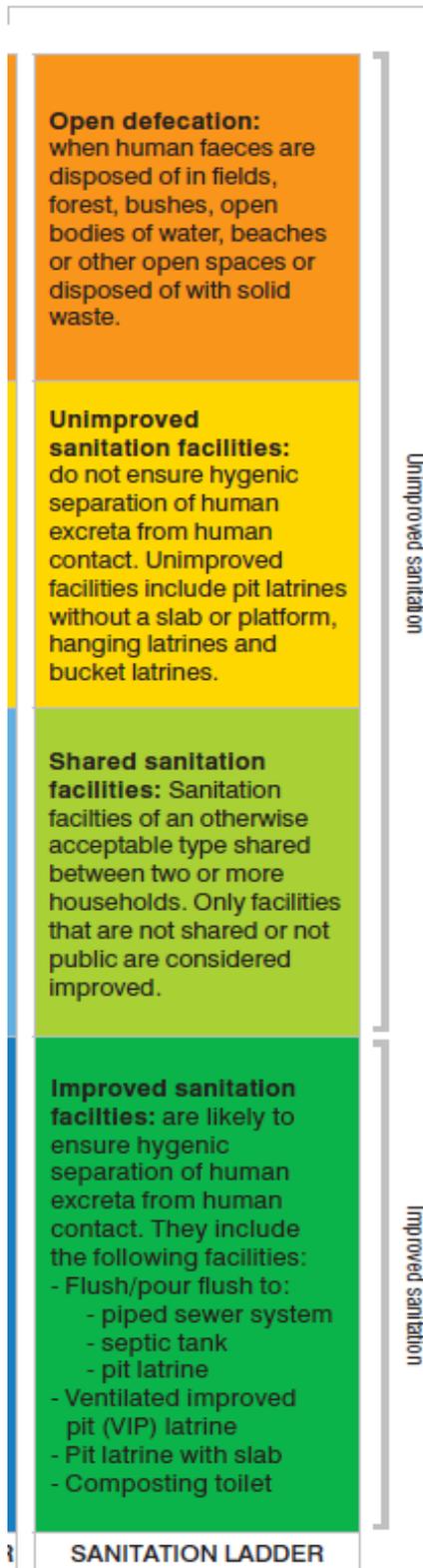


Figure 1.2: JMP sanitation ladder [25]

1.1.6 Sanitation and diarrhoea

Improved sanitation through separating human faeces from the household environment is expected to create a primary barrier to break the chain of transmission of enteric pathogens through fields, fingers, fluids and flies (Figure 1) [14-16]. Inappropriate disposal of human faeces has been found to be associated with increased risk of childhood diarrhoea in several epidemiological studies conducted across different low-income country contexts [44, 45]. For example, in Ethiopia, children in households with no toilet facility were at six times greater risk of diarrhoea than children living in households with a toilet facility, after adjusting for other socio-economic and environmental determinants of diarrhoea [46]. Improper disposal of children's faeces was found to be associated with higher diarrhoeal disease risk among children under five years of age in several studies conducted in low income country contexts [44, 46, 47]. For example, in the Philippines, disposal of children's faeces in the open was associated with a 34% increase in clinically diagnosed diarrhoea among children under two years of age [48].

Evidence from several systematic reviews suggests that interventions to improve excreta disposal are effective in preventing diarrhoea morbidity. A meta-analysis conducted by Fewtrell and colleagues suggests that sanitation interventions in low-income country settings reduce diarrhoeal illness, with a pooled relative risk of 0.68 (0.53-0.87)[49]. This meta-analysis included two studies of sanitation intervention. In both of these studies, there was little evidence that the relationship between sanitation and diarrhoea was confounded by socioeconomic status [45, 50]. A Cochrane review conducted by Clasen and colleagues suggests that in low-income settings, interventions to improve excreta disposal are effective in preventing diarrhoeal disease [24]. However, due to major differences among the studies in term of study context, exposure levels, type of intervention, as well as methodological deficiencies in the studies themselves, the review could not provide any quantification of the pooled effect of the interventions on diarrhoea.

A recent systematic review conducted by Wolf and colleagues included randomized controlled trials, quasi-randomised trials with control group,

observational studies using matching techniques and observational studies with a well-defined control group. The meta-analysis from this study reported a relative risk of 0.72 (95% CI: 0.59, 0.88), indicating that improved sanitation had a protective effect on diarrhoeal incidence, compared to unimproved sanitation. Inadequate sanitation is not only linked with diarrhoea morbidity but also with mortality [37, 51-53]. In 2012, an estimated 58% (Population-Attributable Fraction, PAF) of the diarrhoea deaths that occurred in 145 low and middle-income countries were attributable to inadequate water, sanitation and hygiene [53].

Although the evidence regarding the effectiveness of sanitation interventions in preventing diarrhoea has been criticized as being of relatively poor quality, it is considered to be sufficient to support the provision of sanitation for all, especially in low income countries [37, 54].

1.1.7 Sanitation and health

Health

Inadequate sanitation is an important risk factor for poor health, especially in low and middle income countries [37, 53-56]. Estimates from 2012 suggest that globally 280,000 deaths were caused by inadequate sanitation. Inadequate sanitation is also associated with risk of other infectious disease such as trachoma [37, 57, 58], helminthiasis [37, 59, 60] and schistosomiasis [54]. Inadequate sanitation is also linked with stunting [61-64]. For example, a study conducted in India found that, compared to open defecation, household access to a toilet facility was associated with 16-39% reduced odds of stunting among children aged 0-23 months [61].

Quality of Life

In addition to health, sanitation is linked with quality of life [65] indicators such as safety/security, privacy/dignity, attendance in school [54, 66-68] and economic development (health system cost, days lost at work or school and convenience time) [54, 56, 69, 70]. Above all, sanitation has been recognized as being a human right by the United Nations General Assembly [71, 72].

1.1.8 Global sanitation context

Globally, the proportion of people with access to private improved sanitation has increased from 54% in 1990 to 68% in 2015. Yet, as of 2015, 946 million people worldwide still defecate in the open and an estimated 2.4 billion people were without access to private improved sanitation facilities. The Global MDG target of 77 percent has been missed by 9% points and almost 700 million people [25].

There is disparity in access to sanitation between rural and urban areas. Globally seven out of 10 people without access to private improved sanitation, and nine out of ten people who practice open defecation, live in rural areas. Southern Asia and Africa still have the lowest coverage of private improved sanitation. There are still 47 countries in the world in which less than half of the population has access to private improved sanitation. Globally, there are 638 million people who use shared sanitation facilities. These facilities, if not for their shared status, would otherwise be considered improved sanitation. Among those who use sanitation facilities of an otherwise improved type, the proportion that share these facilities with others is similar in urban (11%) and rural (12%) areas [25].

1.1.9. The Bangladesh context

Bangladesh, situated in Southern Asia, with a population of more than 160 million (2015 estimate)[25], is one of the most densely populated countries in the world (Population density=1,203 per sq. Km)[73]. According to recent estimates, Bangladesh has an under-five mortality rate of 46 per 1000 live births [74]. According to the 2014 Demographic and Health Survey (BDHS), 6% of children below the age of five years were reported to have had at least one episode of diarrhoea during the preceding two weeks [74]. More than 5% of the under-five child mortality is due to diarrhoea [75]. The percentage of the population living in urban areas has increased from 20% in 1990 to 34% in 2015 [25].

Bangladesh has made good progress in terms of access to sanitation. The proportion of the population with access to private improved sanitation increased from 34% in 1990 to 61% in 2015. The proportion of the population that practices

open defecation decreased from 34% in 1990 to only one percent in 2015. However, irrespective of this good progress, Bangladesh, like many nations, did not meet the MDG target related to sanitation [76]. So, improving sanitation is one of the highest priorities for Bangladesh in order to improve the health and wellbeing of children under five.

There are limited disparities between rural and urban areas in term of progress towards the MDG target related to sanitation access. There is more open defecation in rural areas than in urban areas [36, 77]. However access to improved sanitation is slightly higher in rural areas than in urban areas (62% vs. 58%). The type of sanitation facilities used in Bangladesh varies widely. The majority of the population uses onsite sanitation facilities. In 2013, only 15% of the households in urban areas, and 0.1% of households in rural areas, had a sewerage connection. The most common type of toilet facility available to these households was a pit latrine with a slab (47% in rural and 29% in urban areas).

1.2 Literature review and rationale of the study

This chapter presents the findings from a comprehensive literature review. The literature review aimed to assess the role of latrine quality and coverage on microbiological faecal contamination of the household environment and secondly on diarrhoea.

1.2.1 Protocol for comprehensive literature review

1.2.1.1 Research questions

The literature review was conducted to find answers to the following research questions based on available literature:

1. What is the effect of household sanitation quality on diarrhoea incidence among children under 5?
2. What is the effect of household sanitation quality on faecal contamination of the household environment?
3. What is the effect of a neighbourhood's sanitation coverage on faecal contamination of the household environment?

4. What indicators of household faecal contamination are used?

1.2.1.2 Criteria for inclusion in the literature review

Studies were considered eligible if they compared the effect of different types of sanitation quality and coverage on household faecal contamination and diarrhoea. Two exposures and two outcomes were considered. The first exposure was access to household sanitation. The primary focus of the search was to search the literature with regard to improved sanitation access, as defined by the JMP [25, 36]. However, since some literature may provide relevant evidence without using the standard terminology used by the JMP, any study that compared any classification of domestic excreta disposal facilities was considered. The second exposure was neighbourhood sanitation coverage, which included any type of sanitation facility. 'Community' referred to a neighbourhood or village. The first outcome was diarrhoea among children under five years of age. The second outcome was household faecal contamination, which refers to the microbiological contamination of household surfaces (e.g., floors); fomites (e.g., objects such as toys); hands of children and their caregivers; and household drinking water. Studies were included regardless of study design and location. Articles published in English from the year 2000 till 15th October 2015 were searched, since the term 'improved sanitation' and its related definition was introduced by the JMP in 2000 [25].

1.2.1.3 Conducting the search and identification of studies

Articles published in English from journals, conference proceedings, and books, were searched using OvidSP (Ovid Technologies 2015). The data bases Embase (Table 7.1), Global Health (Table 7.2) and Medline (Table 7.3) were searched. The Cochrane Library was also searched for systematic reviews that included the terms 'sanitation', 'excreta disposal', 'faeces disposal' or 'sewage'. Relevant conference proceeding were hand searched. Researchers working within the sector from institutions, including LSHTM, ICDDR,B and Stanford University were also contacted to gain their recommendations on any additional articles. In addition, the reference list of all studies identified by the above methods, were checked.

Through this process about 5000 titles were identified for review. The search terms are presented in Tables 7.1 to 7.3 in Appendix 1.

All the references identified were transferred and saved in Endnote (EndNote X7). Then using Endnote, duplicates were identified and checked before deletion from the library. The titles were then reviewed first to check if they were relevant according to inclusion criteria. Then the abstracts of the selected articles were reviewed to see if they were relevant according to the inclusion criteria.

1.2.2 Findings from the literature review

The findings from the literature search are presented in two broad sections. The first section (1.2b.1-1.2b.3) presents literature on what is known about how household latrine quality and neighbourhood latrine coverage relate to faecal contamination and diarrhoea. The second section (1.2b.4) presents literature on the link between faecal contamination and health.

1.2.2.1 Sanitation type and diarrhoea

There is limited evidence linking the quality of sanitation facilities with faecal contamination. Nor is there sufficient evidence to support associations between sanitation quality and diarrhoea [24, 37, 78, 79]. Most of the intervention studies compared diarrhoea prevalence/incidence among groups that received a sanitation intervention with groups that did not receive a sanitation intervention [50, 78-81]. Most of the observational studies assessed the effect of access to any type of sanitation on diarrhoea morbidity [45, 48, 82-88]. The few studies that did explore the effect of different types of sanitation facilities on diarrhoeal episodes did not use the sanitation definition proposed by the JMP for international monitoring [30, 35, 89]. For example, an observational study conducted in Mexico, found that children under five years of age, in households with 'poor' sanitation (pit latrines and septic tank) had a higher risk of diarrhoea than children in households with sewage disposal systems [89]. Although, in this study socio-economic variables were included in the multivariable analysis, to adjust for confounding due to difference in socio-economic status, this was an observational study. So confounding by socioeconomic status

cannot be ruled out completely. There is evidence from a small number of observational studies that access to flush or pour flush toilets connected to a piped sewer system [90] or septic tank/pit and composting toilets (hygienic) are associated with a lower risk of diarrhoea [30, 91-96]. However, from these studies it is not known whether pit latrines with a slab (improved, as defined by JMP) provide similar protection from diarrhoea.

Several observational studies have used data from Demographic and Health Surveys (DHS) to assess the effect of improved sanitation on diarrhoea risk. A study conducted in Philippines found that households with access to unimproved sanitation had higher odds of reported diarrhoea (OR 1.63; 95% CI 0.99–2.69) compared to those with access to private improved sanitation [97]. A second study conducted in Malawi, found that children from households with access to private improved sanitation facilities had 45% lower odds of diarrhoea [98] compared to those with no sanitation facility. A third study conducted by Fuller and colleagues used 217 demographic and health surveys from 74 countries. The study found that access to an improved latrine was associated with reduced prevalence of diarrhoea [Prevalence Ratio (PR): 0.93; 95% CI: 0.92-0.95] [99]. In the above mentioned studies effect of sanitation on diarrhoea was independent of the effect of socio-economic factors. However these studies used cross sectional data from nationwide surveys, so cannot rule out the effect of confounding due to socio-economic factors completely.

The observed effects of sanitation quality on diarrhoea, found in the analysis conducted by Fuller and colleagues varied by country and time [99]. One explanation for this variation could be variation in the level of error in the categorisation of sanitation facilities during data collection across these surveys. Demographic and Health Surveys (DHS) have identified over 400 different sanitation classifications in countries in which the surveys have been undertaken [26]. So due to the wide variety of sanitation facilities, it is very difficult to categorise these sanitation facilities reliably across different context. Moreover the questions used in DHS to capture the data on latrine classification are focused on the design of the

toilet rather than the functionality of the toilet [21]. For example a pit latrine with a slab may be considered as improved by the JMP because of the design. But if there is a leakage in the pit, the faeces will come out of the pit and contaminate the environment. So this toilet cannot be considered to separate faeces from the environment hygienically and thereby the JMP should not consider it to be improved. This kind of complexity is not captured by the DHS questionnaire [100]. As a result these surveys are likely to include substantial error in the categorisation of sanitation facilities.

There is also evidence from large nationwide surveys that access to private improved sanitation is associated with reduced diarrhoea incidence. A study conducted in India used data from a large nationwide survey with district level representation of India's rural households. The data show that, on average, children living in households using a private improved sanitation facility have 1.26 percentage points less diarrhoea (10% reduction from 12.1% diarrhoea prevalence) compared to children living in households with unimproved sanitation [101]. A second study conducted by Kumar and colleagues used data from a nationally representative household survey to quantify the effect of improved sanitation access on diarrhoea incidence on India, using propensity score matching. Access to improved sanitation was associated with a 2.2 percent point reduction in the risk of contracting diarrhoea [102]. These large surveys are prone to substantial measurement error in categorising sanitation facilities. Moreover, in these large nationwide surveys data on reported diarrhoea is collected at one point in time and as such does not capture the seasonality of diarrhoea. Sanitation may have variable effects depending on the season. A nationwide study conducted in rural Indonesia suggested that the lack of improved latrines was associated with higher reported diarrhoea (OR=1.23, 95% CI= 1.18-1.29) [51] and under five child mortality (OR = 1.29, 95% CI = 1.25–1.31). This study used the JMP definition and collected longitudinal diarrhoea data to capture variation in seasonality. However this finding has not been replicated in other low-income country contexts.

Some studies were identified that looked at the effect of sharing a toilet facility on diarrhoea. A recent systematic review identified 21 studies with which to compare health outcomes associated with shared versus individual household latrines [103]. However, most of these studies did not adequately address potential confounding factors and did not allow the effect of different types of shared sanitation to be distinguished. An analysis of DHS from 51 countries found shared, improved sanitation facilities to be associated with adverse health outcomes [104] as compared to individual improved latrines, adjusting for potential confounding variables. However this finding was not consistent across all countries, suggesting that the social and economic context is also important. A multi-country case-control study conducted in seven low income country sites in sub-Saharan Africa and South Asia found families of children with moderate to severe diarrhoea more commonly used shared facilities than control families (48% vs. 41% OR=1.2; 95% CI: 1.1-1.3) [105]. Although this finding was consistent across wealth index quintiles, there was significant between-country variation. This would suggest that local context plays an important role. Sharing may also have a variable effect depending on whether a setting is rural or urban and whether the sanitation facility is being shared by extended family, neighbours, and acquaintances or with the public. Consequently limited data are available to understand which contexts are likely to be safe for sharing sanitation.

1.2.2.2 Sanitation and household faecal contamination

Sanitation is expected to create a barrier to break the chain of transmission of diarrhoeal disease [15, 16, 30, 51]. However there is limited evidence about the impact of onsite sanitation quality on specific transmission pathways or on the relative importance of these pathways. The consideration of microbial contamination of surfaces, soil and fomites as possible transmission pathways has been relatively understudied [106].

1.2.2.2.1 Faecal contamination of water

Understanding of faecal-oral disease transmission pathways in relation to sanitation has largely focused on contamination of drinking water [107-116].

However, the literature looking at sanitation and water quality has produced inconsistent results [116-120]. Most of the studies that assessed the relationship between sanitation and water quality had limited sample size or categorised sanitation differently from the JMP definition. However, an observational study by McGarvey and colleagues collected data from a representative sample of 703 households from six coastal districts of Ghana. The study found households with a pit latrine or no facility have two to three times higher odds of having two or more *E. coli* per 100 ml of water relative to those with a water seal toilet, even after adjustment for other sanitary and socio-demographic characteristics [116]. Another study conducted by Mattioli and colleagues found that having an improved sanitation facilities was associated with a 1.7 fold decrease in the odds of detecting *E. coli* virulence genes in stored water [117]. In contrast, findings from a few observational studies suggest that sanitation is not associated with level of faecal indicator bacteria (FIB) in stored water [118-120]. But these observational studies had a limited sample size and were not designed to perform a statistical analysis of the association between sanitation and water quality that adjusted for the effect of confounding variables.

1.2.2.2.2 Faecal contamination of hands

There is limited evidence to link the level or presence of faecal contamination on hands with household sanitation level [106]. A study conducted by Pickering and colleagues measured levels of FIB (*E. coli*, faecal streptococci) on hands in 334 households in Tanzania. Households which had improved toilets (JMP definition) were found to have lower levels of faecal streptococci on children's and mother's hands [106]. A second case-control study conducted in Tanzania (n<306) found that use of improved sanitation (JMP) was not associated with presence of FIB (*E. coli* and enterococci) enteric viruses (enterovirus, adenovirus, and rotavirus) *E. coli* virulence genes (ECVG) and human-specific *Bacteroidales* faecal markers on the hands of adult female caregivers [117]. A third study conducted in Mozambique measured hand contamination using a finger imprint method. This method collects 10 finger prints from each participant and then these are placed in chromogenic agar that stains

Enterococcus spp. and *E. coli* spp. Levels of faecal indicator bacteria on the fingertips of female caregivers were not found to be associated with the type of sanitation in the household [121].

There may be a few alternative explanations for the inconsistencies in findings from these different studies. Firstly the inconsistencies in findings can be due to the difference in indicator organism chosen as outcome. In the study conducted in Tanzania by Pickering and colleagues, level of *E. coli* on hand were not associated with sanitation type but level of faecal streptococci on hands were associated with sanitation type [106]. Secondly the inconsistency in findings can be due to the variation in the methods of sample collection. Hand rinse technique is likely to collect sample from larger surface area of hand than finger imprint technique and may be more accurate indicator of contamination of hand [122]. Thirdly, the inconsistency could be due to difference in contexts. A study found that there was important variation in the level of hand contamination in samples collected from different neighbourhoods [121]. Similarly the factors that contribute to contamination of hands may vary depending on the broader geographical and socio-cultural contexts.

1.2.2.2.3 Faecal contamination of domestic surfaces and soil

The literature linking faecal contamination of domestic surfaces, soil and fomites with sanitation level (JMP definition) is limited [116, 123-128]. For example, a microbial survey of faecal contamination and selected diarrhoea pathogens in soil, surfaces and produce was implemented in Tanzania among 20 households using private pit latrines. In this study all the samples were analysed for FIB (*E. coli* and enterococci). There were no significant differences in the FIB levels that were cultured from soil in households which had pit latrine with a concrete slab and those that had a pit latrine without a slab [123]. The study was also underpowered to detect difference in FIB levels among households with improved and unimproved sanitation. A second study conducted in Tanzania found that households with access to improved (individual or shared) latrines had lower mean *E. coli* concentration in the hand contact surfaces within the toilet, compared to households with access to

unimproved latrine technologies. However when shared sanitation was categorised as unimproved according to MDG classification there no difference in mean *E. coli* concentration in households with access to improved and unimproved latrines [129]. There was no correlation in the level of bacteria found in latrines with the level of bacteria found on the other household surfaces [129]. Although this study provides empirical evidence for the validity of the JMP technology classification it merged data collected from urban and rural areas, potentially hiding the extent to which this is likely to vary by context. Moreover the extent to which a particular household surface comes in contact with young children is not well known.

1.2.2.2.4 Faecal contamination of fomites

It is hypothesised that toys are likely to have high levels of faecal contamination and play an important role in diarrhoeal disease transmission [130-133]. If sanitation facilities are effective in separating human faeces from the environment then this is likely to reduce the microbial contamination of household objects (for example a toy ball). Several small scale observational studies have assessed the effect of sanitation on faecal contamination of the household environment.

In a study conducted in Bangladesh, 39 households with improved sanitation and 61 households with unimproved sanitation were enrolled to assess if faecal contamination of a standard-size toy ball (introduced by the study) was associated with sanitation quality. The mean level of faecal coliforms on the toy balls were found to be higher in households with unimproved sanitation compared to households with improved sanitation. However, the mean level of faecal streptococci was similar in households with improved and unimproved sanitation [134]. A recent study conducted by Torondel and colleagues looked at the correlation between household characteristics and microbiological contamination of toy ball (also introduced by the study) in rural Indian context. The study did not find any difference between households with or without presence of a functional latrine in terms of the presence of any thermotolerant coliforms (TTC) on the toy ball [135]. While these studies demonstrated the feasibility of using sentinel toys as a measure

of household faecal contamination, the studies did not categorise sanitation according to the JMP definition.

A study was conducted in Bangladesh with the aim of comparing the levels of FIB (faecal coliforms and *E. coli*) in indicator fomites (sentinel toys and clothes) in households with improved (JMP) and unimproved latrines. The levels of faecal coliforms on toys in households with improved sanitation were lower (geometric mean: 8 CFU/100 ml) compared to households with unimproved sanitation (geometric mean: 57 CFU/100 ml). There was no significant difference in the geometric means of *E. coli* on the toy comparing households with improved and unimproved sanitation. However, the study had small sample size (n=50)[136]. In another study, conducted in Peru, faecal contamination of toy balls was measured in a subsample of households (n=160) enrolled for an impact evaluation of a water and sanitation program. Improved sanitation as defined by JMP was associated with lower geometric mean concentration (MPN/100ml) of faecal indicator bacteria (*E. coli*) [137] on toys compared to households that lacked improved sanitation. Another study conducted in Honduras found that households with improved latrines had lower geometric mean concentration (MPN/100mL) of total coliforms [138] in both existing and study-introduced toys compared to households with unimproved sanitation. However these studies did not have enough power to assess the effect of a range of confounding variables that may affect the association between faecal contamination and sanitation access.

1.2.2.3 Neighbourhood sanitation coverage

Infectious diarrhoea is transmitted in both public and private domains [18]. So, improved sanitation may reduce the transmission of infectious diarrhoea in two ways. As described in section 1.2.2.1 of this literature review there may be a direct benefit to a household in improving their household sanitation. Additionally there may be an external benefit for that household which arises, due to their neighbours accessing sanitation as this results in a lower probability of human contact with human excreta [101]. An important question often debated in the context of

improving sanitation in low-income settings is whether the benefits of sanitation critically depend on neighbourhood-level sanitation coverage (“herd effect”)[139].

Several studies were identified that assessed the effect of community sanitation coverage on health. A few studies have looked at whether the level of community sanitation coverage has an effect on health by studying sanitation facilities which are connected to sewer systems or septic tanks in urban contexts [140-144]. A study conducted in 45 urban wards in Dar es Salam, found limited change in cholera incidence as the percentage of the ward’s residents connected to a septic tank or sewage system increased (Incidence rate ratio: 1.01; 95% CI: 0.95–1.07). The authors suggest that the lack of association could be due to a narrow range of access to sanitation at the ward level (sanitation coverage) [141]. Another study conducted in an urban area of Dhaka found that among the four wards studied, the ward which had more than 60% of toilets connected to a sewer system or septic tank had 1.25 less DALYs/household/per year compared to a ward in which 95% of residents practiced open defecation or used a hanging latrine [145]. While these studies show the importance of community sanitation access, they cannot fully elucidate the relationship between neighbourhood-level sanitation coverage and faecal contamination or on health outcomes.

A study implemented a city-wide sanitation intervention in Salvador, Brazil which aimed to raise the level of sewerage coverage from 26% to 80%. After the intervention implementation there was a 22% reduction in diarrhoea prevalence (95% CI: 19-26)[142, 143]. In the multivariate model, adjustment for changes in community sewerage coverage explained 100% of risk reduction while changes in household level sanitation related variables explained only 17% of the risk reduction [143]. This finding suggests that that the pathogen transmission reduced by the programme was mainly in the public domain, suggesting that achieving community-wide access to improved sanitation, in addition to household access, is likely to be critical for effective reduction of faecal contamination and diarrhoeal incidence reduction. However, this study was conducted in urban areas with sewage connections, a sanitation technology not feasible in most low-income rural settings.

In rural settings with predominantly onsite sanitation the impact of neighbourhood sanitation may be different.

Studies conducted in rural contexts with predominantly onsite sanitation facilities have also highlighted that neighbourhood sanitation coverage may be important. First a study conducted in rural Zimbabwe assessed the effect of latrine coverage at the community level, on diarrhoea morbidity. In the community with 62% latrine coverage children experienced 68% lower diarrhoea morbidity compared with the children from the community that had no sanitation [139] access. However the study had a relatively small sample size and compared only two communities. A second study conducted in coastal Ecuador analysed data from four years of active diarrhoeal-disease surveillance data across 21 communities. Villages were categorised based on diarrhoea prevalence as 'low' (<0.6%); 'low-medium' (0.6%-2.2%); 'medium-high' (2.2 %-< 5.2%) and 'high' (5.25-100%). The study found that higher levels of improved sanitation were associated with lower diarrhoea prevalence in regions categorised as low risk [146]. This study showed that the association between community sanitation coverage and diarrhoea risk may vary depending on the level of disease in the surrounding villages. These studies provide insufficient evidence of the benefits of externality associated with increased community-level sanitation access.

The studies which were conducted in rural settings indicate that high levels of sanitation coverage within a community may provide additional externality benefits [101] in terms of reducing diarrhoea. For example one study used data from an Indian nationwide survey of rural households. The findings suggest that community-level improved sanitation coverage is associated with a 37% additional reduction in diarrhoea prevalence, in addition to a reduction due to household level improved sanitation coverage [101]. A second study that used demographic and health survey data suggests that children from villages with higher open defecation rates were stunted, controlling for the effect of household level sanitation practices [147]. These findings have so far not been replicated in other settings. Depending on the status of disease in a specific context the effect of risk factors such as lack of

sanitation may have a variable effect. Moreover, most of these studies have used secondary data such as DHS. As acknowledged earlier, the classification of sanitation facilities in DHS may be prone to misclassification bias as the questions used in DHS do not capture the function of sanitation facilities in separating faeces from the environment.

1.2.2.4 Other determinants of household faecal contamination and diarrhoea

In 2012, worldwide 297,000 diarrhoea deaths were estimated to be caused by inadequate hand hygiene [53]. In a study conducted in India, the caregiver's self-reported practices of washing hands with soap before meals (OR=0.85, 95% CI 0.76 to 0.94) or after defecation (OR=0.86, 95% CI 0.80 to 0.93) were inversely associated with child stunting, after adjusting for all potential confounders [61]. A recent systematic review identified individually randomized controlled trials (RCTs) and cluster-RCTs that compared the effects of hand washing interventions, on diarrhoea episodes in children and adults with no intervention. The study found that hand washing promotion among communities in low and middle income countries (LMICs) prevents around one-quarter of diarrhoea episodes (rate ratio 0.72, 95% CI 0.62 to 0.83) [148]. In six out of eight trials identified in this review, soap was provided free alongside hand washing education, and the overall average effect size was larger than in the two trials which did not provide soap.

Findings from observational studies suggest that washing hands with soap is effective in removing microorganisms from hands [106, 149-151]. For example a study conducted in Tanzania among 334 households found that children's hands reported washed within the past hour have an average of 0.3 log₁₀ CFU / 2 hands less *E. coli* (EC) ($t=-3.31$, $df=832$, $P=0.001$) and 0.2 log₁₀ CFU / 2 hands less Faecal Streptococci (FS). ($t=-3.82$, $df=836$, $P<0.001$) compared with children's hands reported not washed within the past hour [106]. More over in this study visible dirt observed on the subject's palm, finger pads, or underneath their nails was significantly related to higher level of both EC and FS on hands. Similarly a second study conducted in Zimbabwe among 80 families found that washing hands with

soap was more effective in reducing faecal indicator bacteria level on hands compared to traditional hand washing [150].

Similarly findings from intervention studies suggest that washing hands with soap is effective in reducing microorganisms from hands [149, 152, 153]. For example, a study conducted in karachi, Pakistan found that, compared to mothers who received no hand-washing intervention, mothers who received soap, would be expected to have 65% fewer thermotolerant coliform bacteria on their hands (95% CI 40%, 79%) and mothers who received soap, a safe water storage vessel, hypochlorite for water treatment, and instructions to wash their hands with soap and chlorinated water would be expected to have 74% fewer (95% CI 57%, 84%) [154]. It is possible that differences in faecal indicator bacteria among the groups reflected underlying divergences in their neighbourhoods rather than the affect of the assigned interventions. However, in this study neighbourhood characteristics likely to affect hand cleanliness and hand washing, was adjusted in the multivariate analysis.

In 2012, globally 502,000 diarrhoea deaths were estimated to be caused by inadequate drinking water [53]. A systematic review conducted by Clasen and colleagues suggests that, water disinfection products for use at the household level may reduce diarrhoea by around one quarter (home chlorination products: RR 0.77, 95% CI 0.65 to 0.91; flocculation and disinfection sachets: RR 0.69, 95% CI 0.58 to 0.82). and point-of-use filtration systems probably reduce diarrhoea by around a half (RR 0.48, 95%CI 0.38 to 0.59)[155]., This findings suggests that water quality is an important determinant of diarrhoeal diseases.

1.2.2..5 Faecal contamination, transmission pathways and link with diarrhoea

1.2.2.5.1 Water

A range of indicators, including FIB, pathogenic microorganisms (viruses and bacteria), Coliphages and species specific faecal markers [117] have been used to assess faecal contamination of drinking water [107-110, 113-116, 118-120, 156-183].

However, the evidence associating faecal contamination of water with health outcomes is inconsistent. Those reporting a linkage between faecal contamination and health outcomes have mostly used FIB to assess faecal contamination. Findings from these observational (large sample size) and intervention studies conducted in both high and low-income countries suggest that the presence of FIB (faecal coliforms, *E. coli*, faecal streptococci and enterococci) in water may be associated with adverse health outcomes [163, 177, 182-186]. However, a few observational and intervention studies did not find the level of FIB in stored water to be associated with adverse health outcomes [106, 117, 168, 178]. The studies which did not find the faecal contamination of water to be associated with health outcomes were weakened by the fact that they had a limited sample size ($N > 335$) to detect differences in health outcome. Moreover presence of FIB in recreational water was found to be associated with gastrointestinal illness in high-income country contexts [187, 188]. So it can be argued that there is a reasonable amount of evidence suggesting that the presence of FIB in water may predict health risk.

1.2.2.5.2 Hands

The available literature suggests that the presence of FIB on children's and caregiver's hands are common [132, 165, 173, 189-192] and plays a significant role in transmission of infectious gastrointestinal illness. In a domestic environment with high microbial contamination, hands that are effectively de-contaminated by washing are often quickly re-contaminated [189, 193, 194] by coming into contact with different vectors in the household environment and through different household activities. In day care centres contamination of hands was found to be correlated with the contamination of inanimate objects [131]. Several small scale studies have identified the level of FIB on hands to be associated with diarrhoea [106, 122, 130-132, 195-197]. However, the evidence is generally weak because of limited sample sizes and is often not consistent between countries. For example studies conducted in Bangladesh [114] and Thailand found the presence of FIB in children's and mothers hands to be associated with higher rates of diarrhoea [197]. However, a study conducted in Karachi by Luby and colleagues suggests that

presence of thermo tolerant coliform on hands was not associated with diarrhoea when measured using finger imprints. In this same study the presence of faecal coliforms were measured using a hand rinse technique and this was found to be associated with diarrhoea [122]. The studies conducted in Thailand [197] and Bangladesh [114] also used similar finger imprinting techniques to assess hand contamination and found the faecal contamination of hands to be associated with diarrhoea. However both of these studies used larger agar plates which allowed a larger hand surface area to be cultured compared to the study in Karachi. This suggests that culturing a larger surface area of the hand may provide a more accurate and useful assessment of faecal contamination on hands.

There is limited evidence about the association between the faecal contamination of hands and diarrhoea. The literature indicates that measuring hand contamination at random could be considered as a potential indicator of the faecal contamination that may be prevalent in household environment. However since hand contamination is highly variable, it may require large sample sizes to capture variation in factors contributing to hand contamination [122].

1.2.2.5.3 Home hygiene (surface/fomite)

There is some evidence from high [198-209] and low-income countries [123, 128, 165, 173, 210] that the microbial contamination of household surfaces and fomites are common and plays a significant role in the transmission of enteric pathogens. However most of these were descriptive studies, with small sample sizes. These studies have mostly described the levels of general microbial contamination or faecal contamination in the household environment but did not link faecal contamination on surfaces and fomites with health outcomes.

1.2.2.5.4 Toys

Evidence suggests that children's toys have a high degree of FIB and can be a potential source of transmission of enteric pathogens [124, 125, 130-132, 211]. There is also some evidence from small scale observational studies, suggesting that the degree of faecal contamination on hands may be associated with the faecal

contamination of toys [125, 131]. However, there is very limited evidence of faecal contamination of toys being associated with diarrhoea in low-income countries.

1.2.2.6 Microbial indicators of faecal contamination:

1.2.2.6.1 Comparison of indicators of faecal contamination

The literature from high and low income countries suggests that, a range of indicators including faecal indicator bacteria (FIB), pathogenic microorganisms (bacteria and viruses) have been used to assess faecal contamination [106, 116, 119, 122, 124, 157, 181, 209, 212-215]. A range of microbial source tracking (MST) methods (genotypic, phenotypic, and chemical) have also been used to identify sources (human/non-human) of faecal pollution in the environment [106, 117, 157, 204, 216-218]. However, all indicators of faecal contamination have some advantages and disadvantages in term of their use to assess faecal contamination in epidemiological studies.

Links between species specific faecal markers in environmental samples and health is yet to be established [106, 216, 217, 219-221]. Moreover the presence of human specific faecal markers identified using MST methods has been found to be a poor predictor of pathogenic bacteria [213, 219]. MST methods are time consuming, labour-intensive, and expensive (require costly laboratory equipment) [220]. As a result this may have limited feasibility in assessing the impact of large scale sanitation/hygiene programme in low income country context.

Pathogenic microorganisms (bacteria and viruses) that are associated with faecal contamination and can cause diarrhoea tend to be found in low concentrations in the environment and there are a large number of them. So it is difficult to monitor them in environmental samples [217, 220, 222] and can be costly in the context of low income country setting if the primary purpose is large scale programme evaluation.

FIB are rapidly detected, easily enumerated, have survival characteristics that are similar to those of the pathogens of concern. There is some evidence that presence of FIB can be associated with the presence of pathogenic microorganisms [217, 219, 222] and *Bacteroidales* faecal marker [223]. More over concentration of

FIB in hand and drinking water was found to be associated with health outcome [114, 122, 163, 167, 170, 177, 180-184, 197, 224-226] in the context of both high and low income countries. In a systematic review in high income country context, higher concentration of FIB bacteria in recreational water was found to be associated with higher relative risk of gastrointestinal illness (GI) in areas with known sources of human faecal contamination [187]. However FIB (faecal coliform, *E. coli*, faecal streptococci, enterococci) are found in faeces of all warm blooded animal [106, 216, 217, 222] and can be naturally found in the environment [227-230]. But there is also evidence from small scale observational studies suggesting that concentration of FIB in hands and toy may be associated with sanitation [106-116].

So use of FIB could be considered as a feasible option to assess faecal contamination in low income country context to predict health risk, although they cannot be used to track source of faecal contamination (human/animal). However the extent to which they represent health risk may vary and some may be more faecal specific than others. In this study level of faecal indicator bacteria will be assessed in hands and toys considering feasibility of measuring in low income country context.

1.2.2.6.2 Comparison of common faecal indicator bacteria used to assess faecal contamination

There is very limited evidence of the performance of four most commonly used faecal indicator bacteria (faecal coliform, *E. coli*, faecal streptococci, enterococci) if found in hands and toys to be associated with health outcome as well as sanitation. Most of the literature on faecal indicator bacteria is related to drinking water or recreational water.

1.2.2.6.2.1 Faecal coliform

Evidence from observational studies conducted in the context of both high and low income countries suggests that concentration of faecal coliform in hands may be associated with higher risk of diarrhoeal illness [122, 130-132, 163, 183, 186]. However there is no evidence of concentration of faecal coliform in hands to be associated with sanitation. But level of faecal coliform in toys was found to be

associated with better quality sanitation [124, 125] in two small scale observational studies conducted in Bangladesh. But we do not know if level of faecal coliform in toys is associated with better health outcome. One of the important limitations of faecal coliform is that faecal coliform can also include some species that can have a non-faecal origin (e.g., *Klebsiella pneumonia*) [226-231]. So concentration of faecal coliform may not represent exposure to human faeces only but if found to be associated with better sanitation, it can provide indication of how better sanitation might contribute in preventing faecal contamination of the household environment.

So concentration of faecal coliform in hands and toy may better predictor of sanitation but may not be good predictor of health and faecal contamination.

1.2.2.6.2.2 *E. coli*

E. coli is more faecal specific than faecal coliform [217, 226, 231] and recommended as indicator for recent faecal contamination in water [232] from human and animal. While there is some evidence to suggest that level of *E. coli* in drinking water and recreational water is associated with health outcome [163, 177, 182-187, 233], there is very limited evidence of level of *E. coli* in hands and toys to be associated with sanitation or health outcome. However a study conducted in 334 households in Tanzania, found that level of *E. coli* in mothers and children's hands was not associated with prevalence of gastrointestinal symptoms although this study measured gastrointestinal symptoms in one season only. Moreover in this study level of *E. coli* in children's and mothers hands were not associated with sanitation level (JMP definition) [106]. There was no evidence found about level of *E. coli* in toy to be associated with health outcome, however studies conducted in Bangladesh with limited sample size found that level of *E. coli* in toy was not associated with sanitation level [125].

So concentration of *E. coli* in hands and toy might be good predictor of faecal contamination but may not be good predictor of sanitation.

1.2.2.6.2.3 Faecal streptococci

Faecal streptococci survive longer in the environment than faecal coliforms and *E. coli* [220, 226, 234]. There is limited evidence of level of faecal streptococci in

hands and toys to be associated with health outcome as well as sanitation. In observational studies conducted in Thailand and Tanzania level of faecal streptococci in hands was found to be associated with health outcome [106, 197]. Moreover in the study conducted in Tanzania level of faecal streptococci in hands were found to be associated with sanitation level. However in Bangladesh level of faecal streptococci in toy was not found to be associated with sanitation level in a study with limited sample size [124].

So level of faecal streptococci in hands may be good predictor of health and faecal contamination but may not be good predictor of sanitation.

1.2.2.6.2.4 Enterococci

Enterococci are more faecal specific [217, 220] than faecal streptococci. A study conducted by Pinto and colleagues has found majority of enterococci (84%) found in variety of polluted water source to be true faecal species [235]. Level of enterococci in drinking and recreational water was found to be better predictor of diarrhoeal risk compared to faecal streptococci [185, 187, 188, 236]. In a study conducted in France, level of enterococci in water was found to be correlated with level of *Bacteroidales* faecal marker [223]. Another study conducted in Tanzania found higher concentration of enterococci in water to be associated with presence of *E. coli* virulence genes (ECVG) [219]. However there is lack of evidence of the presence of enterococci in hands and toys to be associated with health outcome and sanitation.

So concentration of enterococci in hand and toys might be the best predictor of faecal contamination while its association with sanitation and health is yet to be explored.

Taken together these findings suggests that, there is limited evidence comparing the utility of faecal coliform, *E. coli*, faecal streptococci and enterococci as indicator of faecal contamination on hands and toys in relation to linkage between both sanitation and health. Concentration of *E. coli* and enterococci is better predictor of faecal contamination (water) and health, compared to faecal coliform and faecal streptococci. But there is limited evidence of concentration of *E. coli* and

enterococci in hands and toys to be associated with sanitation as well as health. There is some evidence suggesting concentration of faecal streptococci in hands may be associated with sanitation level, while concentration of faecal streptococci in toys may not be. Although faecal coliforms are not faecal specific but concentration of faecal coliform in hands and toys were found to be associated with sanitation. Since this study aims to assess faecal contamination of hands and toys in relation to sanitation, faecal coliform (found to be linked with sanitation) and enterococci (most faecal specific) can be considered as potential indicator of faecal contamination. As concentration of *E. coli* and faecal streptococci in hands and toys were not found associated with sanitation level in small scale studies conducted in low income country context.

1.2.2.7 Summary of literature review and gap in knowledge

The findings from the literature review suggest that access to private improved sanitation may be associated with modest reductions in diarrhoeal disease but the effect may vary depending on the country, rural or urban environments and seasonality. Sharing a sanitation facility may be associated with higher diarrhoea risk but depending on the context the effect may vary. Most of the existing studies assessing sanitation quality and health outcomes were observational and had important methodological limitations. Many of the existing studies could not capture the seasonal variation of diarrhoea. Moreover many of the existing studies used reported data and standard questionnaires used by JMP/DHS to assess sanitation. This approach assesses only the presence of sanitation technology rather than its functionality, which can lead to potentially inaccurate categorisations of latrines. As a result these studies are prone to misclassification bias.

There are limited numbers of studies that have looked at the effect of sanitation on household faecal contamination. Understanding of faecal-oral disease transmission pathways in relation to sanitation has largely focused on drinking water. The available evidence suggests that both hands and toys could be considered as potential indicators of household faecal contamination. However the findings are based on observational studies and there is heterogeneity in the effect of sanitation

in preventing faecal contamination. The inconsistencies in findings across different studies may be explained by the difference in indicator organism chosen as outcome, variation in methodology of sample collection and the differences in context. Important limitations of existing studies include that many are underpowered to understand the role of confounding factors. Further studies with large enough sample sizes to allow adjustment for possible confounders are needed to see if faecal contamination of hands and toys are associated with sanitation.

There is a reasonable amount of evidence suggesting that the presence FIB in water may predict health risk although there are some inconsistencies in findings across different studies. There is limited evidence linking the faecal contamination of hands with diarrhoea but hand contamination measured at random could be considered as a potential indicator of faecal contamination in household environment. However since hand contamination is highly variable, it may require large sample sizes to capture variation in factors contributing to hand contamination. There is limited evidence to suggest that faecal contamination of surfaces, soil, fomites and toys are associated with increased diarrhoea.

Neighbourhood-level sanitation may provide important externality benefits in reducing diarrhoea disease transmission. But the effect is likely to be different in rural and urban contexts. There is limited evidence to suggest that the level of neighbourhood sanitation coverage has an effect on health outcomes. The literature on the role of neighbourhood sanitation coverage in reducing household faecal contamination is even more limited.

From the literature review presented above, a few important gaps in evidence in relation to improving sanitation coverage in the context of low-income countries can be highlighted. There is limited evidence of the comparative benefits of different levels of onsite sanitation facilities as defined by JMP in terms of reducing faecal contamination of hands and toys and protecting health. There is also limited knowledge about role of sanitation coverage in the neighbouring households on environmental faecal contamination and health. Important limitations of the

studies which have assessed faecal contamination include limited sample sizes and lack of understanding of the role of confounding factors.

1.3 Study aims and objectives

The present study assessed whether faecal contamination of hands and toys is associated with level of sanitation access in a rural setting with predominantly onsite sanitation. The study used sentinel toy and hand contamination as indicators of household environmental contamination in rural areas of Bangladesh. The study collected data from a sample size large enough to capture variability in the degree of faecal contamination comparing households with different level of sanitation. A range of potential household factors (water, sanitation and hygiene related) and neighbourhood level factors was measured to see how they modify or confound the association between sanitation and faecal contamination.

1.3.1 Aim

The aim of the study was to further our understanding of the importance of sanitation quality and coverage, in protecting health.

1.3.2 Specific Objectives

1. To assess the association between different types of onsite sanitation provision (as defined by the JMP and the Govt of Bangladesh) in the household and faecal contamination of the household environment.
2. To assess the association between neighbourhood sanitation coverage and faecal contamination of the household environment.
3. To assess the association between different types of onsite sanitation provision (as defined by the JMP and the Govt of Bangladesh) in the household and the occurrence of diarrhoeal disease in children younger than five years of age.

1.3.3 Research questions

1. Is access to better onsite sanitation (as defined by the JMP and the Govt of Bangladesh) in the household, associated with a lower level of faecal contamination of the household environment?

2. Is higher coverage of improved latrine in the neighbourhood, associated with lower level of faecal contamination of the household environment?
3. Is access to better onsite sanitation provision (as defined by the JMP and the Govt of Bangladesh) in the household, associated with lower reported diarrhoea among children less than five years of age in rural Bangladesh?

1.3.4 Impact of the study

This study will help develop a better understanding of the impact of different type of onsite sanitation in reducing environmental faecal contamination and diarrhoea, and of the effect of sanitation coverage in the neighbourhood on environmental faecal contamination. As a result this will add to the evidence base on health impact of sanitation facility. The evidence could help inform policymakers as to what type of onsite sanitation facilities should be promoted in low-income settings such as Bangladesh. This will also help improve the evidence base regarding the classification of sanitation facilities that is used for international monitoring.

1.4 Thesis components

The thesis consists of six chapters. The contents of each chapter are summarized below.

Chapter 1: Background and literature review

Background to the thesis

Comprehensive literature review

Aim and objectives of the thesis

Chapter 2: Comparing measures of household faecal contamination in rural Bangladesh

This chapter presents data on children's exposure to household faecal contamination and data from piloting several measures of household faecal contamination to inform decisions regarding indicator of household faecal

contamination, to be used in the next chapters. This chapter includes a ready for submission manuscript, which describes the main results.

Chapter 3: A cross sectional study of the association between sanitation type and faecal contamination of the household environment in rural Bangladesh

This chapter compares the relevance of different classifications of improved sanitation used for international monitoring in term of reducing microbiological contamination of household environment. This chapter includes a manuscript submitted for publication, which describes the main results.

Chapter 4: Effect of neighbourhood sanitation coverage on faecal contamination of the household environment in rural Bangladesh

This chapter explores the role of neighbourhood sanitation coverage on household faecal contamination as measured through toy ball and children's hands. This chapter includes a ready for submission manuscript, which describes the main results.

Chapter 5: A cross sectional study to explore the association between sanitation type and diarrhoeal disease.

This chapter compares the relevance of different classifications of improved sanitation used for international monitoring in term of reducing diarrhoea among children less than five years of age using previous data from a programme evaluation conducted in Bangladesh. This chapter includes a ready for submission manuscript, which describes some of the main results.

Chapter 6: Discussion

This last chapter provides a summary of the results from all the chapters, provides an overall interpretation of the results, discusses notable strengths and limitations of the research and finally provides recommendation for policy and future research.

Chapter 7: Appendices that include details of microbiological sample collection and processing; and data collection tools

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Chapter 2: Comparing measures of household faecal contamination in rural Bangladesh

2.1: Introduction to the chapter

This chapter includes the first of the four manuscripts presenting results of the studies conducted for this thesis. The results presented in this manuscript are from the pilot study that was conducted to identify suitable sites on which to measure indicators of household faecal contamination.

2.2 Role of the authors in the research paper

Tarique M.N. Huda (TH): TH is the first author of the research paper. He had the primary role of designing the study, overseeing the field work, cleaning and analyzing the data, interpreting the results and drafting the manuscript.

Amy J. Pickering (AP): AP provided guidance on the microbiological sample collection protocol; provided feedback on analysis and interpretation of the data and reviewed the draft manuscript.

Stephen P. Luby (SL): SL provided guidance on design of the study and reviewed the draft manuscript.

Leanne Unicomb (LU): LU provided guidance during data collection in Bangladesh and reviewed the draft manuscript.

Wolf-Peter Schmidt (WS): WS contributed to the conception of the study, defining the research questions, provided guidance on design of the study; reviewed the data analysis and the draft manuscript.

Zahid H. Mahmud (ZM): ZM reviewed the protocol for the microbiological sample processing in the lab, helped with supervision of the sample processing in the lab and reviewed the draft manuscript.

Probir K. Ghosh (PG): PG reviewed the data analysis strategy and the draft manuscript.

Adam Biran (AB): AB was the executive author for this manuscript. He contributed to the conception of the study, contributed in defining the research questions, approved the overall study design, data/sample collection protocols and reviewed the draft manuscript.

2.3 Research paper cover sheet

Since this thesis is 'Research Paper' style thesis, the following cover sheet is being included in accordance with the regulations, mentioned in the LSHTM Research Degree Handbook guidance.

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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	Tarique Mohammad Nurul Huda
Principal Supervisor	Adam Biran
Thesis Title	Role of Sanitation in preventing faecal contamination of the domestic environment and protecting health: An observational study.

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			
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SECTION C – Prepared for publication, but not yet published

Where is the work intended to be published?	American Journal of Tropical Medicine and Hygiene
Please list the paper's authors in the intended authorship order:	Tarique M N Huda, Wolf-Peter Schmidt, Amy J. Pickering, Leanne Unicomb, Zahid Hayat Mahmud, Stephen P. Luby and, Adam Biran
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 had the primary role of designing the study, overseeing the field work, analysing the data, and drafting the manuscript
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Date: 25th January 2016

Manuscript title: Comparing measures of household faecal contamination in rural Bangladesh

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2.4 Abstract

The objectives of this study were a) to identify potentially suitable (relevant to local context and standardized) sites at which to measure indicators of household faecal contamination and b) to compare different measures of household faecal contamination in terms of feasibility of assessment and variation across different households.

We conducted three-hour observations in ten households with at least one child less than five years of age to identify surfaces and objects that came in contact with the children. Children's hands came into contact with earth floors, including living room, entrance of main house, yard, and kitchen. Children played with a wide range of objects of different sizes and shapes. Only in half of the households were children playing with commercially available toys.

To assess household faecal contamination, a microbiologist collected samples from mother's hands, child's hands, toy balls (so called 'sentinel toys' provided by the study), the floor of entrance to the main house and a composite floor sample (collected from middle of yard, bedroom of the child and the kitchen) from 20 households (five samples per household). A microbiologist enumerated presumptive faecal coliforms (FC) and *presumptive E. coli* (EC) using the membrane filtration technique. The results are presented in terms of colony forming unit (CFU) per 100 cm² sampling area.

The coefficient of variation (CV) of FC count among both the floor samples (CV=0.16-0.17) was lower compared to hand rinse samples (mother's hands=0.47 and children's hands=0.41) and sentinel toy ball (CV= 0.60). The coefficient of

variation (CV) of EC count among both the floor samples (CV=0.17-0.20) was lower compared to hands (mother's hands=0.44 and children's hands=0.48). The median level of FC on children's hands from households with access to improved latrine was lower compared to households with access to unimproved latrines (1.94 vs. 2.67; \log_{10} CFU)¹. The median level of FC in sentinel toy samples collected from households with improved latrine were lower compared to samples collected from unimproved latrines (1.32 vs. 2.10; \log_{10} CFU).

Contamination of children's hands and study-provided sentinel toys can be used as indicator of children's exposure to household faecal contamination, as these measures can be identified and sampled reliably across different households, capture variation and are feasible to measure.

Key words: faecal contamination, sentinel toy, hands, and Bangladesh

¹ Since the sample size was small and the sample was selected purposively significance level was not presented. As, the differences could be due to selection bias.

2.5 Introduction

Diarrhoea-causing enteric pathogens pass from one host to another through the environment before reaching a new host. For young children, the environment is the home and its immediate vicinity [1, 2]. Containing contamination at the sanitation point is one way to prevent faeces and their associated pathogens from contaminating the household environment [2-5]. To assess the effectiveness of sanitation interventions in reducing contamination within the household environment, we need suitable indicators of faecal contamination of the household environment.

Within the household environment there may be multiple sources of children's exposure to faecal contamination, including hands, objects, surfaces, food and drinks [1, 2]. Research assessing household faecal contamination has conventionally focused on hands, food, and drinking water [6-40]. However, contaminated household surfaces and inanimate objects can also play an important role in transmission of enteric pathogens [41-44] and microbial contamination of household surfaces, inanimate objects, and soil, as transmission pathways has been relatively understudied [34, 44-51]. One major difficulty in measuring household surfaces and inanimate objects is identifying a standard surface or object to sample across different study households. Moreover, the extent to which young children come into contact with particular household surfaces or objects is not well known [47] and is likely to be context-specific for the most part.

A useful indicator of household faecal contamination should be relevant to the context, standard across different households, capture variation and be feasible to measure. Depending on the social, cultural and environmental context of a particular household and behaviour of the children in that household, the importance of a particular transmission pathway in transmitting enteric pathogens may vary. So the first objective of the study was to explore where the children under five are potentially exposed to faecal contamination in the household environment, in the context of rural areas of Bangladesh. This understanding will then further help to identify potentially suitable (relevant to context and standard) sites at which to

measure indicators of household faecal contamination. If contamination level on a transmission pathway is very high and there is no variation across different households, we are less likely to capture any difference between two groups of households separated by sanitation characteristics. So the second objective of this pilot study was to compare different measures of household faecal contamination in terms of feasibility of assessment and variation in the level of contamination across different household.

2.6 Methods

We conducted an observational, cross-sectional study between July and September 2012 in eight rural areas of Bangladesh. The field workers identified study villages from a list of villages that were part of an impact assessment implemented by icddr,b [52] and were situated within four hours travel time from Dhaka (in order to facilitate transporting microbiological samples on the day of collection). The study was conducted in two phases. During phase one the field workers conducted semi-structured observations to identify surfaces and objects that commonly came in contact with children's hands and mouth. Then in phase two the field workers conducted a cross-sectional survey (household questionnaire survey and microbiological sample collection) to assess the suitability of measures of children's exposure to faecal contamination. To assess suitability of the measures of exposure to faecal contamination we compared the variation in levels of presumptive faecal coliform and the practical experience of collecting and processing the samples in the laboratory with the local resources available.

Ethics

Participation was on the basis of written, witnessed, informed consent. The study protocol received ethical approval from Ethical Review Committee (ERC) of London School of Hygiene and Tropical Medicine (LSHTM) and icddr,b.

2.7 Phase 1: Identifying suitable measures of household faecal contamination

2.7.1 Observation

The purpose of the observations was to collect descriptive data to identify and list the surfaces and objects that a child under five years of age may touch with their hands or mouth.

The field team consisted of two male research officers trained in collecting observation data from rural Bangladesh. They received 2 days training on ethics, observation methods, study objectives and the observation guideline developed for the study. The first author supervised the field workers and was with them in the field during the entire data collection period. At the end of each data collection day the first author reviewed the transcripts.

The field workers conducted observations in ten households from four villages from four sub-districts (Muktagacha, and Fulbaria from Mymensingh district; Roypura and Narshingdi Sadar from Narshingdi district). From each village the observers purposively selected at least one household with a child who was under six months of age, one household with a crawling child and one household with a walking child from a list of households provided by a previous health impact study [52].

The field workers conducted the observations in the morning (9 a.m.-12 a.m.) using a detailed observation guideline. They first visited the entire household premises and noted a detailed description of the household setting and the presence of animal or human faeces. The field workers observed the focal children for the entire period. They recorded the surfaces or object that came in contact with the focal child's hands or mouth. For each of these events the observers noted the site of child's activities within the household and the immediate vicinity. The observers collected narrative field notes using pen and paper. The first author then reviewed the narrative field notes to list the surfaces or objects that came in contact with child's hands and mouth. Then for each surface or object the frequency of contact

with children's hands and mouth was extracted to identify the common surface or object.

2.7.2 Findings from observation

Observed children spent time in the child's bedroom, inside and around the kitchen, in the courtyard and in neighbouring households, as well as in public places such as shops. All the households selected for semi-structured observation had mud floors in the child's bedroom, kitchen and yard. In four out of 10 households a cowshed was attached to the main house.

The children came into contact with soil in the front yard (common open area surrounded by multiple households that form a compound owned by several related nuclear families), back yard (smaller private household yard, usually situated between the main house and the water and sanitation facilities), bedroom, and in the indoor and outdoor kitchen within the household as well as in the neighbouring households. For example in one of the households, the child played with vegetables on the floor of the kitchen while the mother was cooking. The children were also found to be in contact with surfaces of furniture, doors, walls, hands and bodies of other children and caregivers. In two households, children were playing with poultry and goats.

During the observations the children were found to be playing with a range of objects, including cooking utensils, natural objects (tree branches, leaves) and miscellaneous household objects of different size and shape. In four out of ten households, children were found to be playing with commercially-available toys. The commercial toys that were found in these households included a marble made of glass, a bamboo flute, wooden spinning, plastic doll, fabric doll and football (Table 2.1). In these households, children were found to be putting a range of objects (toys, clothes, fingers utensils, soil) in their mouths. In half of the households (n=5), children were found to put their own hands in their mouths while playing. In one instance a child was found crawling in the yard and putting mud in her mouth. In most of the houses children's hands came into contact with caregiver's hands and in three households children put caregiver's finger in their mouth.

2.7.3 Potential measures of household faecal contamination

Children under five years of age came into contact with soil from different parts of the household floor and were observed to consume soil. These findings are in line with reports from previous studies conducted in Zimbabwe and Bangladesh [53, 54], reiterating that the surface of floors may play an important role in transmission of infectious disease in these settings. However, we found from our observational data that it was difficult to identify one single specific part of the floor surfaces that would be most important in disease transmission. We therefore chose multiple floor surfaces with reference to a household landmark that can be easily identified across different study households. These multiple floor samples together contributed to a composite indicator of floor contamination, with the assumption that the amount of environmental exposure to contamination is likely to be an average of contamination levels measured from different floor surfaces.

The children touched a range of objects of different size, shape and material during their daily activities so it is difficult to identify one standard object that could be used as a measure of household environmental contamination. Children are more likely to be exposed to contamination on toys in comparison to a particular surface and fomite. The commercially-available toys in these households were of different size and shape, were not common across all households and many households had no toys. This makes existing household toys unsuitable for measuring microbiological faecal contamination across different households. Several previous studies have introduced standardised toy balls as an indicator of household faecal contamination [47, 49-51, 55]. Therefore, contamination on study-introduced toy ball can be used as an indicator of household faecal contamination.

Hands are a closer indicator of level of contamination that a child may encounter in comparison to household surfaces and fomites. It is easy to sample hands across different study households. Several small-scale studies have assessed the association between level of faecal indicator bacteria on children's and mother's hands and diarrhoea [19, 26, 31-38]. Therefore, contamination on hands can be used as an indicator of household faecal contamination.

There can be several source of children's exposure to household faecal contamination. Considering relevance to local context and the ability to collect standard sample across different household, we collected samples from children's and mother's hands; study-introduced toy balls; and a floor sample from the entrance of main house, middle of the living room, middle of a general yard, and the middle of the kitchen.

2.8 Phase 2: Comparing measures of household faecal contamination

2.8.1 Methods for cross-sectional survey

The household questionnaire survey and microbial assessment was conducted in four villages from four sub-districts of Comilla and Pabna districts (different villages from those used for observation). The field workers purposively selected ten households with improved latrines and ten households with unimproved latrines from a list of households provided by a previous study [52]. They categorised sanitation facilities using the current UNICEF/WHO Joint Monitoring Programme (JMP) definition of improved (individual pit latrine with a slab or better) and unimproved, based on spot-check of sanitation facilities.

2.8.1.1 Household questionnaire survey

The field workers, conducted a verbally-administered questionnaire survey, along with spot-checks of household facilities [52, 56-58]. The initial questionnaires were developed based on the study research questions and directed acyclic graph developed for the study. The questionnaire was then reviewed by one of the authors (AB) as a quality assurance procedure, including checking for ambiguous or potentially leading questions. The questionnaire included questions about household possessions, parental education, water, and sanitation and hygiene behaviour. The questionnaire was developed in English and then translated in Bengali. Based on the questionnaire a data collection application was developed to collect data using hand held computers. The questionnaire and the data collection application was pilot tested in the field for comprehensibility prior to final data collection. Questions were

amended, reworded or replaced following piloting. The data collection application was then updated based on the changes in the questionnaire and feedback on the application from the pre-testing.

The data collectors were trained on the use of questionnaire, ethics and interview techniques. Once the class room training was over there was practice data collection in the field before the actual data collection. The first author supervised the data collectors in the field. The first author visited all the study households to collect data on the key water sanitation and hygiene facilities so that the data collected by the data collectors can be cross checked. At the end of data collection in each household the data collectors reviewed the questionnaire to check for completeness of data. All the completed questionnaires were reviewed by the first author completeness before data entry

2.8.1.2 Microbial assessment

A microbiologist collected samples from mother's hands, children's hands, sentinel toy balls (details given below), floor of the entrance to the main house and a composite floor sample (collected from middle of yard, bedroom of a child less than five and the kitchen) in each household (Table 2.2). A total of 100 environmental samples from 20 households (five samples per household) were collected.

2.8.1.2.1 Hand contamination sample collection

A sample was collected from both hands of the primary caregiver and the child under five years of age on the same day as the initial household questionnaire survey following a similar technique used in previous studies [22, 29]. A microbiologist rinsed the hands for 30 seconds, one after another in a Whirl-pak bag (Nasco, Fort Atkinson, WI) containing 200 ml sterile Ringer's solution (A solution that includes sodium chloride, potassium chloride, calcium chloride di-hydrate, and sodium lactate). The mother/child was instructed to rub the fingers with palm for 15 seconds. Then the microbiologist massaged the inserted hand from the outside of the bag for an additional 15 seconds.

2.8.1.2.2 Sentinel toy sample collection

A sterile non-porous plastic ball (20 cm circumference) (Picture 1) was given to each study household on the day of the initial household questionnaire survey. The mother was instructed to let her child to play with the toy ball with his/her usual playmates and at the usual sites. The microbiologist returned to the household 23-25 hours later and rinsed the ball in a Whirl-Pak bag filled with 200 ml ringer's solution for 30 seconds, fully immersed, using methodology described previously [47].



Picture 2.1: Sentinel toy Ball

2.8.1.2.3 Floor/yard sample collection

The first floor sample was collected from the earthen floor entrance of the main house. One side of a pre-hydrated sponge (3.6 cm wide, 7.6 cm long and 1.5 cm thick) was twice rubbed over 100 cm² sampling area, marked with a sterile aluminium stencil frame, and then placed back into the Whirl-Pak bag (Whirl-Pak Speci-Sponge bag, Nasco, Fort Atkinson, WI). For the composite floor sample the microbiologist identified middle of the yard, under five child's bed room and kitchen, based on a visual estimate. Then, one half of one side of a sponge was swiped over 100 cm² sampling area twice so that sample from each of the three sites could be collected using the same sponge.

