BANGLADESH MICS 2019

WATER QUALITY THEMATIC REPORT

Bangladesh Bureau of Statistics
Statistics Division, Ministry of Planning
Government of the People's Republic of Bangladesh

unicef
for every child

Bangladesh MICS 2019: Water Quality Thematic Report

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SEPTEMBER 2021

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Foreword

Bangladesh has made remarkable progress towards achieving its goal of universal access to improved drinking water sources to 98.5 per cent[1]. At the same time, only 42.6 per cent of the population have access to a drinking water source that is on premises, available when needed, arsenic safe and free from microbial contamination[2]. The Government of Bangladesh has made clear its commitment to *'Ensuring sustainable use and availability of safe water for drinking for all urban and rural population of Bangladesh'* in its 8th Five Year plan for the period of July 2020 to June 2025. Investments by government and development partners have ensured that an additional 65 million people gained access to improved water sources between 1990 and 2015. Though there has been laudable progress, some challenges remain. For instance, an estimated 46.7 per cent of the population still lack access to drinking water that is safe from arsenic and free from microbial contamination[2]. Currently, 11.8 per cent[2] of the population – 17.5 million[2] people – remain exposed to arsenic in their drinking water above Bangladesh's national standard of 50 ppb. which can damage the normal development of a child's brain and health.

The water quality testing and survey was carried out in 2019 by Bangladesh Bureau of Statistics (BBS) in collaboration with UNICEF and icddr,b, as part of the Bangladesh Multiple Indicator Cluster Survey (MICS). Based on MICS 2019, the Water Quality Thematic Report provides evidence of critical aspect of arsenic and faecal contamination (Escherichia coli or E.coli) of water supply and drinking water at the division and district levels. This publication presents information on arsenic and fecal contamination of drinking water at source and household level. It also provides relevant insights using the equity lens to examine the disparities between districts by key variables such as education, socioeconomic status as well as household water treatment and storage practices. The evidence presented facilitates planning, programming, advocacy and effective targeting of the most vulnerable and also serves as a bench mark for the SDG 6.1 "by 2030, achieve universal and equitable access to safe and affordable drinking water for all". The MICS 2012-13 Water Quality Thematic Report published in 2018 was the first of its kind in Bangladesh, and in this second Water Quality Thematic Report, it is now possible to track where improvements are happening and identify areas where more actions are needed.

The Government of Bangladesh has a commitment to ensure safe drinking water through large-scale water supply projects undertaken by the Department of Public Health Engineering (DPHE) and Water Supply and Sewerage Authority (WASAs). In an endeavor to provide all its citizens with safe drinking water, the Government of Bangladesh has recently started implementing a four-year arsenic mitigation project with an estimated cost of US$ 240 million and has also approved another large-scale water supply project recently. Further, many WASH sector partners are implementing programmes to advance access to

1 Multiple Indicator Cluster Survey (MICS), 2019

2 ibid

safe drinking water and implement water safety plans. This survey is critical to measure the overall progress and impact of all these efforts.

This is an important step in ensuring drinking water quality and safety for the people of Bangladesh. The data generated from the survey is critical for the WASH sector in Bangladesh for advocacy, planning and implementation of programmes. The initial data is already being used to monitor SDG 6.1 progress and will be instrumental in guiding policy for the WASH sector.

We firmly believe that the publication of this report will benefit to technocrats and policy makers and contribute to the ongoing efforts of the Government of Bangladesh to meet the Sustainable Development Goal for safe drinking water.

We thank and congratulate all the stakeholders that contributed to the preparation of this publication and wish to reaffirm our commitment to evidence-based planning for progressive improvement in drinking water quality in Bangladesh. Our special thanks go to Dr. Katrina Charles of University of Oxford, Dr. Li Ann Ong, Dr Nassim El Achi from Oxford and Dr. Kazi Matin Ahmed of Dhaka University for authorship of the report. Further, we would like to express our gratitude and thanks to Mr. Tushar Mohon Sadhu Khan of DPHE, Moustapha Niang, Ms. Nargis Akter and Md. Monirul Alam of UNICEF Bangladesh, for their utmost effort to facilitate and contribute in developing this publication for WASH sector in Bangladesh.

Suggestions and comments on the survey are most welcome for improvement of the report in future.

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Abbreviations

ARI	acute respiratory infection
BBS	Bangladesh Bureau of Statistics
BGS	British Geological Survey
cfu	Colony forming unit
DPHE	Department of Public Health Engineering
GoB	Government of Bangladesh
icddr,b	International Centre for Diarrhoeal Disease Research, Bangladesh
JMP	Joint Monitoring Programme
MDG	Millennial Development Goals
MICS	Multiple Indicator Cluster Survey
NGO	Non-Governmental Organization
PoC	Point of Collection
PoU	Point of Use
ppb	Part per billion,
SDGs	Sustainable Development Goals
UNICEF	United Nations Children's Fund
WASH	Water, sanitation and hygiene
WHO	World Health Organization

Executive Summary

The Bangladesh Multiple Indicator Cluster Survey (MICS) 2019 was conducted from January to June, 2019 by the Bangladesh Bureau of Statistics (BBS), Ministry of Planning. It covered the 64 districts of eight divisions of Bangladesh. A two-stage (stratified) systematic random sample of 61,242 households were interviewed to provide estimates for a number of indicators on the situation of women and children and on development-related criteria including drinking water, sanitation and hygiene (WASH). As part of MICS, drinking water was sampled from a proportion of the households at the point of collection and at the point of use and analysed for arsenic and faecal (*E. coli*) contamination. This Drinking Water Quality Thematic report presents division and district level data about arsenic and faecal contamination of drinking water in the 64 districts of Bangladesh. It explores the geographic and socio-economic disparities in access to improved and safe drinking water in the country, and includes an analysis to assess the links between WASH access, diarrhoea and stunting. Bangladesh has included arsenic measurement since 2009, and is the first country to complete two MICS campaigns with water quality modules that include *E. coli*, so this report reflects on the progress made across the years.

Access to WASH has improved in Bangladesh since 2012-13. In 2019, the MICS results show there was an almost universal access to improved drinking water sources (98.5 percent) in Bangladesh. Tubewells remain the most common source of drinking water for households (85.6 percent). The majority of the population have access to a water source on premises (82.4 percent). Despite the Government's huge efforts and commitment towards achieving SDGs, equitable access to basic sanitation is still not universal; 64.4 percent have access to improved sanitation with inequalities based on socio-economic demographics and geography. Similar inequalities exist for access to basic handwashing facilities.

Water quality has not improved in line with the WASH access. Microbiological water quality at the point of collection (PoC) has improved in Bangladesh from MICS 2012-2013 to MICS 2019, but without a commensurate improvement in water quality at the point of use (PoU), based on a seasonally-adjusted comparison. At the point of collection, 59.7 percent of the population had access to drinking water that was free from faecal contamination; this varied between systems, with 63.0 percent of those using tubewells and 43.7 percent of those using piped systems having access to water free from faecal contamination. At the point of use, only 18.1 percent of the population had access to drinking water that was free from faecal contamination. Progress has been made at the national level to reduce arsenic exposure from drinking water, with the proportion of households with access to water below the WHO guideline value of 10 ppb rising from 75.3 percent in 2012-13 to 83.3 percent in 2019.

Water quality remains a major challenge in Bangladesh. Safely managed drinking water - the use of an improved drinking water source which is located on premises, with sufficient drinking water available when needed, free of faecal (*E. coli*) and priority chemical contamination (arsenic below the national standard) – was accessible to 42.6 percent of the population, with water quality being the main limitation. For arsenic, there are on-going challenges to reduce the proportion of the population consuming drinking water with arsenic above the Bangladesh standard for drinking water, with only a 1 percent decrease in the proportion of households drinking water exceeding the 50 ppb level since MICS 2012-13. Furthermore, the proportion of the population exposed to high levels of arsenic, >= 200 ppb, increased from 2.8 percent in 2012-13 to 5.3 percent in rural areas and overall 5.3 percent in 2019. Chattogram and Sylhet divisions have the highest prevalence of arsenic, including of high arsenic levels in drinking water.

The proportion of the population with access to safely managed sanitation was estimated to be 58.9 percent. Difficulties in tracking faecal sludge management suggest this is likely to be an overestimate. Associations between stunting and diarrhoea with WASH access, at the district level contributes to the evidence of the importance of access to a high level of water, sanitation and hygiene services to ensuring the health and development of children.

Water safety risks varied geographically due to differences in geology and geogenic risks, differences in access to types of water sources, and in availability of water supplies on premises. Notably, access to safely managed drinking water (adjusted for arsenic) varied across districts from 6.5 percent to 91.9 percent. Progress on access to WASH varied for different wealth quintiles with good progress for the poorest achieved for access to water on-premises and to basic sanitation.

The results of this MICS campaign emphasise that water quality is the greatest challenge to achieving safely managed water in Bangladesh. However, the MICS data alone are not enough to target interventions and track progress. Methodological challenges in the MICS water quality sampling limit the comparability of the water quality data generated, while the design limits communication of the data to water managers. Sampling methods do not enable differentiation of contamination of water source from poor hygiene, but the latter is estimated to account for two-thirds of reported contamination. The focus on *E. coli* and arsenic disregards the growing impact of salinity, manganese and other contaminants on the ability of Bangladeshis to access safe water. A major challenge to attaining safely managed water is that water sources in the country have poor climate resilience, with water quality fluctuating throughout the year based on rainfall, temperature and other climate phenomena which are expected to get more frequent and intense with climate change. The report concludes with recommendations based on these analyses for (1) improving data quality in water quality sampling and MICS in Bangladesh, (2) advancing water safety in Bangladesh, and (3) ensuring data quality and value for money in water quality modules in MICS.

1 Introduction

Bangladesh continues to make progress towards achieving the Sustainable Development Goal (SDG) for universal access to improved water supply and sanitation. This latest Multiple Indicator Cluster Survey (MICS), which was undertaken in 2019, estimates that 98.5 percent of the population have access to an improved water source, however, only 4 percent have access to basic sanitation and 4.7 percent to basic hygiene. Challenges reside in addressing inequalities as significant disparities are evident between rural and urban areas, wealthy and poor households and among the different districts within the country, with the more vulnerable being the least accessible and thus are hit the hardest.

Access to an improved drinking water source doesn't necessarily guarantee that the water provided or accessed is safe. Water quality continues to be a major challenge for Bangladesh due to geogenic threats, rising sea levels and widespread microbiological contamination. The country struggles with the worst arsenic contamination of groundwater at the global scale, with millions subject to the short-term and long-term health and economic impacts associated with arsenic consumption, with the biggest implications for children's development (Pitt, Rosenzweig, & Hassan, 2020; Smith, Lingas, & Rahman, 2000). Safe water access is also challenged by other contaminants which are not considered in MICS data, but are detected in various areas across the country at levels that exceed the World Health Organisation's (WHO) guidelines for drinking water quality (WHO, 2017a), like manganese and salinity. Exposure to high levels of manganese has also been reported in the literature to be linked to impaired cognitive function in children (Bouchard et al., 2011; Khan et al., 2012), with a health-based guideline currently under development by WHO. Contaminants are of concern if they have a direct health risk or if they affect the taste of water such that an individual might choose a different, less safe water source.

This drinking water quality thematic report explores the data collected by the MICS 209 in more detail, to focus more on the populations most exposed to unsafe levels of arsenic and microbial contamination, and risk factors associated with exposure. Furthermore, this is the first report to provide comparison with previous MICS campaigns on microbiological water quality, both for Bangladesh and globally. It is also the first of the MICS water quality reports that provides an analysis to the correlation between improved sanitation and stunting.

The report highlights some of the limitations in the current sampling methods and in the contaminants considered which could be addressed to provide more representative results. It presents an analysis of climate resilience of water supplies, and makes recommendations to advance sustainable safely managed water services in the country. This detailed information will assist the Government of Bangladesh in setting targets for drinking water services, in the context of SDG 2030.

1.1 Context

The Bangladesh MICS 2019 was conducted from January to June, 2019 by the Bangladesh Bureau Statistics, Ministry of Planning. Technical and financial support for the survey was provided by the United Nations Children's Fund (UNICEF) in Bangladesh. MICS is designed to collect estimates of indicators that are used to assess the situation of children and women, expanding over the past 20 years to become a key source of data on child protection, early childhood education, and a major source of data on child health and nutrition, and on drinking water quality. Bangladesh MICS 2019 provides the latest evidence and information on the situation of children and women in Bangladesh, updating information from the previous 2012-13 and 2009 Bangladesh MICS surveys.

The survey presents data from an equity perspective by indicating disparities by sex, area, division, education, living standards, and other characteristics. It is based on a sample of 61,242 interviwed households (rural: 77.9 percent and urban: 22.1 percent) from sixty-four districts. Topics covered by the MICS include mortality rates for neonatal, post neonatal, infant and children up to five years old, reproductive and maternal health, child health, nutrition, development and education, domestic violence victimization and protection from exploitation, and life expectation. Summary results are presented in the appendices in Table A1.1. The survey includes a section about water and hygiene and a water quality module that measured the levels of arsenic and *E. coli* contamination in drinking water. This was the third Bangladesh MICS programme to survey drinking water quality, and the second to survey *E. coli*:

- In 2009, MICS4 collected samples from 15,000 households, which were analysed for arsenic and metals, with additional samples collected by the Department of Public Health Engineering (DPHE) for anion analysis, including fluoride.
- In 2012-13, MICS5 sampled water both from the point of collection (PoC) and household drinking water quality at the point of use (PoU), and included analyses for arsenic and recent faecal contamination using the indicator bacteria *Escherichia coli*. Approximately 2,500 source samples were analysed for both arsenic and *E. coli*, while 12,952 household samples were analysed for arsenic and 2,538 for *E. coli*.
- In 2019, MICS6 measured drinking water quality at both the PoC and PoU. A total of 12,238 household PoU samples and 3,028 PoC samples were tested for arsenic, while 6,069 PoU and PoC samples were tested for *E. coli*.

1.2 Progress towards global and national targets

The Government of Bangladesh Five-Year Plan (2016-2020) includes the country's plan to increase inclusive economic growth with support for environmental sustainability. It also aims to ensure access to safe water to the entire rural and urban population by 2020. The latter target aligns well with the Sustainable Development Goal (SDG) targets for water, sanitation and hygiene set in 2015 by the United Nations General Assembly and are intended to be achieved by the year 2030. Globally, progress on access to water, sanitation and hygiene (WASH) is monitored by the UNICEF and WHO Joint Monitoring Programme (JMP) metrics. For drinking water, the metrics are the proportion of the population using:

- basic water - water from an improved source[3], provided collection time is not more than 30 minutes for a roundtrip including queuing; and
- safely managed drinking water services – water from an improved source, accessible on premises, with water available when needed, and free from contamination.

Free from contamination is judged as being compliant with standards for faecal (*E. coli*) and priority chemical contamination. In Bangladesh, arsenic is considered a priority chemical contaminant due to its distribution across the country; thus, it is included in the MICS6 drinking water quality module.

Table 1: Summary of key WASH indicators, Bangladesh, 2019

Indicator	National (%)	Urban (%)	Rural (%)
Main improved drinking water sources:	**98.5**	**99.6**	**98.2**
Tubewell/Borehole	85.6	59.6	92.8
Piped water	11.7	38.1	4.4
Other improved sources	1.1	2.0	0.8
Time taken to collect drinking water from improved sources			
Water on premises	82.4	87.5	81.0
<30 mins	15.6	11.7	16.7
>30 mins	0.5	0.4	0.5
Sanitation and hygiene			
Population practicing open defecation	1.5	0.4	1.9
Population using improved sanitation	84.6	90.6	82.9
Safe disposal of child's faeces	49.2	68.3	44.0
Availability of a handwashing facility with soap and water	74.8	87.0	71.4

Bangladesh has made significant progress in achieving the Sustainable Development Goal (SDG) targets for water, sanitation and hygiene. For drinking water, access to improved water sources has continued to increase from 97.9 percent to 98.5 percent between MICS5 (2012-13) and MICS6 (2019), with access advancing in both urban (99.6 percent) and rural (98.2 percent) areas, with the majority of water sources being on the premises or less than 30 minutes away from the household (Table 1). The main improved drinking water option used was the tubewell (85.6 percent), which was used more by rural household members (92.8 percent) than those in urban areas (59.6 percent); there was also disparity in use of piped water between urban (38.1 percent) and rural (4.4 percent) households. For sanitation and hygiene, progress towards SDG target 6.2, to 'achieve access to adequate and equitable sanitation and hygiene for all, and ending open defecation, paying special attention to the needs of women and girls and those in vulnerable situations by 2030', has similarly continued. Only 1.5 percent of the population practiced open defecation in MICS 2018-19 compared to 3.9 percent in MICS 2012-13. Similarly, access to improved

3 Improved water sources include piped supplies, boreholes/tubewells, protected wells and springs, rainwater, and packaged water, including bottled water and sachet water

sanitation facilities have increased from 55.1 percent to 84.6 percent within the same period. Almost half (49.2 percent) of the population safely disposed of child faeces, and 74.8 percent of the households had a handwashing facility with soap and water. Table 1 describes the status of some WASH indicators according to the MICS 2019.

Despite considerable progress towards the SDGs and the Government of Bangladesh's strong commitment to increasing access to basic sanitation and hygiene services, poverty and socio-demographic disparities still pose challenges to the equitable access to quality basic WASH services. Sub-national disparities are also evident in the coverage of basic social services between rural/urban locations, geographic regions, and wealth.

1.3 Report structure

This report presents a summary and analysis of the water quality results of the MICS 2019 sampling in Bangladesh. After presenting the methods, the results for arsenic and *E. coli* are outlined in separate chapters, each providing a comparison with results from MICS 2012-13, with full statistics provided in tables in the appendices. This is followed by an assessment of the water quality challenge overall, and reporting on the level of access to safely managed drinking water services. An analysis between WASH access, stunting and diarrhoea is then presented. Finally, the discussion section reviews the methodological limitations, analyses what the results can tell us about if Bangladesh's water safety is improving, and identifies the areas with the most urgent water quality needs. Finally, the discussion concludes with recommendations for advancing water quality monitoring and water safety in Bangladesh.

2 Methods

2.1 Survey design

The sampling method for the Bangladesh MICS 2019 was designed to provide estimates of indicators to determine the situation of children and woman at the national level and disaggregated to consider variation across urban and rural areas, eight sub-national divisions, and sixty-four districts. The survey was conducted in 3,220 clusters. The districts were identified as the main sampling strata and the sample was selected in two stages. Within each stratum, a specified number of census enumeration areas were selected systematically with probability proportional to size. After a household listing was carried out within the selected enumeration areas, a sample of 20 households was drawn in each of the clusters. As the sample is not self-weighting, sample weights are used for reporting survey results.

Among the 20 households selected for the main survey in each enumeration area, a subsample of four households were selected using random systematic selection for conducting water quality testing for arsenic in household drinking water. From those four selected households, a sub-sample of two households were randomly selected for testing *E. coli*. Respondents in each selected household were asked to provide "a glass of water which you would give a child to drink" for drinking water quality testing; these samples are referred to as point of use (PoU) or household samples. Arsenic content in the household drinking water was tested for all four selected households. In addition, two of the four households were selected for additional water quality testing, which included measurement of *E. coli* in the household drinking water and at the point of collection (PoC) of the drinking water. Additionally, one of the households selected for *E. coli* testing was also selected for arsenic testing at the PoC of drinking water. Selection tables containing random numbers were provided to all supervisors to ensure that households selected for water quality testing were randomly chosen. Duplicate analyses were completed for 2.5 percent of arsenic samples (n=322 household samples and n=81 source samples) covering all districts; duplicates were collected by the water quality specialists from the International Centre for Diarrhoeal Disease Research, Bangladesh (icddr,b) and were analysed both in the field (replicating methods used by enumerators), and in a centralised laboratory. A total of 10 percent of households were identified for duplicate analysis for *E. coli* (n=602), with additional samples of household and source drinking water analysed by icddr,b water quality specialists both in the field (replicating methods used by enumerators), and in a centralised laboratory. Furthermore, one household in every 5 enumeration areas was selected for a blank water quality test, which included analysis of blank samples for both arsenic and *E. coli*, to ensure the reliability of the field test results. As listed in Table 2, household response rates were high for water quality testing (> 98 percent) and completion of the full questionnaire (95 percent).

Table 2: Household and water quality testing response rates, Bangladesh, 2019

Indicator	Households selected	Households completed	Household response rate (%)
Main MICS questionnaire	64,400	61,242	95.1
Arsenic testing (household)	12,251	12,238	99.9
Arsenic testing (source)	3,074	3,028	98.5
E. coli testing (household and source)	6,149	6,069	98.7

2.2 Training and fieldwork

The overall data collection for the survey was conducted by 33 teams, each of the teams included four interviewers, one measurer, and one supervisor. The measurers were selected to conduct water quality tests as well as anthropometric measurements using portable field equipment. Training of the measurers in water quality testing was conducted for 8 days in January 2019. The supervisors were also oriented on the testing procedures. One MICS international consultant and a team of water quality specialists headed by Dr. Md. Sirajul Islam from icddr,b conducted the training.

In order to get hands on experience in water quality testing, measurers were trained in six separate groups of 6 people. Measurers practiced the testing procedure in small groups, ensuring that each measurer conducted at least five practice tests in the presence of other trainees. Towards the end of the training period, trainees spent two days in practice interviewing and conducting water tests at field level in several areas of Manikganj as pilot fieldwork. The MICS fieldwork began in January 2019 and concluded in June 2019 with the icddr,b team providing follow-up support throughout the survey implementation.

2.3 Sample collection

Water samples were collected from both the household (PoU) and from the PoC of water used by that household following the MICS Manual for Water Quality Testing (JMP/UNICEF/WHO, 2016). At the household level, survey respondents were asked to provide "a glass of water you would give a child to drink". For arsenic testing, measurers collected the water provided by the respondent in the designated bottle supplied with the arsenic testing kit. For *E. coli* testing, the water provided by the respondent was collected in a Whirl-Pak bag.

The measurer would then ask to see the source of the water supplied by the respondent, and would collect a sample directly from the source into the designated bottle (for arsenic test) and in a Whirl-Pak bag (for *E. coli*). Where feasible, the water was flushed for 30 seconds before collecting samples from source sites; for sources at which water is collected by hand, flushing was not necessary. As there was no sterilization of the source prior to sampling, it is possible that some of the *E. coli* contamination found in the source water tests was due to unsanitary handling by users of the taps or tubewell spouts rather than the water source itself being contaminated.

2.4 Arsenic testing

Arsenic was measured using the Arsenic Econo-Quick™ Test Kit (Industrial Test Systems, USA), which yields a semi-quantitative measure of arsenic in drinking water, following the same methods as MICS 2012-13. Table 3 indicates the testing procedure.

Table 3: Arsenic testing procedure

Step	Instructions
1	Put on gloves.
2	Slowly fill the reaction bottle to top line (100 mL) with sample water.
3	Add 3 level pink spoonfuls of Reagent 1 to the Reaction bottle. Close using the yellow cap and shake vigorously, with bottle upright, for 15 seconds (approximately 60 times).
4	Uncap the Reaction bottle and add 3 level red spoonfuls of Reagent 2. Close using the yellow cap and shake vigorously, with bottle upright, for 15 seconds (approximately 60 times). Allow the sample to sit for 2 minutes. The water may turn yellow, this is normal.
5	Uncap the Reaction bottle and add 3 level white spoonfuls of Reagent 3. Close using the yellow cap and shake vigorously, with bottle upright, for 5 seconds (approximately 20 times).
6	Remove the yellow cap and replace with the white cap immediately. Make sure that the white cap does not get wet.
7	Remove one test strip, and immediately close the test strip bottle. Open the white cap tip and insert the test strip through the small hole. Make sure the red line is facing the back of the cap, and the bromide paper square is inside the bottle. Insert the strip until the red line is touching the tip. Close the tip. Make sure the test strip does not touch the contents of the bottle; otherwise the reaction will not take place.
8	Wait 10 minutes (no longer than 12 minutes).
9	Open the tip and remove the test strip, making sure the strip does not touch the liquid. Check the color of the bromide paper square against the colour chart by placing the test pad behind the punched holes, and record the arsenic level in ppb. Only use the levels indicated on the chart: 0, 10, 25, 50, 100, 200, 300, 500, and >500. If the color on the bromide paper square is in between two of these colors on the colour chart, use the higher value. Make sure to check the colour against the colour chart within 30 seconds of removing the paper.
10	Clean up. Place the test strip paper in the bag marked USED Mercuric Bromide Test Strips. Dispose of the test water, make sure that the place of disposal is not associated with food preparation. Shake any powder off of the spoons and place them back in the plastic bag.

The Bangladesh standard for tolerable level of arsenic in drinking water is 50 ppb, which is considerably higher than the WHO guidelines of 10 ppb. This report also uses a non-statutory level of 200 ppb as the level of high risk as some groundwaters in Bangladesh are highly contaminated.

2.5 *E. coli* testing

Assessment of faecal contamination was done by the enumeration of *Escherichia coli* (*E. coli*) in 100 mL water samples. *E. coli* is the preferred indicator of faecal contamination (WHO/UNICEF, 2017; WHO, 2017a). In MICS6, following the same methods as MICS5, *E.*

coli was measured in the field (Table 2) by filtering 100 mL of sample water through a 0.45 µm filter (Millipore Microfil®), which was then placed onto compact dry growth media plates. The plates contain a chromogenic compound (X-gluc) that is metabolised by the beta-glucuronidase enzyme produced by *E. coli*, resulting in blue/green coloured colonies. The field teams were equipped with incubation belts for storing the media plates close to their bodies so as to provide the appropriate temperature (37°C) for E coli colony growth. After 24 hours, the number of blue/green colonies, each signifying the presence of an *E. coli* colony forming unit (cfu), was recorded. Laboratory testing of the duplicates was undertaken using membrane filtration with mTEC media.

Bangladesh has set a standard that no *E. coli* should be found in a 100 mL sample of drinking water. This is aligned with the WHO Guidelines for Drinking Water Quality (WHO, 2017b).

Table 4: Field *E. coli* testing procedure

Step	Descriptions
1	Sanitize hands using the hand sanitizer gel.
2	Open Compact Dry Plate packet. Use the Marker pen to label a Compact Dry plate.
3	Tear open an alcohol wipe. Use the alcohol wipe to sterilize the forcep and the top of the filtration stand and frit (use forceps to keep wipe from sticking to the rough surface).
4	Place the forceps on top of the alcohol wipe to keep it sterile.
5	Remove one membrane filter from box. Remove the white gridded filter (discard the blue paper) – do not allow the filter to touch any other surfaces or your fingers; if dropped accidentally, use a new one.
6	Place the filter, gridded side up, on top of the filtration stand.
7	Remove funnel from the plastic sleeve; be careful not to touch the inside of the funnel.
8	Lock the funnel onto the filtration stand, touching only the outside of the funnel.
9	Fill the funnel with the water sample up to the 100 mL mark.
10	Open one sterile 1 mL disposable syringe and withdraw 1 mL of sample water.
11	Use the other hand to lift off the cover of the Compact Dry plate and add the 1 mL from the syringe.
12	Switch the blue valve on the filtration stand into the open position (vertical).
13	Use the large syringe to slowly pull the entire water sample through the filter; discard the water in the syringe.
14	Carefully remove and discard the funnel, leaving the filter on the filtration stand.
15	Use the sterile forceps to remove the filter from the filtration stand.
16	Place the filter, gridded side up, onto the plate.
17	Wipe down the surface of the filtration stand and allow any water still inside to drain out.
18	Collect all garbage and dispose of properly; show respect to households and do not leave behind any materials.
19	Place the Compact dry plate into the incubation belt. Only place one plate in each of the pockets.
20	Incubate for 24-48 hours and then record result in water quality questionnaire.

2.6 Data analysis

The water quality results were recorded on paper questionnaires, and the Bangladesh Bureau of Statistics carried out the subsequent data entry. Analysis reported in this document is based on the datasets available from the MICS website, and additional data provided by UNICEF Bangladesh and icddr,b. All data analyses were done with SPSS version 26 to calculate true estimates. Weighted estimates were produced using MICS weights as appropriate for sample subsets.

During data analysis the number of colony forming units (CFU) counted by the measurers on the compact dry plates were categorized into risk groups, corresponding with WHO risk categories which is further detailed in Section 4. Data are compared to results from MICS 2012-13 and other available data from Bangladesh on water quality.

Safely managed water and sanitation were estimated using MICS methods that require a water or sanitation system to meet all the requirements simultaneously. This differs from the JMP method which uses data from multiple sources. For drinking water, the JMP defines the proportion of the population with access to safely managed drinking water as the minimum value for those using improved supplies from data on accessibility, availability and quality (WHO/UNICEF, 2017). In both cases, safely managed drinking water is calculated using water quality data from the PoC. In this report, for discussion of safely managed drinking water, we refer to those with access to water an improved drinking water source located on premises, free of E. coli, with <50 ppb arsenic and available when needed. For this analysis, the estimation of safely managed sanitation was based on the JMP methodology which considers safely managed sanitation services as safe emptying, collection and disposal of excreta by a service provider. Household disposal of excreta from onsite facilities are not considered safely managed. Onsite sanitation system that has not been emptied is considered safely contained and therefore managed. Finally, as there is insufficient data on the treatment and disposal of piped wastewater from the household, it is not considered safely managed by the JMP methodology.

For analysis of stunting, due to restrictions in the data available for both water quality and anthropometric data, analysis uses averages at the district level to explore associations.

3 Arsenic contamination results

Arsenic was tested in 12,238 household water and 3,028 source water samples[4]. Based on the level of arsenic concentrations, the results have been grouped into three key risk categories as described in Table 3.

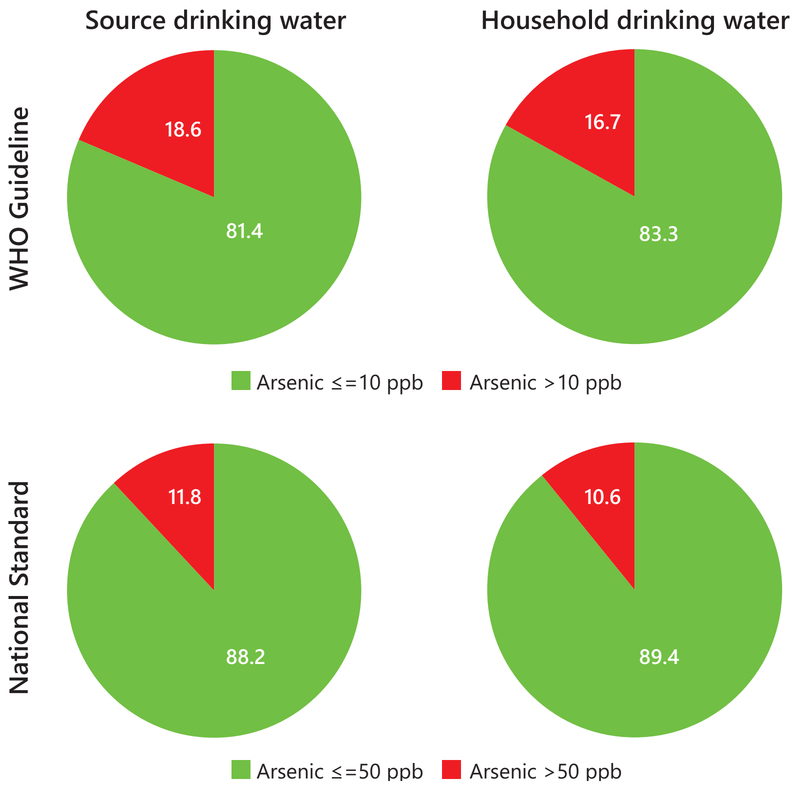
Table 5: Description of reference arsenic concentrations

Arsenic (ppb)	Description of significance
<=10	WHO provisional guideline value for drinking water since 1993. The same value has been adopted as a standard by the US EPA and the European Union amongst others.
<-50	The Bangladesh Standard for drinking water. The same value applies in some other severely arsenic affected countries. This was the WHO guideline value for drinking water up to 1993.
>=200	A non-statutory standard, used to allow comparison with MICS 2012-2013 reporting, to characterise high levels of health risk for descriptive statistics.

Figure 1 presents the summary of test results with reference to Bangladesh and WHO drinking water standards, respectively, both for the household and source water samples. Source water samples had slightly higher proportions (18.5 percent) of samples exceeding the WHO limit compared to the household samples (16.7 percent). In the case of the Bangladesh standard, the difference is smaller where 11.8 percent of samples of source water exceeded the limit, compared to about 10.6 percent of household samples. This small difference could have been resulted from passive sedimentation of arsenic along with iron as most households do not use any removal technology apart from storing water at household after collection.

