Association between Escherichia coli (E. coli) contamination in household drinking water and risk of childhood diarrheal disease in Bangladesh.

Mohammad Nayeem Hasan1, Muhammad Abdul Baker Chowdhury2, Md Jamal Uddin1\*, Maya Biswas1, Moumita Paul1, Tanvir Ahammed1

1.  Department of Statistics, Shahjalal University of Science & Technology, Sylhet-3114, Bangladesh

2. Department of Emergency Medicine, University of Florida College of Medicine, Gainesville, FL, USA.

**Abstract:**

In low-income and developing nations, Escherichia coli (E. coli) is one of the most common etiological agents of moderate-to-severe diarrhea. In this study, we determine the association between E. coli and risk of childhood diarrheal disease by applying a propensity score approach. Data were used from the Multiple Indicator Cluster Survey, 2019 and 2012. To emulate a propensity score weighted population, we utilized propensity score weighting to reweight both unexposed (E. coli contamination level <1 CFU/100 ml) and exposed (E. coli contamination level 1–10 and > 10 CFU/100 ml) groups. The propensity scores for E. coli contamination were formulated using 14 covariates. From the Multiple Indicator Cluster Survey, 2019, it was found that compared to the children from households with a low risk of E. coli contamination in drinking water, children from households with a moderate risk of E. coli contamination were 1.60 times (p = 0.19) more likely to have diarrhea, which was 2.09 times (P=0.01) among children from households with a high risk of E. coli contamination. However, after applying the propensity score weighting approach, like the primary analysis, we observed 1.36 times (p = 0.38) more likely to have diarrhea, which was 1.93 times (p = 0.04) among children from households with a high risk of E. coli contamination. We found a similar strength of relationship in propensity score weighing as we did in survey weighting. But from the Multiple Indicator Cluster Survey, 2012 the relation was insignificant both before & after applying the propensity score weighing. The research's verdict has notable policy insinuation and suggests ensuring pure water supplies, ameliorate the drinking water system, and developing hygiene habits to decrease childhood diarrhea.

**Introduction:**

Diarrhea occurs when the usual net absorptive condition of water and electrolyte absorption is switched to secretion (Yang et al., 2017). Diarrhea is one of the main reasons for children's death & illness worldwide. Every year, over 1.7 billion episodes of diarrheal illness in children are reported worldwide(Sarker et al., 2016) . Diarrhea is the most common reason for the dearth of nutrition in children under the age of five. Diarrhea is also a prominent cause of death in children, accounting for around 8% of all fatalities among children under the age of five globally in 2017(*(Doh.Gov.Ph).* , n.d.). Diarrhea is the second-largest cause of death in children under the age of five, according to the World Health Organization(WHO, 2017). Although diarrheal infections are significantly less common in industrialized nations, they are a major public health concern in low and middle-income countries such as Bangladesh (Sarker et al., 2018). In addition to death and morbidity, diarrhea can have a devastating economic impact on families due to out-of-pocket (OOP) healthcare costs. When compared to the wealthiest families, these economic consequences disproportionately affect the poorest (Sarker et al., 2018) . The cost of treating diarrhea in Bangladesh was estimated at $79 million in 2018. Using a 10% threshold as a criterion, over 46% of those surveyed said that diarrheal sickness had cost them more than 10% of their income (Hasan et al., 2021). It is, however, avoidable and treated. Safe drinking water, adequate sanitation, and good hygiene can all help to prevent diarrheal illness (Diouf et al., 2014).