2.8.1.2.4 Quality control

A sample Whirl-Pak bag with 200 ml of Ringer's solution and a pre-hydrated sponge was opened at the household during sample collection and then closed without collecting any sample. This way a field blank was collected every sample collection day to ensure sample rinse bags were free of indicator organisms and not contaminated during the field sampling process.

2.8.1.2.5 Sample processing

The closed Whirl-Pak bags, with the collected samples, were placed immediately into a cold box, maintained at a temperature of $\leq 10^{\circ}\text{C}$. The samples were transported to the Environmental Microbiology Laboratory of icddr,b. The samples were processed to detect presumptive faecal coliforms (FC), using mFC media and presumptive *Escherichia coli* (EC) using MI media (BD Difco, Franklin Lakes, NJ), via membrane filtration technique (EPA method) [59, 60] and drop plate technique [61, 62].

2.8.1.2.6 Enumeration of faecal coliforms (FC) and *E. coli* (EC)

The microbiologist filtered 50 ml to 1 ml (Table 2.3) of liquid recovery media, depending on turbidity and type of the sample, through a $0.22\ \mu\text{m}$ Millipore (Billerica, MA) membrane filter using a vacuum pump. In the majority of cases only one volume was filtered. The plates were then incubated at a temperature of $44.5 \pm 0.2^{\circ}\text{C}$ for 24 ± 2 hours for faecal coliforms and at $35 \pm 2^{\circ}\text{C}$ for 24 hours for *E. coli*. The microbiologist then counted the blue and greenish-blue-coloured colonies on the mFC agar as presumptive faecal coliforms and the deep blue-coloured colonies on the MI agar plate as presumptive *E. coli*. If fewer than 500 characteristic colonies were present, the result was reported as number of CFU per 200 ml of recovery media.

If the samples processed via membrane filtration on the first day produced no detectable colonies, a higher concentration was filtered on the second day using samples stored at 4°C temperature. If there were no target colonies found in the plates on both the days, then the microbiologists reported 0 CFU/200 ml of recovery media. For each sample, droplets of the original recovery media, 10^{-1} and 10^{-2} dilutions of the recovery media, was also plated on the first day at a total volume of $100\ \mu\text{l}$ in case the results from the membrane filtration appeared too numerous to count (TNTC) [61, 62]. To monitor the quality, test negative controls were tested for contamination for each set of agar media. Every day one laboratory blank was tested for contamination. For mFC agar *Escherichia coli* ATCC-13706 was used as positive control and *Staphylococcus aureus* ATCC-25923 was used as negative control. For

MI agar Escherichia coli ATCC-13706 was used as positive control and Staphylococcus aureus ATCC-25923 was used as negative control.

The detection limits ranged from 2 [0.5 for 0 CFU for a maximum of 50 ml filtered; so $0.5 \times (200/50) = 2$] to 1,000,000 CFU [maximum 500 CFU detection limit for a minimum of 100µl of 10^{-2} dilutions; so $500 \times (200000/100) = 1000000$] per 200 ml recovery media (Table 2.3).

2.8.2 Statistical analysis

For standardization purposes, all data are presented in terms of bacterial counts per 100 square centimetres surface area. Since the distribution of the bacterial counts were found to be not normally distributed, they were transformed into log base 10 [63]. Before the log transformation we replaced the 0 values with 0.5. Then we calculated arithmetic mean and median of the \log_{10} transformed counts of FC and EC. To assess variation we also compared mean and median level of contamination between household with improved latrine and unimproved latrine. To test the association between faecal contamination (FC and EC counts) and sanitation type we used Wilcoxon rank-sum test [63]. We also calculated the coefficient of variation (SD/Mean) to achieve an indication of the dispersion of the data. To assess the correlation between levels of faecal contamination across different samples we calculated Pearson's correlation coefficient and associated significance level.

2.8.3 Results of cross sectional survey (Phase 2)

All households reported having access to a latrine. Among these 35% had access to a pit latrine with a slab and a further 25% had a pit latrine with a slab but with a visible broken pit lining allowing leakage of faeces. A quarter of all the latrines had visible faeces on the slab or floor. Forty percent of the households reported sharing the latrine with other households. In 60% of the households the focal child was reported to defecate in the open, in and around the household. The majority (85%) of households had animal faeces present within the household premises (Table 2.6). Nineteen out of the 20 households had soap available for handwashing.

Hand contamination

Mother's hands recorded a mean of 2.79 log₁₀ [Standard deviation (SD) =1.33] FC and 1.96 log₁₀ (SD= 0.86) CFU of *EC*. Compared to mother's hands, children's hands had lower levels of mean FC (Mean= 2.30 log₁₀; SD=0.94) and EC (Mean=1.72; SD= 0.82). The median levels of FC and EC in mother's hands from households with access to improved and unimproved sanitation were similar² (for FC 2.57 vs. 2.65 log₁₀ CFU and for EC 1.90 vs. 2.02 log₁₀ CFU). The median level of FC on children's hands from households with access to improved latrine was lower compared to households with access to unimproved latrines (1.94 vs. 2.67 log₁₀ CFU). However the median level of EC in children's hands from households with access to improved latrine and unimproved latrine were similar (1.89 vs. 1.72 log₁₀ CFU). Hand rinse samples had higher coefficient of variation (CV) in FC count (CV for children's hands=0.47 and mother's hands=0.47) compared to floor samples (CV for entrance of main house=0.16 and composite floor sample=0.17) (Table 2.4).

Household floor/yard contamination

The floor samples collected from the entrance of the main house had a mean of 5.84 log₁₀ CFU of FC (SD=0.91, N=20) and 5.38 log₁₀ CFU of *EC* (SD=0.91). The mean level of FC (Mean=5.43 log₁₀ CFU; SD=0.92) and EC (Mean=4.66, SD=0.91) found in composite floor samples was lower than³ the floor samples collected from the entrance of the living room (Table 2.4). The coefficient of variation among both the floor samples was lowest among all the five types of samples for both FC and EC (CV=0.16-0.18) (Table 2.4).

Sentinel toy ball

The samples collected from the sentinel toy balls had 2.22 log₁₀ CFU of presumptive faecal coliforms on average (SD=1.39). The median level of FC in

² Since the sample size was small and the sample was selected purposively significance level was not presented. As, the differences could be due to selection bias.

³ Since the sample size was small and the sample was selected purposively significance level was not presented. As, the differences could be due to selection bias.

sentinel toy samples collected from households with improved latrine were lower (1.32 log₁₀ CFU) compared to households with unimproved latrines (2.10 log₁₀ CFU). Toys had most variation (CV= 0.60) in FC counts in comparison to all other environmental samples (Table 2.4). FC contamination level in sentinel toys was positively correlated with FC contamination level of children's hands (r=0.42, P=0.07) and composite floor sample (r=0.31, P=0.19) (Table 2.5).

2.9 Discussion on indicators of microbial faecal contamination of the household environment

In this study hands, floor surfaces and objects were assessed for the presence of faecal indicator bacteria, with the purpose of identifying a suitable measure of household faecal contamination to assess the effect of sanitation. All samples showed faecal indicator bacteria, even among households with an onsite latrine. This indicates that a child and a mother could be exposed to faecal contamination via multiple transmission pathways. Children practiced open defecation in these setting [64, 65], which could also contribute to household faecal contamination, even in the presence of a functional latrine. There was frequent movement of animals within the households and the majority of household had some sort of animal faeces present during the survey. Therefore, animal faeces are likely to contribute to the faecal contamination of the household environment and environmental samples collected for this study.

In our study, earthen floor samples had the lowest coefficients of variation, thus requiring a large sample to detect associations with sanitation, making it an unsuitable indicator. However, the sample size was small and therefore limited variation could be due to chance alone. Nonetheless, the probability of a child coming into contact with a particular household surface is unknown making it difficult to estimate the health risk posed by a particular surface.

Contamination on mothers' hands and children's hands had higher level of variation than soil samples. Hand rinse samples were more suitable to process via membrane filtration, compared to soil samples. Therefore, hand contamination could be a potential indicator of household faecal contamination. In this study there

was more variation recorded between households with improved and unimproved sanitation in the level of presumptive faecal coliform contamination on children's hands in comparison to mother's hands. Mothers' hands showed a higher level of faecal indicator bacteria than children's hands. Previous studies have suggested variation in women's hand contamination is due to the activity immediately prior to sample collection [22, 39]. So the higher level of contamination in mothers' hands may be because of contamination of mothers' hands while doing household activities. Although mothers wash their hands more frequently than children (with water only) they may also touch contaminated surfaces/objects more frequently. In our study we found that children put their hands in their mouth frequently while playing. Therefore, contamination of children's hands may be a relevant and a useful indicator of the amount of children's exposure to faecal contamination.

In our study, sentinel toys demonstrated the highest CV among the five samples tested. If there is a difference in levels of faecal contamination comparing household with access to improved and unimproved latrines, this indicator is likely to capture it. Moreover, contamination levels in sentinel toys was positively correlated with contamination level of children's hands, indicating that contamination level in the sentinel toys could be a useful proxy for child exposure. A reduction in the microbiological contamination levels on toys is a proximal indicator of household faecal contamination that a child may encounter in comparison to other exposure pathways such as surfaces and object. Toy balls might be more directly exposed to the household environment than water. As a result, the contamination level on the toy ball (the sentinel toy) might be a suitable indicator of a child's exposure to household faecal contamination. The sentinel toy method has been used in previous studies of sanitation in Bangladesh [47] and in India [55].

This study had some important limitations. Faecal contamination was measured using faecal indicator bacteria (FIB). There is evidence from small-scale observational studies suggesting that presence of FIB on hands and toys may be associated with household sanitation [12-21, 34]. Presence of FIB may have non-human origin and does not necessarily signify risks to human health [34, 66-68] [69-72]. More over presence of FIB may not be correlated with presence of viruses that

may originate in human faeces. It is important to note that here presence of FIB is used to imply human faecal contamination. This makes presence of FIB bacteria an imprecise outcome indicator for sanitation. As a consequence, the confidence intervals of the estimates presented are likely to be wider, making the results less likely to be statistically significant. even if in reality a difference exists [73]. Using markers of human specific pathogens as indicator of human faecal contamination could help us better understand the association between sanitation and human faecal contamination in future studies.

This study was conducted in low-income rural Bangladeshi households with multiple source of household faecal contamination in which children are exposed to earthen surfaces in the household and immediate vicinity. However, the children's exposure to faecal contamination may be different in urban contexts or in high-income countries. In particular, the contamination of surfaces may have different levels of importance or different levels of variation. However, at least in similar settings contamination of children's hands and sentinel toy ball is likely to be as useful as in this context. The experience of this study and its findings can therefore be used in other contexts, with similar environmental and social contexts.

The findings from this small-scale study suggest that children are likely to be exposed to faecal contamination from different household surfaces and objects but that identifying a standard surface or object for measurement across different households is difficult. Since the contamination level of soil demonstrated low variation across different households, a larger sample size will be required in studies to capture the difference in contamination level. Children's hands and study-introduced sentinel toys are standard across different households and are more feasible to collect and process using membrane filtration. Moreover, there is more variation in level of faecal contamination on hands and sentinel toys in comparison to earthen surfaces. Therefore children's hands and study-introduced sentinel toys could be used to assess child exposure to household faecal contamination. Although this study was undertaken in a small number of households, it provides important insight as to the feasibility and relevance of alternative measures of household faecal

contamination. Future studies of environmental contamination would benefit from undertaking a feasibility study of the measures of environmental contamination.

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Table 2.1: Surfaces and objects that came in contact with children’s hands and mouth during structured observation conducted in rural Bangladeshi households (HH), July-August 2012

Surface/Object that came in contact with hand	No of Households (HH) where event was observed (N=10)
Soil from floor in	
Bed room	5
Yard adjacent to entrance of main house	3
General yard	3
Kitchen	2
Furniture/door/walls/fence	
(Bamboo pillars, wooden, plastic chair, wooden chair, bed)	6
Bed linen/towel	4
Cooking utensils or household objects	7
(mug, plastic bottle, jug, plastic hand fan, drinking glass, spoon, <i>Badna</i> , plastic bottle, plastic food storage box)	
Formal toys	4
(glass marble , bamboo flute , wooded <i>latim*</i> , nail cutter, plastic doll, fabric doll, football)	
Natural objects	9
(Tree branches, leaves, crop residue, produce brought for cooking, fire wood, fruits)	
Miscellaneous objects	
(Pen, sandals, nail cutter, screw driver)	5
Hands and body of other children	7
Hands and body of caregiver	8
Hands and body of neighbours	3
Domestic animal (chicken, duck and goat)	2
Clothes of care giver	5
Objects that a child put in mouth (non-food item)	
Soil	1
Caregivers’ clothes	1
Own clothes	1
Toys (doll)	1
Tree branch, leaves, crop residue	7
Own fingers	5
Finger of sibling	1
Fingers of caregivers	3
Uncooked vegetable/fruit (Produce)	4
Utensils (glass, plastic bottle)	2
Miscellaneous (Pen)	1

* A traditional wooden toy

† A small water vessel made of plastic or aluminium or copper used to transfer/carry water to the latrines. ([http://en.wikipedia.org/wiki/Lota_\(vessel\)](http://en.wikipedia.org/wiki/Lota_(vessel)))

Table 2.2: Summary of environmental samples collected from Rural Bangladesh, 2012

Type of sample	Sample collection method	Indicator bacteria
Mother's hands (N=20)	Rinsing both hands in 200 ml ringer's solution	<i>E. coli</i> Faecal coliform
Children's Hands (N=20)	Rinsing both hands in 200 ml ringer's solution	<i>E. coli</i> Faecal coliform
Sentinel toy (N=20)	Rinsing standard toy ball in 200 ml of ringer's solution, 24 hours after supplied.	Faecal coliform*
Floor of entrance of living room (N=20)	Sponging 100 sq cm surface using a pre-hydrated sponge	<i>E. coli</i> Faecal coliform
Composite-floor (N=20)	Sponging 100 sq cm from 3 surface area using one pre-hydrated sponge (Middle of yard, middle of living room and middle of kitchen)	<i>E. coli</i> Faecal coliform

*Since a study conducted in Bangladesh did not find *E. coli* level in sentinel toy to be associated with sanitation type we have not measured *E. coli* level for sentinel toy [51]

Table 2.3: Showing the percentage of samples with various detection limits for each type of sample (N=20)

Method	Amount filtered or drop plated	Detection limit†		Mother's hands (%)		Children's hands (%)		Sentinel toy	Entrance of living room		Composite floor sample	
		Lower	Upper	EC*	FC*	EC	FC	FC	EC	FC	EC	FC
Drop plate technique	100 µl of 10 ⁻² dilution											
	Drop	100000	100000000		10%		5%		45%	35%	40%	4%
	100 µl of 10 ⁻¹ dilution	10000	10000000									
	Drop								20%	35%	5%	10%
	100 micro litter	1000	1000000		25%		20%	30%	10%	30%	15%	6%
Membrane filtration	1 ml filtration	100	100000						20%		25%	
	2 ml filtration	50	50000	30%	10%	35%	5%		5%		15%	
	5 ml filtration	20	20000	50%	15%	45%	20%	10%				
	10 ml filtration	10	10000	5%	25%	5%	25%	10%				
	20 ml filtration	5	5000	15%	10%	10%	15%	40%				
	50 ml	2	2000	0	5%	5%	10%	10%				

* *E. coli* (EC), Faecal coliform (FC)

† For lower detection limit we counted 0.5 for no characteristic colony per plate and for upper detection limit we considered 500 colonies per plate to countable.

Table 2.4: Mean log₁₀-transformed colony forming units (CFU) of presumptive faecal coliforms and *Presumptive E. coli* per 100 cm² of environmental sample (N=20), rural Bangladesh 2012

Type of environmental sample	All households (HHs) N=20			HHs with Improved latrine N=10		HHs with unimproved latrine N=10		P value†
	Mean (SD)	Median	CV*	Mean (SD)	Median	Mean (SD)	Median	
Faecal coliform								
Mother's hands	2.79 (1.33)	2.58	0.47	2.42 (0.96)	2.57	3.16 (1.58)	2.65	0.43
Children's hands	2.30 (0.94)	2.50	0.41	1.94 (0.86)	2.13	2.67 (0.89)	2.92	0.06
Sentinel toy	2.22 (1.39)	1.62	0.63	2.42 (1.77)	1.32	2.03 (0.94)	2.10	0.94
Entrance of main house	5.84 (0.91)	5.91	0.16	5.88 (0.76)	5.74	5.81 (1.08)	6.17	0.85
Composite Floor‡	5.43 (0.92)	5.54	0.17	5.55 (0.56)	5.39	5.32 (1.20)	5.71	0.79
<i>E. coli</i>								
Mother's hands	1.96 (0.86)	2.02	0.44	1.80 (0.84)	1.90	2.12 (0.89)	2.02	0.52
Children's hands	1.72 (0.82)	1.81	0.48	1.58 (0.84)	1.89	1.86 (0.82)	1.72	0.71
Entrance of main house	5.38 (0.91)	5.51	0.17	5.39 (0.80)	5.34	5.36 (1.06)	5.61	0.91
Composite floor‡	4.66 (0.91)	4.60	20	4.71 (0.80)	4.69	4.60 (1.04)	4.58	0.76

* Coefficient of variation (SD/Mean)

† Association between faecal coliform counts and sanitation type using Wilcoxon rank sum test

‡ Composite floor: Sample collected from middle of the yard, bed room of <5 child and kitchen by microbiologist based on visual estimate using one sponge.

Table 2.5: Correlation of presumptive faecal coliform (FC) and *Presumptive E. coli* (EC) contamination among samples collected from different sampling sites in rural Bangladeshi households (N=20).

Variable 1	Variable 2	Faecal coliform (FC)		<i>E. coli</i> (EC)	
		r	P value	r	P value
Composite Floor	Entrance of main house	0.29	0.21	0.49	0.03
Composite Floor	Sentinel toy	0.31	0.19	-	
Composite Floor	children's hands	-0.15	0.54	-0.13	0.58
Composite Floor	Mother's hands	-0.30	0.20	-0.15	0.54
Entrance of main house	Sentinel toy	0.07	0.76	-	
Entrance of main house	children's hands	-0.13	0.57	-0.37	0.11
Entrance of main house	Mother's hands	-0.23	0.33	-0.38	0.09
Sentinel toy	Children's hands	0.42	0.07	-	
Sentinel toy	Mother's hands	0.01	0.97	-	
Children's hands	Mother's hands	0.48	0.03	0.52	0.02

Table 2.6: Characteristics of the participating households, Comilla and Pabna districts, Bangladesh, August/September 2012.

Characteristics	All participating households (HH)		HHs with Improved latrine		HHs with unimproved latrine	
	n	Percent or Mean	n	Percent or Mean	n	Percent or Mean
General						
Mean Number of HH residents	20	5	10	5.1	10	4.8
Mean Number of children age <5 years	20	1.1	10	1.0	10	1.1
Mean age (months) of children <5 years	20	38.8	10	40.1	10	37.7
Mother of youngest child lacked formal education	7	35%	6	60%	1	10%
Father of youngest child lacked formal education	11	55%	8	80%	3	30%
Occupation of the father of the youngest child						
Farmer	9	45%	5	50%	4	40%
Labourer	5	25%	-	-	2	20%
Salaried employee	1	5%	3	30%	1	10%
Business owner	5	25%	2	20%	3	30%
Proportion who owned						
House	20	100%	10	100%	10	100%
Wardrobe	6	30%	3	30%	3	30%
Table	17	85%	8	80%	9	90%
Chair	19	95%	10	100%	9	90%
Bed	9	45%	3	30%	6	60%
Inexpensive cot	15	75%	10	100%	5	50%
Watch/clock	12	60%	5	50%	7	70%
Bicycle	6	30%	3	30%	3	30%
Mobile Phone	18	90%	9	90%	9	90%
Television	5	25%	3	20%	3	30%
Refrigerator	0	-	0	-	0	-
Goat	9	45%	4	40%	5	50%
Cow	16	85%	8	80%	8	80%
Chicken	16	85%	8	80%	8	80%
Mean acres of agricultural land	20	0.9	10	0.54	10	1.3
Mean acres of non-agricultural land	20	0.2	10	0.2	10	0.2
House construction						
Tin roof	19	95%	10	100%	9	90%
Cement floor	2	10%	0	-	2	20%
Mean number of rooms	20	1.9	10	2	10	1.7
Electrical connection	16	80%	7	70%	9	90%
Cooking Fuel						
Wood	4	20%	3	30%	1	10%
Crop residue	13	65%	4	40%	9	90%
Cow dung	2	10%	2	20%	-	-

Kerosene	1	5%	1	10%	-	-
Water source for drinking						
Shallow tube-well	19	95%	9	90%	10	10%
Type of latrine facility used by the household						
Flush latrine connected to						
septic tank	1	5%				
offset pit	6	30%				
somewhere else	1	5%				
Pit latrine with slab	7	35%				
Pit latrine with slab but the pit is leaking	5	25%				
User of latrine facility						
Individual	12	60%				
Shared	8	40%				
Visible faeces on latrine slab	5	25%				
Animal faeces present within the household	17	85%				
Defecation site for <5 children*						
Potty/Nappy	4	20%				
Latrine	4	20%				
Open within the household	8	40%				
Open in the nearby bush	4	20%				

* Household

Chapter 3: A cross sectional study of the association between sanitation type and faecal contamination of the household environment in rural Bangladesh

3.1 Introduction to the chapter

This chapter compares different classifications of improved sanitation used for international monitoring in terms of their effectiveness at reducing microbiological contamination of household environment. This chapter includes a submitted manuscript which describes the main results of the study conducted for this thesis.

3.2: Role of the authors in the research paper

Tarique M.N. Huda (TH): TH is the first author of the research paper. He had the primary role of designing the study, overseeing the field work, cleaning and analyzing the data, interpreting the results and drafting the manuscript.

Wolf-Peter Schmidt (WS): WS contributed to the conception of the study, defining the research questions, provided guidance on design of the study; reviewed the data analysis and the draft manuscript

Amy J. Pickering (AP): AP provided guidance on the microbiological sample collection protocol; provided feedback on analysis and interpretation of the data and reviewed the draft manuscript.

Zahid H. Mahmud (ZM) and Md. Sirajul Islam: ZM and SI reviewed the protocol for the microbiological sample processing in the lab, helped with supervision of the sample processing in the lab and reviewed the draft manuscript.

Md. S. Rahman: SR helped with supervision of data collection in the field, data cleaning and reviewed the draft manuscript.

Stephen P. Luby (SL): SL provided guidance on design of the study and reviewed the draft manuscript.

Adam Biran (AB): AB was the executive author for this manuscript. He contributed to the conception of the study, contributed in defining the research questions, approved the overall study design, data/sample collection protocols and reviewed the draft manuscript.

3.3 Research paper cover sheet

Since this thesis is 'Research Paper' style, the following cover sheet is being included in accordance with the regulations as mentioned in the LSHTM Research Degree Handbook guidance.

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SECTION A – Student Details

Student	Tarique Mohammad Nurul Huda
Principal Supervisor	Adam Biran
Thesis Title	Role of Sanitation in preventing faecal contamination of the domestic environment and protecting health: An observational study.

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?			
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SECTION C – Prepared for publication, but not yet published

Where is the work intended to be published?	American Journal of Tropical Medicine and Hygiene
Please list the paper's authors in the intended authorship order:	Tarique M N Huda, Wolf-Peter Schmidt, Amy J. Pickering, Zahid Hayat Mahmud, Md. Sirajul Islam, Md. S. Rahman, Stephen P. Luby and, Adam Biran
Stage of publication	Submitted for publication

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 had the primary role of designing the study, overseeing the field work, analysing the data, and drafting the manuscript
--	---

Student Signature: T. Triane

Date: 22nd January 2016

Supervisor Signature: [Signature]

Date: 25th January 2016

Title: A cross sectional study of the association between sanitation type and faecal contamination of the household environment in rural Bangladesh

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3.4 Abstract

A cross-sectional study was conducted to assess the association between different types of sanitation facilities and faecal contamination in the household environment. Households with a child aged 6-24 months (target child) were enrolled for the study. Sanitation facilities in 454 households in rural Bangladesh were assessed. Sanitation was categorised using; a) The Millennium Development Goal (MDG) definition of improved (Individual pit latrine with a slab or better) and unimproved; b) the proposed Sustainable Development Goal (SDG) definition of improved (pit latrine with a slab or better used by up to five households) and unimproved. In each household an identical toy ball was given to the target child. After 24 hours the balls were rinsed to enumerate faecal coliforms, using the membrane filtration technique as an indicator of household faecal contamination.

Households with individual improved sanitation (MDG) had lower faecal coliform contamination than households with unimproved sanitation [adjusted difference in means $-0.31 \log_{10}$ colony forming units (CFU)/toy ball; 95% CI $-0.61, -0.01$]. Households with improved (SDG) sanitation used by up to five households had a similar level of faecal coliform contamination to households with access to unimproved sanitation. Shared sanitation facilities of otherwise improved technology were more likely to be dirtier compared to private facilities. Households with no visible faeces on the latrine slab at the time of assessment had less contamination than households with visible faeces on the latrine slab (adjusted difference in means $-0.38 \log_{10}$ CFU/toy ball; 95% CI: $-0.77, 0.02$)

A sanitation facility used by an individual household may be better at reducing household faecal contamination compared to shared facilities.

Key words: sanitation, faecal contamination, faecal coliform, Bangladesh

3.5 Introduction

Inadequate sanitation is an important risk factor for poor health especially in low and middle income countries [1-5]. In addition to its link with diarrhoea morbidity [2, 5-15] and mortality [2, 5, 16, 17], inadequate sanitation is associated with the risk of trachoma,[2, 18, 19] helminthiasis [2, 20, 21] and schistosomiasis [4].

The WHO/UNICEF Joint monitoring Programme (JMP) for water supply and sanitation categorised sanitation as improved or unimproved to monitor progress towards Millennium Development Goal (MDG) 7, target 10 which addressed sanitation coverage [22-24]. The JMP defines improved sanitation as access to a pit latrine with a slab, ventilated improved pit latrine or a flush/pour-flush latrine, (Table 1)[23, 25]. For the MDG shared facilities, otherwise of improved technology are considered unimproved because of concerns regarding cleanliness, maintenance and access [23, 26]. However, the implications of using a shared facility are likely to be different in the urban and rural context. In crowded, urban areas of most low-income countries, shared facilities might be the only viable option to avoid open defecation and in rural areas households with family ties often share a facility to keep costs down [23]. The JMP is revising its definition to monitor the progress towards sanitation for the post-2015 Sustainable Development Goals (SDG). In the revised definition, there is discussion as to whether to consider sanitation facilities of otherwise improved technology, shared among no more than five households or 30 persons, whichever is fewer, as improved [25].

Although these standard definitions proposed by the JMP allow comparable data among countries and across time, [22] they may differ from the criteria used by national governments [25]. For example the Government of Bangladesh (GoB) categorises sanitation as hygienic or unhygienic. The GoB definition of hygienic

excludes pit latrines with a slab (Table 1)[27] and allows sharing by a maximum of two households. There is very limited empirical evidence to judge the extent to which improved or hygienic sanitation facilities achieve their purpose in separating faeces from the environment [14, 28, 29].

Few studies have explored the effect on health of access to different levels of sanitation as classified by JMP, [16, 29, 30]. Findings from Indonesia suggested that lack of improved sanitation was associated with higher reported diarrhoea (OR=1.23, 95% CI=1.18-1.29) [16]. A recent systematic review identified 21 studies that compared health outcomes associated with shared versus individual household latrines [29]. However, most of these studies did not adequately address potential confounding and did not allow the effect of different types of shared sanitation to be distinguished. An analysis of Demographic and Health surveys (DHS) from 51 countries found shared, improved sanitation facilities to be associated with adverse health outcomes [30]. However, this finding was not consistent across all countries, suggesting that environmental, social and economic contexts are also important. There is evidence from a small number of observational studies that access to flush or pour flush latrines connected to a piped sewer system or septic tank or pit and composting latrines are associated with lower risk of diarrhoea [31-35]. However, from these studies it is not known whether pit latrines with a slab (improved, as defined by the JMP) provide similar protection from diarrhoea.

Safe disposal of faeces is expected to create a barrier to multiple faeco-oral disease transmission pathways [36]. However there is limited evidence about the relative impact of improved and unimproved sanitation (JMP definition) on specific transmission pathways. [37-40]. The current approaches to measure level of environmental exposure to faecal contamination includes sampling for contamination in drinking water [37-39, 41-43], on hands [39], and on household surfaces[37, 40]. However most of these studies did not use the JMP definition or had limited sample size.

Toys used by young children may have a high level of faecal contamination and play an important role in diarrhoeal disease transmission [44-47]. Children are

more likely to be exposed to contamination on toys in comparison to other surfaces and fomites. Hands may be a closer indicator of level of contamination that the child may encounter. However, hand contamination [48] data are likely to be more variable because of variation in handwashing practices. Compared to hands, toy balls are less subject to washing. Toy balls might be more directly exposed to the household environment than stored water. As a result, the contamination level on the toy ball (the sentinel toy) might be a useful indicator of a child's exposure to household faecal contamination [49]. The sentinel toy method has been used in previous studies of sanitation in Bangladesh [49] and in India [50]. While these studies demonstrated the feasibility of using toy balls as a measure of household faecal contamination, sanitation was not categorised using the JMP definition.

A study conducted in Peru found that improved sanitation, as defined by the JMP (MDG definition), was associated with lower levels of faecal indicator bacteria (*E. coli*) [51] in toys compared to households that lacked improved sanitation. A second study conducted in Honduras also found that households with improved latrines had lower levels of total coliforms [52] on toys. However these studies had limited sample size and so could not assess the effect of a range of confounding variables that may affect the association between faecal contamination and sanitation access.

In this study we assessed the association between sanitation facility type and microbial faecal contamination of the household environment. We assessed faecal contamination using the sentinel toy method where by an identical toy ball (the 'sentinel toy') was given to a child in each participating household and microbial contamination of the balls was subsequently measured.

3.6 Methods

An observational, cross-sectional study was conducted between September and October 2013, in rural areas of Mymensingh and Narshingdi districts of Bangladesh. The study was conducted in villages that were participating in the Sanitation, Hygiene Education, and Water supply in Bangladesh (SHEWA-B) health impact study described elsewhere [53].

3.6.1 Household selection

First a list of study villages enrolled in the SHEWA-B health impact study situated in Mymensingh and Narshingdi districts was collected. Using the list a simple random sample of 46 villages was selected using the random number generator in Microsoft Excel. Fieldworkers identified 10 households in each village by using a random walk algorithm. A household was considered eligible if it included a child aged between 6 and 24 months residing at the house (target child) on the day of the visit, had no more than one latrine and was more than 50 meters from any other selected household. Field workers entered the village and identified the beginning of its main road by asking the local inhabitants. From the starting point they searched for the closest eligible household. After selecting the first study household they looked for the next eligible household. The distance between households was measured using a handheld global positioning system (GPS) unit “Garmin Etrex legend H” (GARMIN)[54].

3.6.2 Data and sample collection

Data were collected using a questionnaire survey and environmental spot-check. To assess faecal contamination of household environments the enumerators also collected microbiological samples. These methods are outlined below.

3.6.2.1 Training of field staff

All enumerators received seven days training on overall study objectives; study protocol; consent process; interview and spot-check techniques; use of data collection instruments; collection and handling of microbiological samples; and quality control approaches. The training also included practice data and microbiological sample collection in the field followed by feedback session.

3.6.2.2 Questionnaire survey

The enumerators used a verbally administered, structured questionnaire survey to collect information from the primary caregivers (usually the mothers) of the target children. The initial questionnaires were developed based on the study research questions and directed acyclic graph developed for the study. The questionnaire was then reviewed by one of the authors (AB) as a quality assurance

procedure including checking for ambiguous or potentially leading questions. The questionnaire included questions about household possessions, parental education, water, and sanitation and hygiene behaviour. The questionnaire was developed in English and then translated in Bengali. Based on the questionnaire a data collection application was developed to collect data using hand held computers. The questionnaire and the data collection application was pilot tested in the field for comprehensibility prior to final data collection. Questions were amended, reworded or replaced following piloting. The data collection application was then updated based on the changes in the questionnaire and feedback on the application from the pre-testing.

3.6.2.3 Environmental spot-check

The environmental check included a visual inspection of the house and compound. A compound in rural Bangladesh is comprised of a few households, often owned by members of an extended family who usually share a yard and water and sanitation facilities. The enumerators conducted visual inspections of water, sanitation and hygiene related infrastructure using a checklist. The enumerators recorded the features related to infrastructure and cleanliness at the time of visit. They also visually checked around the house and compound for presence of animal and human faeces and recorded the number and type of faeces observed. The field workers inspected the hands and nails of the target child for visible dirt.

3.6.2.4 Microbiological sample collection

3.6.2.4.1 Sample collection

Fieldworkers, trained in collection and handling of microbiological samples, supplied an identical, sterile, rubber toy ball (sentinel toy ball) with a 20 centimetre circumference (Picture 3.1) to the target child in every study household. The primary caregiver was told that the child should be allowed to play with the toy ball in his/her usual play



Picture 3.1: Sentinel toy ball .

sites and with his/her usual playmates. The fieldworkers returned to the households approximately 23 to 25 hours after supplying the toy balls. They rinsed the balls in a Whirl-pak bag (19×38 cm) filled with 200 ml of Ringer's solution for 30 seconds [49]. The field workers transported the samples to the Environmental Microbiology Laboratory of icddr,b within 15-18 hours of collection, maintaining a temperature of 4–10 °C in a cool box.

3.6.2.4.2 Enumeration of faecal coliforms

The samples were stored at 2-8°C and were analysed by a microbiologist within 24 hours of collection to detect faecal coliforms. Five millilitres (ml) of the recovery medium that bathed the toy ball was collected and filtered through a 0.22 µm Millipore (Billerica, MA) membrane filter. The membrane filter was then placed on to modified faecal coliform (mFC) agar plates. The plates were incubated at 44.5 ± 0.2°C for 22-26 hours and the blue and greenish-blue coloured colonies on the mFC agar were then counted as presumptive faecal coliforms following standard procedures [55, 56].

If no colonies were found, 50 ml of recovery media was filtered on the following day from the stored sample and the culturing process was repeated. If the characteristic colony counts from the 1st day were more than 500 per plate, 5 ml of 10 times diluted sample was taken and the filtration and culturing process was repeated [57]. Hundred µl of original, 10 times diluted and 100 times diluted samples were also inoculated onto mFC media following the drop plate technique to quantify samples from which the colonies on the membrane filters from the 2nd day also appears too numerous to count. The results were expressed as colony forming units (CFU) per 200 ml of recovered media that bathed the toy ball.

3.6.2.5 Quality control/Quality assurance

During development of the data collection application, auto skips were included in appropriate places. Validation rules were set-up to prevent incorrect data entry. Options were included to notify the user should they try to input incompatible data. Manual typing was minimized by setting choice list for responses.

Options for reviewing the full questionnaire and answer at a glance through data collection app was provided.

All the completed questionnaires were checked by the enumerators for completeness before leaving the household. The field supervisors reviewed all the data on the day of collection and discussed any ambiguities with the enumerator concerned. The first author randomly checked data from at least one household collected by each enumerator in 50% (20/40) of the village clusters, to check for completeness of data and provided feedback on the quality of the data. In each village cluster the field supervisor observed the data collection process in a random selection of at least 5% of households (6 HH per village) and conducted repeat interviews in a (different) random selection of 5% of households (6 HH per village), making sure that the data collection of each enumerator was assessed at least once in each village cluster. The field supervisor visited the sanitation facilities in all the study households and cross checked with the enumerators to make sure the sanitation facilities were coded with minimal error. The first author visited 50% (20/40) of the village clusters to monitor quality of data. In each of these villages the data collection process was observed in a random selection of at least 5% of households (6 HH per village) and a repeat spot-check was conducted in a (different) random selection of at least 5% of households (6 HH per village), making sure that the data collection of each enumerator was assessed at least once in each village.

The first author performed random observation of the microbial sample collection process in at least 25% (3/10 HH per village) in 50% (20/40) of the village clusters to check for adherence to protocol. One field blank per 9 samples was collected to ensure sample rinse bags are free of indicator organisms and were not getting contaminated during the field sampling process. In the laboratory the samples were received and checked for the physical quality of sample. Every 10th sample was run in duplicate. Test negative controls were tested for contamination for each set of agar media. For mFC agar *Escherichia coli* ATCC-13706 is used as positive control and *Staphylococcus aureus* ATCC-25923 is used as negative control. Every day laboratory blanks were run to check for quality of laboratory methodology. The laboratory techniques were observed by the first author once every week to make

sure that the protocol for processing in the laboratory was followed. The bacterial counts were reviewed once every week to look for any outliers.

3.6.3 Human subject protection

The study protocol was approved by the Ethical Review of icddr,b and the London School of Hygiene and Tropical Medicine (LSHTM), United Kingdom. Written, informed consent was taken from the primary caregiver of the child.

3.6.4 Sample size calculation

Results of a pilot study conducted in 20 households found that in households with access to improved latrines the mean faecal coliform count was 2.33 log₁₀ CFU per toy ball. The ratio of households with unimproved latrines to households with improved latrines was expected to be 1.5 in the sample selected regardless of the latrine access status based on an earlier study in a similar setting [53]. Assuming a design effect of 2, comparing 180 households with improved latrines and 270 household with unimproved latrines with at least 80% power, the study was estimated to be able to detect a minimum difference of -0.65 mean log₁₀ CFU of faecal coliforms per sentinel toy ball. Allowing for a 2% loss to follow up the necessary sample size was estimated to be 460 households.

3.6.5 Data analysis

Sanitation technologies were first categorised as: a) improved (flush/pour flush latrines and pit latrines with slab as in table 1), b) unimproved (pit latrines without slab, hanging latrines, flush/pour flush latrines connected to open water bodies) and c) no facility, following the JMP categorisation [58]. Sanitation access was then categorised considering technology type as well as sharing status, as a binary variable following 1) definition used for MDG: referred to as improved-MDG and unimproved MDG; 2) post-2015 JMP definition proposed for the SDGs: referred to as improved-SDG and unimproved-SDG; and 3) GoB definition referred to as hygienic and unhygienic (Table 1). In all 3 definitions “no facility” was considered as unimproved/unhygienic.

Principal component analysis (PCA) with 23 household characteristics was used to assess household wealth [59, 60] (Table 2), excluding water and sanitation. The means, frequencies and score coefficients were calculated and the correlation matrix of 23 variables was used to calculate sample weights [59, 61, 62].

During the interview, if the data collectors observed no visible dirt on the hands and nails of the target child, the child was considered to have clean hands. During the spot-check, a household was considered to have a clean latrine if the enumerators found no visible faeces on the slab/floor and pan of the latrine. Disposal of faeces of children under 3 years of age was categorised as safe (defecation into a latrine, disposal of stool into a latrine or buried) and unsafe as proposed by JMP [63].

If the faecal coliform concentration was zero it was replaced with 0.5 (half the detection limit) and then faecal coliform concentrations were transformed using logarithm to the base of 10. The difference in \log_{10} transformed arithmetic mean CFU of faecal coliforms comparing households with different types of sanitation using a linear regression model was calculated. To account for clustering effect at village level a generalised least squares (GLS) random-effects model was used that explicitly allowed the average outcome to vary between village clusters [64-68].

Univariable analyses was, conducted to estimate the crude effect of the primary exposure variables and potential confounding variables on the main outcome (faecal coliform count) adjusting for the effect of village level clustering. The multivariable analysis included the primary exposure, primary outcome and potential confounders. A causal diagram was developed to decide which variable should be included as a potential confounder, excluding variables on the same causal pathway as the exposure variables (Figure 2) [68, 69]. All the potential variables that were associated with the exposure and the outcome in the univariable analysis were included in the final multivariable model. The models were tested for normality of residuals and homoscedasticity. We implemented three multivariate models, one for each of the three definitions of sanitation type (Table 3.1) as primary exposure. Two separate models were also implemented to understand the sanitation factors

associated with faecal contamination among subgroup of households that had access to an improved sanitation technology (ignoring sharing).

3.7 Results

Out of 468 households visited eight were excluded because of having more than one latrine. Out of 460 households enrolled for the study the sentinel toys from six households could not be sampled. Data are therefore presented from 454 (99%) households.

Among the 454 households there were on average 5.6 persons per household with on average 1.3 children under the age of 5 years. The majority of households (75%) owned poultry, 41% owned a cow and 23% owned a goat. Most of the households (95%) reported having access to a latrine. Among them, 53% (n=230) reported sharing the latrine with at least one other household. On average a latrine was used by 1.99 households or 7.6 individuals (Table 3.2).

Only 22% of households reported disposing of faeces of children under three years of age in a latrine. Enumerators observed human faeces around the house in 13% of the households. Among the 409 (90%) households with access to a latrine with a slab, enumerators classified 35% of the latrines as clean (Table3.3).

The most common type of latrine was a pit latrine with a slab but no water-seal (n=189, 42%). About half (51%) of the 230 households that reported using a shared latrine reported sharing the facility with only one other household. Only eight households shared a latrine among more than five households.

Less than half (45%) of the households accessed improved sanitation technology and 25% of the households visited had access to individual, improved sanitation (MDG definition). Using the definition of sanitation type as proposed for the SDGs, 205 households (45%) had access to improved (SDG) sanitation shared by a maximum of five households. One in five (n=85, 19%) households had access to hygienic sanitation (GoB) used by a maximum of two households (Table3.3).

3.7.1 Faecal contamination of toy balls

Among the 454 sentinel toys sampled, 49 (11%) of the samples were below the detection limit for faecal coliforms. On average there were 2.09 (SD=1.37) log₁₀ CFU/toy ball of faecal coliforms with a median of 2.08 log₁₀ CFU/toy.

The levels of faecal coliforms in samples collected from Narshingdi district were higher than those collected from Mymenshingh district (difference in mean=0.36 log₁₀CFU/toy ball; 95% CI: 0.07, 0.65). With each one hour increase in time of sample collection (as the day progressed) there was 0.17 log₁₀ decrease in level of faecal contamination (Table 3.3 and 3.4).

Samples collected from households belonging to the richest wealth quintile had lower faecal coliform contamination than households from the poorer wealth quintiles. Samples collected from households where the mother had some formal education had lower level of faecal contamination than those households where the mother had no formal education (Table 3.3).

3.7.2 Improved sanitation and faecal contamination

Samples collected from households with access to improved sanitation technology (JMP technology, ignoring sharing) had similar levels of faecal coliforms as those from households with unimproved sanitation. Toy balls from households using shared sanitation facilities had higher levels of faecal coliform contamination than private facilities (unadjusted, difference in mean=0.19 log₁₀ CFU/toy ball; 95% CI: -0.07, 0.45) (Table 3.3).

Toy rinse samples from households with improved individual sanitation (MDG definition) had less contamination with faecal coliforms (mean=1.84 log₁₀CFU/toy ball) than households with unimproved sanitation (difference in mean=-0.36 log₁₀CFU/toy ball, 95% CI: -0.65, -0.07, P=0.02) (Table 3). After adjusting for potential confounders the difference in mean was reduced to 0.31 log₁₀ CFU/toy ball (95% CI: -0.61, -0.01), and the strength of statistical association became weaker (P value=0.04) (Table 3.4).

The level of faecal contamination in toys was similar in households with improved sanitation (SDG definition) used by a maximum of five households and those with unimproved sanitation (difference in mean= -0.07 log₁₀CFU/toy ball, 95% CI: 0.33, 0.18) (Table 3). In multivariable analysis the results remained similar (Table 3.4).

3.7.3 Hygienic sanitation (GoB definition) and faecal contamination

Households with access to hygienic sanitation (GOB definition) used by a maximum of two households had less faecal coliform contamination (difference in mean=-0.45, 95% CI -0.77, -0.13; P<0.01) than households with unhygienic or no access to latrines (Table 3). Access to hygienic sanitation remained associated with less faecal coliform contamination (difference in mean= -0.34 log₁₀CFU/toy ball; 95% CI: -0.68, 0.01) after adjusting for all the confounding variables. The reduction was statistically significant (P value=0.05) (Table 3.4).

3.7.4 Sanitation characteristics and faecal contamination (sub group analysis)

Households with improved flush/pour flush latrines had less (statistically significant) faecal contamination than those with improved but non-flush technologies (difference in mean -0.45, 95% CI: -0.81, -0.09, P value=0.02). In the adjusted analysis the difference of mean was reduced and the statistical evidence weakened considerably (difference in mean -0.27, 95% CI: -0.67, 0.13, P value=0.19) (Table 3.5).

Toy ball samples collected from households with private improved sanitation had less faecal contamination than those with access to improved sanitation shared by 2-5 households (Difference in mean -0.49 log₁₀ CFU/toy ball, 95% CI: 0.13, 0.85, P=0.01). In the adjusted analysis the difference in mean was somewhat smaller and the strength of association became weaker (difference in mean -0.45 log₁₀CFU/toy ball; 95% CI: -0.05, 0.75; P=0.08) (Table 3.5).

Toy ball samples from households with access to improved and clean latrines had less faecal contamination (difference in mean -0.36 log₁₀ CFU/toy ball; 95% CI: -

0.73, -0.00; P=0.05) compared to dirty improved latrines. In the adjusted analysis the difference in faecal coliform contamination changed slightly with slightly weaker strength of association (difference in mean -0.38 log₁₀ CFU/toy ball; 95% CI: -0.77, 0.02; P=0.06) (Table 3.5).

Toy ball samples collected from households with private flush/pour-flush latrines had less faecal contamination (difference in mean -0.69 log₁₀ CFU/toy ball; 95% CI: -1.06, -0.31), compared to those with access to shared flush/pour-flush or non-flush latrines. In multivariate analysis adjusting for potential confounders the difference in mean was slightly smaller (difference in mean=-0.55 log₁₀ CFU/toy ball; 95% CI -1.00, -0.11; P=0.02) yet statistically significant (Table 3.5).

3.7.5 Faecal contamination of toy balls and other household characteristics

Households in which enumerators observed any goat faeces on the household premises had more contamination with faecal coliforms than those without (difference in mean 0.36 log₁₀ CFU/toy ball; 95% CI: 0.06, 0.67; P value=0.02). In multivariate analysis adjusting for potential confounders the difference in mean was slightly smaller (difference in mean=0.31 log₁₀ CFU/toy ball; 95% CI: 0.02, 0.61; P=0.04) yet statistically significant (Table 4). Households in which enumerators observed more than ten piles of cow dung on the household premises had more contamination with faecal coliforms than those with no cow dung at the time of visit (difference in mean=0.36 log₁₀ CFU/toy ball; 95% CI: -0.05, 0.77; P value=0.08). In multivariate analysis adjusting for potential confounders the difference in mean was slightly bigger (difference in mean=0.40 log₁₀ CFU/toy ball; 95% CI: 0.00, 0.79; P=0.05) yet statistically significant (Table 3.4).

Toy ball samples collected from households with a water drainage system had less contamination than those without, (difference in mean=-0.24 log₁₀ CFU/toy ball; 95% CI: -0.50, 0.01; P=0.06) (Table 3.3). In multivariate analysis adjusting for potential confounders the difference in mean was slightly bigger (difference in mean=-0.32 log₁₀ CFU/toy ball; 95% CI: -0.58, -0.06; P=0.02) and with greater strength of association it was statistically significant (Table 3.4).

Presence of a convenient handwashing place with soap and water was not associated (small and statistically insignificant reduction) with faecal contamination of toy ball (Table 3.3). In households in which the target children's hands and nails looked visibly clean, the toy balls had less faecal contamination than those with visibly dirty hands (difference in mean=-0.35 log₁₀ CFU/toy ball; 95% CI: -0.69, -0.01; P=0.05) (Table 3.3). In multivariate analysis adjusting for potential confounders the difference in mean was slightly bigger (difference in mean=-0.26 log₁₀ CFU/toy ball; 95% CI: -0.06, 0.09; P=0.15) but the difference was not statistically significant (Table 3.4).

3.8 Discussion

In this observational study we assessed the association between sanitation type and microbiological faecal contamination. We found no difference in indicators of faecal contamination on sentinel toys between households with access to improved-SDG and unimproved sanitation. When shared facilities were excluded from the definition of improved sanitation (MDG definition), access to improved sanitation was associated with lower levels of faecal contamination compared to households with access to unimproved sanitation after adjusting for potential confounding factors. Although 0.05 log₁₀ CFU/toy ball difference in faecal contamination observed in this study was due to confounding factors there were still statistically significant differences in levels of household faecal contamination that could be due to the protective effect of access to improved-MDG sanitation.

Since this was an observational study the findings are prone to confounding due to important household characteristics. In this study a directed acyclic graph was developed to identify the potential confounding factors (Figure 3.1). The confounding factors considered were presence of animal faeces, presence of appropriate water and solid waste disposal system, visible cleanliness of hands and nail (proxy for hand hygiene), household wealth, mother's education, study site and time of data collection among others. Findings from observational studies suggest that washing hands with soap is effective in removing microorganisms from hands [39, 70-72] and there for an important determinant of household faecal

contamination. In this study presence of soap and water at a handwashing station was not associated with faecal contamination of toy ball in the univariable analysis. So this was not included as a potential confounder to be included in the multivariable analysis. But since visible cleanliness of hand was associated with faecal contamination of hand, this was used as a proxy for hand hygiene and included in the multivariate analysis as a potential confounder.

In this study sanitation was measured before faecal contamination. The association of improved sanitation (MDG) with faecal contamination in the unadjusted analysis is consistent with findings from earlier studies conducted in Honduras [52], Peru [51], and Bangladesh [38, 49]. Although in contrast, in a study conducted in Tanzania improved sanitation was not found to be associated with faecal indicator bacteria level on hand-contact surfaces in latrines [40]. However, the geographical context was different and most importantly the exposure pathway measured was different. Studies conducted in Kenya and Indonesia that attempted to adjust for the effect of several confounding factors found improved sanitation (MDG) to be associated with lower levels of both faecal indicator bacteria [39] and diarrhoea [16].

However in this observational study we cannot establish causality because there are many unmeasured household and child characteristics that may influence faecal contamination. In this study lower faecal contamination of the toy ball was also associated with absence of animal faeces, mother's education, and presence of appropriate water drainage and study site. In this study wealth was associated with lower faecal contamination of the toy ball in the unadjusted analysis, so is an important confounder. Therefore wealth was included in the multivariate analysis to adjust for its effect. But faecal contamination of the household environment is actually influenced by underlying, unmeasured, broader, social, economical, cultural and environmental differences [30, 73]. The confounding factors considered in this study are only proxy for these underlying unmeasured broader factors. It is possible that access to an improved latrine and absence of animal faeces, mother's education, and presence of appropriate water drainage are all proxy measures of these unmeasured differences and hence associated with faecal contamination. A

two-arm, randomised, controlled trial in which households in one arm receive improved sanitation and households in the other arm receive unimproved sanitation could help better understand this issue.

Our data suggest that the observed differences in indicators of faecal contamination on sentinel toys between households with access to improved-MDG and unimproved sanitation may be attributed to factors related to use rather than the sanitation infrastructure. When we categorised latrines based on technology alone, ignoring sharing, and access to latrines considered as improved was not associated with any reduction in household faecal contamination in comparison to those households with access to unimproved sanitation. There can be several possible explanations for this finding.

First it is possible that the sanitation facilities considered as improved by the JMP are not any more effective in confining faeces than the facilities considered as unimproved. The main infrastructural difference between improved and unimproved sanitation facilities is the presence of a slab. Even in the presence of a slab flies can act as a vector to transmit organisms originating in the faeces and contaminate household environment [74]. In our subgroup analysis, improved sanitation with a water-seal was associated with a greater reduction in faecal contamination than improved sanitation with a slab but without a water-seal. Presence of a water-seal may prevent flies breeding within the latrine and may reduce fly numbers and thereby provide protection from one route of faecal contamination. Our findings are in line with those from previous studies conducted in Ghana where households with a dry pit latrine or no latrine had higher odds of having *E. coli* contamination of stored water than those with a water-seal latrine, even after adjustment for other sanitation related and socio-demographic characteristics [43]. There is also evidence that access to improved sanitation with a water-seal is associated with less diarrhoea morbidity [34, 35] [31]. This may suggest that access to sanitation facilities with a water-seal provides better protection from faecal contamination than non-flush latrines. Alternatively, the difference observed in this observational study could be due to confounding by socio-economic status.

Second, In these settings a household could be exposed to faecal contamination even in the presence of a sanitation facility that successfully separates human faeces from the environment due to other routes of contamination such as unsafe disposal of child's faeces [40, 75], lack of exclusive use of sanitation facilities, lack of improved sanitation facilities in the neighbourhood, and the presence of animal faeces. Moreover lack of proper management of faecal sludge from onsite sanitation facilities may also contribute to contamination that access to household sanitation cannot prevent. This may suggest that provision of sanitation infrastructure alone as a strategy to reduce household faecal contamination may not be sufficient. In the presence of a sanitation system that is effective in separating human faeces from human contact hands can still be contaminated with faeces during anal cleansing. So washing hands with soap is necessary to reduce household faecal contamination.

When a subgroup analysis was conducted among households with access to improved sanitation, it was found that sharing was associated with higher levels of faecal contamination although with small sample size in the subgroup the statistical evidence was weak. Previous studies have also reported adverse health outcomes associated with shared sanitation facilities [29, 30]. While in contrast, shared sanitation was found to be protective against faecal contamination of hand-contact surfaces within a latrine in rural Tanzania [40]. However, in this study the mechanism by which sharing a latrine prevents faecal contamination is unclear. The findings related to the effects of shared sanitation in previous studies are inconsistent and context-specific [30, 76].

Shared sanitation facilities may not be as effective in separating faeces from the environment as individual latrines for several reasons. First, shared facilities may be dirtier and may wear out or break more quickly than private latrines due to higher use rates. In our study shared facilities were more likely to have faeces present on the latrine floor (data not shown). However our data suggest that sharing may lead to higher faecal contamination independent of cleanliness of latrine suggesting that other mechanisms may also play an important role.

Second, the need to share a latrine may result in lower rate of use per user. As a result some users may intermittently use suboptimal sanitation including open defecation. Moreover, families who report sharing a facility may not actually have access to a latrine but because of social desirability they report using their neighbour's latrine. As a result, when shared facilities are grouped together with individual facilities the protective effect of improved sanitation technologies is diluted.

Third, people who use share facilities are likely to be poorer and headed by people with no formal education [77]. Socioeconomic status and lack of parents formal education has been linked with higher level of faecal contamination in this study as well as in a previous study [49]. Although in our study sharing was associated with higher faecal contamination independent of wealth status and mother's education there may be residual confounding due to unmeasured social, environmental and cultural factors that may influence faecal contamination in this context. The mechanism of how shared sanitation increases health risk needs to be understood in more detail in future research.

Our estimated minimum detectable difference in mean faecal coliform counts used for the power calculation was higher than the difference we found from our data. This suggests that our study had low statistical power. Nevertheless, the fact that access to individual improved sanitation is associated with lower levels of faecal contamination even after adjusting for common confounding, which is also consistent with findings from previous studies, may suggest an independent link between sanitation type (MDG) and faecal contamination.

In this study there was a trend of reduction of faecal coliforms as the day progressed (Table 3.4). This could have been due to increasing sunlight causing sunlight induced die-off of pathogens in the environment as well as on the toy ball [78]. It is also possible that as the day progressed the children played less with the toy. It is important to note that this could be a potential confounding factor in the association between sanitation type and faecal contamination of the toy ball. This is why this factor was included in the multivariate analysis.

An important limitation of this study is the use of faecal indicator bacteria to assess faecal contamination as they are not human specific. This random measurement error could introduce bias due to misclassification of the outcome. As a consequence the confidence intervals of the estimates presented are likely to be wide making the results less likely to receive statistical support even if in reality a difference exists [79]. Further study with a larger sample size could increase our understanding of the role of improved sanitation in reducing household faecal contamination [79]. Using molecular markers of human specific pathogens as indicators of faecal coliform could help reduce this bias in future studies. Presence of faecal indicator bacteria does not necessarily mean health risks. However there is evidence to suggest that presence of faecal coliforms in environmental samples may be associated with diarrhoeal illness [44-46, 80-83]. In this study the presence of faecal coliforms was associated with sanitation type after adjusting for the effect of presence of animal faeces in consistence with findings from similar settings [38, 84].

The findings from this observational study suggest that improved sanitation used by individual households may be better in reducing household faecal environmental contamination than shared facilities. Sanitation facilities with a water-seal might also be better in reducing faecal contamination of the household environment than dry pit latrines with a slab but no water-seal. However, further studies with experimental design and larger sample sizes are required to understand if this association is causal. In addition to sanitation infrastructure, cleanliness of latrines should be considered an important indicator for sanitation monitoring. Even in the context of rural areas in which sanitation facilities are shared by acquaintances shared facilities may be dirtier than individual latrines. An intervention to improve and monitor latrine cleanliness particularly for shared sanitation may be useful. Shared facilities may pose health risks due to many factors other than cleanliness. Further studies are needed to better understand the mechanism by which shared facilities pose health risks if any. Moreover, to reduce household faecal contamination washing hands with soap after anal cleansing has to be ensured.

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Table 3.1: Comparing definitions of sanitation proposed by WHO/UNICEF Joint monitoring programme for water supply and sanitation (JMP) and the Government of Bangladesh (GoB) [25, 27]

Latrine characteristics	Improved	Improved		Hygienic
	JMP	MDG	SDG*	GOB
Sanitation technology				
Flush or pour-flush latrine to Sewerage pipe/Septic tank/Pit	×	×	×	×
Pit latrine with slab and lid/flap	×	×	×	×
Ventilated Improved Pit latrine	×	×	×	×
Composting latrine	×	×	×	×
Pit latrine with slab	×	×	×	
Number of households using latrine facility	Not considered	1	Up to 5	Up to 2
*As a part of the process of identifying targets and indicators for global monitoring post-2015 there was proposal to change the definition of improved sanitation to include share sanitation of otherwise improved technology as improved [25]. This is why this definition is referred to as SDG definition				

Figure 3.1: Directed acyclic graph showing the variables that were measured and included in the multivariable analysis

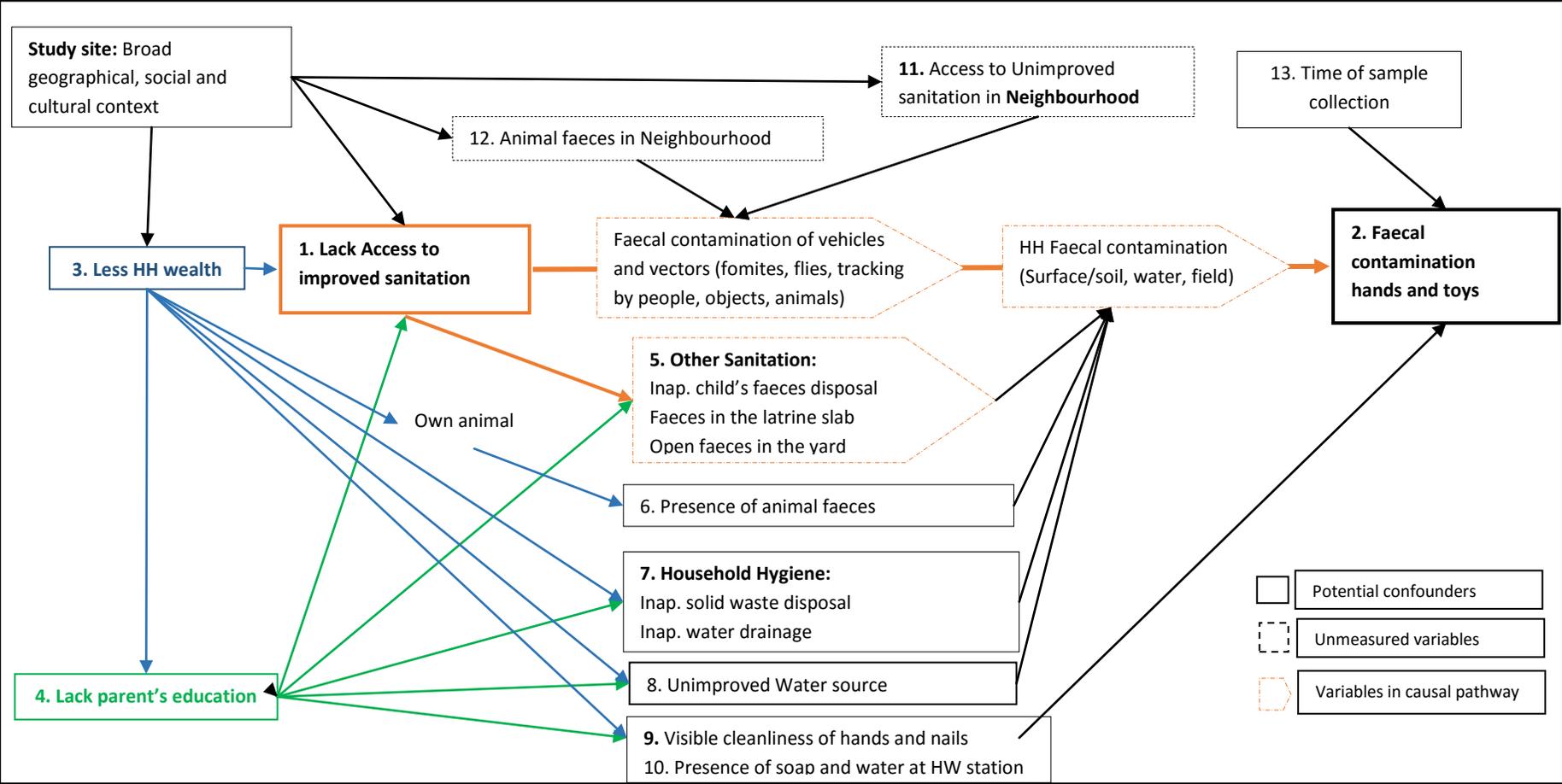


Table 3.2: Household characteristics (n=454)¹

Variable (n)	n*	Percent or mean
Mean Number of HH residents	454	5.6
Mean Number of children age <5 y	454	1.3
Mother with no formal education	78	17%
Father with no formal education[†]	135	30%
Father's occupation		
Farmer	103	23%
Day labour, Rickshaw puller	100	22%
House construction		
Tin roof [†]	438	96%
Cement floor [†]	73	16%
Brick walls [†]	69	15%
Mean number of rooms [†]	454	2.0
Household with electric connection[†]	309	68%
Proportion who owned		
House [†]	430	95%
Wardrobe [†]	189	42%
Bicycle [†]	109	24%
Mobile phone [†]	378	83%
Black and white television [†]	36	8%
Colour television [†]	109	24%
Sewing machine [†]	52	11%
Refrigerator [†]	44	10%
Motor cycle [†]	22	5%
Mean number of items owned		
Tables [†]	454	1
Chairs [†]	454	2.2
Watches/clocks [†]	454	0.6
Beds [†]	454	0.9
Inexpensive sleeping cots [†]	454	1.3
Acres of agricultural land [†]	453	0.52
Acres of non-agricultural land [†]	451	0.13
Owned any domestic animal	375	83%
Owned any goat	104	23%
Owned any cow	186	41%
Owned any poultry	341	75%
Access to improved water source for drinking	454	100%
Have access to a latrine	431	95%
Have access to a shared latrine	230	53%
Mean number of household sharing a latrine facility	431	1.99
Mean number of individuals sharing a latrine facility	431	7.6
Ownership of latrine (n=437)		

¹ If sample size is different it is presented next to the variable in the table

Individual ownership	247	57%
Shared ownership	114	26%

* Number with presented category

† Included to calculate wealth quintile.