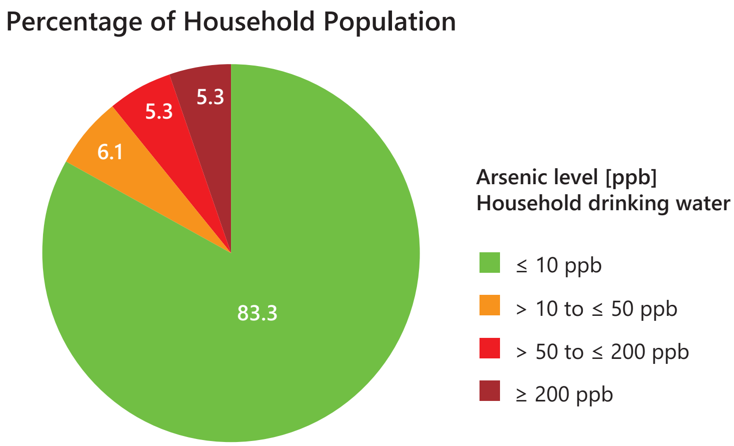
4 Arsenic is not expect to change significantly between the source and point of collection, or between the storage and point of use unless any arsenic removal technology is used. Therefore, for this section the broader terms of source and household are used to define the point of sampling.

Figure 1: **Arsenic in source and household drinking water from sources compared with the WHO Guidelines (10 ppb) and national standard (50 ppb) in percent**



Analysis of household drinking water samples indicates that 83.3 percent of the population consumes water within the level of WHO guideline (Figure 2), while six percent consume water having concentrations between >10 and <50 ppb and over five percent drink water with a level of arsenic between >50 and <200 ppb. A little over five percent of the household population drink in excess of 200 ppb, the highest risk category. In total, 89.4 percent of the population drink within Bangladesh limit and remaining 10.6 percent consume above the 50 ppb level.

Figure 2: **Arsenic risk levels in household drinking water (in percent)**



3.1 Arsenic by type of drinking water source

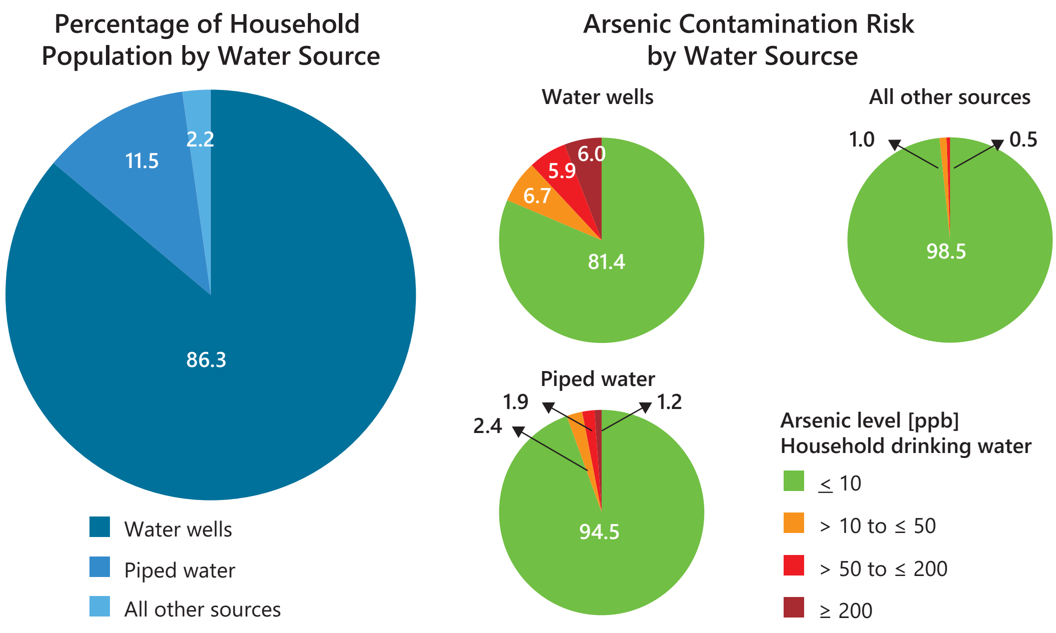
The majority of the population surveyed in Bangladesh had access to an improved drinking water source (98.5 percent). Of those using an improved source, 10.7 percent consume water with arsenic concentrations above the Bangladesh standard of 50 ppb, while 16.9 percent use water over the WHO provisional guidelines (Table A3.1 in the appendices).

Tubewells used by over 86 percent of the population , had the highest proportions of samples exceeding 50 ppb (11.9 percent). Shallow tubewells are more likely to be contaminated than deep tubewells (typically classified as deeper than 500 ft), however, the MICS questionnaire does not allow differentiation between shallow and deep tubewells.

The second most common type of water supply is piped water used by 11.5 percent of the household population. Piped water was found to have much lower concentrations of arsenic with 3 percent exceeding 50 ppb and 5.5 percent above 10 ppb. However, about 1.0 percent of the household water samples contained arsenic >= 200 ppb among the piped supplies.

A very small proportion of the population use other sources including unimproved sources (2.2 percent). These other sources were generally lower risk for arsenic. Rain water, bottled water and kiosk water sources were all safe in terms of arsenic with 100 percent samples bellow the Bangladesh guideline value. A small proportion of samples from surface water exceeded the 50 ppb limit. Figure 3.1 presents the proportions of households falling into different arsenic risk categories according to water source types. Water sources located within the household have relatively lower arsenic risk (7 percent >50 ppb) compared to >1 percent wells falling in the same category located outside the dwelling.

Figure 3: **Arsenic contamination in household water from water sources by type, quality, and location of drinking water source**

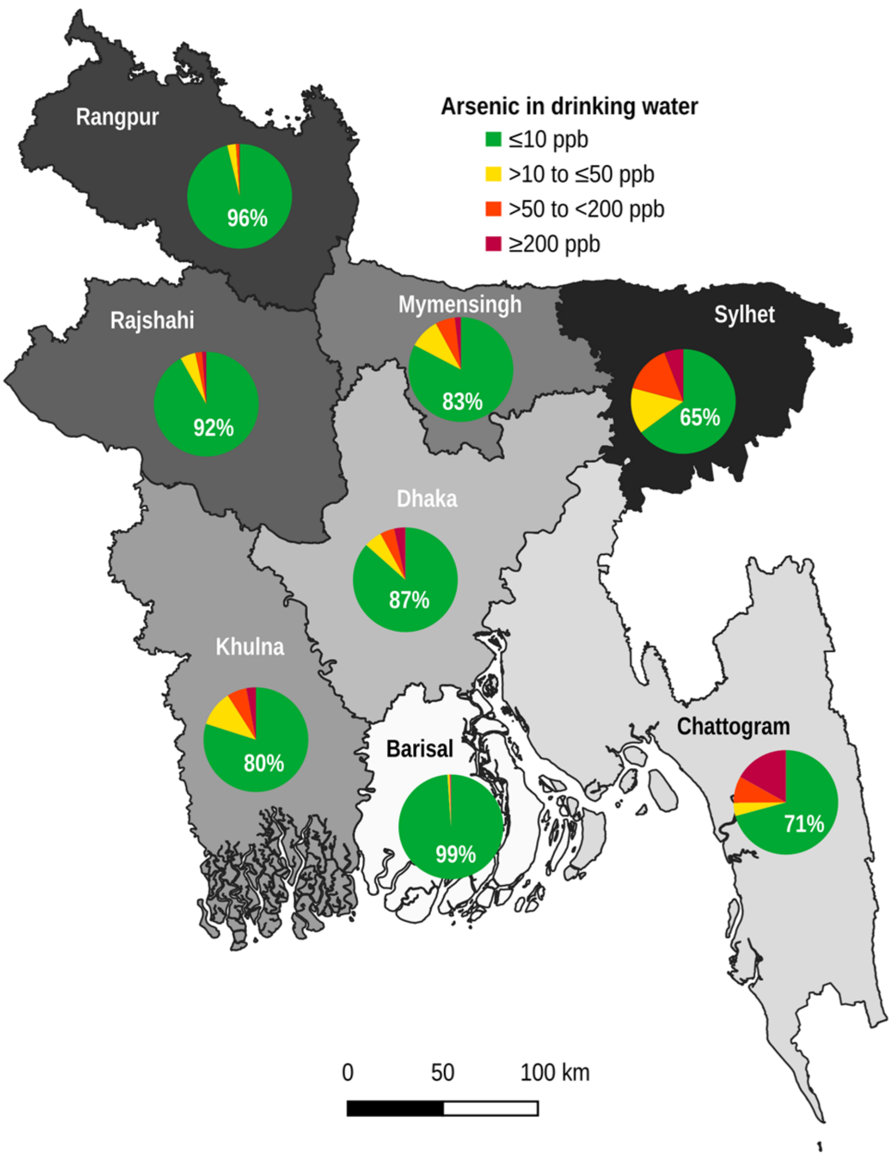


3.2 Geographic variability in arsenic

There are strong geographic variations in arsenic contamination in drinking water based due to the local geogenic contamination as well as the differences in water systems.

At Divisional level, the prevalence of arsenic reflects the geology (Figure 4, Table A3.2), with the highest prevalence in Chattogram division, where about 25.1 percent of the population surveyed are exposed to levels above the Bangladesh Standard of 50 ppb. In contrast, in Barishal division almost 100 percent of the population drink water within the WHO and Bangladesh limits. Sylhet has the highest proportions of the household population drinking water with arsenic above WHO level of 10 ppb (35.1 percent). About 17% of the surveyed population in Chattogram division are exposed to very high levels >= 200 ppb arsenic followed by Sylhet (5.9 percent), Dhaka (3.5 percent) and (3.5 percent) and Khulna (3 percent).

Figure 4: **Division wise distribution of proportions of people exposed to four arsenic risk categories.**



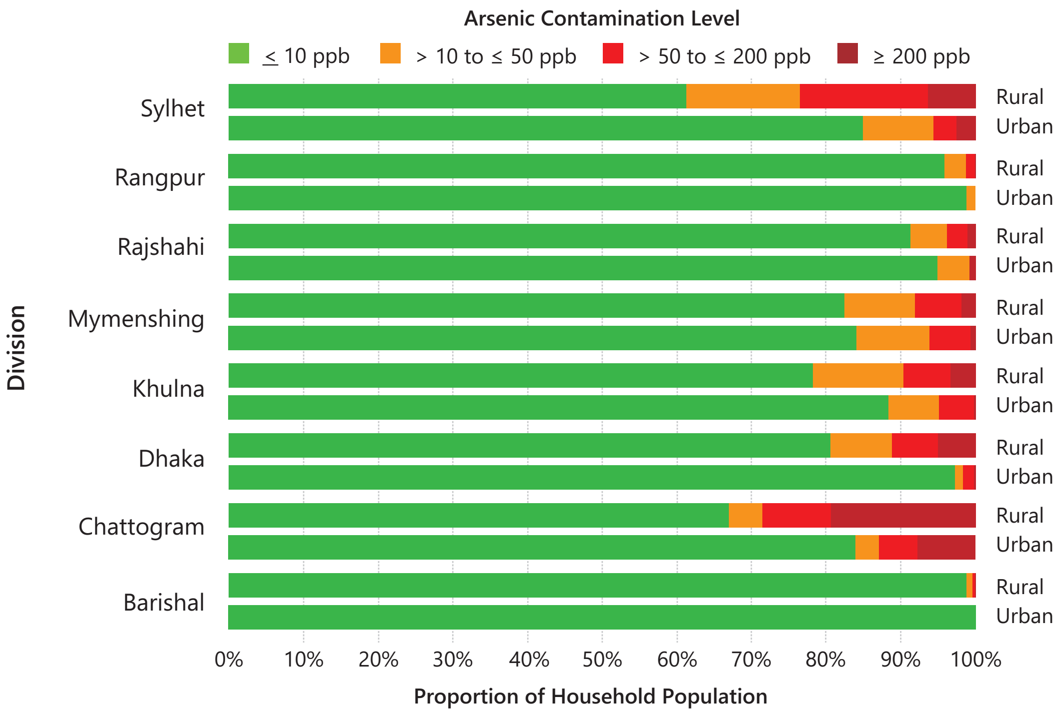
There are marked differences in arsenic exposure between urban and rural households. Overall, the urban population has better quality water compared to the rural population with 92.5 percent in urban areas having access to drinking water with less than 10 ppb arsenic compared to 80.7 percent in rural areas (Table 4). 12.3 percent of people in rural areas are exposed to the >50 ppb level compared to 4.5 percent in urban areas. The proportion of the population exposed to >=200 ppb is about three time higher in rural areas (6.2 percent) than in urban areas (2.1 percent). This marked difference may be due to higher proportions of piped water sources in urban areas compared to higher proportions of tubewells in rural areas.

Table 6: Arsenic contamination by area

Area	Risk level based on Arsenic in household drinking water					Percent over 10 ppb	Percent over 50 ppb	Number of household members	Percent of household population
	≤10 ppb	>10 to ≤50 ppb	>50 to <200 ppb	≥200 ppb	Total				
Rural	80.7	7.0	6.2	6.2	100.0	19.3	12.3	41,080	78.3
Urban	92.5	3.0	2.4	2.1	100.0	7.5	4.5	11,399	21.7
Total	**83.3**	**6.1**	**5.4**	**5.3**	**100.0**	**16.7**	**10.6**	**52,479**	**100.0**

The geographic differences across divisions are reflected in the urban-rural divide (Figure 5, Tables A3.3. and A3.4). The widest divide is found in Sylhet, where 6 percent of the urban population are exposed to 50 ppb compared to 24 percent of rural population. High differences also exit in Chattogram and Dhaka divisions.

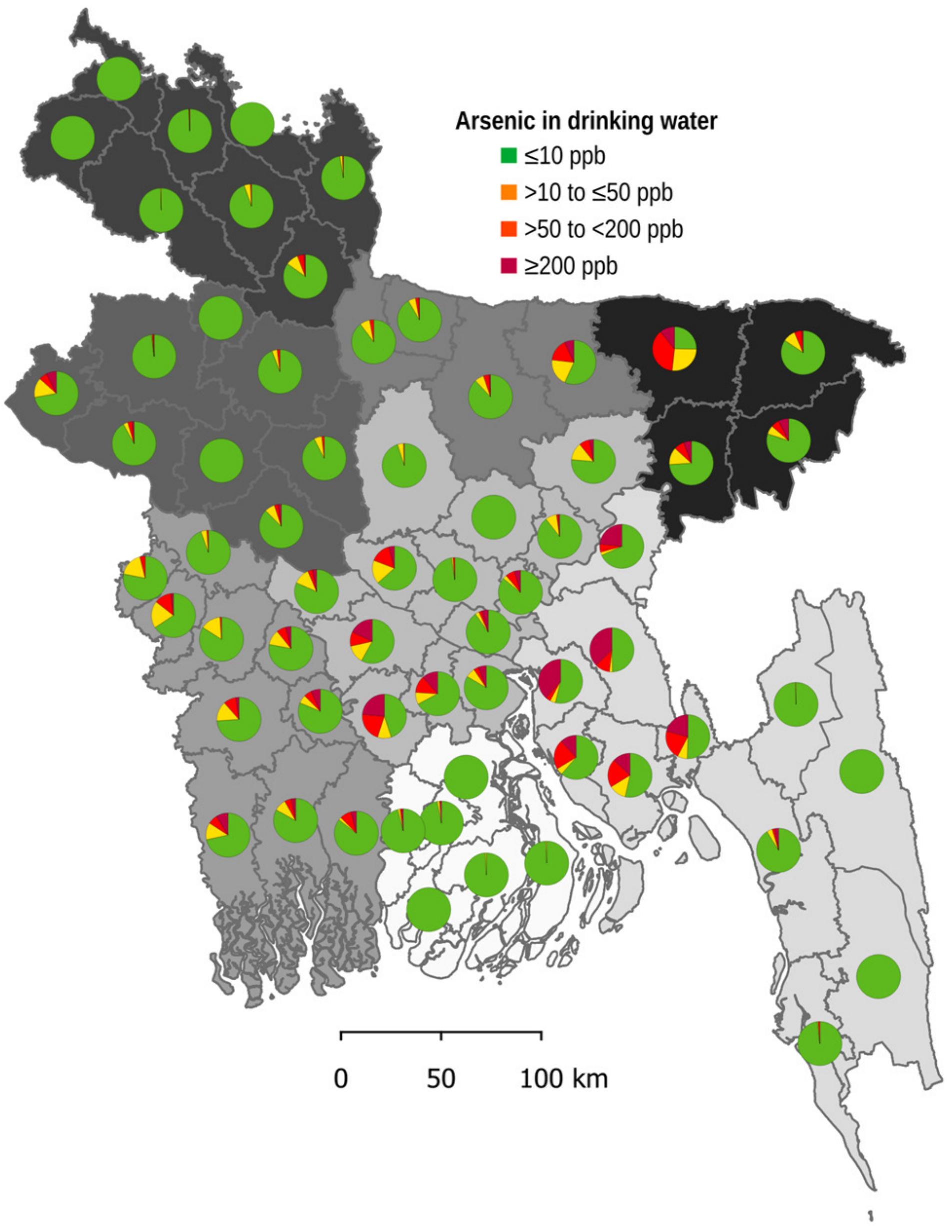
Figure 5: Contamination comparison between rural and urban population in different divisions.



An analysis of arsenic by district provides a more granular view of the geographic variability. The proportions of household water samples exceeding 50 ppb ranged from 0 percent up to 48 percent (Figure 6, Table A3.5). In line with this analysis, districts were categorized by the proportion of samples that exceeded the Bangladesh limit as shown in Figure 7:

- No Risk where no sample exceeded the limit (14),
- Low Risk where 0.1 to 10 percent of samples exceeded the limit (27),
- Medium Risk where 10.1 to 20 percent exceeded the limit (11),
- High Risk where 20.1 to 30 percent exceeded the limit (4) and
- Very High Risk where 30.1 percent or more exceeded the limit (8).

Figure 6: **Percentages of household population exposed to different arsenic categories in 64 districts**



In terms of concentrations >= 200 ppb, the districts of Chandpur, Cumilla are in the very high risk category and districts of Brahmanbaria, Gopalganj and Feni are considered high risk; and Faridpur, Lakshmipur, Noakhali, Madaripur and Sunamganj has Medium Risk. The high-risk districts are shown in Figure 8 and Figure 9.

Figure 7: **Number of districts classified into various risk categories as per percentages of household population consuming water with a) >50 ppb arsenic and b) >200 ppb arsenic.**

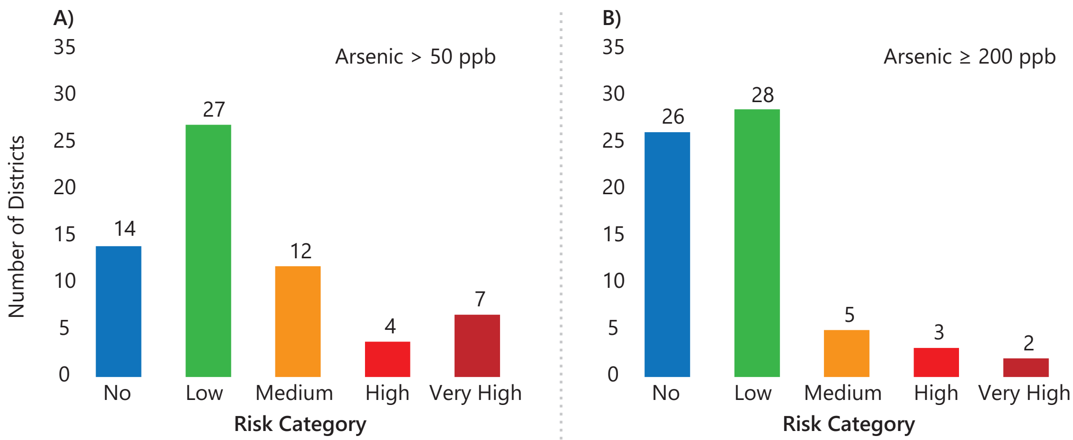


Figure 8: **High risk districts in terms of exposed population to (A) 50 (left) and (B) 200 ppb arsenic levels (right)**

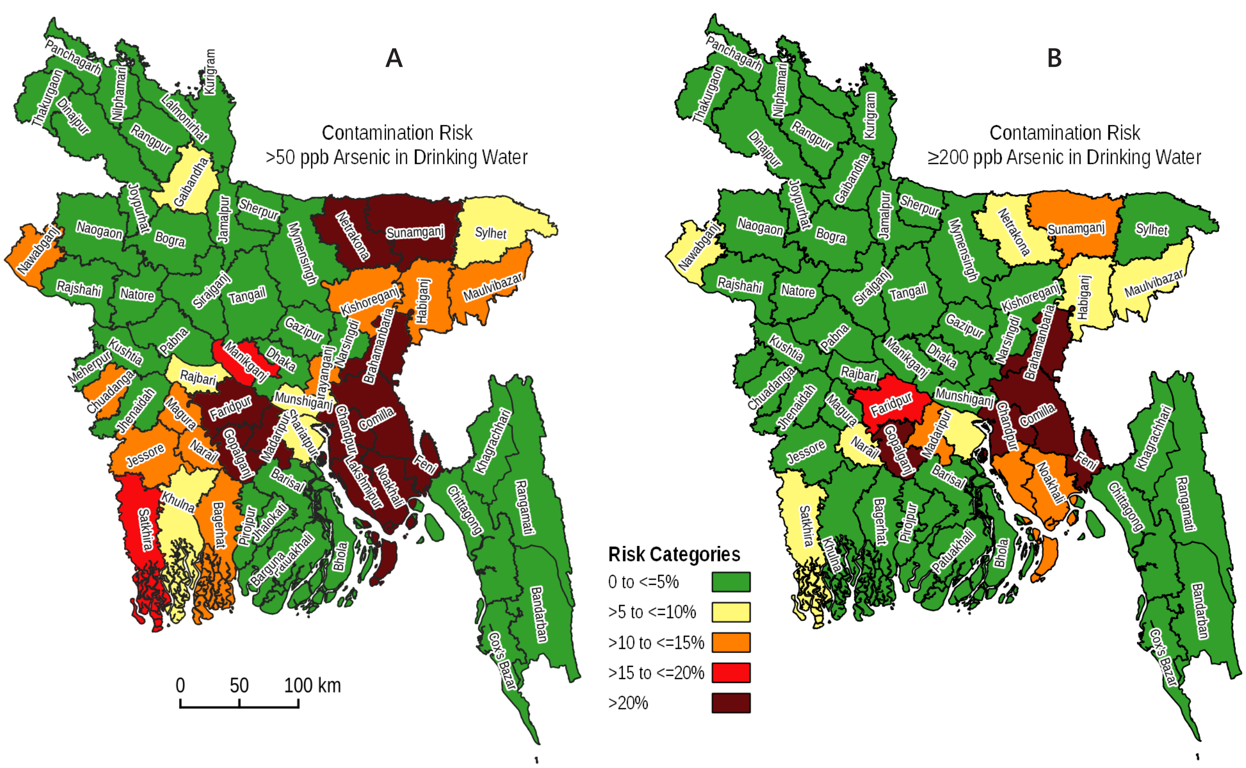
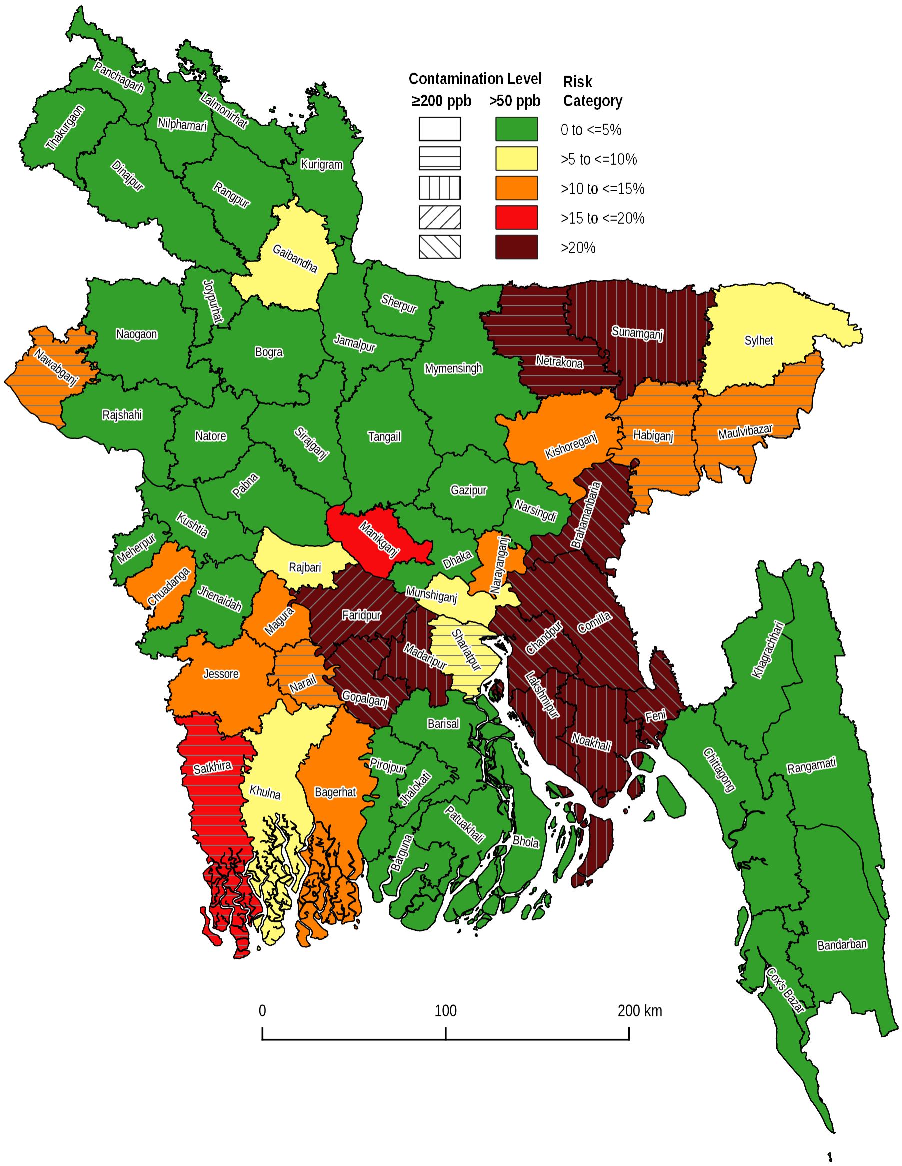


Figure 9: Combined map of high-risk districts in terms of exposed population to 50 and 200 ppb arsenic levels



3.3 Arsenic by socio-economic status and education

With regards to wealth class and arsenic risk categories, there is an apparent trend among the five wealth classes (Figure 10, Table A3.6). For both >10 ppb and >50 ppb, the proportion of the population exposed to arsenic increased with wealth from the poorest quintile, expect for the wealthiest quintile which had the lowest exposure to arsenic in drinking water. A similar trend is also apparent for the >= 200 ppb arsenic category. A likely explanation for this could be that the poorer communities tend to rely more on public/community water sources with higher likelihood of being tested and having lower arsenic levels compared to individually owned sources. The drop in exposure levels for the richest community could be due to relatively higher access to piped water associated with greater investments for deep and arsenic safe tubewells.

Arsenic contamination in drinking water decreased with the level of education of the household head (Figure 11). This could be linked to higher level of awareness about arsenic safe water among the head of households with higher levels of education.

Figure 10: **Relationship between arsenic contamination and wealth classes**

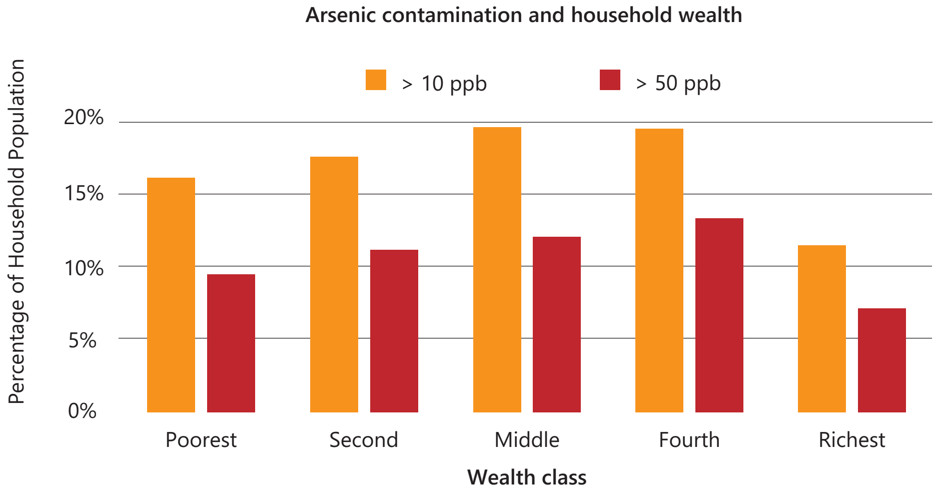
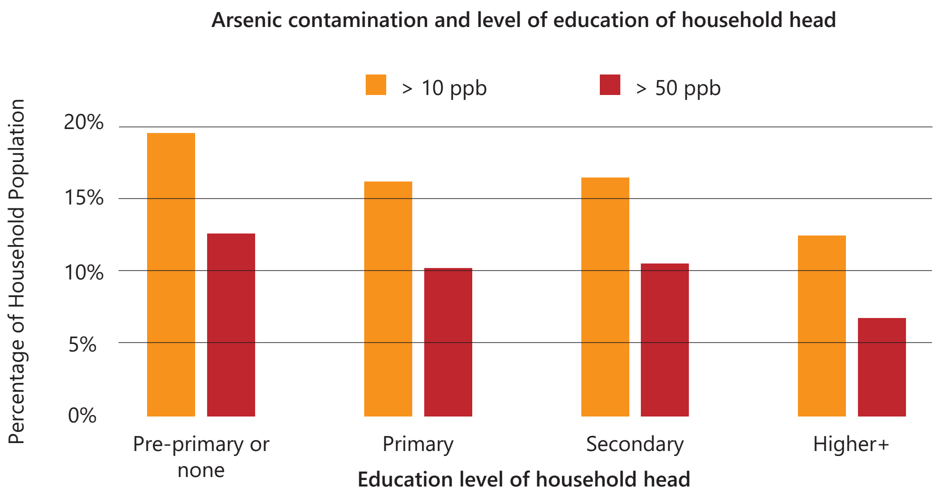


Figure 11: **Relationship between arsenic contamination and level of education of household head**

b)



3.4 Changes in water quality (arsenic) since MICS 2012-13

Data from the three MICS carried out in 2009, 2012-13 and 2019 have been compared at national and divisional levels to assess the progress of arsenic mitigation (Table A3.7). At the national level, strong progress has been made with increases in the proportion of the population with access to water below the WHO guide level value of 10 ppb; the proportion of households in this category has increased from 68 percent in 2009 to 75 percent in 2012-13 and 83 percent in 2019. However, the proportion of samples exceeding 50 ppb level show only a very slight decline of 1 percent between 2009 to 2019 (Figure 12).

Notably, the proportion of samples having >=200 ppb arsenic has increased in 2019 to 5.3 percent; it was previously 2.8 percent in 2013 and 3.4 percent in 2009. These two issues, i.e. very slow rate of decline in >50 ppb level and increase in >=200 ppb level need special attention during future planning of arsenic mitigation. Although it is heartening to see the significant increase in proportion of samples at the WHO guide level, however, there is also higher uncertainty of field kit measurements for the 10-50 ppb ranges. Stringent quality control during testing can reduce this uncertainty.

Figure 12: **Trend in contamination proportion on household data**

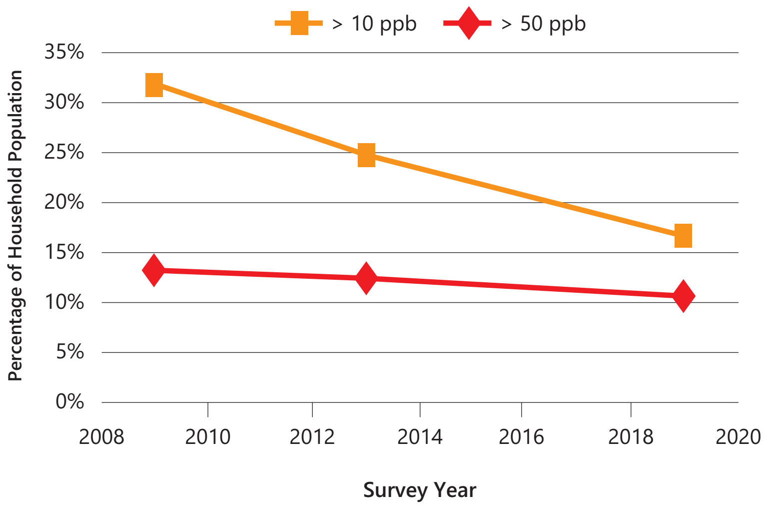


Figure 13 presents the comparisons of three MICS campaigns at divisional level. It is evident from the figure that systematic improvement has taken place in the all the divisions with varying proportions. Across all divisions, the proportion of people with access to drinking water that meets the WHO limit of <10 ppb has increased from 2013 to 2019, with notable increases in Mymensingh and Dhaka. However, this trend is not true for the Bangladesh limit of 50 ppb or for the >=200 ppb category. Chattogram has seen increases in the proportion of the population with arsenic above 50 ppb and above 200 ppb between 2012-13 and 2019, while Sylhet and Khulna have seen increases in those with arsenic >=200 ppb.