Among the microbiological causes of diarrhea, Escherichia coli (E. coli) is considered the most common cause of diarrhea in children. E. coli lives in symbiosis with its host in the vertebrate gut, where it is the most common aerobic organism (Yang et al., 2017). In children under the age of five years old in underdeveloped nations, E. coli is one of the most common causes of acute diarrhea, with high illness and death (Vieira et al., 2007).  In the 1940s, E. coli was originally considered a cause of children's diarrhea when nursery outbreaks of severe diarrhea were linked to certain E. coli serotypes. (Qadri et al., 2005). In Salvador, Bahia, Franzolin et al. investigated and reported the prevalence of the several diarrheagenic Escherichia coli (DEC) types isolated from children with acute endemic diarrhea. Colony blot hybridization was used to investigate the E. coli isolates. In 138 samples, E. coli was suspected, and 30 of these were determined to have diarrheagenic strains (i.e., 17.1% of all samples received, 21.7% of all samples tested for) (Franzolin et al., 2005). In a separate study from 2003, Ahrabi et al looked at E. coli and severe diarrhea in Tehranian children. Diarrhea-affected children's stools (n=200) (Salmanzadeh-Ahrabi et al., 2005). In Eastern Ethiopia, it was discovered that the frequency of E. coli-related diarrhea among children under the age of five is rather high Researchers in another study(Getaneh et al., 2021). According to a previous report from Bangladesh children who died from diarrhea in their study more often had E. coli (OR = 5.69, 95% CI = 2.42-13.39, p <0.001) compared to those who survived (Shahunja et al., 2020). According to research conducted in Dhaka, Bangladesh's urban slums, children living in families with very high-risk levels of E. coli in their source drinking water were more likely to suffer from diarrhea(Parvin et al., 2021).

Pathogens in contaminated water are harmful for human consumption. In a study of urban areas of Africa, diarrhea was one of the most common illnesses or syndromes utilized to investigate the link between urban health and water scarcity (Mutono et al., 2021). E. coli diarrhea is associated with poverty, lack of safe drinking water, and inadequate sanitation. In Bangladesh, however, empirical research on association between E. coli and acute diarrhea in children under five with the comparison of different survey data is lacking. We sought to determine whether the E. coli, acute diarrhea and its associated factors changed in two consecutive Multiple Indicator Cluster Surveys (MICS) in Bangladesh. The bacteria E. coli is the most often used fecal indicator, and many nations, including Bangladesh, have set a criterion that no E. coli should be detected in a 100 mL sample of drinking water (MICS 2012). The results of this study will provide information that can help policymakers make decisions about how to manage E. coli in drinking water and how frequently childhood diarrhea is seen in Bangladesh.

**Methods:**

We followed the STROBE guidelines for better observational cross-sectional study reporting in epidemiology.

Data source

We used data from two surveys, i.e., Bangladesh's Multiple Indicator Cluster Surveys (MICS) 2012 and 2019. MICS has grown to become the world's greatest source of statistically sound and internationally comparable statistics on children and women (UNICEF).  This national survey followed a two-stage sampling procedure. First, a stratified random sampling procedure was used to select individuals. Then, the individuals were asked questions to measure their opinions and experiences. Children were the final sampling unit in this study. In the final report of the 2012 and 2019 Bangladesh MICS survey, the method of survey has described. The 2012 dataset includes 51,895 households, while the 2019 dataset includes 64,400 households. A randomly selected subset of these households was chosen for water quality testing. A questionnaire was created to gather a wide range of data, including sociodemographic factors and health issues. We obtained data on environmental science and pollution research from sources that are internationally recognized. We also gathered information on household water quality using reliable methods. Altogether total individual (children under age 5) was 4,405.

Outcome variables

Diarrhea in children beneath the age of 5 was expected the outcome variable. In this overview, diarrhea is defined as the mother’s or caregiver’s acknowledgement of whether their child had a diarrheal scene within the 2 weeks going before the overview (Bangladesh MICS 2012 and 2019). The response variable was categorized as 1 when the answer was ‘yes’, and ‘0’ something else.

Covariates

We considered 14 covariates for this research.  Child’s age (0-59 months) and sex (male & female) were considered as child characteristics. Mother’s educations were categorized as none/ primary incomplete, primary complete, secondary complete/ higher. **Household size (<5 , 5/5+),  Livestock ownership (Yes, No), Wealth status( Poor, Middle, Rich), source water type (improved, unimproved), toilet facility type (improved, non-improved), toilet facility shared, household water *E. coli* concentration(low, moderate, high), source of water(**direct from source, covered container**,** uncovered container) **source water *E. coli* concentration (low, moderate, high), water treatment was included as household characteristics. Community characteristics contain place of residence (rural/urban), divisions.**

Exposure

The exposure variable of curiosity was the E. coli content in household water. Respondents were asked to serve a glass of their regular drinking water. 1 ml sample of water placed very carefully and technically on a compact dry plate and to allow bacterial colonies to form, the plates were incubated for 24 to 36 hours, first at body temperature (while in the field) and then overnight at 35°C in a NQ09 incubator (Darwin Chambers). The number of E. coli colonies were counted, recorded, and integrated into the survey micro dataset after this time. Based on the number of colonies identified in 100 ml of water, we established risk levels for E. coli: <1 ("low risk"), 1–10 ("moderate risk"), 10> ("high risk") per 100 ml. Details on the tests can be found in the MICS Manual for Water Quality Testing, which is available online.

Statistical analysis

At first, we utilized logistic regression to investigate the association between diarrhea in children under age 5 and drinking water that E. coli contaminated.  Child age, sex, mother's educational status, household size, livestock ownership, household wealth status, water source type, toilet facility type, shared toilet facility, source water E. coli concentration risk, source of household water sample, water treatment, place of residence, and division were all considered in the analysis. The crude odds ratio (COR) and adjusted odds ratio (AOR) were calculated, together with the 95% confidence interval (CI) and p-values. R adaptation 4.0.3 was used for all the research. The pr. was used to assess the strength of the findings from our foundational investigations.

Table 1 Frequency distribution of the study sample by diarrhea (weighted1) prevalence in Bangladesh among children younger than 5 years of MICS 2019 and MICS 2012 data.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Characteristics | MICS 2019 | | | MICS 2012 | | |
| Diarrhea | | | Diarrhea | | |
| Yes | No | Total | Yes | No | Total |
| Frequency (Percentage) | | | | | |
| **Child Characteristics** | | | | | | |
| **Age** |  |  |  |  |  |  |
| 0-11 | 38  (7.96) | 438  (92.04) | 476  (20.40) | 21  (5.04) | 387 (94.96) | 407 (19.64) |
| 12-23 | 49  (10.88) | 398 (89.12) | 446 (19.14) | 25  (5.49) | 439 (94.51) | 464 (22.40) |
| 24-35 | 37  (7.79) | 440  (92.21) | 478 (20.48) | 13  (3.15) | 394 (96.85) | 407 (19.62) |
| 36-47 | 29 (6.17) | 443  (93.83) | 472  (20.23) | 9  (2.23) | 382 (97.77) | 391 (18.84) |
| 48-59 | 20 (4.35) | 440 (95.65) | 460 (19.74) | 6  (1.57) | 398 (98.43) | 404 (19.50) |
| **Sex** |  |  |  |  |  |  |
| Male | 91 (7.35) | 1152 (92.65) | 1244 (53.33) | 34  (3.17) | 1028 (96.83) | 1062 (51.21) |
| Female | 81 (7.48) | 1007 (92.52) | 1088 (46.67) | 40  (3.98) | 971 (96.02) | 1011 (48.79) |
| **Maternal Characteristics** | | | | | |  |
| **Education Status** |  |  |  |  |  |  |
| None/Primary incomplete | 28 (10.17) | 248 (89.83) | 276 (11.86) | 24  (3.30) | 690 (96.70) | 714 (34.42) |
| Primary Complete | 30 (5.59) | 513 (94.41) | 543 (23.31) | 12  (3.53) | 317 (96.47) | 329 (15.85) |
| Secondary | 91 (7.88) | 1059 (92.12) | 1150 (49.31) | 32  (4.40) | 704 (95.60) | 736 (35.50) |
| Secondary Complete/ Higher | 24 (6.52) | 338 (93.48) | 362 (15.53) | 6  (2.16) | 288 (97.84) | 295 (14.22) |
| **Household Characteristics** | | | | | | |
| **Household size** |  |  |  |  |  |  |
| <5 | 76 (7.89) | 884 (92.11) | 960 (41.18) | 47  (3.91) | 1165 (96.09) | 1213 (58.51) |
| 5/5+ | 97 (7.07) | 1275 (92.93) | 1372 (58.82) | 26  (3.07) | 834 (96.92) | 860 (41.49) |
| **Livestock ownership** |  |  |  |  |  |  |
| Yes | 102 (7.39) | 1276 (92.61) | 1378 (59.14) | 47  (3.98) | 1139 (96.02) | 1186 (57.31) |
| No | 71 (7.45) | 881 (92.55) | 952 (40.86) | 27  (3.02) | 857 (96.98) | 883 (42.69) |
| **Wealth status** |  |  |  |  |  |  |
| Poor | 90 (9.12) | 894 (90.88) | 984 (42.19) | 36  (3.81) | 903 (96.19) | 939 (45.28) |
| Middle | 23 (5.10) | 425 (94.90) | 448 (19.21) | 15  (3.56) | 398 (96.44) | 412 (19.90) |
| Rich | 60 (6.70) | 840 (93.30) | 900 (38.59) | 23  (3.25) | 698 (96.75) | 722 (34.82) |
| **Source water type** |  |  |  |  |  |  |
| Improved | 171 (7.47) | 2120 (92.53) | 2291 (98.27) | 73  (3.61) | 1944 (96.39) | 2017 (97.28) |
| Unimproved | 2 (3.77) | 39 (96.23) | 40 (1.73) | 1  (1.79) | 55  (98.21) | 56 (2.72) |
| **Toilet facility type** |  |  |  |  |  |  |
| Improved | 168  (7.44) | 2083 (92.56) | 2251 (96.54) | 69  (3.45) | 1915 (96.54) | 1984 (95.69) |
| Non-improved | 5 (6.43) | 76 (93.57) | 81 (3.46) | 5  (5.98) | 84  (94.02) | 89 (4.31) |
| **Toilet facility shared** |  |  |  |  |  |  |
| Yes | 58 (7.85) | 675 (92.15) | 733 (31.81) | 14  (2.67) | 514 (97.33) | 528 (25.77) |
| No | 115 (7.32) | 1456 (92.68) | 1571 (68.19) | 59  (3.86) | 1462 (96.14) | 1520 (74.23) |
| **Household water *E. coli* concentration2** |  |  |  |  |  |  |
| Low | 16 (4.25) | 369 (95.75) | 386 (16.54) | 13  (3.19) | 383 (96.81) | 396 (19.08) |
| Moderate | 31 (6.63) | 438 (93.37) | 469 (20.10) | 14  (3.88) | 359 (96.12) | 373 (18.00) |
| High | 125 (8.48) | 1352 (91.52) | 1477 (63.36) | 47 (3.59) | 1258 (96.41) | 1305 (62.92) |
| **Source of water** |  |  |  |  |  |  |
| Direct from source | 11 (7.37) | 134 (92.63) | 145 (6.21) | 3 (2.51) | 106 (97.49) | 108 (5.26) |
| Covered container | 117 (7.99) | 1346 (92.01) | 1463 (62.86) | 48  (3.70) | 1259 (96.30) | 1307 (63.35) |
| Uncovered container | 45 (6.28) | 675 (93.73) | 720 (30.93) | 23  (3.52) | 625 (96.48) | 648 (31.39) |
| **Source water *E. coli* concentration** |  |  |  |  |  |  |
| Low | 96 (7.25) | 1227 (92.75) | 1323 (57.37) | 49 (4.00) | 1186 (96.00) | 1235 (60.50) |
| Moderate | 39 (7.44) | 488 (92.56) | 527 (22.86) | 13 (2.67) | 476 (97.33) | 489 (23.98) |
| High | 38 (8.23) | 418 (91.76) | 456 (19.77) | 10 (3.24) | 307 (96.76) | 317 (15.52) |
| **Water treatment** |  |  |  |  |  |  |
| Yes | 58 (7.85) | 675 (92.15) | 733 (31.81) | 14 (2.67) | 514 (97.33) | 528 (25.77) |
| No | 115 (7.32) | 1456 (92.68) | 1571 (68.19) | 59 (3.86) | 1462 (97.14) | 1520 (74.23) |
| **Community characteristics** | | | | | | |
| **Place of residence** |  |  |  |  |  |  |
| Rural | 36 (7.49) | 438 (92.51) | 474 (20.33) | 18 (4.17) | 423 (95.82) | 441 (21.29) |
| Urban | 137 (7.39) | 1720 (92.61) | 1858 (79.67) | 55 (3.40) | 1576 (96.60) | 1632 (78.71) |
| **Division** |  |  |  |  |  |  |
| Barisal | 23 (17.34) | 108 (82.66) | 131 (5.62) | 2 (2.09) | 117 (97.91) | 119 (5.74) |
| Chattogram | 38 (7.18) | 496 (92.82) | 534 (22.92) | 20 (3.95) | 488 (96.05) | 508 (24.53) |
| Dhaka | 38 (7.00) | 500 (93.00) | 537 (23.04) | 19 (3.16) | 580 (96.84) | 598 (28.87) |
| Khulna | 15 (6.67) | 212 (93.33) | 228 (9.76) | 10 (4.43) | 211 (95.57) | 221 (10.64) |
| Mymensingh | 23 (12.56) | 158 (87.44) | 181 (7.77) | - | - | - |
| Rajshahi | 15 (5.26) | 278 (94.74) | 293 (12.58) | 6 (2.62) | 226 (97.38) | 232 (11.21) |
| Rangpur | 14 (5.68) | 235 (94.32 | 249 (10.67) | 11 (4.30) | 242 (95.70) | 253 (12.18) |
| Sylhet | 7 (3.69) | 172 (96.31) | 178 (7.64) | 6 (4.01) | 136 (95.99) | 142 (6.83) |

1 Frequencies are weighted using sample weight (the survey design that accounts for survey features such as strata, primary sampling unit and survey weights).

2 E. coli colonies were counted as CFUs per 100 ml of water and categorised as low (<1 CFU/100 ml), moderate (1–10 CFU/100 ml) and high (>10 CFU/100 ml).

Table 2 Association between household drinking water E. coli contamination and diarrhea among children in Bangladesh

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | MICS 2019 | | | | MICS 2012 | | | |
| Exposure of interest | Unadjusted model |  | Adjusted model1 |  | Unadjusted model |  | Adjusted model1 |  |
|  | COR (95% CI) | p-value | AOR (95% CI) | p-value | COR (95% CI) | p-value | AOR (95% CI) | p-value |
| Household water E. coli concentration |  |  |  |  |  |  |  |  |
| Low | Ref |  | Ref |  | Ref |  | Ref |  |
| Moderate | 1.60 (0.79 – 3.25) | 0.193 | 1.46 (0.71 – 3.01) | 0.301 | 1.23 (0.53 – 2.81) | 0.632 | 1.29 (0.54 – 3.10) | 0.562 |
| High | 2.09 (1.17 – 3.72) | 0.012 | 1.96 (1.06 – 3.63) | 0.032 | 1.13 (0.57 – 2.24) | 0.725 | 1.29 (0.62 – 2.69) | 0.496 |

Table 3 Sensitivity analysis using the propensity score weighting approach to explore the association between household drinking water E. coli contamination and diarrhea among children in Bangladesh

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | MICS 2019 | | MICS 2012 | |
| Exposure of interest | Adjusted model |  | Adjusted model |  |
|  | AOR (95% CI) | p-value | AOR (95% CI) | p-value |
| Household water E. coli concentration |  |  |  |  |
| Low | Ref |  | Ref |  |
| Moderate | 1.46 (0.71 – 3.01) | 0.418 | 1.01 (0.45 – 2.28) | 0.981 |
| High | 1.96 (1.06 – 3.63) | 0.077 | 1.07 (0.53 – 2.16) | 0.847 |

|  |  |
| --- | --- |
| MICS 2019 | MICS 2012 |
| Chart  Description automatically generated | Chart  Description automatically generated with medium confidence |