Table 3.3: Univariable relationship between water, sanitation, and hygiene related variables and log₁₀ transformed faecal coliform CFU/toy ball (n=454)

Exposures	n* (%)	Mean (SD)	Median	Diff. in mean [†] (95% CI) [†]	P value [†]
<i>Sanitation type</i>					
JMP technology type					
Improved	205 (45)	2.06 (1.33)	1.90	-0.06 (-0.32, 0.20)	0.64
Unimproved	226 (50)	2.10 (1.41)	2.08		
(Baseline)	23 (5)	2.23 (1.45)	2.08	0.09 (-0.49, 0.69)	0.75
Open					
MDG					
Improved	113 (25)	1.84 (1.23)	1.60	-0.36 (-0.65, -0.07)	0.02
Unimproved	341 (75)	2.17 (1.41)	2.20		
SDG					
Improved	205 (45)	2.06 (1.33)	1.90	-0.07 (-0.33, 0.18)	0.58
Unimproved	249 (55)	2.12 (1.41)	2.08		
GOB					
Hygienic	85 (19)	1.76(1.21)	1.60	-0.45 (-0.77, -0.13)	<0.01
Unhygienic	369 (81)	2.17 (1.40)	2.08		
Sharing status‡ (N=431)					
Shared	230 (53)	2.17 (1.45)	2.08	0.19 (-0.07, 0.45)	0.15
Individual	201 (47)	1.98 (1.28)	1.90		
Number of person using a sanitation facility (N=431)‡					
Up to 6	218 (51)	2.18 (1.42)	2.14	0.16 (-0.10, 0.42)	0.22
More than 6	213 (49)	2.01 (1.31)	1.90		
Increase in number of person using the sanitation facility ‡ (N=431)				0.00 (-0.3, 0.04)	0.83
<i>Other sanitation and hygiene characteristics</i>					
<3 Child faeces disposal (n=454)					
Safe	98 (22)	1.95 (1.35)	1.90	-0.23 (-0.54, 0.07)	0.14
Unsafe	356 (78)	2.13 (1.38)	2.08		
Cleanliness of sanitation facility (N=409)					
Clean	142 (35)	1.94 (1.21)	1.90	-0.25 (-0.53, 0.03)	0.08
Dirty	267 (65)	2.16 (1.45)	2.08		
Presence of open human faeces in/around household premises					
Presence of any goat faeces	60 (13)	2.38 (1.52)	2.08	0.34 (-0.03, 0.71)	0.07
Presence of any goat faeces					
Number of cow dung pile					
No cow dung	103 (23)	2.36 (1.46)	2.38	0.36 (0.06, 0.67)	0.02
No cow dung	264 (58)	2.04 (1.38)	1.90	0	
1 to 10 cow dung	136 (30)	2.08 (1.37)	2.20	0.04 (-0.25, 0.32)	0.79
More than 10 cow dung	54 (12)	2.37 (1.35)	2.45	0.36 (-0.05, 0.77)	0.08

Presence of any poultry faeces						
No faeces	92 (20)	1.97 (1.23)	1.90	0		
1 to 10 piles	224 (49)	2.12 (1.46)	2.14	0.15 (-0.19, 0.49)		0.38
More than 10 piles	138 (30)	2.13 (1.30)	2.08	0.17 (-0.20, 0.53)		0.38
Visibly clean hands and nails vs. unclean	71 (16)	1.81 (1.34)	1.90	-0.35 (-0.69, -0.01)		0.05
Presence of convenient HW place with soap and water	95 (21)	2.00 (1.19)	1.90	-0.15 (-0.46, 0.17)		0.36
Presence of appropriate water drainage system	261 (57)	1.99(1.36)	1.90	-0.24 (-0.50, 0.01)		0.06
Appropriate Solid waste disposal	11 (2)	1.59 (2.00)	1.90	-0.47 (-0.29, 0.34)		0.26
Other variables						
Wealth quintile						0.02
Lowest	91 (20)	2.22 (1.43)	2.20			
Lower middle	91 (20)	1.98 (1.23)	1.90	-0.24 (-0.65, 0.14)		0.21
Middle	91 (20)	2.42 (1.35)	2.44	0.19 (-0.20, 0.59)		0.34
Upper Middle	91 (20)	2.03 (1.57)	1.90	-0.21(-0.60, 0.19)		0.31
Upper	90 (20)	1.81 (1.22)	1.70	-0.48 (-0.88, -0.08)		0.02
Household belongs to upper wealth quintile						
Yes	90 (20)	1.81 (1.22)	1.70	-0.41(-0.72, -0.09)		0.01
No	364 (80)	2.16 (1.40)	2.08			
Mother with formal education vs. (no formal education)	376 (83)	2.03 (1.36)	1.90	-0.33 (-0.66, 0.00)		0.05
Change in time of data collection by hour as the day progress				-0.17 (-0.27, -0.06)		0.02
Study site (District)						
Narshingdi	238 (52)	2.26 (1.38)	2.20	0.36 (0.07, 0.65)		0.01
Mymensingh	216 (48)	1.90 (1.34)				

* Number with presented category

† Adjusting for clustering at village

‡ Among those who has access to a latrine (N=431)

Table 3.4: Multivariable relationship between water sanitation and hygiene related variables and log₁₀ transformed faecal coliform CFU per toy ball (Total N=454)

Variables (n [†])	A. MDG		B. SDG		C. GOB	
	Diff. mean* (95% CI [‡])	P Value [†]	Diff. mean* (95% CI [‡])	P Value [†]	Diff. mean* (95% CI [†])	P Value [†]
Sanitation type (Improved/hygienic) (113/85) Vs unimproved/unhygienic	-0.31 (-0.61, -0.01)	0.04	-0.01 (-0.26, 0.25)	0.95	-0.34 (-0.68, 0.005)	0.05
Presence of any goat faeces (103) Vs absence of any goat faeces	0.31 (0.02, 0.61)	0.04	0.32 (0.02, 0.62)	0.03	0.30 (0.002, 0.60)	0.05
Presence of cow dung						
No cow dung (264)	-		-			
Up to 10 piles (136)	0.08 (-0.21, 0.36)	0.60	0.09 (-0.20, 0.37)	0.55	0.08 (-0.21, 0.36)	0.60
More than 10 piles (54)	0.40 (0.00, 0.79)	0.05	0.42 (0.02, 0.82)	0.04	0.40 (0.01, 0.79)	0.05
Presence of appropriate water drainage (261) Vs absence of appropriate water drainage	-0.32 (-0.58, -0.06)	0.02	-0.30 (-0.56, -0.04)	0.02	-0.29 (-0.55, -0.03)	0.03
Hands and nails looked visibly clean (71) Vs Hands and nails looked visibly dirty	-0.26 (-0.06, 0.09)	0.15	-0.27 (-0.62, 0.08)	0.13	-0.26 (-0.60, 0.09)	0.15
Household belongs to upper wealth quintile (90) Vs lower wealth quintile	-0.18 (-0.52, 0.16)	0.31	-0.30 (-0.63, 0.03)	0.08	-0.19 (-0.53, 0.15)	0.26
Mother's with form education (376) Vs mothers with no formal education	-0.30 (-0.64, 0.04)	0.08	-0.28 (-0.61, 0.06)	0.11	-0.27 (-0.61, 0.06)	0.11
Change in time of data collection by hour as the day progress	-0.16 (-0.27, -0.06)	0.002	-0.16 (-0.26, -0.05)	0.003	-0.16 (-0.27, -0.06)	0.002

Study site Narshingdi district (238) vs. Mymensingh	0.52 (0.25, 0.78)	<0.01	0.50 (0.23, 0.78)	<0.01	0.52 (0.25, 0.79)	<0.01
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* Difference in mean

† Adjusting for the effect of all the other variables in the model

‡ Number with presented category

Table 3.5: Relationship between sanitation and log₁₀ transformed faecal coliform CFU per toy ball, among households with access to improved sanitation technologies as defined by JMP (N=205) (subgroup analysis).

Sanitation characteristics among household with improved sanitation technology.	n (%)	Descriptive			Univariable*		Multivariable**	
		Mean	(SD)	Median	Difference in mean (95% CI)	P Value	Difference in mean (95% CI)	P Value
Sanitation technologies (n=205)								
Flush/pour-flush	97 (47)	1.83	1.27	1.60	-0.45 (0.81, -0.09)	0.02	-0.27 (-0.67, 0.13)	0.19
Non flush/pour-flush [‡]	108 (53)	2.27	1.34	2.20				
Sharing status (n=205)								
Private/individual	113 (55)	1.84	1.23	1.60				
Shared by 2-5 HH	92 (45)	2.33	1.39	2.30	0.49 (0.13, 0.85)	0.01	0.35 (-0.05, 0.75)	0.08
<3 Child's faeces disposal practices								
Safe	54 (26)	2.03	1.27	1.90	-0.05 (-0.46, 0.36)	0.82	0.19 (-0.23, 0.61)	0.37
Unsafe	151 (74)	2.07	1.35	1.90				
Cleanliness of latrine								
Clean	92 (45)	1.87	1.08	1.90	-0.36 (-0.73, -0.00)	0.05	-0.38 (-0.77, 0.02)	0.06
Dirty	113 (55)	2.22	1.48	2.08				
Presence of open faeces in and around HH								
Open faeces	20 (10)	2.21	1.49	1.90	0.15 (-0.46, 0.77)	0.62	0.10 (-0.53, 0.72)	0.76
No open faeces	185 (90)	2.05	1.31	1.90				
Considering technology and sharing status								
Individual flush/pour flush	66 (32)	1.60	1.14	1.60	-0.69 (-1.06, -0.31)*	<0.001	-0.55 (-1.00, -0.11) [§]	0.02
Shared flush/pour flush or Non flush	139 (68)	2.28	1.34	2.20				

* Adjusting for clustering at village

† Adjusting for all other variable in the table as well as presence of cow/goat, visible cleanliness of hands, wealth, mothers education and study site/district, time of sample collection, water waste disposal.

‡ This includes pit latrine without slab which is considered improved according to JMP but unhygienic technology according to GOB.

§ Separate multivariate model Adjusting for child, faeces disposal, cleanliness of latrine, presence of open faeces, presence of cow/goat, visible cleanliness of hands, wealth, mothers education and study site/district, time of sample collection, water waste disposal.

Chapter 4: Effect of neighbourhood sanitation coverage on faecal contamination of the household environment in rural Bangladesh.

4.1 Introduction to the chapter

This chapter explores the role of neighbourhood sanitation coverage on faecal contamination of the target household as measured through toy ball and children's hands. This chapter includes a ready for submission manuscript, which describes some of the main results.

4.2: Role of the authors in the research paper

Tarique M.N. Huda (TH): TH is the first author of the research paper. He had the primary role of designing the study, overseeing the field work, cleaning and analyzing the data, interpreting the results and drafting the manuscript.

Wolf-Peter Schmidt (WS): WS contributed to the conception of the study, defining the research questions, provided guidance on design of the study; reviewed the data analysis and the draft manuscript

Amy J. Pickering (AP): AP provided guidance on the microbiological sample collection protocol; provided feedback on analysis and interpretation of the data and reviewed the draft manuscript.

Leanne Unicomb (LU): LU provided guidance during data collection in Bangladesh and reviewed the draft manuscript

Zahid H. Mahmud (ZM) and Md. Sirajul Islam: ZM and SI reviewed the protocol for the microbiological sample processing in the lab, helped with supervision of the sample processing in the lab and reviewed the draft manuscript.

Stephen P. Luby (SL): SL provided guidance on design of the study and reviewed the draft manuscript.

Adam Biran (AB): AB was the executive author for this manuscript. He contributed to the conception of the study, contributed in defining the research questions, approved the overall study design, data/sample collection protocols and reviewed the draft manuscript.

4.3 Research paper cover sheet

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

SECTION A – Student Details

Student	Tarique Mohammad Nurul Huda
Principal Supervisor	Adam Biran
Thesis Title	Role of Sanitation in preventing faecal contamination of the domestic environment and protecting health: An observational study.

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.

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SECTION C – Prepared for publication, but not yet published

Where is the work intended to be published?	American Journal of Tropical Medicine and Hygiene
Please list the paper's authors in the intended authorship order:	Tarique M N Huda, Wolf-Peter Schmidt, Amy J. Pickering, Leanne Unicomb, Zahid Hayat Mahmud, Stephen P. Luby and, Adam Biran
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 had the primary role of designing the study, overseeing the field work, analysing the data, and drafting the manuscript
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Title: Effect of neighbourhood sanitation coverage on faecal contamination of the household environment in rural Bangladesh

Authors: Tarique M N Huda¹, Wolf-Peter Schmidt¹, Amy J. Pickering², Leanne Unicomb³, Zahid Hayat Mahmud³, Stephen P. Luby² and, Adam Biran¹

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4.4 Abstract

Enteric pathogens can be transmitted within the household and the surrounding neighbourhood. The objective of this study was to understand the effect of neighbourhood level sanitation coverage on faecal contamination of the household environment in rural Bangladesh. Spot-check observations of sanitation facilities was conducted in neighbouring households within a 20 meter radius of target households with children aged 6-24 months. Following the Millennium Development Goal (MDG) definition sanitation facilities were defined as improved (a private pit latrine with a slab or better) or unimproved. Faecal coliforms (FC) on children's hands and sentinel toy balls were measured and used as indicators of household-level faecal contamination.

We visited 1,784 neighbouring households surrounding 454 target households. Twenty two percent of these neighbouring households had access to a private improved latrine. On average, sentinel toy balls had 2.09 (SD=1.37) log₁₀ colony forming units (CFU) of FC/toy ball and children's hands had 2.25 (SD=1.14) log₁₀ CFU of FC/two hands. Access to 100% private improved sanitation coverage in the neighbourhood was associated with a small but statistically insignificant difference in contamination of sentinel toy ball (difference in mean: -0.09 log₁₀ CFU/toy ball; 95% CI: -0.56, 0.38; P=0.70) and children's hands (difference in mean: -0.20 log₁₀ CFU/two hands; 95% CI: -0.45, 0.14; P=0.25).

Improved sanitation coverage in the neighbourhood had limited measurable effect on faecal contamination of the target household environment. Other household and community level factors may be more important in reducing faecal contamination of the household environment.

Key words: Neighbourhood, sanitation, faecal coliform, hands, sentinel toys

4.5 Introduction

Enteric pathogens excreted within faeces can be transmitted through contaminated food and drink, person to person (hand to mouth), or contact with a fomite and flies either through contaminated food and utensils or landing directly on children [1-4]. In rural areas of densely populated countries households live very close to each other. Members of neighbouring households often share a yard along with basic water and sanitation infrastructure [5]. This allows frequent movement of adults and children between households within the neighbourhood [6] resulting in enteric pathogens being transmitted within households [7] and the surrounding community [8].

Sanitation facilities that separate faeces from the environment are expected to create a primary barrier to break the chain of transmission of enteric pathogens [1, 2]. There may be two source of benefit of sanitation in reducing transmission of enteric pathogens. There may be a direct benefit to a household due to improving household sanitation. There may be also an external benefit due to immediate neighbour's access to sanitation that result in a lower probability of human contact with human excreta [9]. We have limited empirical evidence to understand whether the benefits of sanitation at household level critically depend on sanitation coverage across the neighbourhood [10].

Several studies were identified that assessed the effect of community sanitation coverage on health. A few studies have looked at the effect of community coverage of sanitation facilities connected to sewer systems or septic tanks in urban contexts [11-16]. These studies show the importance of community sanitation

access, but they do not clarify the role of neighbourhood sanitation on target households in reducing faecal contamination and related health outcomes.

A study conducted in Brazil assessed the effect on child diarrhoea of a city-wide intervention to improve sewerage coverage. Following the intervention there was a 22% reduction in the longitudinal prevalence of diarrhoea. Household-level sanitation-related variables (indoor latrine, household excreta disposal) explained only 17% of the heterogeneity of the effect of programme. Whereas, neighbourhood sanitation coverage through sewerage connection explained 100% of the heterogeneity in the effect of the programme [14]. This suggests that in this setting the neighbourhood level sanitation access was more important than household level sanitation access in reducing diarrhoeal disease transmission. However the study was conducted in urban areas with sewage connections, a sanitation technology not feasible in most low income rural settings. As of 2010, 60% of global urban residents reported using facilities linked to sewers compared to only 12% in rural areas [17]. Most sanitation facilities in rural areas of low income countries are onsite (pit latrines, septic tanks and other household level technologies that do not involve sewerage). In 2010 64% of the global rural population reported using onsite sanitation facilities [17]. In rural settings with predominantly onsite sanitation the impact of neighbourhood sanitation may be different.

Studies conducted in rural contexts with predominantly onsite sanitation facilities have also highlighted that neighbourhood sanitation coverage may be important. First a study conducted in rural Zimbabwe assessed the effect of latrine coverage at the community level, on diarrhoea morbidity. A community where 62% of the children lived in a household with a latrine experienced 68% lower diarrhoea morbidity compared to the children living in a community with no sanitation [10]. However the study had a relatively small sample size and compared only two communities. A second study conducted in coastal Ecuador analysed data from four years of active diarrhoeal-disease surveillance data across 21 communities. Villages were categorised based on diarrhoea prevalence as “low” (<0.6%); “low-medium” (0.6%-2.2%); “high-medium” (2.2 %-< 5.2%) and “high” (5.25-100%). The data

suggests that the overall increase in percentage of village level improved sanitation was associated with higher diarrhoea prevalence in the context of low regional risk of diarrhoea [18]. This study showed that the association between community sanitation coverage and diarrhoea risk may vary depending on the level of disease in the surrounding villages. This suggests that disease dynamics is influenced by disease status of neighbouring communities. However from these studies we cannot understand the benefits of externality due to sanitation access in the neighbourhood. Another important limitation of this study was that it looked at the effectiveness of water treatment and sanitation without considering hand washing with soap.

Studies conducted in the rural context suggest that neighbourhood sanitation may provide additional externality benefits [9] in terms of reducing diarrhoea. For example, a study used data from an Indian nationwide survey of rural households. The findings suggest that community level improved sanitation coverage is associated with a 37% additional reduction in diarrhoea prevalence, in addition to reduction due to household level improved sanitation coverage [9]. A second study that used demographic and health survey (DHS) data suggests that children from villages with higher open defecation rate were shorter controlling for effect of household level sanitation practices [19]. However these studies did not control for the effect of handwashing practices on health. Moreover these findings have so far not been replicated in other settings. Depending on the status of disease in a specific context the effect of risk factors like lack of sanitation may have variable effect [20, 21]. The classification of sanitation facilities in demographic and health surveys may be prone to misclassification bias as the questions used in DHS do not capture the function of sanitation facilities in separating faeces from environment.

The objective of this study was to assess the association between neighbourhood sanitation coverage and microbial faecal contamination at the household-level so that informed decisions can be made regarding the focus of sanitation interventions and how we monitor global progress.

4.6 Methods

An observational, cross-sectional study was conducted between September and October 2013, in rural areas of Mymensingh and Narshingdi districts of Bangladesh. The study was conducted in villages that were participating in the Sanitation, Hygiene Education, and Water supply in Bangladesh (SHEWA-B) health impact study described elsewhere [22]. Verbally administered questionnaire surveys, spot-check of sanitation facilities and microbial assessment of children's hands and sentinel toy ball (described below).

4.6.1 Neighbouring household selection

The study was conducted in rural areas of Mymensingh and Narshingdi districts of Bangladesh between September and October 2013. The enumerators systematically selected 454 target households with a child aged 6-24 months, from a simple random sample of villages enrolled for a health impact study as described elsewhere [23]. All neighbouring households within a 20 metre radius of the entrance to the living room of each target household were enrolled in this study. The cut-off point of a 20 meter radius was arbitrary, based on logistical convenience and resources available for data collection rather than scientific evidence. During the pilot study (Chapter 2) high population density was found and within a 20 meter radius 4-10 neighbouring households were found. In this manuscript the term "neighbourhood" refers to these immediate neighbouring households. The distance between households was measured using a handheld global positioning system (GPS) unit "Garmin Etrex legend H" (GARMIN)[24]. Target households were separated by a distance of at least 50 meters ensuring that none of the neighbouring households was counted for more than one target household.

4.6.2 Data collection tools

Neighbourhood and target household surveys: The enumerators used a verbally administered, structured questionnaire and spot-check observation to collect information about household possessions; water, sanitation and hygiene related behaviour and facilities in target households [23] (Chapter 3). The

information on training of enumerators and quality control during data collation are described elsewhere (Chapter 3). Enumerators used a shorter version of this procedure to collect information about human and animal faeces disposal practices in the neighbouring households. Data were recorded using a tablet computer.

4.6.3 Microbiological sample collection

We used contamination of toys and hands by faecal indicator bacteria as an indicator of faecal contamination of the household environment.

Hand rinse: Prior to administering the household survey the field team rinsed both the hands of the target child, (aged 6-24 months) from each target household. Hands were rinsed for 30 seconds each, in a Whirl-Pak bag (19×38 cm) (Nasco, Fort Atkinson, WI) filled with 200 ml of Ringer's solution [25].

Sentinel toy ball rinse: Standard sized (20 cm circumference) sentinel toy balls given to children to play with were collected after 24 hours and rinsed in a Whirl-pak bag (19×38 cm) filled with 200 ml of Ringer's solution for 30 seconds following methods used previously [26].

All samples were transported in a cool box to the Environmental Microbiology Laboratory of icddr, b laboratory within 15-18 hours of collection maintaining the temperature of 4–10 °C.

4.6.4 Enumeration of faecal coliforms

The enumeration procedure for faecal coliforms is described in detail elsewhere [23]. Presumptive faecal coliforms were enumerated using a membrane filtration technique with modified faecal coliform (mFC) agar plates, within 24 hours of collection [27, 28]. The results were calculated as colony forming units (CFU) present per 200 ml of recovered media that bathed the toy balls or hands.

4.6.5 Ethics

Written informed consent was taken from the primary caregiver of the child aged 6-24 months before enrolling for the study (Appendix 3). The study protocol

was approved by the ethical review committee of icddr,b, Bangladesh and London School of Hygiene and Tropical Medicine (LSHTM), United Kingdom.

4.6.6 Operational definitions of variables used in the analysis

Our analysis included the following variables, household access to improved sanitation, neighbourhood sanitation coverage, household wealth, latrine cleanliness, hand cleanliness, appropriate child faeces disposal and faecal coliform counts from hands and sentinel toys. These variables are defined below.

Access to improved sanitation: We categorised access to improved sanitation using 2 different definitions used by the WHO/UNICEF Joint Monitoring Programme (JMP) for water supply and sanitation []. Definition 1 was used for monitoring progress towards the Millennium Development Goal (MDG). We refer to this as the MDG definition. Definition 2 was that proposed for future monitoring of progress towards the post-2015 Sustainable Development Goal (SDG) [30]. We refer to this as the SDG definition. The key difference between these definitions is that MDG does not include any shared sanitations in the definition of improved whereas the proposed SDG does include some types of shared sanitation within the definition of improved provided they are shared by no more than five households.

Following the MDGs we categorised flush/pour flush latrines and pit latrines with slabs as improved provided these were not shared between households. Unimproved sanitation included pit latrines without slabs, hanging latrines, flush/pour flush latrines with no connection to a sewer or septic tank; no facility; and any shared facilities. We also defined improved sanitation following the SDG definition where shared facilities of otherwise improved technology (flush/pour flush latrines and pit latrines with slabs) if shared by a maximum of five households as improved [17]. So for the SDG definition unimproved sanitation included pit latrines without slabs, hanging latrines, flush/pour flush latrines connected to open; no facility; and improved technologies shared by more than five households.

Neighbourhood sanitation coverage: We calculated neighbourhood sanitation coverage as the proportion of neighbouring households with access to

improved (MDG and SDG definitions) latrines. We treated the neighbourhood improved (MDG and SDG) sanitation coverage variable in 2 different forms: a) continuous and b) binary (100% and < 100%).

Household wealth: To assess the wealth of target households we used principal component analysis (PCA) with 23 household characteristics [31, 32] excluding sanitation and water access. We calculated the means, frequencies and score coefficients and used the correlation matrix of the 23 variables to calculate sample weights [31, 33, 34]. We initially divided the wealth score into quintiles (lower, lower middle, middle, upper middle and upper). Then we recoded the wealth score as a binary variable rich (upper wealth quintile) or poor (lower, lower middle, middle and upper middle wealth quintiles).

Hand cleanliness: If the trained enumerators observed no visible dirt on the hands or under the nails of the target child then the child was considered to have clean hands.

Latrine cleanliness: We considered a household to have a clean latrine if the enumerators observed no faeces on the slab/floor and pan of the latrine at the time of visit.

Safe child's faeces disposal: The faeces of children (below 3 years of age) were considered to be disposed safely if they were reported to be disposed inside a latrine [35].

4.6.7 Data analysis

We first converted the faecal coliform concentrations to their base 10 logarithms for calculating means. A faecal coliform level of <1 was replaced with the value 0.5 (half the detection limit) before the conversion. We calculated the difference in \log_{10} transformed arithmetic means CFU of faecal coliforms comparing households with different levels of sanitation coverage in the neighbourhood using a linear regression model. To account for the clustering effect at village level we used a

generalised least squares (GLS) random-effects model explicitly allowing the average outcome to vary between village clusters [36-40]

We conducted univariable analyses to estimate the crude effect of the primary exposure variables and potential confounding variables on the main outcome, adjusting for the effect of village level clustering. For the multivariable analysis, adjusting for potential confounders, we used causal diagrams to decide which variables to include as potential confounders, excluding variables on the same causal pathway as the exposure variables (Figure 4.1). We decided *a priori* to include mother's education and wealth as confounders even if they were not associated with the outcome in this study. We included all potential confounders in the multivariable model if they were associated with the exposure and outcome in the univariable analysis [40, 41]. We also tested for normality of residuals and homoscedasticity of the models.

We generated separate multivariable models for toy contamination and hand contamination as outcomes. For each of the outcomes we used 2 different forms for neighbourhood improved (MDG and SDG) sanitation coverage variable (continuous and binary).

4.7 Results

4.7.1 Neighbourhood characteristics

The 454 target households visited had a mean of four neighbouring households within a 20 metre radius. Twenty two target households had no neighbouring household within a 20 metre radius and an additional four target households had one neighbouring household but none of the family members of those neighbouring households were present during data and sample collection.

We visited 1,948 neighbouring households of 454 target households. We could not collect data on sanitation status from 165 neighbouring households (8%) because of absence or refusal so we have data on sanitation status from 1,784 neighbouring households. These neighbouring households had five members on

average and 35% (n=684) had at least one child under 5 years of age. Two thirds of neighbouring households reported that the children under 5 years of age defecated in the open in or around the household. Among 432 households with one or more children under 3 years of age, 22% reported that they disposed of the child's faeces in a latrine. The majority (n=1431, 80%) of the neighbouring households had animal faeces present within the household premises at the time of observation. Among these, 24% (n=467) had more than 10 piles of open poultry faeces, and 11% (n=213) had more than 10 piles of cow dung, while 16% (n=321) had goat faeces present (Table 4.1).

Among the neighbouring households, 1,682 (94%) reported having access to a latrine. Almost all of the households with latrine access had a worn path to the latrine suggesting regular use. Almost all of these households (99%) reported using the latrine within the 24 hours preceding spot-checks. Among all the neighbouring households 60% (n=1012) reported access to a shared latrine. About 22% of the households had a flush or pour flush latrine with a septic tank or a pit, while, 24% households reported to have access to a pit latrine without flush technology. Twenty two percent of the households had access to a private improved latrine (MDG). While 42% had access to improved latrine (SDG) shared by a maximum of 5 households. There were 1615 households that had a latrine with a slab. Seventeen percent of these latrines were visibly clean (Table 4.1). Shared latrines were more likely to be dirty than individual latrines (182/969=19% vs. 90/646=14%, P value=0.01)

4.7.2 Target household characteristics

A quarter (25%) of the target households had access to private improved sanitation(MDG) while 45% of the target households had access to an improved latrine, as defined by JMP for the SDG (Table 4.2). Characteristics of the target households have been presented in more detail elsewhere [23].

Almost half of the target households (n=220, 49%) were from neighbourhoods with no improved (MDG) sanitation access. Nine percent of the

target households (n=39) were from neighbourhoods with 100% improved (MDG) sanitation coverage (Table 4.2).

4.7.3 Faecal contamination of sentinel toy ball

Among the 454 sentinel toys 49 (11%) of the rinse samples were below the detection limit for faecal coliforms. No samples had faecal coliform levels that were above the detection limit. On average there were 2.09 (SD=1.37) \log_{10} CFU/toy ball with a median of 2.08 \log_{10} CFU/toy ball.

Toy ball samples collected from target households in neighbourhoods with no private, improved (MDG) sanitation access had 2.04 (SD=1.47) \log_{10} CFU/toy ball on average. There was minimal change in the level of toy ball contamination associated with each 1% increase in the private, improved (MDG) sanitation coverage in the neighbourhood. Toy ball samples collected from households in neighbourhoods with less than 100% improved (MDG) sanitation coverage had somewhat lower levels of contamination than households in neighbourhoods with 100% improved (MDG) sanitation coverage (difference in mean: -0.19 \log_{10} CFU/toy ball; 95% CI: -0.64, 0.27), but differences of this magnitude are consistent with random variation (P=0.42). After adjusting for potential confounding household and neighbourhood characteristics the findings remained unchanged (Table 4.2).

In restricted analysis among 113 target households with access to unimproved sanitation a higher proportion of access to improved sanitation in the neighbourhood was not associated with any reduction in faecal contamination of the toy ball in the target households. Even access to 100% improved sanitation coverage in the neighbourhood was only associated with minimal reduction in faecal contamination of the toy ball (difference in mean -0.06; 95% CI:-0.62, 0.50) compared to household with less than 100% improved sanitation access.

There was minimal change in the level of toy ball contamination associated with each 1% increase in the improved (SDG) sanitation coverage in the neighbourhood. Toy ball samples collected from households in neighbourhoods with

less than 100% improved (SDG) sanitation coverage had somewhat similar levels of contamination as households in neighbourhoods with 100% improved (SDG) sanitation coverage. Coverage of shared sanitation in the neighbourhood was not associated with any statistically significant change in level of faecal contamination of the toy ball (Table 4.2).

4.7.4 Faecal contamination of hands

Among the hand rinse samples taken from 454 children under 2 years of age, 6% (n=28) of the samples were below the detection limit for faecal coliforms. On average children's hands had 2.25 (SD 1.14) \log_{10} CFU/two hands with a median of 2.20 \log_{10} CFU/two hands. Contamination of hands was weakly correlated with contamination of the toy balls ($r=0.19$, $P=0.44$). A one \log_{10} increase in level of faecal coliform per two hands was associated with 0.24 \log_{10} increase in level of faecal coliform per sentinel toy ball (95% CI: 0.12, 0.34) (Figure 4.4).

In households from neighbourhoods with no improved (MDG) sanitation access there were on average 2.29 (SD=1.12) \log_{10} CFU /two hands. With each 1% increase in neighbourhood improved sanitation coverage there was a reduction of 0.17 \log_{10} CFU of faecal coliform contamination (95% CI: -0.50, 0.16). This reduction could be due to chance ($P=0.32$). Households in neighbourhoods with 100% improved (MDG) sanitation coverage had similar levels of hand contamination as those in neighbourhoods with <100% coverage (difference in mean -0.11; 95% CI: -0.48, 0.26) (Table 4.3).

In the restricted analysis among target households with access to unimproved (MDG) sanitation a higher proportion of access to improved sanitation in the neighbourhood was not associated with any reduction in faecal contamination of children's hands in the target household (Data not shown).

With each 1% increase in neighbourhood improved (SDG) sanitation access there was a reduction of 0.15 \log_{10} CFU of faecal coliform contamination (95% CI: -0.43, 0.13). This reduction could be due to chance ($P=0.29$) (Table 4.3). With each 1%

increase in neighbourhood shared sanitation coverage was an increase of 0.26 log₁₀ CFU of faecal coliform contamination (95% CI: -0.43, 0.13) per two hands. Although the statistical evidence was weak (P=0.07). In the adjusted analysis the estimates and the strength of the statistical evidence remained similar.

In the multivariate analysis, hand contamination was similar in target households with access to private, improved sanitation and unimproved sanitation (difference in mean: 0.12; 95% CI -0.14, 0.38). Children, who were playing in the half hour preceding hand rinse sample collection, had more faecal contamination than children who were inactive (for example sleeping) (difference in mean=0.29 log₁₀ CFU/two hands, 95% CI: 0.04, 0.54). Children with visibly clean hands had lower faecal coliform contamination than children with dirty hands (difference in mean=-0.56 log₁₀ CFU/two hands, 95% CI: -0.84, -0.27). Presence of soap and water in the handwashing station was not associated with faecal coliform level in children's hands. Household wealth and mother's education were not associated with faecal contamination of the children's hands (Table 4.3).

4.8 Discussion

In rural areas of Bangladesh with predominantly onsite sanitation, access to improved (MDG) sanitation in neighbouring households was associated with small and statistically insignificant reductions in faecal indicator bacteria in the domestic environment. For both measures of household faecal contamination (children's hands and toys) this finding was consistent. Even 100% improved (MDG) sanitation coverage was not associated with significant reduction in contamination level. The association between neighbourhood sanitation coverage and faecal contamination was similar when improved sanitation was defined using the SDG definition proposed by JMP. Access to private improved (MDG) sanitation in the target household was associated with lower level of faecal contamination of the sentinel toy ball. But access to improved sanitation as defined for SDG was not associated with any reduction in faecal contamination.

These findings suggest that improved sanitation access in the neighbourhood may not be sufficient to prevent faecal contamination of the domestic environment. Other household and community-level factors may also be necessary. This does not imply that neighbourhood sanitation is not important in reducing faecal contamination.

There are several possible explanations as to why neighbourhood sanitation coverage was not associated with levels of faecal contamination of children's hands and toys. Firstly, it is possible that household sanitation access is more important than neighbourhood coverage in reducing faecal contamination within the target household. Since children under two years of age are likely to spend most time within the household premises the hand/toy ball contamination are most likely to represent the contamination level of the household's domestic environment. In our study as well as in previous small-scale studies conducted in Bangladesh [26, 42] and Tanzania[43] household-level access to improved sanitation was found to be associated with lower contamination of toy balls [26, 42] and hands [43].

Secondly there are other routes of contamination, such as poor cleanliness of the latrine, presence of animal faeces or unsafe disposal of children's faeces, that neither target household nor neighbourhood sanitation access prevent. In this study presence of soap and water at a convenient handwashing location was not associated with lower level of faecal contamination but visible cleanliness of hands were associated with level of faecal contamination of children's hands and toys. A previous study conducted in Tanzania among 334 households found that washing hands with soap within the past hour was associated with lower level of faecal contamination [43]. More over in Tanzania study visible dirt observed on the subject's palm, finger pads, or underneath their nails was significantly related to higher level both of EC and FS on hands. So handwashing practice may be more important than neighbourhood sanitation access. There may also be important community-level social, geographical, economical, cultural and or environmental factors that we did not capture in our study since we found sentinel toys in

Narshingdi district had higher level of contamination compared to children's toys in Mymensingh district even after adjusting for potential confounding factors.

Thirdly, it is possible that we were unable to detect a difference in faecal contamination associated with neighbourhood sanitation due to low statistical power. Previous studies have found contamination level in toys and hands [26] to be highly variable and so requiring a large sample size to evaluate group differences. The sample size calculation for this study was not determined considering neighbourhood level sanitation coverage as the primary exposure. Future research with a larger sample size might help to better understand this phenomenon.

Previous studies have identified neighbourhood sanitation coverage as important in reducing diarrhoeal disease transmission [10, 14, 44]. This apparent contradiction to the findings of the present study might arise if children visiting neighbouring households are exposed to faecal pathogens in the neighbouring households. Or other household members bring in contamination from neighbouring households. It is also possible that other more important transmission pathways (e.g. water or food) that operate at household as well as neighbourhood level and that could not be captured by assessing faecal contamination of toy balls and hands.

An important limitation of this study is use of faecal indicator bacteria to assess faecal contamination as they are not human specific. This random measurement error can introduce bias due to misclassification of outcome. As a consequence the confidence intervals of the estimates presented are likely to be wider making the results less likely to be statistically significant even if in reality they are statistically significant [45]. For example, having 100% improved sanitation access in the neighbourhood was associated lower but statistically insignificant reduction in level of faecal contamination. So, further study with larger sample size could help better understand the role of neighbourhood sanitation[45]. Using molecular markers of human specific pathogens as indicator of faecal coliform could help reduce this bias in future studies.

Finally, our definition of neighbourhood may be problematic. The cut-off point of a 20 meter radius was arbitrary, based on logistical convenience and high population density in this context rather than scientific evidence. So our conclusion may be conservative given small radius. Selecting a larger radius might have resulted in a different conclusion. More over there may be issues with generalisability of these findings. Bangladesh has high water tables and high number of domestic animal, as a result Bangladesh may have many determinants of household faecal contamination that are not impacted on by neighbourhood sanitation practices.

Neighbourhood coverage with improved sanitation within 20 meters of households in rural Bangladesh had no effect on faecal contamination of the household environment measured as indicator bacteria on children's hands and toys. Household sanitation access is probably more important than neighbourhood sanitation coverage in reducing faecal contamination of domestic environment. Intervention studies with appropriate sample size might help us better understand the impact of neighbourhood sanitation coverage on faecal contamination of household environments.

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Figure 4.1: Directed acyclic graph (DAG) showing the variables measured and included in the multivariable analysis.

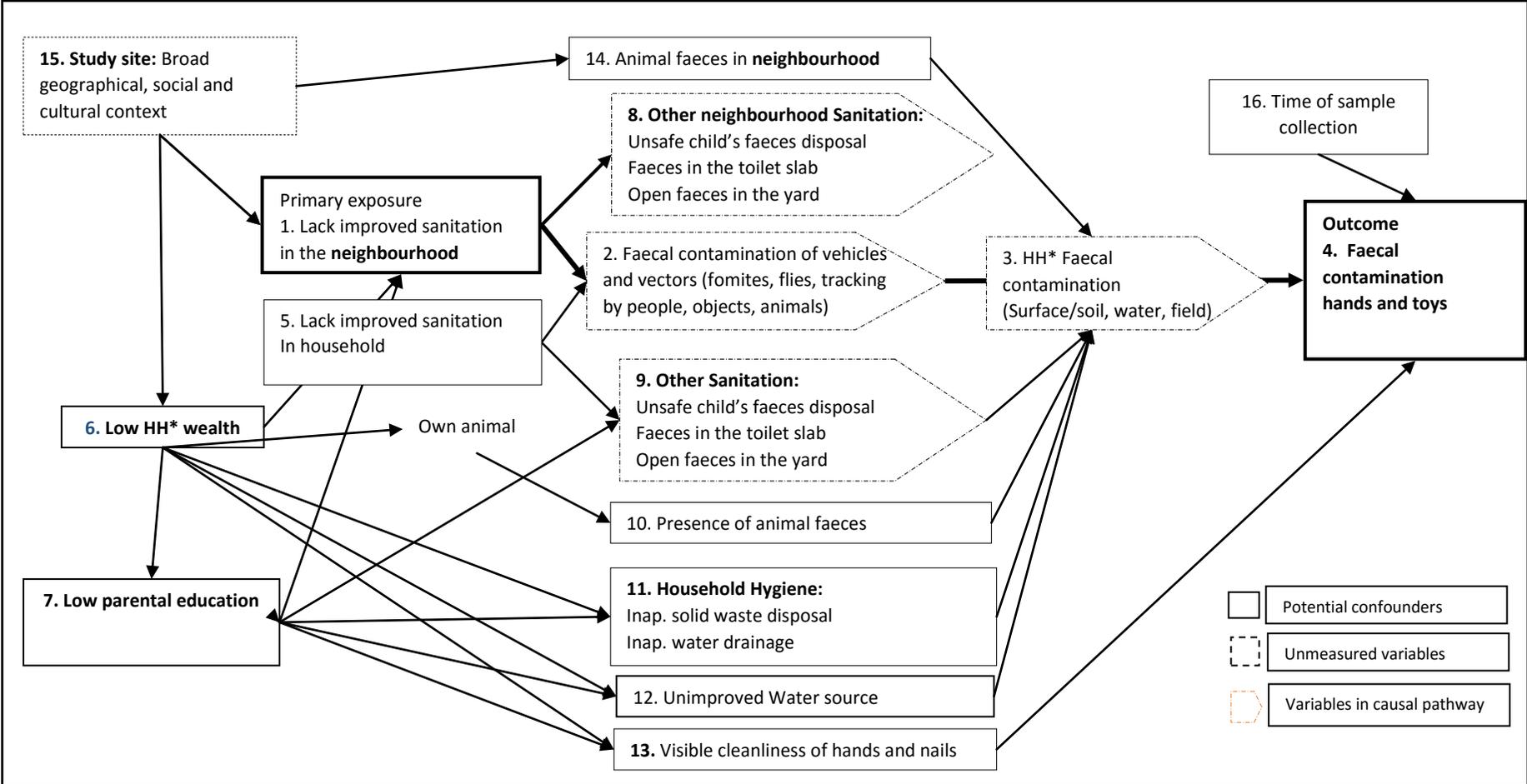


Table 4.1: Neighbourhood household (NH) characteristics (n=1784)*

	n	% or mean
Mean number of household(HH) member	1,784	4.6
Proportion of HH with a <5 child	684	35%
Proportion of HH with access to a latrine	1,672	94%
Proportion of HH with worn path to latrine (N=1682)	1,666	99%
Sanitation access according to technology (Ignoring sharing)		
Open defecation	102	5.7%
Pit latrine without slab, hanging latrine and pit latrine with a slab but broken pit	858	48%
Pit latrine with a slab	436	24%
Flush/pour flush latrine with septic tank or pit	388	22%
Proportion of HH that privately owns a latrine (N=1682)	862	51%
Proportion of HH with access to a shared latrine (N=1682)	1,012	60%
Mean number of individuals using a latrine	1,682	8
Mean number of HH sharing a latrine	1,012	2.9
Sanitation access according JMP (MDG) classification		
Private Improved	389	22%
Unimproved	1,395	78%
Access to Improved (JMP-SDG) sanitation	816	42%
Proportion of HH with dirty latrine (N=1,615)	272	17%
Reported <5 child faeces defecation site		
Open: filed/bush/yard/floor	390	57%
Potty	80	12%
Nappy	69	10%
In a latrine	145	21%
Safe child's faeces disposal (N=432)	93	22%
Proportion of HH where children aged 5-18 not using a latrine	601	34%
Number of piles of poultry faeces found in or around HH		
No faeces	613	31%
1-10 piles	868	45%
10> piles	467	24%

Number of pile of cow dung found in or around HH		
No faeces	1,323	68%
1-10 piles	412	21%
10> piles	213	11%
Goat faeces found in or around HH		
Present	1,627	84%
Absent	321	16%

*If sample size is different it is presented next to the variable in the table

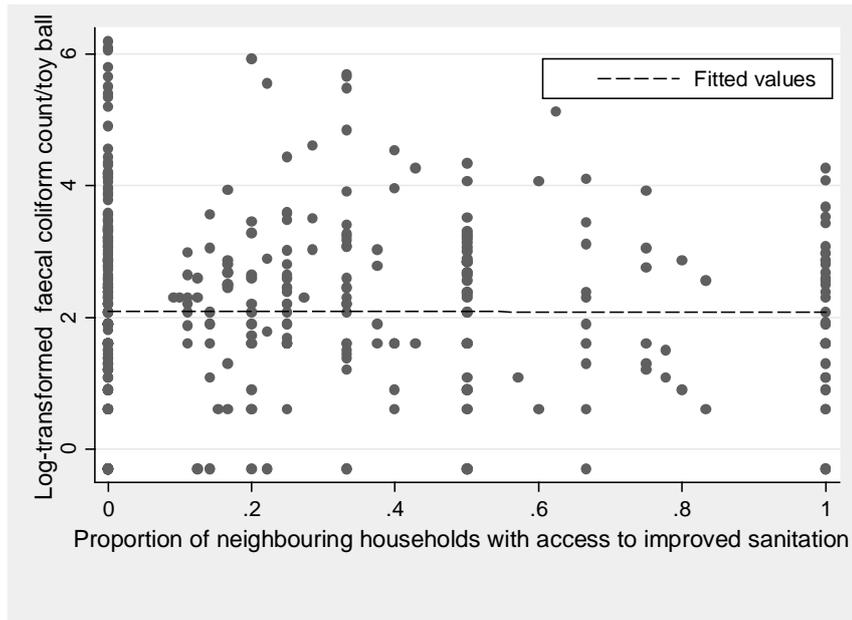


Figure 4.2: Scatter plot and fitted line showing relationship between proportion of neighbouring households (NH) with improved (JMP-MDG) sanitation access and \log_{10} transformed CFU of faecal coliform per toy ball.

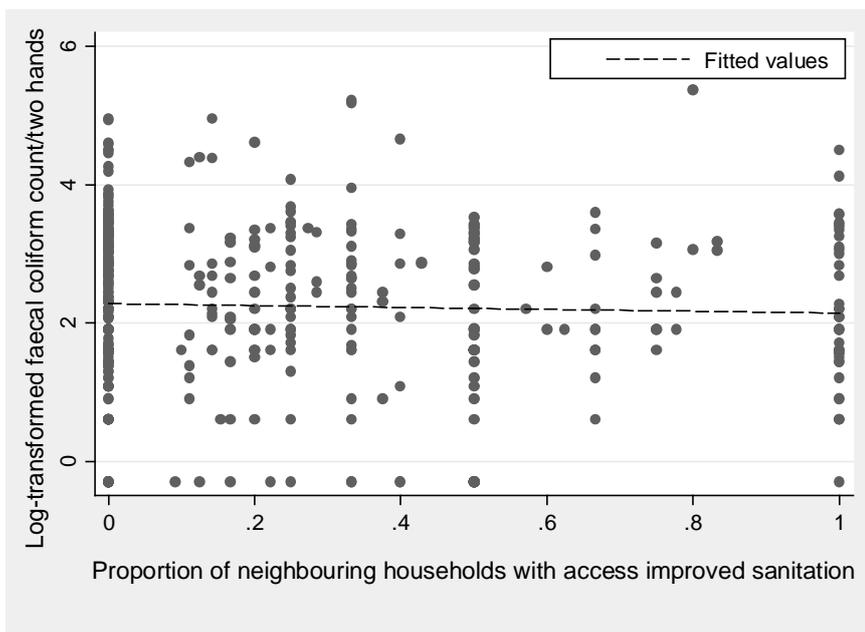


Figure 4.3: Scatter plot and fitted line showing relationship between proportion of neighbouring households (NH) with improved (JMP-MDG) sanitation access and \log_{10} transformed CFU of faecal coliform per two hands of children.

Table 4.2: Relationship between neighbourhood (NH) sanitation and log₁₀ transformed faecal coliform CFU/toy ball (n=454 households)

Exposures	n* (%)	Mean (SD) [†]	Median	Univariable Difference in mean [‡] (95% CI [§])	P value [‡]	Multivariable Difference. in mean [‡] (95% CI [§])	P value [‡]
Primary Exposure: NH Sanitation coverage (MDG)							
1a. Increase in improved sanitation coverage in the NH (Continuous)	454	2.09 (1.37)	2.08	-0.06 (-0.47, 0.34)	0.75	0.06 (-0.37, 0.49)	0.79
1c. Improved sanitation coverage in the NH							
100% coverage	39 (9)	1.93 (1.20)	1.90	-0.19 (-0.64, 0.27)	0.42	-0.09 (-0.56, 0.38)	0.70
<100% coverage	415 (91)	2.11 (1.39)	2.08				
Primary Exposure: NH Sanitation type (SDG)							
1a. Increase in improved sanitation coverage in the NH (Continuous)	454	2.09 (1.37)	2.08	0.12 (-0.22, 0.46)	0.48	0.18 (-0.17, 0.52)	0.31
1b. Improved sanitation coverage in the NH							
100% coverage	365 (80)	2.10 (1.40)	2.08	-0.07 (-0.39, 0.24)	0.65	0.03 (-0.35, 0.29)	0.86
<100% coverage	89 (20)	2.06 (1.29)	1.90				
1c. Increase in NH shared sanitation access (cont.)	444**			0.12 (-0.23, 0.46)	0.52		
Other household variables							
2a. Improved (JMP-MDG) sanitation access target HH [¶]							
Improved	113 (25)	1.84 (1.23)	1.60	-0.36 (-0.65, -0.07)	0.02	-0.34 (-0.63, -0.00)	0.05
Unimproved	341 (75)	2.17 (1.41)	2.20				
2b. Improved (JMP-SDG) sanitation access target HH [¶]	205 (45)	2.06 (1.33)	1.90	-0.07 (-0.33, 0.18)	0.58		

	Improved	249 (55)	2.12 (1.41)	2.08				
	Unimproved							
3.	Number of goat faeces pile in compound							
	No faeces	312 (69)	2.02 (1.34)	1.90			-	
	1 to 10 piles	95 (21)	2.15 (1.32)	2.20	0.16 (-0.15, 0.48)	0.30	0.17 (-0.15, 0.48)	0.30
	> 10 piles	47 (10)	2.43 (1.62)	2.20	0.45 (0.02, 0.87)	0.04	0.34(-0.08, 0.76)	0.12
4.	Presence of any goat faeces in HH ^{fl} (Vs absence of any goat faeces)	103 (23)	2.36 (1.46)	2.38	0.36 (0.06, 0.67)	0.02		
5.	Number of cow dung pile in compound							
	No cow dung	198 (44)	2.07 (1.37)	1.90	0		-	
	1 to 10 cow dung	165 (36)	2.09 (1.34)	2.08	0.03 (-0.25, 0.32)	0.83	0.09 (-0.20, 0.38)	0.55
	10> cow dung	90 (20)	2.15 (1.45)	2.36	0.11 (-0.23, 0.46)	0.53	0.08 (-0.28, 0.45)	0.66
6.	Number of cow dung pile in household							
	No cow dung	264 (58)	2.04 (1.38)	1.90	0			
	1 to 10 cow dung	136 (30)	2.08(1.37)	2.20	0.04 (-0.25, 0.32)	0.79	0.09 (-0.19, 0.38)	51
	10> cow dung	54 (12)	2.37(1.35)	2.45	0.36 (-0.05, 0.77)	0.08	0.36 (-0.05, 0.77)	0.08
7.	Number of poultry faeces piles in the compound							
	≤10 piles	233 (51)	2.10 (1.37)	2.08				
	10> piles	221 (49)	2.08 (1.38)	2.08	-0.01 (-0.26, 0.25)	0.96		
8.	Number of poultry faeces piles in HH ^{fl}							
	No faeces	92 (20)	1.97 (1.23)	1.90	0			
	1 to 10 piles	224 (49)	2.12 (1.46)	2.14	0.15 (-0.19, 0.49)	0.38		
	More than 10 piles	138 (30)	2.13 (1.30)	2.08	0.17 (-0.20, 0.53)	0.38		
9.	Presence of appropriate water drainage (Vs absence of appropriate water drainage)	261 (58)	1.99 (1.36)	1.90	-0.24 (-0.50, 0.01)	0.06	-0.33 (-0.59, -0.07)	0.01

10. Presence of appropriate solid waste disposal system (Vs absence of appropriate solid waste disposal system)	11	1.59 (2.00)	1.90	-0.47 (-0.29, 0.34)	0.26		
11. Hands/nails looked visibly clean (Vs hands/nails visibly dirty)	71 (16)	1.81 (1.34)	1.90	-0.35 (-0.69, -0.01)	0.05	-0.26 (-0.61, 0.09)	0.14
12. HW place with soap and water (Vs no soap and/or water)	95 (21)	2.00 (1.19)	1.90	-0.15 (-0.46, 0.17)	0.36		
13. Mother with any formal education (Vs mothers with no formal education)	376 (83)	2.03 (1.36)	1.90	-0.33 (-0.66, 0.00)	0.05	-0.29 (-0.63, 0.05)	0.09
14. Household belongs to upper (richest) wealth quintile (Vs poorer quintiles)	90 (20)	1.81 (1.22)	1.70	-0.41 (-0.72, -0.09)	0.01	-0.18 (-0.53, 0.16)	0.29
15. Change in time (hour) of sample collection as the day progress				-0.17 (-0.27, -0.06)	0.002	-0.17 (-0.27, -0.06)	0.002
16. Study site			2.20	0.36 (0.07, 0.65)	0.01	0.53 (0.26, 0.79)	<0.001
Narshingdi district	238 (52)	2.26 (1.38)					
Mymensing district	216 (48)	1.90 (1.34)					
17. Increase in number of neighbouring household	454			0.002 (-0.05, 0.05)	0.92		

* Number with presented category † Standard Deviation (SD)

‡ Adjusting for clustering at village

§ Confidence interval

|| The estimates and associated 95% confidence intervals for the other household variables presented here are from the multivariable model with variable 1a (Increase in improved sanitation coverage in the NH (as the primary outcome).

¶ Household

**Excluding target households that had at no neighbouring households with access to a latrine

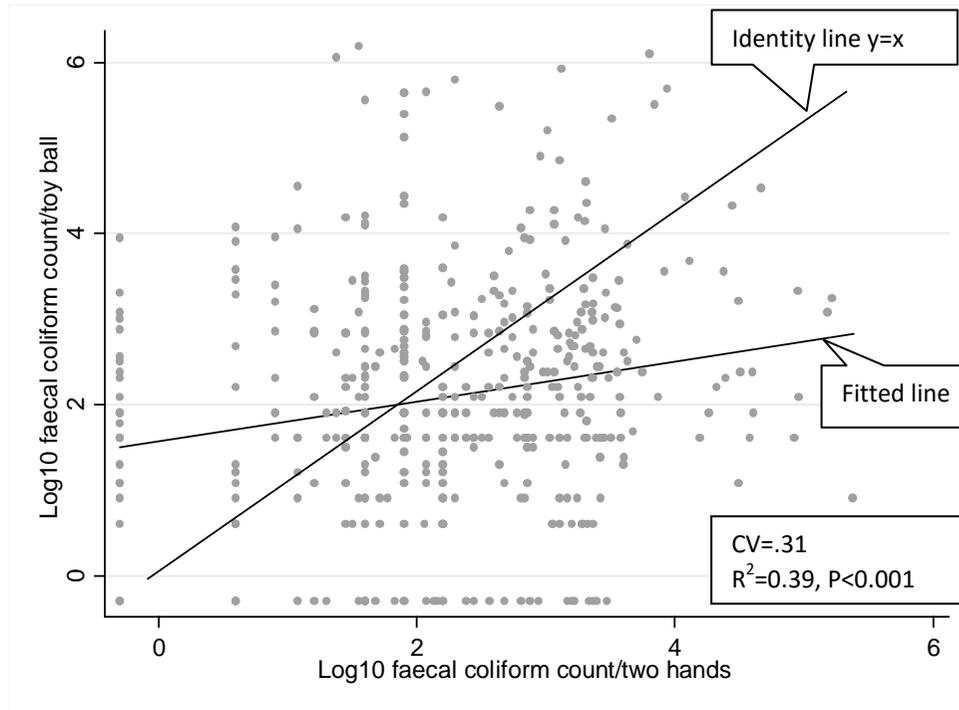


Figure 4.4: Scatter plot showing log₁₀ transformed faecal coliform contamination of children's hands and toys in rural Bangladesh. Here CV refers to covariance.

Table 4.3: Relationship between community level water sanitation and hygiene related variables and log₁₀ transformed faecal coliform CFU/two hands of children under 2 years of age in rural Bangladesh (n=454 households)

Exposures	n* (%)	Mean (SD) [†]	Median	Univariable		Multivariable	
				Difference in mean [‡] (95% CI [§])	P value [‡]	Difference in mean [‡] (95% CI [§])	P value [‡]
<i>NH improved (MDG) sanitation coverage</i>							
1a. Increase improved sanitation coverage in the NH (Continuous)	454	2.25 (1.14)	2.20	-0.17 (-0.50, 0.16)	0.32	-0.20 (-0.55, 0.14)	0.25
1b. Improved sanitation coverage in the NH							
100% coverage	39 (9%)	2.17 (1.09)	2.08	-0.11 (-0.48, 0.26)	0.55	-0.18 (-0.56, 0.21)	0.35
<100% coverage	415 (91%)	2.25 (1.15)	2.30				
<i>NH improved (SDG) sanitation coverage</i>							
1a. Increase in improved sanitation coverage in the NH (Continuous)	454	2.25 (1.14)	2.20	-0.15 (-0.43, 0.13)	0.29	-0.14 (-0.42, 0.14)	0.34
1b. Improved sanitation coverage in the NH							
100% coverage	365 (80%)	2.22 (1.18)	2.20	0.05 (-0.21, 0.31)	0.70	0.04 (-0.23, 0.30)	0.78
<100% coverage	89 (20%)	2.33 (0.99)	2.20				
1c. Increase in NH shared sanitation access (cont.)	444			0.26 (-0.02, 0.55)	0.07	0.27 (-0.01, 0.56) ⁺⁺	0.06
<i>Other confounding variables[¶]</i>							
2a. Improved sanitation access in the target HH** ,							
Improved	113 (25)	2.23 (1.14)	2.20	-0.01 (-0.25, 0.23)	0.95	0.12 (-0.14, 0.38)	0.38
Unimproved	341 (75)	2.25 (1.15)	2.20	-			
2b. Improved (JMP-SDG) sanitation access target HH**							

	Improved	249 (55)	2.27 (1.17)	2.20	-0.06 (-0.28, 0.15)	0.55		
	Unimproved	205 (45)	2.21 (1.12)	2.20				
3.	Number of goat faeces piles in compound							
	No faeces	312 (69%)	2.19 (1.16)	2.20	-			
	1 to 10 piles	95 (21%)	2.30 (1.12)	2.20	0.09 (-0.17, 0.36)	0.50	0.08 (-0.18, 0.34)	0.57
	> 10 piles	47 (10%)	2.48 (1.09)	2.86	0.29 (-0.06, 0.64)	0.11	0.18 (-0.17, 54)	0.28
4.	Presence of any goat faeces in HH** (Vs absence of any goat faeces)	103 (23)	2.38 (1.11)	2.45	0.15 (-0.10, 0.40)	0.23		
5.	Number of cow dung piles in the compound							
	No cow dung	198 (44%)	2.23 (1.14)	2.20	-			
	1 to 10 cow dung	165 (36%)	2.19 (1.13)	2.20	-0.05 (-0.29, 0.18)	0.66		
	10> cow dung	90 (20%)	2.35 (1.19)	2.45	0.13 (-0.16, 0.41)	0.37		
6.	Number of cow dung piles in the HH**							
	No cow dung	264 (58)	2.15 (1.13)	2.20				
	1 to 10 cow dung	136 (30)	2.31 (1.18)	2.34	0.14 (-0.10, 0.37)	0.25	0.14(-0.09, 0.37)	0.23
	10> cow dung	54 (12)	2.57 (1.07)	2.87	0.46 (0.13, 0.80)	0.01	0.42 (0.08, 0.76)	0.02
7.	Number of poultry faeces piles in the compound							
	≤10 piles	233 (51%)	2.24 (1.17)	2.20	-			
	10> piles	221 (49%)	2.25 (1.12)	2.27	-0.02 (-0.22, 0.19)	0.87		
8.	Number of poultry faeces piles in HH**							
	No faeces	92 (20)	2.09 (1.23)	1.98				
	1 to 10 piles	224 (49)	2.30 (1.14)	2.20	0.10 (-0.18, 0.38)	0.48		
	More than 10 piles	138 (30)	2.27 (1.10)	2.30	0.12 (-0.19, 0.42)	0.46		
9.	Presence of appropriate water drainage (Vs absence of appropriate water drainage)	261 (43%)	2.22 (1.14)	2.20	0.03 (-0.19, 0.24)	0.81		
10.	Presence of appropriate solid waste disposal system (Vs absence of	11 (2.4%)	2.17 (1.39)	2.20	-0.00 (-0.67, 0.67)	0.99		

Chapter 5: A cross sectional study to explore the association between sanitation type and diarrhoeal disease.

5.1 Introduction to the chapter

This chapter compares the different classifications of improved sanitation used for international monitoring in terms of reducing diarrhoea among children less than five years of age using existing data from a programme evaluation conducted in Bangladesh. This chapter includes a ready for submission manuscript, which describes results from the secondary data analysis that was conducted as part of the PhD thesis.

5.2: Role of the authors in the research paper

Tarique M.N. Huda (TH): TH is the first author of the research paper. He had the primary role of developing the concept for secondary data analysis, reviewing the literature, cleaning and analyzing the data, interpreting the results and drafting the manuscript

Leanne Unicomb (LU): LU reviewed the concept for secondary data analysis and manuscript drafts.

Amal K. Halder (AKH): AKH was part of the team that collected the data used for this secondary data analysis. He contributed by reviewing the draft manuscripts

Wolf-Peter Schmidt (WS): WS contributed in refining the research questions; reviewed the data analysis and the draft manuscript.

Probir K. Ghosh (PKG): PKG reviewed the data analysis strategy and the draft manuscript.

Richard B. Johnston (RBJ): RBJ was involved in the conception of the study that generated the data for this secondary data analysis. He contributed by reviewing the draft manuscript.

Adam Biran (AB): AB contributed in defining the research questions for the secondary data analysis, supported the first author during the literature review, reviewed the data analysis, helped with interpretation of data and reviewed the draft manuscript.

Stephen P. Luby (SL): SL was the executive author for this manuscript. He was the Principal investigator for the study that generated the data for this secondary data analysis. He contributed in defining the research questions for the secondary data analysis, reviewed the data analysis, helped with interpretation of data and reviewed the draft manuscript.

5.3 Research paper cover sheet

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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	Tarique Mohammad Nurul Huda
Principal Supervisor	Adam Biran
Thesis Title	Role of Sanitation in preventing faecal contamination of the domestic environment and protecting health: An observational study.

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.

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SECTION C – Prepared for publication, but not yet published

Where is the work intended to be published?	American Journal of Tropical Medicine and Hygiene
Please list the paper's authors in the intended authorship order:	Tarique M N Huda, Wolf-Peter Schmidt, Amy J. Pickering, Leanne Unicomb, Zahid Hayat Mahmud, Stephen P. Luby and, Adam Biran
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 had the primary role of designing the study, overseeing the field work, analysing the data, and drafting the manuscript
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Student Signature: Triaune

Date: 22nd January 2016

Supervisor Signature: [Signature]

Date: 25th January 2016

Title: A cross sectional study to explore the association between sanitation type and diarrhoeal disease.

Authors: Tarique M. N. Huda¹, Leanne Unicomb², Amal K. Halder², Wolf-Peter Schmidt¹, Probir K. Ghosh², Richard B. Johnston^{4,5} and Adam Biran¹, Stephen P. Luby^{2,3}

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5.4 Abstract

This secondary data analysis aimed to assess the relationship between sanitation type, and diarrhoeal disease using data collected as part of a programme evaluation. The evaluation was conducted in Bangladesh to assess the impact of a large-scale water, sanitation and hygiene education programme implemented by the government of Bangladesh with technical support from UNICEF Bangladesh, between 2007 and 2011.