Remarkable improvements have been achieved in Rangpur and Rajshahi divisions. The situation is worst in Sylhet, followed by Chattogram, Khulna, Mymensingh and, to some extent, in Dhaka divisions, where major interventions are needed for providing arsenic safe water for all. Proportions of households consuming at both WHO and Bangladesh have increased in all cases.

As the data do not allow mapping below district level, it is not possible to identify the Upazila where high risk zones are located. But it is possible to identify the districts (Figure 9) where larger proportion of populations are exposed to high risks. These districts are Chandpur, Cumilla, Brahmanbaria, Lakshmipur, Noakhali and Feni of Chattogram division; Gopalganj, Faridpur and Madaripur of Dhaka division; Netrakona of Mymenshingh division; and Sunamganj of Sylhet division.

Figure 13: Comparison of contamination scenario by division using household arsenic data.

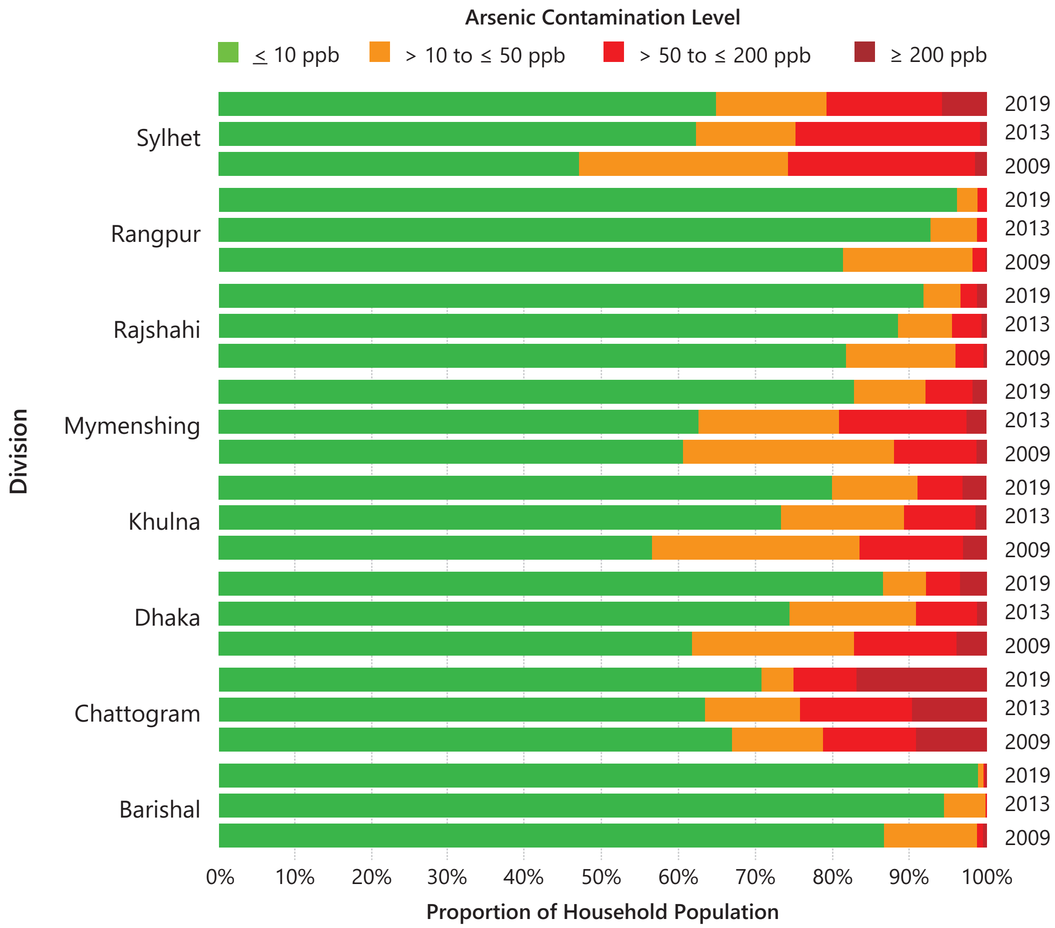


Figure 14: Trend in population exposure

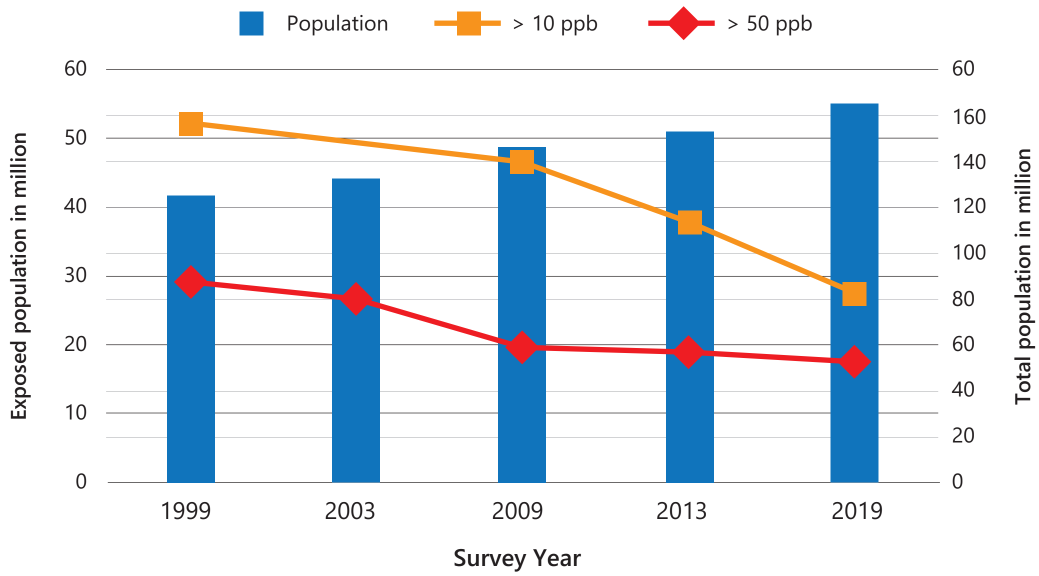


Table 7: Year to year population exposure. Total population based on United National Department of Economic and Social Affairs (2019).

Year	Agency	Survey Type	Test Method	Number of Samples	%>10 ppb	% >50 ppb	Total Population (million)	Population exposed >10 ppb (million)	Population exposed >50 ppb (million)
1998-99	BGS/ DPHE	Random	Laboratory	3,540	42.%	25.%	125.0	52.5	29.2[1]
2002-03	DPHE	Blanket	Field Kit	5,000,000	N/A	20.%	132.5	N/A	26.5
2009	UNICEF/ BBS	Cluster	Digital Arsenator	14,442	32%	13.4%	146.0	46.7	19.6[2]
2013	UNICEF/ BBS	Cluster	Arsenic Econo-Quick™ Test Kit (Industrial Test Systems, USA)	12,952	24.8%	12.4%	152.7	37.9	18.9[3]
2019	**UNICEF/ BBS**	**Cluster**	**Field Kit with Lab QC**	**12,933**	**16.7%**	**10.6%**	**164.7**	**27.5**	**17.5**

[1] 29.2 is the Government of Bangladesh estimate for >50 ppb category after adjustment to national scale, 52.5 is our estimate for >10 ppb category without any adjustment

[2]Previously reported estimates were 52.2 and 22 million for >10 and >50 ppb categories, respectively considering country population of 164 million in 2010. This is clearly a mistake, country population in 2010 was 146 million. [3]Previously reported estimates were 38.8 and 19.4 million for >10 and >50 ppb categories, respectively considering country population of 156.5 millions in 2013.

Since the first National Hydrochemical Survey conducted in 1999-2000, as shown in Table 7 and Figure 14, the number of people drinking arsenic safe water has increased. Rapid progress on reducing the population exposed to arsenic above 50 ppb was made during the decade 1999 to 2009 when the exposed population declined from 29.2 million to 19.6 million. Over the more recent decade, from 2009-2019, the rate of decline for those exposed to arsenic above 50 ppb has stagnated, reducing from 19.6 to 17.5 million, while the rate for those exposed to arsenic above 10 ppb has accelerated. Rapid progress made during the first decade can be attributed to high levels of activity by the government, development partners and NGOs. However, the interest faded out from 2009 onwards and there was no large-scale arsenic mitigation project and that is the reason for slow rate of decline. An important issue should be kept in mind that during this time Bangladesh population has increased from 122 million to 156 million. Despite this growth, rate of exposure above 50 ppb levels continued to decline (Figure 14).

3.5 Quality control for arsenic data

Duplicate analyses were undertaken in the field to evaluate the quality of performance by the survey team measurer, and in the laboratory to evaluate the performance of the field tests.

There were an inadequate number of samples in the higher category for making any statistical judgment to apply a correction to the national dataset. Also, samples for laboratory testing have not been collected randomly from all districts. Therefore, it was decided to report the national statistics using the survey data as it is and provide a summary of how much changes could there be if a correction based on the limited and non-representative quality control dataset is applied. There is adequate data only for the <=10 ppb class (Table 6) and if the correction is applied, the proportion of samples in this category would reduce from 83.3 percent to 71.7 percent. At the same time, the proportions of wells in the >10 to <=50 ppb would increase from 6.1 percent to 15.7 percent and the percentages of samples in >50ppb category would slightly increase from 10.6 percent to 12.6 percent.

Table 8: Quality control data analysis

Count - HH_ID	Category Arsenic POU Lab (ppb)				
Category Arsenic POU Field (ppb)	<=10	11 -50	200+	51-200	Total Result
1<=10	180	24	1	4	209
11-50	2	9		6	17
200+			4	2	6
51-200				8	8
Total Result	182	33	5	20	240

National Summary	<=10 ppb	<=10 to <=50 ppb	>=50 ppb	Total
Without correction	83.3%	6.1%	10.6%	100.%
With correction	**71.7%**	**15.7%**	**12.6%**	**100.%**

4 Microbiological water quality

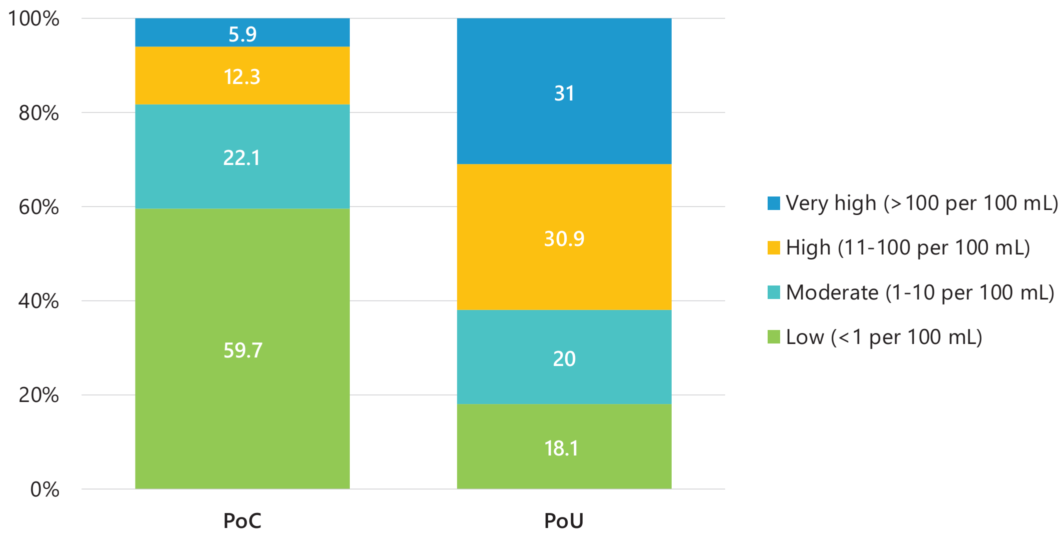
Microbiological water quality was assessed using a single sample analysed for the faecal indicator bacteria, *E. coli*. *E. coli* are recognised as the most precise indicator of faecal pollution in freshwater because they largely originate from human and warm-blooded animal faeces; however, they can also be naturalized in water environments and in soils (Charles, Nowicki, & Bartram, 2020), Nowicki et al., 2021. Nevertheless, presence of *E. coli* in drinking water is linked with increased risk of diarrhoea (Gruber, Ercumen, & Colford, 2014).

The *E. coli* data, which are reported as colony forming unit (CFU) counts, were grouped into four risk categories based on the WHO Guidelines for Drinking Water Quality (2017) (but without information from sanitary inspections) as shown in Table 9.

Table 9: *E. coli* risk categories

E. coli [cfu/100 ml]	Risk Level	Priority for Action
<1	Low	None
1 – 10	Moderate	Low
11-100	High	Higher
>100	Very High	Urgent

Figure 15: *E. coli* risk levels in PoC and PoU drinking water

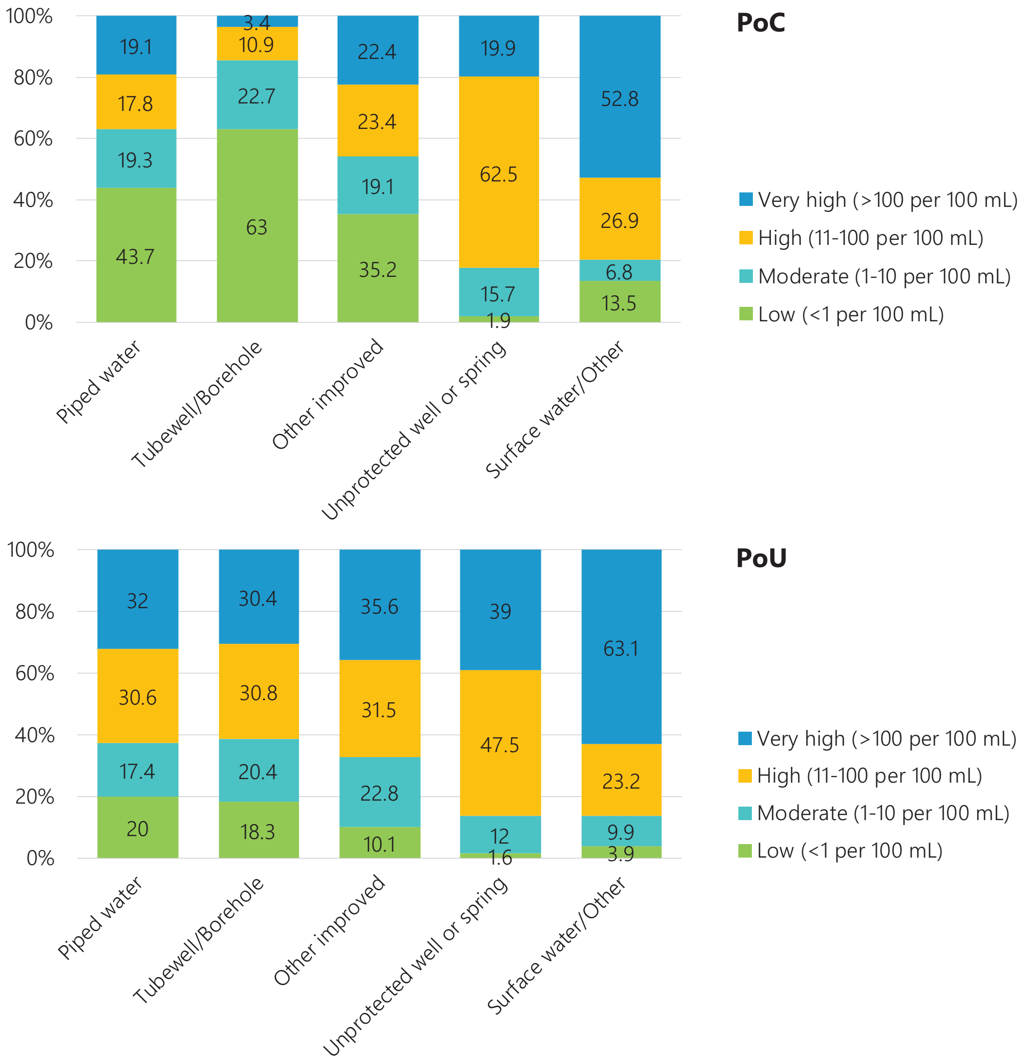


This section will present the assessment of microbial contamination in drinking water for MICS6, providing breakdowns by source, geography, and socio-economic indicators, as well as by other WASH indicators, before comparing the MICS6 data to that collected in 2012-13 as part of MICS5. Overall, in MICS6, 40.3 percent of households used a water source containing *E. coli* at the PoC (Figure 15). Notably, the drinking water at the point of use (PoU) was even more likely to be unsafe: 81.9 percent of households provided a glass of drinking water that contained *E. coli*.

4.1 Microbiological water quality by type of drinking water source

The risk of faecal contamination varies by type of water supply. The majority of the population in Bangladesh (98.6 percent) report using an improved drinking water source as their main source of water. Sources types that are considered 'improved' are better protected from faecal contamination by their design and construction (WHO/UNICEF, 2017), they include piped water, boreholes or tubewells, protected dug wells, rainwater, and packaged or delivered water.

Figure 16: ***E. coli*** **risk levels in PoC (top) and PoU (bottom) water by source type**



Nevertheless, even when sources are protected, faecal contamination may still occur due to damage to the infrastructure, poor management or poor hygiene practices at the PoC. The risk of faecal contamination in water varies by type of water supply for PoC water quality and PoU water quality (Figure 16; Tables A4.1& A4.2). Improved sources were free of *E. coli* at the PoC in more than 60 percent of cases, but results varied between types. Tubewells were most frequently low risk (63.0 percent), while 43.7 percent of piped water supplies were low risk, and 35.5 percent of other improved sources were low risk; it is not possible to differentiate shallow tubewells from deep tubewells as this data is not collected.

4.2 Water quality at the PoC versus the PoU

Even when water is free from faecal contamination at the PoC, drinking water quality can deteriorate before it is consumed. The potential for faecal contamination to enter the water can occur at different points from the PoC to the PoU through the use of unhygienic containers for collection, transport, storage and use. Conversely, water quality may improve as a result of treatment at household level. For the PoU sample, survey respondents were asked to provide "a glass of water you would give a child to drink", making the sample representative of the water that would be consumed. Only 4.1 percent of households experienced an improvement in microbial contamination risk between the PoC and PoU, which may be attributed to treatment in the household, die-off of *E. coli* since collection, or changes in the source water quality since the water was collected. Water quality deteriorated in 66.8 percent of households (Table 10).

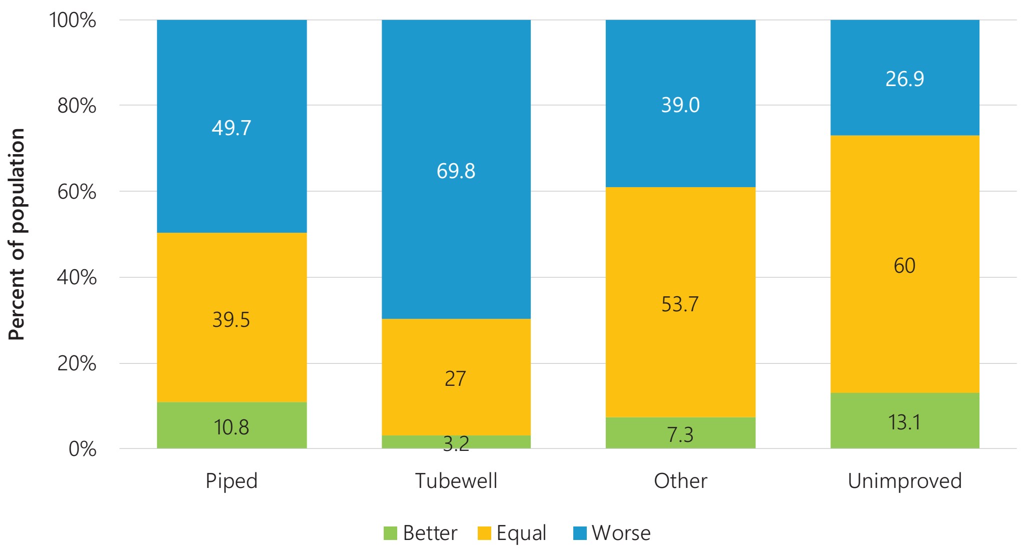
Table 10: Percentage of household water quality samples that demonstrated deterioration of water quality between the PoC and the PoU (orange) or improvements in water quality (green).

***E. coli* risk level in PoU water** [A]	***E. coli* risk level in PoC water**			
	Low (<1 per 100 mL)	Moderate (1-10 per 100 mL)	High (11-100 per 100 mL)	Very high (>100 per 100 mL)
Low (<1 per 100 mL)	25.8	6.6	3.5	6.7
Moderate (1-10 per 100 mL)	23.2	21.3	7.0	6.3
High (11-100 per 100 mL)	29.2	34.0	43.8	16.7
Very high (>100 per 100 mL)	21.7	38.1	45.8	70.3
Total	**100.0**	**100.0**	**100.0**	**100.0**
Number of households	**6069**			
[A] Both source and household *E. coli* tests were conducted in the same household				

Reduction in risk level between PoC and PoU	4.1 percent
No change in risk level between PoC and PoU	29.1 percent
Increase in risk level between PoC and PoU	66.8 percent

In piped water systems, where 49.7 percent were low risk at the PoC, water quality deteriorated between PoC and PoU in 49.7 percent of households sampled. In tubewells, a higher proportion were low risk at the PoC (64.7 percent), but water quality deteriorated from PoC to PoU in 69.7 percent of households sampled (Figure 17) associated with either collection and storage. As a result, the proportion of households sampled which did not have *E. coli* detected at the PoU was 23.1 percent and 18.1 percent for piped water and tubewells, respectively. This reflects that where PoC water quality is low risk, it is more likely that increases in contamination will be measured (Wright, Gundry, & Conroy, 2004). For example in Table 8, 23.2 percent of low risk PoC samples had moderate risk at the PoU, indicating contamination of less than 10 cfu per 100ml; a similar increase for a higher risk PoC samples would not necessarily result in a change of risk category.

Figure 17: **Change in E. coli risk level between PoC and PoU by source type**

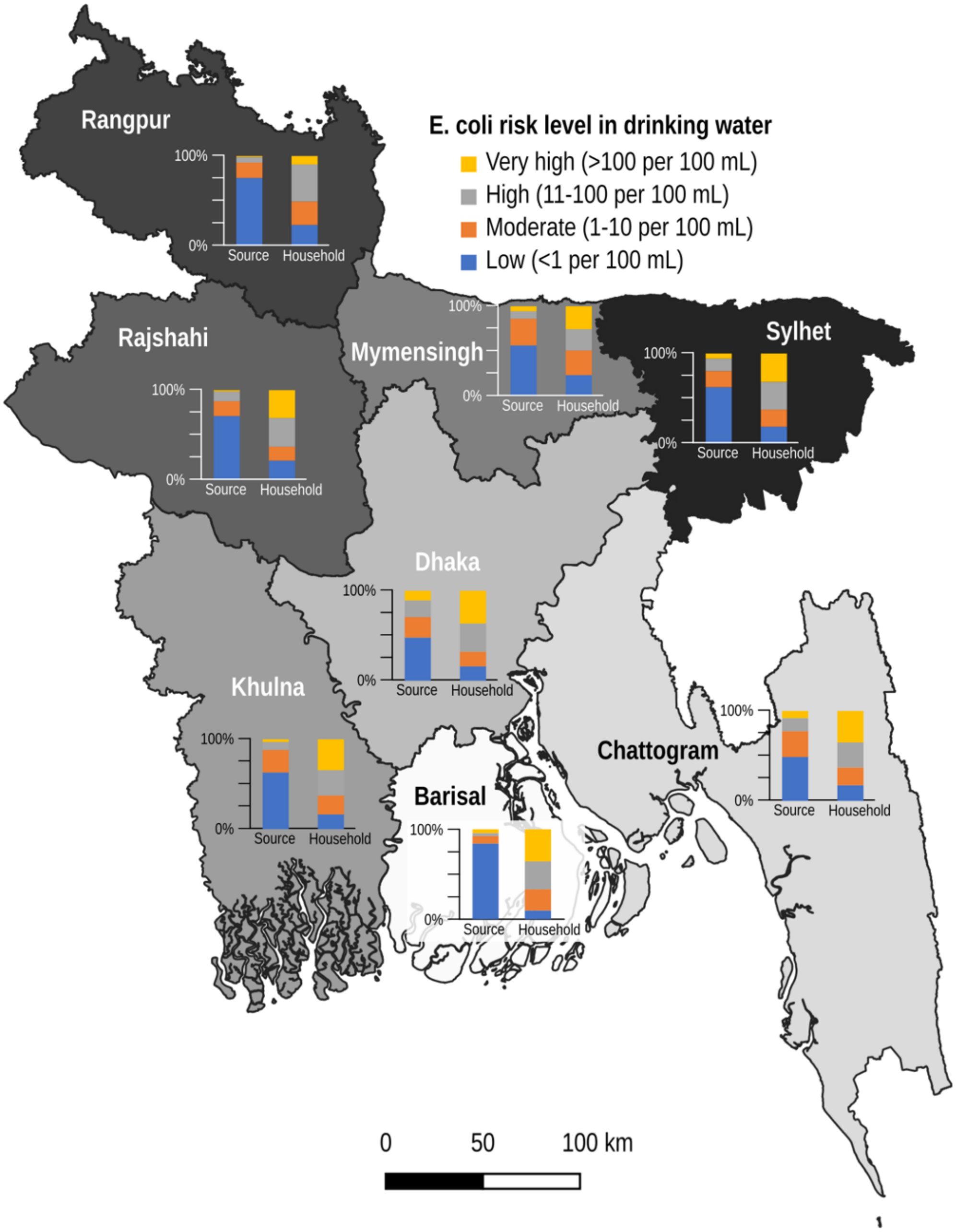


4.3 Geographic and socio-economic variability in water quality

This section provides an analysis of the relationship between geographic and socio-economic variables and microbial water quality. These variations are often linked to water source types and other WASH variables as discussed in the next section.

Inequalities between Divisions are stark which reflect the differences in types of water access (Figure 18). Barisal, where 94.0 percent of the population rely on tubewells and the majority of water sources (55.1 percent) are off-premises, has the highest proportion of the population with access to water that is free from *E. coli* at the PoC (84.1 percent), but the lowest proportion of the population with access to water that is free from *E. coli* at the PoU (9.7 percent).

Figure 18: **Proportion of the population with access to water in the low risk category at the PoC (source) and PoU (household).**



The risk levels at PoC (Figure 19, Tables A4.3 & A4.5) and PoU (Figure 20, Tables A4.4 & A4.6) within each Division highlight inequalities between rural and urban populations. For example, in the Dhaka Division, urban populations had higher proportions of households with very high level of contamination at the PoC (24.4 percent) compared with rural households (2.7 percent). Overall, PoC water was more likely to be contaminated in urban areas (48.0 percent), where piped water access was more common, than in rural areas (38.2 percent), where tubewells served over 9 percent of the population (Table A4.2). Conversely, PoU water was slightly more likely to be contaminated in rural than urban areas (82.5 percent compared to 79.4 percent).

Figure 19: **PoC water risk categories by Division for urban and rural areas**

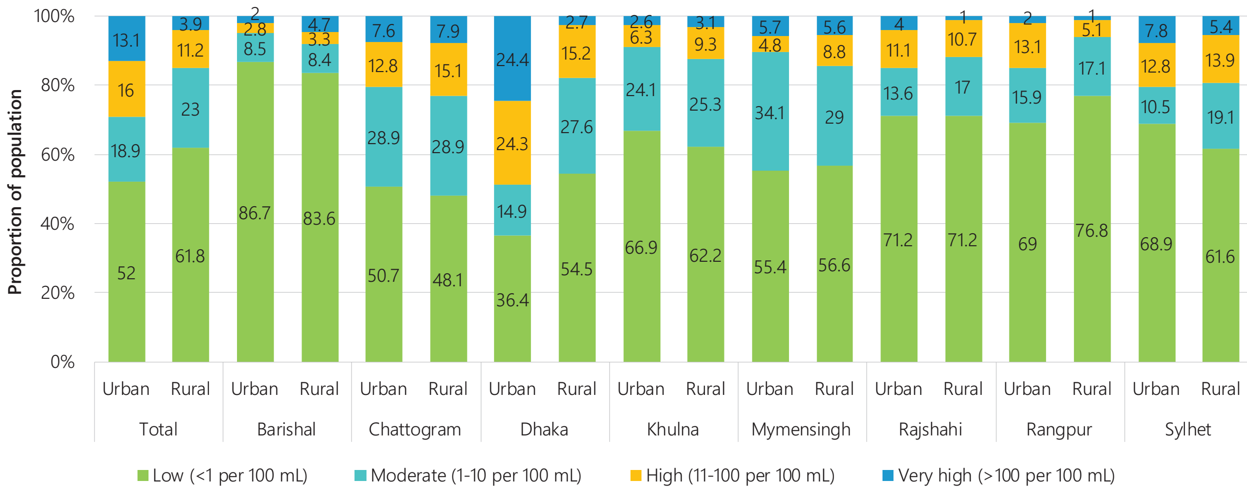
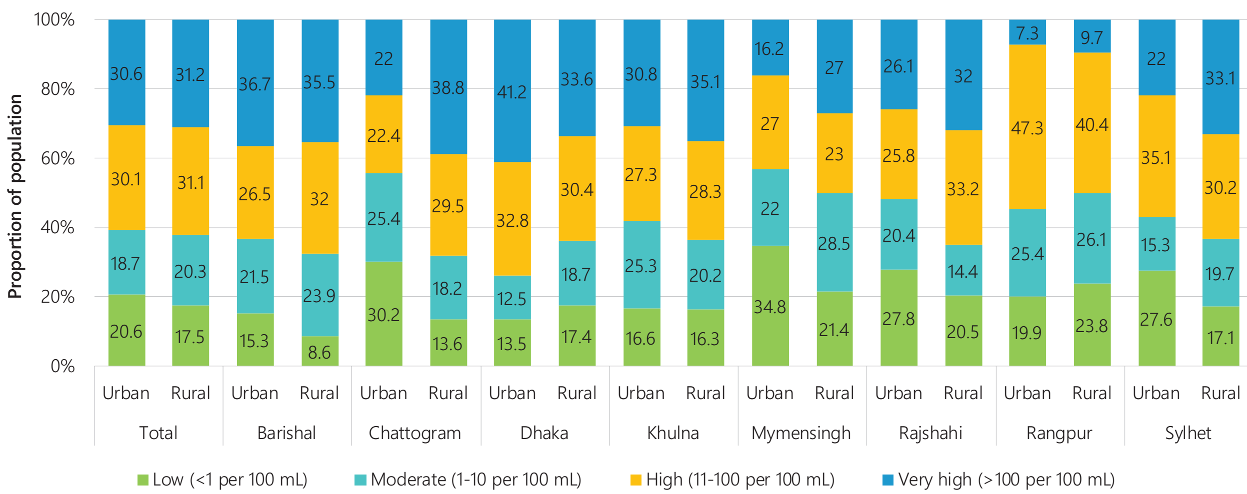


Figure 20: **Household water risk categories by Division for Urban and rural areas**



Although wealth and education indicators are correlated with one another, *E. coli* contamination has different relationships with wealth and education at PoC (Table A4.7, Figure 21) and PoU (Table A4.8). At the PoC, higher levels of education were associated with better water quality, but this relationship is not the same for wealth: higher wealth quintiles have greater access to piped water and, as a result, have worse source water quality than poorer quintiles that reliant on tubewells. However, at the PoU, both wealth and education are associated with improved water quality. The proportion of the population with low risk water at the PoU increases from 14.8 percent in households where the head is only educated up to primary level to 27.1 percent in households where the head has an education level of secondary schooling or above. For wealth, a similar relationship is evident, with the proportion of the population with low risk water at the PoU increasing from 13.5 percent in the poorest quintile to 23.1 percent in the wealthiest quintile. Similar trends were seen in urban and rural areas (Table A4.9).