Fig. 1 Absolute standardised mean differences (SMD) between low, moderate and high household water E. coli concentration in unweighted and propensity score (PS)–weighted samples

Result

The sample size in MICS 2019 was 2,332 and in MICS 2012 was 2073. The number of female children in MICS 2019 and 2012 were respectively 1088 and 1011. Educational status of mother’s None/Primary incomplete were 276 and Secondary Complete/ Higher 362 in MICS 2019. In MICS 2012 Educational status of mother’s None/Primary incomplete were 714 and Secondary Complete/ Higher 295. In MICS 2019 survey household size were mostly 5 or greater then 5. On the contrast, in MICS 2012 household size were mostly less then 5 members. In MICS 2019 and in MICS 2012 the number of children from families that owned livestock respectively 1378 and 1186. In both surveys children who had diarrhea were highest in number from poor households. In MICS 2019, 96.52% household used improved source water type and in MICS 2012 it was 97.29%.  73.32% and 62.43% did not share toilet facility respectively in MICS  2019 and MICS 2012.  Highest number of individuals were from urban areas in both surveys and from Dhaka division. **The sources of water of 720 households were Uncovered containers and 145 households used water from a direct source in MICS 2019.  The sources of water of 648 households were Uncovered containers and 108 households used water from a direct source in MICS 2019.  Household water *E. coli* concentration were high in 1477 households in MICS 2019 survey and 1305 households in MICS 2012.  On the other hand, source water *E. coli* concentration were high in 456 households in MICS 2019 survey and 317 households in MICS 2012 survey.  1571 households did not use water treatment in MICS 2019 survey and 1520 in MICS 2012 survey.**

Association between household drinking water E. coli contamination and diarrhea among children in Bangladesh

Discussion

The study investigated the household water E. coli contamination and the risk of diarrhea in under-five children in Bangladesh using data collected across the country. This study discloses the E-coli contamination in household drinking water in Bangladesh, which could result from educational and wealth status of household, source water type, storage status (unsafe and safe), inadequate treatment. According to a recent study done in Bangladesh, numerous water sources were contaminated with feces that included pathogens including E. coli (Bangladesh Bureau of Statistics and UNICEF Bangladesh 2019). Water source pollution may be caused by a variety of environmental factors, such as tube wells near ponds and latrines. And results from different study evince that, the establishment of tube wells near the latrines can be the major cause of contamination of drinking water at the source. In this case, water treatment can meager the risk of water contamination from difference sources. Tube well water is frequently recognized as a safe water source in Bangladesh, where water treatment is quite uncommon. In Bangladesh, water is conserved for drinking and cooking, especially in rural areas where residents&#39; access to water sources is remote. When water from storage pots is touched with dirty hands, water storage containers (like a kolshi, bucket, or jug) might get contaminated. This is true even for relatively clean sources of water where contamination levels are low enough, like tube wells (Bangladesh Bureau of Statistics and UNICEF Bangladesh 2019). Therefore, the pivotal reason for the decline in water quality is point of use pollution of water storage. Additionally, unsanitary practices such not washing hands with soap before preparing, eating, and defecating can contribute to water pollution at the point of use. Finally, children may be impacted by the high degree of contamination in drinking water due to E. coli and other harmful organisms that cause diarrhea. This study discovered a stronger link between diarrhea and the spring season, despite the fact that flooding during the summer is supposed to increase diarrhea transmission because contaminated matter can be moved from source sites to nearby locations more easily. In developing countries, the prevention and severity of diarrheal illnesses can be prevented or treated more effectively by breastfeeding. Breast milk has anti-infective antibodies and hormones that can heal from infections.

Strengths and limitations

This study basically based on recent MICS data in the context on developmental status of Bangladeshi children. We used a sufficiently large nationally representative dataset, which represents the respective children and women of Bangladesh. We considered a great variety of influential factors that affect the dependent variable. This study however is not devoid of some drawbacks. The selection variables, data quality, and indicator measurement were out of control because the data was secondary data. Furthermore, it is challenging to determine the relationship between the exposure and the outcome variable due to the cross-sectional data. To distinguish between pathogenic and non-pathogenic E. coli, our E. coli definition falls short. Finally, there are many other things that can cause diarrhea, such as bacterial and viral infections, food allergies and intolerances, malnutrition, parasites that enter the body by food or drink, and drug reactions, among others. However, we don’t get any potential contaminants other than E-coli bacteria that result in childhood diarrhea. No microbiological testing of such water sources was done to determine levels of contamination and evaluate water quality, even though it was known which water sources were used for which household and private uses. In children under the age of five, diarrhea is one of the main causes of malnutrition. Malnutrition, which makes children more vulnerable to diarrhea may worsen the immunity power of them and become the cause of death.

Recommendations

The findings of our study have some potential implications for our policy makers. Different government and non-government organizations, international agencies and public health professional who work for the betterment of children health can initiate awareness rising activities to make the people understand about the cause and prevention of E-coli contamination in drinking water. The awareness-raising campaign should also emphasize educating people how to use water that has been tested or inspected by the appropriate authorities. The relevant authorities must carry out the awareness-raising initiatives. In Bangladesh it is found that high

education level of parents has sense about the sanitation and hygiene of their children. The household access to electronic media can seek concern of public for childhood diarrhea. Specially, the young women are likely to be more exposed than older women can contribute for better health seeking behavior of younger mother. Department of environment (DoE) can take essential steps to keep water source such as tube wells from contaminants and the drinking water source can be tested for E-coli before consumption by the mass people. Future research should concentrate on both the amount and quality of water in Bangladesh&#39;s rural villages. Water storage capabilities play a role in how much water is available for washing and cleaning in the home.

Conclusion

Diarrhea is still an important public health issue in children younger than 5 years in Bangladesh. The current investigation revealed a substantial correlation between E. coli contamination in drinking water and instances of childhood diarrhea as well as a high degree of E. coli contamination in drinking water. The findings suggest implementing interventions focusing on reducing faecal contamination at the drinking water source as well as in stored water. As the prevalence of diarrhea and behavior of mothers in Bangladesh is patterned by their age, wealth, educational status, ethnicity interventions should focus the mothers of low-income country like Bangladesh. Policymakers, public health practitioners and community-based organizations should focus on raising mass awareness on the use of safe drinking water. Additionally, appropriate authorities should improve drinking water management (such as handling practices, treatment, and storage) and make sure that water supplies are safe, help modify personal hygiene behavior, improve health literacy and engaging community health workers in the prevention of diarrhea prevention, control and treatment.

Acknowledgement

The authors would like to acknowledge the contributions of the BBS and UNICEF to conduct the survey and to provide open access to the dataset

Ethical Consent

The MICS 2019 was carried out in collaboration with the Bangladesh Bureau of Statistics (BBS) and UNICEF. The protocol of this survey was approved by technical committee of the Government of Bangladesh lead by the BBS. This present study used publicly available secondary MICS 2012 &amp; 2019 datasets. Before making the datasets public, all respondents were unidentified by survey authorities.

Acknowledgment:

Conflicting interest

The author(s) declared no potential conflicts of interest with respect to the research,

Funding

The author(s) received no financial support for the research, authorship and/or publication of this

article.

References

Diouf, K., Tabatabai, P., Rudolph, J., & Marx, M. (2014). Diarrhoea prevalence in children under five years of age in rural Burundi: an assessment of social and behavioural factors at the household level. *Global Health Action*, *7*(1). https://doi.org/10.3402/GHA.V7.24895

*(doh.gov.ph).* . (n.d.).

Franzolin, M. R., Alves, R. C. B., Keller, R., Gomes, T. A. T., Beutin, L., Barreto, M. L., Milroy, C., Strina, A., Ribeiro, H., & Trabulsi, L. R. (2005). Prevalence of diarrheagenic Escherichia coli in children with diarrhea in Salvador, Bahia, Brazil. *Memórias Do Instituto Oswaldo Cruz*, *100*(4), 359–363. https://doi.org/10.1590/S0074-02762005000400004

Getaneh, D. K., Hordofa, L. O., Ayana, D. A., Tessema, T. S., & Regassa, L. D. (2021). Prevalence of Escherichia coli O157:H7 and associated factors in under-five children in Eastern Ethiopia. *PLoS ONE*, *16*(1 January). https://doi.org/10.1371/journal.pone.0246024

Hasan, M. Z., Mehdi, G. G., de Broucker, G., Ahmed, S., Ali, M. W., Martin Del Campo, J., Constenla, D., Patenaude, B., & Uddin, M. J. (2021). The economic burden of diarrhea in children under 5 years in Bangladesh. *International Journal of Infectious Diseases*, *107*. https://doi.org/10.1016/j.ijid.2021.04.038

Mutono, N., Wright, J. A., Mutembei, H., Muema, J., Thomas, M. L. H., Mutunga, M., & Thumbi, S. M. (2021). *The nexus between improved water supply and water-borne diseases in urban areas in Africa: a scoping review [version 1; peer review: 2 approved]*. https://doi.org/10.12688/aasopenres.13225.1

Parvin, T., Thomas, E. D., Islam Bhuyian, M. S., Uddin, I. M., Hasan, M. T., Rahman, Z., Barman, I., Zohura, F., Masud, J., Sultana, M., Westin, A., Johura, F. T., Monira, S., Biswas, S. K., Sack, D. A., Perin, J., Alam, M., & George, C. M. (2021). Fecal contamination on the household compound and in water sources are associated with subsequent diarrhea in young children in Urban Bangladesh (CHoBI7 Program). *American Journal of Tropical Medicine and Hygiene*, *105*(1). https://doi.org/10.4269/ajtmh.20-1516

Salmanzadeh-Ahrabi, S., Habibi, E., Jaafari, F., & Zali, M. R. (2005). Molecular epidemiology of Escherichia coli diarrhoea in children in Tehran. *Annals of Tropical Paediatrics*, *25*(1). https://doi.org/10.1179/146532805X23335

Sarker, A. R., Sultana, M., Mahumud, R. A., Ali, N., Huda, T. M., Salim uzzaman, M., Haider, S., Rahman, H., Islam, Z., Khan, J. A. M., van der Meer, R., & Morton, A. (2018). Economic costs of hospitalized diarrheal disease in Bangladesh: a societal perspective. *Global Health Research and Policy*, *3*(1), 1–12. https://doi.org/10.1186/S41256-017-0056-5/TABLES/6

Sarker, A. R., Sultana, M., Mahumud, R. A., Sheikh, N., Meer, R. van der, & Morton, A. (2016). Prevalence and Health Care–Seeking Behavior for Childhood Diarrheal Disease in Bangladesh. *Global Pediatric Health*, *3*, 2333794X1668090. https://doi.org/10.1177/2333794X16680901

Shahunja, K. M., Ahmed, T., Iqbal Hossain, M., Munirul Islam, M., Begum Monjory, M., Sadat Mohammad Sayeem Bin ShahidID, A., Syed Golam Faruque, A., & Jobayer ChistiID, M. (2020). *Clinical and laboratory characteristics of children under five hospitalized with diarrhea and bacteremia*. https://doi.org/10.1371/journal.pone.0243128

Vieira, N., Bates, S. J., Solberg, O. D., Ponce, K., Howsmon, R., Cevallos, W., Trueba, G., Riley, L., & Eisenberg, J. N. S. (2007). High prevalence of enteroinvasive Escherichia coli isolated in a remote region of northern coastal Ecuador. *The American Journal of Tropical Medicine and Hygiene*, *76*(3), 528–533. https://doi.org/10.4269/ajtmh.2007.76.528

WHO. (2017). *Diarrhoeal disease*.

Yang, S.-C., Lin, C.-H., Aljuffali, I. A., & Fang, J.-Y. (2017). Current pathogenic Escherichia coli foodborne outbreak cases and therapy development. *Arch Microbiol*, *3*, 811–825. https://doi.org/10.1007/s00203-017-1393-y