Field workers interviewed the primary caregivers of children under five years of age and performed a spot check of sanitation facilities. Those households with at least one child < 3 years of age (N=995 households) were also visited by a female community monitor, monthly for 24 months to collect data on reported diarrhoea in the preceding 2 days. We first categorised sanitation facilities based on UNICEF/WHO Joint Monitoring Programme (JMP) technology type, as “improved” (latrine with a water seal connected to sewer/septic tank/pit, pit latrine with a slab), “unimproved” (pit latrine without slab, hanging latrines) and “no facility”. We then further classified sanitation facilities according to JMP sanitation ladder with 4 categories: “private improved, shared improved, unimproved and no facility

Children from households with access to unimproved sanitation had similar prevalence of diarrhoea as those with a private improved sanitation (Prevalence= 11.1 vs. 10.2; adjusted PR=1.001; 95% CI: 0.80, 1.25). Children belonging to households with access to shared improved sanitation had similar prevalence of

diarrhoea (11.6%) as those with access to private improved sanitation (adjusted PR=1.01; 95% CI: 0.90, 1.13). Households with visible faeces on the slab had higher prevalence of diarrhoea compared to those with no faeces on the slab (Adjusted PR=1.09; 95% CI=0.96, 1.25).

Children from households with an appropriate solid waste disposal system had lower risk of diarrhoea (PR=0.74, 95% CI: 0.61, 0.89) compared to those without appropriate solid waste disposal. Adjusting for other variables in the multivariate model did not change the effect estimate. Presence of soap and water in a handwashing station was only weakly associated with lower diarrhoea risk (PR=0.91; 95% CI: 0.82, 1.02; P=0.12). Children from households with an appropriate solid waste disposal system had lower (statistically significant) risk of diarrhoea (PR=0.74, 95% CI: 0.61, 0.89) compared to those without appropriate solid waste disposal system. Adjusting for other variables in the multivariate model did not change the effect estimate.

Household level provision of onsite sanitation facilities considered as improved for international monitoring does not prevent diarrhoea disease in context where diarrhoea is endemic. Sharing a sanitation facility does not appear to be a risk factor for diarrhoeal disease in the context where sanitation facilities are shared among relatives or neighbours who know each other. In addition presence of soap and water at the designated handwashing station and storing water in a covered container was not associated with any reduction in diarrhoea prevalence. However presence of an appropriate solid waste disposal system was associated with reduction in the prevalence of diarrhoea.

Key words: Improved sanitation, diarrhoea, shared sanitation, 5>children

5.5 Introduction

Diarrhoeal diseases are among the top five causes of death in children under five years of age [1, 2]. Although there has been a decline in the incidence of diarrhoea there were still 1.7 billion episodes of diarrhoea in 2010, in 139 low and middle income countries [3]. Diarrhoea is also a risk factor for pneumonia [4, 5]. Repeated episodes of early childhood diarrhoea have a lasting influence on the physical growth, cognitive function and school performance [6-9].

Most cases of diarrhoea are transmitted through the faecal oral route [10]. Appropriate human excreta disposal systems, generally referred to as sanitation, are expected to break the chain of transmission by separating faeces from the environment [11, 12]. In 2012, 280,000 diarrhoea deaths were estimated to be caused by inadequate sanitation [13]. A recent systematic review suggests that interventions to improve sanitation were associated with a 28% reduction in diarrhoeal disease [14]. In recognition of the need for action on sanitation, Millennium Development Goal (MDG) 7, target 10 was to “halve, by 2015, the proportion of people without sustainable access to basic sanitation” [15, 16].

The WHO/UNICEF Joint monitoring Programme (JMP) for water supply and sanitation is the official United Nations mechanism tasked with monitoring towards the MDG related to water and sanitation. Access to sanitation is monitored using the indicator “proportion of population with access to improved sanitation.” [16-18]. The terminology used for the MDG target is “basic sanitation” but JMP refers to basic sanitation as “improved sanitation”. According to JMP, improved sanitation refers to “facilities that ensure hygienic separation of human excreta from human contact” [19, 20]. The JMP improved sanitation technologies include: latrine with a water seal connected to a sewer system or septic tank, and pit; ventilated improved pit latrine; composting latrine and pit latrine with slab. However sanitation facilities are not counted towards MDG coverage and are considered “unimproved” if they are shared [20], because of concerns regarding cleanliness, maintenance of the facility and access [21]. In addition, JMP also uses a four rung-ladder of sanitation, defined by a hierarchy of predefined sanitation technologies that allows monitoring

progress without changing the MDG definition [22]. The sanitation technologies on the higher rung of the ladder are believed to be better at hygienically separating faeces from the environment and thereby reducing health risk [17, 22]. Ideally for international monitoring sanitation would be classified on the basis of evidence for its relative effectiveness in delivering health benefits, but this evidence base is generally weak [23-26].

Findings from a few observational studies suggest that access to latrines with water seals connected to a piped sewer system, septic tank/pit and composting latrines are associated with lower risk of diarrhoea [25, 27-30]. However, from these studies we do not know if pit latrines with a slab but without a water seal will provide similar protection.

Several observational studies have used data from demographic health surveys (DHS) to assess the effect of improved sanitation on diarrhoea risk. Studies conducted in Indonesia [31] and Malawi, found that children from households with access to a private improved sanitation facility had lower odds of diarrhoea [32] compared to those with no sanitation facility. A study conducted by Fuller and colleagues used 217 Demographic and Health Surveys from 74 countries, found that access to improved sanitation was associated with reduced prevalence of diarrhoea [Prevalence Ratio (PR): 0.93 95% CI; 0.92-0.95] [33]. But the effect of sanitation on diarrhoea varied between countries and across time suggesting that the environmental, social and geographical context plays important role. The questions used for DHS to capture the data on latrine classification are focused on the design of the latrine rather than the functionality of the latrine [34]. For example a pit latrine with a slab may be considered as improved by JMP because of the design. But if there is a leakage in the pit, the faeces will come out of the pit and contaminate the environment. So this latrine cannot be considered to hygienically separate faeces from the environment and thereby JMP should not consider it as improved. But, the DHS questionnaire does not include questions to capture this information [35]. As a result these national surveys likely include substantial measurement error of exposure.

There is also evidence from large nationwide surveys that access to private improved (MDG) sanitation is associated with less diarrhoea [36, 37]. These large surveys are prone to substantial measurement error in categorising sanitation facilities due to reliance on report by the respondent and lack of detailed questions to assess the functionality of the latrine in confining faeces. More over in these large nationwide surveys data on reported diarrhoea is collected at one point in time that cannot capture the seasonality of diarrhoea. However diarrhoeal diseases follow seasonal variation [38] and sanitation may have a variable effect depending on the season. This is why longitudinal prevalence of diarrhoea estimated through repeated measures has been identified as a preferable indicator of diarrhoea for low income high risk populations [39, 40]. A nationwide study conducted in rural Indonesia suggested that lack of improved latrines was associated with higher reported diarrhoea (OR=1.23, 95% CI: 1.18-1.29) [26] and under 5 child mortality (OR = 1.29, 95% CI = 1.25–1.31). This study used the JMP definition and collected longitudinal diarrhoea data to capture variation in seasonality. However this finding has not been replicated in other low income country contexts.

We have identified some studies that have looked at the effect of sharing a latrine on diarrhoea. A recent systematic review conducted to compare health outcomes associated with shared sanitation versus individual household sanitation reported increased adverse health outcomes associated with shared sanitation. However most of the studies included in the review did not adequately address potential confounding and did not allow the effect of different types of shared sanitation (Improved/unimproved) to be distinguished [24]. An analysis of DHSs from 51 countries reported a 10% reduction in diarrhoea among households with private sanitation facilities compared to households with shared sanitation [23]. The study also reported heterogeneity in the effect of shared sanitation across countries. A multicounty case control study conducted in 7 low income country sites in sub-Saharan Africa and South Asia found families of children with moderate to severe diarrhoea more commonly used shared facilities than control families (47.5% vs. 41.2% OR=1.2; 95% CI 1.1-1.3) overall [41]. But these findings were not consistent in all the 7 countries. Suggesting that local context plays an important role. More over

within the same country sharing may have variable effect in rural and urban context or depending on whether sanitation is shared by neighbours or acquaintances or by public. We have limited data to understand the context in which shared sanitation is as effective in separating human faeces from human contact as private sanitation.

The objective of the present study was to assess the association between sanitation type and diarrhoeal disease among children <5 years of using data collected as part of an evaluation of a water, sanitation and hygiene intervention project [42-44]. The findings of this study will help us to understand the relevance of different classifications of sanitation used for international monitoring.

5.6 Methods

The data used in this secondary analysis was collected as part evaluation of the sanitation, hygiene education and water supply in Bangladesh (SHEWA-B) programme. The methods of the programme evaluation including household enrolment, assessment of exposure and outcome, human subject protection has been described elsewhere [42-44]. However for the convenience of the reader some of these are described briefly.

5.6.1 Study population

The study population of this secondary data analysis were the households with children <5 years of age in rural Bangladesh where a large health impact study was being implemented. The SHEWA-B programme selected the specific intervention sub-districts with lower than average performance in term of health and social indicators because of the perceived need and the absence of other active programs addressing water, sanitation and hygiene in these communities. The control areas of the SHEWA-B health impact study were selected from similar geographical and socioeconomic status as the intervention areas [42-44].

5.6.2 Household enrolment

The SHEWA-B health impact study team selected fifty intervention unions using probability proportional to population size. Fifty control unions were also selected using probability proportional to population size of the union.

The SHEWA-B health impact study team collected a list of all the villages from the union council. From each of the selected unions a village was selected randomly from the list of villages in that union. The field workers visited the village and identified the centre of the village by asking the residents. They then identified an eligible household nearest to the centre point and sought consent for an interview. A household was considered to be eligible if they had at least one children <5 years of age. To enrol the next household, the field workers skipped the next two closest households, and then looked for the next closest eligible household. The first 10 households with a child <3 years of age were also requested to participate in a monthly disease surveillance [42-44].

5.6.3 Assessment of household sanitation

In 2007, the SHEWA-B health impact study field workers conducted a face to face interview with the primary caregivers of children <5 years of age to fill out a structured questionnaire survey. The field workers were trained in data collection using the assessment tool, how to conduct interviews, and human subject protection. Before the actual data collection the field workers conducted practice interviews outside the study areas.

The questionnaire survey included questions regarding demographic information, household possessions and behaviour related to water sanitation and hygiene. Then fieldworkers also conducted a spot check of the household water, sanitation and hygiene related infrastructure to record the quality and upkeep of the facility. The initial questionnaires were developed based on the indicators for the evaluation. The questionnaire was then reviewed by the principle investigator of the evaluation as a quality assurance procedure including checking for ambiguous or potentially leading questions. The questionnaire was developed in English and then translated in Bengali. The questionnaire was pilot tested in the field for comprehensibility prior to final data collection. Questions were amended, reworded or replaced following piloting.

A field supervisor was responsible for ensuring the quality of data collected in the field. For at least 5% of the surveys the field worker observed the data collectors and conducted repeat interviews. Each field facilitator was observed to make sure the questions were asked as intended. At the end of data collection each data collector reviewed the completed forms, before leaving the house to check for completeness. At the end of a data collection day, the enumerators cross-checked each other's completed questionnaire in the presence of the field supervisor for any inconsistency in data.

5.6.4 Assessment of diarrhoea

The SHEWA-B health impact study team recruited a female community member with at least eight years of formal education and trained them as a community monitor in each of the study villages. The community monitor was trained in use of the data collection tool, interview technique and human subject protection. The community monitor visited each of the enrolled households after the initial questionnaire survey, every month for 24 months, starting from October 2007. They collected information on episodes of diarrhoea among all children <5 years of age in a household, during the 2 days preceding the interview. Diarrhoea was defined as the passage of 3 or more loose or watery stools in the 24 hours period preceding the interview [45]. The questionnaire was designed following the same steps as the questionnaire for household assessment.

A field supervisor monitored the collection of data by the community monitors. The community monitors reviewed the completed data collection forms before leaving the respondents household. Every month the field supervisor reviewed the completed data collection forms to check for consistency and completeness of data. Then before entering the data a research officer reviewed the completed data collection forms for consistency and completeness.

5.6.5 Operational definitions of variables used in the secondary data analysis

We categorised the primary exposure variable, sanitation access in four different ways based on information collected through the survey. First, we

categorised sanitation facilities as “improved” or “unimproved” as defined by JMP based on technology type (Table 1). Second, we further categorised improved sanitation facilities based on whether the facility used water seal technology. Thus we classified all households in four technology categories: a) improved with a water seal, b) improved without a water seal, c) unimproved facility, and d) open defecation. If during visual inspection, a sanitation facility was found to have a water seal but the seal was broken then it was considered as an improved facility without water seal. Third, we categorised sanitation facilities according to the four categories of the JMP sanitation ladder: a) improved private facilities b) improved shared facilities c) unimproved facilities (pit latrine without a slab or hanging latrine) d) no facilities. Fourth, we categorised sanitation facilities based on the MDG definition where improved private facilities were considered “improved” and the rest of the categories in the ladder were considered “unimproved” (Table 1). A latrine was considered to be dirty if the field workers could see faeces in the commode or slab/floor.

A household was considered to have appropriate water drainage if it had either a drain (constructed with or without concrete and cement) or a soak pit in order to dispose of household waste water. A household was considered to have appropriate solid waste disposal if it had a drum or a specific pit and the waste was found to be disposed in such a way that no waste was observed outside the pit or drum. A household was considered to have appropriate drinking water storage if the field workers found all drinking water containers fully covered at the time of rapid observation. A household was considered to have a proper handwashing facility if water and soap was found in a convenient hand washing station.

To assess the household wealth, we used principal component analysis (PCA) with 23 household characteristics (Table 2) [43, 46-48] excluding water and sanitation infrastructure.

5.6.6 Sample size calculation

We analysed data collected from 1000 SHEWA-B health impact study households. Since the intervention had very limited impact on diarrhoea prevalence

in the first two years of implementation we included both the intervention and control households [49]. We assumed 95% confidence and a design effect of 2.5 and had 86% power to detect 30% (12% to 8%) difference in diarrhoea prevalence among 1.4 children per HH when comparing 400 households with improved latrines to 600 households with other type of latrines.

5.6.7 Human subject protection

All study participants of SHEWA-B health impact study provided written informed consent. The Government of Bangladesh Department of Public Health Engineering and UNICEF approved the evaluation. icddr,b administration provided an expedited approval of the study [43]. The hard copies of the questionnaire were stored in a locked cabinet at the icddr,b head office and were only available to the study officials. The electronic data were kept in a password protected computer and were accessed by the study officials only.

5.6.8 Data analysis

We calculated the prevalence ratio (PR) of reported diarrhoea among children <5 years of age comparing households with different type of sanitation access using a log-binomial model [50]. To calculate 95% confidence intervals (CI) adjusting for clustering at the village level and repeated observations of diarrhoea in a single household we used generalised estimating equation (GEE) [51] with a robust standard error estimator with the village as the cluster variable.

We conducted univariable analysis to estimate the crude effect of the primary exposure variables and potential confounding variables on the main outcome, adjusting for the effect of village level clustering. We used causal directed acyclic graph (DAG) [52-54] to decide which variable to be included as a potential confounder, excluding variables on the same causal pathway as the exposure variable [55]. All the potential confounding variables that were associated with the outcome and exposure in the univariable analysis were included in the multivariable model [53, 56]. We also considered some forced-in variables (age, gender, wealth, and mother's education) to be included in the model. For the multivariable model

we included the main exposure, outcome, forced-in and all the confounders together. We calculated the variance inflation (VIF) factor for all the variables in the model to assess multicollinearity [57-59]. We implemented separate multivariate models for the four definitions of sanitation type as primary exposure.

5.7 Results

5.7.1 General household characteristics

Among the 1000 households enrolled in the study who completed the initial questionnaire survey, the field team collected at least one measure of diarrhoea symptoms from 1272 children belonging to 995 households. Twenty nine percent of the mothers reported to have some formal education. More than half of the fathers were farmers or daily wage earners. The most common source of drinking water were shallow tube-wells (81%) (Table 5.2).

Most (92%) of the households reported having access to a latrine. More than half of the households individually owned a latrine. Among the households who reported access to any latrine, 44% (n=400) reported sharing the facility with at least 1 other household (Table 5.2). The most common type of latrine accessed by these households was a pit latrine with a slab (n=553, 56%) More than 90% of the households had access to an improved source of water for drinking. Thirty one percent of these households individually owned a water source (Table 5.3). About 50% of these households had access to soap and water at a convenient place. About a quarter of these households stored water in a covered container.

5.7.2 Diarrhoea prevalence

Over 24 months time period, on average the community monitors visited children 22 times with the majority (67%, 863) of them visited 24 times. In total the field team completed 27, 843 monthly child visits, diarrhoea was reported in 26,097 of the child visits. In the 26,097 child visits, the primary caregiver reported that their child had diarrhoea in the preceding 2 days in 2,804 monthly child visits (10.7%).

Male children had nine percent higher diarrhoea prevalence compared to female children (95% CI: 0%, 20%; P=0.05). In the multivariate analysis the estimate

remained the same although the strength of the statistical evidence became slightly weaker (adjusted PR=1.09; 95% CI: 1.00, 1.19; P=0.06). Children under 2 years of age had increased risk of diarrhoea than older children (PR=1.43; 95% CI: 1.26, 1.63; P<0.001). Adjusting for other variable changed the effect estimate only slightly.

Children whose mother had formal education had 13% lower risk of diarrhoea (PR=0.87; 95% CI: 0.77, 0.98). In multivariable analysis the effect was attenuated slightly but the 95% confidence limit included the null (adjusted PR=0.89 95% CI: 0.78, 1.01; P=0.07). Children belonging to upper middle wealth quintile had lower prevalence of diarrhoea compared to children in poorest quintile (PR= 0.85; 95% CI: 0.72, 1.01) (Table 5.4). In the multivariate analysis the estimate changed towards the null and the strength of the statistical evidence became much weaker (PR= 0.91; 95% CI: 0.75, 1.09).

5.7.3 Sanitation technology type

Twenty three percent of households had access to an improved sanitation facility with a water seal and 56% had access to an improved sanitation facility without a water seal (Table 5.3). Children from households with access to an improved sanitation facility without a water seal had a 14% higher prevalence of diarrhoea compared to children from households with access to an improved sanitation facility with a water seal (95% CI: -2%, 33%) (Table 5.4 and 5.5). In the multivariate analysis the estimate of diarrhoea risk was slightly lower and the strength of the statistical evidence became weaker (PR=1.11; 95% CI: 0.94, 1.30, P=0.12). In reference to the households with access to an improved sanitation facilities with a water seal access to an improved sanitation facilities without a water seal and access to unimproved sanitation facility (PR=1.10; 95% CI 0.86, 1.40; P=0.46) was associated with similar reduction in the prevalence of diarrhoea (Table 5.5).

Children belonging to households with access to improved sanitation technology had only 5% reduced risk of diarrhoea compared to those with access to unimproved sanitation technology (excluding open defecation) (PR=1.05; 95% CI

0.82, 1.25) (Table 5.4, 5.5). But the 95% confidence interval included null. In the multivariate analysis most of this small effect size was eliminated by confounders.

5.7.4 JMP sanitation ladder

Less than half (43%) of the households had access to private improved sanitation where about 36% of households had access to a shared improved sanitation. Children from households with access to a private improved sanitation had diarrhoea on 10% of the monthly visits. Children belonging to households with access to a shared improved sanitation had only 4% increased risk of diarrhoea compared to those with access to private improved sanitation (PR=1.04; 95% CI: 0.93, 1.17) (Table 5.4, 5.5). But the 95% confidence interval included null. In the multivariate analysis, adjusting for the effect of confounders like; children's gender, age, presence of soap and water at a convenient location, presence of solid waste disposal system, mother's education and wealth, most of this small effect size was eliminated (PR=1.01; 95% CI: 0.90, 1.13) by confounders (Table 5.5).

5.7.5 MDG classification

The prevalence of diarrhoea among children <5 years of age in households with access to private improved sanitation was 10.2% and in households with access to unimproved sanitation the prevalence was 11.2%. The mean diarrhoea prevalence over the 24 months in households with access to improved sanitation as defined by MDG, was only 5% lower than households with access to unimproved sanitation facilities (PR=1.05; 95% CI: 0.94, 1.18)(Table 5.4 and Table 5.5). However, the 95% confidence interval included null. In the multivariate analysis most of this small effect size was eliminated by confounders (Table 5.4 and Table 5.5).

5.7.6 Other sanitation characteristics

The mean diarrhoea prevalence among children from households with access to any type of shared sanitation facilities was 11.7%. The children from households with access to shared sanitation facilities had 6% higher diarrhoea prevalence compared to those with access to private sanitation facilities (PR=1.06; P=0.27).

However, the difference observed could be due to chance alone. (Table 5.4 and Table 5.5).

Among households with access to improved sanitation technology as defined by JMP, households with access to a dirty improved sanitation had 15% higher diarrhoea prevalence compared to those with clean improved sanitation (PR: 1.15; 95% CI: 1.01, 1.30; P=0.04). In the adjusted analysis the prevalence ratio was smaller and was not statistically significant (PR: 1.09; 95% CI: 0.96, 1.25; P=0.20) (Table 5.6).

5.7.7 Other household characteristics

Children from households with an appropriate solid waste disposal system had lower risk of diarrhoea (PR=0.74, 95% CI: 0.61, 0.89) compared to those without appropriate solid waste disposal system. Adjusting for other variables in the multivariate model did not change the effect estimate. Presence of soap and water in a handwashing station was associated with 9% lower prevalence of diarrhoea but the association was not statistically significant (PR=0.91; 95% CI: 0.82, 1.02; P=0.12). Children from households who stored water in a covered container had lower prevalence of diarrhoea but the reduction was not statistically significant (PR=0.94; 95% CI: 0.84, 1.05; P=0.25). Children who were exclusively breast fed as reported by the mother in the past 24 hours had lower prevalence of diarrhoea compared children who were not exclusively breastfed. But the difference was not statistically significant (PR=0.92; 95% CI: 0.72, 1.17; P=0.50).

5.8 Discussion

The proportion of the rural Bangladeshi population living in the study area, with access to MDG defined improved sanitation was below 50%, which is slightly lower than the national estimate of 52% in 2007 [60]. This could be due to the study area being chosen for its lower than national average performance in term of water sanitation coverage [61].

The objective of the study was to assess the association between sanitation type and diarrhoea. We classified sanitation using three classifications (JMP

technology, MDG, JMP sanitation ladder) used for international monitoring. None of the classifications of household level sanitation explained differences in diarrhoea prevalence that was independent of confounding child and household characteristics. Neither technology types that were considered as improved nor sharing of a sanitation facility was associated with diarrhoea prevalence independent of confounding. Other household and child characteristics that were associated with diarrhoea risk independent of effect of other variables included female gender, lower age and absence of appropriate solid waste disposal, and lack of mother's education. Taken together these findings suggest that in the context of rural areas with predominantly onsite sanitation, household provision of sanitation may not be causally associated with any reduction in diarrhoea risk among children under 5 years of age. The fact that none of the classifications of sanitation used for international monitoring explained difference in diarrhoea risk that is independent of confounding and the fact that other sanitation factors like cleanliness of latrines were associated with modest and statistically insignificant reduction in diarrhoea may suggest that in this context other determinants of childhood diarrhoea such as open defecation by children, lack of cleanliness of latrine, lack of sanitation in the neighbourhood, presence of animal faeces, lack of handwashing with soap, poor food hygiene, drinking water quality and nutritional status may be more important.

Previous studies that have evaluated the relationship between improved sanitation technology (ignoring sharing) access and diarrhoea have shown conflicting results [26, 33]. The heterogeneity in the effect of improved sanitation technology across different studies and surveys could be due to difference in the degree of measurement error or due to difference in various factors related context of the study. In the study conducted in Indonesia [26] latrine categorisation was based on self-reports rather than visual inspection. Even the standard questionnaire used in DHS has the potential to cause misclassification bias as a latrine is judged based of the design of the facility rather than function of the latrine in separating faeces from the environment. For example, a latrine might have a pit latrine with a water seal but if the pit is broken from the back it will contaminate the environment [62]. This misclassification bias due to measurement error would influence the measure of

association toward the null. However in this study the categorisation of latrine was done based on visual inspection rather than self-report to minimise misclassification bias. The source of heterogeneity could also be due to different contexts. A multi-country analysis of the effect of improved sanitation technologies on diarrhoea found that in some contexts access to improved sanitation was protective while in some there was no association while in some, there was a harmful effect [26].

In our study context access to improved sanitation technologies may not be associated with diarrhoea for two important reasons related to study context. First, in our study context diarrhoea is endemic, so the population is likely to have some level of immunity to common circulating pathogens. This may attenuate the relationship between improved sanitation access and diarrhoea [63].

Second there may be other sources of household faecal contamination like open defecation by children, lack of cleanliness of latrine, lack of sanitation in the neighbourhood and presence of animal faeces that are important in reducing diarrhoeal disease but access to improved sanitation cannot prevent them. In addition lack of proper faecal sludge management could also contribute to faecal contamination of the community and there by contribute in diarrhoea disease transmission that household access to sanitation could not capture in this study. So even if improved sanitation technologies are effective in confining faeces if used, access to improved sanitation may still not be associated with reduced diarrhoea.

Moreover it is possible that in this context other transmission pathways like hands, food and drinking water are more important determinants of diarrhoea disease. Although in this analysis storing drinking water in a covered container was not associated with diarrhoea but in similar setting microbiological quality of drinking water was associated with diarrhoea [64]. Furthermore, in a recent systematic review it was found that intervention to improve water quality at point of use may reduce diarrhoea by at least around a quarter [65]. In our study presence of soap and water was associated with small and statistically insignificant reduction in diarrhoea. But evidence from a recent systematic review suggests that handwashing promotion among communities in low and middle income countries (LMICs)

prevents around one-quarter of diarrhoea episodes [66]. Exclusive breast feeding has been recommended as an important diarrhoea prevention strategy [67, 68]. But in this study exclusive breast feeding was also not associated with reduction in diarrhoea. Take together these findings suggest that this setting diarrhoea disease can only be prevented by interventions that address more than one transmission pathway. A recent study has identified that during the past ten years sanitation or water have only been effective in reducing diarrhoea if they were combined [33]. Further studies to look at the combined effect of these factors on faecal contamination and diarrhoea would be informative.

The MDG classification of sanitation combines the technology type as well as sharing status. It is possible that sharing of latrines does not pose any additional risk. As a result categorisation of shared facilities as unimproved might account for no association between improved sanitation as defined by MDG and diarrhoea. However in this study when shared facilities were also considered as improved access to improved sanitation had no effect on the prevalence of diarrhoea that is independent of confounding. This may suggest that sharing is less likely to dilute the effect of sanitation on diarrhoea. The evidence in the existing literature linking access to shared sanitation and diarrhoea is inconsistent [23, 24, 69]. In some countries sharing a latrine has been found to be associated increased risk of diarrhoea (not always statistically significant), in some other countries sharing was associated with reduced risk of diarrhoea [24], and in some countries there was no relationship between sharing and diarrhoea [23, 24, 69]. This heterogeneity among countries suggests that the specific social economic and environmental context matters.

Sharing a latrine may have harmful effects because of issues related to cleanliness, maintenance, over use or lack of full time access. These factors are likely to vary depending on the relationship between families sharing the facilities and interaction between them. It is possible that in the context where the people are related or know each other sharing poses less risk because there is less problems with maintenance, access and over use. Although in this study the shared facilities were more likely to be dirty but dirty latrines were more likely to be poorer. The

relationship between shared facilities and cleanliness of latrine was confounded by wealth (Data not shown). So in this context the cleanliness of latrine is less likely to be due to sharing. Households or people sharing the latrine in rural Burundi was not found to be influential [60] in the cleanliness of the latrine. But in urban India sharing a latrine among non-family members were found to be dirtier [61]. It is beyond the scope of this study to fully explain the mechanism by which sharing poses increased risk or setting shared sanitation is safe. Further studies looking at shared facilities comparing different management arrangement of shared facilities will be helpful.

In this study we found that access to an improved and clean latrine was associated with a modest reduction in diarrhoea, with some evidence of confounding. Although the statistical evidence to support this association was weak. It is important to note that this study was not powered to conduct this subgroup analysis. Cleanliness of latrines have been linked with increased bacterial pathogens, latrine use [70, 71], diarrhoea outbreaks [72, 73] and reduced absence from school [74]. Cleanliness might improve use and thereby reduce contamination and prevent diarrhoea. Latrine cleanliness might also be a proxy for general cleanliness and hygiene of the household that are important in reducing transmission of infectious diarrhoea. Although in this observational study we cannot establish causality our findings suggest that latrine cleanliness should be considered as an important component of sanitation interventions.

Our analysis suggests that access to latrines with water seal is associated with more than a 14% reduction in diarrhoea, although the 95% confidence limits included the null. The multivariable analysis suggests that this weak statistical association was confounded by household and child characteristics. Although confounders explained some of the difference it did not explain all of the difference. In this study sanitation was measured before diarrhoea so reverse causality is less likely to affect the estimates. Latrines with water seals prevent flies from coming out of latrines. Presence of flies in the latrine has been found to be associated with diarrhoea [75]. Although, the reduction could be due differences in socio-economic status, between the households with and without presence of flies. The study by Fink and colleagues found children living in households with latrines with water seals

had lower odds of diarrhoea than children in households with basic/improved pit latrine or no latrine. So taken together these findings suggest that access to improved sanitation with water seal technologies might be better in reducing diarrhoea independent of confounding. In this observational study we cannot establish causality as there may be residual confounding due to unmeasured confounding factors. Moreover we did not measure fly density to understand the underlying mechanism by which flush latrines with water seals prevent diarrhoea disease transmission. Further studies with randomised intervention trial might help us better understand this issue.

Appropriate solid waste disposal was found to be associated with lower prevalence of diarrhoea in this study as well as in other studies conducted in different contexts [76, 77]. This may suggest that in this setting, factors like waste disposal might be playing important role in reducing diarrhoeal disease transmission.

Our analysis has some important limitations. This analysis used data from both intervention and control households. It is possible that the intervention area had more improved sanitation and less diarrhoea and there by attenuating the effect of sanitation on diarrhoea. However the intervention did not have any effect on diarrhoea or access to sanitation [61], moreover in our analysis intervention status did not change the effect of sanitation on diarrhoea when adjusted for one variable at a time (Data not shown).

It is possible that households with access to improved sanitation as defined by the MDG were still exposed to diarrhoea causing pathogens from the faecal material of their neighbour [78] if their neighbours have unimproved or no access to a latrine. Infectious diseases are transmitted in both private and public domain [79, 80]. But we do not have data on neighbourhood sanitation to disentangle the effect of improved sanitation given the neighbourhood context. However these findings emphasize that household sanitation access alone may not be a good predictor of diarrhoeal disease in this context.

An important limitation of this study is lack of data on microbiological drinking water quality [64] and nutritional [81-83] status of the child. These are important determinant of diarrhoea and could be a potential confounder. Future studies should collect data on these important determinants of diarrhoea.

The findings from this analysis suggest that in the context where diarrhoea is endemic access to improved onsite sanitation may not be sufficient in reducing diarrhoea disease transmission among children less than five years of age. Additional sanitation related factors such as latrine cleanliness, child faeces disposal, presence of water seal may be necessary in separating human faeces from human contact. Future research to see how these sanitation factors interact with each other in reducing diarrhoeal disease transmission might help us to decide the focus of future sanitation intervention and indicators of international monitoring of sanitation. In rural context where sanitation facility is shared among neighbours or extended family members sharing may not pose additional risk of diarrhoea. However apart from concerns related to health risk associated with shared sanitation there are concerns from a human rights perspective that has to be considered if shared facilities are to be considered as improved for the Sustainable Development Goals. Intervention to improve sanitation may not be sufficient in reducing diarrhoea, so we may need to combine intervention to improve hand hygiene, food hygiene, water quality and nutritional status. Future studies to see combined effect of intervention may be relevant for policy makers to decide how sanitation can be combined with other interventions to achieve maximum health benefit.

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Figure 5.1: Directed acyclic graph (DAG) showing general child level/household level; water, sanitation, and hygiene related exposure variables and diarrhoea disease transmission.

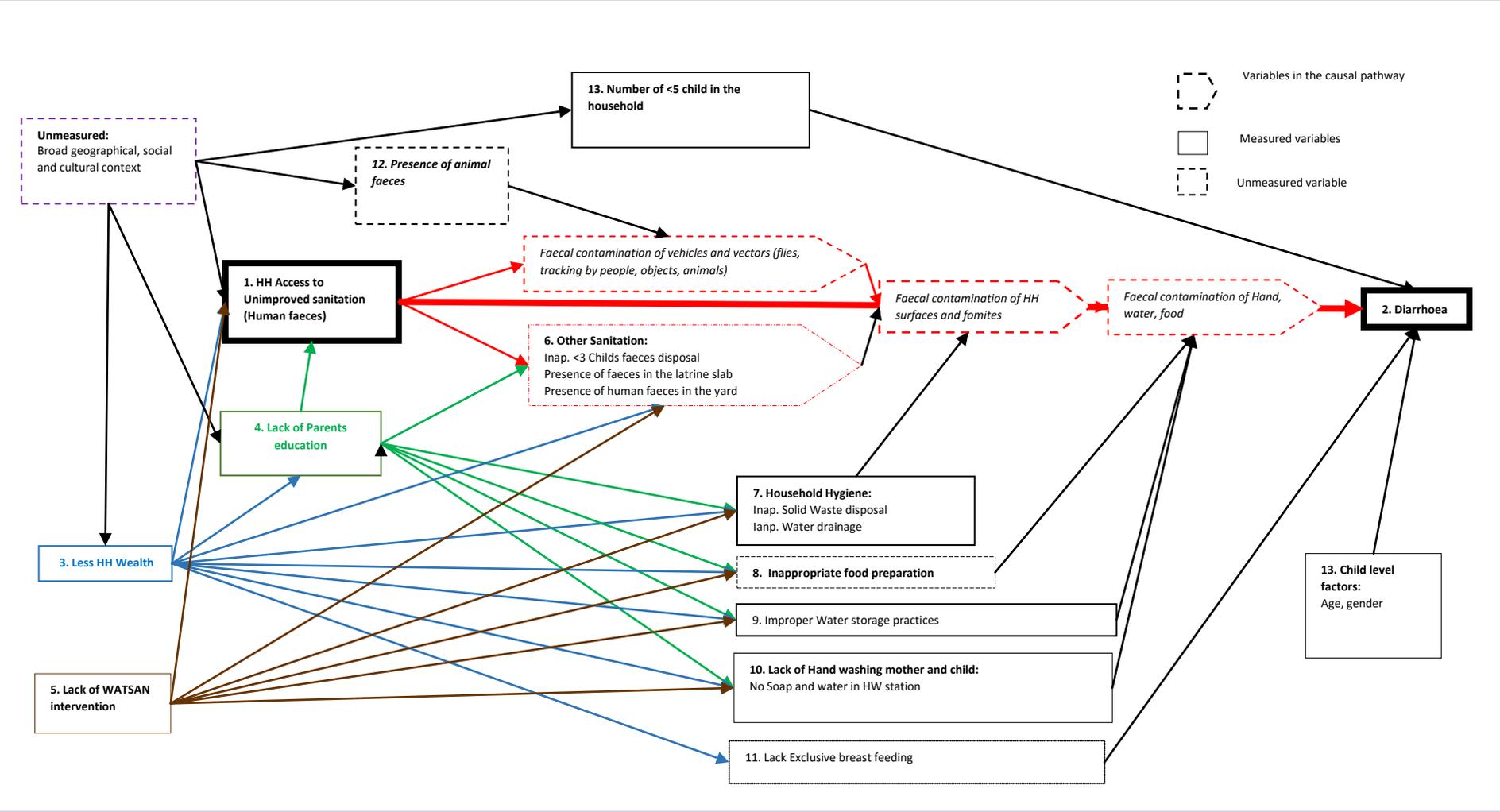


Table 5.1: Classification of sanitation used for international monitoring [20].

MDG	JMP sanitation ladder	JMP technology type*	Technology type*	Sanitation technology
Unimproved	Open defecation	Open defecation		Defecation in fields, forests, bushes, bodies of water or other open spaces, or disposal of human faeces with solid waste.
	Unimproved	Unimproved		Facilities that do not ensure hygienic separation of human excreta from human contact. <u>Unimproved facilities</u> include <ul style="list-style-type: none"> • pit latrines without a slab or platform • hanging latrines/ Bucket latrines. • flush or pour-flush latrine/latrine to open • pit latrine with a slab but with a leakage in the pit lining
	Shared improved	Improved	Improved With water seal	Facilities that ensure hygienic separation of human excreta from human contact. They include: <ul style="list-style-type: none"> • <u>Improved-flush or pour-flush latrine/latrine</u> to: <ul style="list-style-type: none"> – piped sewer system – septic tank – pit latrine
Improved	Improved Without water seal		<ul style="list-style-type: none"> • <u>Improved-Non flush pit latrine with slab</u> 	
*Ignoring sharing of facility				

Table 5.2: Household characteristic in rural Bangladesh, 2007 (N=995).

Variable	n	Percent or mean
Mean Number of household (HH) residents	995	5.6
Mean Number of children age <5 years	995	1.3
Female <5 children	505	51
Mothers with no formal education	286	29
Fathers with no formal education	347	35
Father's occupation		
Farmer/homemaker	247	25
Day labour, Rickshaw puller	288	29
Skilled worker	93	9.5
Working abroad	68	6.8
Salaried employee	109	11
Business owner	176	18
House construction		
Tin roof [†]	905	91
Cement floor [†]	88	8.8
Brick walls [†]	98	10
Mean number of rooms [†]	996	2.2
Household with electric connection [†]	459	46
Proportion who owned		
House [†]	930	93
Wardrobe [†]	286	29
Radio [†]	210	21
Bicycle [†]	258	26
Mobile phone [†]	309	31
Black and white television [†]	190	19
Colour television [†]	90	9.1
Sewing machine [†]	62	6.2
Refrigerator [†]	23	2.3
Motor cycle [†]	23	2.3
Mean number of items owned		
Tables [†]	995	1.1
Chairs [†]	995	2.2
Watches/clocks [†]	995	1.4
Beds [†]	995	0.9
Inexpensive sleeping cots [†]	995	1.3

Mean acres of agricultural land [†]	995	0.88
Mean acres of non-agricultural land [†]	995	0.19
Have access to a latrine	918	92
Have shared access to a latrine	400	44
Individually owned a latrine	518	56
Source of water for drinking		
Shallow tube well	805	81
Deep tube well	96	10
Individually owned source of drinking water	306	31
Cooking Fuel [†]		
Wood	249	25
Crop residue/grass	611	61
Dung	127	13

[†]Included to calculate wealth quintile.

Table 5.3: Distribution of latrine characteristics in rural Bangladesh according to different classification of sanitation (N=995).

Classification	Sanitation Type	n	%
JMP sanitation technology type	Improved	786	79
	Unimproved	132	13
	No facility	77	8
Sanitation technology type (Modified JMP)	Improved with a water seal	233	23
	Improved without a water seal	553	56
	Unimproved	132	13
	No facility	77	8
JMP sanitation ladder	Private improved	425	43
	Shared improved	361	36
	Unimproved	132	13
	Open defecation	77	8
MDG sanitation type	Improved	425	43
	Unimproved	570	57

Table 5.4: Univariable relationship between sanitation, water and hygiene related variables and diarrhoea among children < 5 years of age in rural Bangladesh, 2007-2009 (N=26,097) *.

Exposure *	No. (%) monthly visit with this exposure	No. (%) monthly visits with diarrhoea With exposure	Without exposure	PR [†]	95% CI ^{‡§}	P value [§]
Sanitation type						
Based on technologies						
(N=24,029)						
Improved with a water seal	5,984 (25)	589 (9.8)	589 (9.8)	1		
Improved without a water seal	14,464 (60)	1,624 (11.2)	589 (9.8)	1.14	0.98, 1.33	0.09
Unimproved	3,581 (14)	397 (11.1)	589 (9.8)	1.16	0.92, 1.46	0.21
JMP technologies(N=24,029)						
Improved	20,448 (85)	2,213 (10.8)	2,213 (10.8)	1		
Unimproved	3,581 (15)	397 (11.09)	2,213 (10.8)	1.05	0.86, 1.29	0.61
JMP sanitation ladder						
(N=26,097)						
Private improved	11,213 (43)	1,142 (10.2)	1,142 (10.2)	1		
Shared improved	9,235 (35)	1,071 (11.6)	1,142 (10.2)	1.04	0.93, 1.17	0.48
Unimproved	3,681 (14)	397 (11.1)	1,142 (10.2)	1.07	0.87, 1.33	0.51
Open defecation	2,068 (8)	194 (9.4)	1,142 (10.2)	1.08	0.88, 1.32	0.47
MDG (N=26,097)						
Improved	11,213 (43)	1,142 (10.2)	1,142 (10.2)	1		
Unimproved	14,884 (57)	1,662 (11.2)	1,142 (10.2)	1.05	0.94, 1.18	0.38
Other sanitation variables						
Dirty latrine (N=20,448)	12,634 (61)	720 (9.2)	1,493 (11.8)	1.15	1.01, 1.30	0.04
Sharing of latrine (N=24,029)	10,192 (42)	1,190 (11.7)	1,420 (10.3)	1.06	0.96, 1.17	0.27

5> Child defecation site							
In a latrine	3,712 (13)	329 (9.6)		1			
In potty/nappy	1,630 (6)	131 (9.0)	329 (9.55)	0.90	0.66, 1.22		0.49
No specific place (open)	22,501 (81)	2,344 (11.1)	329 (9.55)	1.18	1.03, 1.36		0.02
Household and child characteristics							
(N=26,097)							
Mother's education >0 years	19,712 (71)	1,843 (10.1)	961 (12.4)	0.87	0.77, 0.98		0.03
Father's Education >0 years	18,185 (65)	1,676 (9.9)	1,128 (12.3)	0.92	0.82, 1.03		0.16
Presence of water and soap at handwashing station	14,335 (52)	1,392 (10.3)	1,412 (11.2)	0.91	0.82, 1.02		0.12
Store drinking water in fully covered container	5,938 (21)	516 (9.5)	1,305 (11.2)	0.94	0.84, 1.05		0.25
Has appropriate solid waste disposal system	845 (3)	66 (8.1)	2,738 (10.8)	0.75	0.63, 0.89		0.001
Appropriate water drainage system	11,762 (42)	1,081 (9.7)	1,723 (11.5)	0.94	0.82, 1.07		0.32
Exposed to WATSAN ^{II} intervention	13,015 (50)	1,418 (10.9)	1,386 (10.6)	1.08	0.78, 1.49		0.63
Male child	12,687 (49)	1,377 (10.9)	1,427 (10.6)	1.09	1.00, 1.20		0.05
Number of < 5 child in a house							<0.001
1 child <5 years of age	16,994 (65)	1,746 (10.3)					
2 child <5 years of age	7,785 (30)	853 (11.0)	1,746 (10.3)	1.05	0.93, 1.20		0.41
3 child <5 years of age	1,092 (4)	173 (15.8)	1,746 (10.3)	1.09	0.78, 1.53		0.62
4 child <5 years of age	226 (1)	32 (14.2)	1,746 (10.3)	1.94	1.53, 2.47		<0.001
Number of < 5 child continuous				1.09	0.98, 1.21		0.12
>1 <5 child in same household	9,103 (35)	1,058 (11.6)	1,746 (10.3)	1.07	0.95, 1.23		0.25
Age <2 years	9,614 (37)	1,287 (13.4)	1,517 (9.2)	1.43	1.26, 1.63		<0.001
Year 2 surveillance (vs. Year 1)	13,410 (51)	1,094 (8.2)	1,710 (13.5)	0.61	0.51, 0.71		<0.001

Month since initiation of surveillance				0.97	0.96, 0.98	<0.001
Exclusive breast feeding last 24 hours (N=8,889)	904 (10)	114 (12.6)	1,079 (13.5)	0.92	0.72, 1.17	0.50
Wealth index quintile						0.01
Poorest	5,232(20)	562(10.7)	562 (10.7)	1		
Lower middle	5,221 (20)	725(13.9)	562 (10.7)	1.15	0.95, 1.38	0.15
Middle	5,220 (20)	588 (11.3)	562 (10.7)	1.07	0.89, 1.27	0.45
Upper middle	5,222 (20)	445 (8.5)	562 (10.7)	0.85	0.72, 1.01	0.07
Richest	5,202 (20)	448 (9.3)	562 (10.7)	0.95	0.77, 1.16	0.59

*Some variable has different denominators. In those cases denominators are presented next to the name of the variable in column 1.

†Prevalence Ratio

‡95% Confidence Interval

§Adjusting for clustering at village level

|| Water Sanitation and Hygiene intervention

Table 5.5: Multivariable relationship between sanitation, water and hygiene related variables and diarrhoea among children under 5 years of age in rural Bangladesh 2007-2009 (N=26,097).

Exposure*	Crude [†] prevalence ratio (95% confidence interval)	P value [†]	Adjusted [‡] prevalence ratio (95% confidence interval)	P value [‡]
Sanitation type: technologies*[§] (N=24,029)				
Improved with a water seal	1		1	
Improved without a water seal	1.14 (0.98, 1.33)	0.09	1.11 (0.94, 1.30)	0.21
Unimproved: Pit latrine without slab/hanging latrine	1.16 (0.92, 1.46)	0.21	1.10 (0.86, 1.40)	0.46
Sharing a latrine (Vs non-shared latrines)	1.06 (0.96, 1.117)	0.27	1.05 (0.95, 1.16)	0.35
Male child (Vs female child)	1.09 (1.00, 1.20)	0.05	1.11 (1.01, 1.21)	0.04
<2 years of age (Vs 2 years and above)	1.43 (1.26, 1.63)	<0.001	1.42 (1.25, 1.62)	<0.001
Presence water and soap at handwashing station (Vs no soap and/or water)	0.91 (0.82, 1.02)	0.12	0.95 (0.84, 1.07)	0.38
Has appropriate solid waste disposal system (Vs no solid waste disposal system)	0.75 (0.63, 0.89)	0.001	0.78(0.65, 0.95)	0.01
Mother's education >0 years (s any formal education)	0.87 (0.77, 0.98)	0.03	91 (79. 1.03)	0.15
Wealth index quintile				
Poorest	1			
Lower middle	1.15 (0.95, 1.38)	0.15	1.15 (0.94, 1.40)	0.19
Middle	1.07 (0.89, 1.27)	0.45	1.08 (0.89, 1.31)	0.42
Upper middle	0.85 (0.72, 1.01)	0.07	0.89 (0.72, 1.09)	0.25
Richest	0.95 (0.77, 1.16)	0.59	1.04 (0.80, 1.35)	0.79
Sanitation type: JMP technology*[§] (N=24,097)				
Unimproved technology (vs. Improved technology)	1.05 (0.86, 1.29)	0.61	1.01 (0.82, 1.25)	0.89

Sanitation type: JMP sanitation ladder[§] (N=26,097)				
Private improved	1		1	
Shared improved	1.04 (0.93, 1.17)	0.476	1.01 (0.90, 1.13)	0.90
Unimproved	1.07 (0.87, 1.33)	0.514	1.001 (0.80, 1.25)	0.99
Open defecation	1.08 (0.88, 1.32)	0.469	1.00 (0.81, 1.23)	0.98
Sanitation type: MDG[§] (N=26,097)				
Unimproved sanitation (vs. private improved sanitation)	1.05 (0.94, 1.18)	0.377	1.00 (0.89, 1.13)	0.94

* Among households that has access to any latrine.

† Adjusting for clustering at village level. P value for comparing prevalence of diarrhoea among households grouped according to different household characteristics.

‡ Adjusting for clustering at village level and all the other variable presented in the table

§ Separate multivariate model for each classification of sanitation as primary exposure variable.

Table 5.6: Multivariable relationship between sanitation, water and hygiene related variables and diarrhoea among children under 5 years of age, restricted to household with access to improved technology as defined by JMP (N=20,448).

Exposure	Crude prevalence ratio (95% confidence interval)	P value*	Adjusted prevalence ratio (95% confidence interval)	P value†
Improved latrine with water seal (vs. latrine without water seal)	1.16 (0.99, 1.35)	0.06	1.09 (0.92, 1.29)	0.33
Shared improved latrine (vs. Private improved latrine)	1.04 (0.93, 1.18)	0.46	1.00 (0.89, 1.13)	0.94
Dirty latrine (Vs clean latrine)	1.15 (1.01, 1.30)	0.04	1.09 (0.96, 1.25)	0.20
Male child (Vs female child)	1.13 (1.02, 1.25)	0.02	1.12 (1.01, 1.24)	0.03
<2 years of age (Vs 2-5 years of age)	1.44 (1.25, 1.66)	<0.001	1.45 (1.26, 1.67)	<0.001
Presence of water and soap at handwashing station (Vs absence of soap and/or water)	0.93 (0.81, 1.05)	0.24	0.94 (0.83, 1.07)	0.35
Has appropriate solid waste disposal system (Vs no solid waste disposal)	0.71 (0.59, 0.86)	0.001	0.71 (0.58, 0.87)	0.001
Mother's education >0 years (Vs any formal education)	0.89 (0.74, 0.99)	0.04	0.89 (0.76, 1.04)	0.14
Wealth index quintile				
Poorest				
Lower middle	1.13(0.92, 1.39)	0.25	1.14 (0.92, 1.41)	0.24
Middle	1.07 (0.87, 1.29)	0.55	1.12 (0.92, 1.38)	0.25
Upper middle	0.83 (0.67, 1.01)	0.07	0.90 (0.72, 1.13)	0.37
Richest	0.94 (0.76, 1.18)	0.61	1.04 (0.79, 1.37)	0.78

*Adjusting for clustering at village level using generalised estimating equation (GEE) [51] with a robust standard error estimator with the village as the cluster variable

† Adjusting for clustering at village level and all the other variable presented in the table

Chapter 6: Discussion

This chapter summarizes the key findings, discusses strengths and limitations, explains how this research has contributed to the knowledge base in the sector and considers the implications for policy and future research.

The aim of the study was to further our understanding of the importance of sanitation quality and coverage, in protecting health. A cross sectional study to assess the association between sanitation quality and microbiological faecal contamination of households was conducted. To explore the effect of neighbourhood sanitation coverage on faecal contamination of the household environment sanitation coverage among neighbouring households within 20 metres of a target household we measured. An analysis to assess the relationship between type of sanitation facility and childhood diarrhoea using secondary data from a health impact evaluation was conducted. In carrying out this study the issue of identifying feasible and valid indicators of faecal contamination had to be confronted. Following a pilot of several methods contamination of sentinel toys and children's hands by indicator organisms as indicators of household faecal contamination was ultimately used. The thesis thus additionally contributes to the knowledge base relating to what type of microbiological indicator and site should be considered in measuring household faecal contamination in the rural low-income country context.

International monitoring of sanitation helps to understand needs of countries, informs policy and facilitates implementation of policies to improve services. Worldwide there is a wide variety of sanitation facilities [1]. This variation can affect not only user experience but also the extent to which faeces are contained and contamination prevented [2-5]. For international monitoring of sanitation this variation is a challenge. The WHO/UNICEF Joint monitoring Programme (JMP) categorizes sanitation facilities as improved and unimproved based on the technology used by the household. For the Millennium Development Goal (MDG) target related to sanitation, shared facilities are considered unimproved regardless of the sanitation category [6, 7]. Now that the MDG era is coming to an end the

related indicators and definitions are being modified for monitoring progress towards the post 2015 Sustainable Development Goals (SDGs). There is discussion about whether to consider improved but shared sanitation categories as improved facilities for the SDG target if the facility is shared by a limited number of households (five households or 30 people). Ideally, for international monitoring sanitation would be classified on the basis of evidence for its relative effectiveness in isolating human excreta from the environment and delivering health benefits, but this evidence base is weak.

Sanitation quality was classified using a variety of existing definitions used for international monitoring, as the intention was also to comment on the public health significance of these definitions. To define sanitation quality, four different definitions of sanitation were used that considered the technology categorisation and number of households using the facility. The categorisation included: a) JMP technology classification of 'improved' and 'unimproved'; b) segregated JMP improved technology classification of 'improved with water seal' and 'improved without water seal'; c) JMP sanitation ladder with four groups including 'private improved' 'shared improved' 'unimproved' and 'open defecation'; and d) Binary MDG classification of 'private improved' and 'unimproved' (Figure 6.1) [6, 7].

6.1 Key findings

Households with flush or pour flush latrines connected to pits or tanks and households with basic pit latrines with slabs (JMP improved) had no less faecal contamination than those with poorer quality latrines (JMP unimproved). However, households with *private* (not shared) flush or pour flush latrines connected to pits or tanks or with private pit latrines with slabs had somewhat lower levels of contamination than households with access to poorer quality and/or shared sanitation, independent of potentially confounding household characteristics.

Increasing neighbourhood coverage with good quality (JMP improved) sanitation (flush or pour flush latrines connected to pits or tanks or basic pit latrines with slabs) or good quality (JMP improved), *private* sanitation was not associated with a decrease in faecal contamination in target households.

Other household characteristics that were associated with higher levels of faecal contamination on sentinel toys included cleanliness of latrine, presence of animal faeces, having a mother with no formal education, lacking an appropriate water drainage system and study site. Contamination of children's hands was associated with visible cleanliness of hands and child's activity prior to sample collection. However contamination of children's hands was not associated with any of the variables related to sanitation (household sanitation access or coverage in the neighbourhood).

There was no association between sanitation characteristics (either technology or sharing) and diarrhoea prevalence in children less than five years of age.

Other household characteristics that were associated with lower diarrhoea prevalence included having a mother with any formal education, and having an appropriate solid waste disposal system.

6.2 Interpretations of key findings

In this rural context, with multiple source of household faecal contamination, variation in sanitation infrastructure did not explain variation in faecal contamination or diarrhoeal disease. Neighbourhood level sanitation coverage was not found to be an important determinant of household faecal contamination. Private use and cleanliness of latrine was associated with lower faecal contamination. But these factors were not associated with any reduction in the prevalence of diarrhoeal disease. Taken together these findings suggest that onsite sanitation access may have limited effect in hygienically separating human faeces from human contact and thereby reducing transmission of diarrhoea-causing enteric pathogens. There may be several possible explanations for limited effectiveness of sanitation access. First, there may be other sanitation-related factors (such as cleanliness of latrine, presence of water seal and safe child's faeces disposal) that are necessary in hygienically separating human excreta from human contact and reducing transmission of diarrhoea-causing enteric pathogens. Second, ensuring separation of human excreta from human contact at household level is not sufficient in reducing

transmission of diarrhoea causing enteric pathogens. Other routes of transmission like food, drinking water and hands may need to be targeted simultaneously. In addition nutritional status may also need to be improved. Third, it is also possible that the measure of household faecal contamination used in the study is not a good indicator of the reduction in household faecal contamination associated with sanitation.

The reason access to improved (JMP) sanitation is not associated with reduced faecal contamination and diarrhoea is possibly because firstly, access to sanitation alone is not sufficient to separate human faeces from human contact. In this study, even access to sanitation facilities with a water seal was no better at reducing faecal contamination and diarrhoea compared to improved sanitation facilities without water seal. Presence of a water seal may prevent flies from breeding within the latrine and may reduce fly numbers and thereby provide protection from one route of faecal contamination within household environment [8]. This may provide additional evidence that provision of sanitation infrastructure may not be enough to prevent household faecal contamination and diarrhoea. The limited impact of provision of improved (JMP) sanitation on faecal contamination and diarrhoea found in this study is supported by a recent study that presents a pooled estimate of Demographic and Health Surveys (DHS) conducted between 2003 and 2013 [9], though in contrast, a study conducted in Indonesia found improved sanitation (JMP) to be protective against diarrhoea [10]. But the inconsistency in the findings could be due to difference in country context [9] or due to variation in important confounders such as soap use for handwashing and water quality. Similarly, a study conducted in Kenya found access to improved (JMP) sanitation to be associated with reduction in faecal contamination of hand contact surfaces within the toilet but the same study found the level of faecal contamination in the toilet was not correlated with faecal contamination of household surfaces [11]. In this study, household faecal contamination was measured using the sentinel toy method, which is more likely to capture the contamination within the household rather than the latrine.

There may be several sources of household faecal contamination, such as poor cleanliness of the toilet, poor maintenance of facility, unsafe disposal of

children's faeces [11, 12] that access to good quality sanitation alone cannot prevent. In this study, private use was associated with lower contamination of sentinel toys, even after adjusting for the effect of wealth, mother's education, presence of animal faeces, presence of appropriate water and solid waste disposal system, visible cleanliness of hands and nail (proxy for hand hygiene), study site and time of data collection, among others. Findings from observational studies suggest that washing hands with soap is effective in removing microorganisms from hands [39, 70-72] and there for an important determinant of household faecal contamination. In this study presence of soap and water at a handwashing station was not associated with faecal contamination of toy ball in the univariable analysis. So this was not included as a potential confounder to be included in the multivariable analysis. But since visible cleanliness of hand was associated with faecal contamination of hand, this was used a proxy for hand hygiene and included in the multivariable analysis as a potential confounder. However, in this observational study we cannot exclude the possibility that there may be residual confounding due to unmeasured household characteristics (such as general cleanliness of the household, family members attitude and practices towards cleanliness of the household, general hygiene practices of the household members) that may influence faecal contamination. These factors are difficult to measure but may be important predictors of household faecal contamination.

In this study lower faecal contamination of the toy ball was also associated with absence of animal faeces, mother's education, and presence of appropriate water drainage and study site. In this study wealth was associated with lower faecal contamination of the toy ball in the unadjusted analysis, so it is an important confounder. Therefore wealth was included in the multivariate analysis to adjust or its effect. But Faecal contamination of the household environment is actually influenced by underlying, unmeasured, broader, social, economical, cultural and environmental differences [30, 73]. The confounding factors considered here are only proxy for these underlying unmeasured broader factors. It is possible that access to an improved latrine and absence of animal faeces, mother's education, and presence of appropriate water drainage are all proxy measures of these unmeasured

differences and hence associated with faecal contamination. A two-arm, randomised, controlled trial in which households in one arm receive improved sanitation with private use and households in the other arm receive improved sanitation with shared use, could help better understand this issue.

Sharing a latrine may have a harmful effect due to issues related to cleanliness, maintenance, over use or lack of fulltime access. Moreover cleanliness of latrine was also associated with lower contamination of sentinel toys. In this study, sanitation access (exposure) was measured prior to outcome (faecal contamination) measurement so reverse causality is less likely to be an issue. Nonetheless the findings suggest that these factors related to maintenance and use of sanitation facilities, may be important in hygienically separating human faeces from human contact. These factors were also found to be important predictors of diarrhoea in previous studies [2, 3, 13-16].

Although in this study private use and cleanliness of latrine were associated with reduction in faecal contamination, these factors were not associated with reduced diarrhoea prevalence. This may be because the faecal contamination and health outcome studies were conducted in slightly different settings and at different times. Therefore some of the difference in effect could be due to social, cultural and environmental differences between the study site and time, as observed in previous studies of sanitation [9, 16]. Moreover, the inconsistency could be due to the degree of measurement error in assessing sanitation. Depending on the degree of measurement error, the misclassification bias would lead to underestimation of the effect of sanitation on faecal contamination or diarrhoea. In addition, the indicator organisms are only weakly associated with presence of enteric pathogens [17, 18]. As a result, presence of indicator organisms is likely to be weakly associated with diarrhoea disease. Moreover in the context of this study, the population is likely to develop some degree of immunity to common circulating enteric pathogens. This may attenuate the relationship between microbiological indicators of faecal contamination and diarrhoea [19]. Therefore, even if sanitation may be associated with contamination by indicator organisms, it may not be associated with diarrhoea. It is possible that in this context none of these factors are sufficient alone to prevent

faecal contamination to a degree that would prevent diarrhoea. Maybe a combination of these factors is necessary. In a previous study conducted in Bangladesh it was found that households that had access to sanitation facilities with a water seal and had no visible faeces in the premises had lower level of household faecal contamination [20].

The second reason for the limited effect of sanitation access may be that in this setting other routes of transmission are more important. In similar setting microbiological quality of drinking water was associated with diarrhoea [21]. Furthermore, in a recent systematic review it was found that intervention to improve water quality at point of use may reduce diarrhoea by at least around a quarter [22]. In the study presented in chapter five, presence of soap and water was associated with small and statistically insignificant reduction in diarrhoea. But evidence from a recent systematic review suggests that handwashing promotion among communities in low and middle income countries (LMICs) prevents around one-quarter of diarrhoea episodes [23]. Exclusive breast feeding has been recommended as an important diarrhoea prevention strategy [24-26]. Malnutrition has been also identified as important determinant of diarrhoea [27-29] although in the secondary data analysis presented in chapter six data on nutritional status was not included. Take together these findings suggest that in this setting, diarrhoea disease can only be prevented by interventions that address more than one transmission pathways. A recent study has identified that during the past ten years sanitation or water have only been effective in reducing diarrhoea if they were combined [9]. Further studies to look at the combined effect of these factors on faecal contamination and diarrhoea would be informative.

In this study, household waste disposal was found to be associated with 25% reduction of diarrhoea with limited effect of confounding. This finding is consistent with two previous studies [31, 32]. However the mechanism by which household waste disposal reduces diarrhoeal disease risk is not well known. It is possible that solid waste disposal is a proxy indicator for general cleanliness of the household member and household, which could not be captured in this observational study. Although in the observational study causality could not be established but the

findings highlight the importance of considering factors other than sanitation in reducing transmission of diarrhoea causing enteric pathogens.

The third reason for the limited effect of sanitation on faecal contamination observed in this study could be the choice of measure of household faecal contamination. Toy contamination has been found to be associated with several sanitation-related factors including, household sanitation, presence of animal faeces, cleanliness of children's hands and presence of an appropriate water drainage system, suggesting that the level of toy ball contamination is likely to be a reasonable proxy of household sanitation and hygiene. Previous studies have also found toy ball contamination to be linked to household sanitation [20, 33, 34]. A reduction in the microbiological contamination levels on toys is a proximal indicator of household contamination that a child may encounter in comparison to other exposure pathways such as surface and fomites. Toy balls might be more directly exposed to the household environment than water. Hands may be a closer indicator of level of contamination that the child may encounter however, hand contamination [35] data are likely to be more variable because of variation in handwashing practices. In this study, hand contamination was not found to be associated with any of the variables related to sanitation, suggesting that random hand contamination may not be a good indicator of household sanitation. Compared to hands, toy balls are less subject to frequent washing. Further studies with experimental study design might help us to better understand the utility of sentinel toys as a proxy for household faecal contamination.

6.3 Strengths and Limitations of the research

In this thesis, access to sanitation was the primary exposure of interest, so it was important to minimize any misclassification of sanitation as improved or unimproved due to error in coding sanitation facilities during data collection. The standard core questionnaire used by the JMP was used to collect data on sanitation status [36]. However there are concerns about reliability of these questions as there are many types of sanitation facilities available [36, 37]. In this study additional questions were added to the survey to cross check functionality of the sanitation

facilities. Moreover prior to the main data collection, the set of questionnaires to assess sanitation access was assessed for Inter-observer reliability. The questions to assess sanitation status were found to be highly reliable in the inter-observer reliability study. In addition extensive training on coding of sanitation with several field practices was provided, to ensure that all the data collectors could code the latrines correctly and reliably across different households. During the data collection, the principal investigator (Tarique Huda) and the field supervisors observed the data collection process in a random selection of at least 5% of households (6 HH per village) and conducted repeat spot-check in a (different) random selection of 5% of households (6 HH per village), to cross-check the coding of latrines extensively.

An important limitation of this study was the use of faecal indicator bacteria (FIB) to assess faecal contamination because presence of FIB may not be correlated with presence of viruses that may originate in human faeces. But presence of Coliphages indicate the presence of enteric viruses, and *Clostridium perfringens*, an obligate anaerobe, indicates presence of parasitic protozoan and enteric viruses [38]. So may be monitoring a suite of indicator organisms is more likely to be predictive of risk to human health.