Figure 21: **Water quality risk categories by wealth quintile for PoC (top) and PoU (bottom) water quality**

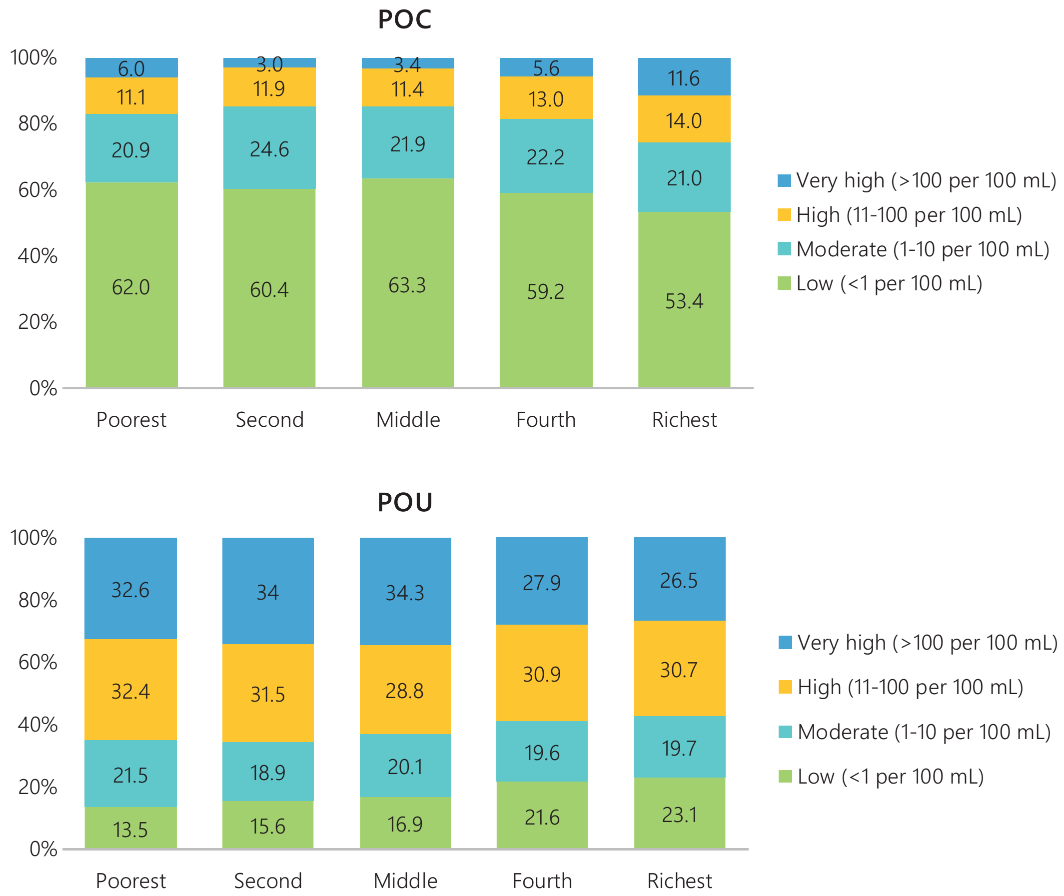


Figure 22: **Access to water source type by wealth quintile**

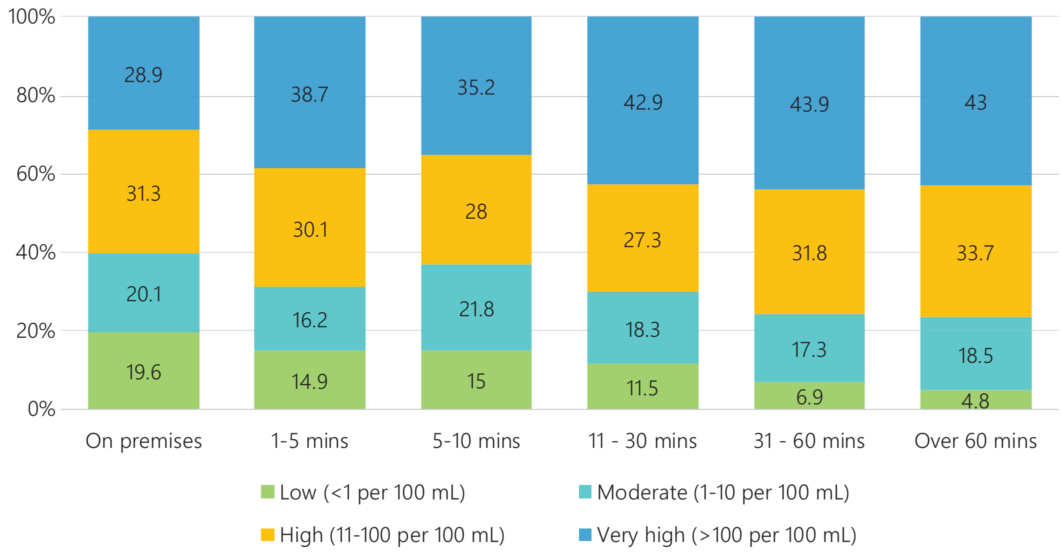
The differences in water quality by geography and socioeconomic indicators are not independent, with urban populations more likely to be wealthier and better educated. Between Divisions, there was greater variation in wealth than in education levels.

4.4 Influence of WASH service levels on water quality

This section provides an analysis of the relationship between WASH service levels and water quality. This includes time to collect water, household water treatment, water storage conditions, and sanitation and handwashing facilities.

The round-trip time to collect water from an improved source was less than 30 minutes for the majority of the population (96.0 percent). However, water quality at the PoU worsened with increasing time for collection (Figure 23, Table A4.10), with *E. coli* risk level correlated with round trip collection time. Wealthier households with better educated heads were more likely to have a water source in their own dwelling, or on premises.

Figure 23: ***E. coli* risk categories for PoU microbial water quality for time to get water and come back**



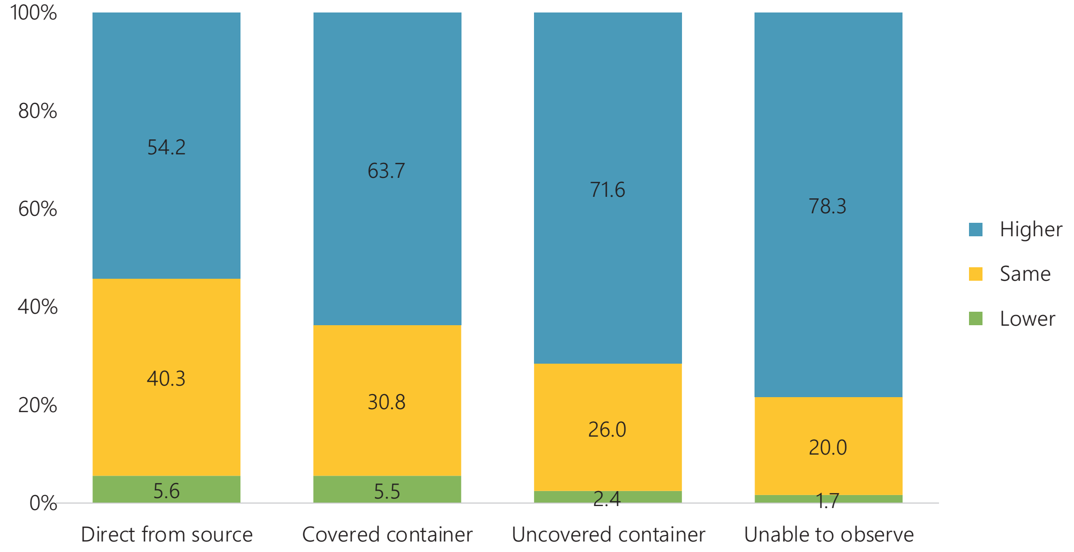
Treating water in the home can improve microbial water quality and remove harmful pathogens from drinking water; however, the cost, time and training needed can mean that sustained effectiveness of home treatment is lower than during trial periods. Of the 10.6 percent of the population who treat their water at home, a small reduction in contamination of PoU water was observed, with the percent of the population with *E. coli* at the PoU reducing from 82.3 without treatment to 77.9 percent with treatment (Table A4.11). The proportion of households reporting treating their water did increase with the level of contamination at the PoC, from 7.7 percent for those using low risk sources, to 50.4 percent for those using high risk sources (Table A4.12). Overall, 43.7 percent demonstrate an increase in contamination from PoC to PoU with treatment, which may indicate treatment is ineffective or that the water has been further contaminated during storage (Table 11). Treatment was related to socio-economic factors, with those who report treating water more likely to be in the wealthiest quintile, better educated, and in urban areas.

Table 11: Change in *E. coli* risk level between PoC and PoU sample with or without household-level water treatment

		Proportion of households (percentage)		
		***E. coli* risk level in household drinking water**		
		Lower	Same	Higher
Total		**4.5**	**29.8**	**65.7**
Treat water to make safer for drinking	Yes	14.7	41.5	43.7
	No	3.3	28.4	68.2
Water treatment method	Boil	22.2	45.2	32.6
	Filter	11	39.9	49
	Other	19.6	47.3	33.2

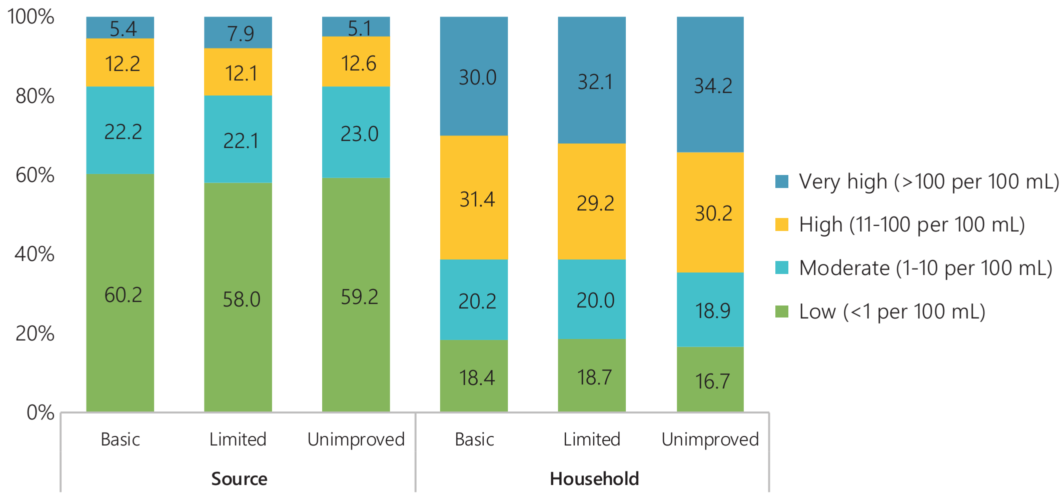
Storage conditions were observed by enumerators when PoU water quality samples were requested. When water was collected directly from a source on premises, it was less likely to be contaminated with *E. coli* compared to water collected from covered or uncovered storage containers (Table A4.13). Thus, samples of drinking water from storage vessels were associated with a greater change in *E. coli* risk levels (compared to source water) than samples obtained from drinking vessels that were filled directly at the source (Figure 24). Water quality was more likely to deteriorate when stored in uncovered containers (more commonly used by the poorest quintile) rather than covered storage containers. This indicates that water quality deterioration at household level is not just a reflection of the cleanliness of vessels used to serve drinking water, but the processes of transport and storage within the home are likely to increase *E. coli* risk level (Figure 24).

Figure 24: Household water storage practices and changes in *E. coli* risk level from PoC to PoU



A lack of adequate sanitation facilities can affect water quality at the PoC and at the PoU. Overall, however, *E. coli* risk levels in PoC drinking water and PoU drinking water only varied by a limited amount based on sanitation access (Figure 25, Tables A4.14 & A4.15). Similarly, there was little variation in water quality between households with improved and unimproved sanitation facilities. The use of shared toilet facilities was associated with a small increase in contamination of PoC water (from 60.5 percent low risk with non-shared facilities to 57.1 percent with shared facilities) and PoU water (from 18.3 percent low risk with non-shared facilities to 17.7 percent with shared facilities). Flush or pour-flush to sewer facilities were associated with poor water quality at PoC, likely related to higher use of piped water in these households, but were also associated with poorer water quality at the PoU than other types of improved sanitation.

Figure 25: Changes in *E. coli* contamination of drinking water at the PoC and PoU with sanitation



Sufficient handwashing relies on households having access to cleansing agents, for example, soap or other local cleansing materials. Where handwashing isn't practiced properly, there is a chance of contaminating the water with contaminated fingers during collection, storage and when accessing water for drinking. Handwashing facilities in households were observed by enumerators, as was the presence of soap or another cleansing agent (ash or sand). Households with handwashing facilities were more likely to have a low *E. coli* risk level at the PoU (19.0 percent) than those where facilities were not observed (12.3 percent) (Table A4.16). Households where both water and soap were available, had slightly better reductions in contamination between PoC and PoU (Table 12). There was a smaller difference in contamination at the PoC (Table A4.17), with households with handwashing facilities more likely to have low risk water (59.1 percent) than those where facilities were not observed (63.9 percent). This may be related to wealth since wealthier households were more likely to have a handwashing facility (96.9 percent in the wealthiest quintile compared to 68.7 percent in the lowest); however, the relationship between wealth and PoC water quality is complicated by the use of unsafe piped supplies as explained in Section 4.3.

Table 12: Change in *E. coli* risk level between PoC and PoU sample, by availability of a handwashing facility, soap and water

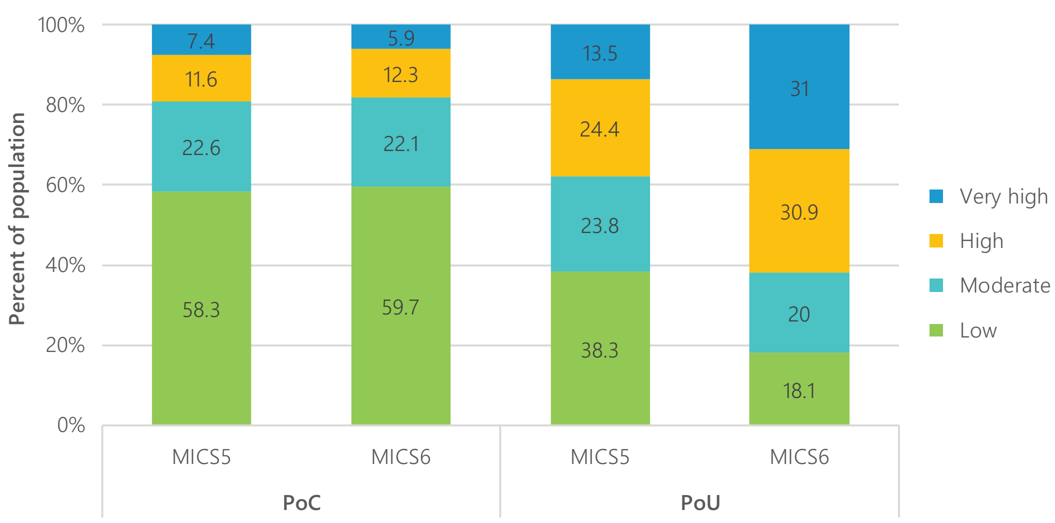
	Proportion of households (percentage)		
	Change in *E. coli* risk level between PoC and PoU		
	Lower	Same	Higher
Total	**4.5**	**29.8**	**65.7**
Place for handwashing			
Observed	4.7	30.4	64.9
Not observed	3.4	25.7	70.9
Handwashing facility observed and			
Water available	4.8	30.4	64.9
Soap available	5.0	30.0	65.0
Ash/mud/sand available	4.0	27.5	68.5
Place for handwashing with soap and water			
Water and soap available	5.1	30.1	64.8
Water is available, soap is not available	1.8	32.8	65.4

In summary, higher levels of water accessibility, safe water storage and handwashing facilities were associated with better water quality. Notably, access to a water source on premises, which reduces collection time and the need for storage, is important for delivering advances in water safety.

4.5 Changes in water quality since MICS 2012-13

The previous MICS campaign in 2012-13, MICS5, collected comparable water quality and household survey data. A brief analysis is presented here, which is expanded on in the discussion.

Figure 26: Comparison of risk levels for PoC and PoU water quality between MICS5 and MICS6

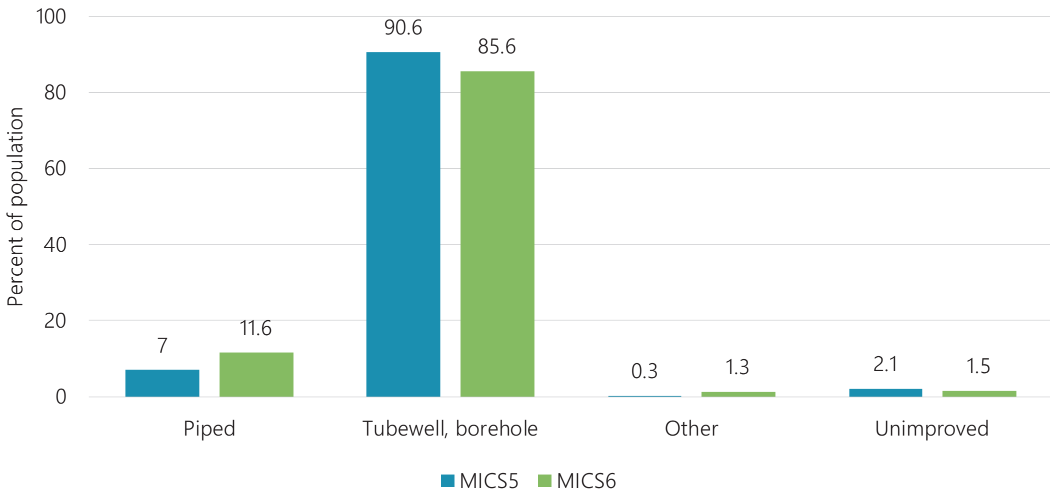


Overall, the proportion of the population with access to low risk water at the PoC, as characterised by absence of *E. coli*, increased slightly between the MICS5 and MICS6 campaigns, from 58.3 to 59.7 percent. Conversely, the proportion of the population with access to low risk water at the PoU reduced from 38.3 percent to 18.1 percent (Figure 26). This large deterioration of water quality is a concern and is investigated further in the following analysis of changes in water service levels.

In addition to the slight improvement in the proportion of people with access to water sources in which *E. coli* were not detected, other aspects of water services also improved between MICS5 and MICS6:

- There was an increase in the proportion of the population using piped water (from 7.0 percent in MICS5 to 11.6 percent in MICS6) (Figure 27), particularly in urban areas (from 28.7 to 38.8 percent).
- Use of tubewells that were located on premises, suggesting private ownership, increased from 75.2 to 82.3 percent.
- Increased access to water on premises from 74.7 to 83.3 percent coincided with a decrease in the time taken to access water, with mean water collection times dropping from 14.4 minutes to 12.1 minutes.
- The overall population using improved water sources increased from 97.9 to 98.5 percent.
- Reported treatment of water rose from 8.0 percent to 10.5 percent.

Figure 27: Changes in proportion of population using different source types between MICS5 and MICS6



Improvements were also observed between MICS5 and MICS6 for sanitation and hygiene facilities:

- Access to improved sanitation increased from 76.9 percent to 84.6 percent.
- Access to handwashing facilities become more common, increasing from 82.0 percent to 86.8 percent, with large increases in the proportion of people with access to a facility with water and soap (from 59.1 percent to 74.8 percent).

These results highlight that WASH service levels have improved and do not account for the reduction in household water quality observed in MICS6. Further discussion of these results and methodological issues that limit the comparability of the *E. coli* analysis are provided in Section 6.1.

4.6 Data quality assurance

It is important to note that over 56 percent of the onsite-sanitation facilities have never been emptied, which accounts to 81.5 percent of the safely managed sanitation coverage. This serves to highlight the current disparity in infrastructure to service coverage in the sanitation sector.

This section addresses quality assurance activities within MICS6. To assess the accuracy of the *E. coli* tests performed in field using field kits, duplicate samples were tested in field and in the icddr,b laboratory. Field duplicates were tested by icddr,b personnel in the field using the same field kit as the Bangladesh Bureau of Statistics (BBS) team to evaluate the quality of the test performed by the measurers. Comparison of field duplicates by icddr,b with those by BBS provides a measure of how well the BBS enumerators have been trained. Duplicate samples were also collected and sent to the icddr,b laboratory for crosschecking. These provide an indication of how the results of the field *E. coli* tests compare with results from lab tests; however, the comparison is limited due to longer transport and storage times between sampling and analysis in the lab.

There was good agreement between field duplicates supporting that the BBS teams were well trained. Approximately three quarters of icddr,b duplicate analyses tested in the field had the same *E. coli* risk class as the BBS analysis for the PoC samples, and two thirds for PoU water quality samples (Table 13). Nevertheless, some disagreement between duplicates was observed. This may be due to short-term variability in the water quality, inherent variability in the methods, or issues with how effectively the tests were applied (human error). For PoU samples, in which *E. coli* was detected more frequently than for PoC samples, a third of samples were in different risk categories. There was no consistent directionality in the disagreement between duplicates, with similar proportions of BBS samples higher and lower than iccdr,b samples.

Table 13: Comparison of BBS field results and icddr,b duplicates by *E. coli* risk class

		PoC (icddr,b field results)	PoU (icddr,b field results)
BBS samples	Lower	8.0	15.8
	Same	75.8	66.7
	Higher	16.2	17.6

Comparing icddr,b's laboratory and field duplicates, 61.2 percent of the field tests indicated the same risk category for *E. coli* as their corresponding laboratory tests, which is comparable to results from quality assurance testing in the previous MICS campaign (64 percent agreement). Analysis based on the *E. coli* concentration reported from field duplicate and laboratory analyses (Table 14) indicated similar proportions of lower and higher results, indicating random variability. However, it does highlight poor agreement for samples in the medium risk and high risk range, where less than 50 percent of results were in agreement for the same risk category. While laboratory methods are expected to have higher precision, water quality variability between samples, as well as transport and storage can affect the results.

Table 14: Comparison of laboratory and field duplicates

	E. coli [CFU/100 ml]	Risk Level	PoC (Lab results)			PoU (Lab results)		
			Lower	Same	Higher	Lower	Same	Higher
Contamination in field samples chosen for duplicate analysis	<1	Low	-	88.5	11.5	-	52.3	47.7
	1 – 10	Medium	62.3	14.9	22.8	33.9	9.2	56.9
	11-100	High	59.2	10.2	30.6	36.2	5.6	58.2
	>100	Very High	45.5	54.5	-	39.6	60.4	-
	Total		18.3	66.9	14.8	30.4	33.6	36.0
Blanks	-						99.0	1.0

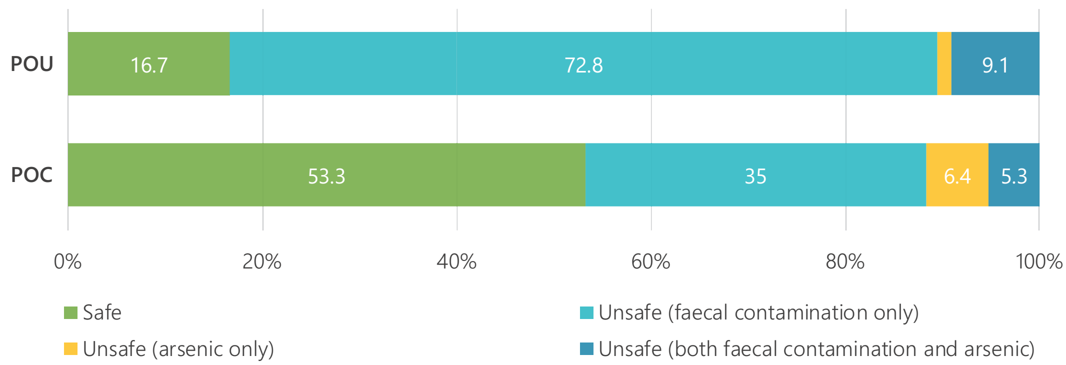
5 Safely managed drinking water and sanitation

This section presents a combined assessment of arsenic and *E. coli* contamination and focusses on coverage of safely managed drinking water services.

5.1 Combined water quality: arsenic and *E. coli*

Combined information on arsenic and faecal contamination provides a more thorough assessment of access to safe water. Arsenic was quantified at each household where *E. coli* was also estimated, and at approximately half the sources. *E. coli* contamination was a more frequent challenge than arsenic contamination, with 40.3 percent of the population estimated to have *E. coli* in their source water compared to 11.8 percent of the population having arsenic above the Bangladesh standard of 50 ppb in their source water. **Overall, the proportion of people with access to water with no *E. coli* and below 50 ppb of arsenic was 53.3 percent at the source, and 16.7 percent at the household** (Figure 28).

Figure 28: **Proportion of the population with safe water quality (no *E. coli* and <50 ppb arsenic) at the source and household**

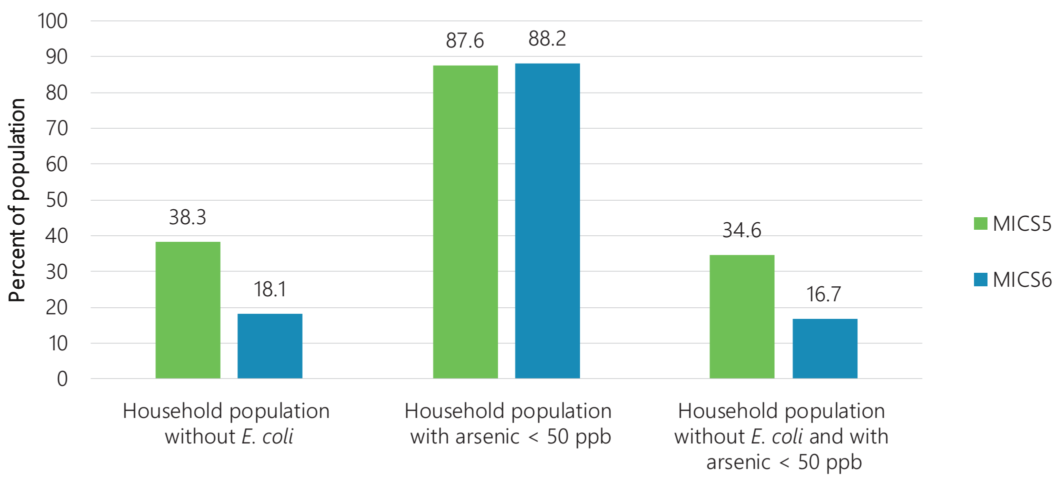


Combined arsenic and *E. coli* water quality followed similar trends in terms of local and socio-economic factors to *E. coli* contamination alone. This is because *E. coli* was the more frequent contaminant in households (Table A5.1) and at sources (Table A5.2). Urban populations had better water quality at the household than rural populations, but worse water quality at the point of collection. Access to safe water generally improved with level of education of the household heads. With regards to wealth, the poorest quintile had the lowest proportion with access to safe water at the household (13.1 percent), but the highest at the source (59.6 percent).

The percentage of households where the drinking water source quality satisfied the national standards for both arsenic and *E. coli* varied depending on source type, from 37.5 percent for piped water to 56.4 percent for tubewells (Table A5.3). Improved sources were more likely to meet the national standards (53.9 percent) than unimproved sources (2.2 percent). Location and time to collect water had limited impact on the source water quality, but were notably associated with household water quality (Table A5.4), with water quality deteriorating both with location (from 17.7 percent considered safe for sources on premises to 10.7 percent for off-premises sources) and time to collect (from 17.9 percent on premises to 4.0 percent where collection takes more than 30 minutes). Again, these patterns were driven by *E. coli* results since it was the more frequent contaminant and more subject to change between source and household.

Comparison with MICS5 found similar relationships to those discussed in Section 4.5, with large increases in household population with *E. coli* contamination, and small improvements in those with arsenic contamination (Figure 29).

Figure 29: **Comparison of results from MICS5 and MICS6 for household water quality**

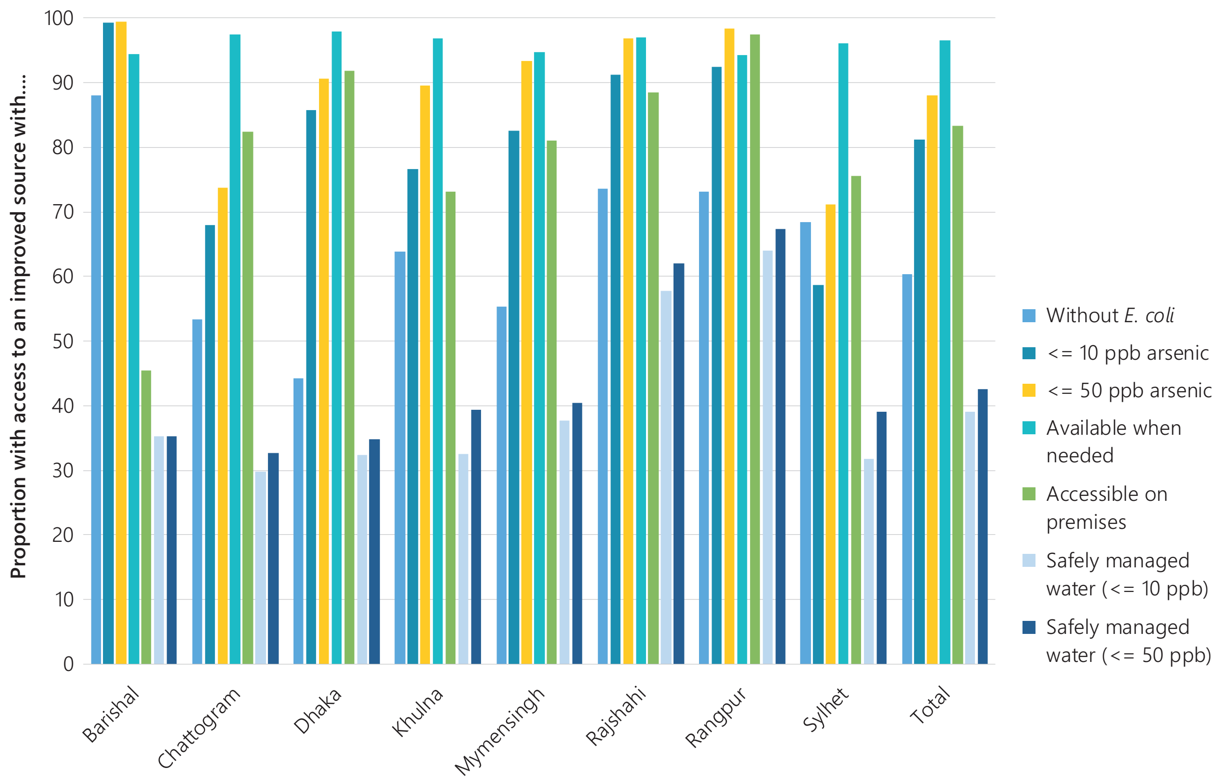


5.2 Safely managed drinking water services

Safely managed drinking water services are defined as improved sources with drinking water free from faecal contamination, and meeting international and national standards for arsenic, available when needed, and accessible on premises. In line with MICS approaches, these have been calculated to identify how many systems simultaneously meet all of these criteria. This is different from the JMP methodology for international comparisons which is based on the lowest of the three additional criteria of located on premises, available when needed and free from faecal contamination. Nationally, 42.6 percent of the population had access to a safely managed drinking water service.

Microbial water quality was the largest limitation to safely managed water in Chattogram, Dhaka, Khulna, Mymensingh, Rajshahi and Rangpur (Figure 30). In Barisal, it was accessibility, with only 45.5 percent having access on premises. In Sylhet, arsenic was the key limiting factor, particularly at 10 ppb. The differences in access to safely managed water by district (Figure 31) and wealth quintile (Figure 32) highlight the national inequalities, with greater differences by geographic location than is seen for the wealth quintiles.

Figure 30: **Safely managed water by division**



Analysis of safely managed drinking water is based on PoC water quality, not PoU water quality (Table A5.5). This restricts the sample size to those households where arsenic was sampled at PoC. However, as arsenic does not differ greatly between PoC and PoU, an analysis was undertaken of the differences in safely manged water based on calculation with PoC or PoU arsenic. At a national level, there were no substantive difference in the proportion of the population using safely managed water. At a district level, there difference of up to 13 percent; in Chuadanga the proportion with access dropped 12 percent, while in Jhenaidah, Kurigram and Rajbari all saw increases over ten percent. Furthermore, adopting a limit of 10 ppb arsenic at PoU, the proportion of the national population using safely managed water dropped in line with PoC analysis; individual districts with over 10 percent drop in access compared to PoU at up to 50 ppb were Chuadanga, Jashore, Jhenaidah, Kishoregonj, Manikganj, Meherpur, Maulvibazar, Chapai Nawabganj and Rajbari.

