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

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**Abstract**

Escherichia coli (E. coli) is one of the most prevalent etiological agents causing moderate-to-severe diarrhea in low- and middle-income nations. In this study, we identified a relationship between E. coli concentration in household drinking water and diarrheal disease in Bangladeshi children under the age of five. Two waves of the Multiple Indicator Cluster Survey (MICS), from 2012 and 2019, were used as the data source for this investigation. By correcting for potential confounders, design-based logistic regression was used to determine the relationship between E. coli risk groups in household drinking water and risk of childhood diarrheal illness. Colony-forming units (CFUs) of E. coli were measured per 100 ml of water and divided into three risk categories. Less than one CFU/100 ml of E. coli contamination is considered as low risk, one to ten CFU/100 ml is considered as moderate risk, and more than ten CFU/100 ml is considered as high risk. By requesting information from the mothers or other primary caretakers of the children, we were able to determine the risk of childhood diarrhea. We discovered a substantial correlation between children's diarrheal disease and household drinking water E. coli risk groups in recent survey. Children from households with a moderate risk of E. coli contamination in drinking water were 1.46 times (AOR = 1.46, 95% confidence interval (CI): 0.71 - 3.01) and 1.29 times (AOR = 1.29, 95 percent CI: 0.54 - 3.10) more likely to have diarrhea in MICS 2019 and 2012, respectively, compared to children from households with a lower risk of E. coli contamination. According to MICS 2019 and 2012, children from households with a high risk of E. coli contamination were 1.96 and 1.29 times more likely to suffer diarrhea than children from households with a lower risk of E. coli contamination. However, when comparing the moderate and high risk E. coli contamination groups to the lower risk E. coli contamination group, the sensitivity analysis utilizing the propensity score weighting approach revealed that moderate and high risk groups were more likely to experience diarrhea than lower risk group. The study's conclusion makes clear policy insinuations and advises providing clean water supplies, improving the drinking water system, and forming good hygiene practices to reduce childhood diarrhea.

**Key Words:** Escherichia coli, Drinking water contamination, Diarrhea, Under-5 children, propensity score approach

**Introduction**

Diarrhea is caused by variety of bacterial, viral, and parasite organisms, the majority of which are spread by contaminated water (WHO, 2017). Having at least three loose, liquid, or watery bowel motions each day is the conditions of diarrhea. Due to fluid loss, it frequently lasts for a few days and can lead to dehydration. Diarrhea may be acute, persistent, or chronic. It is one of the leading causes of pediatric sickness and mortality (Liu et al. 2012; Kotloff et al. 2013). Every year, there are around 1.7 billion cases of childhood diarrhea worldwide (A. R. Sarker et al., 2016). In children under the age of five, diarrhea is one of the main causes of malnutrition. Approximately 8% of all fatalities among children under the age of five globally in 2017 were due to diarrhea. Around 525,000 children every year, or over 1,400 young children per day are dying (UNICEF, 2021). Diarrhea is the second most common cause of death in children under five, according to the World Health Organization (WHO). It is, however, both treatable and preventable by using clean water, maintain proper sanitation, and practice good hygiene (Diouf et al., 2014).

In low and middle income nations, E. coli is one of the most frequent etiological agents of moderate-to-severe diarrhea (WHO, 2017). It can be found in the intestines of mammals, including humans (Kaper et al. 2004; Alam et al. 2006). E. coli was suspected in 138 samples, and it was discovered that 30 of these samples contained strains that were diarrheagenic (Franzolin et al., 2005). Ahrabi et al. in 2003 investigated at E. coli in youngsters from Tehran who had serious diarrhea. It was shown that diarrhea caused by E. coli occurs often in children under the age of five in Eastern Ethiopia (Getaneh et al., 2021). In a different study, Qu et al. evaluated 2524 patients and found that 10.7% cases had diarrhea and 4.6% causes from E. coli (4.6 percent) (Qu et al., 2016).

Around 7% of Bangladesh's children under five get affected by diarrhea (Bangladesh Bureau of Statistics and UNICEF Bangladesh 2019). Around half of those surveyed claimed that diarrheal illness had cost them more than 10% of their income, with the cost of treating diarrhea in Bangladesh estimated to be $79 million in 2018 (Hasan et al. 2021). Water contamination by E. coli is fairly widespread in Bangladesh. According to MICS 2012 and MICS 2019, respectively, 61.7% and 81.9% of the population of households had drinking water that was contaminated with bacteria like E. coli (Bangladesh Bureau of Statistics and UNICEF Bangladesh 2014 and 2019). A recent study in Bangladesh has determined the spatial risk distribution and contributing factors of E. coli contamination in household drinking water (Khan and Bakar 2020). After examining data from fifty villages in rural Bangladesh, Luby et al. (2015) discovered an association between the severity of childhood diarrhea and E. coli-polluted drinking water (Luby et al. 2015). Children who lived in households with very high-risk levels of E. coli in their source drinking water were more likely to experience diarrhea, according to research done in the urban slums of Dhaka, Bangladesh (Parvin et al. 2021).

However, there is a lack of empirical study comparing various survey data on the relationship between E. coli risk groups and diarrhea in children under five. The current study aims to analyze the current situation of E. coli contamination in household drinking water in Bangladesh and its relationship to childhood diarrhea in order to fill this information gap. We sought to determine whether the E. coli, diarrhea and its associated factors changed in two consecutive Multiple Indicator Cluster Surveys (MICS) in Bangladesh. 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.

**Material and methods**

To improve the reporting of observational cross-sectional studies in epidemiology, we adhered to the STROBE guideline (see Supplementary Materials for more details).

*Data source and sampling design*

Two reports from the Multiple Indicator Cluster Surveys (MICS) of Bangladesh, from 2012 and 2019 (https://www.unicef.org/), were used. To gather information at the household level for this nationwide survey, a two-stage stratified cluster sampling method was used. The final report of the Bangladesh MICS surveys from 2012 and 2019 contains information on the comprehensive survey methodology. 64,400 households participated in MICS 2019, compared to 51,895 households in MICS 2012. A randomly determined subset of 2760 and 6440 households, respectively, were chosen in MICS 2012 and MICS 2019 for water quality testing.

*Outcome variables*

The outcome variable was diarrhea among children under the age of five, which was defined if the mother's or caregiver's know whether their child experienced any sort of diarrheal disease within the two weeks prior to the survey (Bangladesh MICS 2012 and 2019).

*Exposure*

The exposure variable was the concentration of E. coli present in household water. A glass of water that the respondents often drink was requested of them to check the water quality (Bangladesh Bureau of Statistics and UNICEF Bangladesh 2012 and 2019). In this study, 100 ml water was tested for E. coli and test was done within 30 minutes of sample collection. Colony-forming units (CFUs) of E. coli colonies per 100 ml of water were measured to categorized the risk of water quality (Bangladesh Bureau of Statistics and UNICEF Bangladesh 2012 and 2019). The E. coli CFU information from family drinking water were gathered into different risk categories according to the WHO criteria (World Wellbeing Organization, 1997). Less than one CFU/100 ml of E. coli contamination is considered as low risk, one to ten CFU/100 ml is considered as moderate risk, and more than ten CFU/100 ml is considered as high risk. A more detailed description of the water quality test can be found in the Bangladesh MICS reports. (Bangladesh Bureau of Statistics and UNICEF Bangladesh 2012 and 2019).

*Confounding variables*

Based on the available data, the variables child age at months, gender, and mother's educational status (None/primary incomplete, primary complete, secondary incomplete, secondary complete or higher) were included to the study. Household size (<5 or 5/5+), household wealth status (Poor, middle or rich), and other factors were taken into account. Based on information from household assets and separated into three groups based on quintile, the household wealth index was calculated using a principal component analysis (Bangladesh Bureau of Statistics and UNICEF Bangladesh 2019). Place of residence (rural vs. urban) and administrative division were two variables at the community level (Barisal, Chattogram, Dhaka, Khulna, Mymensingh, Rajshahi, Rangpur and Sylhet).

In addition, toilet facility types (improved or non-improved), shared toilet facilities, and source water quality (low, moderate, and high) should all be considered. A source water sample E. coli test, similar to an exposure sample test, was used to assess the risk of E. coli contamination in the source water.