Another important limitation of using FIB is that, FIB may have non-human origin and does not necessarily signify risks to human health [39-42] [43-46]. In a cross-sectional study conducted in India assessed faecal exposure via community water sources (N = 123) and in the home (N = 137) using human- and nonhuman-associated Bacteroidales microbial source tracking (MST) markers and faecal coliforms (FCs). Animal faecal markers were widely detected in both public and domestic domains, indicating ubiquitous risks of exposure to animal faeces and Zoonotic pathogens [47]. This makes presence of FIB bacteria an imprecise outcome indicator for sanitation. As a consequence the confidence intervals of the estimates becomes wider, making the results less likely to be statistically significant even if a true difference exists [48]. A range of microbial source tracking (MST) methods (genotypic, phenotypic, and chemical) are available that can be used to identify human/non-human sources of faecal pollution in the household environment [39,

40, 42, 49-52]. But MST methods are time consuming, labour-intensive, and expensive (require costly laboratory equipment) [53]. As a result this may have limited feasibility in assessing the impact of large scale sanitation/hygiene programme in low income country context.

[20]

It is possible that the overall level of faecal coliforms on the toy balls and hands might represent faecal coliforms originating from both human and animal faeces. Nevertheless in this study presence of faecal coliforms was associated with lack of access to flush latrine and inadequate latrine cleanliness (Chapter 3) after adjusting for the effect of presence of animal faeces , consistent with findings from similar settings [54]. There is evidence from small-scale observational studies suggesting that presence of FIB on hands and toys may be associated with household sanitation [42, 55-64]. Although our estimates may not represent the true contribution of sanitation in reducing human faecal contamination of toy balls, it could give some indication of reduction from overall faecal contamination.

6.4 Policy implications of the research

Based on the findings of this observational study conducted in rural areas in which diarrhoea is endemic, no conclusive recommendation regarding changes to policy in relation to classification of sanitation used for international monitoring can be provided.

Nevertheless, findings from observational study presented in this thesis add to the evidence base that does not support the inclusion of shared facilities as 'improved'. Although in this study sharing a latrine was not associated with additional risk of diarrhoea, the shared latrines were found to be dirtier than individual latrines and associated with higher faecal coliform contamination. This suggests that even in a context in which a sanitation facility is shared among extended families or among acquaintances, there may still be concerns related to maintenance and use. Further research needs to be undertaken to understand the context in which shared sanitation is safe before considering shared sanitation as improved for international monitoring.

Apart from concerns related to health risk there other factors related to privacy and access, particularly for women and young children that also need to be considered. For example, in rural areas of Bangladesh families sharing the facilities may not have shared ownership. As a result, non owning families may not have continuous access to the latrine. But this scenario may be different for shared urban toilets in rented houses or public toilets. Sharing may have different implication in rural and urban areas, even if it is shared by families who know each other. For example, sharing a latrine among families that are renting their house in urban areas may have different level of access compared to household who share a latrine owned by an extended family member.

For the MDGs the definition of 'improved sanitation' focused on the provision of hardware. In the study reported here a limited effect of sanitation infrastructure on faecal contamination of the household environment was found. This may suggests that other sanitation, related factors such as maintenance of sanitation facility, use by all household members including children and faecal sludge management should be considered if intervention to improve sanitation is expected to provide maximum reduction in health risk.

Future interventions to prevent diarrhoea may need to target additional transmission routes such as food, water and hands.

The current sets of questions in national surveys to collect information on sanitation do not include questions to elucidate whether there is leakage in the latrine pit/tank. Therefore, future questions on sanitation could include the option for visual inspection of sanitation facility to collect detailed information on the sanitation infrastructure in order to minimise measurement error.

6.5 Conclusions

The experience of working towards achieving the Millennium Development Goals (MDG) related to sanitation have provided the international community with an opportunity to generate important knowledge regarding the strength and limitations of defining and monitoring access to sanitation. Now that the world has

adopted the Sustainable Development Goals (SDG), evidence-based changes in the definition of improved sanitation will shape how low income countries improve the health of their populations by ensuring adequate sanitation. The findings of this thesis provide further evidence of limited effectiveness of sanitation infrastructure in reducing household faecal contamination and diarrhoea in contexts in which diarrhoea is endemic. The thesis provides further evidence that contamination of study-introduced toy balls could be used as a proxy indicator of household faecal contamination if found to be associated with health outcome in future studies. The findings of this thesis also add to existing knowledge by providing evidence of the potential adverse effects of access to shared sanitation on household faecal contamination in the context of rural areas in which latrines are shared among neighbours or acquaintances. Although this thesis has important limitations (such as using faecal indicator bacteria which are likely to be an imprecise measure of human faecal contamination as primary outcome) in the absence of convincing evidence that shared sanitation provides similar protection to individual latrines, shared facilities can only be considered improved if issues with maintenance can be tackled effectively. More research needs to be undertaken to understand the challenges of ensuring hygienic sanitation for un-served and underserved population, how to address these challenges. We also need to increase research efforts to integrate sanitation, water quality, handwashing and nutritional interventions and to understand better ways to monitor the impact of these interventions on ensuring better health and quality of life.

6.6 References

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2. JMP* Technology	Improved			Unimproved	Open defecation
	<p><u>With water seal</u></p> <ul style="list-style-type: none"> - Flush or pour-flush latrine to: <ul style="list-style-type: none"> o piped sewer system o septic tank o pit latrine with slab - Ventilated Improved pit latrine - Composting latrine <p><u>Without water seal</u></p> <ul style="list-style-type: none"> - Pit latrine with slab 			<ul style="list-style-type: none"> - Flush or pour-flush latrine to: <ul style="list-style-type: none"> o Else where - Unimproved pit latrines without a slab/ platform - Hanging latrines/Bucket latrines. - flush or pour-flush latrine to open - pit latrine with a slab but with a leakage in the pit 	Defecation in fields, forests, bushes, bodies of water or other open spaces
No. of Using	1 Household (HH)	2-5 HHs	6 or more HHs		
2. JMP Ladder	Private Improved	Shared Improved		Unimproved	Open defecation
3. MDG	Improved	Unimproved			
4. SDG‡	Improved	Unimproved			

Figure 6.1: Comparing classification of sanitation used for international monitoring. Note: JMP classification does not consider sharing status but for all the other definition sharing by different number of households are considered in the definition. For the classification 2, 3 and 4 some of the shared facilities are also considered to be unimproved even if the toilet is of improved technology. * The WHO/UNICEF Joint monitoring Programme (JMP) for water supply and sanitation, † Millennium Development Goal definition related to sanitation, ‡ Sustainable Development Goal definition of sanitation

Appendix 1: Search terms used for comprehensive literature review.

Table 7.1: Search terms and strategy for Embase conducted on 15th October 2015

	Search strategy
1.	Sanitation/ or environmental sanitation/ or sewage/ or sewage disposal/
2.	(sanita* or latrine* or toilet* or water closet or privy or sewer* or sewage or septic tank or ((excreta or faeces or feces or stool or faecal or fecal) adj disposal)).ab,ti.
3.	diarrhea/dm, ep, pc or Enterobacteriaceae infection/ or Enterobacteriaceae/
4.	(diarrh*ea or diarrh*eal disease* or waterborne infection* or waterborne illness* or dysenter* or cholera or shigell* or cryptosporid* or salmonell* or escherichia or campylobacter or cyclospor* or giardia* or rotavirus).ab,ti.
5.	Microbial contamination/ or bacterium contamination/ or enterobacteriaceae/ or coliform bacterium/ or faecal coliform/ or Escherichia coli/ or Streptococcus/ or Enterococcus/ or enterococcaceae/
6.	((micro* or bacteria* or environment* or fecal or faecal or household or domestic or home or water or hand or floor or surface or soil or toy or produce) adj3 (contamina* or pollut* or hygiene)) or (water adj3 quality) or ((fecal or faecal or total or thermotolerant) adj3 coliform) or Escherichia coli or E coli or streptococ* or enterococ* or Enterobacteriaceae or heterotrophic plate count bacteria).ab,ti.
7.	(quality or coverage or type or ladder or level or commun* or categor* or neighbourhood or neighborhood).ab,ti.
8.	((sanita* or latrine* or toilet* or water closet or privy or sewer* or sewage or septic tank or ((excreta or faeces or feces or stool or faecal or fecal) adj disposal)) adj (quality or improv* or hygienic or coverage or type or ladder or level or commun* or categor* or neighbourhood or neighborhood)).ab,ti.
9.	((quality or improv* or hygienic or coverage or type or ladder or level or commun* or categor* or neighbourhood or neighborhood) adj (sanita* or latrine* or toilet* or water closet or privy or sewer* or sewage or septic tank or ((excreta or faeces or feces or stool or faecal or fecal) adj disposal))).ab,ti.
10.	(1 or 2) and (3 or 4)
11.	(1 or 2) and (5 or 6)
12.	(1 or 2) and 7 and (3 or 4)
13.	(8 or 9) and (3 or 4 or 5 or 6)
14.	JMP.mp.
15.	14 and 2
16.	10 or 11 or 12 or 13 or 15
17.	Limit 16 to (human and English language and article and yr="2000-Current)

Table 7.2: Search terms and strategy for Global health conducted on 15th October 2015

1	(sanita* or latrine* or toilet* or water closet or privy or sewer* or sewage or septic tank or ((excreta or faeces or feces or stool or faecal or fecal) adj disposal)).ti.
2	(diarrh*ea or diarrh*eal disease* or waterborne infection* or waterborne illness* or dysenter* or cholera or shigell* or cryptosporid* or salmonell* or escherichia or campylobacter or cyclospor* or giardia* or rotavirus).ab,ti.
3	diarrhoea/
4	Microbial contamination/ or enterobacteriaceae/ or coliform bacteria/ or faecal coliforms/ or Escherichia coli/ or Streptococcus/ or Enterococcus/ or enterococcaceae/
5	(((((micro* or bacteria* or environment* or fecal or faecal or household or domestic or home or water or hand or floor or surface or soil or toy or produce) adj3 (contamina* or pollution* or hygiene)) or (water adj3 quality) or ((fecal or faecal or total or thermotolerant) adj3 coliform) or Escherichia coli or E coli or streptococ* or enterococ* or Enterobacteriaceae or heterotrophic plate count bacteria).ab,ti.
6	1 and (2 or 3 or 4 or 5)
7	(sanita* or latrine* or toilet* or water closet or privy or sewer* or sewage or septic tank or ((excreta or faeces or feces or stool or faecal or fecal) adj disposal)).ab,ti.
8	((quality or improv* or hygienic or coverage or type or ladder or level or commun* or categor* or neighbourhood or neighborhood) adj (sanita* or latrine* or toilet* or water closet or privy or sewer* or sewage or septic tank or ((excreta or faeces or feces or stool or faecal or fecal) adj disposal))).ab,ti.
9	((sanita* or latrine* or toilet* or water closet or privy or sewer* or sewage or septic tank or ((excreta or faeces or feces or stool or faecal or fecal) adj disposal)) adj (quality or improv* or hygienic or coverage or type or ladder or level or commun* or categor* or neighbourhood or neighborhood)).ab,ti.
10	8 or 9
12	10 and (2 or 3 or 4 or 5)
13	JMP.mp. [mp=abstract, title, original title, broad terms, heading words, identifiers, cabicodes]
14	7 and 14
15	6 or 12 or 14
17	limit 15 to (english language and journal article and yr="2000 -Current")

Table 7.3: Search terms and strategy for Medline conducted on 15th October 2015

1	(sanita* or latrine* or toilet* or water closet or privy or sewer* or sewage or septic tank or ((excreta or faeces or feces or stool or faecal or fecal) adj disposal)).ti.
2	(diarrh*ea or diarrh*eal disease* or waterborne infection* or waterborne illness* or dysenter* or cholera or shigell* or cryptosporid* or salmonell* or escherichia or campylobacter or cyclospor* or giardia* or rotavirus).ab,ti.
3	diarrhea/dm, ep, pc or Enterobacteriaceae infection/
4	Microbial contamination/ or bacterium contamination/ or enterobacteriaceae/ or coliform bacterium/ or faecal coliform/ or Escherichia coli/ or Streptococcus/ or Enterococcus/ or enterococcaceae/
5	((micro* or bacteria* or environment* or fecal or faecal or household or domestic or home or water or hand or floor or surface or soil or toy or produce) adj3 (contamina* or pollution* or hygiene)) or (water adj3 quality) or ((fecal or faecal or total or thermotolerant) adj3 coliform) or Escherichia coli or E coli or streptococ* or enterococ* or Enterobacteriaceae or heterotrophic plate count bacteria).ab,ti.
6	1 and (2 or 3 or 4 or 5)
7	(sanita* or latrine* or toilet* or water closet or privy or sewer* or sewage or septic tank or ((excreta or faeces or feces or stool or faecal or fecal) adj disposal)).ab,ti.
8	((quality or improv* or hygienic or coverage or type or ladder or level or commun* or categor* or neighbourhood or neighborhood) adj (sanita* or latrine* or toilet* or water closet or privy or sewer* or sewage or septic tank or ((excreta or faeces or feces or stool or faecal or fecal) adj disposal))).ab,ti.
9	((sanita* or latrine* or toilet* or water closet or privy or sewer* or sewage or septic tank or ((excreta or faeces or feces or stool or faecal or fecal) adj disposal)) adj (quality or improv* or hygienic or coverage or type or ladder or level or commun* or categor* or neighbourhood or neighborhood)).ab,ti.
10	(8 or 9) and (2 or 3 or 4 or 5)
11	JMP.mp. [mp=title, abstract, subject headings, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword]
12	7 and 11
13	6 or 10 or 12
14	limit 13 to (human and english language and yr="2000 -Current")

Appendix 2: Consent form and guideline for 3 hours observation

Informed consent form for 3 hours semi-structured observation

Project title: Role of sanitation in preventing contamination of the domestic environment and protecting health.

Investigator: Tarique Md. Nurul Huda

Part I: Information Sheet

Introduction

Hello (Assalamualaikum/Nomoshkar). My name is _____ and I work with the ICDDR,B (Cholera Hospital) in Dhaka. I am here to invite you to take part in a research study. You are free to decide whether or not to be in the study.

Purpose of the research:

The purpose of the study is to understand whether latrine quality is linked with household environmental contamination. This will help us understand how to improve health of under-5 children.

Procedure:

We are interested in the health of <5 children. Because you have a child under the age of 5, we would like to invite you to participate in this study. If you agree to participate in the study I will observe the activities of your child <5. I will also observe your general household activities. I will spend 3 hours in your household. I will stay in your household from 9 AM-11 AM. During the observation, you can carry on your usual daily routine, as if I was not present. I will not obstruct any of your daily activities. I also wish to ask you for the permission to take pictures. I might take pictures of different activities within your household. I will show you the pictures. If you agree, these pictures might be used as illustration of my observations in future presentations. If you do not want your face to be visible on the pictures, I will blur your face. This way nobody will be able to recognize you. I will also take some notes on paper.

Benefits:

There is no immediate benefit to you from this study. The study will help us better understand conditions in Bangladesh. This information may help to improve child health in future.

Costs and Compensation:

There is no cost to you for being in this study. You will not receive anything for being in the study.

Risks:

There is no risk from being in the study. We will only collect information. My presence in your home for several hours may be uncomfortable for you. But we do not expect any harm to come to you or your family because of the study.

Privacy:

We assure that the privacy of information identifying you will be strictly maintained. The information identifying you will only be accessible to me, my research team, the ethical Review Committee. Any information that is gathered about you and your family will be kept anonymous. All paper documents will be kept in a locked cabinet at ICDDR,B. The research team will have sole access to the locked cabinet. All digital data with personal identifiers will be maintained on secure systems protected by passwords. Your name and identity will not be used in reporting and presenting study findings, or in their publication in journals. We will use the information only for the purpose of research. In case of future use of the information collected from the study anonymous information may be supplied to other researchers. But this will not compromise with your privacy and anonymity.

Voluntary participation:

You are free to decide whether or not to be in the study. You are free to leave the study at any time. You do not have to give any reason for leaving the study. You will not lose any benefits for leaving the study. If you do take part in the study, you are free to refuse to answer any question. You do not have to give any reason for refusing to answer any questions.

Persons to Contact

If you have any question about this research study you may contact Mr. Tarique Md. Nurul Huda (Study Coordinator). His mobile number is 01772362311. His office number is 988-1761.

If you have questions about your right in the study, you may call Mr. M A Salam Khan, Committee coordination secretariat at 9886498. His office is located at 68, Shaheed Tajuddin Ahmed Sarani Mohakhali, Dhaka 1212.

Part II: Consent Form

The nature of the study has been explained to me. I have had the opportunity to ask questions about it. I understand what will be required of me and what will happen to me, if I take part. I understand that my participation in this study is voluntary. I understand that I do not have to answer any questions if I do not want. I understand that I can leave the study freely at any time. I understand that these conditions also apply to any children for whom I give consent to participate in the study. I do agree to quotations from my participation in the study to be included anonymously in reports about the study

I agree to participate in the study (*tick*)

I do agree to quotations from my participation in the study to be included anonymously in reports about the study.

I give my consent for pictures of me and my household facilities to be taken and used.

I give my consent for all household members below the age of 18 years and for whom I am the parent of guardian to participate in the study. (*Tick*)

Observation guideline

Project title: Role of sanitation in preventing contamination of the domestic environment and protecting health.

Objective of the observation: To understand, where the <5 children are potentially exposed to pathogens that are washed or carried into their environment (Household surfaces /fomite)

Household identification

Date of observation □□/□□/□□ Time of Starting (24 hrs)□□:□□

Observation:

1. Get an idea about the setting of the household and compound?
2. Get an idea about the cleanliness of different parts of the household/compound?
3. Get an idea about the daily routine of the child? What the child does in different time of the day?
4. Get an idea about animal movement in the household?
5. Get an idea about the place for different household activities?
6. Observe where the child spends his time? Where does the child go?
7. During different activities (During playing, roaming around) of the child what surfaces come in contact with the child's hands?
 - a. How often?
 - b. What is the general cleanliness status of the place/surface?
 - c. Where is the place in respect to latrine, tube well
 - d. What else happens in that place to get an idea about how clean that place is?
 - i. Is it a place for defecation, cleaning, and other household activity?
 - ii. Is there animal moving around, presence of animal faeces nearby?
8. During the observation time what objects comes in contact with the child's hands and mouth?
9. Collect information of the object the child comes in contact/play with
 - a. Identify/describe the place/object specifically
 - b. How much time the child spends there?
 - c. What else comes in contact with that object?
10. Use of cow dung in the households and in the cooking. How is child come in contact with any cow dung?

Time of finishing (24 hrs)□□:□□

Appendix 3: Consent form and questionnaire for household questionnaire survey

Informed consent form for Household questionnaire survey

Project title: Role of sanitation in preventing contamination of the domestic environment and protecting health.

Part I: Information Sheet

Introduction

Hello (Assalamualaikum/Nomoshkar). My name is _____ and I work with the ICDDR,B (Cholera Hospital) in Dhaka. I am here to invite you to take part in a research study. You are free to decide whether or not to be in the study.

Purpose of the research:

The purpose of this study is to understand whether latrine quality is linked with household environmental contamination. *This will help us understand how to improve health of children.*

Procedure:

We are enrolling households with at least one child aged between 6 and 24 months. If you agree to participate in the study I will visit different parts of your household. At the end of observation i will ask some questions about your household routine and practices. It will take around 2 hours. I will also ask about your child's health. I will take some notes on a tablet computer.

I also wish to ask you for the permission to take pictures. I might take some pictures of different facilities and activities of your household. I will show you the pictures that I will take. If you agree, these pictures might be shown as illustration in future presentations. If you do not want your face to be visible on the pictures I will blur your face, so that nobody can recognize you

I will ask you to rinse your hands in a liquid of plastic bag. I will also ask your child to rinse his/her hands, similarly in a liquid of plastic bag. I will demonstrate the hand rinse procedure. After that I will take the plastic bags with the hands rinse liquid in it. We will test the hand rinse liquid in a lab. We are interested to see if there is any harmful germ in it.

Today, I will give your child a toy ball to play with. I will leave the ball overnight with your child. Tomorrow, I will come back to your household same time as today. I will rinse the ball in a liquid of plastic bag. After taking the toy rinse liquid I will return the ball to you for your child to keep.

When I return to rinse the ball after 24 hours, I will also ask you some question about what happened to the ball within the last 24 hours.

Benefits:

There is no immediate benefit to you from this study. The study will help us better understand conditions in Bangladesh. This information may help to improve child health in future.

Costs and Compensation:

There is no cost to you for being in this study. You will not receive anything for being in the study.

Risks:

There is no risk from being in the study. We will only collect information. My presence in your home for several hours may be uncomfortable for you. But we do not expect any harm to come to you or your family because of the study.

Privacy:

We assure that the privacy of information identifying you will be strictly maintained. The information identifying you will only be accessible to me, my research team, the ethical Review Committee. Any information that is gathered about you and your family will be kept anonymous. All paper documents will be kept in a locked cabinet at ICDDR,B. The research team will have sole access to the locked cabinet. All digital data with personal identifiers will be maintained on secure systems protected by passwords. Your name and identity will not be used in reporting and presenting study findings, or in their publication in journals. We will use the information only for the purpose of research. In case of future use of the information collected from the study anonymous information may be supplied to other researchers. But this will not compromise with your privacy and anonymity.

Voluntary participation:

You are free to decide whether or not to be in the study. You are free to leave the study at any time. You do not have to give any reason for leaving the study. You will not lose any benefits for leaving the study. If you do take part in the study, you are free to refuse to answer any question. You do not have to give any reason for refusing to answer any questions.

Persons to Contact

If you have any question about this research study you may contact Mr. Tarique Md. Nurul Huda (Study Coordinator). His mobile number is 01772362311. His office number is 988-1761.

If you have questions about your right in the study, you may call Mr. M A Salam Khan, Committee coordination secretariat at 9886498. His office is located at 68, Shaheed Tajuddin Ahmed Sarani Mohakhali, Dhaka 1212.

Part II: Consent Form

The nature of the study has been explained to me. I have had the opportunity to ask questions about it. I understand what will be required of me and what will happen to me, if I take part. I understand that my participation in this study is voluntary. I understand that I do not have to answer any questions if I do not want. I

understand that I can leave the study freely at any time. I understand that these conditions also apply to any children for whom I give consent to participate in the study. I do agree to quotations from my participation in the study to be included anonymously in reports about the study

I agree to participate in the study (*tick*)

I do agree to quotations from my participation in the study to be included anonymously in reports about the study.

I give my consent for pictures of me and my household facilities to be taken and used.

I give my consent for all household members below the age of 18 years and for whom I am the parent of guardian to participate in the study. (*Tick*)

Name of the main caregiver _____

Age _____ Years

Signature of the Investigator or his representative

Date

HOUSEHOLD CROSS SECTIONAL SURVEY

Project title: Sanitation and faecal contamination of the domestic environment

Note: Ask these questions to the mother or the main caregiver of the child.

[এই প্রশ্নগুলো বাচ্চার মাকে অথবা মূল পরিচর্যাকারীকে জিজ্ঞেস করুন]

PART A: QUESTIONNAIRE

Section 1. Questionnaire identification

1.1 খানা নং (Household ID): □□□□□□

(Please follow the specific code sheet)

1.2 ইন্সট্রুমেন্ট টাইপ [Instrument Type] (Code: Cross Sectional Survey=A1):.....

A	1
---	---

1.3 ক্লাস্টার নং[Cluster number (starting point number)]: □□□

1.4 জেলা নাম এবং কোড (District name & district geocode): □□□

1.5 উপজেলা নাম এবং কোড (Upazila name & code): □□□

1.6 ইউনিয়নের নাম (Union name):

1.7 ঠিকানা (Address):

add1 খানা প্রধানের নাম [Name of household head]:.....

add2 খানা প্রধানের পিতা/স্বামীর নাম [Father's/ husband's name of HH head]:.....

add3 বাড়ির নাম [Bari Name]:

add4 গ্রামের নাম [Village]:

add5 বাড়ির অবস্থান (নির্দিষ্ট করুন) [Location (specify)]:

1.8 FRA নাম এবং কোড (FRA name & code): □□□□

1.9 তথ্য সংগ্রহের তারিখ (Date of data collection): DD/MM/YYYY□□/□□/□□□□

1.10 তথ্য সংগ্রহ শুরু সময় (24 N>Uv) [Time of Starting (24 hrs)]: HH:MM□□:□□

1.11 শোবার ঘরের প্রবেশ মুখের জিআইএস কোঅর্ডিনেট লিপিবদ্ধ করুন [GIS coordinates of the entrance of the living room].

Latitude

Longitude

Section 2. Respondent and household demographics

- 2.1 প্রধান উত্তরদাতার নাম [Name of respondent:]
- 2.2 প্রধানউত্তরদাতার পরিচয় [Status of main respondent]
- সবচেয়ে ছোট বাচ্চার মা [Mother of youngest child]..... 1
- প্রধানপরিচর্যাকারী (পুরুষ) [Main-Male caregiver]..... 2
- প্রধানপরিচর্যাকারী (মহিলা) [Main-Female caregiver]..... 3
- 2.3 প্রধানউত্তরদাতার বয়স (বছরে) (Rvwbbv=999) [Age of main respondent: (in years) DK=999].....
- 2.4 খানাপ্রধানের লিঙ্গ (পুরুষ = ১, মহিলা = ০) [Sex of head of household (1=Male,0=Female)].....
- (Note: খানা বলতে একই হাড়িতে রান্না করে খায় এমন সদস্যদের বুঝানো হয়েছে) [Note: By household, I mean all the people that eat food from the same cooking pot]
- 2.5 খানাপ্রধান কি অক্ষম বা শারীরিক/মানসিকভাবে ভিন্ন ধারায় সক্ষম (হ্যাঁ = ১, না = ০) [Is the household head differently able? (1=Yes, 0=No)]
- 2.6 খানাপ্রধানের বয়স (বছরে) (জানিনা=৯৯৯) [Age of household head: (in years) DK=999]
- 2.7 টার্গেট শিশুর মা কত ক্লাস পর্যন্ত পড়ালেখা শেষ করেছেন? (জানি না = ৯৯৯) [Education of mother of the target child(Years of education completed, DK=999)].....
- 2.8 টার্গেট শিশুর বাবা কত ক্লাস পর্যন্ত পড়ালেখা শেষ করেছেন? (জানি না = ৯৯৯)[Education of father of the targetchild<5 (Years of education completed, DK=999)].....
- 2.9 টার্গেট শিশুর বাবার প্রধান পেশা [Main occupation of father of the target].....

Occupation Code:

- | | |
|--|---|
| 1. কৃষক [Farmer/Cultivator] | 22. পোলট্রি/ ব্যবসার জন্য পশু লালন-পালনকারী [Poultry /livestock rearer] |
| 2. ঘরে কাজ করে [Homemaker] | 23. বৈদ্যুতিক মিস্ত্রী [Electrician] |
| 3. কৃষি শ্রমিক [Agri-labor] | 24. হোমিওপ্যাথি ডাক্তার [Homeopath] |
| 4. শ্রমিক (কৃষি শ্রমিক ছাড়া) [Non-agri labor] | 25. আধ্যাতিক চিকিৎসক/ কবিরাজ/ ওঝা [Spiritual healer/kabiraj/ Ojha] |
| 5. বেতনভুক্ত কর্মচারী (সরকারী/প্রাইভেট/এন.জি.ও) [Salaried job (Govt./Private/NGO)] | 26. পেশাদার ডাক্তার/উকিল [Professional practitioner (Doctor/lawyer)] |
| 6. রাজমিস্ত্রী [Mason (Rajmistri)] | 27. ইমাম/ ধর্মযাজক [Imam/priest] |
| 7. কাঠ মিস্ত্রী [Carpenter] | 28. অবসরপ্রাপ্ত চাকুরীজীবী [Retired service holder] |
| 8. ভ্যান/রিকশা চালক [Van/Rickshaw puller] | 29. ছাত্র [Student] |
| 9. জেলে [Fisherman] | 30. বেকার [Unemployed] |
| 10. নৌকা চালক/মাঝি [Boatman] | |

- | | |
|--|--|
| 11. কর্মকার [Blacksmith] | 31. ভিন্নধারায় সক্ষম [Differently able] |
| 12. স্বর্ণকার[Goldsmith] | 32. কাজের লোক [Domestic maid / servant] |
| 13. কুমার/কুম্ভকার [Potter (soil smith)] | 33. জমিদার (শস্য উৎপাদন অথবা অন্য কোন কাজে কৃষকদের জমি বর্গা দেয়) [Landlord (Provide land for farmers for sharecropping or others)] |
| 14. মুচি [Shoe polish /maker] | 34. বিদেশে থাকে [Staying abroad] |
| 15. দোকানদার [Shopkeeper] | 35. মৃত/নিখোঁজ [Died/untraced] |
| 16. ফেরিওয়ালা [Vendor (Feriwala/howker)] | 36. ভিক্ষুক [Begger] |
| 17. ক্ষুদ্র ব্যবসায়ী (মূলধন<=১০০০০) [Petty trader, capital <=10000] | 37. শিক্ষক [Teacher] |
| 18. ব্যবসায়ী(মূলধন >১০০০০) [Business, capital >10000] | 777. অন্যান্য (বর্ণনা লিখুন) [Others (specify)] |
| 19. দর্জি [Tailor] | 999. জানিনা [Don't know] |
| 20. ড্রাইভার [Driver] | |
| 21. কুটীর শিল্প [Cottage industry] | |

2.10. আপনার খানাতে/পরিবারে বর্তমানে কত জন লোক বসবাস করছে? [How many people in total live in your household at present?.....

(নোট: খানা বলতে একই হাড়িতে রান্না করে খায় এমন সদস্যদের বুঝানো হয়েছে) (Note: Household would be defined as cooking in the same pot regardless of number of living house/room.)]

2.11 আপনার খানাতে ৫ বছরের নীচে কত জন শিশু আছে? [How many children less than five years old live in your household?].

2.11.x ছেলে [Male].....

2.11.y মেয়ে [Female].....

2.11.1 এই খানার ৫ বছরের নীচের সব শিশুর তথ্য লিপিবদ্ধ করুন [প্রথমে টার্গেট শিশুর তথ্য লিপিবদ্ধ করুন, তারপর খানার অন্য সব বাচ্চার (ছোট থেকে বড়)তথ্য লিপিবদ্ধ করুন, সব বাচ্চার নাম এবং আইডি নোট বুকো লিপিবদ্ধ করুন, কারণ এই জরিপের অন্য অংশে বাচ্চার আইডি প্রয়োজন হবে।] [Include the information of the target child first. Then, list rest of the <5 children's (youngest to old) information. Make sure you also keep a list of the child with the ID in your note book as the ID will be needed later in the questionnaire].

A. বাচ্চার নাম [Child Name]	B. জন্ম তারিখ (দিন/মাস/বছর) [Date of birth (DD/MM/YY)]	C. বয়স (মাসে) [Age in months]	D. লিঙ্গ [Gender] ছেলে [Male=1] মেয়ে [Female=0]	E. শিশুর বৃদ্ধির ধাপ [Motor milestone] 0=বিছানায় নরাচরা করতে পারে [Bed mobility] 1=হামা গুরি দেয় [Crawling] 2=সহায়তা নিয়ে হাটে [assisted walking] 3=একা একা হাটে

				[Independent walking]
1.				
2.				
3.				
4.				
5.				

2.12 এই বাড়ীতে/কম্পাউন্ডে কতগুলো খানা আছে? (জানি না = ৯৯৯) [How many Household are there in your compound (Bari) (DK=999?).....□□□

[(নোট: বাড়ি বলতে একই উঠানে বসবাসকারী খানা সদস্যদের বুঝানো হয়েছে, সাধারণত রক্তের সম্পর্ক আছে এমন ৫-১২ টি খানা একই বাড়িতে বসবাস করে) (Note: Bari is comprised of a group of usually 5-12 households that share a common courtyard or have linked courtyard and are usually blood relatives.)]

Section 3. Respondent's Hand washing practices

3.1 আপনি কখন কখন সাবান দিয়ে হাত ধোঁন? (এ প্রশ্নটি খোলা প্রশ্ন, নীচের দেয়া উত্তরগুলোর কোনটিই উত্তরদাতাকে মনে করিয়ে দেয়া যাবে না) [When do you wash your hands with soap? (This is an open-ended question)] _____

Note: উত্তরদাতা যা বলে তা হুবহু/নোট বুক লিখে নিতে হবে এবং পরে নীচের দেয়া উত্তরগুলোর সাথে মিলিয়ে হ্যাঁ বা না কোড করতে হবে [After noting down the answers of this open-ended question, check appropriate code to the boxes below]

হ্যাঁ [Yes]...1, না [No]...0

- 3.1.1 খাবার তৈরী করার আগে [Before preparing food]□
- 3.1.2 নিজে খাবারের পূর্বে [Before eating]□
- 3.1.3 নিজে খাবারের পর [After eating].....□
- 3.1.4 বাচ্চাকে খাওয়ানোর পূর্বে [Before feeding a child]□
- 3.1.5 বাচ্চাকে সৌচানোর পর [After cleaning child's anus]□
- 3.1.6 বাচ্চার পায়খানা ফেলার পর [After disposal of child feces:]□
- 3.1.7 পায়খানার পর [After defecation]□
- 3.1.8 গোবর সাফ করা বা ধরার পর [After handling cow-dung]□
- 3.1.9 বাহির থেকে কোন কাজ শেষে ঘরে আসার পর [After returning from outside compound]□
- 3.1.10 খাবার তৈরী করার পর/রান্নার পরে [After cooking]□
- 3.1.11 হাড়ি/পাতিল ধোয়ার পর [After dish/crockery washing].....□

- 3.1.12 মাছ কাটা/ ধোয়ার পর [After cutting /cleaning fish].....□
- 3.1.13 উঠান বাডু দেয়ার / ঘর পরিষ্কার করার পর [After cleaning yard/household].. ..□
- 3.1.14 হাতে ময়লা লাগলে / ময়লা ধরার পর [After contacting with dirt].....□
- 3.1.15 খাবার পরিবেশন করার আগে [Before serving food].....□
- 3.1.16 কখনই ধোয়া হয় না [Never].....□
- 3.1.777 অন্যান্য (বর্ণনা লিখুন) [Others (Specify)].....□

3. 2 হাত ধোয়ার জন্য আপনার খানাতে কোন সাবান আছে কি? [Do you have soap available for hand washing?].....□

- Code: হ্যাঁ [Yes]1
- না [No]0
- জানিনা [DK]999

Skip Note: 3.2 নং প্রশ্নের উত্তর ০ বা ৯৯৯ হলে ৩.৪ নং প্রশ্নে চলে যান। [If the answer to question 3.2 is 0 or 999 go to question 3.4]

3.3 যদি ৩.২ নং প্রশ্নের উত্তর হ্যাঁ (১) হয়ে থাকে, তাহলে আমি কি তা দেখতে পারি? (পর্যবেক্ষণ করুন এবং সঠিক কোড বসান) [If 3.2 is yes(1), can I see it? (Observe and put appropriate code)]
.....□□□

- পাওয়া গেছে [Available]1
- পাওয়া যায়নি [Not available]0
- জানি না [DK]999

3.4 কখন কখন আপনি সাবান দিয়ে হাত ধোয়া দরকার বলে মনে করেন? (এটা একটা উন্মুক্ত প্রশ্ন, উত্তরদাতা যা বলবে তা শুনে নিচের উত্তরগুলো পূরণ করবেন এখানে একাধিক উত্তর গ্রহণযোগ্য।) [When do you think it is important to wash hands with soap? Open ended question. Multiple answers are allowed here.]

Note: উত্তরগুলো কোনভাবেই পড়ে শুনানো যাবে না, উত্তরদাতা যাতে সঠিক উত্তর বলতে পারে সেভাবে তাকে সহায়তা করতে হবে যেমন, আরও কিছু আছে কিনা বা অন্য কিছু ...। [Don't read the answer, encourage by asking if there is anything else until he/she mentions there in nothing else and check all mentioned?]

- হ্যাঁ [Yes]1
- না [No]0

- 3.4.1 খাবার তৈরী করার আগে [Before preparing food]□
- 3.4.2 নিজে খাবারের পূর্বে [Before eating]□
- 3.4.3 নিজে খাবারের পর [After eating].....□
- 3.4.4 বাচ্চাকে খাওয়ানোর পূর্বে [Before feeding a child].....□

- 3.4.5 বাচ্চাকে সৌচানোর পর [After cleaning child's anus]□
- 3.4.6 বাচ্চার পায়খানা ফেলার পর [After disposal of child feces:]□
- 3.4.7 পায়খানার পর [After defecation]□
- 3.4.8 গোবর সাফ করা বা ধরার পর [After handling cow-dung].....□
- 3.4.9 বাহির থেকে কোন কাজ শেষে ঘরে আসার পর [After returning from outside compound]□
- 3.4.10 খাবার তৈরী করার পর/রান্নার পরে [After cooking]□
- 3.4.11 হাড়ি/পাতিল ধোয়ার পর [After dish/crockery washing]□
- 3.4.12 মাছ কাটা/ ধোয়ার পর [After cutting /cleaning fish].....□
- 3.4.13 উঠান ঝাড়ু দেয়ার / ঘর পরিষ্কার করার পর [After cleaning yard/household] □
- 3.4.14 হাতে ময়লা লাগলে / ময়লা ধরার পর [After contacting with dirt]..... □
- 3.4.15 খাবার পরিবেশন করার আগে [Before serving food].....□
- 3.4.16 কখনই ধোয়া হয় না [Never].....□
- 3.4.777 অন্যান্য (বর্ণনা লিখুন) [Others (Specify)].....□
- 3.4.999 জানিনা [DK].....□

3.5 গত আধা ঘন্টার মধ্যে আপনি কি কি কাজ করেছেন? (Note: উত্তর পড়ে শুনানো যাবে না। তবে বলা যেতে পারে যেমন, আরও কিছু আছে কিনা বা অন্য কিছু ...? (একাধিক উত্তর গ্রহণযোগ্য) [What have you done in the last half an hour? (Note: Do not read the answers. Probe, anything else?. (Multiple answer possible)]

উল্লেখ করেছে [Mentioned]1

উল্লেখ করেনি [Not mentioned].....0

1. খাবার তৈরী করেছে [Prepared food]□
2. খাবার খেয়েছে [Ate foods]□
3. বাচ্চাকে খাবার খাইয়েছে [Fed the child]□
4. বাচ্চাকে সৌচ করিয়েছে [Cleaned child anus]□
5. বাচ্চার মল পরিষ্কার করেছে [Disposed child's faeces]□
6. মলত্যাগ করেছে [Defecated].....□
7. গোবর ঘেঁটেছে [Handled cow dung]□
8. কৃষি পণ্য / ফসল ঘেঁটেছে [Handled agricultural products/crops]□
9. বাড়ীর বাহির থেকে ফিরেছে [Returned from outside compound]□
10. থালা-বাসনপরিষ্কার করেছে [Washed dishes]□
11. খানা পরিষ্কার করেছে [Cleaned household]□

12. গরু ছাগল ইত্যাদি ধরেছে [Handled animals]□
13. কাপড় পরিষ্কার করেছে [Washed clothes]□
14. কিছুই করেনি [Nothing].....□
777. অন্যান্য (লিখুন) [Other: specify]□

3.6 গত আধা ঘন্টায় আপনি কি আপনার হাত ধৌত করেছেন? [Did you wash your hand(s) within last half hour?]......□

হ্যাঁ [Yes]1

না [No].0 (3.10-এ স্কিপ করুন) [(Skip to question no 3.10)]

3.8 গত আধা ঘন্টায় আপনি আপনার হাত কতবার হাত ধৌত করেছেন? [How many time(s) did you wash your hand(s) within last half hour?]

1. শুধুডান হাত [Right hand]□
2. শুধুবাম হাত [Left hand]□
3. উভয় হাত [Both hands]□

3.9 গত আধা ঘন্টায় আপনি আপনার হাত ধৌত করার জন্য কি ব্যবহার করেছেন? (পরিষ্কারকের কোড ব্যবহার করুন) [What did you use to clean hands within last half an hour? (Use the code for the cleansing agents)].....□□□

1. গোসলের সাবান [Bar soap]
2. ডিটারজেন্ট গুড়া [Powdered detergent]
3. শুধু পানি [Only water]
4. কাপড় ধোয়া সাবান [Laundry soap]
5. ছাই [Ash]
6. মাটি [Mud]
7. তরল সাবান [Liquid soap]
777. অন্যান্য (লিখুন) [Other (Specify)]

3.10 গত আধা ঘন্টায় আপনার শিশুটি (টার্গেট শিশু) কি কি করেছে? [What did your child do within the last half hour?

উল্লেখ করেছে [Mentioned]1

উল্লেখ করেনি [Not mentioned].....2

1. ঘুমিয়েছে [Slept]□
2. খাবার খেয়েছে [Ate]□
3. খেলা করেছে [Played]□
4. মলত্যাগ করেছে [Defecated]□
777. অন্যান্য (লিখুন) [Others (Specify)]□

3.11 গত আধা ঘন্টায় আপনার শিশুটি (টার্গেট শিশু) কি হাত ধৌত করেছে? [Did he/she wash hand(s) within last half an hour?].

হ্যাঁ [Yes]1

না [No].....0 (3.10.নতে যান) [(Skip to question no 3.10.b)

জানিনা [DK].....999 (3.10.b তে যান) [(Skip to question no 3.10.b)

3.13 গত আধা ঘন্টায় আপনার শিশুটি (টার্গেট শিশু) কতবার হাত ধৌত করেছে? [How many time(s) did he/she wash hand(s) within last half an hour?]

1. শুধুডান হাত [Right hand]

2. শুধুবাম হাত [Left hand]

3. উভয় হাত [Both hands]

3.14 গত আধা ঘন্টায় আপনার শিশুটি (টার্গেট শিশু) হাত ধৌত করার জন্য কি ব্যবহার করেছে? (পরিষ্কারকের কোড ব্যবহার করুন) What did he/she use to clean hands after the following event(s) within last half an hour? (Use the code for the cleansing agents).....

1. গোসলের সাবান [Bar soap]

2. ডিটারজেন্ট গুড়া [Powdered detergent]

3. শুধু পানি [Only water]

4. কাপড় ধোয়া সাবান [Laundry soap]

5. ছাই [Ash]

6. মাটি[Mud]

7. তরল সাবান [Liquid soap]

777. অন্যান্য (লিখুন) [Other (Specify)]

3.10.b ইন্টানভিউ শুরু করার পর থেকে শিশুটি (টার্গেট শিশু) কি কি করেছে? [What did the child do since starting of the interview?

উল্লেখ করেছে [Mentioned]1

উল্লেখ করেনি [Not mentioned].....2

1. ঘুমিয়েছে [Slept]

2. খাবার খেয়েছে [Ate]□

3. খেলা করেছে [Played]□

4. মলত্যাগ করেছে [Defecated]□

777. অন্যান্য (লিখুন) [Others (Specify)]□

3.11.b ইন্টারভিউ শুরু করার পর থেকে শিশুটি (টার্গেট শিশু) কি হাত ধোঁত করেছে? [Did he/she wash hand(s) since starting of the interview?]

.....□

হ্যাঁ [Yes]1

না [No].....0 (১১.৬ তে যান) [(Skip to question no 11.6)

জানিনা [DK].....999 (১১.৬ তে যান) [(Skip to question no 11.6)

3.13.b ইন্টারভিউ শুরু করার পর থেকে শিশুটি (টার্গেট শিশু) কতবার হাত ধোঁত করেছে? [How many time(s) did he/she wash hand(s) since starting of the interview?]

1. শুধু ডান হাত [Right hand]□

2. শুধু বাম হাত [Left hand]□

3. উভয় হাত [Both hands]□

3.14.b ইন্টারভিউ শুরু করার পর থেকে শিশুটি (টার্গেট শিশু) হাত ধোঁত করার জন্য কি ব্যবহার করেছে? (পরিষ্কারকের কোড ব্যবহার করুন) What did he/she use to clean hands after the following event(s) since starting of the interview? (Use the code for the cleansing agents).....□□□

1. গোসলের সাবান [Bar soap]

2. ডিটারজেন্ট গুড়া [Powdered detergent]

3. শুধু পানি [Only water]

4. কাপড় ধোঁয়া সাবান [Laundry soap]

5. ছাই [Ash]

6. মাটি [Mud]

7. তরল সাবান [Liquid soap]

777. অন্যান্য (লিখুন) [Other (Specify)]

11. 6 আমি কি (বাচ্চার নাম) হাতগুলো দেখতে পারি ? (যদি একই খানাতে ৫ বছরের নীচে একাধিক বাচ্চা থাকে এবং তাদের প্রত্যেকের তথ্য লিপিবদ্ধ করুন) [May I please look at (**Child's name**) hands (if more than one under-5 children living in a household than observed and collect information on all of the children <5]

ময়লা স্পষ্টভাবে দেখা যাচ্ছিল [Visible dirt].....1

ময়লা স্পষ্টভাবে দেখা না গেলেও অপরিচ্ছন্নতাব ছিল [Unclean appearance]2

পরিষ্কার ছিল [Clean]3

পর্যবেক্ষণ করা সম্ভব হয়নি/প্রত্যাখান [Observation was not possible/refused]4

	Child ID 1	Child ID 2	Child ID 3	Child ID 4	Child ID 5
a. হাতের নখ [Fingernails]					
b. করতল [Palms]					
c. আঙ্গুলের সম্মুখভাগ [Fingerpads]					

হাত ধোয়ার পানির নমুনা সংগ্রহ [Collection of hands rinse sample]

তথ্য সংগ্রহকারীর জন্য নির্দেশনা: নিচের নির্দেশনাগুলো শিশুর মা কে পড়ে শোনান ।

এখন আমি আপনাকে এই ব্যাগের তরলের মধ্যে আপনার শিশুর(টার্গেট শিশু) হাত ধোয়ানোতে সাহায্য করার অনুরোধ করব (মা কে ব্যাগটি দেখান যাতে করে তিনি শিশুটিকে দেখাতে পারেন) । দয়া করে আপনি আমার নির্দেশনাগুলো অনুসরণ করুন (মা কে হাত ধোয়ার পদ্ধতি দেখান এবং সঠিক নির্দেশনা অনুযায়ী শিশুটির হাত ধোয়ানোর জন্য বলুন । সকল নমুনা সঠিক নির্দেশনা (বাগুচ) অনুযায়ী সংগ্রহ করুন)

[Instruction to data collector: Read to the mother the following instruction. I will now request you to help me to rinse your child's hands in this bag (Show the mother the whirl-pak bag so that she can show the child). Please follow my instructions. (Demonstrate the mother hand rinse technique and ask her to help the child rinse hands following the standard operating procedure for hand rinse) Please take all the samples following the standard operating procedures (SOP).]

3.15 টার্গেট শিশুর হাত ধোয়ার পানির নমুনা সংগ্রহ সম্পন্ন হয়েছে কি? [Is Collection of hands rinse sample complete?].....
...□

হ্যাঁ [Yes]1

না [No].0

Toy Ball collection: খেলনা বল সংগ্রহ:

তথ্য সংগ্রহকারীর জন্য নির্দেশনা: এই খানার টার্গেট শিশুকে একটি বল দিন । মা কে বলুন যাতে বাচ্চটি বলটি দিয়ে খেলা করে এবং আগামীকাল বলটিকে একটি ব্যাগের তরলের মধ্যে ধৌত করার জন্য ফিরে আসবেন ও পরে বলটি ফেরত দিয়ে যাবেন ।

[Toy Ball collection: Instruction to data collector: Give the child the sentinel ball and tell the mother that he can play with the ball and you will come back tomorrow to rinse the ball in a similar bag used for hand and will return the Ball.]

3.16 টার্গেট শিশুকে বল সরবরাহ করা হয়েছে কি? [Is ball supplied to the child?]

.....□

হ্যাঁ [Yes]1

না [No].....0

3.17 বল সরবরাহ করার সময় [Time of supplying the toy ball].....□□:□□

3.19 গত দুই সপ্তাহের মধ্যে সর্বশেষ কতদিন আগে বৃষ্টি হয়েছিল?(১৪ দিনের মধ্যে বৃষ্টি না হলে ৮৮৮ কোড করুন) [When was the most recent time it rained in the past 2 weeks?(Code 888 if it did not rain within 14 days)]

.....□□

[days ago]

Section 4: Faeces disposal

4.1 আপনার খানার সদস্যরা পায়খানা করার জন্য সাধারণত কোথায় যায়? (Note: উত্তরদাতাকে উত্তরগুলো পড়ে শোনান) [Where do the members of your household usually go for defecation? (Note: Read out the responses to the respondent)].....□

1. খোলা জঙ্গলে [Open bush]
2. খোলা মাঠে [Open field]
3. খোলা জায়গায়, নদী/পুকুর/লেকের পাশে [Open, by the side of river/pond/lake]
4. পায়খানায় [In a toilet]

4.2 আপনি সাধারণত কোথায় পায়খানা করেন?(ঘড়ঃব:উত্তরদাতাকে উত্তরগুলো পড়ে শোনান) [Where do you usually defecate?].....□

1. খোলা জঙ্গলে[Open bush]
2. খোলা মাঠে [Open field]
3. খোলা জায়গায়, নদী/পুকুর/লেকের পাশে [Open, by the side of river/pond/lake]
4. পায়খানায় [In a toilet]

4.3 আপনার খানার অন্যান্য প্রাপ্ত বয়স্ক (১৮+) সদস্যরা সাধারণত কোথায় পায়খানা করেন? (Note: উত্তরদাতাকে উত্তরগুলো পড়ে শোনান) [Where do other adults (18+) in the household usually defecate?]

.....□

1. খোলা জঙ্গলে[Open bush]
2. খোলা মাঠে [Open field]
3. খোলা জায়গায়, নদী/পুকুর/লেকের পাশে[Open, by the side of river/pond/lake]

4. পায়খানায় [In a toilet]

4.4 আপনার খানার <3 বছর শিশু (টার্গেট শিশু) সাধারণত কোথায় পায়খানা করে? (২.১১নং প্রশ্ন থেকে শিশুর নাম ব্যবহার করুন) [Where do the <3 child in the household usually defecate? (Use name of the child from question

2.11).....□□□

1. পটি [Potty]
 2. ন্যাপি/ডায়পার [Nappy / diaper]
 3. উঠানে (পটি ছাড়া) [In the courtyard (without potty)]
 4. ঘরের ভিতরে (পটি ছাড়া) [Inside the house (without potty)]
 5. পায়খানায়/টয়লেটে [In Toilet / Latrine]
 6. বোপ-ঝাড়/জঙ্গলে [Bush / forest / field]
 7. কোন নির্দিষ্ট জায়গায় নয় [No specific place]
777. অন্যান্য (বর্ণনা লিখুন) [Other (specify)]

888. প্রযোজ্য নয় [Not Applicable]

999. জানি না / নিশ্চিত নয় [Don't know / Not sure] খানার অন্য কেউ জানে কি না দেখুন [Probe to see if someone in the HH knows]

4.5 আপনার খানার 3-5 বছরের শিশু সাধারণত কোথায় পায়খানা করে? [Where do the children aged 3-5 years usually defecate?

].....□□□

1. পটি [Potty]
 2. ন্যাপি/ডায়পার [Nappy / diaper]
 3. উঠানে (পটি ছাড়া) [In the courtyard (without potty)]
 4. ঘরের ভিতরে (cwU Qvov)[Inside the house (without potty)]
 5. পায়খানায়/টয়লেটে [In Toilet / Latrine]
 6. বোপ-ঝাড়/জঙ্গলে [Bush / forest / field]
 7. কোন নির্দিষ্ট জায়গায় নয় [No specific place]
777. অন্যান্য (বর্ণনা লিখুন) [Other (specify)]

888. প্রযোজ্য নয় [Not Applicable]

999. জানি না / নিশ্চিত নয় [Don't know / Not sure] খানার অন্য কেউ জানে কি না দেখুন [Probe to see if someone in the HH knows]

4.6 আপনার খানার ৫ বছরের বেশী (১৮ বছর পর্যন্ত) বয়সের বাচ্চারা সাধারণত কোথায় পায়খানা করে? [Where do the children above 5 (up to 18 years) usually defecate?

].....□□□

1. পটি [Potty]
 2. ন্যাপি/ডায়পার [Nappy / diaper]
 3. উঠানে (পটি ছাড়া) [In the courtyard (without potty)]
 4. ঘরের ভিতরে (পটি ছাড়া) [Inside the house (without potty)]
 5. পায়খানায়/টয়লেটে [In Toilet / Latrine]
 6. বোপ-বাড়ে/জঙ্গলে [Bush / forest / field]
 7. কোন নির্দিষ্ট জায়গায় নয় [No specific place]
777. অন্যান্য (বর্ণনা লিখুন) [Other (specify)]

888. প্রযোজ্য নয় [Not Applicable]

999. জানি না / নিশ্চিত নয় [Don't know / Not sure] খানার অন্য কেউ জানে কি না দেখুন
[Probe to see if someone in the HH knows]

4.7 আপনি সর্বশেষ কোথায় পায়খানা করেছেন? (Note: উত্তরদাতাকে উত্তরগুলো পড়ে শোনান) [Where did you defecate the last time? (Note: Read out the responses to the respondent)]

.....□□□

1. খোলা জঙ্গলে [Open bush]
2. খোলা মাঠে [Open field]
3. খোলা জায়গায়, নদী/পুকুর/লেকের পাশে [Open, by the side of river/pond/lake]
4. পায়খানায় [In a toilet]

4.8 আপনার <৩ বছর শিশু (টাগেট শিশু) সর্বশেষ কখন পায়খানা করেছে? [When was the last time your youngest child / infant (<3 years) defecated?]

.....□□□

1. আজ [Today]
 2. গতকাল [Yesterday]
 3. ২ দিন বা তার আগে [2 or more days ago]
 4. মনে করতে পারছি না [Cannot remember] ৪.১২নং প্রশ্নে চলে যান(Skip to q4.12)
 5. বলতে রাজি নয় [Refused] ৪.১২নং প্রশ্নে চলে যান(Skip to q4.12)
888. প্রযোজ্য নয় [Not Applicable] ৪.১২নং প্রশ্নে চলে যান(Skip to q4.12)

4.9 আপনার <3 বছর শিশু (টার্গেট শিশু) সর্বশেষ কোথায় পায়খানা করেছে? [Where did the child (<3 years) defecate the last time?]  উত্তর পড়ে শোনাবেন না [Do Not Read Responses].....□□□

1. পটি [Potty]
2. ন্যাপি/ডায়পার [Nappy / diaper]
3. উঠানে (পটি ছাড়া) [In the courtyard (without potty)]
4. ঘরের ভিতরে (পটি ছাড়া) [Inside the house (without potty)]
5. পায়খানায়/টয়লেটে [In Toilet / Latrine] 8.1২নং প্রশ্নে চলে যান(Skip to q4.12)
6. ঝোপ-ঝাড়/জঙ্গলে [Bush / forest / field]
7. কোন নির্দিষ্ট জায়গায় নয় [No specific place]
777. অন্যান্য (বর্ণনা লিখুন)[Other (specify)]

-
888. প্রযোজ্য নয় [Not Applicable] 8.1২নং প্রশ্নে চলে যান(Skip to q4.12)
999. জানি না / নিশ্চিত নয় [Don't know / Not sure] খানার অন্য কেউ জানে কি না দেখুন [Probe to see if someone in the HH knows] 8.1২নং প্রশ্নে চলে যান(Skip to q4.12)

4.10 সেই পায়খানা কি করা হয়েছিল? [What was done with the faeces?]  উত্তর পড়ে শোনাবেন না [Do Not Read Responses].....□□□

1. যেখানে পায়খানা করেছিল সেখানেই ফেলে রাখা হয়েছিল [Left there] 8.1২নং প্রশ্নে চলে যান[skip to 4.12]
2. টয়লেট/পায়খানার ভিতরে ফেলা/ধোয়া হয়েছিল [Put / rinsed into toilet or latrine]
3. ড্রেনে/নর্দমার ভিতরে ফেলা/ধোয়া হয়েছিল [Put / rinsed into drain or ditch]
4. টিউবওয়েল/ পুকুরের কাছে ধোয়া হয়েছিল [Rinsed near tubewell/pond]
5. ঝোপ-ঝাড়/জঙ্গলে ফেলা হয়েছিল [Thrown into the bush / forest / field]
6. ময়লা আবর্জনার মধ্যে ফেলা হয়েছিল [Thrown into garbage]
7. নির্দিষ্ট গর্তে ফেলা হয়েছিল [Thrown into a specific pit for child's faeces]
8. মাটির নীচে পুতে ফেলা হয়েছিল [Buried]
777. অন্যান্য (বর্ণনা লিখুন) [Other (specify)]

-
999. জানি না / নিশ্চিত নয় [Don't know / Not sure] 8.1২নং প্রশ্নে চলে যান[skip to 4.12]

4.11 সেই পায়খানা আপনি কিভাবে পরিষ্কার করেছিলেন? [How did you handle the faeces?]  উত্তর পড়ে শোনাবেন না [Do Not Read Responses]

.....□□□

1. নগ্ন/খালি হাতে [Hands only/bare hands]
2. কাপড়/পাতা/কাগজ/খড়কুটা [Hands and cloth / paper / leaves / straw]

3. কোদাল/স্থানীয় কৃষিকাজ-এর হাতিয়ার [Local agricultural hoe/instrument]

4. সেনি স্কুপ [Sani-scoop]

5. কোন কিছুই করা হয় না [Did nothing]

777. অন্যান্য (বর্ণনা লিখুন) [Other (specify)]

999. জানি না / নিশ্চিত নয় [Don't know / not sure]

4.12 আপনার শিশু (৩-৫ বছরের) সর্বশেষ কখন পায়খানা করেছে? [When was the last time your youngest child / infant (3-5) defecated?].

1. আজ [Today]

2. গতকাল [Yesterday]

3. ২ দিন বা তার আগে [2 or more days ago]

4. মনে করতে পারছি না [Cannot remember] ৪.১৬নং প্রশ্নে চলে যান(Skip to 4.16)

5. বলতে রাজি নয় [Refused] ৪.১৬নং প্রশ্নে চলে যান(Skip to 4.16)

888. প্রযোজ্য নয় [Not Applicable] ৪.১৬নং প্রশ্নে চলে যান(Skip to 4.16)

4.13 আপনার (৩-৫ বছর) শিশু সর্বশেষ কোথায় পায়খানা করেছে? [Where did the child 3-5 years defecate the last time?].

1. পটি [Potty]

2. ন্যাপি/ডায়পার [Nappy / diaper]

3. উঠানে (পটি ছাড়া) [In the courtyard (without potty)]

4. ঘরের ভিতরে (পটি ছাড়া)[Inside the house (without potty)]

5. পায়খানায়/টয়লেটে [In Toilet / Latrine] ৪.১৬নং প্রশ্নে চলে যান(Skip to 4.16)

6. বোাপ-ঝাড়/জঙ্গলে [Bush / forest / field] ৪.১৬নং প্রশ্নে চলে যান(Skip to 4.16)

7. কোন নির্দিষ্ট জায়গায় নয় [No specific place]

777. অন্যান্য (বর্ণনা লিখুন) [Other (specify)]

888. প্রযোজ্য নয় [Not Applicable]

999. জানি না / নিশ্চিত নয় [Don't know / Not sure] খানার অন্য কেউ জানে কি না দেখুন [Probe to see if someone in the HH knows] ৪.১৬ নং প্রশ্নে চলে যান (Skip to 4.16)

4.14 সেই পায়খানা কি করা হয়েছিল? [What was done with the faeces?]  উত্তর পড়ে শোনাবেন না
[Do Not Read
Responses].....□□□

1. যেখানে পায়খানা করেছিল সেখানেই ফেলে রাখা হয়েছিল [Left there] ৪.১৬ নং প্রশ্নে চলে যান (Skip to 4.16)
 2. টয়লেট/পায়খানার ভিতরে ফেলা/ধোয়া হয়েছিল [Put / rinsed into toilet or latrine]
 3. ড্রেনে/নর্দমার ভিতরে ফেলা/ধোয়া হয়েছিল [Put / rinsed into drain or ditch]
 4. টিউবয়েল/ পুকুরের কাছে ধোয়া হয়েছিল [Rinsed near tubewell/pond]
 5. ঝোপ-ঝাড়/জঙ্গলে ফেলা হয়েছিল [Thrown into the bush / forest / field]
 6. ময়লা আবর্জনার মধ্যে ফেলা হয়েছিল [Thrown into garbage]
 7. নির্দিষ্ট গর্তে ফেলা হয়েছিল [Thrown into a specific pit for child's faeces]
 8. মাটির নীচে পুতে ফেলা হয়েছিল [Buried]
777. অন্যান্য (বর্ণনা লিখুন) [Other (specify)]

999. জানি না / নিশ্চিত নয় [Don't know / Not sure] ৪.১৬ নং প্রশ্নে চলে যান (Skip to 4.16)

4.15 সেই পায়খানা আপনি কিভাবে পরিষ্কার করেছিলেন? [How did you handle the faeces?]  উত্তর পড়ে শোনাবেন না [Do Not Read
Responses].....□□□

1. নগ্ন/খালি হাতে [Hands only/bare hands]
 2. কাপড়/পাতা/কাগজ/খড়কুটা [Hands and cloth / paper / leaves / straw]
 3. কোদাল/স্থানীয় কৃষিকাজ-এর হাতিয়ার [Local agricultural hoe/instrument]
 4. সেনি স্কুপ [Sani-scoop]
 5. কোন কিছুই করা হয় না [Did nothing]
777. অন্যান্য (বর্ণনা লিখুন) [Other

(specify)] _____

999. জানি না / নিশ্চিত নয় [Don't know / not sure]

4.16 আপনার খানার ৫ বছরের বেশী শিশু(১৮ বছর পর্যন্ত) সর্বশেষ কোথায় পায়খানা করেছে? [Where did the child above 5 years (up to 18 years) defecate the last time?]......□□□

1. পটি [Potty]
2. ন্যাপি/ডায়পার [Nappy / diaper]
3. উঠানে (পটি ছাড়া) [In the courtyard (without potty)]
4. ঘরের ভিতরে (পটি ছাড়া) [Inside the house (without potty)]
5. পায়খানায়/টয়লেটে [In Toilet / Latrine]
6. ঝোপ-ঝাড়/জঙ্গলে [Bush / forest / field]

7. কোন নির্দিষ্ট জায়গায় নয় [No specific place]

777. অন্যান্য (বর্ণনা লিখুন) [Other (specify)] _____

888. প্রযোজ্য নয় [Not Applicable]

999. জানি না / নিশ্চিত নয় [Don't know / Not sure] খানার অন্য কেউ জানে কি না দেখুন
[Probe to see if someone in the HH knows]

4.17 পরিষ্কার পায়খানা ব্যবহারের উপকারিতা কি কি? (এটা একটা উন্মুক্ত প্রশ্ন) [Note: উত্তরগুলো কোনভাবেই পড়ে শুনানো যাবে না, উত্তরদাতা যাতে সঠিক উত্তর বলতে পারে সেভাবে তাকে সহায়তা করতে হবে যেমন , আরও কিছু আছে কিনা বা অন্য কিছু (কৃমি: অন্যান্যতে ৭ লিখুন:) [What are the benefits of using clean toilet? Note: Don't read the answer, encourage by asking if there is anything else until he/she mentions there in nothing else and check all mentioned?]

উল্লেখ করেছে [Mentioned].....1

উল্লেখ করেনি [Not mentioned].....0

1. ডায়রিয়া কম হয় [Less diarrhoea].....

2. অসুখ-বিসুখ কম হয় (নির্দিষ্ট কোন রোগের নাম বলেনি) [Less illness (type of illness not specified).....