Figure 31: **Breakdown of safely managed drinking, demonstrating drop across criteria and inequalities between Districts. Grey dots represent percent meeting the criteria per individual districts. Red dots provide the average across the districts, with the interquartile range in the boxes.**

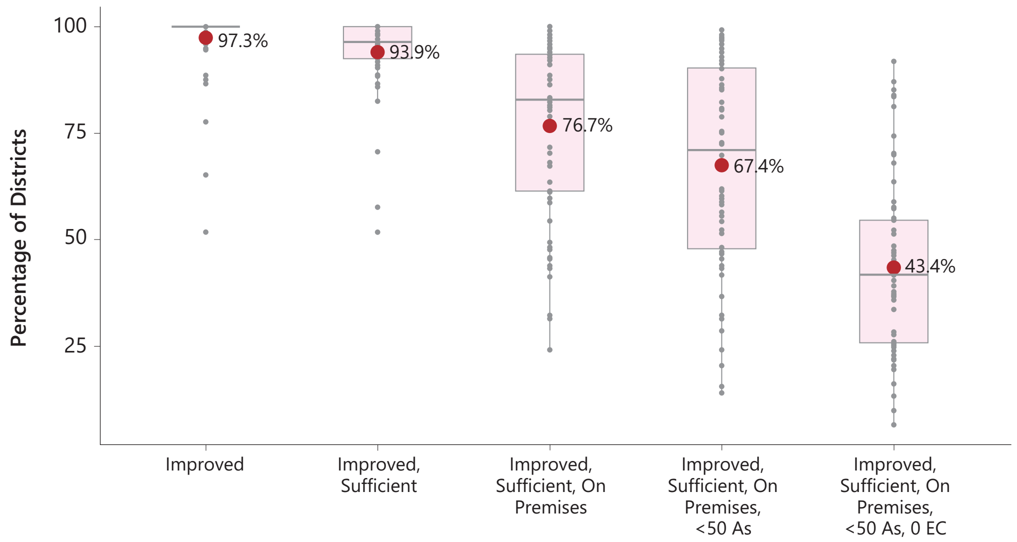
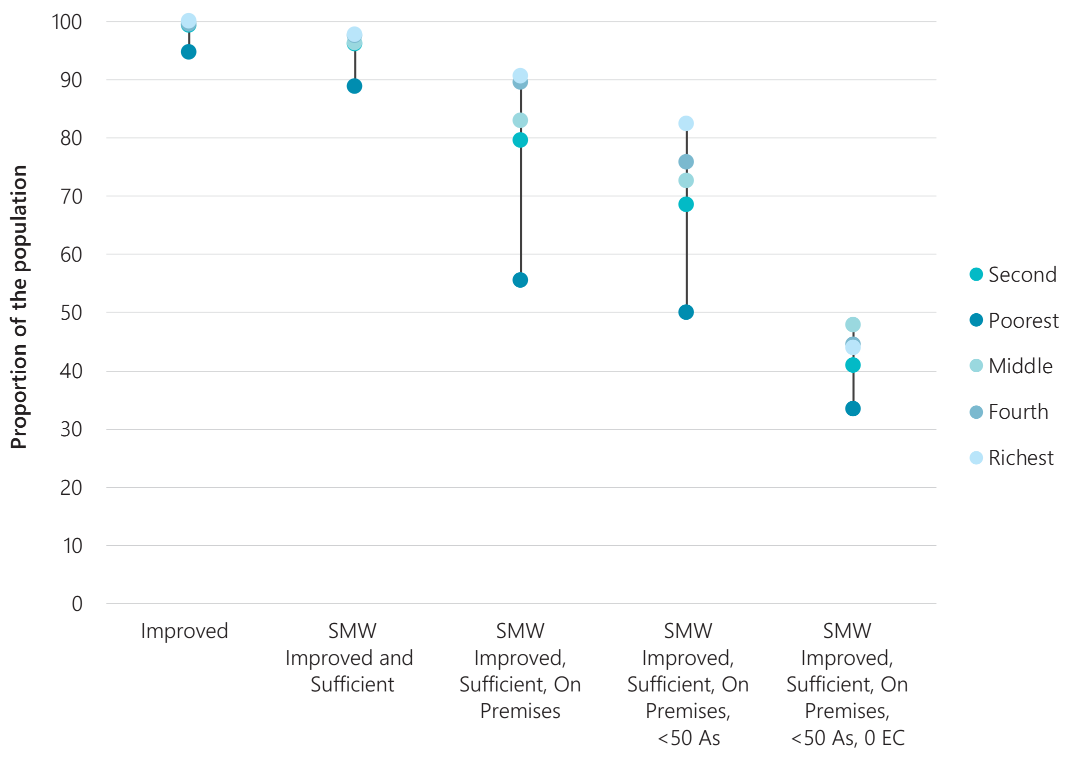


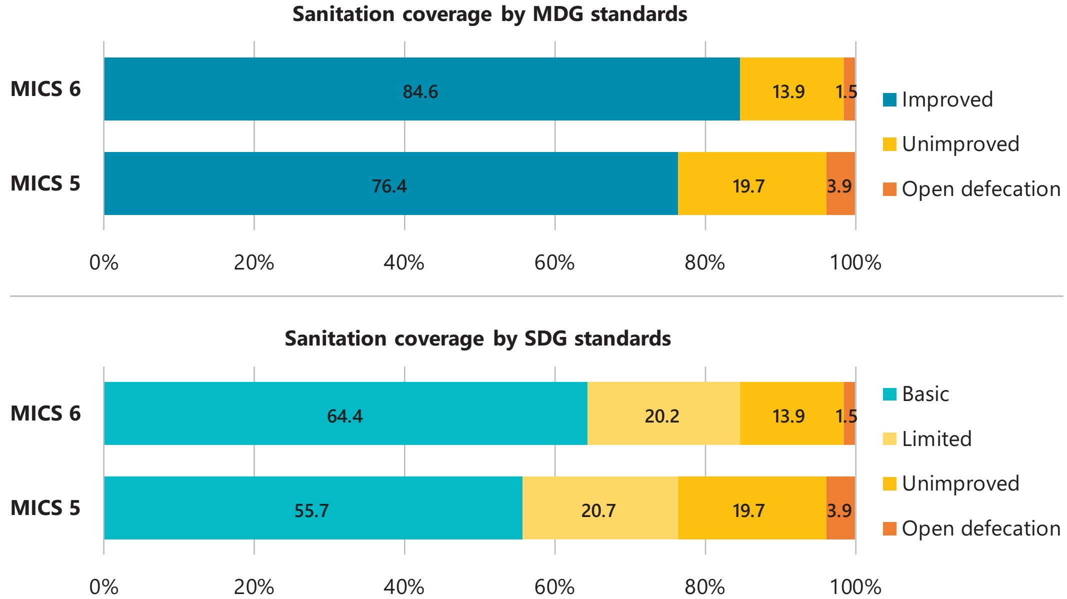
Figure 32: **Variability in safely drinking managed water (SMW) by wealth quintile**



5.3 Safely managed sanitation

Bangladesh has made considerable gains on household access to improved and basic sanitation services as evident in the MICS5 and MIC6 surveys (Figure 33). In the MICS6 household survey, secondary household reporting of the sanitation technology and excreta management services have facilitated the precedence for safely managed sanitation service coverage estimation. However, there is still considerable data gaps and assumptions on faecal sludge management at the household level in the MICS6 that will impact on the reporting of service coverage, which will be discussed in the following section.

Figure 33: Comparison of results from MICS5 and MICS6 for household sanitation services by MDG and SDG standards



Safely managed sanitation

The definition of safely managed sanitation services is determined by two hierarchical criterions in the JMP methodology.[5]

i. Household access to improved sanitation facilities that are not shared with another household,

ii. Safe containment, emptying, transport, treatment, and final disposal of the excreta as informed by the excreta flow diagram concept.

Thus, the SDG sanitation service with inclusion of safely managed service as defined by the JMP methodology, can be stratified by the following service ladder

5 JMP METHODOLOGY: 2017 UPDATE & SDG BASELINES (https://washdata.org/monitoring/methods)

SERVICE LEVEL	DEFINITION
SAFELY MANAGED	Use of improved facilities that are not shared with other households and where excreta are safely contained, emptied, transported and treated offsite
BASIC	Use of improved facilities that are not shared with other households
LIMITED	Use of improved facilities shared between two or more households
UNIMPROVED	Use of pit latrines without a slab or platform, hanging latrines or bucket latrines
OPEN DEFECATION	Disposal of human faeces in fields, forests, bushes, open bodies of water, beaches or other open spaces, or with solid waste

Note: improved facilities include flush/pour flush to piped sewer systems, septic tanks or pit latrines; ventilated improved pit latrines, composting toilets or pit latrines with slabs.

However, there are some notable differences in the classification of safe disposal of excreta from onsite system adopted in the MICS6 reporting as compared to the JMP methodology, which ultimately impacts on the reporting of service coverage (Figure 34).

In the JMP methodology, the consideration of safely managed services is reliant on availability of data on wastewater or excreta management services, notably the emptying and final disposal method in practice. When excreta are reported to be emptied from on-site sanitation systems, but there is no information on transport to a faecal sludge treatment plant, the JMP assumes that the removed excreta *are not safely managed*. Similarly, when there is no reliable information on the treatment of piped sewage treatment, the wastewater from those households is considered as *unsafely managed*. If the onsite sanitation systems have not been emptied, the JMP methodology categories it as safely contained, and thus managed. When data is not available, the service will not be considered as safe.

In the Bangladesh MICS6 report, improved pit latrines and septic tanks that were never emptied or emptied and buried in a covered pit (by service providers and households) were classed as *'safely disposed in situ'*. This is a notable difference to the JMP, which only considers safe disposal of excreta by a service provider. Household emptying and burial of excreta in covered pits are not considered as safe management. This comprises of over 38 percent of the disposal method practiced by households with onsite sanitation facilities. Therefore, the national coverage of safely managed sanitation services is 42.3 percent when applying the more prudent JMP methodology which excludes unknown data and household handling of excreta. Whereas, using the MICS6 classification, with the broader inclusion of *'safely disposed in situ'* and unknown responses as safely managed sanitation services, the national coverage is 58.9 percent.

Figure 34: **Breakdown of safely managed sanitation by a) JMP and b) MICS-6 methodology, demonstrating the disparity service coverage by different methodology and inequalities between districts. Grey dots represent percent meeting the criteria per individual districts. Red dots provide the average, with the interquartile range in the boxes.**

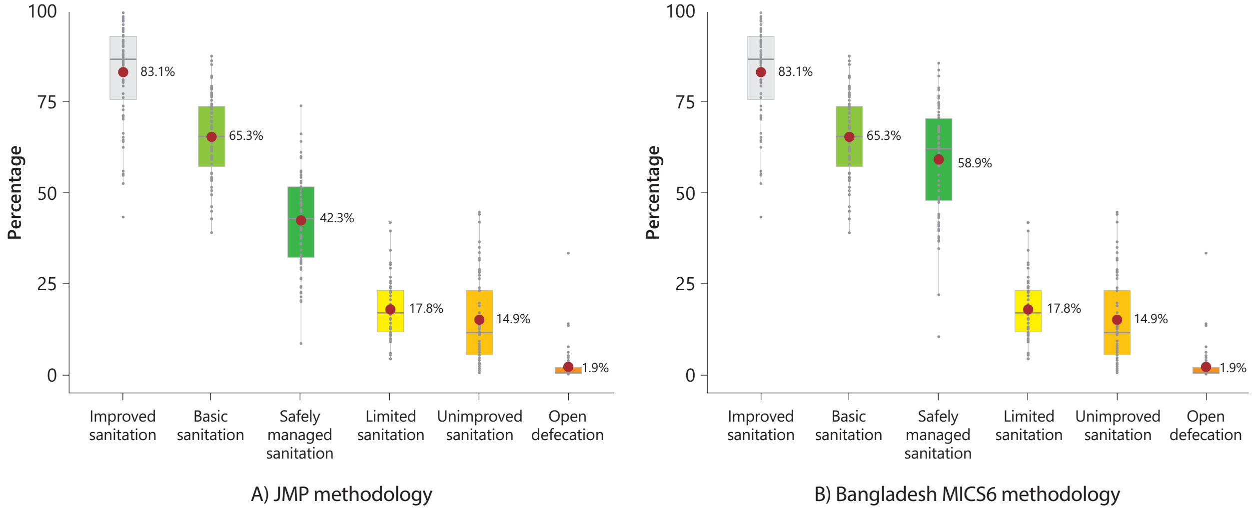
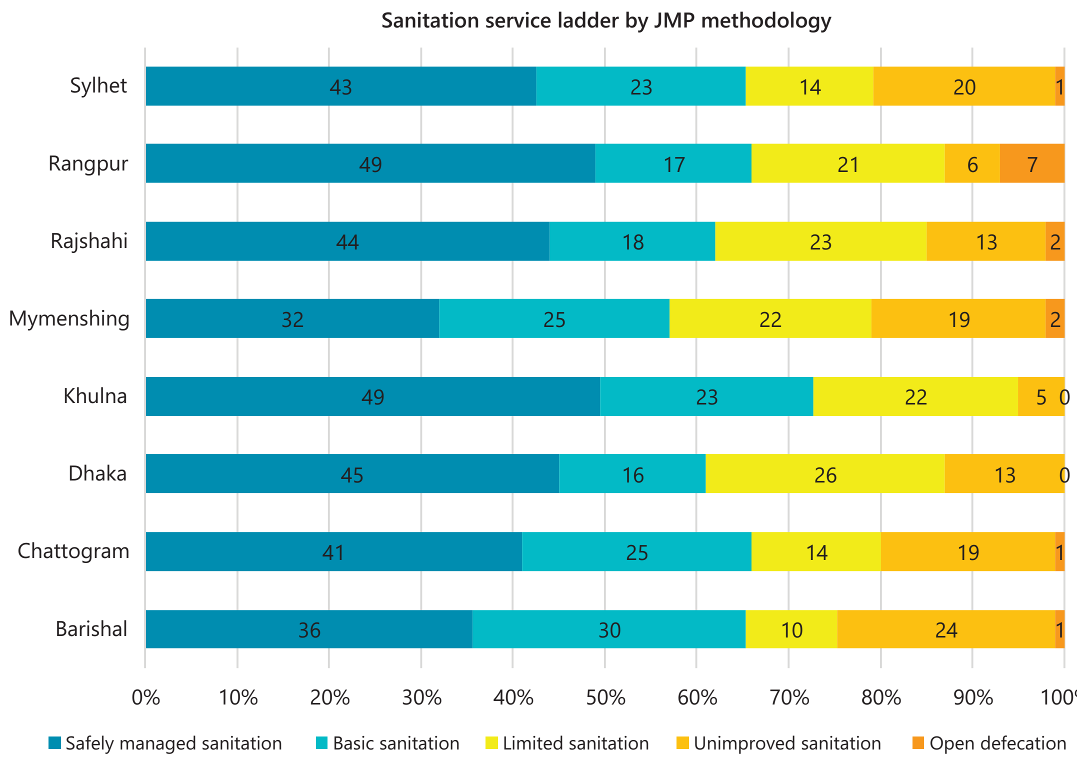


Figure 35: **Safely managed sanitation by the districts**



Although the estimation of the sanitation services by the JMP methodology is more conservative, it is a truer reflection of the current sanitation service capacity in Bangladesh which is lagging the infrastructural gains. Hence, for this analysis, the coverage estimation will be based on the JMP methodology which considers sanitation services as safe when there is available data on safe emptying, collection and disposal of excreta by a service provider. Household management of faecal sludge from onsite sanitation systems is not included. Onsite sanitation systems that has not been emptied is considered safely managed. As there is insufficient data on the treatment and disposal of piped wastewater from the household, it is not considered safely managed by the JMP methodology.

It is important to note that over 56 percent of the onsite-sanitation facilities have never been emptied, which accounts to 81.5 percent of the safely managed sanitation coverage. This serves to highlight the current disparity in infrastructure to service coverage in the sanitation sector.

6 Links between WASH, diarrhoea and stunting

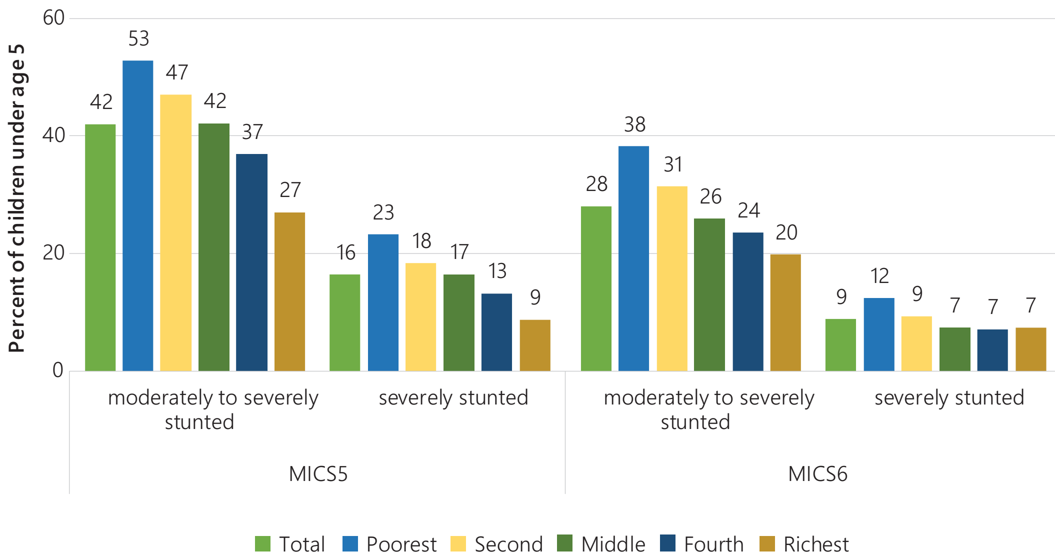
An analysis was undertaken to assess the links between WASH access, including water quality, diarrhoea and stunting. Diarrhoea is an indicator of current health, but which can vary rapidly with strong seasonal patterns, requiring caution in the interpretation of results. Assessment of diarrhoea in MICS is based on survey questions directed to mothers or caretakers asking them to report on disease episodes in children under 5 within the past two weeks, including diarrhoea, symptoms of acute respiratory infection (ARI), and fever. WASH is considered necessary but not sufficient to achieve reductions in childhood diarrhoeal diseases (Cumming et al., 2019).

Stunting (linear growth faltering) is derived from the anthropometric measurement of height or length of children under five in the sample population included in MICS6, and provides an indicator of child development over a longer term, that may have been influenced by WASH as well as other factors. The categorisation of the presence and severity of stunting is expressed in standard deviation units (z-scores) from the median of the WHO growth standards reference population. Children whose height-for-age is more than two standard deviations below the median of the reference population are considered short for their age and are classified as moderately or severely stunted. Those whose height-for-age is more than three standard deviations below the median are classified as severely stunted. In this analysis, "stunting" refers to children with either moderate-to-severe and severe stunting. An analysis on childhood malnutrition by socioeconomic data including maternal characteristics (e.g. education, functional status) and household wealth is provided in the MICS6 Survey Findings Report (Government of the People's Republic of Bangladesh et al., 2019).

In MICS6, age and height were collected for 22,055 children and health symptoms for 23,099 children; while household survey data on WASH access was available for all children, only 2,215 had matched anthropometric and water quality data. Therefore, there are significant limitations to deriving any statistical inferences on the association between water quality and stunting at the household level.

Stunting is the most appropriate measure for comparisons between MICS campaigns. In Bangladesh, the percentage of children under the age of 5 who were moderately to severely stunted decreased from 42.0 percent in MICS5 to 28.0 percent in MICS6, with the proportion who were severely stunted almost halving from 16.4 percent to 8.8 percent (Figure 36, Table A6.1). As demonstrated in Figure 36, childhood stunting is associated with poverty. Stunting is more prevalent in rural areas (28.4 percent) and divisions with greater rates of wealth disparity such as Mymenshing (34.5 percent in rural areas), Barishal (31.3 percent in rural areas) and Sylhet (38.4 percent in rural and 32.5 percent in urban areas). The likelihood of stunting reduces by 21.3 percent nationally and by 24.3 percent in the rural areas with every increase in household wealth quintile. Children in rural areas in the poorest quintile are 3.1 times more likely to be stunted compared to those in the richest quintile. Although the urban areas have comparatively lower rates of stunting (26.3 percent), children from the poorest households are still 1.9 times more likely to be stunted compared to the richest quintile.

Figure 36: Prevalence of stunting for MICS5 and MICS6 for the total population and by wealth quintile



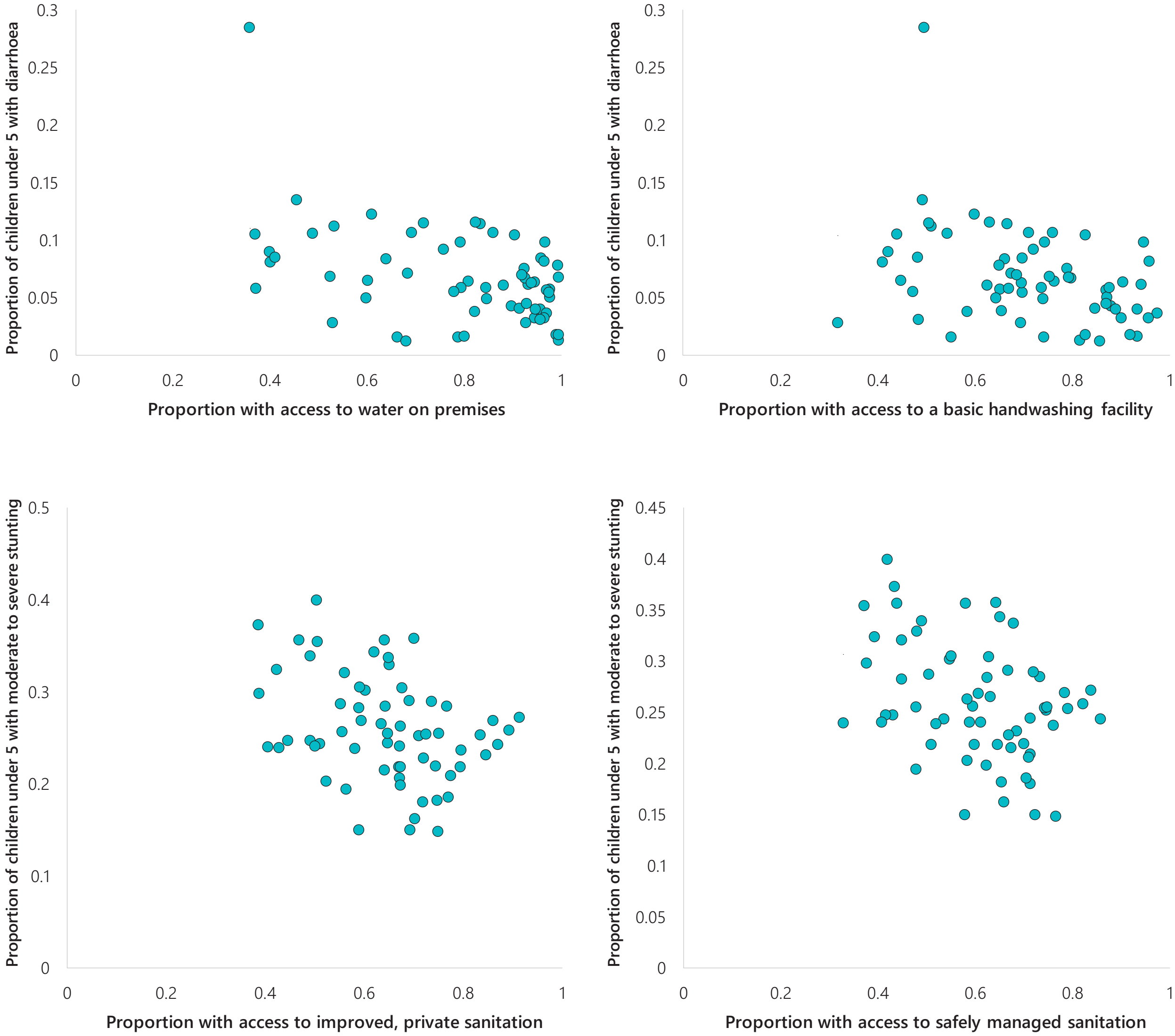
Due to the low number of data points available for WASH access, anthropometrics and water quality, results presented below are based on an analysis of diarrhoea and stunting at the district level. This method aggregates rates of access and health impacts by district overcoming limitations in sample number, enabling an assessment of correlations.

Diarrhoea prevalence at the district level decreases with increased access to water on premises (Figure 37a). This relationship is robust, remaining when the outlier is removed, but does not hold for stunting. An increase in the proportion with access to a handwashing facility where water and soap are present was associated with a decrease in diarrhoea (Figure 37b), and to a lesser extent with a decrease in symptoms of an ARI; it was also associated with a decrease in moderate to severe stunting. Water quality (microbial or arsenic, at PoC or PoU) was not associated with diarrhoea or stunting at the district level. Safely managed drinking water was not associated with stunting, but was associated with a slight reduction in diarrhoea.

Access to private, improved sanitation was associated with reduction in moderate to severe stunting (Figure 37c), as was access to safely managed sanitation (Figure 37d).

This contributes to the evidence of the importance of access to a high level of water, sanitation and hygiene services to ensuring the health and development of children. Poverty remains an important mediator of these effects due to the associations with other environmental and social determinants of stunting.

Figure 37: **Correlations between diarrhoea and access to (a, top left) water on premises and (b, top right) a basic handwashing facility and between moderate to severe stunting and (c, bottom left) improved, private sanitation, and (d, bottom right) access to safely managed sanitation.**



7 Discussion & recommendations: National drinking water quality challenges

This section will advance discussion of the results presented in the previous sections to consider the context and limitations of the MICS, and to provide some additional analyses.

7.1 Methodological challenges and data interpretation

There are limitations in the methodologies used within MICS that should be considered in the interpretation of sampling results. This section will address general limitations, before expanding on the limitations of microbiological sampling methods.

Working with subsets of data. The number of households where water quality is sampled represents a subset of the total population included: 20 percent of households were selected for arsenic testing at the household and 5 percent for arsenic testing at the source; 10 percent had samples taken for *E. coli* analysis. This restricts the analyses in this report. Notably, the estimation of safely managed water is based on 12,770 people, compared to the total population surveyed of 260,959. The MICS survey is not designed for analysis of stunting and water quality, resulting in a small proportion of households for which stunting data was available and water quality information (population included in stunting data: 23,101; population for which both stunting and water quality data is available: 2,215). These considerations have led to caution in the analyses to ensure that the data remains representative.

Geographic restrictions. The data is clustered at district level without georeference and location information at Upazila or Union level. Therefore, it was not possible do point mapping and or to extract a statistical summary at Upazila or Union levels. Water quality is influenced by hydrogeology, not administrative boundaries. Districts can cover several hydrogeological zones, and no not facilitate analysis that link with hydrogeological studies of arsenic occurrences and distribution patterns.

Source data. Information on water sources was limited to the PoC within MICS categories which has limitations for the reporting and analysis. For piped water supplies, there is not information on whether water was sourced from surface or groundwater, or if they were managed for water quality. For tubewells, no depth information was collected to classify shallow or deep tubewells, or differentiate tubewells attached to Managed Aquifer Recharge systems, for which different water quality would be expected. Additionally, no information is collected on the type of pump used, such as the No 6 or Tara handpump, which would have allowed better understanding of the hydrogeological constraints for planning alternative safe water supplies.

Insufficient quality assurance data. Quality assurance data was used to provide an analysis of the reliability and repeatability of results. For arsenic samples, duplicate analyses were only performed on 2.5 percent of samples, providing insufficient data to correct for analytical errors in field kit measurement.

7.1.1 Microbiological sampling methods

The MICS methodology for microbial sampling is designed to assess water quality at the point of collection and the point of use. The methodology is designed to reflect the risks to the users. In this section we discuss the limitations to understanding the sources of these risks and appropriate interventions to address them.

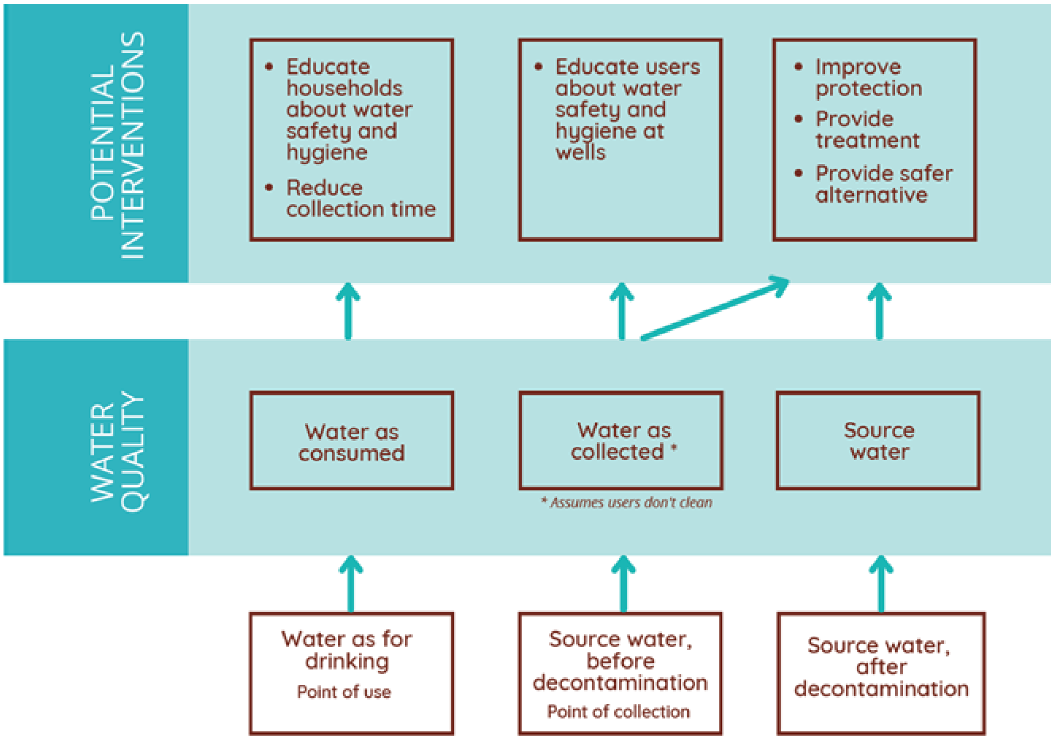
At the point of the collection, the methodology for *E. coli* sampling in MICS6, in accordance with the MICS manual for water quality testing (JMP/UNICEF/WHO, 2016), specifies that water be flushed at the point of collection for 30 seconds before sampling but taps and handpumps were not cleaned or sterilised. In contrast, other methods for source water quality sampling recommend decontamination of the point of collection. For example, the Rapid Assessment of Drinking Water Quality protocol (WHO & UNICEF, 2012) recommends cleaning the "tap or outlet with a clean, dry cloth" and flushing. The Standard Methods for the Examination of Water and Wastewater (APHA, 2017) recommend sampling from a clean tap and where a clean tap isn't available or if using an outside tap, disinfecting with a sodium hypochlorite solution prior to sampling. The ISO Standards for sampling recommend "faucets should be cleaned, disinfected and flushed if samples are to be collected for microbiological analysis". Specifically, BS EN ISO 19458:2006 "Water Quality Sampling for Microbiological Quality" recommends that taps be disinfected, unless the purpose of sampling is "to know the quality of the water as it is consumed"; in this latter document flaming is the preferred form of disinfection.

Table 15: Methods of water source sampling and interpretation for *E. coli*

Method	Used by	Interpretation
Flushing of water source for 30 seconds.	MICS	Samples indicate potential contamination of both the source water and the water point apparatus. They are intended to represent the water the users would collect, although it is not known how well flushing represents normal collection practices or whether users clean the source.
Wiping with dry clean cloth and flushing of water source.	RADWQ	
Use of disinfectant like sodium hypochlorite or flame and flushing water source.	International standards	Samples indicate contamination in source water only.

At the point of use, the household sample provides information on the quality of water as it is consumed. But the current approach to source water sampling will provide information on source water quality plus potential contamination from hygiene conditions of the point of collection (Table 15). Consequently, it is more difficult to attribute the cause of contamination when interpreting the source water sampling results, and to identify appropriate actions (See Figure 38). Furthermore, it is important to highlight that there is no evidence available to confirm how well the current MICS method of flushing reflects normal water collection behaviour. Information on user cleaning practices before collection is not available. Further information on practices at the point of collection are needed to characterise collected water quality.