3. রোগ জীবাণু কম [Less germs].....

4. ভালো গন্ধ (Smell better).....

5. বেশী গোপনীয়তা [More Privacy].....

6. সামাজিক মর্যাদা [Social Status].....

777. অন্যান্য: নির্দিষ্ট করে লিখুন [Other: specify].....

999. জানি না [DK].....

4.18 আপনার জানা মতে, গত ২৪ ঘন্টায় এই খানার প্রাপ্তবয়স্ক কোন সদস্য খোলা জায়গাতে পায়খানা করেছে কি? [Do you know if any adult in you household had to defecated open with last 24 hours?]

হ্যাঁ [Yes]1

না [No].....0

জানি না [DK].....999

4.19 আপনার জানা মতে, গত ৭ দিনে এই খানার প্রাপ্তবয়স্ক কোন সদস্য খোলা জায়গাতে পায়খানা করেছে কি? [Do you know if any adult in your household had to defecate open with last 7 days?].....

হ্যাঁ [Yes]1

না [No].....0

জানি না [DK].....999

4.20 বর্তমানে এই বাড়ীতে কতগুলো খানার পায়খানা/টয়লেট ব্যবহারের সুযোগ আছে? (জানি না [DK]=999)

[Among the Households in your compound how many has access to a latrine?].....□□□ খানার সংখ্যা

4.21 বর্তমানে এই বাড়ীতে কতগুলো খানা একক ভাবেপায়খানা/টয়লেট ব্যবহার করে? [Among the Households in your compound individually uses a latrine?].....□□ খানার সংখ্যা

Section 5: Household asset

5.1. আপনার খানাতে কি নিম্নের জিনিসগুলো আছে? [Does your household (or any member of your household) have]:

হ্যাঁ (Yes)....1, না (No)....0, জানি না (DK).....999

- a. বিদ্যুৎ [Electricity]□□□
- b. আলমারী/ওয়ারড্রব (সংখ্যা) [Number of Almirah or wardrobe]□□□
- c. টেবিল (সংখ্যা) [Number of tables]□□□
- d. চেয়ার/বেঞ্চ(সংখ্যা) [Number of chair or bench]□□□
- e. হাত ঘড়ি/দেয়াল ঘড়ি(সংখ্যা) [Number of watch or clock]□□□
- f. খাট(সংখ্যা) [Number of khat]□□□
- g. চৌকি (সংখ্যা) [Number of chouki]□□□
- h. রেডিও [A radio that is working].....□□□
- i. টেলিভিশন (সাদা/কালো) [A B/W television that is working]□□□
- j. টেলিভিশন (রঙিন) [A color television that is working]□□□
- k. রেফ্রিজারেটর [Refrigerator]□□□
- l. সাইকেল (খেলনা সাইকেল নয়) [A bicycle (used for commercial purposes not toy for children)].....□□□
- m. মটর সাইকেল [A motorcycle]□□□
- n. সেলাই মেশিন [A sewing machine]□□□
- o. মোবাইল ফোন(সংখ্যা) [Number of Mobile phones]□□□
- p. ল্যান্ড ফোন [A land phone]□□□

5.2. খানার ঘরটিতে কতগুলো কক্ষ আছে? (রান্নাঘর ও বাথরুম বাদে) [How many rooms the households have (exclude bathroom and Kitchen)?].....□□

5.3 বসতবাড়ি [Status of living house].....□□□

- নিজের বাড়ি [Self-owned].....1
- ভাড়া বাড়ি [Rental]2
- সরকারী জমি [Govt. land]3

কোন জমিদারের/জোতদারের বাড়িতে থাকে [Owned by a landlord].....4

অন্যান্য (লিখুন) [Others: specify]..... 777

Skip Note-5.1: যদি কোড ২ নাহয়, তবে ৫.৫- এয়ান [If answer is not 2 then skip to 5.5]

5.4 যদি ৫.৩ - এর উত্তর ২ হয় (ভাড়া বাড়ি), তবে বসতবাড়িটির আয়তন কি ২০০ বর্গফুটের কম?¹ [If 5.3 answer is 2 (rental) then do the area is less than 200 sq. ft.?].....□

Code: হ্যাঁ [Yes].....1

না [No]0

5.5. আপনার খানায় রান্নার জন্য প্রধানত কি ধরনের জ্বালানী ব্যবহার করা হয়? [What type of fuel does your household mainly use for cooking?].□□□

কাঠ [Wood]01

শস্যের অবশিষ্টাংশ/ঘাস [Crop residue / grass]02

শুকনা গোবর[Dung cakes]03

কয়লা [Coal / coke / lignite]04

কাঠ কয়লা [Charcoal]05

কেরোসিন [Kerosene]06

বিদ্যুৎ [Electricity]07

তরল গ্যাস/প্রাকৃতিক গ্যাস [Liquid gas / gas]08

গ্যাস [Bio-gas/LPG gass]09

অন্যান্য[Other]..... 777

(বর্ণনা লিখুন) [Specify other] _____

জানি না [Don't know]999

5.6 আপনার খানা সদস্যদের কি কোন বসতভূমি আছে?[Does your household own any homestead land?].□□□

Code: হ্যাঁ [Yes].....1

না [No].0

বলতে রাজি হয়নি [Refused].....666

জানি না [Don't know].....999

Skip Note: ৫.২যদি ৫.৬ নং প্রশ্নের উত্তর ০/৬৬৬/৯৯৯ হয়, তবে ৫.৮নং প্রশ্নে চলে যান। [If Answer of 5.6 is 2/666/999, skip to 5.8]

¹ We need to set up a cut off area (200 sq feet) by practical demonstration during training and train FRAs according so that they can assess easily by observing the household whether the household area is less than 200 sq feet or not.

5.7 (৫.৬)এর উত্তর হ্যাঁ হলে, খানার সদস্যদের বসতবাড়িতে মোট কতটুকু জমি আছে (ডেসিমেল)? [How much homestead land (decimal) does your household own?].....□□□□□

জমির পরিমাণ বলতে না পারলে ৯৯৯৯৯ বসান [If Answer of 5.7 is Don't know please insert 99999]

পরিমাণ [AMOUNT] _____ (একক নির্দিষ্ট করে লিখুন) [SPECIFY UNIT] _____

পরিমাণ [AMOUNT] _____ (একক নির্দিষ্ট করে লিখুন) [SPECIFY UNIT] _____

5. 8 আপনার খানা সদস্যদের কি বসতভূমি ছাড়া অন্য কোন জমি আছে ? [Does your household own any land, other than homestead land?].....
.....□□□

Code: হ্যাঁ [Yes].....1

না [No].0

বলতে রাজি হয়নি [Refused].....666

জানি না [Don't know].....999

Skip Note: যদি ৫.৮নং প্রশ্নের উত্তর ০/৬৬৬/৯৯৯ হয়, তবে ৫.১০নং প্রশ্নে চলে যান। [If Answer of 5.8 is 0/666/999, skip to 5.10]

5.9 (৫.৭) হ্যাঁ হলে, খানার সদস্যদের বসতবাড়ি বাদে মোট কতটুকু জমি আছে (ডেসিমেল)? [How much land (decimal) does your household own (other than the homestead land)?]...□□□□□

জমির পরিমাণ বলতে না পারলে ৯৯৯৯৯ বসান [If Answer of 5.9 is Don't know please insert 99999]

পরিমাণ [AMOUNT] _____ (একক নির্দিষ্ট করে লিখুন) [SPECIFY UNIT] _____

পরিমাণ [AMOUNT] _____ (একক নির্দিষ্ট করে লিখুন) [SPECIFY UNIT] _____

5.10 আপনার মতে সামাজিক প্রেক্ষাপটে আপনার খানাটির অবস্থান কি রকম? [How would you describe your economic status?].....

□

ধনী [Dhoni/Rich].....1

উচ্চ মধ্যবিত্ত [Uchho modho bitto/Upper middle class].....2

মধ্যবিত্ত [Modho Bitto/Middle class].....3

দরিদ্র [Doridro or Nimno motho bitto/ Poor].....4

হতদরিদ্র [Hotodoridro/ Extreme Poor].....5

5.11 আপনি থাকার ঘরের মেঝেতে গোবর ব্যবহার করেন কী? [Do you use cow dung in the floor of living room?].

হ্যাঁ [Yes].....1

না [No].....0

5.12 আপনি রান্না ঘরের মেঝেতে গোবর ব্যবহার করেন কী? [Do you use cow dung in the floor of kitchen room?].

হ্যাঁ [Yes].....1

না [No].....0

5.13 আপনি রান্নার জন্য গোবর ব্যবহার করেন কী? [Do you use cow dung for cooking?].

হ্যাঁ [Yes].....1

না [No].....0

5.14 আপনার কোন গৃহপালিত পশুপাখি আছে কী? [Do you have any domestic animal?].

হ্যাঁ [Yes].....1

না [No].0 ৫.১৬- এ যান (skip to

5.16)

5.15 (৫.১৪)এর উত্তর হ্যাঁ হলে, কি ধরনের এবং কতগুলো? [If yes what type (how many)?]

1. ছাগল [Goat].....

2. গরু [Cow].....

3. মুরগী [Chicken].....

4. হাঁস [Duck]

5. বিড়াল [Cat].....

6. কবুতর [Pigeon].....

7. কুকুর [Dog].....

777. অন্যান্য[Other].....

[Specify other] _____

5.16 গত ২৪ ঘন্টায় আপনি আপনার খানার গৃহপালিত পশুপাখি ছাড়া অন্য কোন প্রাণী দেখেছেন কী? [Have you observed any animal that is not domestic in your household within last 24 hours?].

হ্যাঁ Yes.....1

না No.0

৬.১- এ যান (skip to

6.1)

5.17 (5.16) এর উত্তর হ্যাঁ হলে, কি ধরনের এবং কতগুলো? [If yes what type (how many)?]

1. ছাগল [Goat].....□□
 2. গরু [Cow].....□□
 3. মুরগী [Chicken].....□□
 4. হাঁস [Duck]□□
 5. বিড়াল [Cat].....□□
 6. কবুতর [Pigeon].....□□
 7. কুকুর [Dog].....□□
 777. অন্যান্য [Other].....□□
- [Specify other]_____

Section 6: Reported diarrhea

Note: প্রশ্ন নং ২.১১ অনুসারে খানার সকল ৫ বছরের কম বয়সী শিশু চিহ্নিত করুন এবং নিচের প্রশ্নগুলোতে প্রত্যেক শিশুর জন্য উত্তর লিপিবদ্ধ করুন। [Note: Identify all <5 child in the household according to ID given in question 2.11 and record answer to the following questions for each child.]

6.1 গত ২ দিনে শিশুটির পাতলা পায়খানা ছিল কী? [Has the child had diarrhoea during the past two days?]......□□□

(Note: ২৪ ঘন্টার মধ্যে শিশুটির কমপক্ষে ৩ বা ততোধিক সংখ্যক বার পাতলা পায়খানা (যে পায়খানাতে পানির পরিমাণ বেশী কিন্তু মল কম থাকে) হলে তাকে ডায়রিয়া বলা হয়। আমাশয় বা রক্ত আমাশয়কেও ডায়রিয়া বলা হয় কারণ তাতে পানির পরিমাণ বেশী থাকে এবং তাতে শিশু বার বার পায়খানা করতে থাকে। যে পায়খানাতে পানির পরিমাণ কম কিন্তু মলের পরিমাণ বেশী তা ২৪ ঘন্টায় ৩ বা ততোধিকবার হলেও তাকে ডায়রিয়া বলা যাবে না। যে বাচ্চা শুধুমাত্র বুকের দুধ খায় তারা কখনো কখনো ২৪ ঘন্টায় ৩ বা ততোধিকবার পাতলা এবং পেস্টের মত পায়খানা করে থাকে, তাকে ডায়রিয়া বলা যাবে না) [Diarrhoea is the passage of unusually loose or watery stools, usually at least three times in a 24 hour period. However, it is the consistency of the stools rather than the number that is most important. Frequent passing of formed stools is not diarrhoea. Babies fed only breast milk often pass loose, "pasty" stools; this also is not diarrhoea. Mothers usually know when their children have diarrhoea and may provide useful working definitions in local Situations (WHO, 2005)]

হ্যাঁ [Yes].....1

না [No].....0

জানি না [Don't know].....999

1. <5 Child ID no 1 (Target child).....□□□
2. <5 Child ID no 2□□□
3. <5 Child ID no 3□□□
4. <5 Child ID no 4.....□□□
5. <5 Child ID no 5.....□□□

6.2 গত ১ সপ্তাহের মধ্যে শিশুটির পাতলা পায়খানা ছিল কী? [Has the child had diarrhoea during the past 1 week?]

হ্যাঁ [Yes].....1
না [No].....0
জানি না [Don't know].....999

1. <5 Child ID no 1 (Target child).....
2. <5 Child ID no 2
3. <5 Child ID no 3
4. <5 Child ID no 4.....
5. <5 Child ID no 5.....

6.3 গত ২ সপ্তাহের মধ্যে শিশুটির পাতলা পায়খানা ছিল কী? [Has the child had diarrhoea during the past two weeks?]

হ্যাঁ [Yes].....1
না [No].....0
জানি না [Don't know].....999

1. <5 Child ID no 1 (Target child).....
2. <5 Child ID no 2
3. <5 Child ID no 3
4. <5 Child ID no 4.....
5. <5 Child ID no 5.....

6.4 যদি ৬.১/৬.২/৬.৩এর উত্তর ১ হয় তাহলে, কতদিন ধরে পাতলা পায়খানা ছিল? (প্রযোজ্য নয় N/A=888, জানি না DK= 999) [If 6.2 answer is 1, then how long did the diarrhoea last for?(N/A=888, DK= 999)]

1. <5 Child ID no 1 (Target child).....a. Hours b. Days
2. <5 Child ID no 2
3. <5 Child ID no 3
4. <5 Child ID no 4.....
5. <5 Child ID no 5.....

PART B: SPOT CHECKS

আপনার খানার পানি, পয়ঃনিষ্কাশন এবং স্বাস্থ্যসম্মত ব্যবস্থার সাথে সম্পর্কিত বিষয়গুলো দেখার জন্য আমি কি আপনার ঘরের ভিতর এবং বাহিরের চারপাশ একটু ঘুরে দেখতে পারি [May I take a look around your home to look at some of the items related to water, sanitation, and hygiene?]

Section 7. Water-handling

7.1 এই খানার সদস্যরা সাধারণত কোন উৎসেরপানি পান করে? (উত্তরদাতাকে খাবার পানির উৎস দেখাতে বলুন। প্রয়োজনে দেখে ও প্রশ্ন করে খাবার পানির উৎস যাচাই করুন) [What is the source of the water that the household usually use for drinking? [(Ask the respondent to show you the source. Observe and ask question if necessary to identify the type of water source)]

.....□□□

অগভীর টিউবওয়েল (২৫০ ফিটের কম) [Shallow tube well(<250 feet)].	01
গভীর টিউবওয়েল (২৫০ ফিটের বেশী) [Deep tube well(250+ feet)].	02
সুরক্ষিত পাতকুয়া [Protected ring/dug well].....	03
অসুরক্ষিত পাতকুয়া [Unprotected dug well].....	04
অগভীর তারা পাম্প [Shallow Tara pump].....	05
গভীর তারা পাম্প [Deep Tara pump]	06
আর্সেনিক শোধনাগার [Arsenic free treatment plant].....	0 7
সুরক্ষিত বার্নার পানি [Water from protected spring].....	0 8
অসুরক্ষিত বার্নার পানি [Water from unprotected spring]... ..	0 9
ভূপৃষ্ঠের পানি (Surface water):	
বৃষ্টির পানি [Rainwater].....	10
ট্যাংকার ট্রাক [Tanker truck].....	11
ছোট ট্যাংকযুক্ত কার্ট [Cart with small tank].....	12
নদী/বাধ/লেক/পুকুর/সেচ নালা/টিউবওয়েল থেকে জীবানুমুক্তকরণ পানি [<u>Pathogen treatment plant (Pond Sand Filter)</u>]: River/dam/lake/ponds/stream/canal/irrigation channel/tube well]	13
নদী/বাধ/লেক/পুকুর/সেচ নালা থেকে সরাসরি সংগৃহীত পানি [Directly from River/dam/lake/ponds/stream/canal/irrigation channel]	14
ঘরের ভিতর ট্যাপ বা পাইপের পানি [Piped water into dwelling]	15
উঠানে ট্যাপ বা পাইপের পানি [Piped water into yard/plot].....	16
পাবলিক ট্যাপ [Public tap/stand pipe]	17
অন্যান্য (wjLyb) [Other: specify]	777

7.1.1 খাবার পানির উৎসের জিআইএস কোঅর্ডিনেট লিপিবদ্ধ করুন [GIS coordinates of the source fo drinking water].

Latitude

Longitude

7.2 পানির উৎসের মালিকানা ? (প্রশ্ন করুন এবং পরিদর্শন করুন) [(Ask and check): Ownership type of the water point?]□

শুধুমাত্র ঐ খানার [Only for the household] 1

কয়েকটি খানা মিলে/ অংশীদার [Shared] 2

অন্য কেউ [Someone else] 3

পাবলিক [Public] 4

7.3 পানির উৎসের ব্যবহারকারী? (প্রশ্ন করুন এবং পরিদর্শন করুন) [(Ask and check): User of the water point?].□

শুধুমাত্র ঐ খানার[Only for the household] 1

কয়েকটি খানা মিলে/ অংশীদার[Shared] 2

পাবলিক [Public] 3

Skip Note: যদি ৭.৩ নং প্রশ্নের উত্তর ১ হয় তাহলে ৭.৫ -এ যান। [If answer of 7.3 is 1, skip to 7.5]

7.4 যদি ৭.৩-এর উত্তর ২ বা ৩ হয়, কতগুলো খানা ঐ পানির উৎসটি ব্যবহার করেন? (প্রশ্ন করুন এবং পরিদর্শন করুন) [(Ask and check): If 7,3 is 2/3, how many households sharing the water point?].....□□

7.5 উৎস থেকে থাকার ঘর পর্যন্ত খাবার পানি আনতে কত সময় লাগে ?(উত্তরদাতাকে প্রশ্ন করুন) [How much time is needed to bring drinking water to the living room?(Ask the respondent).....□□□ Minutes]

7.6 খানাটিতে রান্না করার জন্য ব্যবহৃত পানির প্রধান উৎস কী (৭.১ এ দেয়া কোড লিস্ট থেকে কোড বসান)? [উত্তরদাতাকে পানির উৎস দেখাতে বলুন। প্রয়োজনে দেখে ও প্রশ্ন করে পানির উৎস যাচাই করুন] [What is the source of the water that usually used by the household for cooking foods (follow code list of 7.1)? (Ask the respondent to show you the source. Observe and ask question if necessary to identify the type of water source)]..... □□□

7.7 আপনার গোসলের পানির প্রধান উৎস কী? (উত্তরদাতাকে পানির উৎস দেখাতে বলুন। প্রয়োজনে দেখে ও প্রশ্ন করে পানির উৎস যাচাই করুন। ৭.১এ দেয়া কোড লিস্ট থেকে কোড বসান) [What is the source of the water that you usually use for bathing?] (follow code list of 7.1)..... □□□

[উত্তরদাতাকে পানির উৎস দেখাতে বলুন। প্রয়োজনে দেখে ও প্রশ্ন করে পানির উৎস যাচাই করুন] (Ask the respondent to show you the source. Observe and ask question if necessary to identify the type of water source)

7.8 খানাটিতে ফল-মূল এবং তরি-তরকারি ধোয়ার জন্য ব্যবহৃত পানির প্রধান উৎস কী? (৭.১এ দেয়া কোড লিস্ট থেকে কোড বসান) [উত্তরদাতাকে পানির উৎস দেখাতে বলুন। প্রয়োজনে দেখে ও প্রশ্ন করে পানির উৎস যাচাই করুন] [What is the source of the water that usually used by the household for washing fruits and vegetables? (follow code list of 7.1) (Ask the respondent to show you the

source. Observe and ask question if necessary to identify the type of water source).....□□

7.9 আপনার খালা বাসন ধোয়ার পানির প্রধান উৎস কী? (৭.১এ দেয়া কোড লিস্ট থেকে কোড বাসন) [উত্তরদাতাকে পানির উৎস দেখাতে বলুন। প্রয়োজনে দেখে ও প্রশ্ন করে পানির উৎস যাচাই করুন] [What is the source of the water that you usually use for washing utensils? (follow code list of 7.1)] (Ask the respondent to show you the source. Observe and ask question if necessary to identify the type of water source)].....□□□

7.10 খানাটি সকল ধরনের কাজের জন্য সারা বছর পর্যাপ্ত পরিমাণে পানি পায় কি? (প্রশ্ন করুন) (খাওয়ার জন্য, রান্নার জন্য, ফল-মূল এবং তরি-তরকারি ধোয়ার জন্য) [Dose the household get enough water through the year for all purpose (Drinking, Cooking, Washing fruits & Vegetables)?].

□

হ্যাঁ [Yes]1

না[No].....0

7.11 (7.1 এ উল্লেখিত) পানির উৎসের স্থানটি দেখতে পরিষ্কার ছিল কী? [Did the source of water point observe looked clean?]......□

Note: (পরিষ্কার অর্থ স্থানটিতে পানি জমে থাকবে না, চারপাশে পায়খানা বা অন্য কোন ময়লা পড়ে থাকবে না) [Clean means no water logging, no feces besides, no dirt besides, etc.]

হ্যাঁ [Yes]1

না[No].....0

7.12 পানির উৎসের স্থানটি দেখতে কেমন ছিল? (Note: পানির উৎসটি(খাবার পানি) পর্যবেক্ষণ করে নিম্নোক্ত বিষয় গুলো সমন্ধে তথ্য সংগ্রহ করুন [How was the source of water point looking?]) (Note: Observe the water point and note the following points)

হ্যাঁ [Yes].....1

না [No].....0

প্রযোজ্য নয় [N/A].....888

1. প্ল্যাটফর্ম আছে [Plat form present].....□□□

2. প্ল্যাটফর্ম ভাঙ্গা [Plat form broken].....□□□

3. স্থানটিতে পানি জমে ছিল [water logging].....□□□

4. চারপাশে পায়খানা ছিল [feceswere presented besides].....□□□

5. চারপাশে ময়লা পড়ে ছিল [garbage were presentedaround.].....□□□

Section 8: Waste disposal

8.1. খানাটিতে ময়লা/ আর্বজনা (তরল নয়) ফেলার জন্য নির্দিষ্ট কোন স্থান রয়েছে কী? [Do the household has fixed place for solid waste disposal?]......□□□

হ্যাঁ [Yes]1

না [No].....0

বলতে রাজি না [Refused]666

Skip Note: যদি উত্তর ০ বা ৬৬৬ হয়, তবে ৮.৪-এ যান [If answer of 8.1 is 0 or 666 , skip to 8.4.]

8.2 যদি ৮.১এর উত্তর ১ হয়, তাহলে সেটা কি ধরনের স্থান? [If 8.1 is 1 (yes), what kind of fixed place it is?]......

[উত্তরদাতাকে ময়লা/ আর্বজনা ফেলার জায়গাদেখাতে বলুন। প্রয়োজনে দেখে ও প্রশ্ন করে যাচাই করুন] [Ask the respondent to show you the place of solid waste disposal. Observe and ask question if necessary]

- ড্রাম [Drum]1
গর্ত/পিট [Pit]2
নদী/বাধ/লেক/পুকুর/নালা [River/dam/lake/ponds/stream/canal]3
রাস্তার পাশে [Road side]4
ড্রেন [Drain]5
উঠানের পাশে/রান্নাঘরের পাশে [Besides homestead/ besides kitchen].....6
ঝোপ-ঝাড়/ জঙ্গলে [In Jungle]7
অন্যান্য (নির্দিষ্ট করে লিখুন) [Other: specify]
777

8.3 সেখানে কিভাবে ময়লা/ আর্বজনা ফেলা হয়? [How do the household dispose solid waste there?]......

- সঠিকভাবে (বাহিরে বা আশেপাশে কোথাও ময়লা/ আর্বজনা পড়ে থাকে না)
[Completely/rightly (no waste outside)]..... 1
আংশিক সঠিকভাবে (কিছু ময়লা ভিতরে এবং কিছু ময়লা বাহিরে পড়ে আছে)
[Partially (Wastes are disposed partly inside and partly outside)]..... 2
সেখানে ময়লা ফেলে না (ভিতরে কোন ময়লা নেই এবং ময়লা ফেলার কোন চিহ্ন নেই)
[Do not (no garbage inside and no symptoms of waste disposal
on the way or inside)] 3

8.4. খানাটিতে কি কোন পানি নিষ্কাশন ব্যবস্থা আছে? [Do the household has any water drainage system?].....

- হ্যাঁ [Yes]1
না [No]0
বলতে রাজি না [Refused]666

Skip Note: যদি উত্তর ০/৬৬৬ হয়, তবে সেকসন ৯-এ যান [If answer of 8.4 is 0 or 666, skip to Section 9]

8.5. যদি ৮.৪এর উত্তর ১ হয়, তবে কি ধরনের পানি নিষ্কাশন ব্যবস্থা আছে ? [If 8.4 is 1 (Yes), what kind of drainage system it is?]......

[উত্তরদাতাকে পানি নিষ্কাশন ব্যবস্থার জায়গাদেখাতে বলুন। প্রয়োজনে দেখে ও প্রশ্ন করে যাচাই করুন] [Ask the respondent to show you the place of water drainage. Observe and ask question if necessary]

পাকা ড্রেন/ পাইপ[Pukka drain/ piped]	1
কাঁচা ড্রেন[Katcha drain]	2
ভাঙ্গা ড্রেন [Broken drain]	3
টিউবয়েলের পণ্ডাটফর্মের সাথে কাঁচা মাটির ড্রেন করে কিছুদূর নিয়ে গর্ত করে মিলিয়ে দেয়া [Soak pit]	4
অন্যান্য (লিখুন) [Other: specify]	777

Section 9: Materials of the living household

9.1. ছাদ তৈরীতে কি কি উপাদান ব্যবহার করা হয়েছে? (পরিদর্শন করে যাচাই করুন) [Main material of the roof]....□□

(Interviewer: Record your observation)

[Natural roof]

কাঁচা (বাঁশ/খড়) [Kaccha (bamboo / thatch)]1

[Rudimentary roof]

টিন [Tin]2

[Finished roof (pukka)]

সিমেন্ট/ কংক্রিট/ টালি [Cement / concrete / tiled]...3

অন্যান্য (লিখুন) [Other: Specify]777

9.2. দেয়াল তৈরীতে কি কি উপাদান ব্যবহার করা হয়েছে? (পরিদর্শন করে যাচাই করুন) [Main material of the walls].....□□

(Interviewer: Record your observation)

[Natural walls]

পাট/বাঁশ/মাটি (কাঁচা) [Jute / bamboo / mud (kaccha)]1

[Rudimentary walls]

কাঠ [Wood]2

[Finished walls]

ইট/সিমেন্ট [Brick / cement]3

টিন [Tin].....4

অন্যান্য (নির্দিষ্ট করে লিখুন) [Other: Specify].....777

9.3. মেঝে তৈরীতে কি কি উপাদান ব্যবহার করা হয়েছে? (পরিদর্শন করে যাচাই করুন) [Main material of the floor].....□□

(Interviewer: Record your observation)

[Natural floor]

মাটি/বাঁশ (কাঁচা) [Earth / bamboo (kaccha)]1

[Rudimentary floor]

কাঠ [Wood]2

[Finished floor (pukka)]

ইট/সিমেন্ট [Cement / concrete].....3

অন্যান্য (বর্ণনা লিখুন) [Other: Specify].....777

Section 10: Sanitation

10.1.1 আপনার খানার সদস্যরা সাধারণত কোন ধরনের পায়খানা ব্যবহার করেন? [What kind of toilet facility do members of your household usually use?]..... □□□

[Note: উত্তরদাতাকে পায়খানাটি দেখাতে অনুরোধ করুন এবং পায়খানাটি পর্যবেক্ষণ করার পর কোড করুন। যদি ফ্ল্যাশ অথবা পানি ঢেলে ফ্ল্যাশ করা পায়খানা থাকে তাহলে ফ্ল্যাশকরে ব্যর্জ কোথায় যায় তা প্রোব/চেক করুন।

(Note: Request the respondent to show the toilet facility and code after observing the facility. If “flush” or “pour flush” probe/check: Where does it flush to?)

ফ্ল্যাশ-টয়লেট অথবা পানি ঢেলে ফ্লাস করা টয়লেট (স্ল্যাব এবং পানি ধারণকারী ওয়াটার সিল পর্যবেক্ষণ করুন) [Flush or pour flush toilet flushed to](Observe the slab and water seal containing water):

টয়লেটিতে পয়ঃনিষ্কাশন পাইপের সাথে সংযোগ করে দেয়া [Piped sewer system]..... 01

টয়লেটিতে সেপটিক ট্যাংক বসানো আছে(ট্যাংকটি কংক্রীট দিয়ে ঢাকা আছে কিনা পর্যবেক্ষণ করুন) [Septic tank](Observe the concrete cover of the tank) 02

সেপটিক ট্যাংক নাই কিন্তু ফ্লাস করে বা পানি ঢেলে পায়খানা নীচে/দুরে পিটের মধ্যে সরিয়ে দেয়া যায় [Flush to pit latrine (onsite/Off set) with slab and water seal] 03

অজানা জায়গায় /নির্দিষ্ট কোন জায়গায় নেই/ জানিনা [Unknown place/not sure/DK where]..... 04

পিট-টয়লেট, স্ল্যাব আছে কিন্তু ওয়াটার সিল নেই তবে কনক্রিট ঢাকনা দেয়ার ব্যবস্থা আছে [Pit latrine with slab & no water seal but with a lid]..... 05

পিট-টয়লেট যাতে স্ল্যাব আছে, তবে ওয়াটার সিল নেই কিন্তু ফ্ল্যাপ আছে (উত্তরদাতাকে ফ্ল্যাপ সম্পর্কে জিজ্ঞাসা করুন. এ ক্ষেত্রে পইপ এর শেষ মাথায় প্লাস্টিক লাগানো থাকে যা মশা মাছি বাইগে আশা প্রতিরোধ করে) [Pit latrine with slab and flap, no water seal] (Ask the respondent about the flap, Flap: a plastic is attached at the end of the pipe to prevent flies from coming out of the pit)

..... 06

বায়ু চলাচল উপযোগী উন্নত ল্যাট্রিন(স্ল্যাব এবং ভেন্টিলেশন পাইপ পর্যবেক্ষণ করুন) [Ventilated Improved Pit (VIP) latrine](Observe the slab and ventilation pipe)..... 07

কমপোস্টিং টয়লেট (শাক সবজির ময়লা, খড়, ঘাস, কাঠের গুড়া, ছাই পিটের মধ্যে মিশ্রিত হয়, সার হিসাবে এই ময়লা ব্যবহৃত হয়, ওয়াটার সিল নেই। একটি কমপোস্টিং টয়লেটে প্রস্রাব আলাদাকরণ ডিভাইস থাকতে পারে বা নাও থাকতে পারে) [Composting toilet, (Composting toilet ensure separation of urine, water and excreta(vegetable wastes, straw, grass, sawdust, ash added in the pit, the waste used as manure, no water

seal. A composting latrine may or may not have a urine separation device.).....	08
পিট/গর্ত পায়খানা স্ল্যাব আছে তবে,ওয়াটার সিল নেই অথবা ওয়াটার সিল ভাঙ্গা এবং কোন ঢাকনাও নেই [Pit latrine with slab & no water seal/broken water seal and no lid].....	09
ফ্লাশ-টয়লেট অথবা পানি ঢেলে ফ্লাস করা টয়লেট যা কোন খাল, ড্রেন, নদী ইত্যাদির সাথে সংযোজন করার ফলে অস্বাস্থ্যকর অবস্থার সৃষ্টি করে থাকে [Flush or pour flush toilet connected to somewhere else (canal, ditch, river, etc.)]	10
পিট/গর্ত পায়খানা, স্ল্যাব নেই এবং যেখান থেকে মশা/মাছি যাওয়া আসা করতে পারে এবং দুর্গন্ধ ছড়ায় [Pit latrine without slab/open pit]	11
ঝুলন্ত পায়খানা [Hanging toilet/latrine].....	12
বালতি [Bucket].....	13
খোলা পায়খানা/ টয়লেট (Open defecation):	
কোন পায়খানা নেই/জঙ্গলে/ঝোপে ঝাড়ে/ খোলা জায়গায় [No facility/bush/field]	14
অন্যান্য (নির্দিষ্ট করে লিখুন) [Others: Specify]	777

10.1.2 পায়খানার জিআইএস কোঅর্ডিনেট লিপিবদ্ধ করুন [GIS coordinates of the source for drinking water].

Latitude

Longitude

Skip Note: যদি ১০.১ নং প্রশ্নের উত্তর ১৪ হয়, তবে ১০.১৮নং প্রশ্নে যান। [If answer of 10.1 is 12, skip to 10.18]

10.1.3 আপনার জানা মতে সর্বশেষ এই পায়খানাটি কখন ব্যবহার করা হয়েছিল? [When was the most recent time this toilet was used?]

.....□□ দিন আগে [days ago]

10.2.1 আপনি কি এই পায়খানাটি অন্য খানার সাথে মিলে ব্যবহার করেন? [Do you share this toilet facility with other households?]

.....□□□

(Note: কোন ব্যক্তি বা গোষ্ঠী, যারা একই আবাস স্থানে বসবাস করেন বা একই উৎস থেকে খাবারে শরীক হয় না, তারা অন্য খানার অন্তর্গত হিসাবে বিবেচিত হবে।) (Note: Any person or group of persons related or unrelated who do not live in the same dwelling space and do not share a common source of food as the respondent would be considered to belong to other household.)

1= হ্যাঁ[yes]

0= না [No]

১০.২.৪নং প্রশ্নে চলে যান [[skip to 10.2.4](#)]

999= জানিনা [DK]

১০.২.৪নং প্রশ্নে চলে যান [[skip to 10.2.4](#)]

888= প্রযোজ্য নয় [Not applicable]

১০.২.৪ নং প্রশ্নে চলে যান [[skip to 10.2.4](#)]

10.2.2 কতগুলো খানা মিলে পায়খানাটি ব্যবহার করে? (প্রশ্ন করুন) [(Ask): how many households sharing the toilet facility?]

□□

10.2.4 শিশুসহ আপনারা কতজন এই পায়খানাটি ব্যবহার করেন? [How many people including children use this toilet?]□□

10.3 পায়খানাটির মালিকানা? (প্রশ্ন করুন) [(Ask): Ownership type of the Toilet?]□

শুধুমাত্র ঐ খানার [Only for the household] 1

কয়েকটি খানা মিলে/ অংশীদার [Shared] 2

অন্য কেউ [Someone else] 3

পাবলিক [Public] 4

পায়খানা ব্যবস্থার বিশদ পর্যবেক্ষণ [Detail observation of the toilet facility]

10.4 পায়খানায় যাবার রাস্তা দেখে বুঝা যাচ্ছে কি যে এটা নিয়মিত ব্যবহার করা হয় (পরিষ্কার, জীর্ণ ইত্যাদি) [Path to the toilet suggests regular use (is clear, well-worn, without grass or any barriers etc.)].....□□□

(1= হ্যাঁ [Yes], 0= না [No], 999= জানিনা [DK], 888= প্রযোজ্য নয় [Not applicable])

10.5 টয়লেটের বাইরের অবস্থা পর্যবেক্ষণ [Observe the general exterior of the toilet]

(1= হ্যাঁ [Yes], 0= না [No], 999= জানিনা [DK], 888= প্রযোজ্য নয় [Not applicable])

- পায়খানাটির উপর কোন স্থাপনা আছে কি? [Is there any superstructure on the toilet?]....□□□
- কোন দরজা / পর্দা আছে কি? [Is there a door/curtain?].....□□□
- বাইরে থেকে দেখা যাওয়া ছাড়া গড় প্রাপ্ত বয়স্ক কোন ব্যক্তি এই টয়লেট ব্যবহার করতে পারবে কি? [Can an average sized adult use the toilet without being seen?].....□□□
- টয়লেটের উপর ছাদ আছে কি? [Is there roof over the toilet?].....□□□
- ছাদে এমন কোন ছিদ্র আছে কি যার মাধ্যমে ছাদ দিয়ে পানি পড়তে পারে? [Is there any hole in the roof that may allow water to enter through the roof?].....□□□
- বায়ু চলাচল উপযোগী কোন পাইপ আছে কি? [Is there a ventilation pipe?].....□□□

a. **Skip Note:** যদি ১০.৫.৬ নং প্রশ্নের উত্তর ০ হয়, তবে ১০.৫.৭ নং প্রশ্নে যান। [If answer of 10.5.6 is 0, skip to 10.5.7]

- পাইপের মাথায় কোন কভার আছে কি যা মশা মাছি বের হওয়া প্রতিরোধ করতে পারে? [Is there a cover on top of the ventilation pipe that protects the flies from coming out?].....□□□

- পায়খানার দেয়ালগুলো মূলত কি দিয়ে তৈরী? [What are the walls of the toilet mostly made of?].□□□

- কংক্রিট [Concrete]
- টিন [Tin]
- বাঁশ/মাটি [Bamboo/Mud]
- প্লাস্টিক [Plastic]
- গাছের পাতা [Tree leaves]
- পাটের থলে [Jute bag]
- খড় [Straw]

8. কাঠ [Wood]

888= প্রযোজ্য নয় [Not applicable]

i) পায়খানার ছাদ মূলত কি দিয়ে তৈরী? [What is the roof of the toilet mostly made of?]......□□□

1. কংক্রিট [Concrete]
2. টিন [Tin]
3. বাঁশ [Bamboo]
4. প্লাস্টিক [Plastic]
5. গাছের পাতা [Tree leaves]
6. পাটের থলে [Jute bag]
7. খড় [Straw]

888= প্রযোজ্য নয় [Not applicable]

10.6 টয়লেট থেকে ময়লা কোথায় যায়? (জিজ্ঞাসা করুন এবং সম্ভব হলে পর্যবেক্ষণ করুন) [Where does the waste from toilet go? (Ask and observe if possible)].....□□□

1. ময়লা 'পয়ঃনিষ্কাশন ব্যবস্থার' পাইপের মাধ্যমে যাচ্ছে (জিজ্ঞাসা করুন) [Waste drains to underground piped sewer system (Ask)] (১০.৮.১ নং প্রশ্নে চলে যান Skip to Q10.8.1)
2. ময়লা নীচে পিটের মধ্যে পড়ছে এবং সেখানেই থাকছে (উত্তরদাতা পিট তৈরীতে কংক্রিটের রিং সম্পর্কে উল্লেখ করবে। পিটের উপরিভাগ এবং ছিদ্র আছে কি না পর্যবেক্ষণ করুন) [Waste goes into onsite pit and stays there (Respondent will report using concrete rings to make the pit. Observe the top of the pit and any leakage)]
3. ময়লা দূরে পিটের মধ্যে পড়ছে এবং সেখানেই থাকছে (উত্তরদাতা পিট তৈরীতে কংক্রিটের রিং সম্পর্কে উল্লেখ করবে। পিটের উপরিভাগ এবং ছিদ্র আছে কি না পর্যবেক্ষণ করুন) [Waste goes into offset pit and stays there (Respondent will report using concrete rings to make the pit. Observe the top of the pit and any leakage)]
4. ময়লা নীচে ট্যাংকির মধ্যে পড়ছে এবং সেখানেই থাকছে (ট্যাংকির উপরের কংক্রিটের ঢাকনা এবং ছিদ্র আছে কি না পর্যবেক্ষণ করুন। [Waste goes into onsitetank and stays there (Observe the concrete cover of the tank and any leakage. Respondent will report building the tank with concrete lining rather than buying the ring for pit lining)]
5. ময়লা দূরেট্যাংকির মধ্যে পড়ছে এবং সেখানেই থাকছে (ট্যাংকির উপরের কংক্রিটের ঢাকনা এবং ছিদ্র আছে কি না পর্যবেক্ষণ করুন। [Waste goes into offset tank and stays there (Observe the concrete cover of the tank and any leakage. Respondent will report building the tank with concrete lining rather than buying the ring for pit lining)]
6. কমপোষ্ট পিট (শাক সবজির ময়লা, খড়, ঘাস, কাঠের গুড়া, ছাই পিটের মধ্যে মিশ্রিত হয়, সার হিসাবে এই ময়লা ব্যবহৃত হয়, ওয়াটার সিল নেই, এটি এনজিও/সরকার সহায়তায় স্থাপিত) [Compost pit (vegetable wastes, straw, grass, sawdust, ash added in the pit, the waste used as manure, no water seal, Built in assistance with the NGOs/government)]
7. পাইপ বা ঢাকনিযুক্ত নালা দিয়ে ময়লা খোলা জায়গায় (লেক/নদী/পানিতে) পড়ছে (সম্ভব হলে পর্যবেক্ষণ করুন) [Waste drains to open (lake/river/water) via

pipe/covered drain (Observe if possible)] (১০.৮.১ নং প্রশ্নে চলে যান Skip to Q10.8.1)

8. ঢাকনি ছাড়া নালা দিয়ে ময়লা খোলা জায়গায় (লেক/নদী/পানিতে) পড়ছে (পর্যবেক্ষণ করুন) [Waste drains to lake/river/water via open drain (Observe)] (১০.৮.১ নং প্রশ্নে চলে যান Skip to Q10.8.1)
9. বালতিতে পড়ছে [Bucket] (১০.৮.১ নং প্রশ্নে চলে যান Skip to Q10.8.1)
10. ময়লা সরাসরি জলাশয়ে বা নিচু জমিতে পড়ছে (ঝুলন্ত) [Waste directly fall into water body or low land (Hanging)] (১০.৮.১ নং প্রশ্নে চলে যান Skip to Q10.8.1)

777. অন্যান্য (নির্দিষ্ট করে লিখুন) [Other (specify)]_____

888. প্রযোজ্য নয় [Not applicable]

31. ময়লা দূরে পিটের মধ্যে পড়ছে (রিং নাই, স্লাব আছে) [Waste goes into offset pit (Using no rings but slab)]
32. ময়লা দূরে পিটের মধ্যে পড়ছে (রিং নাই, স্লাব নাই) [Waste goes into offset pit (Using no rings or slab)]
33. ময়লা দূরে পিটের মধ্যে পড়ছে (রিং আছে, স্লাব নাই) [Waste goes into offset pit (Using rings but no slab)]

10.7 পিটের/ ট্যাংকির বাইরে বা ভিতরের চতুর্দিকে পর্যবেক্ষণ করুন [Observe the onsite or off site pit/tank in all direction]

(1= হ্যাঁ [yes], 0= না [No], 999= জানিনা [DK], 888= প্রযোজ্য নয় [Not applicable])

1. পিটের/ট্যাংকির উপরিভাগ মাটি থেকে উপরে দেখা যাচ্ছে কি?[Is the top of the pit visible (above the ground)]?.....□□□
2. সংযোগ নলের ছিদ্রের/ভাংগার কারণে পাইপের ভিতরে বা বাইরে ময়লা দেখা যাচ্ছে কি? [Waste/faeces visible in or around the pipe, because of Leakage in the connecting pipe?].....□□□
3. পিট/ট্যাংকির ছিদ্রের কারণে ভিতরে বা বাইরে ময়লা দেখা যাচ্ছে [Waste/faeces visible because of leakage in the pit/tank?].....□□□

Skip Note: ১০.৭.৩ নং প্রশ্নের উত্তর ১ হলে ১০.৮ নং প্রশ্নে চলে যান। [If the answer to question 10.7.3 is 1 go to question 10.8]

4. ময়লা দেখা যাচ্ছে না কিন্তু পিট/ট্যাংকি ভাংগায়া দিয়ে মশা মাছি আশা যাওয়া করতে পারবে [No visible waste but broken pit/tank that may allow flies coming out of the toilet?].....□□□

Skip Note: ১০.৭.৪ নং প্রশ্নের উত্তর ১ হলে ১০.৮ নং প্রশ্নে চলে যান। [If the answer to question 10.7.4 is 1 go to question 10.8]

5. ময়লা দেখা যাচ্ছে না কিন্তু পিট/ট্যাংকিতে ফাটল/ ভাংগন দেখা যাচ্ছে যা দিয়ে মশা মাছি আশা যাওয়া করতে পারবে না [No visible waste but crack in the pit/tank?].....□□□

পায়খানার অভ্যন্তরীণ অবস্থা পর্যবেক্ষণ [Observe the interior of the toilet]

10.8.1 পায়খানা/টয়লেটে পায়খানার গন্ধ রয়েছে কি? [Odor of feces in the latrine/bathroom?]
.....□

(1=হ্যাঁ [Yes], 0= না [No], 888=প্রযোজ্য নয় [not applicable])

10.8.2 মাছির উপস্থিতি রয়েছে কি? [Flies present?]......□

(1=হ্যাঁ [Yes], 0= না [No], 888=প্রযোজ্য নয় [not applicable])

10.8.3 পায়খানাতে স্ল্যাব/ প্লাটফর্ম আছে কি? [Is there a slab/platform in the toilet?]......□

(Note: স্কোয়াটিং স্ল্যাব/ প্লাটফর্ম পিটকে চতুর্দিক থেকে ঢেকে রাখে, যার একটি নির্গমন ছিদ্র আছে এবং যা পিটের ভিতরে যে কোন ভূ-পৃষ্ঠের পানি প্রবেশ প্রতিরোধে ভূস্তরের উপরে অবস্থিত থাকে।) (Note: Squatting slab or platform that is covering the pit on all sides, has a squatting hole and rose above the surrounding ground level to prevent any surface water entering the pit)

হ্যাঁ [Yes] =1

না [No]=0

১০.৮.৬ নং প্রশ্নে চলে যান (Skip to 10.8.6)

প্রযোজ্য নয় [Not applicable]=888 ১০.৮.৬নং প্রশ্নে চলে যান (Skip to 10.8.6)

10.8.4 মেঝের প্রধান উপাদান [Main material of the floor (select 1)]......□□□

1 মাটি [Mud]

2 কাঠ [Wood]

3 সিমেন্ট [Cement]

4 টাইলস/ইট [Tile / brick]

5 প্লাস্টিক [Plastic]

888 প্রযোজ্য নয়/পর্যবেক্ষণ সম্ভব হয় নি [N/A / could not observe / cannot tell]

10.8.5 স্ল্যাবঅথবা মেঝেতে পায়খানা দেখতে পাওয়া গেছে? [Is stool visible on the slab or floor?]......□

(1=হ্যাঁ [Yes], 0= না [No], 888=প্রযোজ্য নয় [not applicable])

10.8.6 পায়খানার দেয়ালে কোনপায়খানা দেখতে পাওয়া গেছে কি? [Is stool visible on the walls?]......□

(1=হ্যাঁ [Yes], 0= না [No], 888=প্রযোজ্য নয় [not applicable])

10.8.7 পায়খানার দরজায় কোনপায়খানা দেখতে পাওয়া গেছে কি? [Is stool visible on the door/curtain?]......□

(1=হ্যাঁ [Yes], 0= না [No], 888=প্রযোজ্য নয় [not applicable])

Skip note: If 10.8.3= 0/888 skip to 10.10

10.8.8 টয়লেটে কোন কমোড আছে কি? [Is there any commode in the toilet?]......□□□

1= হ্যাঁ [Yes]

0= না [No]

১০.৯ নং প্রশ্নে চলে যান (Skip to

10.9)

888= প্রযোজ্য নয় [not applicable]

১০.৯ নং প্রশ্নে চলে যান (Skip to

10.9)

10.8.9 কমোড টি কি ভাঙ্গা? Is the commode broken?

.....□□□

1= হ্যাঁ [Yes]

0= না [No]

888= প্রযোজ্য নয় [not applicable]

10.8.10 কমোডে কোন পায়খানা দেখতে পাওয়া গেছে কি [Is there faeces visible in the commode?]□□□

(1=হ্যাঁ [Yes], 0= না [No], 888=প্রযোজ্য নয় [not applicable])

10.9 নির্গমন ছিদ্রটিতেকোন ঢাকনা আছে কি? [Is there a lid covering the squatting hole/drop hole?]□□□

হ্যাঁ [Yes] =1

না [No]=0

১০.১০নং প্রশ্নে চলে যান (Skip to

10.10)

প্রযোজ্য নয় [Not applicable]=888

১০.১০ নং প্রশ্নে চলে যান (Skip to

10.10)

10.9.1 পর্যবেক্ষণের সময় নির্গমন ছিদ্রটি সম্পূর্ণভাবে ঢাকা ছিল কি? [Is there a lid fully covering the squatting hole at the time of observation?]

.....□□□

হ্যাঁ [Yes] =1

না [No]=0

প্রযোজ্য নয় [Not applicable]=888

10.10 পায়খানাটি কি মল দ্বারা ভরে গেছে? (Note: পায়খানাটি মল দ্বারা পূর্ণ হিসাবে গণ্য হবে যদি কমোড মল দ্বারা পূর্ণ থাকে। এক্ষেত্রে, ওয়াটার সীল যুক্ত পায়খানা বা বাইরের পিট/ট্যাংকি সহ পায়খানার জন্য, যদি সন্দেহ থাকে মল নির্গমন দেখার জন্য পানি ফ্ল্যাশ করুন। (Is the toilet full? (Note: Toilet is considered full if faeces have reached over the exit of the squatting hole. In case of toilets with water seal or offset pit/tank, if there is confusion flush water to see if the faeces flushes away.).....□□□

হ্যাঁ[Yes] =1

না [No]=0

জানিনা [DK]=999,

প্রযোজ্য নয় [Not applicable]=888

Skip note: If 10.8.3= 0/888 skip to 10.13

10.11 পায়খানার কমোডএর ছিদ্রটি পর্যবেক্ষণকরুন [Observe through the hole in the toilet].....□□□

1. পাইপে পানি আছে (ওয়াটার সীলে পানি আছে কি না তা দেখার জন্য অল্প পানি ঢালুন)
[Water in pipe (Water seal, pour some water in the hole to check if there is water in the water seal)]
2. শুধু পাইপ দেখা যাচ্ছে কোন ওয়াটার সীল নেই [Only pipe visible (no water seal)]
3. পাইপ ভাঙ্গা (ওয়াটার সীল ভাঙ্গা) [Broken pipe (Water seal broken)]

4. পাইপ নেই, খোলা গর্ত দিয়ে সরাসরি মল দেখা যাচ্ছে (পিটের গর্ত খোলা), তবে পিটটি এখনও সম্পূর্ণ ভরে যায়নি [No pipe, open hole to the pit, can see faeces in the pit, but the pit is not full yet]
5. কমোডএর ছিদ্রটি মল দিয়ে ভরে গেছে (faeces have reached the exit of the squatting hole)

888. প্রযোজ্য নয় [Not applicable]

10.12 যদি ১০.১১ নং প্রশ্নের উত্তর ২ বা ৩ হয়, তবে ময়লা নির্গমন প্রতিরোধে পাইপের শেষে কোন ফ্ল্যাপ আছে কি? (উত্তরদাতাকে জিজ্ঞাসা করুন) [If answer to 12 is 2 or 3, is there any flap at the end of the pipe to prevent files from coming out?] (Ask the respondent).....□□□

হ্যাঁ[Yes] =1

না [No]=0

জানিনা [DK]=999

প্রযোজ্য নয় [Not applicable]=888

10.13 পর্যবেক্ষন: সৌচ কার্য সম্পন্ন করার ও হাত ধোয়ার জন্য পায়খানার ভিতরে বা সন্নিহিত কি কি উপাদান উপস্থিত আছে/রয়েছে? [Observation: What materials for anal cleansing and hand wash are present inside or immediately outside the latrine?]

হ্যাঁ [Yes] =1

না [No]=0

প্রযোজ্য নয়/পর্যবেক্ষন করা সম্ভব হয় নাই [Not Applicable/ Could not observe]=888

1. পাতা/ঘাস [Leaves/grass].....□□□
2. কাঠি [Twigs/ sticks].....□□□
3. কাপড় [Rag or cloth].....□□□
4. পাথর [Stones].....□□□
5. টয়লেট পেপার [Hygienic (toilet) paper].....□□□
6. পানির পাত্র/বদনা/মগ [Water container / vessel].....□□□
7. পানির ট্যাপ [Water tap].....□□□
8. সাবান [Soap].....□□□
9. ছাই অথবা মাটি [Ash or soil for cleansing].....□□□
10. খবরের কাগজ [Newspaper].....□□□
11. কিছুই নাই [Nothing].....□□□

10.14 এই স্থানে এই পায়খানাটি কত বছর ধরে আছে? (জানি না=৯৯৯) [How long have you had the present toilet in this place? (Don't know = 999)].....□□□

□□□ বছর (years)

□□□ মাস (Month)

10.15 বর্তমান পায়খানা তৈরির পূর্বে খানার সদস্যরা কোথায় মল ত্যাগ করতেন?(ঘড়ঃব: উত্তরদাতাকে উত্তরগুলো পড়ে শোনান) [Where did the household member defecate before this latrine was built? (Note: Read out the responses to the respondent)].....□

খোলা জায়গায় [Open].....1

কয়েকটি খানা মিলে/ অংশীদার [Owned a shared latrine].....2

অন্য কারো [Used someone's latrine].....3

নিজস্ব (GKK) [Had another latrine (individual)].....4

জানি না [Don't know].....999

প্রযোজ্য নয় [Not applicable].....888

10.16 সর্বশেষ কখন আপনার ল্যাট্রিনটি (মল/ পায়খানা দ্বারা) ভরে গিয়েছিল? [When did the latrine that you use last fill up?]

.....□□□

গত তিন মাসের মধ্যে [Within the last 3 months].....1

>৩-৬ মাস আগে [> 3 – 6 months ago].....2

>৬-১২ মাস আগে [> 6 – 12 months ago].....3

>১২ মাস আগে [> 12 months ago].....4

এখনও ভরে নাই [Not yet filled up].....5

প্রযোজ্য নয় [Not applicable].....888

জানেনা/ বলতে পারেনা [DK/Unable to say].....999

Skip Note: যদি ১০.১৬নং প্রশ্নের উত্তর ৫/৮৮৮/৯৯৯ হয়, তবে ১০.১৮নং প্রশ্নে যান। [If answer of 10.16 is 5/888/999, skip to 10.18]

10.17 যখন ল্যাট্রিনটি/পায়খানাটি ভরে গিয়েছিল তখন আপনি কি করেছিলেন? [What did you do when the latrine filled?]

.....□

ল্যাট্রিনের ২০০ মিটারের মধ্যে গর্ত করে পয়: বর্জ্য ও অন্যান্য বর্জ্য অপসারণ [Discarded contents in a pit within 200 meters of the latrine].....1

ল্যাট্রিনের ২০০ মিটারের বাইরে গর্ত করে পয়: বর্জ্য ও অন্যান্য বর্জ্য অপসারণ [Discarded contents in a pit > 200 meters from the latrine].....2

নিকটবর্তী বোপ /জঙ্গলে/নদী/ পুকুর বা অন্য কোন পানির উৎসের কাছে খোলা জায়গায় অপসারণ [Discarded contents openly nearby bushes, river, pond or any other general water body].....3

ল্যাট্রিনটি ঢেকে ফেলা এবং নতুন একটি তৈরী করা [Covered the latrine and built a new one].....	4
দুই গর্ত বিশিষ্ট ল্যাট্রিনের দ্বিতীয় গর্তে স্থানান্তরিত হওয়া [Switched to the second pit of a dual pit latrine]	5
অন্যান্য (নির্দিষ্ট করে লিখুন) [Other (Specify)].....	777
প্রযোজ্য নয় [Not applicable].....	888

10.18 খানার সীমানার মধ্যে মানুষের মল/পায়খানা পড়ে থাকতে দেখেছেন কি? [Is there any Human faeces present within the household?].

হ্যাঁ [Yes]1

না [No].....0 ১০.২০ নং প্রশ্নে চলে যান (Skip to

10.20)

10.19 খানার সীমানার মধ্যে মানুষের মল/পায়খানা পড়ে আছে যা উন্মুক্ত পায়খানা হিসেবে বিবেচিত হবে, তার সংখ্যা? [Number of piles of Human faeces within the household that could be considered open defecation].....

555 অধিক সংখ্যক (স্বপের সংখ্যা ১০টির উপরে) [Too numerous to count (more than 10 piles)]

999 বলা যাচ্ছে না/পর্যবেক্ষণ করা সম্ভব হয়নি [Cannot tell / could not observe]

10.20 খানার সীমানার মধ্যে পশুর-পাখির মল/পায়খানা পড়ে থাকতে দেখেছেন কি? [Is there any Animal faeces present within the household?].

হ্যাঁ [Yes]1

না [No].....0 ১০.২২ নং প্রশ্নে চলে যান (Skip to

10.22)

10.21 খানার সীমানার মধ্যে পশুর/পাখির মল/পায়খানা পড়ে আছে, যা উন্মুক্ত পায়খানা হিসেবে বিবেচিত হবে, তার সংখ্যা? (নির্দিষ্টভাবে সংখ্যা উল্লেখ করুন) [Number of piles of Animal faeces present within the household (mark all that apply)]

555 অধিক সংখ্যক (স্বপের সংখ্যা ১০টির উপরে) [Too numerous to count (more than 10 piles)]

999 বলা যাচ্ছে না/পর্যবেক্ষণ করা সম্ভব হয়নি [Cannot tell / could not observe]

1. পাখি বিশেষ (মুরগী/হাঁস/কবুতর) [Poultry (chicken, duck, and pigeon)]

2. গরু/মহিষ [Cow / Buffalo].....

3. ছাগল/ভেড়া [Goat / Sheep].....

4. শুকর [Pig].....

5. কুকুর অথবা বিড়াল [Dog or Cat].....

777. অন্যান্য [Other].....

10.22 এই বাড়ীর সীমানার মধ্যে মানুষের মল/পায়খানা পড়ে থাকতে দেখেছেন কি? [Is there any human faeces present within the compound?]

হ্যাঁ [Yes]1

না [No].....0 ১০.২৪ নং প্রশ্নে চলে যান (Skip to 10.24)

10.23 এই বাড়ীর সীমানার মধ্যে মানুষের মল/পায়খানা পড়ে আছে/থাকলে যা উন্মুক্ত পায়খানা হিসেবে বিবেচিত হবে, তার সংখ্যা? [Number of piles of Human faeces within the compound that could be considered open defecation]

555 অধিক সংখ্যক (স্বপের সংখ্যা ১০টির উপরে) [Too numerous to count (more than 10 piles)]

999 বলা যাচ্ছে না/পর্যবেক্ষণ করা সম্ভব হয়নি [Cannot tell / could not observe]

10.24 এই বাড়ীর সীমানার মধ্যে পশুর-পাখির মল/পায়খানা পড়ে থাকতে দেখেছেন কি? [Is there any Animal faeces present within the compound?]

হ্যাঁ [Yes]1

না [No].....0 ১১.১ নং প্রশ্নে চলে যান (Skip to 11.1)

10.25 এই বাড়ীতে পশুর/পাখির মল/পায়খানা পড়ে আছে, যা উন্মুক্ত পায়খানা হিসেবে বিবেচিত হবে, তার সংখ্যা? (নির্দিষ্টভাবে সংখ্যা উল্লেখ করুন) [Number of piles of Animal faeces present within the compound (mark all that apply)]

555 অধিক সংখ্যক (স্বপের সংখ্যা ১০টির উপরে) [Too numerous to count (more than 10 piles)]

999 বলা যাচ্ছে না/পর্যবেক্ষণ করা সম্ভব হয়নি [Cannot tell / could not observe]

1. পাখি বিশেষ(মুরগী/হাঁস/কবুতর) [Poultry (chicken, duck, and pigeon)]
.....□□□

2. গরু/মহিষ [Cow / Buffalo].....□□□

3. ছাগল/ভেড়া [Goat / Sheep].....□□□

4. শুকর [Pig].....□□□

5. কুকুর অথবা বিড়াল [Dog or Cat].....□□□

777. অন্যান্য [Other].....□□□

Section 11: Hand washing

11.1 পায়খানার পর আপনি বেশির ভাগ সময় কোথায় হাত ধোয়? (দেখাতে বলুন এবং পর্যবেক্ষণ করুন) [Can you show me where you mostly wash your hands after you back from the toilet?] [(ASK TO SEE AND OBSERVE)]□

পায়খানার ভিতরে/কাছে [Inside/near toilet facility] 1

রান্নাঘর/ রান্নার স্থানের ভিতরে/কাছে [Inside/near kitchen/cooking place].....2

উঠানে (পায়খানা থেকে ৩ কদমের মধ্যে) [Elsewhere in yard (within 3 steps)].....3

উঠানে (পায়খানা থেকে ৩ কদমের বেশি কিন্তু ১০ ফুটের মধ্যে) [Elsewhere in yard (>3 steps but ≤ 10 feet)].....4

উঠানের বাহিরে (পায়খানা থেকে ১০ ফুটের বাহিরে) [Outside yard (>10 feet from the latrine)]5

উঠানে (পায়খানা থেকে ১০ ফুটের বাহিরে) [Elsewhere in yard (>10 feet from the latrine)]6

নির্দিষ্ট কোন স্থান নেই [No specific place]7

দেখাতে ইচ্ছুক নয় [No permission to see]666

Skip Note: যদি ১১.১নং প্রশ্নের উত্তর ৭ হয়, তবে ১১.৫-এ যান [If answer is 7, skip to 11.5]

Skip Note: যদি ১১.১নং প্রশ্নের উত্তর কোড ৬৬৬ হয়, তবে ১১.৫-এ যান [If answer of 11.1 is 666, skip to 11.5]

11.2 সেখানে কি হাত ধোয়ার জন্য যথেষ্ট পানি আছে (পর্যবেক্ষণ করুন) [Observation only: Is water available there for hand washing?]□

হ্যাঁ [Yes].....1

না [No].....0

11.3 সেখানে সাবান/ ডিটারজেন্ট অথবা হাত ধোয়ার অন্য কোন উপাদান দেখতে পেয়েছেন কী? (পর্যবেক্ষণ করুন) [Observation only: Is there soap or detergent or locally used cleansing agent?]

হ্যাঁ [Yes].....1

না [No].....0

1. সাবান [Soap]□
2. ডিটারজেন্ট [Detergent]□
3. ছাই [Ash].....□
4. মাটি/ বালু [Mud/sand]□
777. অন্যান্য (নির্দিষ্ট করে লিখুন) [Other: specify]□
6. উপরের কোনটিই না [None of the above].....□

11.4 (শুধুমাত্র পর্যবেক্ষণ করুন) যদি হাত ধোয়ার স্থানে হাত ধোয়ার কোন উপাদান না থাকে তবে উত্তরদাতা কি ১ মিনিটের মধ্যে হাত ধোয়ার কোন উপাদান আনতে পারে? [Observation only: If cleaning agent is not present, can the respondent bring cleaning agent within 1 minute?]

হ্যাঁ [Yes].....1

না [No].0

প্রযোজ্য নয় [Not applicable].....888

1. সাবান [Soap]□□□

2. ডিটারজেন্ট [Detergent].....□□□

3. ছাই [Ash].....□□□

4. মাটি/ বালু [Mud/sand]□□□

777. অন্যান্য (নির্দিষ্ট করে লিখুন) [Other: specify]□□□

6. উপরের কোনটিই না [None of the above]□□□

11.5 খানাটিতে পানির ট্যাপ আছে কি? [Do you have water tap for your household?]□

হ্যাঁ [Yes].....1

না [No].....0

11.7 আমি কি আপনার হাতগুলো দেখতে পারি? [May I please look at your hands?]

ময়লা স্পষ্টভাবে দেখা যাচ্ছিল [Visible dirt].....1

ময়লা স্পষ্টভাবে দেখা নাগেলেও অপরিচ্ছন্নভাব ছিল [Unclean appearance].....2

পরিস্কার ছিল [Clean]3

পর্যবেক্ষণ করা সম্ভব হয়নি/প্রত্যাখান [Observation was not possible/refused]]4

1. হাতের নখ [Fingernails]□

2. করতল [Palms]□

3. আঙ্গুলের সম্মুখভাগ [Fingerpads]□

11.8 হাত ধোয়া প্রদর্শন: ৩-৫ বছর বয়সের বাচ্চার হাতধোয়া প্রদর্শনঃ [(Hand washing demo): Hand washing demo for child 3 – 5 years old]:

দয়া করে তুমি দেখাবে সাধারণভাবে/সচরাচর কিভাবে তুমি পায়খানা করার পর হাত ধোও (খালি স্থানে নোট রাখুন যে উত্তরদাতা কিভাবে হাত ধুয়েছিলেন এবং পরবর্তীতে তিনি কিভাবে হাত শুকিয়েছিলেন যা কিনা নিম্নের কোডগুলো পূরণ করতে সাহায্য করবে। [Please show me how you usually wash your hands after you go to the toilet for defecation. (Please note in the blank space about how did she washed her hands and later on how did she dry and fill up the following questions with appropriate code)]

নীচের দেয়া উত্তরগুলোর সাথে মিলিয়ে হ্যাঁ বা না কোড করুন [Please check this based on answers of the open question.]

হ্যাঁ (Yes).....1

না (No).....0

11.8.1 খানাটিতে কি ৩-৫ বছর বয়সের বাচ্চা আছে? [Do the household has a baby aged 3-5 years...]

Skip Note: যদি ১১.৮.১ নং প্রশ্নের উত্তর ০ হয় তাহলে ১১.৯-এ যান। [If answer of 11.8.1 is 0, skip to 11.9]

11.8.2 অংশগ্রহণ করেছিল [Participated].....

Skip Note:-যদি ১১.৮.২ নং প্রশ্নের উত্তর ০ হয় তাহলে ১১.৯-এ যান [If answer of 11.8.2 is 0, skip to 11.9]

11.8.3 শুধু পানি [Used only water]

11.8.4 সাবান ব্যবহার করেছিল [Used soap]

11.8.5 দুই হাতই ধুয়েছে কিনা? [Washed both hands]

11.8.6 কতক্ষণ (সেকেন্ডে গননা করুন) সাবান দিয়ে হাত ঘষেছেন? [How long (count seconds) the person rubs hands with soap?

11.8.7 কি ভাবে হাত মোছা/ শুকানো হয়েছে [Dried with].....

পরিধেয় কাপড়ে (শাড়ির আচল, সেলোয়ার/ কামিজ ইত্যাদি) [Dried hands on clothing that she was wearing]: *Sharir Anchal, shalwer/ kamiz etc....* 1

ময়লা কাপড় (যেমন: লুঙ্গি, গামছা, তোয়ালে ইত্যাদি) [Dirty cloth (such as lungi, gamsa, towel etc. those looked dirty)] 2

পরিস্কার কাপড় [Clean cloth] 3

বাতাসে [Air dry] 4

শুকানো হয়নি [Not dry] 5

প্রযোজ্য নয় [Not applicable] 888

11.9 হাত ধোয়া প্রদর্শন : এই খানার টার্গেট শিশুর প্রধান পরিচর্যাকারীর হাতধোয়া প্রদর্শন (**Hand washing demo**): Hand washing demo child caregiver:]

দয়া করে আপনি দেখাবেন সাধারণভাবে/সচরাচর কিভাবে আপনি পায়খানা করার পর হাত ধোন (খালি স্থাননোট রাখুন যে উত্তরদাতা কিভাবে হাত ধুয়েছিলেন এবং পরবর্তীতে তিনি কিভাবে হাত শুকিয়েছিলেন যা কিনা নিম্নের কোডগুলো পূরণ করতে সাহায্য করবে।) [Please show me how you usually wash your hands after you go to the toilet for defecation. (Please note in the blank space about how did she washed her hands and later on how did she dry and fill up the following questions with appropriate code)

নীচের দেয়া উত্তরগুলোর সাথে মিলিয়ে হ্যাঁ বা না কোড করুন [Please check this based on answers of the open question.

হ্যাঁ (Yes).....1

না (No).....0

11.9.1 অংশগ্রহণ করেছিলেন [Participated].....□

Skip Note:-যদি ১১.৯.১ নং প্রশ্নের উত্তর ০ হয় তাহলে ১২-এ যান। [If answer of 11.9.1 is 0, skip to 12]

11.9.2 শুধু পানি ব্যবহার করেছিলেন [Used only water].....□

11.9.3 সাবান ব্যবহার করেছিলেন [Used soap].....□

11.9.4 দুই হাত ধুয়েছিলেন [Washed both hands].....□

11.9.5 কতক্ষণ ধরে (সেকেন্ড গণনা করুন) হাত সাবান দিয়ে ঘষেছিলেন [How long (count seconds) the person rub hands with soap?□□□

11.9.6 হাত শুকিয়েছিলেন [Dried with].....□

পরিধেয় কাপড়ে (শাড়ির আঁচল, সেলোয়ার/ কামিজ ইত্যাদি) [Dried hands on clothing that she was wearing]: *Sharir Anchal, shalwer/ kamiz et*..... 1

লুঙ্গি/গামছা/অন্যান্য (যা পরিধাণ করেননি) নোংরা দেখাচ্ছিল [Lungi / gamsa / others (not wearing) and looked dirty]..... 2

পরিষ্কার কাপড় [Clean cloth] 3

বাতাসে [Air dry] 4

শুকানো হয়নি [Not dry] 5

প্রযোজ্য নয় [Not applicable] 888

12. এই খানা থেকে হাত ধোয়া নমুনা সংগ্রহ করা হয়েছে কি? Has hand risne sampel been taken for this household?.....□□□

হ্যাঁ [Yes].....1

না [No].0

প্রযোজ্য নয় [Not applicable].....888

13. এই খানতে বল সরবরাহ করা হয়েছে কি? Was a ball supplied to a child in this household?.....□□□

হ্যাঁ [Yes].....1

না [No].0

প্রযোজ্য নয় [Not applicable].....888

14. এই খানতে মাছি ধরার টেপ স্থাপন করা হয়েছে কি? Has Fly tapes been placed in this household?.....□□□

হ্যাঁ [Yes].....1

না [No].....0

প্রযোজ্য নয় [Not applicable].....888

15. এই খানা থেকে সব তথ্য সঠিকভাবে সংগ্রহ করা হয়েছে কি না তা নিশ্চিত হয়েছেন কি? Have you checked if all the questionnaire is complete before leaving the household?.....□□□

হ্যাঁ [Yes].....1

না [No].0

প্রযোজ্য নয় [Not applicable].....888

Thank you. Part-B is finished.

Name, signature of FRA:

Checked by FRO:

Follow up questionnaire survey

Project title: Role of sanitation in preventing contamination of the domestic environment and protecting health

Note: Ask these Questions to the mother or the main caregiver of the child.

[এই প্রশ্নগুলো বাচ্চার মাকে অথবা মূল পরিচর্যাকারীকে জিজ্ঞেস করুন]

TOY COLLECTION SHEET (A4)

Household ID <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/>	
Baseline visit related information বেসলাইন ভিজিট সংক্রান্ত তথ্য	
1. Data collectors name	
2. Date of Interview <input type="text"/> / <input type="text"/> / <input type="text"/> (dd/mm/yy)	3. Time of Interview <input type="text"/> : <input type="text"/> (hh:mm, 24 hr format)

Follow up Visit

Household ID <input type="text"/> <input type="text"/> <input type="text"/>	
4. Data collectors name	
5. Date of Interview <input type="text"/> / <input type="text"/> / <input type="text"/> (dd/mm/yy)	6. Time of Interview <input type="text"/> : <input type="text"/> (hh:mm, 24 hr format)
7. Number of full hours since Baseline visit <input type="text"/> : <input type="text"/> (hh:mm, 24 hr format)	

Toy collection খেলনা বল সংগ্রহ		
<p>8. অবস্থান [Location] <input type="checkbox"/></p> <p><u>বসত ঘরের বাইরে [Outside home]</u></p> <p>1 <u>বসত ঘরের বাইরে- উঠানে মাটিতে [Outside home- on ground in yard]</u></p> <p>2 <u>বসত ঘরের বাইরে- কোন পাত্রে [Outside home- in a container]</u></p> <p>3 <u>বসত ঘরের বাইরে- অন্য কোন খানায় [Outside home- in another home]</u></p> <p><u>বসত ঘরের ভিতরে [Inside home]</u></p> <p>4 <u>বসত ঘরের ভিতরে- সুরক্ষিত কোন পাত্র/আলমিরা/ সোকেজ [Inside home- in storage container/cabinet]</u></p> <p>5 <u>বসত ঘরের ভিতরে- মাটি ছাড়া অন্য কোন সমতল জায়গায় (বিছানা, টেবিল) [Inside home- on surface other than ground, not in container (table,bed,etc)]</u></p> <p>6 <u>বসত ঘরের ভিতরে- মেঝেতে [Inside home- on ground/floor]</u></p> <p>7 <u>বল শিশুর হাতে ছিল [in child's hand]</u></p> <p>777 অন্যান্য (বর্ণনা লিখুন) [Others (Specify)]</p> <p>9...বল পাওয়া যায়নি (২০নং প্রশ্নে যান) [Could not retrieve](Skip to 20.)</p>	<p>9. বাহ্যিক রূপ Appearance...<input type="checkbox"/></p> <p>1... অব্যবহৃত Unused</p> <p>ব্যবহৃত এবং <u>Used and..</u></p> <p>2 ব্যবহৃত এবং পরিষ্কার [<u>Used and clean appearing</u>]</p> <p>3 ব্যবহৃত এবং অপরিষ্কার [<u>Used and unclean appearance</u>]</p> <p>4 ব্যবহৃত এবং অনেক ময়লা মাটি জরানো [<u>Used and visibly dirty</u>]</p>	<p>10. (Write any additional notes on toy appearance, location, damage, retrieval process, etc.)</p> <p>বলের অবস্থান, বাহ্যিক রূপ, ক্ষয়-ক্ষতি, সংগ্রহ প্রকৃয়া ইত্যাদি সম্পর্কে কোন তথ্য: (যদি থাকে, না থাকলে চর্চ কোড করুন)</p>
<p>11. প্রধান উত্তরদাতার নাম [Name of Respondent]:</p>		
<p>12. এই খানার টার্গেট শিশুর সাথে প্রধান উত্তরদাতার সম্পর্ক? (index) [Relationship of respondent to index child].....<input type="checkbox"/><input type="checkbox"/></p> <p>1... সবচেয়ে ছোট বাচ্চার মা [Mother of youngest child]</p> <p>2... পরিচর্যাকারী (পুরুষ) [Male caregiver]</p> <p>3... পরিচর্যাকারী (মহিলা) [Female caregiver other than mother]</p>		

888... প্রযোজ্য নয় [Not applicable]

PART B: Use of Toy Ball

13. আপনার মতে, আপনার শিশু (টার্গেট) কি খেলনা বলটি দিয়ে খেলা করেছে? [In your opinion, did your child (target) play with the toy ball?].

1... হ্যাঁ [Yes]

0... না [No]

999... জানি না [DK]

14. আপনার মতে, আপনার শিশুটি (টার্গেট) খেলনা বল দিয়ে কতক্ষণ খেলা করেছে? (উত্তর পড়ে শোনান) [In your opinion, how much did your child (target) play with the toy ball? (read each choice)].

1... দিনে অনেক বার (4 বা তার বেশী বার) [Several times a day (4 or more times)]

2... দিনে কয়েক বার (2/3 বার) [Few times a day (2/3 times)]

3... শুধু এক বার, বল পাওয়ার পর থেকে [Only once since he/she got the ball]

4... খেলা করেছে কিন্তু কতবার বলতে পারে না [Played but can't tell how many times]

5... কখনই নয় [Never]

999... জানি না [DK]

15. আপনার মতে, আপনার খানার বা বাড়ীর ৫ বছরের কম বয়সী অন্য কোন শিশু কি খেলনা বলটি দিয়ে খেলা করেছে? [In your opinion, did any of the children play with the toy ball?].

1... হ্যাঁ [Yes]

0... না [No] [17 নং প্রশ্নে যান (skip to 17)]

999... জানি না [DK] [17 নং প্রশ্নে যান (skip to 17)]

16. আপনার মতে, আপনার খানার বা বাড়ীর ৫ বছরের কম বয়সী অন্য কোন শিশু এই খেলনা বল দিয়ে কতক্ষণ খেলা করেছে? (উত্তর পড়ে শোনান) [In your opinion, how much did any of the other children in the household or Bari play with the toy ball? (read each choice)].

1... দিনে অনেক বার (4 বা তার বেশী বার) [Several times a day (4 or more times)]

2... দিনে কয়েক বার (2/3 বার) [Few times a day (2/3 times)]

3... শুধু এক বার, বল পাওয়ার পর থেকে [Only once since he/she got the ball]

4... খেলা করেছে কিন্তু কতবার বলতে পারে না [Played but can't tell how many times]

5... কখনই নয় [Never]

999... জানি না [DK]

17. আপনার দেখা মতে, আপনার শিশু (টার্গেট) কি বেশীরভাগ সময় বসং ঘরের ভিতরে, বাহিরে, না কি ভিতরে-বাহিরে সমান ভাবে বলটি দিয়ে খেলা করেছে? [From what you saw, did the children play with

the ball mostly inside the home, mostly outside the home or equal amount inside and outside the home?].....□□

- 1... বেশীরভাগ সময় বসৎ ঘরের ভিতরে [Mostly inside the home]
- 2... বেশীরভাগ সময় বসৎ ঘরের বাহিরে [Mostly outside the home]
- 3... বসৎ ঘরের ভিতরে-বাহিরে সমান ভাবে [equal amounts inside and outside the home]
- 999... জানি না [DK]

18. যখন বলটি বসৎ ঘরের ভিতরে ছিল তখন কত ঘন ঘন বলটি মেঝে স্পর্শ করছিল? (উত্তর পড়ে শোনান)
[When the ball was inside, how often did the ball touch the ground? (read each choice)]...... □□

- 1...সব সময় [All of the time]
- 2...বেশীরভাগ সময় [Most of the time]
- 3... কখনও কখনও [Sometimes]
- 4... কদাচিৎ [Rarely]
- 5... কখনই নয় [Never]
- 7... বসৎ ঘরের ভিতরে কখনই খেলা করেনি [Was never played with inside]
- 999... জানি না [DK]

19. যখন বলটি বসৎ ঘরের বাহিরে ছিল তখন কত ঘন ঘন বলটি মেঝে স্পর্শ করছিল? (উত্তর পড়ে শোনান)
[When the ball was outside, how often did the ball touch the ground? (read each choice)]...... □□

- 1...সব সময় [All of the time]
- 2...বেশীরভাগ সময় [Most of the time]
- 3... কখনও কখনও [Sometimes]
- 4... কদাচিৎ [Rarely]
- 5... কখনই নয় [Never]
- 7... বসৎ ঘরের বাহিরে কখনই খেলা করেনি [Was never played with outside]
- 999... জানি না [DK]

Appendix 4: Details of Microbiological sample collection and laboratory procedures used in pilot study presented in chapter 2 and 3.

Hand contamination sample collection

Hand rinse sampling technique of collecting hand contamination data was used since this technique has been used in many studies [1, 2] to assess hand contamination and has been found to be associated with diarrhoea [2]. A microbiologist trained in aseptic method of microbiological sample collection, collected data on unannounced hand contamination from both hands of the mother and the <5 children on the same day as the initial household questionnaire survey.

The mother of the <5 child was asked to give consent for giving hand rinse sample for the under <5 child and herself. Hand rinsed samples were collected at the beginning of the household questionnaire survey after the consent process was complete. Both hands were rinsed in a Whirl-Pak bag (Nasco, Fort Atkinson, WI) containing 200 ml sterile Ringer's solution one after another. Ringer's solution contains sodium chloride, potassium chloride, calcium chloride di-hydrate, and sodium lactate. The microbiologist held the bag from outside. When the selected hand of the mother/child completely came into contact with the Ringer's solution, the microbiologist asked the mother/child to rub the fingers and palm against each other for 15 seconds. Then the microbiologist massaged the inserted hand from the outside of the Whirl-pak bag for additional 15 seconds to ensure that all parts of the hand are fully immersed in Ringer's solution. The microbiologist then instructed the respondent to remove the hand, shaking it so that all the drops of solution remain in the bag. The closed Whirl-Pak bags were placed immediately into a cold box, maintained at $\leq 10^{\circ}\text{C}$ with ice packs, to prevent bacterial multiplication. Then the samples were transported to the Environmental Microbiology Laboratory of icddr,b for processing.

Sentinel toy sample collection

We measured contamination of a sentinel non-porous plastic toy ball (20 cm diameter) (Picture 1) as a measure of environmental contamination, as this has been found to be associated with quality of latrine in Bangladesh [3, 4]. The sentinel toy sample collection was conducted following similar methodology as used in these studies.

The toy balls were initially sterilized, wrapped in foil paper and stored in a sterile bag until it was given to the selected households. The sentinel toys were given to the households for the child to play with on the same day as the initial household questionnaire survey. The mother was instructed that the child can play with the toy ball with his usual play



Picture 7.1: Sentinel toy Ball

mates and sites. The field team visited the household 24 hours later on the following day to collect the toy rinse sample. During the follow up visit the microbiologist asked the mother to locate the ball. The mother was then requested to place the ball in a Whirl-Pak bag filled with 200 ml ringer's solution. The ball was rinsed in the solution for 30 seconds fully immersed. The bag was first shaken for 15 seconds and then rubbed from outside for an additional 15 seconds to make sure all sides of the ball is rinsed in the solution. Once the ball has been rinsed it was dried and given back to the child. The closed Whirl-Pak bags were placed immediately into a cold box, maintained at $\leq 10^{\circ}\text{C}$ with ice packs, to prevent bacterial multiplication. Then the samples were transported to the lab for processing within 24 hours.

Floor/Yard sample collection

Based on the formative research, the field team identified potential mud surfaces that can be consistently identified in different household. Surface rather than soil sample was chosen as most of the contamination was found in the upper surface of the soil [5] in a previous study. The surfaces were chosen based on the experience of the formative research and the data on soil contamination in rural Tanzania [5]. Two type of surface sample was collected. We collected environmental contamination sample from the surfaces using a sterile Whirl-Pak Speci-Sponge bags (Whirl-Pak Speci-Sponge bag, Nasco, Fort Atkinson, WI) (3.6 cm wide, 7.6 cm Long and 1.5 cm thick) . The sponge was pre-hydrated with 20 ml of ringer's solution in the Environmental Microbiology Laboratory of icddr,b.

The first surface sample was collected from the **floor of entrance of the main house**. A 100 cm² sampling area was marked on the centre of the floor/surface with a sterile aluminium stencil frame. Between the samples collection in different household the stencil frame was sterilized using 70% methanol. The sponge was rubbed over the fixed sampling area twice, and then placed into the Whirl-Pak bag.

The second surface sample was a **composite floor sample**. The idea was to collect surface sample from 3 different part of the same household to measure an average of the faecal contamination. The 3 surface areas included the middle of the yard, middle of the living room and middle of the kitchen. For the composite sample one pre-hydrated sponge was used. The data collector first identified 100 cm² area in each of the areas and sponged the area twice. One half of one side of a sponge was swiped over 100 cm² sampling area twice so that sample from each of the 3 sites can be collected using the same sponge.

The closed Whirl-pak bags were placed immediately into a cold box, maintained at $\leq 10^{\circ}\text{C}$ with ice packs, to prevent bacterial multiplication. Then the samples were transported to the lab for processing within 24 hours.

Quality Control

A sample Whirl-Pak bag was opened at the household during sample collection and then closed without collecting any sample using the bag. This way a field blank was analyzed every day to ensure sample rinse bags are free of indicator organisms and are not getting contaminated during the field sampling process.

Laboratory procedures

All the laboratory procedures took place in Environmental Microbiology Laboratory of icddr,b.

Preparing toy balls

The toy balls were prepared following similar standard operating procedure as a previous study conducted in Bangladesh [6]. The microbiologist washed the balls with soap and water. Then the balls were dried with paper towel. Then the toys were bathed in bleach [200mL of industrial bleach (5.25%) and 1.8 liters of distilled water] for 10 minutes, making sure that the balls were coated with bleach, and after 5minutes the balls were re-submerged into the bleach. The microbiologist then removed the toys from bleach bath and placed in tub that was sterilized in with bleach. Then the toys were rinsed with distilled water 3 times transferring to sterile tubs between each rinse. Then the balls were left a sterile tub to dry for 30 minutes to 1 hour. Once the balls were dry, they were wrapped in aluminium foil (Cleaned with 70% ethanol), placed inside zipper bags and stored in bucket for the field team to pick up.

Preparing sample for membrane filtration

The environmental contamination samples were processes by a microbiologist in the Environmental Microbiology Laboratory of icddr,b. All the environmental samples were stored in 2-8 °C refrigerators in the lab after transported to the lab until analysed within 24 hours. The samples collected from mother's hands, child's hands and sentinel toy was directly processed. In case of sponge samples collected from the surfaces, 180ml of Ringer's solution was poured into each of the bags containing the sponge. Then the bags were manually shaken vigorously for 1 minute and rubbed with hands for an additional minute. The sponges were then removed from the bags leaving the solutions ready for further processing.

Enumeration of faecal coliform and *E. coli* using membrane filtration

The samples were processed by a microbiologist via membrane filtration technique to detect faecal coliform using mFC media and *E.coli* using MI media following EPA method [7, 8] (Box 1) used for drinking water.

The microbiologist filtered 50 ml to 1 ml (Table 2) of liquid recovery media depending on turbidity and type of the sample through a 0.22 µm Millipore (Billerica, MA) membrane filter using a vacuum pump. In majority of the cases only one volume was processed for each sample considering the resource constraints. To develop preliminary understanding of the amount of sample to we first processed samples collected from 3 households (Table 1). The samples from the first 3 households were not included in the final analysis. For each sample droplets of the original recovery media, 10^{-1} and 10^{-2} dilutions of the recovery media, was also plated at a total volume of 100 µl in case the results from the membrane filtration appears Too Numerous to Count (TNTC) [9, 10]. If the samples processed via membrane filtration on the first day produced no detectable colonies, a higher concentration was filtered on the second day using samples stored at 4 °C

temperature. If there were no target colonies found in the plates on both the days, then the microbiologists reported 0 CFU/200 ml of recovery media.

If there is no target colonies found in the plates then reported 0.5 CFU/200 ml of recovery media. If there is characteristic colony present and less than 500, report as number of CFU per 200 ml of recovery media. If there is characteristic colony present but exceed 500 CFU per membrane, then count the colonies found in the in the droplet of the original recovery media. If the droplet of the original recovery media is also found too numerous to count, then count droplet for 10^{-1} dilution were interpreted. In case the droplet of the 10^{-1} is also too numerous to count then consider the droplet of 10^{-2} dilution to count the number of CFU per 200 ml of recovery media. To control the quality of the test negative controls were tested for contamination for each set of agar media. Every day one lab blank was tested for contamination. The samples were processed by a microbiologist who followed general standard operating procedures that are followed in the lab as described in box 1.

Box 1: Standard operating procedure of enumeration of faecal coliform and *E. coli* followed in the environmental microbiology laboratory of ICDDR,B

<p><u>Filtration of sample through membrane filtration procedure</u></p> <ol style="list-style-type: none">1. Label laboratory ID and processing date on mFC agar plate with a label pen.2. Sterilize the surface of the Microfil Membrane Filtration Unit (Billerica, MA) by flaming for 3-5 sec, paying particular attention to the outer edges.3. Open a membrane (0.22μm) envelope by peeling back one of the two “easy-to-open” corners and place it on the Microfil support after sufficient cooling.4. Take a sterile funnel, grasping from the middle and place it carefully on to the support.5. Shake the sample for a while and then pour 50-1 ml or recovery media based on visual inspection of turbidity and experience with the sample into the funnel. Filter the sample under vacuum until the sample has passed entirely through the membrane. Close valve of vacuum, remove the funnel, and press the lever on the vacuum support stem to lift the membrane filter from the vacuum support surface. <p><u>Plating and Incubation</u></p> <ol style="list-style-type: none">6. Use sterile forcep to remove the membrane filter and place the membrane filter on to the mFC agar Petri dish for faecal coliform and MI agar (BD Difco, Franklin Lakes, NJ) Petri dish for <i>E. coli</i>. The orientation of the filter should remain the same as in the filtration unit.7. Drop plate 100 μl of original sample as well as 10 and 100 times diluted sample on to mFC agar (faecal coliform) and MI agar (<i>E. coli</i>).8. Incubate the plate at $44.5 \pm 0.2^{\circ}\text{C}$ for 24 ± 2 hours for faecal coliform. Incubate the plates at $35 \pm 2^{\circ}\text{C}$ for 24 hours for <i>E. coli</i>. Store the remaining sample at $2-8^{\circ}\text{C}$ in a refrigerator for further repetition, if required. <p><u>Enumeration</u></p> <ol style="list-style-type: none">9.<ol style="list-style-type: none">a) Carefully count the blue and greenish blue coloured colonies on the mFC agar and keep record as FC in the Laboratory work log sheet.

- b) Carefully count the deep blue colour colonies on the MI agar plate and record as *E. coli*.

Quality Control

10. Quality control is performed with each new lot of media prepared

- a) For mFC agar *Escherichia coli* ATCC-13706 is used as positive control and *Staphylococcus aureus* ATCC-25923 is used as negative control.
- b) For MI agar *Escherichia coli* ATCC-13706 is used as positive control and *Staphylococcus aureus* ATCC-25923 is used as negative control.

Interpretation

- a) If there are no target colonies of faecal coliforms/*E. coli* on first day then filter a higher amount of recovery media from the stored sample on the second day. If there are no target colonies of faecal coliforms/*E. coli* both days, report: 0 CFU/200 mL.
- b) If there is characteristic colony present and less than 500 CFU per membrane, report: number of CFU/ 200 mL.
- c) If there is characteristic colony present but exceed 500 CFU per membrane, than interpret the colonies in the 100 µl droplets of the original sample.
- d) If the 100 µl droplets of the original sample also exceed 500 CFU than interpret the colonies in droplets of 10 times diluted sample.
- e)) If the 100 µl droplets of the 10 times diluted sample also exceed 500 CFU than interpret the colonies in droplets of 100 times diluted sample.
- f) If all the in all of the plates of the first day presents with characteristic colony more than 500 than repeat the test using appropriate dilution to achieve countable colony the next day from the sample preserved in the refrigerator.

Table 7.4: Volume of sample filtered or plated as droplets to successfully enumerate *E. Coli* and faecal coliform in 3 household (pilot data not included in the main analysis)

	Type of sample	<i>E. Coli</i>		Faecal Coliform	
		<i>Amount filtered to detect successfully detect colonies</i>	Freq.	<i>Amount filtered to detect colonies</i>	Freq.
1	Mothers hands	Day 1: 5 ml filtration Day 2: 20 ml filtration	2 1	Day 1: 10 ml filtration	3
2	Childs Hands	Day 1: 5 ml filtration Day 2: 20 ml filtration	2 1	Day 1: 10 ml filtration	3
3	Sentinel toy			Day 1: 5 ml filtration 100 µl of 10 ⁻¹ dilution Drop	2 1
4	Entrance of living room	Day 1: 0.5 ml filtration 100 µl Drop	2 1	Day 1: 100 µl of 10 ⁻¹ dilution Drop	3
5	Composite-floor	Day 1: 0.5 ml filtration	3	Day 1: 100 µl of 10 ⁻¹ dilution Drop	3

Table 7.5: Showing the percentage of samples with various detection limits for each type of sample (N=20)

Method	Amount filtered or drop plated	Detection limit†		Mother's hands (%)		Children's hands (%)		Sentinel toy	Entrance of living room		Composite floor sample	
		Lower	Upper	EC*	FC*	EC	FC	FC	EC	FC	EC	FC
Drop plate technique	100 µl of 10 ⁻² dilution Drop	100000	100000000		10%		5%		45%	35%	40%	4%
	100 µl of 10 ⁻¹ dilution Drop	10000	10000000						20%	35%	5%	10%
	100 micro liter	1000	1000000		25%		20%	30%	10%	30%	15%	6%
Membrane filtration	1 ml filtration	100	100000						20%		25%	
	2 ml filtration	50	50000	30%	10%	35%	5%		5%		15%	
	5 ml filtration	20	20000	50%	15%	45%	20%	10%				
	10 ml filtration	10	10000	5%	25%	5%	25%	10%				
	20 ml filtration	5	5000	15%	10%	10%	15%	40%				
	50 ml	2	2000	0	5%	5%	10%	10%				

* *E. coli* (EC), Faecal coliform (FC)

† For lower detection limit we counted 0.5 for no characteristic colony per plate and for upper detection limit we considered 500 colonies per plate to countable.

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Appendix 5: Consent form and questionnaire for Neighbourhood questionnaire survey

Informed consent form for neighbourhood questionnaire survey (Chapter 4)

Project title: Role of sanitation in preventing contamination of the domestic environment and protecting health.

Part I: Information Sheet

Introduction

Hello (Assalamualaikum/Nomoshkar). My name is _____ and I work with the ICDDR,B (Cholera Hospital) in Dhaka. I am here to invite you to take part in a research study. You are free to decide whether or not to be in the study.

Purpose of the research:

The purpose of this study is to understand whether neighbourhood sanitation coverage is linked with household environmental contamination. This will help us understand how to improve health of children.

Procedure:

We are enrolling households with at least one child aged between 6 and 24 months in the neighbourhood. If you agree to participate in the study I will visit different parts of your household. At the end of observation i will ask some questions about your household routine and practices. It will take around 30 monutes. I will take some notes on a tablet computer.

I also wish to ask you for the permission to take pictures. I might take some pictures of different facilities and activities of your household. I will show you the pictures that I will take. If you agree, these pictures might be shown as illustration in future presentations. If you do not want your face to be visible on the pictures I will blur your face, so that nobody can recognize you

Benefits:

There is no immediate benefit to you from this study. The study will help us better understand conditions in Bangladesh. This information may help to improve child health in future.

Costs and Compensation:

There is no cost to you for being in this study. You will not receive anything for being in the study.

Risks:

There is no risk from being in the study. We will only collect information. My presence in your home for several hours may be uncomfortable for you. But we do not expect any harm to come to you or your family because of the study.

Privacy:

We assure that the privacy of information identifying you will be strictly maintained. The information identifying you will only be accessible to me, my research team, the ethical Review Committee. Any information that is gathered

about you and your family will be kept anonymous. All paper documents will be kept in a locked cabinet at ICDDR,B. The research team will have sole access to the locked cabinet. All digital data with personal identifiers will be maintained on secure systems protected by passwords. Your name and identity will not be used in reporting and presenting study findings, or in their publication in journals. We will use the information only for the purpose of research. In case of future use of the information collected from the study anonymous information may be supplied to other researchers. But this will not compromise with your privacy and anonymity.

Voluntary participation:

You are free to decide whether or not to be in the study. You are free to leave the study at any time. You do not have to give any reason for leaving the study. You will not lose any benefits for leaving the study. If you do take part in the study, you are free to refuse to answer any question. You do not have to give any reason for refusing to answer any questions.

Persons to Contact

If you have any question about this research study you may contact Mr. Tarique Md. Nurul Huda (Study Coordinator). His mobile number is 01772362311. His office number is 988-1761.

If you have questions about your right in the study, you may call Mr. M A Salam Khan, Committee coordination secretariat at 9886498. His office is located at 68, Shaheed Tajuddin Ahmed Sarani Mohakhali, Dhaka 1212.

Part II: Consent Form

The nature of the study has been explained to me. I have had the opportunity to ask questions about it. I understand what will be required of me and what will happen to me, if I take part. I understand that my participation in this study is voluntary. I understand that I do not have to answer any questions if I do not want. I understand that I can leave the study freely at any time. I understand that these conditions also apply to any children for whom I give consent to participate in the study. I do agree to quotations from my participation in the study to be included anonymously in reports about the study

- I agree to participate in the study (*tick*)
- I do agree to quotations from my participation in the study to be included anonymously in reports about the study.
- I give my consent for pictures of me and my household facilities to be taken and used.
- I give my consent for all household members below the age of 18 years and for whom I am the parent of guardian to participate in the study. (*Tick*)

Name of the main caregiver _____

Age _____ Years

Signature of the Investigator or his representative

Date

Neighbourhood questionnaire survey

Project title: Role of sanitation in preventing contamination of the domestic environment and protecting health

Note: Ask these Questions to the mother or the main caregiver of the child.

[এই প্রশ্নগুলো বাচ্চার মাকে অথবা মূল পরিচর্যাকারীকে জিজ্ঞেস করুন]

PART A: QUESTIONNAIRE

Section 1: Questionnaire identification

1.1 প্রতিবেশী নং [Neighbourhood ID]:□□□-□□□-□□

1.2 খানা নং [Target Household ID]: □□□-□□□

(Please follow the specific code sheet)

1.3 ইন্সট্রুমেন্ট টাইপ [Instrument Type] (Code: Cross Sectional Survey=A2):.....

A	2
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1.4 ক্লাস্টার নং [Cluster number (starting point number)]:□□□

1.5 জেলার নাম এবং কোড [District name & district geocode]:.....□□□

1.6 ঠিকানা [Address]:

add1 খানা প্রধানের নাম [Name of household head]:.....

add2 খানা প্রধানের পিতা/স্বামীর নাম [Father's/ husband's name]:.....

add3 বাড়ির অবস্থান (নির্দিষ্ট করুন) [Location (specify)]:.....

1.7 FRA -র নাম এবং কোড [FRA name & code]:□□□□

1.8 তথ্য সংগ্রহের তারিখ [Date of data collection]: □□/□□/□□

1.9 তথ্য সংগ্রহ শুরু করার সময় [Time of Starting (24 hrs)]:□□:□□

1.10 শোবার ঘরের প্রবেশ মুখের জিআইএস কোঅর্ডিনেট লিপিবদ্ধ করুন [GIS coordinates of the entrance of the living room].

Latitude

Longitude

1.11 তথ্য সংগ্রহ সম্ভব কি? [Is data collection possible?]□

1= হ্যাঁ [yes]

2.1 নং প্রশ্নে চলে যান [*skip to 2.1*]

0= না [No]

1.12 যদি 1.10 এর উত্তর 0 হয় তবে কেন? [If 6.2 answer is 0, then why?]□

1= অনুপস্থিত [Absent]

0= প্রত্যাখান [Refuse] তথ্য সংগ্রহ শেষ করুন। [Interview ends here]

Section 2: Respondent and household/compound demographics

2.1. প্রধান উত্তরদাতার নাম [Name of respondent]:

2.2 বর্তমানে আপনার এই খানায় কত জন বাস করে? [How many people in total live in your HH at present?]. □□

2.3 আপনার খানাতে ৫ বছরের নীচে কত জন শিশু আছে? [How many children less than five years old live in your household?].

2.3.x ছেলে [Male].....□□

2.3.y মেয়ে [Female].....□□

Skip Note: শিশু সংখ্যা ০০ হলে ৩.১ নং প্রশ্নে চলে যান (If the number of the children=00 skip to q3.12)

2.4 আপনার এই খানায় ৫ বছরের ছোট কতজন শিশু আছে? (ছোট থেকে বড়) [How many children less than five years old live in your household? List the child youngest to old]

A. Child ID/Name	B. Date of birth (DD/MM/YY)	C. Age in months	D. Gender Male=1, Female=0
1.			
2.			
3.			
4.			
5.			

Section 3: Household Faeces disposal

3.1 আপনার খানার সদস্যরা পায়খানা করার জন্য সাধারণত কোথায় যায়? (Note: উত্তরদাতাকে উত্তরগুলো পড়ে শোনান [Where do the members of your household usually go for defecation? (Note: Read out the responses to the respondent)].....□

5. খোলা জঙ্গলে [Open bush]
6. খোলা মাঠে [Open field]
7. খোলা জায়গায়, নদী/পুকুর/লেকের পাশে [Open, by the side of river/pond/lake]
8. পায়খানায় [In a toilet]

3.2 আপনি সাধারণত কোথায় পায়খানা করেন? Note: উত্তরদাতাকে উত্তরগুলো পড়ে শোনান [Where do you usually defecate?].....□

1. খোলা জঙ্গলে [Open bush]
2. খোলা মাঠে [Open field]
3. খোলা জায়গায়, নদী/পুকুর/লেকের পাশে [Open, by the side of river/pond/lake]
4. পায়খানায় [In a toilet]

3.3 আপনার খানার অন্যান্য প্রাপ্ত বয়স্ক (১৮+) সদস্যরা সাধারণত কোথায় পায়খানা করেন? Note: উত্তরদাতাকে উত্তরগুলো পড়ে শোনান [Where do other adults (18+) in the household usually defecate?]

.....□

5. খোলা জঙ্গলে [Open bush]
6. খোলা মাঠে [Open field]
7. খোলা জায়গায়, নদী/পুকুর/লেকের পাশে [Open, by the side of river/pond/lake]

8. পায়খানায় [In a toilet]

3.4 আপনার খানার <3 বছর শিশু সাধারণত কোথায় পায়খানা করে? (2.4 নং প্রশ্ন থেকে শিশুর নাম ব্যবহার করুন)
[Where do the <3 child in the household usually defecate? (Use name of the child from question 2.4)]..... □□□

8. পটি [Potty]

9. ন্যাপি/ডায়পার/কাঁথা [Nappy / diaper]

10. উঠানে (পটি ছাড়া) [In the courtyard (without potty)]

11. ঘরের ভিতরে (পটি ছাড়া) [Inside the house (without potty)]

12. পায়খানায়/টিয়লেটে [In Toilet / Latrine]

13. বোপ-বাড়ে/জঙ্গলে [Bush / forest / field]

14. কোন নির্দিষ্ট জায়গায় নয় [No specific place]

777. অন্যান্য (বর্ণনা লিখুন) [Other (specify)] _____

888. প্রযোজ্য নয় [Not Applicable]

999. জানি না / নিশ্চিত নয় [Don't know / Not sure] খানার অন্য কেউ জানে কি না দেখুন [Probe to see if someone in the HH knows]

3.5 আপনার খানার 3-5 বছর শিশু সাধারণত কোথায় পায়খানা করে? [Where do the children aged 3-5 years usually defecate?] □□□

8. পটি [Potty]

9. ন্যাপি/ডায়পার/কাঁথা [Nappy / diaper]

10. উঠানে (পটি ছাড়া) [In the courtyard (without potty)]

11. ঘরের ভিতরে (পটি ছাড়া) [Inside the house (without potty)]

12. পায়খানায়/টিয়লেটে [In Toilet / Latrine]

13. বোপ-বাড়ে/জঙ্গলে [Bush / forest / field]

14. কোন নির্দিষ্ট জায়গায় নয় [No specific place]

777. অন্যান্য (বর্ণনা লিখুন) [Other (specify)] _____

888. প্রযোজ্য নয় [Not Applicable]

999. জানি না / নিশ্চিত নয় [Don't know / Not sure] খানার অন্য কেউ জানে কি না দেখুন [Probe to see if someone in the HH knows]

3.6 আপনার খানার 5 বছরের বেশী বয়সের বাচ্চারা সাধারণত কোথায় পায়খানা করে? [Where do the children above 5 (Upto 18 usually defecate?] □□□

8. পটি [Potty]

9. ন্যাপি/ডায়পার/কাঁথা [Nappy / diaper]

10. উঠানে (পটি ছাড়া) [In the courtyard (without potty)]

11. ঘরের ভিতরে (পটি ছাড়া) [Inside the house (without potty)]

12. পায়খানায়/টিয়লেটে [In Toilet / Latrine]

13. বোপ-বাড়ে/জঙ্গলে [Bush / forest / field]

14. কোন নির্দিষ্ট জায়গায় নয় [No specific place]

777. অন্যান্য (বর্ণনা লিখুন) [Other (specify)] _____

888. প্রযোজ্য নয় [Not Applicable]

999. জানি না / নিশ্চিত নয় [Don't know / Not sure] খানার অন্য কেউ জানে কি না দেখুন [Probe to see if someone in the HH knows]

3.7 আপনি সর্বশেষ কোথায় পায়খানা করেছেন? উত্তরদাতাকে উত্তরগুলো পড়ে শোনান [Where did you defecate the last time? (Note: Read out the responses to the respondent)]
..... □□□

1. খোলা জঙ্গলে [Open bush]
2. খোলা মাঠে [Open field]
3. খোলা জায়গায়, নদী/পুকুর/লেকের পাশে [Open, by the side of river/pond/lake]
4. পায়খানায় [In a toilet]

3.8 আপনার (<3 বছর) শিশু সর্বশেষ কখন পায়খানা করেছেন? [When was the last time your youngest child / infant (<3 years) defecated?] □□□

1. আজ [Today]
2. গতকাল [Yesterday]
3. ২ দিন বা তার আগে [2 or more days ago]
4. মনে করতে পারছি না [Cannot remember] ৩.১২ নং প্রশ্নে চলে যান (Skip to q3.12)
5. বলতে রাজি নয় [Refused] ৩.১২ নং প্রশ্নে চলে যান (Skip to q3.12)
888. প্রযোজ্য নয় [Not Applicable] ৩.১২ নং প্রশ্নে চলে যান (Skip to q3.12)

3.9 আপনার (<3 বছর) শিশু সর্বশেষ কোথায় পায়খানা করেছেন? [Where did the child (<3 years) defecate the last time?]  উত্তর পড়ে শোনাবেন না [Do Not Read Responses]..... □□□

8. পটি [Potty]
9. ন্যাপি/ডায়পার/কাঁথা [Nappy / diaper]
10. উঠানে (পটি ছাড়া) [In the courtyard (without potty)]
11. ঘরের ভিতরে (পটি ছাড়া) [Inside the house (without potty)]
12. পায়খানায়/টিয়লেটে [In Toilet / Latrine] ৩.১২ নং প্রশ্নে চলে যান (Skip to q3.12)
13. বোপ-বাড়ে/জঙ্গলে [Bush / forest / field]
14. কোন নির্দিষ্ট জায়গায় নয় [No specific place]

777. অন্যান্য (বর্ণনা লিখুন) [Other (specify)] _____

888. প্রযোজ্য নয় [Not Applicable]

999. জানি না / নিশ্চিত নয় [Don't know / Not sure] খানার অন্য কেউ জানে কি না দেখুন [Probe to see if someone in the HH knows]

3.10 সেই পায়খানা কি করা হয়েছিল? [What was done with the faeces?]  উত্তর পড়ে শোনাবেন না [Do Not Read Responses]..... □□□

- 9 যেখানে পায়খানা করেছিল সেখানেই ফেলে রাখা হয়েছিল [Left there]

৩.১২ নং প্রশ্নে চলে যান [skip to 3.12]

- 10 টয়লেট/পায়খানার ভিতরে ফেলা/ধোয়া হয়েছিল [Put / rinsed into toilet or latrine]
- 11 ড্রেনে/নর্দমার ভিতরে ফেলা/ধোয়া হয়েছিল [Put / rinsed into drain or ditch]
- 12 টিউবয়েল/ পুকুরের কাছে ধোয়া হয়েছিল [Rinsed near tubewell/pond]
- 13 বোপ-বাড়ে/জঙ্গলে ফেলা হয়েছিল [Thrown into the bush / forest / field]
- 14 ময়লা আবর্জনার মধ্যে ফেলা হয়েছিল [Thrown into garbage]
- 15 নির্দিষ্ট গর্তে ফেলা হয়েছিল [Thrown into a specific pit for child's faeces]
- 16 মাটির নীচে পুতে ফেলা হয়েছিল [Buried]
777. অন্যান্য (বর্ণনা লিখুন) [Other (specify)] _____
999. জানি না / নিশ্চিত নয় [Don't know / Not sure] ৩.১২ নং প্রশ্নে চলে যান [skip to 3.12]

3.11 সেই পায়খানা আপনি কিভাবে পরিষ্কার করেছিলেন? [How did you handle the faeces?]  উত্তর পড়ে শোনাবেন না [Do Not Read Responses]□□□

6. নগ্ন/খালি হাতে [Hands only/bare hands]
7. কাপড়/পাতা/কাগজ/খড়কুটা [Hands and cloth / paper / leaves / straw]
8. কোদাল/স্থানীয় কৃষিকাজ-এর হাতিয়ার [Local agricultural hoe/instrument]
9. সেনি স্কুপ [Sani-scoop]
10. কোন কিছুই করা হয় না [Did nothing]
777. অন্যান্য (বর্ণনা লিখুন) [Other (specify)] _____
999. জানি না / নিশ্চিত নয় [Don't know / not sure]

3.12 আপনার শিশু (৩ - ৫ বছরের) সর্বশেষ কখন পায়খানা করেছে? [When was the last time your youngest child / infant (3-5) defecated?] □□□

1. আজ [Today]
2. গতকাল [Yesterday]
3. ২ দিন বা তার আগে [2 or more days ago]
4. মনে করতে পারছি না [Cannot remember] ৩.১৬ নং প্রশ্নে চলে যান (Skip to 3.16)
5. বলতে রাজি নয় [Refused] ৩.১৬ নং প্রশ্নে চলে যান (Skip to 3.16)
888. প্রযোজ্য নয় [Not Applicable] ৩.১৬ নং প্রশ্নে চলে যান (Skip to 3.16)

3.13 আপনার (৩-৫ বছর) শিশু সর্বশেষ কোথায় পায়খানা করেছে? [Where did the child 3 –5 years defecate the last time?]..... □□□

8. পটি [Potty]
9. ন্যাপি/ডায়পার/কাঁথা [Nappy / diaper]
10. উঠানে (পটি ছাড়া) [In the courtyard (without potty)]
11. ঘরের ভিতরে (পটি ছাড়া) [Inside the house (without potty)]
12. পায়খানায়/টয়লেটে [In Toilet / Latrine] ৩.১৬ নং প্রশ্নে চলে যান (Skip to 3.16)
13. বোপ-বাড়ে/জঙ্গলে [Bush / forest / field] ৩.১৬ নং প্রশ্নে চলে যান (Skip to 3.16)
14. কোন নির্দিষ্ট জায়গায় নয় [No specific place]

777. অন্যান্য (বর্ণনা লিখুন) [Other (specify)] _____

888. প্রযোজ্য নয় [Not Applicable]

999. জানি না / নিশ্চিত নয় [Don't know / Not sure] খানার অন্য কেউ জানে কি না দেখুন [Probe to see if someone in the HH knows] ৩.১৬ নং প্রশ্নে চলে যান (Skip to 3.16)

3.14 সেই পায়খানা কি করা হয়েছিল? [What was done with the faeces?] ✎ উত্তর পড়ে শোনাবেন না Do Not Read Responses]..... □□□

1. যেখানে পায়খানা করেছিল সেখানেই ফেলে রাখা হয়েছিল [Left there]

৩.১৬ নং প্রশ্নে চলে যান (Skip to 3.16)

2. টয়লেট/পায়খানার ভিতরে ফেলা/ধোয়া হয়েছিল [Put / rinsed into toilet or latrine]

3. ড্রেনে/নর্দমার ভিতরে ফেলা/ধোয়া হয়েছিল [Put / rinsed into drain or ditch]

4. বোপ-বাড়ে/জঙ্গলে ফেলা হয়েছিল [Thrown into the bush / forest / field]

5. ময়লা আবর্জনার মধ্যে ফেলা হয়েছিল [Thrown into garbage]

6. নির্দিষ্ট গর্তে ফেলা হয়েছিল [Thrown into a specific pit for child's faeces]

7. মাটির নীচে পুতে ফেলা হয়েছিল [Buried]

777. অন্যান্য (বর্ণনা লিখুন) [Other (specify)] _____

999. জানি না / নিশ্চিত নয় [Don't know / Not sure] খানার অন্য কেউ জানে কি না দেখুন

[Probe to see if someone in the HH knows] ৩.১৬ নং প্রশ্নে চলে যান (Skip to 3.16)

3.15 সেই পায়খানা আপনি কিভাবে পরিষ্কার করেছিলেন? [How did you handle the faeces?] ✎ উত্তর পড়ে শোনাবেন না Do Not Read Responses]..... □□□

6. নগ্ন/খালি হাতে [Hands only/bare hands]

7. কাপড়/পাতা/কাগজ/খড়কুটা [Hands and cloth / paper / leaves / straw]

8. কোদাল/স্থানীয় কৃষিকাজ-এর হাতিয়ার [Local agricultural hoe/instrument]

9. সেনি স্কুপ [Sani-scoop]

10. কোন কিছুই করা হয় না [Did nothing]

777. অন্যান্য (বর্ণনা লিখুন) [Other (specify)] _____

999. জানি না / নিশ্চিত নয় [Don't know / not sure]

3.16 আপনার খানার ৫ বছরের বেশী শিশু(১৮ বছর পর্যন্ত) সর্বশেষ কোথায় পায়খানা করেছে? [Where did the child above 5 years (up to 18 years) defecate the last time?]..... □□□

8. পটি [Potty]

9. ন্যাপি/ডায়পার/কাঁথা Nappy / diaper

10. উঠানে (পটি ছাড়া) [In the courtyard (without potty)]

11. ঘরের ভিতরে (পটি ছাড়া) [Inside the house (without potty)]

12. পায়খানায়/টয়লেটে [In Toilet / Latrine]

13. বোপ-বাড়ে/জঙ্গলে [Bush / forest / field]

14. কোন নির্দিষ্ট জায়গায় নয় [No specific place]

777. অন্যান্য (বর্ণনা লিখুন) [Other (specify)] _____

888. প্রযোজ্য নয় [Not Applicable]

999. জানি না / নিশ্চিত নয় [Don't know / Not sure] খানার অন্য কেউ জানে কি না দেখুন

[Probe to see if someone in the HH knows]

PART B: SPOT CHECKS

আপনার খানার পানি, পয়ঃনিষ্কাশন এবং স্বাস্থ্যসম্মত ব্যবস্থার সাথে সম্পর্কিত বিষয়গুলো দেখার জন্য আমি কি আপনার ঘরের ভিতর এবং বাহিরের চারপাশ একটু ঘুরে দেখতে পারি? [May I take a look around your home to look at some of the items related to water, sanitation, and hygiene?]

Section 4: Sanitation

4.1 আপনার খানার সদস্যরা সাধারণত কোন ধরনের পায়খানা ব্যবহার করেন?.....□□□

Note: উত্তরদাতাকে পায়খানাটি দেখাতে অনুরোধ করুন এবং পায়খানাটি পর্যবেক্ষণ করার পর কোড করুন। যদি ফ্ল্যাশ অথবা পানি ঢেলে ফ্ল্যাশ করা পায়খানা থাকে তাহলে ফ্ল্যাশ করে ব্যর্জ কোথায় যায় তা প্রোব/চেক করুন

[What kind of toilet facility do members of your household usually use?]

(Note: Request the respondent to show the toilet facility and code after observing the facility. If “flush” or “pour flush” probe/check: Where does it flush to?)

ফ্লাশ-টয়লেট অথবা পানি ঢেলে ফ্লাস করা টয়লেট (স্ল্যাব এবং পানি ধারণকারী ওয়াটার সীল পর্যবেক্ষণ করুন)

[Flush or pour flush toilet flushed to] (Observe the slab and water seal containing water):

টয়লেটিতে পয়ঃনিষ্কাশন পাইপের সাথে সংযোগ করে দেয়া [Piped sewer system]01

টয়লেটিতে সেপটিক ট্যাংক বসানো আছে (ট্যাংকটি কংক্রীট দিয়ে ঢাকা আছে কিনা পর্যবেক্ষণ করুন)
[Septic tank] (Observe the concrete cover of the tank).....02

সেপটিক ট্যাংক নাই কিন্তু ফ্লাস করে বা পানি ঢেলে পায়খানা নীচে/দূরে পিটের মধ্যে সরিয়ে দেয়া যায়
[Flush to pit latrine (onsite/Off set) with slab and water seal] 03

অজানা জায়গায় /নির্দিষ্ট কোন জায়গায় নেই/ জানিনা [Unknown place/not sure/DK
where].....04

পিট-টয়লেট, স্ল্যাব আছে কিন্তু ওয়াটার সিল নেই তবে কমনোডে ঢাকনা দেয়ার ব্যবস্থা আছে [Pit
latrine with slab & no water seal but with a lid]..... 05

পিট-টয়লেট যাতে স্ল্যাব আছে, তবে ওয়াটার সিল নেই কিন্তু ফ্ল্যাপ আছে (উত্তরদাতাকে ফ্ল্যাপ সম্পর্কে জিজ্ঞাসা
করুন. এ ক্ষেত্রে পইপ এর শেষ মাথায় প্লস্টিক লাগানো থাকে যা মশা মাছি বাইরে আশা প্রতিরোধ করে)..... 06

[Pit latrine with slab and flap, no water seal] (*Ask the respondent about the flap, Flap: a plastic is attached at the end of the pipe to prevent flies from coming out of the pit.*)

বায়ু চলাচল উপযোগী উন্নত ল্যাট্রিন (স্ল্যাব এবং ভেন্টিলেশন পাইপ পর্যবেক্ষণ করুন) [Ventilated Improved
Pit (VIP) latrine] (Observe the slab and ventilation pipe)].....07

কমপোষ্টিং টয়লেট [Composting toilet, (*Composting toilet ensure separation of urine, water and excreta*)]..... 08

(শাক সবজির ময়লা, খড়, ঘাস, কাঠের গুড়া, ছাই পিটের মধ্যে মিশ্রিত হয়, সার হিসাবে এই ময়লা ব্যবহৃত হয়, ওয়াটার সিল নেই। একটি কমপোষ্টিং টয়লেটে প্রস্রাব আলাদাকরণ ডিভাইস থাকতে পারে বা নাও থাকতে পারে)
(vegetable wastes, straw, grass, sawdust, ash added in the pit, the waste used as manure, no water seal. A composting latrine may or may not have a urine separation device.)]

পিট/গর্ত পায়খানা স্পন্দন আছে তবে, ওয়াটার সিল নেই অথবা ওয়াটার সিল ভাঙ্গা এবং কোন ঢাকনাও নেই [Pit
latrine with slab & no water seal/broken water seal and no lid]. 09

ফ্লাশ-টয়লেট অথবা পানি ঢেলে ফ্লাস করা টয়লেট যা কোন খাল, ড্রেন, নদী ইত্যাদির সাথে সংযোজন করার ফলে অস্বাস্থ্যকর অবস্থার সৃষ্টি করে থাকে	10
[Flush or pour flush toilet connected to somewhere else (canal, ditch, river, etc.)]	
পিট/গর্ত পায়খানা, স্পন্ডাব নেই এবং যেখান থেকে মশা/মাছি যাওয়া আসা করতে পারে এবং দূর্গন্ধ ছড়ায়	11
[Pit latrine without slab/open pit]	
ঝুলন্ত পায়খানা [Hanging toilet/latrine]	12
বালতি [Bucket].....	13
খোলা পায়খানা/ টয়লেট (Open defecation):	
কোন পায়খানা নেই/জঙ্গলে/বোম্পে ঝাড়ে/ খোলা জায়গায় [No facility/bush/field]	14
অন্যান্য (নির্দিষ্ট করে লিখুন) [Others: Specify]	777

4.1.1 পায়খানার জিআইএস কোঅর্ডিনেট লিপিবদ্ধ করুন [GIS coordinates of the source fo drinking water].

Latitude

Longitude

Skip Note- যদি 4.1 নং প্রশ্নের উত্তর 14 হয়, তবে 4.14 নং প্রশ্নে যান। [If answer of 4.1 is 14, skip to 4.18]

4.2.1 আপনার জানা মতে সর্বশেষ এই পায়খানাটি কখন ব্যবহার করা হয়েছিল? [When was the most recent time this toilet was used?]□□ দিন আগে [days ago]

4.2.2 আপনি কি এই পায়খানাটি অন্য খানার সাথে মিলে ব্যবহার করেন? [Do you share this toilet facility with other households?]□□□

(Note: কোন ব্যক্তি বা গোষ্ঠি, যারা একই আবাস স্থানে বসবাস করেন বা একই উৎস থেকে খাবারে শরীক হয় না, তারা অন্য খানার অন্তর্গত হিসাবে বিবেচিত হবে।) (Note: Any person or group of persons related or unrelated who do not live in the same dwelling space and do not share a common source of food as the respondent would be considered to belong to other household.)

1= হ্যাঁ [yes]

0= না [No]

4.3.2 নং প্রশ্নে চলে যান [skip to 4.3.2]

999= জানিনা [DK]

4.3.2 নং প্রশ্নে চলে যান [skip to 4.3.2]

888= প্রযোজ্য নয় [Not applicable]

4.3.2 নং প্রশ্নে চলে যান [skip to 4.3.2]

4.3 কতগুলো খানা মিলে পায়খানাটি ব্যবহার করে ?□□

(প্রশ্ন করুন এবং পরিদর্শন করুন) [(Ask and check): how many households sharing the toilet facility?]