Figure 38: **Linking intervention to improve water quality to interpretations of water quality.**



Inferring the likely difference between the water quality captured in the MICS (without decontamination of the water point apparatus) and the quality of the groundwater or piped water is difficult. Research on water quality does not routinely report water point decontamination practices as part of the methodology. A review of studies in Bangladesh highlights a range of methods and reporting: including no information on the methodology (Ercumen, Mohd Naser, et al., 2017; Escamilla, Knappett, Yunus, Streatfield, & Emch, 2013; Van Geen et al., 2011), use of flushing only (Ercumen, Pickering, et al., 2017; Ferguson et al., 2012), or use of flushing and disinfection with a wipe (Doza et al., 2020). However, data was available from three studies that enabled analysis of the difference between samples taken before and after decontamination of the water point, including three UNICEF-funded studies, with laboratory analyses by icddr,b:

- CXB: Cox's Bazaar, January to February 2020
- ASWA II: Narila, Faridpu, Pirojpur and Sylhet, December 2018 to January 2019
- REACH: Khulna, January and June 2020

There was a low proportion of *E. coli* positive results in each study. Consequently, the results have been pooled for the following analysis, although it is worth noting that seasonal differences in the level of contamination at the collection point are evident where data is available (Figure 39). Across the three studies, after decontamination there was a decrease in the risk category for 82 percent of water samples where *E. coli* had been detected prior to decontamination (Figure 40), with 69 percent reducing to the low-risk category. Considering these results, it is reasonable to expect that the MICS methodology has overestimated contamination at the source, particularly for tubewells. In MICS6, 37.0 percent of tubewells were contaminated. Drawing on the observed change in proportions of risk categories for tubewells following decontamination in the three UNICEF-funded studies (Figure 40), it can be inferred that the proportion of tubewells for the MICS6 that the proportion of wells in the low risk category might be closer to 89 percent (Figure 41).

Figure 39: **Comparison of three studies of water quality from tubewells (TW) and taps, demonstrating the reduction in detection of *E. coli* after decontamination**

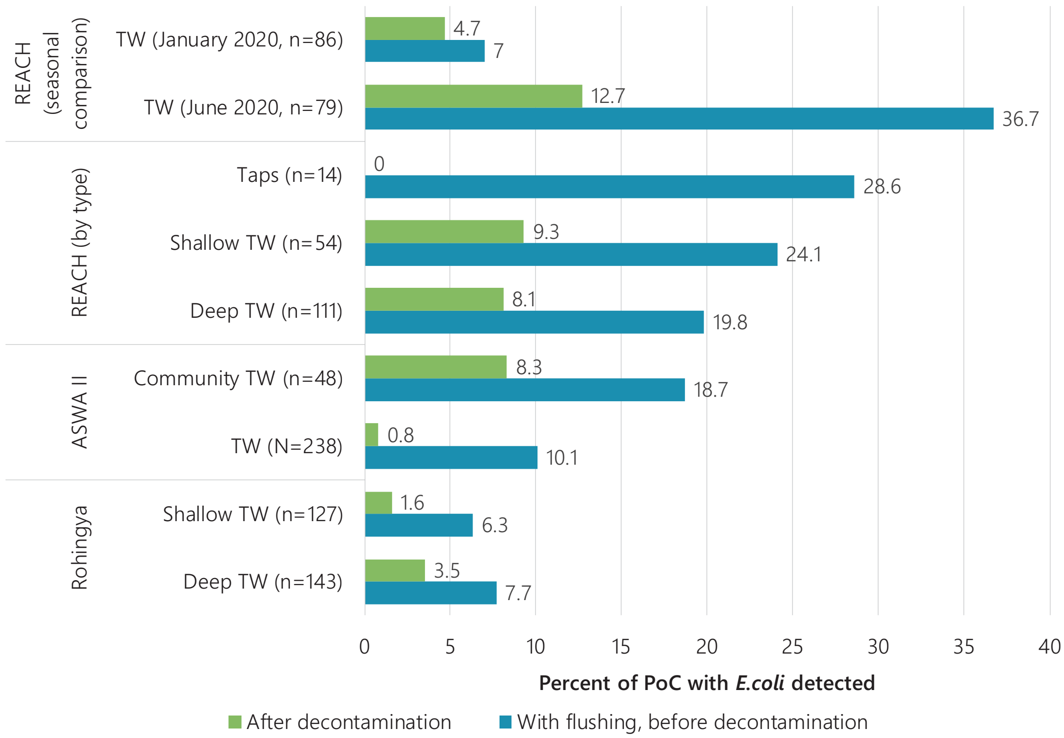


Figure 40: **Change in risk categories from before decontamination (left) to after decontamination (right) of tubewells, demonstrating that 91 percent of medium risk tubewells became low risk after decontamination, 44 percent of high risk tubewells, and 31 percent of very high tubewells. Data aggregated for CXB, ASWA II and REACH studies.**

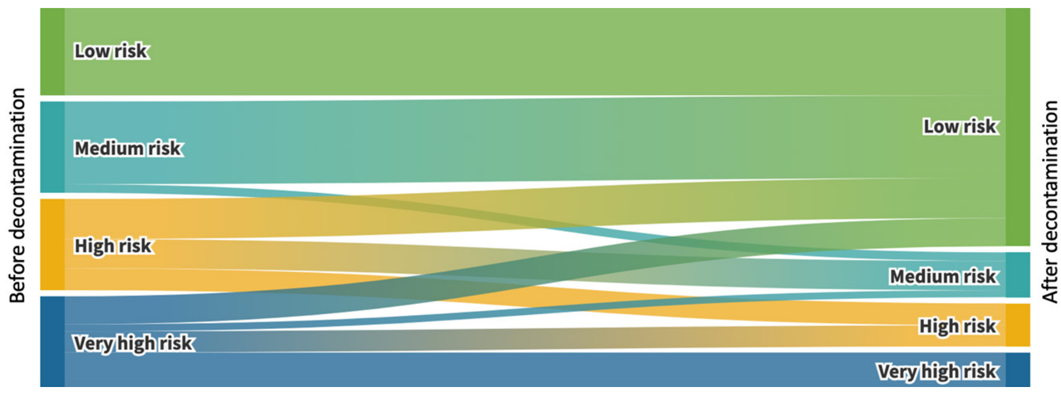
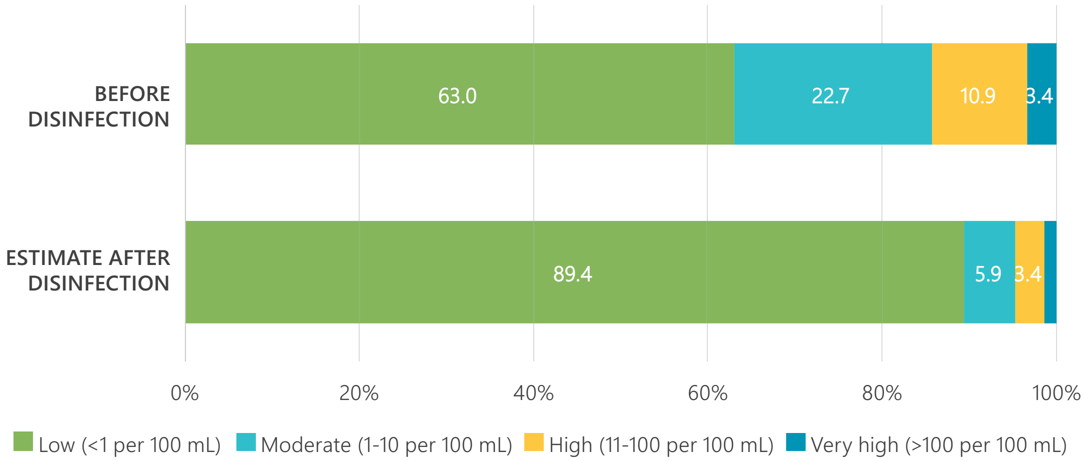


Figure 41: **Risk category proportions for tubewells in MICS6 before disinfection, and inferred risk category proportions after disinfection based on changes in categories in Figure 40.**



The differences in results before and after decontamination have implications for health, and for investments to improve water quality, as highlighted in Figure 38. The water quality contamination introduced at the PoC through unhygienic practices could be reduced considerably through education on good hygiene when collecting water and regular cleaning of the waterpoint apparatus. Good hygiene during collection should be encouraged for all source types, but is not currently consistently included in guidance. The UNICEF manual in Bangla includes guidance on cleaning the spout before handwashing and collection, however, other examples do not address it. WaterAid's Technology Notes (WaterAid, n.d.) provide guidance on hygiene education and water source development, but do not mention cleaning handpumps. The WHO advised in *Surveillance and control of community supplies* (1985) that "improved water sources should be used hygienically" but there is no particular reference to cleaning, and no more recent guidance was identified at the time of writing this report. Furthermore, implementation of good hygiene practices when collecting water are not measured.

Although decontaminating a source will provide a clearer understanding of the risk and appropriate interventions, there are also other methodological limitations to be aware of when interpreting *E. coli* results. For example, the quality of water used to prime the pump can influence the quality of water abstracted and sampled, especially if flushing is insufficient. Additionally, handpumps have been demonstrated to be reservoirs of bacteria including *E. coli* (Ferguson et al., 2011; Osborne, Ward, Santini, & Ahmed, 2018), harboured in biofilms, such that detection of *E. coli* may no longer indicate recent faecal contamination of the water source but colonisation of the apparatus warranting remediation.

While the MICS water quality modules have been useful to highlight drinking water challenges in Bangladesh, there are limitations in the value of repeating the MICS approach to further advance water safety in Bangladesh. The MICS approach trains a small number of enumerators to undertake water quality testing and data are aggregated for analysis and reporting. For example, the following section (7.2) presents an analysis of where water quality interventions might be most usefully targeted. This is useful information for high-level planning, but the MICS data and resulting analyses do not provide actionable information on specific water systems for operational management or regulatory purposes.

Additionally, the MICS approach is not building capacity for water quality monitoring. Using local Division laboratories for water quality testing would facilitate timely reporting to local water managers to inform system improvements and would build capacity in those laboratories to provide ongoing, regular water quality monitoring to support better water safety management. In this local testing, standardising sampling methods to include decontamination before source water samples are taken would help to understand and address potential health risks.

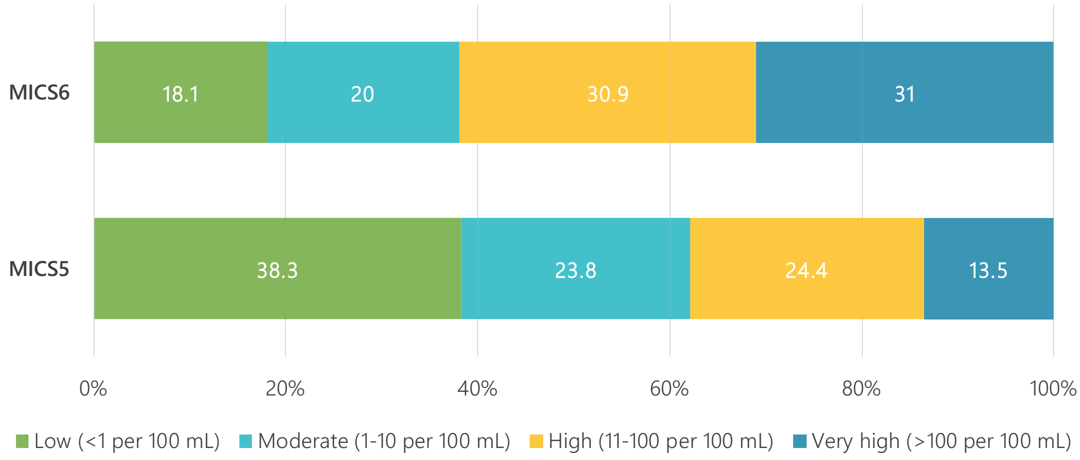
7.2 Is water safety in Bangladesh improving?

The deterioration of household water quality between MICS5 and MICS6 (Figure 42) is concerning, so we explored three potential causes of the change:

1. Changes in WASH services levels,
2. Methodological differences between MICS5 and MICS6,
3. Lack of climate resilience affecting water quality.

Firstly, the changes in WASH service levels have been discussed previously in Section 4.5, which demonstrated improvements in every area with no evidence that change in WASH services levels has driven water quality deterioration.

Figure 42: Household population risk level based on number of *E. coli* per 100 mL in household drinking water



Secondly, methodologies are revised between MICS surveys to improve survey questions and water quality sampling techniques. The methodology for *E. coli* analysis for MICS5 involved testing of separate 100 mL and 1 mL samples, with the risk category of contamination determined by the results of both tests. For MICS6, only one 100 mL sample was used. Nevertheless, this difference does not appear to explain the change in household water quality results between MICS5 and MICS6. Reanalysis of the MICS5 data to compare the results from the 100 mL samples with those adjusted for the results of the 1 mL test found no significant difference in low or moderate risk categories. Overall, only 5.6 percent of sample results were different for PoC samples and 11.6 percent for PoU samples. Furthermore, quality assurance methods demonstrated similar variability in results between MICS5 and MICS6 (Section 4.6). This indicates methodological differences do not account for the deterioration of water quality between the MICS5 and MICS6 sampling campaigns.

Thirdly, we explored seasonality as a potential driver of the observed water quality deterioration was difference in seasonality between the MICS campaigns. The evidence suggests that seasonality explains a large proportion of the change in water quality both within and between campaigns.

Seasonal changes in water quality are well documented and explained by various phenomena. Surface water and groundwater quality varies with weather changes over seasons due to direct changes in temperature and rainfall. Water quality at the source and household can also be affected through impacts of rainfall and temperature on human behaviour. Climate resilient water supplies are those that ensure that the service quality (e.g. water quality, quantity accessibility and reliability) can be sustained through the range of climate conditions expected with climate variability and change. Here, we focus on changes in water quality.

The fieldwork for MICS6 and MICS5 were undertaken under different climate conditions. Fieldwork for MICS5 was undertaken primarily from December 2012 to March 2013 (Figure 43), with over three quarters of samples collected during the cooler months. MICS6 was undertaken from January 2019 to May 2019, with two thirds of samples collected in the hot season. *E. coli* concentrations and the proportion of contaminated samples increased over the sampling period, both for PoU and PoC samples (Figure 44); no pattern was observed in arsenic results. While the MICS data collection is not intended to show climate vulnerability, the declines in water quality over the sampling period and the comparison between MICS5 and MICS6 has highlighted the poor climate resilience in water systems.

In Bangladesh, *E. coli* concentrations in water from improved sources have been found to increase significantly with rainfall and temperature (Charles *et al.,* in review), with household water quality strongly influenced by temperature. Escamilla *et al.* (2013) reported seasonal variability in water quality in Matlab, with winter (January-March) associated with the lowest contamination at the source. A WHO longitudinal study in Faridpur and Rajshahi supports the seasonality of water quality: for tubewells, the proportion contaminated varied from 16 percent in the cold/dry season to 38 percent in the hot/wet season at one site, and from 2 percent to 21 percent at another site. At both sites, the contamination was highest during the monsoon, with the lowest contamination from December through to February and March.

Figure 43: Seasonal differences in sampling periods for MICS5 and MICS6

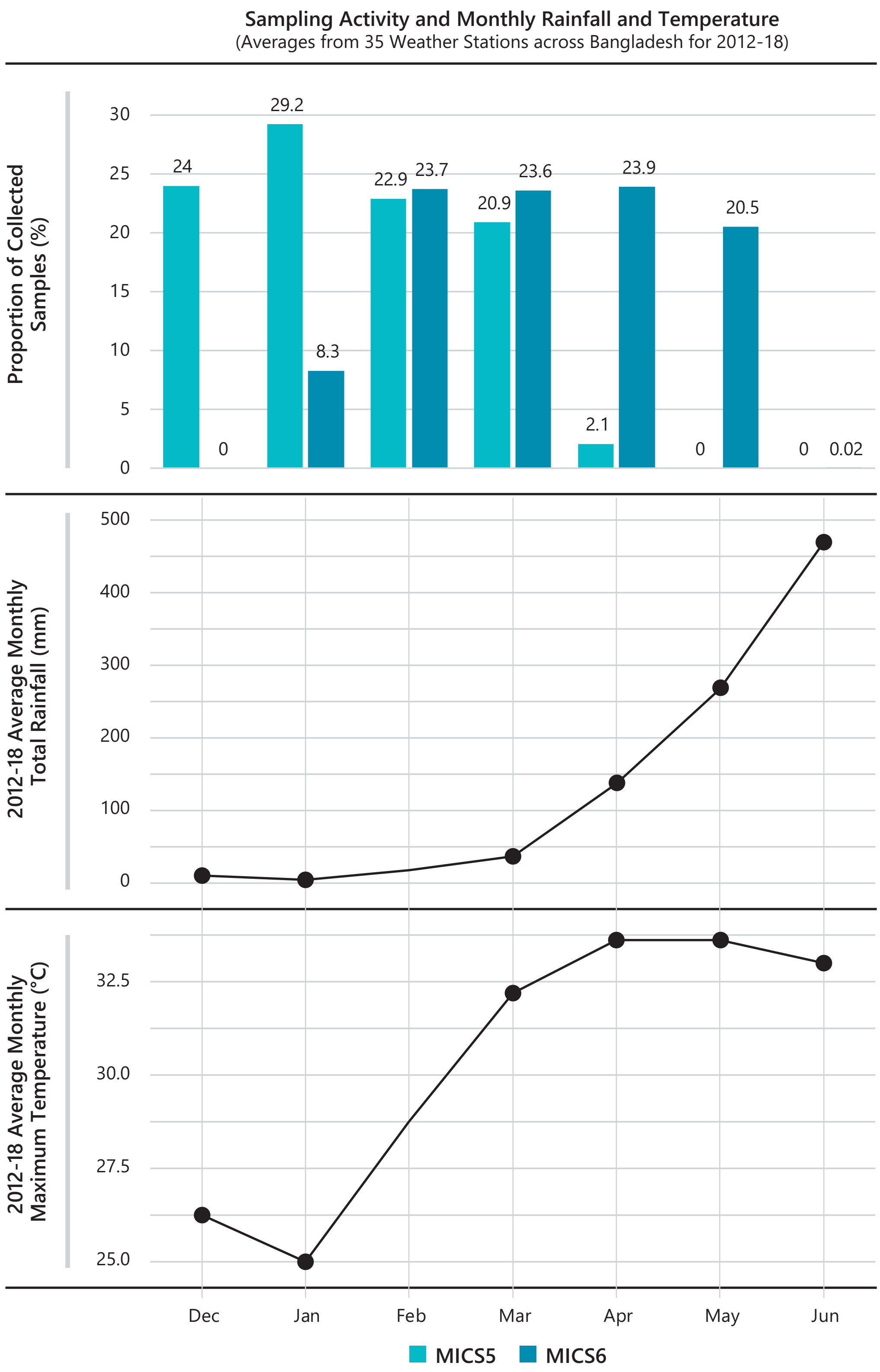
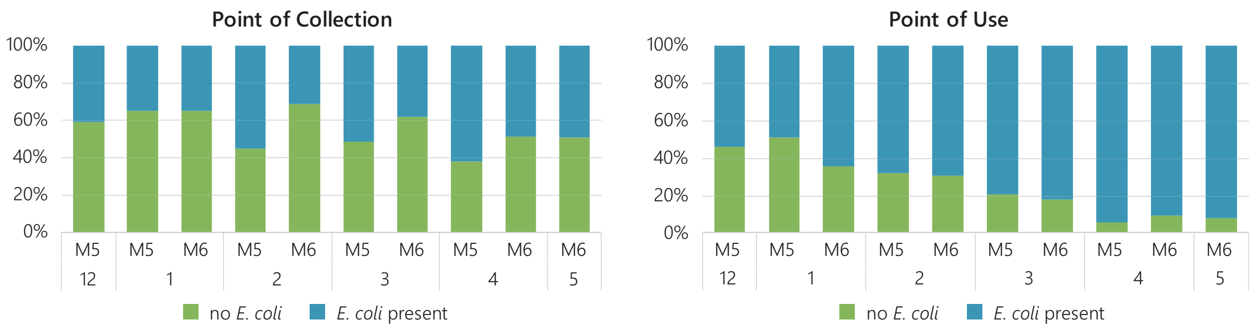


Figure 44: **Average water quality results by month from the MICS6 campaign for arsenic at PoU (top), *E. coli* at PoU (middle), and *E. coli* at PoC (bottom). The axis on the left shows the proportion of samples in the bar graphs, while the axis on the right provides the average concentrations in the line graphs.**

Methodological and internal variability did not explain these trends in the MICS6 results, suggesting that they were driven by seasonal variability. Methodological variability was tested through comparison of *E. coli* samples and duplicates, which demonstrated no significant difference by month, and through comparison of *E. coli* duplicates with laboratory analyses. For the latter, while significant differences were identified between months, there was no significant correlation to indicate a trend, suggesting ambient temperature did not affect field incubation methods. Internal variability was tested through comparisons of key variables, including wealth, education, water source, sanitation type and handwashing facilities. While many indicated significant differences by month, they did not present trends that align with the changes in water quality. For example, availability of soap increased over the months of each MICS sampling campaign, in contrast to the deterioration in water quality in the household.

Given the importance of seasonality and the context of other indicators of water access and hygiene having improved, it is useful to compare the two MICS programmes for the two months with the most overlap: February and March (Figure 45). At the source, 45.2 percent of household populations had no detectable *E. coli* in February for MICS5 and 48.8 percent in March; this compares with 68.8 percent and 61.9 percent in MICS6. At the PoU, 31.7 percent of household populations had no *E. coli* detected in February for MICS5 and 20.3 percent in March; this compares with 30.5 percent and 17.8 percent in MICS6. This subset of data would lead to different conclusions than the overall dataset: **microbiological water quality at the source has improved in Bangladesh from MICS5 to MICS6, but without a commensurate improvement (nor substantial deterioration) in water quality at the household.** This limited analysis highlights the importance of seasonality and the difficulties in comparing one-off grab samples to assess microbiological water quality.

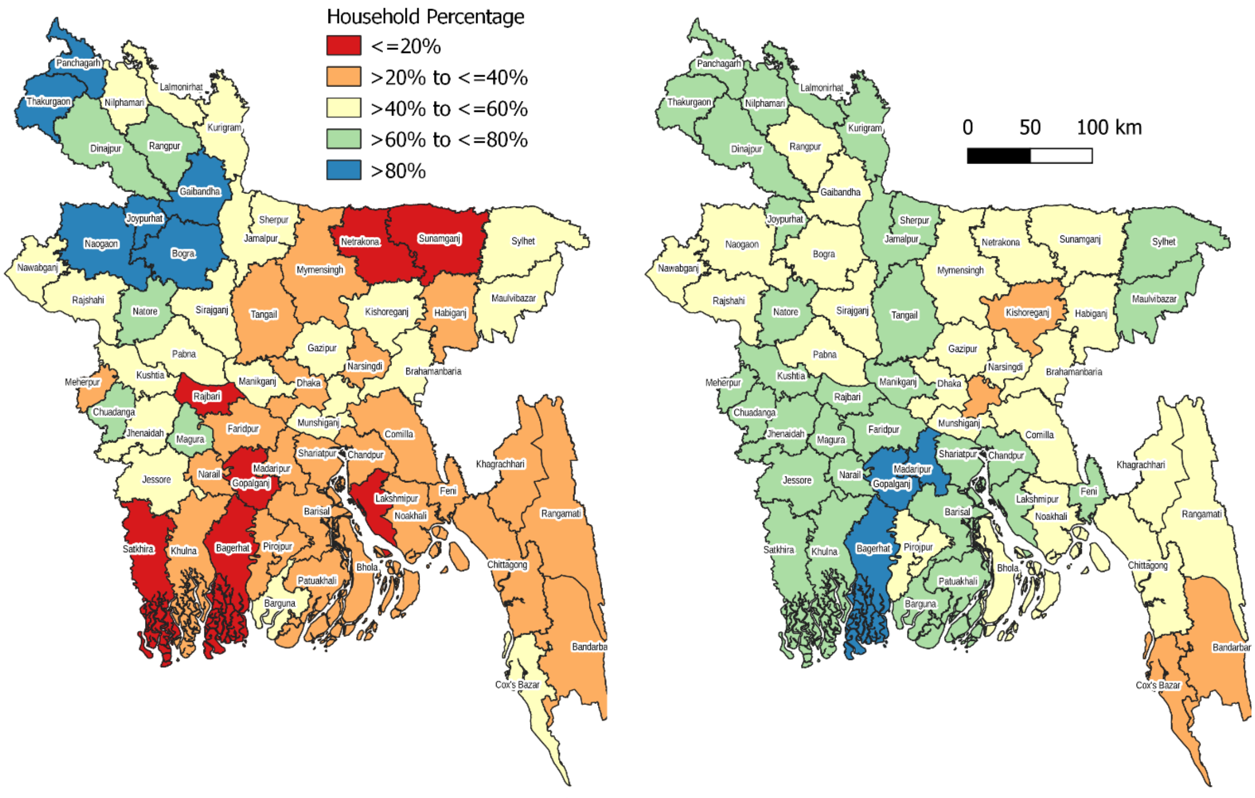
Figure 45: Comparison of *E. coli* presence in water samples by month of sample



7.3 Who are the most vulnerable to water safety risks?

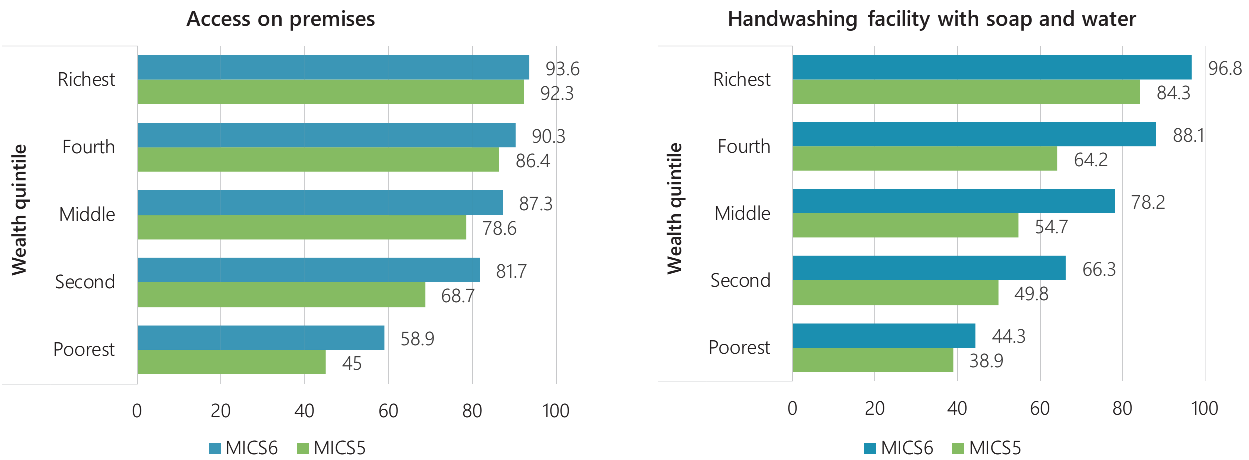
There are different approaches to consider vulnerability to water safety risks. Across these results, there were larger differences between geographic location at division or district level than between wealth quintiles. While wealth inequalities explain variability at a local scale, district or division explain more variability at the national scale. The geographical differences are explained in differences in geology and geogenic risks, differences in access to types of water sources, and in availability of water supplies on premises. Figure 46 demonstrates these inequalities across the country.

Figure 46: Geographic variation in access to safely managed: Access to water an improved drinking water source located on premises, free of *E. coli*, with <50 ppb arsenic and available when needed (left) and to improved sanitation systems that are private, and where excreta are safely managed (right). Note that limitations in methodology to define safely managed services mean that water and sanitation are not directly comparable, and the sanitation challenges associated with faecal sludge management are underrepresented in the data.



Analysis of changes in access between wealth groups suggests that some programming is more successful in achieving improvements for the poorest. While large differences remain, water on-premises has improved most for the poorest (Figure 47); similar advances have been achieved in access to basic sanitation. However, in other areas progress has been greatest for wealthier quintiles, including for access to basic handwashing facilities (Figure 47), access to improved water and to piped water, and to water with <10 ppb arsenic.

Figure 47: **Progress for the poorest wealth quintile has been rapid for access to water on premises (left), but not for access to basic handwashing facilities (right)**



In addition, to those outlined above, it is important to consider those risks that may be unexpected and therefore, less likely to be addressed through current programming. These include:

- Despite efforts to provide alternative sources with reduced levels of arsenic, there are areas where there is evidence of an increase in the proportion of the population drinking from contaminated water sources, and, particularly, evidence of increasing proportions of the population in Chattogram and Sylhet are exposed to high arsenic levels of over 200 ppb (Section 3.5).

- Piped water is generally assumed to provide the best quality water supply, and while access to piped water has increased, the quality of these systems is often poor. Over 40 percent of people using piped systems were drinking from microbiologically contaminated systems. Piped systems were more contaminated in urban areas than rural (65 percent unsafe compared to 34 percent unsafe), and with large geographic differences. Approaches are need to improve monitoring and enforcement of drinking water guidelines in piped systems.

- The coastal belt of Bangladesh needs special attention through water quality surveys as there are multiple hazards in those areas including arsenic, salinity, pathogens and more. Water quality in deep and shallow groundwater variability needs to be tracked, such as variability due to overexploitation, sea water intrusion and inundation by cyclonic storm surges. As the hydrogeological conditions are fragile, understanding of the spatial, depth and temporal variations are essential in making robust plans for supplying water and providing sanitation coverages using appropriate technologies.

- Tubewells remain the primary water source for the majority of the population. However, in areas with difficult hydrogeological conditions improving access to safe water is particularly challenging (GOB, 2011; WSP-WB, 2011). Alternative water supply technologies and sanitation methods are needed for these areas.

7.4 What additional drinking water quality risks might be considered?

The focus of MICS on contamination of water supplies with *E. coli* and arsenic addresses some key risks as have been highlighted in this report, but there are other water quality concerns pertinent to Bangladesh. Two key risks that have not been addressed in this study are manganese and salinity.

Many areas in Bangladesh have high concentrations of Mn as reported by the DPHE and BGS (2001) survey. Hug et al. (2011) reported the occurrences of manganese in both deep and shallow wells in their study area. Neurotoxic impacts on children have been reported by various studies (Akter, Khan, & Rahman, 2019; Iyare, 2019; Khan et al., 2011; Rahman et al., 2017; Wasserman et al., 2006). Some studies reported links between sediment color and manganese; high concentrations found in reddish brown oxidized sediments whereas low concentrations were associated with black sediments (Hossain et al., 2014; von Brömssen et al., 2007)(von Bromssen et al, 2007; Hossain et al, 2014). The distributions of arsenic and manganese differ in groundwater, requiring further research to detect and monitor levels of Mn in water. Currently there is no WHO health-based guide level concentrations, although a health-based guideline of 0.08 mg/L is proposed (WHO, 2020). Environment Canada suggested 0.12 mg/L as health-based limit and 0.02 mg/L as aesthetic limit (Health Canada, 2016).

Salinity is currently is a problem in the coastal area where deep groundwater is not available. Various health issues are linked to high salinity in drinking water. With rising sea levels and increased upstream abstractions associated with climate change, an increase in the area affected by salinity is likely. Approximately 5 percent (risk model 1: arsenic, salinity water-storage depletion combined) to 24 percent (risk model 2: arsenic and salinity) of the land area in Bangladesh is exposed to extremely high to high risks of elevated arsenic, salinity, and groundwater depletion hazards (Ayers et al., 2016; Shamsudduha et al., 2020).

In many areas, water sources will be affected by multiple risks, from pathogens, arsenic, manganese and salinity, as well as the potential from pollution from agricultural and industrial sources. These multiple risks, especially in groundwater, highlight that groundwater will often not be safe without treatment. Furthermore, as groundwater pumping increases, such as to meet the capacity for larger piped water systems, this can result in further changes in water chemistry that can be detrimental for health (Shamsudduha et al., 2020).

7.5 Recommendations

The findings of this MICS Water Quality Thematic Report will assist the Government of Bangladesh and its development partners with prioritising key interventions to close the gap between access to improved drinking water sources and access to safe drinking water. These recommendations have been developed in consultation with the national technical team to inform approaches to drinking water quality monitoring and management in Bangladesh. Recommendations of changes to the MICS water quality modules will be discussed further with the Global MICS Water Quality team to assess opportunities to embed them in future surveys.

7.5.1 Water quality sampling and MICS surveys in Bangladesh

1. Standardise methods for analysis of arsenic

Most of the MICS surveys including 2019 one used Field Kits for arsenic measurement. However, there is uncertainty of this semi-quantitative method for critical ranges like 10-50 ppb. It is better to use quantitative method such as the digital Arsenator used in 2009. Laboratory analysis using AAS would give the most reliable results although analysing thousands of samples could be an issue. Where field kits are used, very strict quality control is necessary with at least 1 percent samples analysed by quantitative method to make any required adjustments for over or under estimation of certain concentrations. Kits can also be used for manganese analysis with good quality measures. Measurements of electrical conductivity using portable meters would provide a good proxy for salinity of samples.

2. Standardise sampling methods

For microbiological sampling, it is recommended that sampling points are decontaminated before source water samples are taken. Household samples provide information on the water consumed. Decontaminating sources before sampling will provide clearer information on the microbiological risks from water sources.

3. Incorporate questions specific to Bangladesh water systems in MICS

Questions should be drafted and piloted that can be brought in to future MICS campaigns in Bangladesh that address locally relevant issues. In particular, a question that enables differentiation of shallow and deep tubewells would enable analyses the national distribution of access to deep tubewells and whether deep tubewells are continuing to provide safe water as infrastructure ages and abstraction increases. Additionally, with a question on the type of pump used, analysis may start to identify the proportion of the population at risk of losing access if groundwater levels drop.

4. Incorporate salinity and manganese in water quality surveys

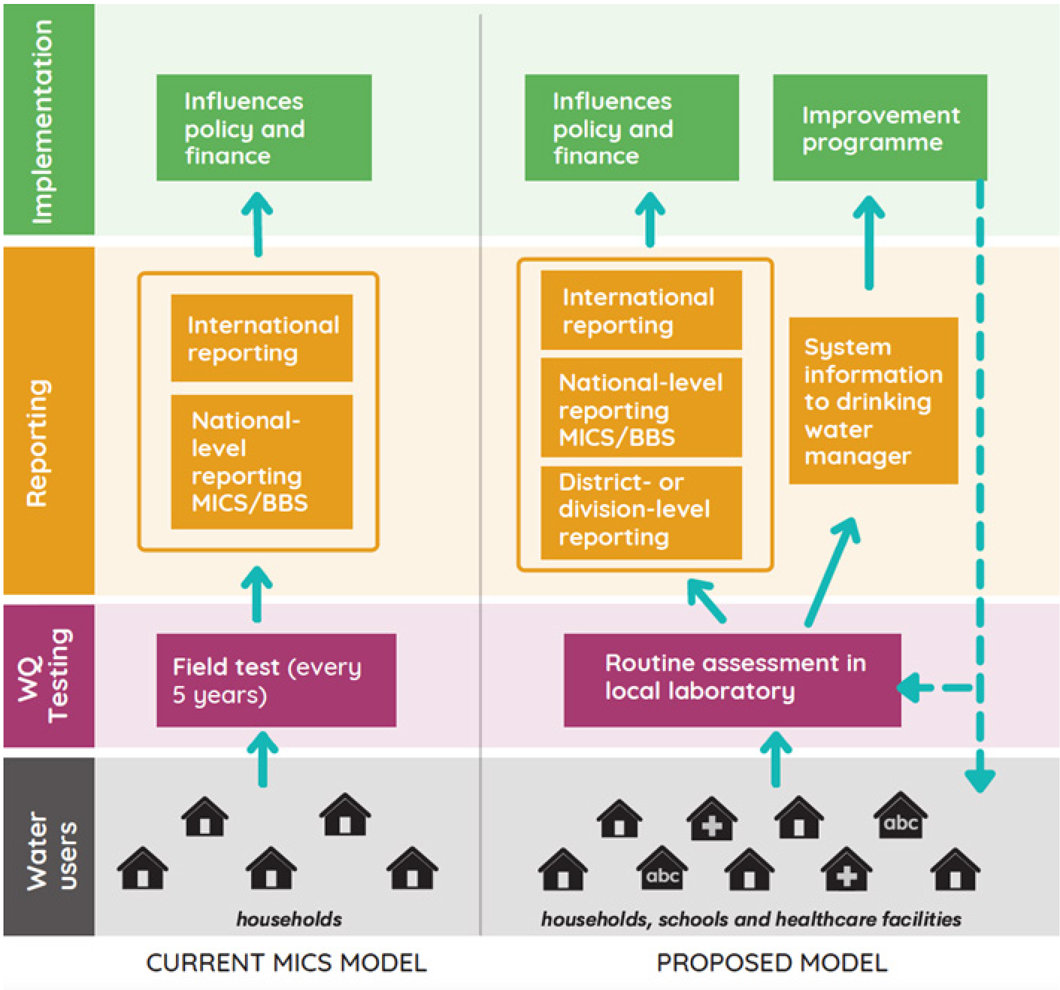
Manganese and salinity pose widespread risks to water safety in Bangladesh. Manganese and salinity should be included as a national level requirements for future surveys to enable the scale of these hazards to be assessed and changes tracked to support design of appropriate interventions.

7.5.2 Advancing water safety for Bangladesh

1. Establish a longitudinal water quality monitoring programme

A nationally representative MICS water quality survey provides a useful snapshot of water quality issues. However, the lack of climate resilience makes for poor comparability between repeated surveys (discussed in section 7.2). It is recommended that Bangladesh establish a longitudinal water quality monitoring programme, sampling a representative range of random water systems on a regular, seasonal basis such as is outlined in Figure 47. This would provide data that would improve tracking of changes in water quality, vulnerability to climate and enable results to be reported to local water managers to support action. Bangladesh has good capacity for managing a longitudinal water quality monitoring programme through its DPHE labs, which would be strengthened by delivering regular water quality assessments.

Figure 48: **Proposed model for national, longitudinal water quality monitoring**



2. Expand implementation of climate-resilient water safety planning

Poor climate resilience was identified as the reason progress on water quality has not matched progress on access to WASH. Climate resilient water safety plans provide a tool that addresses water quality risks from the water source to the user. Expanded adoption can improve water safety and address the lack of climate resilience in water supply systems.

3. Improve hygiene at the point of collection

The potential for contamination to enter the water supply at the point of collection, especially in communal water points, is often overlooked in hygiene programmes. Initiatives to address this could include the specific inclusion of advice on cleaning water points regularly, or appointing of a tubewell operator to service and maintain hygiene on site. The appointment of an operator could have further benefits to reduce handling of the pump and ensure physical distancing to support efforts to reduce transmission of COVID-19 as is recommended in UNICEF /DPHE 'Guideline for the Functional Community Water Points and its Safe Use under COVID 19 Response'. Further research is needed to determine the impact of water collection practices on the quality of water collected.

4. Expand water treatment

In Bangladesh, use of groundwater via tubewells has been promoted to reduce the spread of diarrhoeal diseases. However, increasing evidence of complex water quality risks from arsenic, salinity and manganese, as well as many more contaminants, highlight that improving water safety is likely to require water treatment in many areas. Additionally, increased pumping of groundwater can drawdown more contaminated waters. Water treatment to remove manganese and reduce salinity can be expensive and energy intensive. Surface water, while often high in faecal contamination, can be cheaper and simpler to treat than groundwater for piped water systems.

5. Prioritize highly contaminated and underserved areas

Water quality, and access to safely managed water, vary greatly by location due to the changes in water quality risk associated with geology and different types of infrastructure. This spatial variability will be further amplified by the increasing impact of saline intrusion in coastal areas. Interventions to improve access should focus on these geographic inequalities, and prioritise highly contaminated and underserved areas.

6. Water point regulation: Control over the installation of private wells

Private wells have accounted for part of the increase in on-premises water access. Fischer et al (2020) estimated that the rate of privately financed infrastructure growth is almost 700,000 tubewells per year, with nine million tubewells were installed between 2005 and 2018. However, water quality for private wells is not regulated and not assured. Regulation is needed to ensure private water supplies are delivering safe water.

7.5.3 Water quality sampling in future MICS

As the first country to undertake repeat MICS water quality sampling campaigns, the comparison of results is unique and provides information relevant to MICS campaigns internationally. However, this analysis highlights that MICS *E. coli* results are not reliably comparable between campaigns, so do not adequately reflect improvements or deteriorations in water quality. Furthermore, this has implications for tracking progress of safely managed water services which rely on *E. coli* measures. It is recommended that, MICS water quality sampling programmes focus on initial assessments for all countries, but subsequently try to build capacity for drinking water quality monitoring. It is recommended that single grab samples of *E. coli* are not appropriate for tracking progress on safely managed water. Furthermore, it is recommended that the MICS methodology for sampling include decontamination of taps or handpump spouts prior to sampling to get a more accurate measure of water quality at the source.

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Appendices

Table A1.1 : Selected Characteristics of Household Interviewed	
Indicator	**Percent**
No. of household interviewed	61,242
Area	
Urban	22.1
Rural	77.9
Sex of household head	
Male	87.3
Female	12.7
Education of household head	
Pre-primary or none	35.0
Primary	27.1
Secondary	25.6
Higher secondary+	12.3
Missing/DK	0.0
Education of women aged 15-49 years (%)	
Pre-primary or none	15.8
Primary	22.7
Secondary	44.3
Higher secondary+	17.2
Wealth index quintile: women aged 15-49 years	
Poorest	17.5
Second	19.1
Middle	20.2
Fourth	21.2
Richest	22.0
Percentage of Household interviewed with Children under 5	
Sex of children under age 5 years (%)	
Male	52.0
Female	48.0
Percentage of Household interviewed with Children 5-17	
Sex of chidlren age 5-17 years (%)	
Male	50.8
Female	49.2
Percentage of adolescents in Household Members	20.8
Sex of adolescent (%)	
Male	50.4
Female	49.6
Mean household size	4.3

Table A3.1: Arsenic contamination at the PoU by type, quality, and location of drinking water source									
Characteristics of water source	**Percentage of Sampled Household Population Under Different Contamination Levels of Arsenic and Various Drinking Water Source**					**Percent over 10 ppb**	**Percent over 50 ppb**	**Number of household members**	**Percentage of total household population**
	<=10 ppb	>10 to <=50 ppb	>50 to <=200 ppb	>200 ppb	Total				
Source of Household Water Sample									
Piped Water	94.5	2.4	1.9	1.2	100.0	5.4	3.1	6,062	11.5
Piped into dwelling	97.8	0.5	1.5	0.2	100.0	2.2	1.7	2,700	5.1
Piped into compound, yard or plot	92.2	3.5	2.3	2.0	100.0	7.8	4.3	2,457	4.7
Piped to neighbourhood	79.6	15.4	3.5	1.5	100.0	20.4	5.0	202	0.4
Public tap / standpipe	94.7	1.6	1.3	2.3	100.0	5.3	3.6	693	1.3
Water Wells	81.4	6.7	5.9	6.0	100.0	18.6	11.9	45,291	86.3
Tube well, Borehole	81.2	6.8	6.0	6.0	100.0	18.8	12.0	44,928	85.6
Protected dug well	100.0	0.0	0.0	0.0	100.0	0.0	0.0	127	0.2
Unprotected dug well	97.8	0.0	0.0	2.2	100.0	2.2	2.2	227	0.4
All Other Sources	98.5	1.0	0.5	0.0	100.0	1.5	0.5	1,136	2.2
Protected Spring	(*)	(*)	(*)	(*)	100.0	(*)	(*)	3	0.0
Unprotected Spring	100.0	0.0	0.0	0.0	100.0	0.0	0.0	75	0.1
Rainwater	100.0	0.0	0.0	0.0	100.0	0.0	0.0	226	0.4
Surface water (river, stream, dam, lake, pond, canal, irrigation channel)	98.1	0.7	1.2	0.0	100.0	1.9	1.2	463	0.9
Bottled Water	98.4	1.6	0.0	0.0	100.0	1.6	0.0	219	0.4
Cart with small tank	100.0	0.0	0.0	0.0	100.0	0.0	0.0	34	0.1
Water kiosk	95.5	4.5	0.0	0.0	100.0	4.5	0.0	109	0.2
Others	(*)	(*)	(*)	(*)	100.0	(*)	(*)	6	0.0
Total	**83.3**	**6.1**	**5.4**	**5.3**	**100.0**	**16.7**	**10.6**	**52,479**	**100.0**
Improved/unimproved water source using JMP classification									
Unimproved water Source	98.2	0.4	0.7	0.6	100.0	1.8	1.3	772	1.5
Improved water source	83.0	6.2	5.4	5.4	100.0	17.1	10.8	51,707	98.5
Total	**83.3**	**6.1**	**5.4**	**5.3**	**100.0**	**16.7**	**10.6**	**52,479**	**100.0**
Location of water source									
In own dwelling	85.4	7.6	4.8	2.2	100.0	14.6	7.0	2,737	5.2
In Own yard/plot	81.1	6.7	6.7	5.4	100.0	18.9	12.1	35,165	67.0
Elsewhere	83.7	5.6	6.9	3.8	100.0	16.3	10.7	9,137	17.4
No Information	95.1	2.1	2.0	0.8	100.0	4.9	2.8	5,440	10.4
Total	**83.3**	**6.1**	**6.1**	**4.5**	**100.0**	**16.7**	**10.6**	**52,479**	**100.0**

TableA3.2: Arsenic contamination at the PoU by Division (Both rural and urban areas)									
Area	**Percentage of Sampled Household Population Under Different Contamination Levels of Arsenic and Division**					**Percent over 10 ppb**	**Percent over 50 ppb**	**Number of household members**	**Percent of household population**
	<=10 ppb	>10 to <=50 ppb	>50 to <=200 ppb	>200 ppb	Total				
Barishal	98.9	0.7	0.2	0.2	100.0	1.1	0.4	3,028	5.8
Chattogram	70.8	4.1	8.2	16.9	100.0	29.2	25.1	10,347	19.7
Dhaka	86.6	5.5	4.4	3.5	100.0	13.4	7.9	12,755	24.3
Khulna	79.9	11.1	6.0	3.0	100.0	20.1	9.0	6,053	11.5
Mymenshing	82.7	9.4	6.1	1.9	100.0	17.3	7.9	3,817	7.3
Rajshahi	91.9	4.7	2.2	1.3	100.0	8.1	3.4	6,729	12.8
Rangpur	96.2	2.7	1.0	0.2	100.0	3.9	1.2	5,846	11.1
Sylhet	64.9	14.3	15.0	5.9	100.0	35.1	20.9	3,902	7.4
Total Result	**83.3**	**6.1**	**5.4**	**5.3**	**100.0**	**16.8**	**10.6**	**52,479**	**100.0**

Table A3.3: Arsenic contamination at the PoU by Division (rural areas)									
Area	**Percentage of Sampled Household Population Under Different Contamination Levels of Arsenic and Divison**					**Percent over 10 ppb**	**Percent over 50 ppb**	**Number of household members**	**Percent of household population**
	<=10 ppb	>10 to <=50 ppb	>50 to <=200 ppb	>200 ppb	Total				
Barishal	98.7%	0.8%	0.2%	0.3%	1%	1.3%	0.5%	2,555	4.9%
Chattogram	67.%	4.4%	10.7%	17.9%	1%	33.%	28.6%	8,047	15.3%
Dhaka	80.5%	8.1%	7.3%	4.%	1%	19.5%	11.3%	8,140	15.5%
Khulna	78.3%	11.9%	7.1%	2.7%	1%	21.7%	9.8%	5,055	9.6%
Mymenshing	82.5%	9.3%	6.8%	1.4%	1%	17.5%	8.2%	3,280	6.2%
Rajshahi	91.3%	4.8%	2.8%	1.1%	1%	8.7%	3.9%	5,591	10.7%
Rangpur	95.8%	2.9%	1.3%	0.%	1%	4.2%	1.3%	5,107	9.7%
Sylhet	61.2%	15.2%	18.7%	4.9%	1%	38.8%	23.6%	3,304	6.3%
Total Result	**80.7%**	**7.%**	**7.%**	**5.3%**	**1%**	**19.3%**	**12.3%**	**41,080**	**78.3%**

Table A3.4: Arsenic contamination by Division (urban areas)									
Area	**Percentage of Sampled Household Population Under Different Contamination Levels of Arsenic and Division**					**Percent over 10 ppb**	**Percent over 50 ppb**	**Number of household members**	**Percent of household population**
	<=10 ppb	>10 to <=50 ppb	>50 to <=200 ppb	>200 ppb	Total				
Barishal	100.0	0.0	0.0	0.0	100.0	0.0	0.0	472	0.9
Chattogram	83.9	3.2	5.0	8.0	100.0	16.1	13.0	2,300	4.4
Dhaka	97.2	0.9	1.4	0.4	100.0	2.8	1.9	4,615	8.8
Khulna	88.3	6.7	4.5	0.5	100.0	11.7	5.0	998	1.9
Mymenshing	84.1	9.7	5.4	0.8	100.0	15.9	6.2	538	1.0
Rajshahi	94.9	4.1	0.0	1.0	100.0	5.1	1.0	1,139	2.2
Rangpur	98.8	1.2	0.0	0.0	100.0	1.2	0.0	739	1.4
Sylhet	84.9	9.4	3.0	2.7	100.0	15.1	5.7	598	1.1
Total Result	**92.5**	**3.0**	**2.4**	**2.1**	**100.0**	**7.5**	**4.5**	**11,399**	**21.7**

Table A3.5: Arsenic contamination at the PoU by district (Both rural and urban)										
Division	**District**	**Percentage of Sampled Household Population Under Different Contamination Levels of Arsenic and Districts**					**Percent over 10 ppb**	**Percent over 50 ppb**	**Number of household members**	**Percent of household population**
		<=10 ppb	>10 to <=50 ppb	>50 to <=200 ppb	>200 ppb	Total				
Barishal	Barguna	100.0	0.0	0.0	0.0	100.0	0.0	0.0	310	0.6
	Barishal	100.0	0.0	0.0	0.0	100.0	0.0	0.0	803	1.5
	Bhola	99.4	0.6	0.0	0.0	100.0	0.6	0.0	627	1.2
	Jhalokati	96.7	1.8	0.0	1.5	100.0	3.3	1.5	232	0.4
	Patuakhali	99.2	0.8	0.0	0.0	100.0	0.8	0.0	639	1.2
	Pirojpur	96.2	1.6	1.2	1.0	100.0	3.8	2.2	417	0.8
Chattogram	Bandarban	100.0	0.0	0.0	0.0	100.0	0.0	0.0	229	0.4
	Brahmanbaria	68.3	2.4	6.0	23.3	100.0	31.7	29.3	1,046	2.0
	Chandpur	53.8	4.1	3.4	38.6	100.0	46.2	42.1	812	1.5
	Chattogram	91.2	4.1	1.9	2.8	100.0	8.8	4.7	2,545	4.8
	Cox's Bazar	98.2	0.7	1.2	0.0	100.0	1.8	1.2	800	1.5
	Cumilla	49.6	2.2	10.8	37.4	100.0	50.4	48.2	2,118	4.0
	Feni	50.4	7.2	21.4	20.9	100.0	49.6	42.3	506	1.0
	Khagrachhari	99.7	0.3	0.0	0.0	100.0	0.3	0.0	262	0.5
	Lakshmipur	61.4	4.9	21.8	11.9	100.0	38.6	33.7	633	1.2
	Noakhali	53.5	12.8	20.8	12.9	100.0	46.5	33.7	1,111	2.1
	Rangamati	100.0	0.0	0.0	0.0	100.0	0.0	0.0	286	0.5
Dhaka	Dhaka	97.7	1.1	1.2	0.0	100.0	2.3	1.2	3,863	7.4
	Faridpur	58.1	13.4	10.7	17.8	100.0	41.9	28.4	684	1.3
	Gazipur	100.0	0.0	0.0	0.0	100.0	0.0	0.0	1,153	2.2
	Gopalganj	44.9	10.2	21.3	23.6	100.0	55.1	44.9	445	0.8
	Kishoregonj	76.3	12.9	7.8	3.0	100.0	23.7	10.7	1,084	2.1
	Madaripur	67.3	8.7	12.4	11.6	100.0	32.7	24.0	411	0.8
	Manikganj	63.5	17.4	15.1	4.0	100.0	36.5	19.1	568	1.1
	Munshiganj	90.2	2.9	2.1	4.8	100.0	9.8	6.9	509	1.0
	Narayangonj	85.9	2.9	6.9	4.4	100.0	14.1	11.2	1,069	2.0
	Narsingdi	89.5	8.3	1.6	0.6	100.0	10.5	2.2	768	1.5
	Rajbari	81.7	12.1	3.4	2.8	100.0	18.3	6.2	422	0.8
	Shariatpur	83.6	7.1	3.4	5.9	100.0	16.4	9.4	425	0.8
	Tangail	95.1	4.5	0.5	0.0	100.0	4.9	0.5	1,354	2.6

Division	District	Percentage of Sampled Household Population Under Different Contamination Levels of Arsenic and Districts					Percent over 10 ppb	Percent over 50 ppb	Number of household members	Percent of household population
		<=10 ppb	>10 to <=50 ppb	>50 to <=200 ppb	>200 ppb	Total				
Khulna	Bagerhat	85.6	2.1	8.5	3.9	100.0	14.4	12.3	565	1.1
	Chuadanga	65.9	19.9	12.3	1.8	100.0	34.1	14.1	418	0.8
	Jashore	74.0	14.5	9.3	2.2	100.0	26.0	11.5	1,133	2.2
	Jhenaidah	84.0	14.9	1.1	0.0	100.0	16.0	1.1	691	1.3
	Khulna	83.0	8.9	5.0	3.2	100.0	17.0	8.1	846	1.6
	Kushtia	94.5	4.4	1.1	0.0	100.0	5.5	1.1	750	1.4
	Magura	78.1	11.3	6.9	3.7	100.0	21.9	10.6	373	0.7
	Meherpur	78.2	17.9	3.9	0.0	100.0	21.8	3.9	260	0.5
	Narail	81.4	6.0	5.6	6.9	100.0	18.6	12.6	262	0.5
	Satkhira	71.6	12.6	7.0	8.8	100.0	28.4	15.8	754	1.4
Mymenshing	Jamalpur	89.7	7.4	2.9	0.0	100.0	10.3	2.9	799	1.5
	Mymensingh	88.1	6.8	4.1	1.0	100.0	11.9	5.1	1,771	3.4
	Netrokona	56.9	19.9	16.3	6.8	100.0	43.1	23.2	757	1.4
	Sherpur	91.8	5.4	2.4	0.4	100.0	8.2	2.8	490	0.9
Rajshahi	Bogura	94.2	3.9	1.9	0.0	100.0	5.8	1.9	1,251	2.4
	Chapai Nawabganj	72.2	14.4	5.9	7.4	100.0	27.8	13.4	634	1.2
	Joypurhat	100.0	0.0	0.0	0.0	100.0	0.0	0.0	306	0.6
	Naogaon	98.2	0.5	0.9	0.4	100.0	1.8	1.3	905	1.7
	Natore	100.0	0.0	0.0	0.0	100.0	0.0	0.0	560	1.1
	Pabna	87.5	7.5	2.7	2.3	100.0	12.5	5.0	905	1.7
	Rajshahi	92.0	3.5	3.1	1.4	100.0	8.0	4.5	986	1.9
	Sirajganj	92.5	5.9	1.7	0.0	100.0	7.5	1.7	1,183	2.3
Rangpur	Dinajpur	99.5	0.5	0.0	0.0	100.0	0.5	0.0	1,105	2.1
	Gaibandha	84.8	9.3	4.8	1.0	100.0	15.2	5.8	905	1.7
	Kurigram	97.4	2.0	0.6	0.0	100.0	2.6	0.6	814	1.6
	Lalmonirhat	100.0	0.0	0.0	0.0	100.0	0.0	0.0	489	0.9
	Nilphamari	99.3	0.2	0.5	0.0	100.0	0.7	0.5	620	1.2
	Panchagarh	100.0	0.0	0.0	0.0	100.0	0.0	0.0	341	0.6
	Rangpur	94.7	4.7	0.6	0.0	100.0	5.3	0.6	1,048	2.0
	Thakurgaon	100.0	0.0	0.0	0.0	100.0	0.0	0.0	525	1.0
Sylhet	Habiganj	73.9	12.8	7.6	5.6	100.0	26.1	13.2	766	1.5
	Maulvibazar	80.0	6.3	6.1	7.6	100.0	20.0	13.7	688	1.3
	Sunamganj	25.2	26.5	37.4	10.9	100.0	74.8	48.3	1,101	2.1
	Sylhet	84.4	9.2	5.5	1.0	100.0	15.6	6.4	1,348	2.6
Total		**83.3**	**6.1**	**5.4**	**5.3**	**100.0**	**16.7**	**10.6**	**52,479**	**100.0**

Table A3.6 : Arsenic contamination at the PoU by wealth and education									
Area	**Percentage of Sampled Household Population Under Different Contamination Levels of Arsenic and Household Wealth**					**Percent over 10 ppb**	**Percent over 50 ppb**	**Number of household members**	**Percent of household population**
	<=10 ppb	>10 to <=50 ppb	>50 to <=200 ppb	>200 ppb	Total				
Household Wealth Class									
Poorest	84.0	6.5	5.7	3.8	100.0	16.0	9.5	10,241	19.5
Second	82.6	6.3	5.8	5.3	100.0	17.4	11.1	10,493	20.0
Middle	80.5	7.5	5.7	6.3	100.0	19.5	12.0	10,712	20.4
Fourth	80.7	6.0	6.1	7.2	100.0	19.3	13.3	10,567	20.1
Richest	88.6	4.2	3.4	3.7	100.0	11.4	7.1	10,465	19.9
Total	**83.3**	**6.1**	**5.4**	**5.3**	**100.0**	**16.7**	**10.6**	**52,479**	**100.0**
Education Level of Household Head									
Pre-primary or none	80.7	6.8	6.6	5.8	100.0	19.3	12.5	18,644	35.5
Primary	84.0	5.9	5.1	5.1	100.0	16.0	10.1	14,363	27.4
Secondary	83.8	5.7	4.9	5.6	100.0	16.2	10.5	13,181	25.1
Higher+	87.7	5.5	3.2	3.6	100.0	12.3	6.8	6,269	11.9
Missing/DK	(*)	(*)	(*)	(*)	100.0	(*)	(*)	21	0.0
Total	**83.3**	**6.1**	**5.4**	**5.3**	**100.0**	**16.7**	**10.6**	**52,479**	**100.0**

Table A3.7: Year to Year Comparison of arsenic contamination at the PoU

Division	Year	<=10 ppb	>10 to <=50 ppb	>50 to <=200 ppb	>200 ppb	% >10 ppb	% >50 ppb
Barisal	2009	86.6	12.1	0.7	0.6	13.4	1.3
	2013	94.5	5.4	0.1	0.0	5.5	0.1
	2019	98.9	0.7	0.2	0.2	1.1	0.4
Chattogram	2009	66.9	11.8	12.0	9.3	33.1	21.3
	2013	63.5	12.3	14.6	9.7	36.6	24.3
	2019	70.8	4.1	8.2	16.9	29.2	25.1
Dhaka	2009	61.7	20.9	13.3	4.0	38.3	17.3
	2013	74.4	16.5	7.9	1.3	25.6	9.1
	2019	86.6	5.5	4.4	3.5	13.4	7.9
Khulna	2009	56.4	27.0	13.4	3.2	43.6	16.6
	2013	73.3	16.0	9.3	1.5	26.7	10.7
	2019	79.9	11.1	6.0	3.0	20.1	9.0
Mymensingh	2009	60.5	27.3	10.8	1.4	39.5	12.2
	2013	62.6	18.1	16.6	2.6	37.3	19.2
	2019	82.7	9.4	6.1	1.9	17.3	7.9
Rajshahi	2009	81.7	14.2	3.6	0.5	18.3	4.1
	2013	88.6	7.0	3.8	0.7	11.5	4.5
	2019	91.9	4.7	2.2	1.3	8.1	3.4
Rangpur	2009	81.3	16.7	1.7	0.2	18.7	1.9
	2013	92.7	6.0	1.3	0.0	7.3	1.3
	2019	96.2	2.7	1.0	0.2	3.8	1.2
Sylhet	2009	47.1	27.1	24.2	1.6	52.9	25.8
	2013	*62.3*	*12.9*	24.0	0.9	37.8	24.9
	2019	64.9	14.3	15.0	5.9	35.1	20.8
National	**2009**	**68.0**	**18.6**	**10.0**	**3.4**	**32.0**	**13.4**
	2013	**75.3**	**12.4**	**9.6**	**2.8**	**24.8**	**12.4**
	2019	**83.3**	**6.1**	**5.3**	**5.3**	**16.7**	**10.6**

Table A4.1: *E. coli* level of PoC water by source type

Percentage of household population at risk of faecal contamination based on number of *E. coli* detected in PoC drinking water, Bangladesh, 2019

	Risk level based on number of *E. coli* per 100 mL				Total	Percentage of household population with *E. coli* in PoC water (> 1 per 100mL)[1]	Number of household members
	Low	Moderate	High	Very high			
	(<1 per 100 mL)	(1-10 per 100 mL)	(11-100 per 100 mL)	(>100 per 100 mL)			
Total	**59.7**	**22.1**	**12.3**	**5.9**	**100**	**40.3**	**25,949**
Improved/unimproved water source							
Improved water source	60.4	22.3	11.8	5.4	100	39.6	25,583
Unimproved water source	8.3	10.7	42.8	38.2	100	91.7	366
Main source of drinking water[A]							
Piped water	43.7	19.3	17.8	19.1	100	56.3	3,011
Tubewell/Borehole	63.0	22.7	10.9	3.4	100	37.0	22,269
Other improved	35.5	19.0	23.3	22.3	100	64.5	303
Unprotected well or spring	1.9	15.7	62.5	19.9	100	98.1	163
Surface water/Other	13.5	6.8	26.9	52.8	100	86.5	203

[1] MICS indicator WS.4 - Faecal contamination of PoC water
[A] As collected in the Household Questionnaire; may be different than the source drinking water tested

Table A4.2: *E. coli* level of PoU water by source type

Percentage of household population at risk of faecal contamination based on number of *E. coli* detected in PoU drinking water collected from different source types, Bangladesh, 2019

	Risk level based on number of *E. coli* per 100 mL				Total	Percentage of household population with *E. coli* in PoU water (>1 per 100mL)[1]	Number of household members
	Low	Moderate	High	Very high			
	(<1 per 100 mL)	(1-10 per 100 mL)	(11-100 per 100 mL)	(>100 per 100 mL)			
Total	**18.1**	**20**	**30.9**	**31**	**100**	**81.9**	**26,270**
Improved/unimproved water source							
Improved water source	18.4	20.1	30.8	30.7	100	81.6	25,873
Unimproved water source	2.9	10.8	33.5	52.9	100	97.1	397
Main source of drinking water[A]							
Piped water	20.0	17.4	30.6	32.0	100	80.0	3,047
Tubewell/Borehole	18.3	20.4	30.8	30.4	100	81.7	22,391
Other improved	10.1	22.8	31.5	35.6	100	89.9	435
Unprotected well or spring	1.6	12.0	47.5	39.0	100	98.4	168
Surface water/Other	3.9	9.9	23.2	63.1	100	96.1	229

[1] MICS indicator WS.4 - Faecal contamination of PoU water
[A] As collected in the Household Questionnaire; may be different than the source drinking water tested

Denominators are obtained by weighting the number of households by the number of household members where water quality was assessed for *E. coli* (HH48 * wqsweight).

Levels of *E. coli* are based on the number per 100 mL (WQ27) as follows: Low (0), Moderate (1-10), High (11-100), Very high (101). Households where data are recorded as 998 should be excluded from the denominator.

MICS indicator is WQ27>0.
Note the main source of drinking water (WS1) is used in the tabulation for consistency with other tables including WS.1.8 since safely managed services refer to the household's main source of drinking water.

Table A4.3: *E. coli* level of PoC water by area and division

	Proportion of households						
	Risk level based on number of *E. coli* per 100 mL				Total	Percentage of household population with *E. coli* in PoC water (>1 per 100mL)[1]	Number of household members
	Low	Moderate	High	Very high			
	(<1 per 100 mL)	(1-10 per 100 mL)	(11-100 per 100 mL)	(>100 per 100 mL)			
PoC water quality [A]							
Total	**59.7**	**22.1**	**12.3**	**5.9**	**100**	**40.3**	**25,949**
Area							
Urban	52.0	18.9	16	13.1	100	48	5,643
Rural	61.8	23.0	11.2	3.9	100	38.2	20,306
Division							
Barishal	84.1	8.4	3.2	4.3	100	15.9	1,521
Chattogram	48.7	28.9	14.6	7.9	100	51.3	5,094
Dhaka	47.9	22.9	18.6	10.7	100	52.1	6,349
Khulna	63.0	25.1	8.8	3.0	100	37.0	3,016
Mymensingh	56.5	29.7	8.2	5.6	100	43.5	1,879
Rajshahi	71.2	16.5	10.8	1.5	100	28.8	3,288
Rangpur	75.8	17.0	6.1	1.2	100	24.2	2,904
Sylhet	62.6	17.9	13.8	5.7	100	37.4	1,897

[1] MICS indicator WS.4 - Faecal contamination of PoC water
[A] As collected in the Household Questionnaire; may be different than the source drinking water tested

Table A4.4: *E. coli* level of PoU water by area and division

	Proportion of households						
	Risk level based on number of *E. coli* per 100 mL				Total	Percentage of household population with *E. coli* in PoU water (>1 per 100mL)	Number of household members
	Low	Moderate	High	Very high			
	(<1 per 100 mL)	(1-10 per 100 mL)	(11-100 per 100 mL)	(>100 per 100 mL)			
PoU water quality							
Total	**18.1**	**20.0**	**30.9**	**31.0**	**100**	**81.9**	**26,270**
Area							
Urban	20.6	18.7	30.1	30.6	100	79.4	5,771
Rural	17.5	20.3	31.1	31.2	100	82.5	20,498
Division							
Barishal	9.7	23.5	31.1	35.7	100	90.3	1,536
Chattogram	17.3	19.8	27.9	35.0	100	82.7	5,126
Dhaka	15.9	16.4	31.3	36.4	100	84.1	6,435
Khulna	16.4	21 .0	28.1	34.4	100	83.6	3,153
Mymensingh	23.4	27.6	23.6	25.5	100	76.6	1,900
Rajshahi	21.7	15.3	32.0	31.0	100	78.3	3,297
Rangpur	23.3	26 .0	41.3	9.4	100	76.7	2,913
Sylhet	18.5	19.1	30.9	31.6	100	81.5	1,910

Table A4.5: *E. coli* level of PoC water by division, urban and rural							
	Proportion of households						
	Risk level based on number of *E. coli* per 100 mL				Total	Percentage of household population with *E. coli* in PoC water over 1 cfu/100ml	Number of household members
	Low	Moderate	High	Very high			
	(<1 per 100 mL)	(1-10 per 100 mL)	(11-100 per 100 mL)	(>100 per 100 mL)			
Urban, Total	**52.0**	**18.9**	**16.0**	**13.1**	**100**	**48.0**	**5,643**
Division, urban							
Barishal	86.7	8.5	2.8	2.0	100	13.3	240
Chattogram	50.7	28.9	12.8	7.6	100	49.3	1,123
Dhaka	36.4	14.9	24.3	24.4	100	63.6	2,335
Khulna	66.9	24.1	6.3	2.6	100	33.1	496
Mymensingh	55.4	34.1	4.8	5.7	100	44.6	273
Rajshahi	71.2	13.6	11.1	4.0	100	28.8	537
Rangpur	69 .0	15.9	13.1	2.0	100	31.0	372
Sylhet	68.9	10.5	12.8	7.8	100	31.1	266
Rural, Total	**61.8**	**23.0**	**11.2**	**3.9**	**100**	**38.2**	**20,306**
Division, rural							
Barishal	83.6	8.4	3.3.0	4.7	100	16.4	1,282
Chattogram	48.1	28.9	15.1	7.9	100	51.9	3,970
Dhaka	54.5	27.6	15.2	2.7	100	45.5	4,014
Khulna	62.2	25.3	9.3	3.1	100	37.8	2,521
Mymensingh	56.6	29.0	8.8	5.6	100	43.4	1,606
Rajshahi	71.2	17.0	10.7	1.0	100	28.8	2,751
Rangpur	76.8	17.1	5.1	1.0	100	23.2	2,532
Sylhet	61.6	19.1	13.9	5.4	100	38.4	1,631

Table A4.6: *E. coli* level of PoU water by division, urban and rural

	Proportion of households						
	Risk level based on number of *E. coli* per 100 mL				Total	Percentage of household population with *E. coli* in PoU water over 1 cfu/100ml	Number of household members
	Low	Moderate	High	Very high			
	(<1 per 100 mL)	(1-10 per 100 mL)	(11-100 per 100 mL)	(>100 per 100 mL)			
Urban, Total	**20.6**	**18.7**	**30.1**	**30.6**	**100**	**79.4**	**5,771**
Division, urban							
Barishal	15.3	21.5	26.5	36.7	100	84.7	245
Chattogram	30.2	25.4	22.4	22.0	100	69.8	1,140
Dhaka	13.5	12.5	32.8	41.2	100	86.5	2,411
Khulna	16.6	25.3	27.3	30.8	100	83.4	513
Mymensingh	34.8	22.0	27.0	16.2	100	65.2	273
Rajshahi	27.8	20.4	25.8	26.1	100	72.2	541
Rangpur	19.9	25.4	47.3	7.3	100	80.1	381
Sylhet	27.6	15.3	35.1	22.0	100	72.4	266
Rural, Total	**17.5**	**20.3**	**31.1**	**31.2**	**100**	**82.5**	**20,498**
Division, rural							
Barishal	8.6	23.9	32.0	35.5	100	91.4	1,291
Chattogram	13.6	18.2	29.5	38.8	100	86.4	3,987
Dhaka	17.4	18.7	30.4	33.6	100	82.6	4,023
Khulna	16.3	20.2	28.3	35.1	100	83.7	2,639
Mymensingh	21.4	28.5	23.0	27.0	100	78.6	1,626
Rajshahi	20.5	14.4	33.2	32.0	100	79.5	2,756
Rangpur	23.8	26.1	40.4	9.7	100	76.2	2,532
Sylhet	17.1	19.7	30.2	33.1	100	82.9	1,644

Table A4.7: *E. coli* level of PoC water by wealth and education

Percentage of household population at risk of faecal contamination based on number of *E. coli* detected in PoC drinking water, Bangladesh, 2019

	Risk level based on number of *E. coli* per 100 mL				Total	Percentage of household population with *E. coli* in PoC water over 1 cfu/100ml	Number of household members
	Low	Moderate	High	Very high			
	(<1 per 100 mL)	(1-10 per 100 mL)	(11-100 per 100 mL)	(>100 per 100 mL)			
Total	**59.7**	**22.1**	**12.3**	**5.9**	**100**	**40.3**	**25,949**
Education of household head							
Pre-primary or none	56.2	23.5	13.9	6.4	100	43.8	9,234
Primary	61.3	21.9	11.5	5.3	100	38.7	7,173
Secondary	61.6	22.3	10.6	5.6	100	38.4	6,512
Higher secondary+	62.6	18.4	12.6	6.3	100	37.4	3,014
Missing/DK	34.3*	0.0*	46.5*	19.2*	100	65.7*	16
Wealth index quintile							
Poorest	62.0	20.9	11.1	6.0	100	38.0	5,178
Second	60.4	24.6	11.9	3.0	100	39.6	5,169
Middle	63.3	21.9	11.4	3.4	100	36.7	5,230
Fourth	59.2	22.2	13.0	5.6	100	40.8	5,260
Richest	53.4	21.0	14.0	11.6	100	46.6	5,113

Table A4.8: *E. coli* level of PoU water by wealth and education

Percentage of household population at risk of faecal contamination based on number of *E. coli* detected in PoU drinking water, Bangladesh, 2019

	Risk level based on number of *E. coli* per 100 mL				Total	Percentage of household population with *E. coli* in PoU water over 1 cfu/100ml1	Number of household members
	Low	Moderate	High	Very high			
	(<1 per 100 mL)	(1-10 per 100 mL)	(11-100 per 100 mL)	(>100 per 100 mL)			
Total	**18.1**	**20.0**	**30.9**	**31.0**	**100**	**81.9**	**26,270**
Education of household head							
Pre-primary or none	14.8	18.9	29.9	36.4	100	85.2	9,321
Primary	18.4	19.3	32.2	30.0	100	81.6	7,276
Secondary	18.4	21.2	31.5	29.0	100	81.6	6,602
Higher secondary+	27.1	22.2	29.3	21.5	100	72.9	3,055
Missing/DK	0.0*	19.4*	19.2*	61.4*	100	100*	16
Wealth index quintile							
Poorest	13.5	21.5	32.4	32.6	100	86.5	5,243
Second	15.6	18.9	31.5	34.0	100	84.4	5,222
Middle	16.9	20.1	28.8	34.3	100	83.1	5,259
Fourth	21.6	19.6	30.9	27.9	100	78.4	5,325
Richest	23.1	19.7	30.7	26.5	100	76.9	5,221

Table A4.9: *E. coli* level of PoU water by wealth and education, urban and rural							
Percentage of household population at risk of faecal contamination based on number of *E. coli* detected in PoU water, Bangladesh, 2019							
	Risk level based on number of *E. coli* per 100 mL				Total	Percentage of household population with *E. coli* in PoU water over 1 cfu/100ml	Number of household members
	Low	Moderate	High	Very high			
	(<1 per 100 mL)	(1-10 per 100 mL)	(11-100 per 100 mL)	(>100 per 100 mL)			
Urban, Total	**20.6**	**18.7**	**30.1**	**30.6**	**100**	**79.4**	**5,771**
Education of household head, urban							
Pre-primary or none	16.4	14.4	29.8	39.4	100	83.6	1,518
Primary	19.2	19.9	28.9	32.0	100	80.8	1,300
Secondary	17.8	21.6	29.3	31.2	100	82.2	1,623
Higher secondary+	30.4	19.2	32.7	17.7	100	69.6	1,319
Missing/DK	0.0*	0.0*	27.1*	72.9*	100	100*	11
Wealth index quintile, urban							
Poorest	14.7	13.0	31.6	40.7	100	85.3	1,221
Second	18.6	23.9	27.6	29.8	100	81.4	1,074
Middle	20.1	15.1	31.3	33.5	100	79.9	1,126
Fourth	18.5	22.8	32.1	26.6	100	81.5	1,243
Richest	31.8	19.2	27.5	21.5	100	68.2	1,108
Total, rural	**17.5**	**20.3**	**31.1**	**31.2**	**100**	**82.5**	**20,498**
Education of household head, rural							
Pre-primary or none	14.5	19.8	29.9	35.8	100	85.5	7,803
Primary	18.3	19.2	33.0	29.6	100	81.7	5,976
Secondary	18.6	21.0	32.2	28.2	100	81.4	4,980
Higher secondary+	24.6	24.4	26.7	24.3	100	75.4	1,735
Missing/DK	0.0*	66.5*	0.0*	33.5*	100	100*	5
Wealth index quintile, rural							
Poorest	12.7	21.4	33.8	32.1	100	87.3	4,169
Second	15.4	19.9	31.7	33.1	100	84.6	4,103
Middle	16.8	20.2	28.4	34.6	100	83.2	3,965
Fourth	18.9	20.6	30.3	30.3	100	81.1	4,290
Richest	23.8	19.4	31.0	25.8	100	76.2	3,971

Table A4.10: *E. coli* level of PoU water and time to collect

Percentage of household population at risk of faecal contamination based on number of *E. coli* detected in PoU drinking water, Bangladesh, 2019

	Proportion of households						
	Risk level based on number of *E. coli* per 100 mL				Total	Percentage of household population with *E. coli* in PoU water over 1 cfu/100ml	Number of household members
	Low	Moderate	High	Very high			
	(<1 per 100 mL)	(1-10 per 100 mL)	(11-100 per 100 mL)	(>100 per 100 mL)			
Total	**18.1**	**20.0**	**30.9**	**31.0**	**100**	**81.9**	**26,270**
Time to get water and come back							
On premises	19.6	20.1	31.3	28.9	100	80.4	21,519
1-5 minutes	14.9	16.2	30.1	38.7	100	85.1	499
6-10 minutes	15.0	21.8	28.0	35.2	100	85.0	1,073
11-30 minutes	11.5	18.3	27.3	42.9	100	88.5	2,117
31-60 minutes	6.9	17.3	31.8	43.9	100	93.1	650
>60 minutes	4.8	18.5	33.7	43.0	100	95.2	287

Table A4.11: *E. coli* level of PoU water by household treatment

Percentage of household population at risk of faecal contamination based on number of *E. coli* detected in PoU drinking water, Bangladesh, 2019

	Proportion of households				Total	Percentage of household population with *E. coli* in PoU water over 1 cfu/100ml	Number of household members
	Risk level based on number of *E. coli* per 100 mL						
	Low	Moderate	High	Very high			
	(<1 per 100 mL)	(1-10 per 100 mL)	(11-100 per 100 mL)	(>100 per 100 mL)			
Total	**18.1**	**20.0**	**30.9**	**31.0**	**100**	**81.9**	**26,270**
Treat water to make safer for drinking							
Yes	22.1	17.6	31.8	28.5	100	77.9	2,778
No	17.7	20.2	30.7	31.3	100	82.3	23,489
Missing/ DK	0.0*	0.0*	100	0.0*	100	100	3
Water treatment method							
Boil	21.2	17.8	31.0	30.0	100	78.7	1,260
Filter	26.1	17.1	33.0	23.9	100	73.9	1,610
Other	11.7	18.5	27.5	42.4	100	88.2	917

Table A4.12: *E. coli* level of PoC water by household treatment

Percentage of household population at risk of faecal contamination based on number of *E. coli* detected in PoC drinking water, Bangladesh, 2019

	Proportion of households Risk level based on number of *E. coli* per 100 mL				Total	Percentage of household population with *E. coli* in PoC water over 1 cfu/100ml	Number of household members
	Low (<1 per 100 mL)	Moderate (1-10 per 100 mL)	High (11-100 per 100 mL)	Very high (>100 per 100 mL)			
Total	**59.7**	**22.1**	**12.3**	**5.9**	**100**	**40.3**	**25,949**
Treat water to make safer for drinking							
Yes	41.2	19.9	19.8	19.1	100	58.8	2,700
No	61.8	22.4	11.4	4.4	100	38.2	23,246
Missing/DK	*	*	*	*	100	*	3
Proportion reporting treating their water	7.7	10.3	20.2	50.4			
Water treatment method							
Boil	29.1	18.4	21.6	30.8	100		1,243
Filter	51.4	18.6	17.5	12.5	100		1,566
Other	18.6	22.9	22.6	35.7	100		876

Table A4.13: *E. coli* level of PoU water by observed storage

Percentage of household population at risk of faecal contamination based on number of *E. coli* detected in PoU drinking water, Bangladesh, 2019

	Proportion of households Risk level based on number of *E. coli* per 100 mL				Total	Percentage of household population with *E. coli* in PoU water over 1 cfu/100ml	Number of household members
	Low (<1 per 100 mL)	Moderate (1-10 per 100 mL)	High (11-100 per 100 mL)	Very high (>100 per 100 mL)			
Total	**18.1**	**20.0**	**30.9**	**31.0**	**100**	**81.9**	**26,270**
Observation on source of drinking water sample							
Direct from source	27.5	22.8	31.3	18.4	100	72.4	1,542
Covered container	17.6	19.8	30.2	32.4	100	82.4	16,347
Uncovered container	17.6	19.8	32.1	30.5	100	82.4	8,317
Unable to observe	3.0	18.1	36.8	42.1	100	96.9	65

Table A4.14: *E. coli* level of PoC water by sanitation facility

Percentage of household population at risk of faecal contamination based on number of *E. coli* detected in PoC drinking water, Bangladesh, 2019

	Proportion of households				Total	Number of household members
	Risk level based on number of *E. coli* per 100 mL					
	Low	Moderate	High	Very high		
	(<1 per 100 mL)	(1-10 per 100 mL)	(11-100 per 100 mL)	(>100 per 100 mL)		
Total	**59.7**	**22.1**	**12.3**	**5.9**	**100**	**25,949**
Users of improved sanitation facilities						
Improved	59.6	22.1	12.2	6.0	100	21,863
Unimproved	59.2	23	12.6	5.1	100	3,699
Type of toilet facility						
Flush/Pour Flush: Flush to piped sewer system	34.1	15.7	24.0	26.2	100	1930
Flush / Pour Flush: Flush to septic tank	64.7	22.4	9.1	3.9	100	5689
Flush / Pour Flush: Flush to pit latrine	63.2	21.3	12.2	3.3	100	4472
Flush / Pour Flush: Flush to open drain	54.8	24.1	14.0	7.2	100	904
Flush / Pour Flush: Flush to dont know where	26.4	0	0	73.6	100	21
Pit Latrine: Ventilated improved pit latrine	75.5	12.8	7.6	4.1	100	231
Pit Latrine: Pit latrine with slab	59.8	24.0	11.8	4.4	100	9509
Pit Latrine: Pit Latrine Without Slab / Open Pit	60.9	21.1	12.7	5.3	100	2189
Composting toilet	*	*	*	*	100	(11)
Hanging toilet / hanging latrine	60.1	28.2	10.2	1.5	100	603
No facility / Bush / Field	68.6	13.1	13.5	4.9	100	387
Other	*	*	*	*	100	(3)
Toilet facility shared						
Yes	57.1	22.5	12.5	7.9	100	6437
No	60.5	22.0	12.2	5.2	100	19512
Sanitation ladder						
Basic	60.2	22.2	12.2	5.4	100	16468
Limited	58.0	22.1	12.1	7.9	100	5395
Unimproved	59.2	23.0	12.6	5.1	100	3699
Open defecation	68.6	13.1	13.5	4.9	100	387

Table A4.15: *E. coli* level of PoU water by sanitation facility

Percentage of household population at risk of faecal contamination based on number of *E. coli* detected in PoU drinking water, Bangladesh, 2019

	Proportion of households				Total	Number of household members
	Risk level based on number of *E. coli* per 100 mL					
	Low	Moderate	High	Very high		
	(<1 per 100 mL)	(1-10 per 100 mL)	(11-100 per 100 mL)	(>100 per 100 mL)		
Total	**18.1**	**20.0**	**30.9**	**31.0**	**100**	**26,270**
Users of improved sanitation facilities						
Improved	18.3	20.2	30.9	30.6	100	22,170
Unimproved	16.7	18.8	30.2	34.2	100	3,705
Type of toilet facility						
Flush/Pour Flush: Flush to piped sewer system	13.5	17.4	34.7	34.4	100	1,985
Flush / Pour Flush: Flush to septic tank	24.8	22.0	28.5	24.7	100	5,783
Flush / Pour Flush: Flush to pit latrine	18.6	20.1	32.7	28.6	100	4,520
Flush / Pour Flush: Flush to open drain	24.4	23.2	27.7	24.8	100	904
Flush / Pour Flush: Flush to dont know where	0.0	0.0	23.8	81	100	21
Pit Latrine: Ventilated improved pit latrine	20.3	30.7	20.3	28.1	100	231
Pit Latrine: Pit latrine with slab	15.3	19.5	31.0	34.3	100	9,619
Pit Latrine: Pit Latrine Without Slab / Open Pit	15.0	15.7	31.8	37.5	100	2,195
Composting toilet	*	*	*	*	100	11
Hanging toilet / hanging latrine	11.4	23.5	28.2	36.7	100	603
No facility / Bush / Field	22.8	18.5	33.9	24.8	100	395
Other	*	*	*	*	100	3
Toilet facility shared						
Yes	17.7	20.0	29.4	32.8	100	6,525
No	18.3	19.9	31.3	30.5	100	19,744
Sanitation ladder						
Basic	18.4	20.2	31.4	30.0	100	16468
Limited	18.7	20.0	29.2	32.1	100	5395
Unimproved	16.7	18.9	30.2	34.2	100	3699
Open defecation	23.2	18.8	34.5	23.5	100	387

Table A4.16: *E. coli* level of PoU drinking water by availability of a handwashing facility, soap and water

Percentage of household population at risk of faecal contamination based on number of *E. coli* detected in PoU drinking water, Bangladesh, 2019

	Risk level based on number of *E. coli* per 100 mL				Total	Number
	Low	Moderate	High	Very high		
	(<1 per 100 mL)	(1-10 per 100 mL)	(11-100 per 100 mL)	(>100 per 100 mL)		
Total	**18.1**	**20.0**	**30.9**	**31.0**	**100**	**26,270**
Place for handwashing						
Observed	19.0	20.2	31.3	29.5	100	22,900
Not observed	12.3	18.4	27.8	41.5	100	3,370
Handwashing facility observed and						
Water available	19.3	20.2	31.3	29.3	100	22,055
Soap available	19.3	20.0	31.6	29.1	100	20,403
Ash/mud/sand available	18.6	21.2	35.0	25.2	100	3,346
Place for handwashing with soap and water						
Water and soap available	19.5	20.0	31.6	28.8	100	19,680
Water is available, soap is not available	17.1	21.6	28.2	33.1	100	2,376

Table A4.17: *E. coli* level of PoC water by availability of a handwashing facility, soap and water

Percentage of household population at risk of faecal contamination based on number of *E. coli* detected in PoC drinking water, Bangladesh, 2019

	Proportion of households				Total	Number of household members
	Risk level based on number of E. coli per 100 mL					
	Low	Moderate	High	Very high		
	(<1 per 100 mL)	(1-10 per 100 mL)	(11-100 per 100 mL)	(>100 per 100 mL)		
Total	**59.7**	**22.1**	**12.3**	**5.9**	**100**	**25,949**
Place for handwashing						
Observed	59.1	23.1	12.2	5.7	100	22,641
Not observed	63.9	15.5	13.1	7.4	100	3,308
Handwashing facility observed and						
Water available	59.2	23.0	12.3	5.5	100	21,805
Soap available	58.9	23.0	12.4	5.6	100	20,187
Ash/mud/sand available	62.5	25.0	8.7	3.8	100	3,317
Place for handwashing with soap and water						
Water and soap available	59.0	22.9	12.6	5.5	100	19,463
Water is available, soap is not available	61.1	23.9	9.4	5.6	100	2,342

Table A5.1: PoU water quality by location and socio-economic status: arsenic and *E. coli*						
Percentage of population by levels of arsenic and *E. coli* found in PoU drinking water, Bangladesh, 2019						
	Percentage of population				Total	Number of household members
	Water quality risk level in PoU drinking water					
	Arsenic <= 50ppb and *E. coli* < 1 cfu/100ml1	Arsenic <= 50ppb and *E. coli* ≥ 1 cfu/100ml	Arsenic > 50ppb and *E. coli* < 1 cfu/100ml	Arsenic > 50ppb and *E. coli* ≥ 1 cfu/100ml		
Total	**16.7**	**72.8**	**1.5**	**9.1**	**100**	**26270**
Area						
Urban	19.7	75.1	0.9	4.3	100	5,771
Rural	15.8	72.1	1.7	10.4	100	20,498
Division						
Barishal	9.7	89.8	0.0	0.5	100	1,536
Chattrogram	14.6	60.6	2.7	22.2	100	5,126
Dhaka	14.5	77.5	1.4	6.6	100	6,435
Khulna	14.2	76.9	2.2	6.7	100	3,153
Mymensingh	22.1	70.5	1.3	6.1	100	1,900
Rajshahi	21.3	75.7	0.3	2.6	100	3,297
Rangpur	23.0	75.8	0.3	0.9	100	2,913
Sylhet	16.0	61.9	2.5	19.5	100	1,910
Education of household head						
Pre-primary or none	13.1	73.8	1.7	11.4	100	9,321
Primary	17.0	74.0	1.4	7.6	100	7,276
Secondary	17.1	72.7	1.3	8.9	100	6,602
Higher secondary+	25.7	66.9	1.4	6.0	100	3,055
Missing/Dk	*	*	*	*	100	16
Wealth index quintile						
Lowest	12.8	78.9	0.7	7.6	100	5,243
Second	14.1	73.4	1.5	11.0	100	5,222
Middle	15.6	72.9	1.3	10.2	100	5,259
Fourth	18.8	67.0	2.8	11.4	100	5,325
Richest	22.0	71.8	1.1	5.1	100	5,221

Table A5.2: PoC water quality by location and socio-economic status: arsenic and *E. coli*

Percentage of population by levels of arsenic and *E. coli* found in PoC water, Bangladesh, 2019

	Percentage of population				Total	Number of household members
	Water quality risk level in PoC water					
	Arsenic <= 50ppb and *E. coli* < 1 cfu/100ml1	Arsenic <= 50ppb and *E. coli* ≥ 1 cfu/100ml	Arsenic > 50ppb and *E. coli* < 1 cfu/100ml	Arsenic > 50ppb and *E. coli* ≥ 1 cfu/100ml		
Total	**53.3**	**35.0**	**6.4**	**5.3**	**100**	**12949**
Area						
Urban	45.4	47.5	3.9	3.1	100	2808
Rural	55.4	31.5	7.1	5.9	100	10142
Division						
Barishal	86.2	13.3	0.1	0.4	100	771
Chattrogram	39.4	34.9	12.4	13.3	100	2586
Dhaka	39.6	51.1	4.6	4.6	100	3148
Khulna	55.4	34.5	7.4	2.8	100	1510
Mymensingh	51.9	41.5	3.3	3.4	100	959
Rajshahi	70.9	26.1	2.3	0.7	100	1593
Rangpur	72.4	26.0	1.1	0.5	100	1437
Sylhet	49.0	22.0	18.1	10.9	100	946
Education of household head						
Pre-primary or none	48.0	37.3	7.4	7.3	100	4549
Primary	57.0	32.3	6.2	4.5	100	3534
Secondary	54.9	34.6	6.4	4.1	100	3219
Higher secondary+	56.6	35.0	4.3	4.1	100	1640
Missing/Dk	*	*	*	*	100	7
Wealth index quintile						
Lowest	59.6	31.3	5.1	4	100	2444
Second	50.3	35.2	8.5	5.9	100	2624
Middle	57.3	31.5	4.6	6.7	100	2640
Fourth	50.6	34.4	9.5	5.5	100	2687
Richest	48.8	42.4	4.3	4.5	100	2554

Table A5.3: PoC water quality by water source and location of the water source: arsenic and *E. coli*

Proportion of population by levels of arsenic and *E. coli* found in PoC of drinking water, Bangladesh, 2019

	Percentage of households				Total	Number of household members
	Risk level based on number of *E. coli* per 100 mL					
	Arsenic <= 50ppb and *E. coli* < 1 cfu/100ml1	Arsenic <= 50ppb and *E. coli* ≥ 1 cfu/100ml	Arsenic > 50ppb and *E. coli* < 1 cfu/100ml	Arsenic > 50ppb and *E. coli* ≥ 1 cfu/100ml		
Total	**53.3**	**35.0**	**6.4**	**5.3**	**100**	**12949**
Source of drinking water for WQ sample						
Improved water source	53.9	34.2	6.5	5.4	100	12776
Unimproved water source	2.2	90.8	3.6	3.3	100	173
Source of drinking water						
Piped	37.5	58.9	1.6	2.0	100	1487
Tubewell/Borehole	56.4	30.5	7.2	5.9	100	11156
Other	15.0	81.1	2.0	2.0	100	306
Location of the water source						
In own dwelling	56.8	30.8	4.5	7.9	100	658
In own yard / plot	54.8	31.8	7.5	5.9	100	8691
Elsewhere	55.7	34.4	5.6	4.3	100	2297
Time to get water and come back						
On premises	52.8	35.1	6.6	5.5	100	10,701
1-5 minutes	55.1	32.4	4.9	7.6	100	743
6-10 minutes	56.4	33.5	7.4	2.7	100	783
11-30 minutes	54.9	38.3	4.0	2.8	100	631
>30 minutes	59.2	31.4	9.4	0.0	100	90

Table A5.4: PoU water quality by water source and location of the water source: arsenic and *E. coli*

Proportion of population by levels of arsenic and *E. coli* found in PoU drinking water, Bangladesh, 2019

	Percentage of population				Total	Number of household members
	Water quality risk level in PoU drinking water					
	Arsenic <= 50ppb and *E. coli* < 1 cfu/100ml1	Arsenic <= 50ppb and *E. coli* ≥ 1 cfu/100ml	Arsenic > 50ppb and *E. coli* < 1 cfu/100ml	Arsenic > 50ppb and *E. coli* ≥ 1 cfu/100ml		
Total	**16.7**	**72.8**	**1.5**	**9.1**	**100**	**26270**
Source of drinking water for WQ sample						
Improved water source	16.9	72.4	1.5	9.2	100	25873
Unimproved water source	2.9	95.9	0.0	1.2	100	397
Source of drinking water						
Piped	19.4	76.6	0.6	3.4	100	3047
Tube well/Borehole	16.7	71.5	1.7	10.2	100	22391
Other	6.7	92.7	0.0	0.6	100	832
Location of the water source						
In own dwelling	22.6	70.6	0.8	5.9	100	1338
In own yard / plot	17.3	70.6	1.8	10.3	100	17521
Elsewhere	10.7	79.7	0.9	8.7	100	4655
Time to get water and come back						
On premises	17.9	71.3	1.6	9.2	100	21638
1-5 minutes	13.3	74.6	1.0	11	100	1484
5-10 minutes	13.0	77.1	1.0	8.9	100	1652
11-30 minutes	6.4	87.2	0.6	5.8	100	1317
>30 minutes	4.0	89.6	0.0	6.4	100	178

Table A5.5 Safely managed drinking water services adjusted for arsenic contamination

Percentage of household population with drinking water free from faecal contamination, available when needed, accessible on premises, and meeting international and national standards for arsenic, for users of improved drinking water sources, Bangladesh, 2019

	Main source of drinking water					Percentage of household members with an improved drinking water source located on premises, free of *E. coli*, available when needed and <=10 ppb arsenic	Percentage of household members with an improved drinking water source located on premises, free of *E. coli*, available when needed and <=50 ppb arsenic	Number of household members with information water quality
	Improved sources							
	Without *E. coli* in drinking water source	<= 10 ppb arsenic in drinking water source	<= 50 ppb arsenic in drinking water source	With sufficient drinking water available when needed	Drinking water accessible on premises			
Total	**60.3**	**81.2**	**88.1**	**96.6**	**83.3**	**39.1**	**42.6**	**12770**
Area								
Urban	49.5	90.3	93.1	96.6	87.5	36.5	37.9	2808
Rural	63.4	78.6	86.8	96.6	82.2	39.8	44.0	9962
Division								
Barishal	88.1	99.3	99.4	94.4	45.5	35.2	35.2	744
Chattogram	53.3	67.9	73.8	97.5	82.4	29.8	32.6	2511
Dhaka	44.3	85.7	90.7	97.9	91.8	32.4	34.8	3148
Khulna	63.9	76.6	89.5	96.9	73.1	32.5	39.3	1487
Mymensingh	55.4	82.6	93.3	94.7	81.0	37.7	40.5	956
Rajshahi	73.6	91.3	96.9	97.0	88.5	57.8	62.0	1567
Rangpur	73.2	92.5	98.4	94.3	97.4	64.0	67.3	1439
Sylhet	68.4	58.7	71.1	96.1	75.5	31.8	39.0	917
Education of household head								
Pre-primary or none	56.6	77.1	85.1	97.2	80.7	35.3	38.5	4449
Primary	63.5	83.0	89.3	96.0	82.0	40.3	43.5	3493
Secondary	61.7	82.8	89.4	96.1	84.7	40.0	43.8	3188
Higher secondary+	61.1	85.3	91.6	97.4	91.0	45.0	49.8	1635
Missing/DK	50.2	100	100	100	50.2	50.2	50.2	6
Wealth index quintile								
Poorest	67.9	80.8	90.3	93.8	61.7	31.0	35.4	2311
Second	58.9	78.7	85.7	96.7	82.7	38.0	40.8	2604
Middle	62.1	80.1	88.7	96.7	85.7	42.4	47.6	2622
Fourth	60.4	79.7	85.2	97.9	91.1	42.3	45.0	2677
Richest	52.9	86.9	91.3	97.6	93.1	40.8	43.4	2557

	Main source of drinking water					Percentage of household members with an improved drinking water source located on premises, free of *E. coli*, available when needed and <=10 ppb arsenic	Percentage of household members with an improved drinking water source located on premises, free of *E. coli*, available when needed and <=50 ppb arsenic	Number of household members with information water quality
	Improved sources							
	Without *E. coli* in drinking water source	<= 10 ppb arsenic in drinking water source	<= 50 ppb arsenic in drinking water source	With sufficient drinking water available when needed	Drinking water accessible on premises			
Main source of drinking water[A]								
Improved source	60.3	81.2	88.1	96.6	83.3	39.1	42.6	12770
Piped water	38.8	93.6	96.4	96.5	95.6	31.8	34.1	1492
Tubewell/ Borehole	63.6	79.4	86.9	96.7	81.9	40.3	44.1	11140
Portected well or spring	22.0	100	100	100	85.1	22.0	22.0	36
Rainwater collection	32.6	93.9	93.9	89.8	93.6	24.6	24.6	67
Water kiosk	*	*	*	*	*	*	*	11
Bottled or sachet water	29.9	100	100	89.9	17.6	17.6	17.6	24

Table A6.1: Proportion of children with stunting, episodes of diarrhoea or symptoms of ARI by location and wealth index

		Percent of children moderately to severely stunted	Percent of children severely stunted	Percentage of children who in the last two weeks had an episode of diarrhoea	Percentage of children who in the last two weeks had symptoms of ARI
Total		**28.0**	**8.8**	**6.9**	**2.0**
Division	Barishal	30.6	10.9	14.1	2.6
	Chattrogram	27.0	8.7	7.5	1.7
	Dhaka	28.0	10.0	5.7	1.4
	Khulna	20.6	4.0	6.5	1.9
	Mymensingh	33.3	9.8	8.7	5.4
	Rajshahi	26.3	6.8	6.6	2.3
	Rangpur	26.6	9.0	4.5	2.2
	Sylhet	37.6	12.2	6.3	0.8
Wealth index quintile	Poorest	38.2	12.4	8.4	2.2
	Second	31.4	9.3	8.2	2.3
	middle	25.9	7.4	6.1	2.0
	Fourth	23.5	7.1	6.2	1.7
	Richest	19.8	7.4	5.5	1.9

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