4.3.1 শিশুসহ আপনারা কতজন এই পায়খানাটি ব্যবহার করেন? [How many people including children use this toilet?].....□□

4.3.2 পায়খানাটির মালিকানা ? (প্রশ্ন করুন) [(Ask): Ownership type of the Toilet?].....□

শুধুমাত্র ঐ খানার [Only for the household]..... 1

কয়েকটি খানা মিলে/ অংশীদার [Shared].....2

অন্য কেউ [Someone else].....3

পাবলিক [Public].....4

পায়খানা ব্যবস্থার বিশদ পর্যবেক্ষণ [Detail observation of the toilet facility]

4.4 পায়খানায় যাবার রাস্তা দেখে বুঝা যাচ্ছে কি যে এটা নিয়মিত ব্যবহার করা হয় (পরিষ্কার, জীর্ণ ইত্যাদি) Path to the toilet suggests regular use (is clear, well-worn, without grass or any barriers etc.).....□□□

(1= হ্যাঁ [Yes], 0= না [No], 999= জানিনা [DK], 888= প্রযোজ্য নয় [Not applicable])

4.5 টয়লেটের বাইরের অবস্থা পর্যবেক্ষণ [Observe the general exterior of the toilet]

(1= হ্যাঁ [Yes], 0= না [No], 999= জানিনা [DK], 888= প্রযোজ্য নয় [Not applicable])

1 পায়খানাটির উপর কোন স্থাপনা আছে কি? [Is there any superstructure on the toilet?]..... □□□

2 কোন দরজা / পর্দা আছে কি? [Is there a door/curtain?].....□□□

3 বাইরে থেকে দেখা যাওয়া ছাড়া গড় প্রাপ্ত বয়স্ক কোন ব্যক্তি এই টয়লেটে ব্যবহার করতে পারবে কি? [Can an average sized adult use the toilet without being seen?].....□□□

4 টয়লেটের উপর ছাদ আছে কি? [Is there roof over the toilet?].....□□□

5 ছাদে এমন কোন ছিদ্র আছে কি যার মাধ্যমে ছাদ দিয়ে পানি পড়তে পারে? [Is there any hole in the roof that may allow water to enter through the roof?].....□□□

6 বায়ু চলাচল উপযোগী কোন পাইপ আছে কি? [Is there a ventilation pipe?].....□□□

Skip Note-: যদি 10.5f নং প্রশ্নের উত্তর 0 হয়, তবে 10.5h নং প্রশ্নে যান। [If answer of 10.5f is 0, skip to 10.5h]

7 পাইপ এর মাথায় কোন কভার আছে কি যা মশা মাছি বের হওয়া প্রতিরোধ করতে পারে? [Is there a cover on top of the ventilation pipe that protects the flies from coming out?].....□□□

h) পায়খানার দেয়ালগুলো মূলত কি দিয়ে তৈরী? [What are the walls of the toilet mostly made of?]□□□

8. কংক্রিট [Concrete]
9. টিন [Tin]
10. বাঁশ/মাটি [Bamboo/Mud]
11. প্লাস্টিক [Plastic]
12. গাছের পাতা [Tree leaves]
13. পাটের থলে [Jute bag]
14. খড় [Straw]

8. কাঠ [Wood]

888= প্রযোজ্য নয় [Not applicable])

i) পায়খানার ছাদ মূলত কি দিয়ে তৈরী? [What is the roof of the toilet mostly made of?]..□□□

8. কংক্রিট [Concrete]
9. টিন [Tin]
10. বাঁশ [Bamboo]
11. প্লাস্টিক [Plastic]
12. গাছের পাতা [Tree leaves]
13. পাটের থলে [Jute bag]
14. খড় [Straw]

888= প্রযোজ্য নয় [Not applicable])

4.6 টয়লেট থেকে ময়লা কোথায় যায়? (জিজ্ঞাসা করুন এবং সম্ভব হলে পর্যবেক্ষণ করুন) [[Where does the waste from toilet go? (Ask and observe if possible)] □□

11. ময়লা ভূগর্ভস্থ নালায় পড়ছে (জিজ্ঞাসা করুন) [Waste drains to underground piped sewer (Ask)]
(4..8.1 নং প্রশ্নে চলে যান [Skip to Q4.8.1](#))
 12. ময়লা নীচে পিটের মধ্যে পড়ছে এবং সেখানেই থাকছে (উত্তরদাতা পিট তৈরীতে কংক্রিটের রিং সম্পর্কে উল্লেখ করবে। পিটের উপরিভাগ এবং ছিদ্র আছে কি না পর্যবেক্ষণ করুন) [Waste goes into onsite pit and stays there (Respondent will report using concrete rings to make the pit. Observe the top of the pit and any leakage)]
 13. ময়লা দূরে পিটের মধ্যে পড়ছে এবং সেখানেই থাকছে (উত্তরদাতা পিট তৈরীতে কংক্রিটের রিং সম্পর্কে উল্লেখ করবে। পিটের উপরিভাগ এবং ছিদ্র আছে কি না পর্যবেক্ষণ করুন) [Waste goes into offset pit and stays there (Respondent will report using concrete rings to make the pit. Observe the top of the pit and any leakage)]
 14. ময়লা নীচে ট্যাংকির মধ্যে পড়ছে এবং সেখানেই থাকছে (ট্যাংকির উপরের কংক্রিটের ঢাকনা এবং ছিদ্র আছে কি না পর্যবেক্ষণ করুন) [Waste goes into onsite tank and stays there (Observe the concrete cover of the tank and any leakage. Respondent will report building the tank with concrete lining rather than buying the ring for pit lining)]
 15. ময়লা দূরে ট্যাংকির মধ্যে পড়ছে এবং সেখানেই থাকছে (ট্যাংকির উপরের কংক্রিটের ঢাকনা এবং ছিদ্র আছে কি না পর্যবেক্ষণ করুন) [Waste goes into offset tank and stays there (Observe the concrete cover of the tank and any leakage. Respondent will report building the tank with concrete lining rather than buying the ring for pit lining)]
 16. কমপোষ্ট পিট (শাক সবজির ময়লা, খড়, ঘাস, কাঠের গুড়া, ছাই পিটের মধ্যে মিশ্রিত হয়, সার হিসাবে এই ময়লা ব্যবহৃত হয়, ওয়াটার সিল নেই, এটি এনজিও/সরকার সহায়তায় স্থাপিত) [Compost pit (vegetable wastes, straw, grass, sawdust, ash added in the pit, the waste used as manure, no water seal, Built in assistance with the NGOs/government)]
 17. পাইপ বা ঢাকনিযুক্ত নালা দিয়ে ময়লা খোলা জায়গায় (লেক/নদী/পানিতে) পড়ছে (সম্ভব হলে পর্যবেক্ষণ করুন) [Waste drains to open (lake/river/water) via pipe/covered drain (Observe if possible)] (4..8.1 নং প্রশ্নে চলে যান [Skip to Q4.8.1](#))
 18. ঢাকনি ছাড়া নালা দিয়ে ময়লা খোলা জায়গায় (লেক/নদী/পানিতে) পড়ছে (পর্যবেক্ষণ করুন) [Waste drains to lake/river/water via open drain (Observe)] (4..8.1 নং প্রশ্নে চলে যান [Skip to Q4.8.1](#))
 19. বালতিতে পড়ছে [Bucket] (4..8.1 নং প্রশ্নে চলে যান [Skip to Q4.8.1](#))
 20. ময়লা সরাসরি জলাশয়ে বা নিচু জমিতে পড়ছে (ঝুলন্ত) [Waste directly fall into water body or low land (Hanging)] (4..8.1 নং প্রশ্নে চলে যান [Skip to Q4.8.1](#))
777. অন্যান্য (নির্দিষ্ট করে লিখুন) [Other (specify)] _____
888. প্রযোজ্য নয় [Not applicable]
31. ময়লা দূরে পিটের মধ্যে পড়ছে (রিং নাই, স্লাব আছে) [Waste goes into offset pit (Using no rings but slab)]
 32. ময়লা দূরে পিটের মধ্যে পড়ছে (রিং নাই, স্লাব নাই) [Waste goes into offset pit (Using no rings or slab)]
 33. ময়লা দূরে পিটের মধ্যে পড়ছে (রিং আছে, স্লাব নাই) [Waste goes into offset pit (Using rings but no slab)]

4.7 পিটের/ ট্যাংকির বাইরে বা ভিতরের চতুর্দিকে পর্যবেক্ষণ করুন [Observe the onsite or off site pit/tank in all direction]

(1= হ্যাঁ [yes], 0= না [No], 999= জানিনা [DK], 888= প্রযোজ্য নয় [Not applicable])

1. পিটের উপরিভাগ মাটি থেকে উপরে দেখা যাচ্ছে কি? [Is the top of the pit visible (above the ground)]?.....□□□
2. সংযোগ নলের ছিদ্রের/ভাংগার কারণে পাইপের ভিতরে বা বাইরে ময়লা দেখা যাচ্ছে কি? [Waste/faeces visible in or around the pipe, because of Leakage in the connecting pipe?]□□□
3. পিট/ট্যাংকির ছিদ্রের কারণে ভিতরে বা বাইরে ময়লা দেখা যাচ্ছে [Waste/faeces visible because of leakage in the pit/tank?] □□□

Skip Note: 4.7c নং প্রশ্নের উত্তর 1 হলে 8.৮ নং প্রশ্নে চলে যান।

[If the answer to question 4.7c is 1 go to question 4.8]

4. ময়লা দেখা যাচ্ছে না কিন্তু পিট/ট্যাংকি ভাংগা যা দিয়ে মশা মাছি আশা যাওয়া করতে পারবে [No visible waste but broken pit/tank that may allow flies coming out of the toilet?]□□□

Skip Note: 4.7d নং প্রশ্নের উত্তর 1 হলে 8.৮ নং প্রশ্নে চলে যান।

[If the answer to question 4.7d is 1 go to question 4.8]

5. ময়লা দেখা যাচ্ছে না কিন্তু পিট/ট্যাংকিতে ফাটল/ ভাংগন দেখা যাচ্ছে যা দিয়ে মশা মাছি আশা যাওয়া করতে পারবে না [No visible waste but crack in the pit/tank?].....□□□

পায়খানার অভ্যন্তরীণ অবস্থা পর্যবেক্ষণ [Observe the interior of the toilet]

- 4.8.1 পায়খানা/টয়লেটে পায়খানার গন্ধ রয়েছে কি? [Odor of feces in the latrine/bathroom?]□
(1= হ্যাঁ [Yes], 0= না [No], প্রযোজ্য নয় [not applicable] =888)

- 4.8.2 মাছির উপস্থিতি রয়েছে কি? [Flies present?] □
(1= হ্যাঁ [Yes], 0= না [No], প্রযোজ্য নয় [not applicable] =888)

- 4.8.3 পায়খানাতে স্ল্যাব/ প্লাটফর্ম আছে কি? [Is there a slab/platform in the toilet?]..... □
(Note: স্কোয়াটিং স্ল্যাব/ প্লাটফর্ম পিটকে চতুর্দিক থেকে ঢেকে রাখে, যার একটি নির্গমন ছিদ্র আছে এবং যা পিটের ভিতরে যে কোন ভূ-পৃষ্ঠের পানি প্রবেশ প্রতিরোধে ভূস্তরের উপরে অবস্থিত থাকে।) (Note: Squatting slab or platform that is covering the pit on all sides, has a squatting hole and rose above the surrounding ground level to prevent any surface water entering the pit)

হ্যাঁ [Yes] =1

না [No]=0

4.8.6 নং প্রশ্নে চলে যান (Skip to 4.8.6)

প্রযোজ্য নয় [Not applicable]=888 4.8.6 নং প্রশ্নে চলে যান (Skip to 4.8.6)

- 4.8.4 মেবোর প্রধান উপাদান [Main material of the floor (select 1)]..... □□□

[1] মাটি Mud

[2] কাঠ Wood

[3] সিমেন্ট Cement

[4] টাইলস/ইট Tile / brick

[5] প্লাস্টিক Plastic

[888] প্রযোজ্য নয়/পর্যবেক্ষণ সম্ভব হয় নি N/A / could not observe / cannot tell

- 4.8.5 স্ল্যাব অথবা মেবোতে পায়খানা দেখতে পাওয়া গেছে ? [Is Stool visible on the slab or floor?].....□□□
(1= হ্যাঁ [Yes], 0= না [No], প্রযোজ্য নয় [not applicable] =888)

- 4.8.6 পায়খানার দেয়ালে কোন পায়খানা দেখতে পাওয়া গেছে কি? [Is Stool visible on the walls?]..... □
(1= হ্যাঁ [Yes], 0= না [No], প্রযোজ্য নয় [not applicable] =888)

- 4.8.7 পায়খানার দরজায় কোন পায়খানা দেখতে পাওয়া গেছে কি? [Is Stool visible on the door/curtain?].....□
(1= হ্যাঁ [Yes], 0= না [No], প্রযোজ্য নয় [not applicable] =888)

Skip note: If 4.8.3= 0/888 skip to 4.10

- 4.8.8 টয়লেটে কোন কমোড আছে কি? [Is there any commode in the toilet?].....□□□

1= হ্যাঁ [Yes],

0= না [No],

4.9 নং প্রশ্নে চলে যান (Skip to 4.9)

প্রযোজ্য নয় [not applicable] =888]

4.9 নং প্রশ্নে চলে যান (Skip to 4.9)

4.8.9 কমোড টি কি ভাঙ্গা? Is the commode broken?□□□

(1= হ্যাঁ [Yes], 0= না [No], প্রযোজ্য নয় [not applicable] =888)]

4.8.10 কমোডে কোন পায়খানা দেখতে পাওয়া গেছে কি [Is there faeces visible in the commode?].....□□□

(1= হ্যাঁ [Yes], 0= না [No], প্রযোজ্য নয় [not applicable] =888)]

4.9 নির্গমন ছিদ্রটিতে কোন ঢাকনা আছে কি? [Is there a lid covering the squatting hole/drop hole?]

.....□□□

হ্যাঁ [Yes] =1

না [No]=0

4.10 নং প্রশ্নে চলে যান (Skip to 4.10)

প্রযোজ্য নয় [Not applicable]=888

4.10 নং প্রশ্নে চলে যান (Skip to 4.10)

4.9.1 পর্যবেক্ষণের সময় নির্গমন ছিদ্রটি সম্পূর্ণভাবে ঢাকা ছিল কি? [Is there a lid fully covering the squatting hole at the time of observation?] □□□

হ্যাঁ [Yes] =1

না [No]=0

প্রযোজ্য নয় [Not applicable]=888

4.10 পায়খানাটি কি মল দ্বারা ভরে গেছে? (Note: পায়খানাটি মল দ্বারা পূর্ণ হিসাবে গণ্য হবে যদি কমোড মল দ্বারা পূর্ণ থাকে। এক্ষেত্রে, ওয়াটার সীল যুক্ত পায়খানা বা বাইরের পিট/ট্যাংক সহ পায়খানার জন্য, যদি সন্দেহ থাকে মল নির্গমন দেখার জন্য পানি ফ্ল্যাশ করুন। (Is the toilet full? (Note: Toilet is considered full if faeces have reached over the exit of the squatting hole. In case of toilets with water seal or offset pit/tank, if there is confusion flush water to see if the faeces flushes away.)□□□

হ্যাঁ [Yes] =1

না [No]=0

জানিনা [DK]=999,

প্রযোজ্য নয় [Not applicable]=888

Skip note: If 4.8.3= 0/888 skip to 4.13

4.11 পায়খানার কমোড এর ছিদ্রটি পর্যবেক্ষণ করুন [Observe through the hole in the toilet]..... □□□

6. পাইপে পানি আছে (ওয়াটার সীলে পানি আছে কি না তা দেখার জন্য অল্প পানি ঢালুন) [Water in pipe (Water seal, pour some water in the hole to check if there is water in the water seal)]

7. শুধু পাইপ দেখা যাচ্ছে কোন ওয়াটার সীল নেই [Only pipe visible (no water seal)]

8. পাইপ ভাঙ্গা (ওয়াটার সীল ভাঙ্গা) [Broken pipe (Water seal broken)]

9. পাইপ নেই, খোলা গর্ত দিয়ে সরাসরি মল দেখা যাচ্ছে (পিটের গর্ত খোলা), তবে পিটটি এখনও সম্পূর্ণ ভরে যায়নি [No pipe, open hole to the pit, can see faeces in the pit, but the pit is not full yet]

10. কমোড এর ছিদ্রটি মল দিয়ে ভরে গেছে (faeces have reached the exit of the squatting hole) 888 প্রযোজ্য নয় [Not applicable]

4.12 যদি 4.11 নং প্রশ্নের উত্তর 2 বা 3 হয়, তবে ময়লা নির্গমন প্রতিরোধে পাইপের শেষে কোন ফ্ল্যাপ আছে কি? (উত্তরদাতাকে জিজ্ঞাসা করুন) [If answer to 12 is 2 or 3, is there any flap at the end of the pipe to prevent files from coming out?] (Ask the respondent).....□□□

হ্যাঁ [Yes] =1

না [No]=0

জানিনা [DK]=999

প্রযোজ্য নয় [Not applicable]=888

4.13 পর্যবেক্ষন: সৌচ কার্য সম্পন্ন করার ও হাত ধোয়ার জন্য পায়খানার ভিতরে বা সন্নিহিত কি কি উপাদান উপস্থিত আছে/রয়েছে? [Observation: What materials for anal cleansing and hand wash are present inside or immediately outside the latrine?]

হ্যাঁ [Yes]1
না [No].....0
প্রযোজ্য নয়/পর্যবেক্ষন করা সম্ভব হয় নাই [Not Applicable/ Could not observe].....888

11. পাতা/ঘাস [Leaves/grass].....□□□
12. কাঠি Twigs / sticks].....□□□
13. কাপড় [Rag or cloth].....□□□
14. পাথর [Stones].....□□□
15. টয়লেট পেপার [Hygienic (toilet) paper].....□□□
16. পানির পাত্র/বদনা/মগ [Water container / vessel].....□□□
17. পানির ট্যাপ [Water tap].....□□□
18. সাবান [Soap].....□□□
19. ছাই অথবা মাটি [Ash or soil for cleansing].....□□□
20. খবরের কাগজ [Newspaper].....□□□
11. কিছুই নাই [Nothing].....□□□

4.a আরো পায়খানার তথ্য সংগ্রহ করতে চান কি? Do you want to add more toilet?.....□□□

1= হ্যাঁ [yes] 4.1 নং প্রশ্নে চলে যান [skip to 4.1]
0= না [No]

4.1a আপনার খানার সদস্যরা সাধারণত কোন ধরনের পায়খানা ব্যবহার করেন ?.....□□□

Note: উত্তরদাতাকে পায়খানাটি দেখাতে অনুরোধ করুন এবং পায়খানাটি পর্যবেক্ষন করার পর কোড করুন। যদি ফ্ল্যাশ অথবা পানি ঢেলে ফ্ল্যাশ করা পায়খানা থাকে তাহলে ফ্ল্যাশ করে ব্যর্জ কোথায় যায় তা প্রোব/চেক করুন

[What kind of toilet facility do members of your household usually use?]

(Note: Request the respondent to show the toilet facility and code after observing the facility. If “flush” or “pour flush” probe/check: Where does it flush to?)

ফ্ল্যাশ-টয়লেট অথবা পানি ঢেলে ফ্লাস করা টয়লেট (স্ল্যাব এবং পানি ধারণকারী ওয়াটার সীল পর্যবেক্ষন করুন)

[Flush or pour flush toilet flushed to] (Observe the slab and water seal containing water):

টয়লেটটিতে পয়ঃনিষ্কাশন পাইপের সাথে সংযোগ করে দেয়া [Piped sewer system]..... 01

টয়লেটটিতে সেপটিক ট্যাংক বসানো আছে (ট্যাংকটি কংক্রীট দিয়ে ঢাকা আছে কিনা পর্যবেক্ষন করুন)
[Septic tank] (Observe the concrete cover of the tank). 02

সেপটিক ট্যাংক নাই কিন্তু ফ্লাস করে বা পানি ঢেলে পায়খানা নীচে/দূরে পিটের মধ্যে সরিয়ে দেয়া যায়
[Flush to pit latrine (onsite/Off set) with slab and water seal]..... 03

অজানা জায়গায় /নির্দিষ্ট কোন জায়গায় নেই/ জানিনা [Unknown place/not sure/DK where]
.....04

পিট-টয়লেট, স্ল্যাব আছে কিন্তু ওয়াটার সিল নেই তবে কনক্রিট ঢাকনা দেয়ার ব্যবস্থা আছে)..... 05

[Pit latrine with slab & no water seal but with a lid]

পিট-টয়লেট যাতে স্লাব আছে, তবে ওয়াটার সিল নেই কিন্তু ফ্ল্যাপ আছে (উত্তরদাতাকে ফ্ল্যাপ সম্পর্কে জিজ্ঞাসা করুন. এ ক্ষেত্রে পইপ এর শেষ মাথায় প্লাস্টিক লাগানো থাকে যা মশা মাছি বাইওে আশা প্রতিরোধ করে)..... 06

[Pit latrine with slab and flap, no water seal] (*Ask the respondent about the flap, Flap: a plastic is attached at the end of the pipe to prevent flies from coming out of the pit.*)

বায়ু চলাচল উপযোগী উন্নত ল্যাট্রিন (স্লাব এবং ভেন্টিলেশন পাইপ পর্যবেক্ষন করুন) [Ventilated Improved Pit (VIP) latrine] (Observe the slab and ventilation pipe)]..... 07

কমপোষ্টিং টয়লেট [Composting toilet, (*Composting toilet ensure separation of urine, water and excreta*)]..... 08

(শাক সবজির ময়লা, খড়, ঘাস, কাঠের গুড়া, ছাই পিটের মধ্যে মিশ্রিত হয়, সার হিসাবে এই ময়লা ব্যবহৃত হয়, ওয়াটার সিল নেই। একটি কমপোষ্টিং টয়লেটে প্রস্রাব আলাদাকরণ ডিভাইস থাকতে পারে বা নাও থাকতে পারে) (Vegetable wastes, straw, grass, sawdust, ash added in the pit, the waste used as manure, no water seal. A composting latrine may or may not have a urine separation device.)]

পিট/গর্ত পায়খানা স্পন্ডাব আছে তবে, ওয়াটার সিল নেই অথবা ওয়াটার সিল ভাঙ্গা এবং কোন ঢাকনাও নেই. ... 09

[Pit latrine with slab & no water seal/broken water seal and no lid]

ফ্লাশ-টয়লেট অথবা পানি ঢেলে ফ্লাস করা টয়লেট যা কোন খাল, ড্রেন, নদী ইত্যাদির সাথে সংযোজন

করার ফলে অস্বাস্থ্যকর অবস্থার সৃষ্টি করে থাকে 10

[Flush or pour flush toilet connected to somewhere else (canal, ditch, river, etc.)]

পিট/গর্ত পায়খানা, স্পন্ডাব নেই এবং যেখান থেকে মশা/মাছি যাওয়া আসা করতে পারে এবং দূর্গন্ধ ছড়ায়..... 11

[Pit latrine without slab/open pit]

ঝুলন্ত পায়খানা [Hanging toilet/latrine] 12

বালতি [Bucket].....13

খোলা পায়খানা/ টয়লেট (Open defecation):

কোন পায়খানা নেই/জঙ্গলে/বোম্পে বাড়ে/ খোলা জায়গায় [No facility/bush/field] 14

অন্যান্য (নির্দিষ্ট করে লিখুন) [Others: Specify] 777

Skip Note-: যদি 4.1 নং প্রশ্নের উত্তর 14 হয়, তবে 4.14 নং প্রশ্নে যান। [If answer of 4.1 is 14, skip to 4.18]

4.2.1a আপনার জানা মতে সর্বশেষ এই পায়খানাটি কখন ব্যবহার করা হয়েছিল? [When was the most recent time this toilet was used?].....□□ দিন আগে [days ago]

4.2.2a আপনি কি এই পায়খানাটি অন্য খানার সাথে মিলে ব্যবহার করেন? [Do you share this toilet facility with other households?] □□□

(Note: কোন ব্যক্তি বা গোষ্ঠী, যারা একই আবাস স্থানে বসবাস করেন বা একই উৎস থেকে খাবারে শরীক হয় না, তারা অন্য খানার অন্তর্গত হিসাবে বিবেচিত হবে।) (Note: Any person or group of persons related or unrelated who do not live in the same dwelling space and do not share a common source of food as the respondent would be considered to belong to other household.)

1= হ্যাঁ [yes]

0= না [No]

999= জানিনা [DK]

4.3.2 নং প্রশ্নে চলে যান [skip to 4.3.2]

4.3.2 নং প্রশ্নে চলে যান [skip to 4.3.2]

888= প্রযোজ্য নয় [Not applicable] 4.3.2 নং প্রশ্নে চলে যান [skip to 4.3.2]

4.3a কতগুলো খানা মিলে পায়খানাটি ব্যবহার করে ?□□

(প্রশ্ন করুন এবং পরিদর্শন করুন) [(Ask and check): how many households sharing the toilet facility?]

4.3.1a শিশুসহ আপনারা কতজন এই পায়খানাটি ব্যবহার করেন? [How many people including children use this toilet?].....□□

4.3.2a পায়খানাটির মালিকানা ? (প্রশ্ন করুন) [(Ask): Ownership type of the Toilet?].....□

শুধুমাত্র ঐ খানার [Only for the household]. 1

কয়েকটি খানা মিলে/ অংশীদার [Shared].....2

অন্য কেউ [Someone else].....3

পাবলিক [Public].....4

পায়খানা ব্যবস্থার বিশদ পর্যবেক্ষণ [Detail observation of the toilet facility]

4.4a পায়খানায় যাবার রাস্তা দেখে বুঝা যাচ্ছে কি যে এটা নিয়মিত ব্যবহার করা হয় (পরিষ্কার, জীর্ণ ইত্যাদি) Path to the toilet suggests regular use (is clear, well-worn, without grass or any barriers etc.).....□□□

(1= হ্যাঁ [Yes], 0= না [No], 999= জানিনা [DK], 888= প্রযোজ্য নয় [Not applicable])

4.5a টয়লেটের বাইরের অবস্থা পর্যবেক্ষণ [Observe the general exterior of the toilet]

(1= হ্যাঁ [Yes], 0= না [No], 999= জানিনা [DK], 888= প্রযোজ্য নয় [Not applicable])

1 পায়খানাটির উপর কোন স্থাপনা আছে কি? [Is there any superstructure on the toilet?].....□□□

2 কোন দরজা / পর্দা আছে কি? [Is there a door/curtain?]..... □□□

3 বাইরে থেকে দেখা যাওয়া ছাড়া গড় প্রাপ্ত বয়স্ক কোন ব্যক্তি এই টয়লেটে ব্যবহার করতে পারবে কি? [Can an average sized adult use the toilet without being seen?]..... □□□

4 টয়লেটের উপর ছাদ আছে কি? [Is there roof over the toilet?]..... □□□

5 ছাদে এমন কোন ছিদ্র আছে কি যার মাধ্যমে ছাদ দিয়ে পানি পড়তে পারে? [Is there any hole in the roof that may allow water to enter through the roof?].....□□□

6 বায়ু চলাচল উপযোগী কোন পাইপ আছে কি? [Is there a ventilation pipe?]..... □□□

Skip Note:- যদি 10.5f নং প্রশ্নের উত্তর 0 হয়, তবে 10.5h নং প্রশ্নে যান [If answer of 10.5f is 0, skip to 10.5h]

7 পাইপ এর মাথায় কোন কভার আছে কি যা মশা মাছি বের হওয়া প্রতিরোধ করতে পারে ? [Is there a cover on top of the ventilation pipe that protects the flies from coming out?].....□□□

h) পায়খানার দেয়ালগুলো মূলত কি দিয়ে তৈরী? [What are the walls of the toilet mostly made of?] □□□

1. কংক্রিট [Concrete]
2. টিন [Tin]
3. বাঁশ/মাটি [Bamboo/Mud]
4. প্লাস্টিক [Plastic]
5. গাছের পাতা [Tree leaves]
6. পাটের থলে [Jute bag]
7. খড় [Straw]
8. কাঠ [Wood]

888= প্রযোজ্য নয় [Not applicable]

i) পায়খানার ছাদ মূলত কি দিয়ে তৈরী? [What is the roof of the toilet mostly made of?]

1. কংক্রিট [Concrete]
2. টিন [Tin]
3. বাঁশ [Bamboo]
4. প্লাস্টিক [Plastic]
5. গাছের পাতা [Tree leaves]
6. পাটের খলে [Jute bag]
7. খড় [Straw]

888= প্রযোজ্য নয় [Not applicable]

4.6a টয়লেট থেকে ময়লা কোথায় যায়? (জিজ্ঞাসা করুন এবং সম্ভব হলে পর্যবেক্ষণ করুন) [[Where does the waste from toilet go? (Ask and observe if possible)]

1. ময়লা ভূগর্ভস্থ নালায় পড়ছে (জিজ্ঞাসা করুন) [Waste drains to underground piped sewer (Ask)] (4..8.1 নং প্রশ্নে চলে যান Skip to Q4.8.1)
 2. ময়লা নীচে পিটের মধ্যে পড়ছে এবং সেখানেই থাকছে (উত্তরদাতা পিট তৈরীতে কংক্রিটের রিং সম্পর্কে উল্লেখ করবে। পিটের উপরিভাগ এবং ছিদ্র আছে কি না পর্যবেক্ষণ করুন) [Waste goes into onsite pit and stays there (Respondent will report using concrete rings to make the pit. Observe the top of the pit and any leakage)]
 3. ময়লা দূরে পিটের মধ্যে পড়ছে এবং সেখানেই থাকছে (উত্তরদাতা পিট তৈরীতে কংক্রিটের রিং সম্পর্কে উল্লেখ করবে। পিটের উপরিভাগ এবং ছিদ্র আছে কি না পর্যবেক্ষণ করুন) [Waste goes into offset pit and stays there (Respondent will report using concrete rings to make the pit. Observe the top of the pit and any leakage)]
 4. ময়লা নীচে ট্যাংকির মধ্যে পড়ছে এবং সেখানেই থাকছে (ট্যাংকির উপরের কংক্রিটের ঢাকনা এবং ছিদ্র আছে কি না পর্যবেক্ষণ করুন)। [Waste goes into onsite tank and stays there (Observe the concrete cover of the tank and any leakage. Respondent will report building the tank with concrete lining rather than buying the ring for pit lining)]
 5. ময়লা দূরে ট্যাংকির মধ্যে পড়ছে এবং সেখানেই থাকছে (ট্যাংকির উপরের কংক্রিটের ঢাকনা এবং ছিদ্র আছে কি না পর্যবেক্ষণ করুন)। [Waste goes into offset tank and stays there (Observe the concrete cover of the tank and any leakage. Respondent will report building the tank with concrete lining rather than buying the ring for pit lining)]
 6. কমপোষ্ট পিট (শাক সবজির ময়লা, খড়, ঘাস, কাঠের গুড়া, ছাই পিটের মধ্যে মিশ্রিত হয়, সার হিসাবে এই ময়লা ব্যবহৃত হয়, ওয়াটার সিল নেই, এটি এনজিও/সরকার সহায়তায় স্থাপিত) [Compost pit (vegetable wastes, straw, grass, sawdust, ash added in the pit, the waste used as manure, no water seal, Built in assistance with the NGOs/government)]
 7. পাইপ বা ঢাকনিযুক্ত নালা দিয়ে ময়লা খোলা জায়গায় (লেক/নদী/পানিতে) পড়ছে (সম্ভব হলে পর্যবেক্ষণ করুন) [Waste drains to open (lake/river/water) via pipe/covered drain (Observe if possible)] (4..8.1 নং প্রশ্নে চলে যান Skip to Q4.8.1)
 8. ঢাকনি ছাড়া নালা দিয়ে ময়লা খোলা জায়গায় (লেক/নদী/পানিতে) পড়ছে (পর্যবেক্ষণ করুন) [Waste drains to lake/river/water via open drain (Observe)] (4..8.1 নং প্রশ্নে চলে যান Skip to Q4.8.1)
 9. বালতিতে পড়ছে [Bucket] (4..8.1 নং প্রশ্নে চলে যান Skip to Q4.8.1)
 10. ময়লা সরাসরি জলাশয়ে বা নিচু জমিতে পড়ছে (ঝুলন্ত) [Waste directly fall into water body or low land (Hanging)] (4..8.1 নং প্রশ্নে চলে যান Skip to Q4.8.1)
777. অন্যান্য (নির্দিষ্ট করে লিখুন) [Other (specify)] _____

888. প্রযোজ্য নয় [Not applicable]

31. ময়লা দূরে পিটের মধ্যে পড়ছে (রিং নাই, স্লাব আছে) [Waste goes into offset pit (Using no rings but slab)]

32. ময়লা দূরে পিটের মধ্যে পড়ছে (রিং নাই, স্লাব নাই) [Waste goes into offset pit (Using no rings or slab)]

33. ময়লা দূরে পিটের মধ্যে পড়ছে (রিং আছে, স্লাব নাই) [Waste goes into offset pit (Using rings but no slab)]

4.7a পিটের/ ট্যাংকির বাইরে বা ভিতরের চতুর্দিকে পর্যবেক্ষণ করুন [Observe the onsite or off site pit/tank in all direction]

(1= হ্যাঁ [yes], 0= না [No], 999= জানিনা [DK], 888= প্রযোজ্য নয় [Not applicable])

1. পিটের উপরিভাগ মাটি থেকে উপরে দেখা যাচ্ছে কি? [Is the top of the pit visible (above the ground)]?.....□□□

2. সংযোগ নলের ছিদ্রের/ভাংগার কারণে পাইপের ভিতরে বা বাইরে ময়লা দেখা যাচ্ছে কি? [Waste/faeces visible in or around the pipe, because of Leakage in the connecting pipe?] □□□

3. পিট/ট্যাংকির ছিদ্রের কারণে ভিতরে বা বাইরে ময়লা দেখা যাচ্ছে [Waste/faeces visible because of leakage in the pit/tank?]?.....□□□

Skip Note: 4.7c নং প্রশ্নের উত্তর 1 হলে 8.৮ নং প্রশ্নে চলে যান। [If the answer to question 4.7c is 1 go to question 4.8]

4. ময়লা দেখা যাচ্ছে না কিন্তু পিট/ট্যাংকি ভাংগা যা দিয়ে মশা মাছি আশা যাওয়া করতে পারবে [No visible waste but broken pit/tank that may allow flies coming out of the toilet?]
.....□□□

Skip Note: 4.7d নং প্রশ্নের উত্তর 1 হলে 8.৮ নং প্রশ্নে চলে যান।

[If the answer to question 4.7d is 1 go to question 4.8]

5. ময়লা দেখা যাচ্ছে না কিন্তু পিট/ট্যাংকিতে ফাটল/ ভাংগন দেখা যাচ্ছে যা দিয়ে মশা মাছি আশা যাওয়া করতে পারবে না [No visible waste but crack in the pit/tank?]?.....□□□

পায়খানার অভ্যন্তরীণ অবস্থা পর্যবেক্ষণ [Observe the interior of the toilet]

4.8.1a পায়খানা/টয়লেটে পায়খানার গন্ধ রয়েছে কি? [Odor of feces in the latrine/bathroom?]?.....□
(1= হ্যাঁ [Yes], 0= না [No], প্রযোজ্য নয় [not applicable] =888)

4.8.2a মাছির উপস্থিতি রয়েছে কি? [Flies present?] □
(1= হ্যাঁ [Yes], 0= না [No], প্রযোজ্য নয় [not applicable] =888)

4.8.3a পায়খানাতে স্ল্যাব/ প্লাটফর্ম আছে কি? [Is there a slab/platform in the toilet?]?..... □
(Note: স্কোয়াটিং স্ল্যাব/ প্লাটফর্ম পিটকে চতুর্দিক থেকে ঢেকে রাখে, যার একটি নির্গমন ছিদ্র আছে এবং যা পিটের ভিতরে যে কোন ভূ-পৃষ্ঠের পানি প্রবেশ প্রতিরোধে ভূস্তরের উপরে অবস্থিত থাকে।) (Note: Squatting slab or platform that is covering the pit on all sides, has a squatting hole and rose above the surrounding ground level to prevent any surface water entering the pit)

হ্যাঁ [Yes] =1

না [No]=0

প্রযোজ্য নয় [Not applicable]=888

4.8.6 নং প্রশ্নে চলে যান (Skip to 4.8.6)

4.8.6 নং প্রশ্নে চলে যান (Skip to 4.8.6)

4.8.4a মেঝের প্রধান উপাদান [Main material of the floor (select 1)]?..... □□□

[1] মাটি Mud

[2] কাঠ Wood

[3] সিমেন্ট Cement

[4] টাইলস/ইট Tile / brick

[5] প্লাস্টিক Plastic

[888] প্রযোজ্য নয়/পর্যবেক্ষণ সম্ভব হয় নি N/A / could not observe / cannot tell

4.8.5a স্ল্যাব অথবা মেঝেতে পায়খানা দেখতে পাওয়া গেছে? [Is Stool visible on the slab or floor?]......□□□

(1= হ্যাঁ [Yes], 0= না [No], প্রযোজ্য নয় [not applicable] =888)]

4.8.6a পায়খানার দেয়ালে কোন পায়খানা দেখতে পাওয়া গেছে কি? [Is Stool visible on the walls?]...... □

(1= হ্যাঁ [Yes], 0= না [No], প্রযোজ্য নয় [not applicable] =888)]

4.8.7a পায়খানার দরজায় কোন পায়খানা দেখতে পাওয়া গেছে কি? [Is Stool visible on the door/curtain?].□

(1= হ্যাঁ [Yes], 0= না [No], প্রযোজ্য নয় [not applicable] =888)]

Skip note: If 4.8.3= 0/888 skip to 4.10

4.8.8a টয়লেটে কোন কমোড আছে কি? [Is there any commode in the toilet?]......□□□

1= হ্যাঁ [Yes],

0= না [No],

প্রযোজ্য নয় [not applicable] =888)]

4.9 নং প্রশ্নে চলে যান (Skip to 4.9)

4.9 নং প্রশ্নে চলে যান (Skip to 4.9)

4.8.9a কমোড টি কি ভাঙ্গা? Is the commode broken?□□□

(1= হ্যাঁ [Yes], 0= না [No], প্রযোজ্য নয় [not applicable] =888)]

4.8.10a কমোডে কোন পায়খানা দেখতে পাওয়া গেছে কি [Is there faeces visible in the commode?]......□□□

(1= হ্যাঁ [Yes], 0= না [No], প্রযোজ্য নয় [not applicable] =888)]

4.9a নির্গমন ছিদ্রটিতে কোন ঢাকনা আছে কি? [Is there a lid covering the squatting hole/drop hole?]

.....□□□

হ্যাঁ [Yes] =1

না [No]=0

4.10 নং প্রশ্নে চলে যান (Skip to 4.10)

প্রযোজ্য নয় [Not applicable]=888 4.10 নং প্রশ্নে চলে যান (Skip to 4.10)

4.9.1a পর্যবেক্ষণের সময় নির্গমন ছিদ্রটি সম্পূর্ণভাবে ঢাকা ছিল কি? [Is there a lid fully covering the squatting hole at the time of observation?] □□□

হ্যাঁ [Yes] =1

না [No]=0

প্রযোজ্য নয় [Not applicable]=888

4.10a পায়খানাটি কি মল দ্বারা ভরে গেছে? (Note: পায়খানাটি মল দ্বারা পূর্ণ হিসাবে গণ্য হবে যদি কমোড মল দ্বারা পূর্ণ থাকে। এক্ষেত্রে, ওয়াটার সীল যুক্ত পায়খানা বা বাইরের পিট/ট্যাংক সহ পায়খানার জন্য, যদি সন্দেহ থাকে মল নির্গমন দেখার জন্য পানি ফ্ল্যাশ করুন। (Is the toilet full? (Note: Toilet is considered full if faeces have reached over the exit of the squatting hole. In case of toilets with water seal or offset pit/tank, if there is confusion flush water to see if the faeces flushes away.)□□□

হ্যাঁ [Yes] =1

না [No]=0

জানিনা [DK]=999,

প্রযোজ্য নয় [Not applicable]=888

Skip note: If 4.8.3= 0/888 skip to 4.13

4.11a পায়খানার কমোড এর ছিদ্রটি পর্যবেক্ষণ করুন [Observe through the hole in the toilet]......□□□

1. পাইপে পানি আছে (ওয়াটার সীলে পানি আছে কি না তা দেখার জন্য অল্প পানি ঢালুন) [Water in pipe (Water seal, pour some water in the hole to check if there is water in the water seal)]

2. শুধু পাইপ দেখা যাচ্ছে কোন ওয়াটার সীল নেই [Only pipe visible (no water seal)]

3. পাইপ ভাঙ্গা (ওয়াটার সীল ভাঙ্গা) [Broken pipe (Water seal broken)]

4. পাইপ নেই, খোলা গর্ত দিয়ে সরাসরি মল দেখা যাচ্ছে (পিটের গর্ত খোলা), তবে পিটটি এখনও সম্পূর্ণ ভরে যায়নি [No pipe, open hole to the pit, can see faeces in the pit, but the pit is not full yet]

5. কমোড এর ছিদ্রটি মল দিয়ে ভরে গেছে (faeces have reached the exit of the squatting hole) 888 প্রযোজ্য নয় [Not applicable]

4.12a যদি 4.11 নং প্রশ্নের উত্তর 2 বা 3 হয়, তবে ময়লা নির্গমন প্রতিরোধে পাইপের শেষে কোন ফ্ল্যাপ আছে কি? (উত্তরদাতাকে জিজ্ঞাসা করুন) [If answer to 12 is 2 or 3, is there any flap at the end of the pipe to prevent files from coming out?] (Ask the respondent).....□□□

হ্যাঁ [Yes] =1

না [No]=0

জানিনা [DK]=999

প্রযোজ্য নয় [Not applicable]=888

4.13a পর্যবেক্ষন: সৌচ কার্য সম্পন্ন করার ও হাত ধোয়ার জন্য পায়খানার ভিতরে বা সন্নিহিত কি কি উপাদান উপস্থিত আছে/রয়েছে? [Observation: What materials for anal cleansing and hand wash are present inside or immediately outside the latrine?]

হ্যাঁ [Yes]1

না [No].....0

প্রযোজ্য নয়/পর্যবেক্ষন করা সম্ভব হয় নাই [Not Applicable/ Could not observe].....888

1. পাতা/ঘাস [Leaves/grass].....□□□

2. কাঠি Twigs / sticks].....□□□

3. কাপড় [Rag or cloth].....□□□

4. পাথর [Stones].....□□□

5. টয়লেট পেপার [Hygienic (toilet) paper].....□□□

6. পানির পাত্র/বদনা/মগ [Water container / vessel].....□□□

7. পানির ট্যাপ [Water tap].....□□□

8. সাবান [Soap].....□□□

9. ছাই অথবা মাটি [Ash or soil for cleansing].....□□□

10. খবরের কাগজ [Newspaper].....□□□

11. কিছুই নাই [Nothing].....□□□

4.a আরো পায়খানার তথ্য সংগ্রহ করতে চান কি? Do you want to add more toilet?.....□□□

1= হ্যাঁ [yes]

4.1 নং প্রশ্নে চলে যান [skip to 4.1b]

0= না [No]

4.1b আপনার খানার সদস্যরা সাধারণত কোন ধরনের পায়খানা ব্যবহার করেন ?.....□□□

Note: উত্তরদাতাকে পায়খানাটি দেখাতে অনুরোধ করুন এবং পায়খানাটি পর্যবেক্ষন করার পর কোড করুন। যদি ফ্ল্যাশ অথবা পানি ঢেলে ফ্ল্যাশ করা পায়খানা থাকে তাহলে ফ্ল্যাশ করে ব্যর্জ কোথায় যায় তা প্রোব/চেক করুন

[What kind of toilet facility do members of your household usually use?] (Note: Request the respondent to show the toilet facility and code after observing the facility. If “flush” or “pour flush” probe/check: Where does it flush to?)

ফ্লাশ-টয়লেট অথবা পানি ঢেলে ফ্লাস করা টয়লেট (স্ল্যাব এবং পানি ধারণকারী ওয়াটার সীল পর্যবেক্ষণ করুন)
[Flush or pour flush toilet flushed to] (Observe the slab and water seal containing water):

- টয়লেটিতে পয়ঃনিষ্কাশন পাইপের সাথে সংযোগ করে দেয়া [Piped sewer system]..... 01
- টয়লেটিতে সেপটিক ট্যাংক বসানো আছে (ট্যাংকটি কংক্রীট দিয়ে ঢাকা আছে কিনা পর্যবেক্ষণ করুন)
[Septic tank] (Observe the concrete cover of the tank). 02
- সেপটিক ট্যাংক নাই কিন্তু ফ্লাস করে বা পানি ঢেলে পায়খানা নীচে/দূরে পিটের মধ্যে সরিয়ে দেয়া যায়
[Flush to pit latrine (onsite/Off set) with slab and water seal]..... 03
- অজানা জায়গায় /নির্দিষ্ট কোন জায়গায় নেই/ জানিনা [Unknown place/not sure/DK where]
.....04
- পিট-টয়লেট, স্লাব আছে কিন্তু ওয়াটার সিল নেই তবে কনক্রিট ঢাকনা দেয়ার ব্যবস্থা আছে)..... 05
[Pit latrine with slab & no water seal but with a lid]
- পিট-টয়লেট যাতে স্লাব আছে, তবে ওয়াটার সিল নেই কিন্তু ফ্ল্যাপ আছে (উত্তরদাতাকে ফ্ল্যাপ সম্পর্কে জিজ্ঞাসা করুন. এ ক্ষেত্রে পইপ এর শেষ মাথায় প্লাস্টিক লাগানো থাকে যা মশা মাছি বাইতে আশা প্রতিরোধ করে)..... 06
[Pit latrine with slab and flap, no water seal] (*Ask the respondent about the flap, Flap: a plastic is attached at the end of the pipe to prevent flies from coming out of the pit.*)
- বায়ু চলাচল উপযোগী উন্নত ল্যাট্রিন (স্লাব এবং ভেন্টিলেশন পাইপ পর্যবেক্ষণ করুন) [Ventilated Improved Pit (VIP) latrine] (Observe the slab and ventilation pipe)]..... 07
- কমপোষ্টিং টয়লেট [Composting toilet, (*Composting toilet ensure separation of urine, water and excreta*)]..... 08
- (শাক সবজির ময়লা, খড়, ঘাস, কাঠের গুড়া, ছাই পিটের মধ্যে মিশ্রিত হয়, সার হিসাবে এই ময়লা ব্যবহৃত হয়, ওয়াটার সিল নেই। একটি কমপোষ্টিং টয়লেটে প্রস্রাব আলাদাকরণ ডিভাইস থাকতে পারে বা নাও থাকতে পারে)
(Vegetable wastes, straw, grass, sawdust, ash added in the pit, the waste used as manure, no water seal. A composting latrine may or may not have a urine separation device.)]
- পিট/গর্ত পায়খানা স্প্রাউন আছে তবে, ওয়াটার সিল নেই অথবা ওয়াটার সিল ভাঙ্গা এবং কোন ঢাকনাও নেই. ... 09
[Pit latrine with slab & no water seal/broken water seal and no lid]
- ফ্লাশ-টয়লেট অথবা পানি ঢেলে ফ্লাস করা টয়লেট যা কোন খাল, ড্রেন, নদী ইত্যাদির সাথে সংযোজন করার ফলে অস্বাস্থ্যকর অবস্থার সৃষ্টি করে থাকে 10
[Flush or pour flush toilet connected to somewhere else (canal, ditch, river, etc.)]
- পিট/গর্ত পায়খানা, স্প্রাউন নেই এবং যেখান থেকে মশা/মাছি যাওয়া আসা করতে পারে এবং দূর্গন্ধ ছড়ায়..... 11
[Pit latrine without slab/open pit]
- ঝুলন্ত পায়খানা [Hanging toilet/latrine] 12
- বালতি [Bucket].....13
- খোলা পায়খানা/ টয়লেট (Open defecation):
- কোন পায়খানা নেই/জঙ্গলে/বোম্পে বাড়ে/ খোলা জায়গায় [No facility/bush/field] 14
- অন্যান্য (নির্দিষ্ট করে লিখুন) [Others: Specify] 777

Skip Note-: যদি 4.1 নং প্রশ্নের উত্তর 14 হয়, তবে 4.14 নং প্রশ্নে যান। [If answer of 4.1 is 14, skip to 4.18]

4.2.1b আপনার জানা মতে সর্বশেষ এই পায়খানাটি কখন ব্যবহার করা হয়েছিল? [When was the most recent time this toilet was used?].....□□ দিন আগে [days ago]

4.2.2a আপনি কি এই পায়খানাটি অন্য খানার সাথে মিলে ব্যবহার করেন? [Do you share this toilet facility with other households?] □□□

(Note: কোন ব্যক্তি বা গোষ্ঠি, যারা একই আবাস স্থানে বসবাস করেন বা একই উৎস থেকে খাবারে শরীক হয় না, তারা অন্য খানার অন্তর্গত হিসাবে বিবেচিত হবে।) (Note: Any person or group of persons related or unrelated who do not live in the same dwelling space and do not share a common source of food as the respondent would be considered to belong to other household.)

1= হ্যাঁ [yes]

0= না [No]

4.3.2 নং প্রশ্নে চলে যান [skip to 4.3.2]

999= জানিনা [DK]

4.3.2 নং প্রশ্নে চলে যান [skip to 4.3.2]

888= প্রযোজ্য নয় [Not applicable]

4.3.2 নং প্রশ্নে চলে যান [skip to 4.3.2]

4.3b কতগুলো খানা মিলে পায়খানাটি ব্যবহার করে ?□□

(প্রশ্ন করুন এবং পরিদর্শন করুন) [(Ask and check): how many households sharing the toilet facility?]

4.3.1b শিশুসহ আপনারা কতজন এই পায়খানাটি ব্যবহার করেন? [How many people including children use this toilet?].....□□

4.3.2b পায়খানাটির মালিকানা ? (প্রশ্ন করুন) [(Ask): Ownership type of the Toilet?].....□

শুধুমাত্র ঐ খানার [Only for the household]. 1

কয়েকটি খানা মিলে/ অংশীদার [Shared].....2

অন্য কেউ [Someone else].....3

পাবলিক [Public].....4

পায়খানা ব্যবস্থার বিশদ পর্যবেক্ষণ [Detail observation of the toilet facility]

4.4b পায়খানায় যাবার রাস্তা দেখে বুঝা যাচ্ছে কি যে এটা নিয়মিত ব্যবহার করা হয় (পরিষ্কার, জীর্ণ ইত্যাদি) Path to the toilet suggests regular use (is clear, well-worn, without grass or any barriers etc.).....□□□

(1= হ্যাঁ [Yes], 0= না [No], 999= জানিনা [DK], 888= প্রযোজ্য নয় [Not applicable])

4.5a টয়লেটের বাইরের অবস্থা পর্যবেক্ষণ [Observe the general exterior of the toilet]

(1= হ্যাঁ [Yes], 0= না [No], 999= জানিনা [DK], 888= প্রযোজ্য নয় [Not applicable])

1 পায়খানাটির উপর কোন স্থাপনা আছে কি? [Is there any superstructure on the toilet?].....□□□

2 কোন দরজা / পর্দা আছে কি? [Is there a door/curtain?]..... □□□

3 বাইরে থেকে দেখা যাওয়া ছাড়া গড় প্রাপ্ত বয়স্ক কোন ব্যক্তি এই টয়লেটে ব্যবহার করতে পারবে কি? [Can an average sized adult use the toilet without being seen?]..... □□□

4 টয়লেটের উপর ছাদ আছে কি? [Is there roof over the toilet?]..... □□□

5 ছাদে এমন কোন ছিদ্র আছে কি যার মাধ্যমে ছাদ দিয়ে পানি পড়তে পারে? [Is there any hole in the roof that may allow water to enter through the roof?].....□□□

6 বায়ু চলাচল উপযোগী কোন পাইপ আছে কি? [Is there a ventilation pipe?]..... □□□

Skip Note-: যদি 10.5f নং প্রশ্নের উত্তর 0 হয়, তবে 10.5h নং প্রশ্নে যান। [If answer of 10.5f is 0, skip to 10.5h]

7 পাইপ এর মাথায় কোন কভার আছে কি যা মশা মাছি বের হওয়া প্রতিরোধ করতে পারে ? [Is there a cover on top of the ventilation pipe that protects the flies from coming out?]. □□□

j) পায়খানার দেয়ালগুলো মূলত কি দিয়ে তৈরী? [What are the walls of the toilet mostly made of?] □□□

8. কংক্রিট [Concrete]
9. টিন [Tin]
10. বাঁশ/মাটি [Bamboo/Mud]
11. প্লাস্টিক [Plastic]
12. গাছের পাতা [Tree leaves]
13. পাটের থলে [Jute bag]
14. খড় [Straw]

8. কাঠ [Wood]

888= প্রযোজ্য নয় [Not applicable]

k) পায়খানার ছাদ মূলত কি দিয়ে তৈরী? [What is the roof of the toilet mostly made of?]. □□□

8. কংক্রিট [Concrete]
9. টিন [Tin]
10. বাঁশ [Bamboo]
11. প্লাস্টিক [Plastic]
12. গাছের পাতা [Tree leaves]
13. পাটের থলে [Jute bag]
14. খড় [Straw]

888= প্রযোজ্য নয় [Not applicable]

4.6b টয়লেট থেকে ময়লা কোথায় যায়? (জিজ্ঞাসা করুন এবং সম্ভব হলে পর্যবেক্ষণ করুন) [[Where does the waste from toilet go? (Ask and observe if possible)] □□□

1. ময়লা ভূগর্ভস্থ নালায় পড়ছে (জিজ্ঞাসা করুন) [Waste drains to underground piped sewer (Ask)] (4.8.1 নং প্রশ্নে চলে যান [Skip to Q4.8.1](#))
2. ময়লা নীচে পিটের মধ্যে পড়ছে এবং সেখানেই থাকছে (উত্তরদাতা পিট তৈরীতে কংক্রিটের রিং সম্পর্কে উল্লেখ করবে। পিটের উপরিভাগ এবং ছিদ্র আছে কি না পর্যবেক্ষণ করুন) [Waste goes into onsite pit and stays there (Respondent will report using concrete rings to make the pit. Observe the top of the pit and any leakage)]
3. ময়লা দূরে পিটের মধ্যে পড়ছে এবং সেখানেই থাকছে (উত্তরদাতা পিট তৈরীতে কংক্রিটের রিং সম্পর্কে উল্লেখ করবে। পিটের উপরিভাগ এবং ছিদ্র আছে কি না পর্যবেক্ষণ করুন) [Waste goes into offset pit and stays there (Respondent will report using concrete rings to make the pit. Observe the top of the pit and any leakage)]
4. ময়লা নীচে ট্যাংকির মধ্যে পড়ছে এবং সেখানেই থাকছে (ট্যাংকির উপরের কংক্রিটের ঢাকনা এবং ছিদ্র আছে কি না পর্যবেক্ষণ করুন)। [Waste goes into onsite tank and stays there (Observe the concrete cover of the tank and any leakage. Respondent will report building the tank with concrete lining rather than buying the ring for pit lining)]
5. ময়লা দূরে ট্যাংকির মধ্যে পড়ছে এবং সেখানেই থাকছে (ট্যাংকির উপরের কংক্রিটের ঢাকনা এবং ছিদ্র আছে কি না পর্যবেক্ষণ করুন)। [Waste goes into offset tank and stays there (Observe the concrete cover of the tank and any leakage. Respondent will report building the tank with concrete lining rather than buying the ring for pit lining)]

6. কমপোষ্ট পিট (শাক সবজির ময়লা, খড়, ঘাস, কাঠের গুড়া, ছাই পিটের মধ্যে মিশ্রিত হয়, সার হিসাবে এই ময়লা ব্যবহৃত হয়, ওয়াটার সিল নেই, এটি এনজিও/সরকার সহায়তায় স্থাপিত) [Compost pit (vegetable wastes, straw, grass, sawdust, ash added in the pit, the waste used as manure, no water seal, Built in assistance with the NGOs/government)]
7. পাইপ বা ঢাকনিযুক্ত নালা দিয়ে ময়লা খোলা জায়গায় (লেক/নদী/পানিতে) পড়ছে (সম্ভব হলে পর্যবেক্ষণ করুন) [Waste drains to open (lake/river/water) via pipe/covered drain (Observe if possible)] (4..8.1 নং প্রশ্নে চলে যান [Skip to Q4.8.1](#))
8. ঢাকনি ছাড়া নালা দিয়ে ময়লা খোলা জায়গায় (লেক/নদী/পানিতে) পড়ছে (পর্যবেক্ষণ করুন) [Waste drains to lake/river/water via open drain (Observe)] (4..8.1 নং প্রশ্নে চলে যান [Skip to Q4.8.1](#))
9. বালতিতে পড়ছে [Bucket] (4..8.1 নং প্রশ্নে চলে যান [Skip to Q4.8.1](#))
10. ময়লা সরাসরি জলাশয়ে বা নিচু জমিতে পড়ছে (ঝুলন্ত) [Waste directly fall into water body or low land (Hanging)] (4..8.1 নং প্রশ্নে চলে যান [Skip to Q4.8.1](#))

777. অন্যান্য (নির্দিষ্ট করে লিখুন) [Other (specify)] _____

888. প্রযোজ্য নয় [Not applicable]

31. ময়লা দূরে পিটের মধ্যে পড়ছে (রিং নাই, স্লাব আছে) [Waste goes into offset pit (Using no rings but slab)]
32. ময়লা দূরে পিটের মধ্যে পড়ছে (রিং নাই, স্লাব নাই) [Waste goes into offset pit (Using no rings or slab)]
33. ময়লা দূরে পিটের মধ্যে পড়ছে (রিং আছে, স্লাব নাই) [Waste goes into offset pit (Using rings but no slab)]

4.7b পিটের/ ট্যাংকির বাইরে বা ভিতরের চতুর্দিকে পর্যবেক্ষণ করুন [Observe the onsite or off site pit/tank in all direction]

(1= হ্যাঁ [yes], 0= না [No], 999= জানিনা [DK], 888= প্রযোজ্য নয় [Not applicable])

1. পিটের উপরিভাগ মাটি থেকে উপরে দেখা যাচ্ছে কি? [Is the top of the pit visible (above the ground)]?.....□□□
2. সংযোগ নলের ছিদ্রের/ভাংগার কারণে পাইপের ভিতরে বা বাইরে ময়লা দেখা যাচ্ছে কি? [Waste/faeces visible in or around the pipe, because of Leakage in the connecting pipe?] □□□
3. পিট/ট্যাংকির ছিদ্রের কারণে ভিতরে বা বাইরে ময়লা দেখা যাচ্ছে [Waste/faeces visible because of leakage in the pit/tank?]?.....□□□

Skip Note: 4.7c নং প্রশ্নের উত্তর 1 হলে 8.৮ নং প্রশ্নে চলে যান। [If the answer to question 4.7c is 1 go to question 4.8]

4. ময়লা দেখা যাচ্ছে না কিন্তু পিট/ট্যাংকি ভাংগা যা দিয়ে মশা মাছি আশা যাওয়া করতে পারবে [No visible waste but broken pit/tank that may allow flies coming out of the toilet?]
.....□□□

Skip Note: 4.7d নং প্রশ্নের উত্তর 1 হলে 8.৮ নং প্রশ্নে চলে যান।

[If the answer to question 4.7d is 1 go to question 4.8]

5. ময়লা দেখা যাচ্ছে না কিন্তু পিট/ট্যাংকিতে ফাটল/ ভাংগন দেখা যাচ্ছে যা দিয়ে মশা মাছি আশা যাওয়া করতে পারবে না [No visible waste but crack in the pit/tank?]?.....□□□

পায়খানার অভ্যন্তরীণ অবস্থা পর্যবেক্ষণ [Observe the interior of the toilet]

4.8.1b পায়খানা/টয়লেটে পায়খানার গন্ধ রয়েছে কি? [Odor of feces in the latrine/bathroom?]?.....□

- (1= হ্যাঁ [Yes], 0= না [No], প্রযোজ্য নয় [not applicable] =888)]
- 4.8.2b মাছির উপস্থিতি রয়েছে কি? [Flies present?]
(1= হ্যাঁ [Yes], 0= না [No], প্রযোজ্য নয় [not applicable] =888)]
- 4.8.3b পায়খানাতে স্ল্যাব/ প্লাটফর্ম আছে কি? [Is there a slab/platform in the toilet?].....
(Note: স্কোয়াটিং স্ল্যাব/ প্লাটফর্ম পিটকে চতুর্দিক থেকে ঢেকে রাখে, যার একটি নির্গমন ছিদ্র আছে এবং যা পিটের ভিতরে যে কোন ভূ-পৃষ্ঠের পানি প্রবেশ প্রতিরোধে ভূস্তরের উপরে অবস্থিত থাকে।) (Note: Squatting slab or platform that is covering the pit on all sides, has a squatting hole and rose above the surrounding ground level to prevent any surface water entering the pit)
হ্যাঁ [Yes] =1
না [No]=0 4.8.6 নং প্রশ্নে চলে যান (Skip to 4.8.6)
প্রযোজ্য নয় [Not applicable]=888 4.8.6 নং প্রশ্নে চলে যান (Skip to 4.8.6)
- 4.8.4b মবোর প্রধান উপাদান [Main material of the floor (select 1)].....
[1] মাটি Mud
[2] কাঠ Wood
[3] সিমেন্ট Cement
[4] টাইলস/ইট Tile / brick
[5] প্লাস্টিক Plastic
[888] প্রযোজ্য নয়/পর্যবেক্ষণ সম্ভব হয় নি N/A / could not observe / cannot tell
- 4.8.5b স্ল্যাব অথবা মেঝেতে পায়খানা দেখতে পাওয়া গেছে ? [Is Stool visible on the slab or floor?].....
(1= হ্যাঁ [Yes], 0= না [No], প্রযোজ্য নয় [not applicable] =888)]
- 4.8.6b পায়খানার দেয়ালে কোন পায়খানা দেখতে পাওয়া গেছে কি? [Is Stool visible on the walls?].....
(1= হ্যাঁ [Yes], 0= না [No], প্রযোজ্য নয় [not applicable] =888)]
- 4.8.7b পায়খানার দরজায় কোন পায়খানা দেখতে পাওয়া গেছে কি? [Is Stool visible on the door/curtain?].
(1= হ্যাঁ [Yes], 0= না [No], প্রযোজ্য নয় [not applicable] =888)]
- Skip note: If 4.8.3= 0/888 skip to 4.10
- 4.8.8b টয়লেটে কোন কমোড আছে কি? [Is there any commode in the toilet?].....
1= হ্যাঁ [Yes],
0= না [No], 4.9 নং প্রশ্নে চলে যান (Skip to 4.9)
প্রযোজ্য নয় [not applicable] =888) 4.9 নং প্রশ্নে চলে যান (Skip to 4.9)
- 4.8.9b কমোড টি কি ভাঙ্গা? Is the commode broken ?
(1= হ্যাঁ [Yes], 0= না [No], প্রযোজ্য নয় [not applicable] =888)]
- 4.8.10b কমোডে কোন পায়খানা দেখতে পাওয়া গেছে কি [Is there faeces visible in the commode?].....
(1= হ্যাঁ [Yes], 0= না [No], প্রযোজ্য নয় [not applicable] =888)]
- 4.9b নির্গমন ছিদ্রটিতে কোন ঢাকনা আছে কি? [Is there a lid covering the squatting hole/drop hole?]
.....
হ্যাঁ [Yes] =1
না [No]=0 4.10 নং প্রশ্নে চলে যান (Skip to 4.10)
প্রযোজ্য নয় [Not applicable]=888 4.10 নং প্রশ্নে চলে যান (Skip to 4.10)
- 4.9.1b পর্যবেক্ষণের সময় নির্গমন ছিদ্রটি সম্পূর্ণভাবে ঢাকা ছিল কি? [Is there a lid fully covering the squatting hole at the time of observation?]
হ্যাঁ [Yes] =1
না [No]=0
প্রযোজ্য নয় [Not applicable]=888

4.10b পায়খানাটি কি মল দ্বারা ভরে গেছে? (Note: পায়খানাটি মল দ্বারা পূর্ণ হিসাবে গণ্য হবে যদি কমোড মল দ্বারা পূর্ণ থাকে। এক্ষেত্রে, ওয়াটার সীল যুক্ত পায়খানা বা বাইরের পিট/ট্যাংকি সহ পায়খানার জন্য, যদি সন্দেহ থাকে মল নির্গমন দেখার

জন্য পানি ফ্ল্যাশ করুন। (Is the toilet full? (Note: Toilet is considered full if faeces have reached over the exit of the squatting hole. In case of toilets with water seal or offset pit/tank, if there is confusion flush water to see if the faeces flushes away.)□□□

হ্যাঁ [Yes] =1

না [No]=0

জানিনা [DK]=999,

প্রযোজ্য নয় [Not applicable]=888

Skip note: If 4.8.3= 0/888 skip to 4.13

4.11b পায়খানার কমোড এর ছিদ্রটি পর্যবেক্ষণ করুন [Observe through the hole in the toilet].....□□□

1. পাইপে পানি আছে (ওয়াটার সীলে পানি আছে কি না তা দেখার জন্য অল্প পানি ঢালুন) [Water in pipe (Water seal, pour some water in the hole to check if there is water in the water seal)]

2. শুধু পাইপ দেখা যাচ্ছে কোন ওয়াটার সীল নেই [Only pipe visible (no water seal)]

3. পাইপ ভাঙ্গা (ওয়াটার সীল ভাঙ্গা) [Broken pipe (Water seal broken)]

4. পাইপ নেই, খোলা গর্ত দিয়ে সরাসরি মল দেখা যাচ্ছে (পিটের গর্ত খোলা), তবে পিটটি এখনও সম্পূর্ণ ভরে যায়নি [No pipe, open hole to the pit, can see faeces in the pit, but the pit is not full yet]

5. কমোড এর ছিদ্রটি মল দিয়ে ভরে গেছে (faeces have reached the exit of the squatting hole) 888 প্রযোজ্য নয় [Not applicable]

4.12b যদি 4.11 নং প্রশ্নের উত্তর 2 বা 3 হয়, তবে ময়লা নির্গমন প্রতিরোধে পাইপের শেষে কোন ফ্ল্যাপ আছে কি? (উত্তরদাতাকে জিজ্ঞাসা করুন) [If answer to 12 is 2 or 3, is there any flap at the end of the pipe to prevent files from coming out?] (Ask the respondent).....□□□

হ্যাঁ [Yes] =1

না [No]=0

জানিনা [DK]=999

প্রযোজ্য নয় [Not applicable]=888

4.13b পর্যবেক্ষন: সৌচ কার্য সম্পন্ন করার ও হাত ধোয়ার জন্য পায়খানার ভিতরে বা সন্নিহিত কি কি উপাদান উপস্থিত আছে/রয়েছে? [Observation: What materials for anal cleansing and hand wash are present inside or immediately outside the latrine?]

হ্যাঁ [Yes]1

না [No].....0

প্রযোজ্য নয়/পর্যবেক্ষন করা সম্ভব হয় নাই [Not Applicable/ Could not observe].....888

11. পাতা/ঘাস [Leaves/grass].....□□□

12. কাঠি Twigs / sticks].....□□□

13. কাপড় [Rag or cloth].....□□□

14. পাথর [Stones].....□□□

15. টয়লেট পেপার [Hygienic (toilet) paper].....□□□

16. পানির পাত্র/বদনা/মগ [Water container / vessel].....□□□

17. পানির ট্যাপ [Water tap].....□□□

18. সাবান [Soap].....□□□

19. ছাই অথবা মাটি [Ash or soil for cleansing].....□□□

20. খবরের কাগজ [Newspaper].....□□□

11. কিছুই নাই [Nothing].....□□□

পর্যবেক্ষণ করুন: (নিম্নলিখিত অবস্থা) [Observation] [For the following]:

4.14 খানার সীমানার মধ্যে মানুষের মল/পায়খানা পড়ে থাকতে দেখেছেন কি? [Is there any Human faeces present within the household?].....□

হ্যাঁ [Yes]1

না [No].....0 4.16 নং প্রশ্নে চলে যান (Skip to 4.16)

4.15 খানার সীমানার মধ্যে মানুষের মল/পায়খানা পড়ে আছে যা উন্মুক্ত পায়খানা হিসেবে বিবেচিত হবে, তার সংখ্যা ? [Number of piles of Human faeces within the household that could be considered open defecation].....□□□

555 অধিক সংখ্যক (স্তুপের সংখ্যা ১০টির উপরে)

[Too numerous to count (more than 10 piles)]

999 বলা যাচ্ছে না/ পর্যবেক্ষণ করা সম্ভব হয়নি [Cannot tell / could not observe]

4.16 খানার সীমানার মধ্যে পশুর-পাখির মল/পায়খানা পড়ে থাকতে দেখেছেন কি? [Is there any Animal faeces present within the household?].....□

হ্যাঁ [Yes]1

না [No].....0

4.17 খানার সীমানার মধ্যে পশুর/পাখির মল/পায়খানা পড়ে আছে, যা উন্মুক্ত পায়খানা হিসেবে বিবেচিত হবে, তার সংখ্যা? (নির্দিষ্টভাবে সংখ্যা উল্লেখ করুন) [Number of piles of Animal faeces present within the household (mark all that apply)]

555 অধিক সংখ্যক (স্তুপের সংখ্যা ১০টির উপরে)

[Too numerous to count (more than 10 piles)]

999 বলা যাচ্ছে না/ পর্যবেক্ষণ করা সম্ভব হয়নি [Cannot tell / could not observe]

1. পাখি বিশেষ(মুরগী/হাঁস/কবুতর) [Poultry (chicken, duck, and pigeon)]□□□

2. গরু/মহিষ [Cow / Buffalo].....□□□

3. ছাগল/ভেড়া [Goat / Sheep].....□□□

4. শুকর [Pig].....□□□

5. কুকুর অথবা বিড়াল [Dog or Cat].....□□□

777. অন্যান্য [Other].....□□□

আপনাকে ধন্যবাদ *Thank you.*

Name, signature of FRA:

Checked by FRO: