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Assessing Contributory Factors of Diarrhea Among Under-Five Children in Bangladesh From 2006 to 2019 and Recent Increases: A Cross-Sectional Study

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ABSTRACT

Background and Aims: One-third of all child deaths in this country are caused by diarrhea. The burden of the disease appears to be increasing in recent years in Bangladesh. This study aimed to analyze the prevalence of diarrhea and identify the factors contributing to diarrheal diseases among children aged 0–5 years in Bangladesh from 2006 to 2019, to understand the recent increase in this serious health issue.

Methods: In this study, using the data from the Multiple Indicator Cluster Survey (MICS), a total of 31,566, 23,402, and 24,686 children under five were included from, 2006, 2012, and 2019, respectively. Logistic regressions were applied to analyze the changes in factors influencing childhood diarrhea.

Results: The results revealed a decline in diarrhea prevalence from MICS 2006 (7.1%) to MICS 2012 (3.9%). However, there was a sharp increase to 6.9% in MICS 2019. Notably, children aged 12–23 months exhibited consistently 2.22 times (adjusted odds ratio (AOR) = 2.22, 95% confidence interval (CI): 1.86–2.65), 5.24 times (CI: 2.51–10.95) and 3.36 times (CI: 2.67–4.22) higher likelihood of experiencing diarrhea compared to the older age group (48–59 months) in MICS 2006, 2012 and 2019, respectively. The mother's educational background also played a role, in MICS 2006, 2012, and 2019, children whose mothers had no or incomplete primary education had 1.48 (CI: 1.18–1.86), 1.07 (CI: 0.76–1.50), and 1.34 (CI: 1.06–1.69) times higher chances of diarrhea compared to children of mothers with secondary complete or higher education.

Conclusion: Underweight status, geographical division, household wealth status, and unimproved and shared toilet facilities emerged as contributing factors of diarrhea among children aged 0–5 years. The findings underscore the importance of child nutrition, basic hygiene practices, and special care during the rainy season to mitigate the under-five mortality rate associated with diarrhea.

1 | Background

Diarrhea is a leading cause of under-five child mortality globally. According to the World Health Organization (WHO), every year, there are approximately 1.7 billion cases of diarrheal disease among children worldwide and diarrhea claims the lives of about 443,832 children under the age of 5, along with an additional 50,851 children aged 5 to 9 [1]. The diarrhea-related mortality rate is high in developing countries and deaths from diarrhea are rare in developed countries [2, 3]. Each year in developing countries, almost 2 million people die of diarrhea, a significant number of whom are children aged between 0 and 5 years [3]. Due to high mortality rates in developing countries, the loss of human lives is the main concern for those countries while the developed countries focus on reducing the economic cost associated with cases of diarrhea [4].

Among the South Asian countries, the percentage of deaths due to diarrhea among children under five was high for Pakistan (8%), followed by India (7%) and Bangladesh (7%), and low for Maldives (1%) and Sri Lanka (1%) in 2019 [5]. In a developing country like Bangladesh, most children suffer from diarrheal diseases which ultimately lead them to death [6]. Each year, in Bangladesh, every child suffers three to five times on an average from diarrheal attacks [7]. A previous study showed that diarrhea is the reason behind about 33% of total child deaths in Bangladesh [8]. Most of the deaths due to diarrhea occur in rural areas [6]. According to 2007 Bangladesh Demographic and Health Survey (BDHS) data, most sufferers are 6–23 months old children and boys are more at risk of this disease compared to girls [9].

Being a developing country, Bangladesh has several resource constraints, such as the high density of population (3277 people per meter squares, poverty, lack of awareness, food deficiency, malnutrition, etc. Moreover, in Bangladesh, approximately 2.5 million people suffer from basic sanitation issues, and about one million people are unable to have potable water [8]. Previous studies in Bangladesh showed that age, sex, geographic location, drinking from unprotected water supply, sanitation, hygiene, and household economic status can cause diarrhea among children between 0 and 5 years [8, 10].

Several studies assess the prevalence and identified risk factors of childhood diarrheal diseases at a national, regional, and international level. A prospective, community-based surveillance study in the Peruvian Amazon revealed that diarrheal disease transmission was significantly higher from March to October (rainy season), and having dirt/wood/bark as floor material also increased its risk [11]. A study in Belarus reported that exclusive breastfeeding reduced the risk of diarrhea by 40% [12]. A study among children under five in Nigeria found that lower maternal education levels were associated with higher risks of childhood diarrhea [13]. A case-control study conducted in Kadoma City, Zimbabwe, identified several factors associated with an increased risk of diarrhea. These included the use of outdoor drinking water sources, such as rivers and outdoor faucets, as well as the distance to these water sources. Additionally, the use of unprotected water storage containers, the absence of treated drinking water, the lack of handwashing facilities, and an unhealthy home environment—characterized

by the presence of garbage and flies—were also linked to a higher risk of diarrhea [14]. Additionally, some Brazilian studies found larger household sizes and lower household income, not having antenatal care during pregnancy, and an unimproved sanitation system [15]. In Bolivia, wastewater in septic tanks/streets and disposal of children have increased the risk of diarrhea [16]. Young children in Bangladesh generally experience a variety of common illnesses like fever, cough, short/difficult breathing, diarrhea, etc [17, 18]. To reduce child morbidity and mortality, the prevention of diarrhea is indispensable.

Based on the Multiple Indicator Cluster Surveys (MICS) from 2006, 2012–2013, and 2019, the prevalence of diarrhea among under-five children was reported at 7.1%, 3.9%, and 6.9%, respectively [19–21]. Additionally, the BDHS from 2014, 2017–2018, and 2022 indicated rates of 5.7%, 4.7%, and 4.8% [22–24]. Despite various interventions and innovations aimed at reducing childhood diarrhea, the burden of the disease appears to be increasing in recent years in Bangladesh. In addition to our claim, while numerous previous studies have been conducted and have identified several significant factors, the performance of these studies' analytical models has not been thoroughly examined. Moreover, most of these studies rely on a single survey data set. In contrast, our study utilizes data from three consecutive surveys, allowing us to identify factors that consistently contribute to diarrhea across all three surveys. This approach provides a clearer picture of the factors requiring government intervention.

According to the information that we have, no study was conducted using the MICS data of Bangladesh to portray the changes in factors influencing diarrhea over time. Additionally, we sought to understand the reasons behind the recent increase in diarrhea cases, despite improvements in various health indicators. We also intended to investigate the relationship between diarrhea and important features such as drinking water source, health of children, household economic status, and household environment. Overall, we aimed to analyze the prevalence of diarrhea and identify the factors contributing to diarrheal diseases among children aged 0–5 years in Bangladesh from 2006 to 2019, to understand the recent increase in this serious health issue.

2 | Materials and Methods

We followed the STROBE guideline for better observational cross-sectional study reporting in epidemiology (Supporting Information S1: Table S1).

3 | Data Source

We used secondary data of the years 2006, 2012–2013, and 2019 of MICS of Bangladesh. Bangladesh Bureau of Statistics (BBS) and the Ministry of Planning have been conducting MICS since 1993. As it was a part of the global MICS program, BBS worked with the United Nations Children's Forum (UNICEF) which supported this survey by providing technical and financial

support. This survey report has circumstantial information and investigation on children and women of Bangladesh for disease, health condition, household facilities, educational status, knowledge and practices related to disease prevention, access to media and technology, which is named *"Progotir Pathey"* [25].

4 | Study Design

The sampling procedure was a two-stage stratified cluster sampling covering urban and rural areas of Bangladesh where enumeration areas (EAs) were selected at the first stage and households with each selected EAs were selected at the second stage. In the survey of 2006, the sample included 68,247 households, among which 67,540 had people to be interviewed. Among them, 62, 463 households completed the survey with a response rate of 92.5%. In total, 31,566 children under age 5 completed the questionnaire among 34,710 children identified from interviewed households with a response rate of 90.9%. In the survey of 2012–2013, the sample covered 55,120 households from which 52,711 households had people to attend the interview, and out of these, 51,895 were completely interviewed with a response rate of 98.5%. In total 23,402 children under age five were selected in the sample but completed data found from 20,903 children gave a response rate of 89.3 percent among visited households. The sample of the 2019 survey selected 64,400 households and people inhabited 61,602 households of them. Among those, 61,242 households completed the survey with a response rate of 99.4%. 24,686 children under age five were included in the household survey and among them completed information of 23,099 children was found with a response rate of 93.6% (Figure 1). The sample size estimation and sample allocation are available in detail in the final reports of each survey [25].

The MICS tools of round MICS3 were used in the survey of 2006, MICS5 in 2012–2013, and MICS6 in 2019 for Bangladesh [26]. The round MICS3 had three questionnaires: (i) a household questionnaire which included information of the characteristics of the household, (ii) a questionnaire for individual women which covered information of every woman aged 15–49 years in each household, and (iii) a questionnaire for children under five which covered each children's overall information. The round MICS5 used four sets of questionnaires and along with the three questionnaires of the MICS3 round, another questionnaire was for testing water quality which was used to find out the arsenic and *E. coli* content in potable water of households. The round MICS6 used five questionnaires and the addition in this round was collecting information of one randomly selected child from the 5 to 17 years age group from each household. All questionnaires were interpreted into Bangla.

5 | Outcome Variable

In this study, we assessed diarrhea among children aged 0–5 years based on whether they experienced diarrhea in the 2 weeks before the survey. The responses were provided by mothers or caretakers. We defined the binary outcome variable "Diarrhea," which has two categories: "Yes" for children who had diarrhea and "No" for those who did not in the 2 weeks before the survey.

6 | Covariates

Characteristics of children such as age, sex, child supervision, nutritional status (stunned, wasted, underweight, overweight),
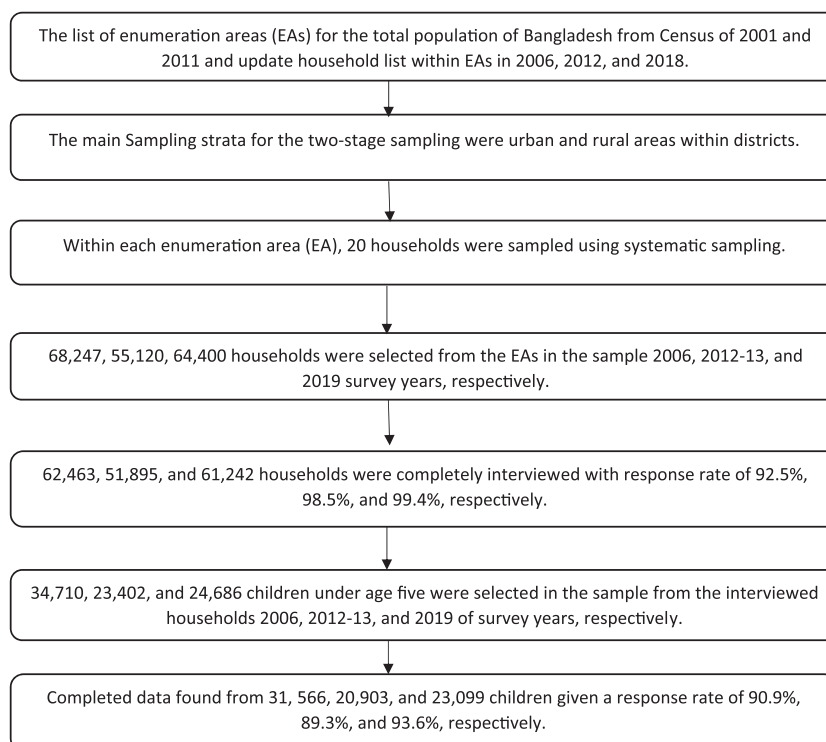

FIGURE 1 | Study population and selection of sample for MICS 2006, 2012–13, and 2019.

community characteristics for example, place of residence, division, parental characteristics for example, mother's education and age, household characteristics for example, wealth index, religion, sex of household head, type of toilet facility and its shared status, salt iodization, access to mass media, household size, possession of livestock, drinking water source and type, water treatment were considered as covariates in the analysis. The covariates were selected for the analysis based on the available information in the MICS data set and the findings of previous studies [8, 10, 14–16, 27].

6.1 | Child Characteristics

We categorized children's ages into six groups: 0–11 months, 12–23 months, 24–35 months, 36–47 months, and 48–59 months. Additionally, we classified child sex as male or female and assessed inadequate supervision, underweight, stunting, wasting, and overweight as binary variables (yes or no). A child was considered under inadequate supervision if the child under age 5 was left alone or under the supervision of another child younger than 10 years old for more than 1 h at least once in the last week [21]. In this study, we categorized inadequate supervision as either "yes" or "no." Stunting, wasting, underweight, and overweight were used as the measurements of nutritional status and height-for-age, weight-for-age and weight-for-height z-scores were used to calculate these measures. The z-scores measure the distance of a measurement from its mean point in terms of standard deviation. A child was considered underweight if the weight for age z-score was less than or equal to -2 and overweight if the weight for height z-score was greater than or equal to 2. A child was stunned if the height for age z-score was less than or equal to -2 and wasted if the weight for height z-score was less than or equal to -2 [28].

6.2 | Community Characteristics

This study categorized places of residence into three types: urban, rural, and tribal. It also included eight administrative divisions or geographic locations: Barishal, Chattogram, Dhaka, Khulna, Mymensingh, Rajshahi, Rangpur, and Sylhet.

6.3 | Parental Characteristics

Mother's education was categorized as follows: incomplete primary, complete primary, incomplete secondary, complete secondary or higher, and non-standard curriculum. Mother's age at the time of the survey was categorized into three groups: 15–19, 20–34, and 35 and older.

6.4 | Household Characteristics

The wealth index is designed to reflect long-term wealth by utilizing information about household assets, aiming to rank households from poorest to richest [29]. The wealth index is designed to reflect long-term wealth by utilizing information about household assets, aiming to rank households from poorest to richest. In this study, we used five categories of the wealth index: Poorest, Poor, Middle, Rich, and Richest. Religion is categorized as Islam and others; the sex of the household head is classified as male or female; ethnicity is divided into Bengali and other; household size is categorized as less than five members and five or more members; and livestock ownership is classified as yes or no.

Flushed to the piped sewer system, septic tank, pit latrine, and open drain, ventilated improved pit latrine, pit latrine with and without slab were categorized as improved toilet facility and hanging toilet/latrine, bucket, composite toilet, and no facility/bush/field were categorized as an unimproved toilet facility [25]. Salt iodization was considered "Yes" if the salt tested result showed 0–15 ppm or above 15 ppm and otherwise "No." Having access to mass media indicated that a household at least accessed newspapers/TV/radio less than once a week. Piped into dwelling, to yard and neighbor, public tap, tube well, dug well (protected), protected spring, rainwater, bottled and sachet water were considered as improved water source and dug well (unprotected), unprotected spring, tanker truck, cart with small tank, water selling plant, surface water (river, dam, lake, pond, canal) and other were considered as unimproved water source. Drinking water was considered treated if any process among boiling, adding bleach/chlorine, straining through cloth, or using any kind of water filter was done [25].

7 | Statistical Analysis

We applied univariate and multivariable logistic regressions to assess the association between diarrhea and the selected covariates at a 5% significance level for each data set. The final model output was represented in a forest plot.

The procedure of choosing the best model was step-wise logistic regression, and it included the factors found relevant and important to explain the behavior of the outcome variable from literature review. we examined multicollinearity in the model using the variance inflation factor (VIF), with a cutoff value of 4.00 [30]. No variables were excluded from the model at this stage, as their VIF values did not exceed the cutoff threshold. The measures of sensitivity and specificity from the receiver operating characteristic (ROC) curve, were used to assess the optimal model. The models performed better, according to the higher area under curve of the ROC. A bigger area under the curve than the 0.50 on the ROC curve indicates that the model discriminates between the two groups [31, 32]. We also employ information criteria, for example, the Akaike information criterion (AIC) and Bayesian information criterion (BIC) as a goodness-of-fit measure for the final multivariable logistic model [33, 34].

We used the Stata command (Svyset) of the survey data reference manual to account for the complex survey settings of the datasets [35, 36]. Svyset commands were developed for STATA (Version 18) to consider the survey design elements such as sample weights, PSU, clusters, and strata [36].

8 | Ethical Approval

Our study was wholly based on an analysis of existing public domain health survey datasets obtained from the MICS 2006, 2012–13, and 2019 which is freely available online with all personal identifying information removed. The MICS procedures were reviewed and approved by the Bangladesh Bureau of Statistics (BBS) and UNICEF. Informed consent was obtained from participants while interviewing them. Because this study involved the analysis of secondary data thus, it did not require the ethical approval of the respective institution.

9 | Results

The occurrence of diarrhea among 0–5-year-old children decreased from 7.1% in 2006% to 3.9% in 2012 then increased to 6.9% in 2019. Moreover, among the age group 12–23-month-old children 10.0%, 7.7%, and 10.1% had diarrhea respectively based on the MICS data of 2006, 2012 and 2019. Among underweight children, 8.5% of them had diarrhea in the MICS data of 2019, which was 4.0% in the MICS data of 2012. Based on the division in Barisal 8.9%, 6.3%, 14.1% children had diarrhea respectively as reported highest in 2006, 2012 and 2019 MICS data. Likewise, the MICS data from 2006, 2012, 2019 reported that in the Khulna division 4.4%, 3.3%, and 6.5% of under-five children had lowest diarrhea respectively. Among the under-five children whose mother's educational level was secondary completed or higher 5.5%, 3.9%, and 5.9% of them had lowest diarrhea in 2006, 2012, and 2019. In 2012, it was lowest in over 35 years age group, 3.2%. According to the wealth index, among under age five children who belonged to rich families 5.6% of them had lowest diarrhea in the survey time of 2006, in contrast, it was lowest 3.4% in middle and 5.5% in richest families in 2012 and 2019, respectively. Among the children under 5 years whose family didn't consume adequately iodized salt 8.6% of them had highest prevalence of diarrhea in 2006 which was decreased to 8.0% in 2019, but lowest in 2012, 3.8% (Table 1).

From the univariate model, we have found that the age of the child, underweight, area of the household, division, education level of the mother, mother's age, wealth status, religion, ethnicity, toilet facilities shared, toilet facility type, salt iodization variables were significantly associated with diarrhea at 5% level of significance (Table 2).

According to multivariate model, we found that, the children of 0–11 months had 1.81 (adjusted odds ratio (AOR): 1.81, 95% CI: 1.50–2.18), 4.35 (AOR: 4.35, 95% CI: 2.10–9.01), and 3.32 (AOR: 3.32, 95% CI: 2.63–4.19) times higher odds of having diarrhea compared with children aged 48-59 months in 2006, 2012 and 2019 respectively. The odds of having diarrhea for the children of all age group was higher than the children of 48–59 months respectively in all survey years. Compared with the children under age 5 from the Sylhet division in 2006, 2012, and 2019 survey, children of Barisal division had 1.27 (AOR: 1.27, 95% CI: 0.99–1.63) and 2.51 (AOR: 2.51, 95% CI: 1.74–3.63) times higher chance of having diarrhea, respectively. However, in 2012 survey, children of Barisal division had 33% (AOR: 0.67, 95% CI: 0.27–1.63) times lower chance of having diarrhea. Children

from poorest family had 30% ([19] AOR: 1.30, 95% CI:1.01–1.65) and 14% ([21] AOR: 1.14, 95% CI: 0.90–1.44) higher odds of having diarrhea compared with children from the richest family. We found that among the children whose families use the shared toilet had 7% (AOR: 1.07, 95% CI: 0.96–1.20) and 23% (AOR: 1.23, 95% CI: 1.07–1.42) higher odds of having diarrhea in 2006 and 2019 respectively, in MICS 2012, 40% (AOR: 0.60, 95% CI: 0.36–0.99) lower odds of having diarrhea in compared with the children whose family did not use the shared toilet (Table 3 and Figure 2).

The area under the ROC curve was found to be 0.6210 ($p < 0.001$), 0.6826 ($p < 0.001$), and 0.6717 ($p < 0.001$). This indicated that the final model chosen for the [19–21] surveys displayed an area under the curve higher than 0.50 (Figure 3).

The improved goodness-of-fit statistics for the final multivariate logistic model lend credence to this inference. In comparison to the MICS-2006 (AIC = 14322.83, BIC = 14545.55) and MICS-2019 (AIC = 9610.21, BIC = 9870.85) final multivariate logistic model, MICS-2012 demonstrated (AIC = 1167.66, BIC = 1295.21). The MICS-2012 survey model therefore provided a good fit, and a normal binary logistic model with variables included in this survey model was suggested to use to describe this type of analysis (Table 4).

10 | Discussion

This study targeted to explore the Multiple Indicator Cluster Survey data of 2006, 2012, and 2019 and assess the association of several factors with diarrhea and the change of it over time. There was a decrease in the prevalence of diarrhea from 2006 to 2012 and an increase in 2019 among 0-5-year-old children in Bangladesh.

The prevalence was higher for 12–23 months children, followed by 0–11 months children, and the difference is significant compared with children of 48–59 months age group in 2006, 2012, and 2019. Children of the 0–24 months age group are in the process of developing immune systems and depend on their mothers to be protected [37]. Also, children from 6 to 24 months start crawling all over the house and put whatever they find around them in their month. As they gradually grow up, they learn what is not to eat or put in their mouths [38]. The findings from previous studies in Bangladesh, Ethiopia, Niger, Nigeria, Cameroon, and Ghana were similar to this [10, 38–42].

Findings showed that the chance of having diarrhea was significantly higher for children from the poorest families in 2006 and children from the second wealth index in 2019. Children from poor families have more probability of being affected by several childhood illnesses due to poor living conditions, not having enough nutritious food, and poor condition of drinking water sources and toilet facilities [10, 38, 43, 44]. Previous studies on Ethiopia and several developing countries reported similar scenarios.

Children from households without improved toilet facilities in 2006 and 2019 were more at risk of experiencing diarrhea.

TABLE 1 | Distribution of several factors with the diarrhea status of children, MICS 2006, 2012–13, and 2019.

Characteristics	2006			2012			2019		
	Diarrhea			Diarrhea			Diarrhea		
	Yes n (%)	No n (%)	p value	Yes n (%)	No n (%)	p value	Yes n (%)	No n (%)	p value
Child characteristics									
Age of child (in months)			<0.001			<0.001			<0.001
0–11	483 (8.5)	5185 (91.5)		213 (5.4)	3769 (94.6)		421 (9.1)	4184 (90.9)	
12–23	606 (10.0)	5423 (90.0)		315 (7.7)	3776 (92.3)		448 (10.1)	3986 (89.9)	
24–35	444 (7.0)	5876 (93.0)		140 (3.3)	4048 (96.7)		326 (7.1)	4279 (92.9)	
36–47	388 (5.7)	6398 (94.3)		97 (2.2)	4232 (97.8)		247 (5.1)	4570 (94.9)	
48–59	332 (4.9)	6410 (95.1)		61 (1.4)	4242 (98.6)		154 (3.3)	4473 (96.7)	
Child's sex			0.107			0.931			0.178
Male	1200 (7.4)	15017 (92.6)		421 (3.9)	10268 (96.1)		860 (7.2)	11144 (92.8)	
Female	1054 (6.9)	14278 (93.1)		404 (4.0)	9799 (96.0)		736 (6.6)	10347 (93.4)	
Inadequate supervision						0.057			0.079
Yes	—	—		82 (5.1)	1504 (94.9)		120 (8.1)	1367 (91.9)	
No	—	—		742 (3.8)	18545 (96.2)		1477 (6.8)	20122 (93.2)	
Underweight						0.879			<0.001
Yes	—	—		259 (4.0)	6167 (96.0)		439 (8.5)	4698 (91.5)	
No	—	—		537 (4.0)	12950 (96.0)		1120 (6.5)	16181 (93.5)	
Stunned						0.867			0.132
Yes	—	—		323 (3.9)	7893 (96.1)		461 (7.4)	5765 (92.6)	
No	—	—		447 (4.0)	10752 (96.0)		1071 (6.8)	14747 (93.2)	
Wasted						0.148			0.053
Yes	—	—		92 (4.7)	1862 (95.3)		178 (8.1)	2028 (91.9)	
No	—	—		699 (4.0)	16979 (96.0)		1353 (6.8)	18442 (93.2)	
Overweight						0.050			0.057
Yes	—	—		44 (2.8)	1529 (97.2)		90 (5.5)	1539 (94.5)	
No	—	—		781 (4.0)	18538 (96.0)		1507 (7.0)	19952 (93.0)	
Community characteristics									
Place of residence									

(Continues)

TABLE 1 | (Continued)

Characteristics	2006 Diarrhea Yes n (%)	No n (%)	p value	2012 Diarrhea Yes n (%)	No n (%)	p value	2019 Diarrhea Yes n (%)	No n (%)	p value
Urban	1630 (7.1)	21394 (92.9)	0.293	627 (3.8)	15598 (96.2)	0.098	1255 (6.9)	16932 (93.1)	0.896
Rural	611 (7.4)	7661 (92.6)		198 (4.6)	4069 (95.4)		342 (7.0)	4560 (93.0)	
Tribal	13 (5.1)	240 (94.9)		—	—		—	—	
Division									
Barishal	167 (8.9)	1705 (91.1)	<0.001	80 (6.3)	1188 (93.7)	0.002	185 (14.1)	1129 (85.9)	<0.001
Chattogram	515 (7.6)	6279 (92.4)		218 (4.6)	4571 (95.4)		380 (7.6)	4651 (92.4)	
Dhaka	704 (7.1)	9228 (92.9)		224 (3.5)	6231 (96.5)		311 (5.7)	5177 (94.3)	
Khulna	139 (4.4)	3008 (95.6)		67 (3.3)	1942 (96.7)		155 (6.5)	2238 (93.5)	
Mymensingh	—	—		—	—		153 (8.7)	1597 (91.3)	
Rajshahi	540 (7.4)	6743 (92.6)		85 (3.6)	2319 (96.4)		182 (6.6)	2568 (93.4)	
Rangpur	—	—		90 (3.8)	2282 (96.2)		112 (4.5)	2379 (95.5)	
Sylhet	189 (7.5)	2333 (92.5)		61 (3.8)	1533 (96.2)		119 (6.3)	1753 (93.7)	
Parental characteristics									
Mother's education									
Primary incomplete	1299 (8.0)	14912 (92.0)	<0.001	319 (4.2)	7323 (95.8)	0.786	199 (7.7)	2387 (92.3)	0.052
Primary complete	274 (6.7)	3808 (93.3)		118 (3.6)	3137 (96.4)		402 (7.3)	5078 (92.7)	
Secondary incomplete	489 (6.2)	7454 (93.8)		282 (3.9)	7003 (96.1)		779 (6.9)	10548 (93.1)	
Secondary complete or higher	178 (5.5)	3027 (94.5)		106 (3.9)	2605 (96.1)		217 (5.9)	3478 (94.1)	
Nonstandard curriculum	14 (13.6)	92 (86.4)		—	—		—	—	
Mother's age									
15–19	471 (7.8)	5605 (92.3)	0.390	71 (5.4)	1251 (94.6)	0.004	294 (6.9)	3944 (93.1)	0.991
20–34	938 (7.1)	12322 (92.9)		578 (4.5)	12410 (95.5)		715 (6.9)	9620 (93.1)	
35+	620 (7.2)	7947 (92.8)		112 (3.2)	3440 (96.8)		475 (7.0)	6334 (93.0)	
Household characteristics									
Wealth index									
Poorest	685 (8.6)	7299 (91.4)	<0.001	246 (4.8)	4857 (95.2)	0.071	421 (8.4)	4615 (91.6)	<0.001
Poor	502 (7.6)	6107 (92.4)		155 (3.6)	4128 (96.4)		371 (8.2)	4159 (91.8)	

(Continues)

TABLE 1 | (Continued)

| | 2006 Diarrhea | | | 2012 Diarrhea | | | 2019 Diarrhea | | |
	Yes n (%)	No n (%)	p value	Yes n (%)	No n (%)	p value	Yes n (%)	No n (%)	p value
Characteristics									
Middle	420 (7.1)	5495 (92.9)		130 (3.4)	3752 (96.6)		262 (6.1)	4036 (93.9)	
Rich	326 (5.6)	5526 (94.4)		139 (3.7)	3609 (96.3)		281 (6.2)	4226 (93.8)	
Richest	321 (6.2)	4867 (93.8)		155 (4.0)	3722 (96.0)		262 (5.5)	4456 (94.5)	
Religion									
Islam	2082 (7.3)	26611 (92.7)	0.061	710 (4.0)	17115 (96.0)	0.904	1489 (7.0)	19658 (93.0)	0.026
Others	172 (6.0)	2684 (94.0)		80 (3.9)	1956 (96.1)		107 (5.5)	1834 (94.5)	
Household head sex									
Male	2155 (7.2)	27838 (92.8)	0.285	689 (4.0)	16519 (96.0)	0.704	1483 (7.0)	19626 (93.0)	0.067
Female	99 (6.3)	1456 (93.7)		101 (3.8)	2552 (96.2)		114 (5.7)	1865 (94.0)	
Ethnicity									
Bengali	2225 (7.2)	28813 (92.8)	0.144	768 (4.0)	18505 (96.0)	0.814	1571 (6.9)	21263 (93.1)	0.019
Other	29 (5.7)	476 (94.3)		22 (3.7)	567 (96.3)		25 (10.0)	229 (90.0)	
Toilet facilities shared									
Yes	943 (7.5)	11636 (92.5)	0.016	175 (3.4)	4942 (96.6)	0.038	541 (7.8)	6365 (92.2)	0.001
No	1076 (6.6)	15123 (93.4)		603 (4.2)	13815 (95.8)		1027 (6.5)	14781 (93.5)	
Toilet facility type									
Improved	1436 (6.5)	20646 (93.5)	< 0.001	758 (4.0)	18343 (96.0)	0.868	1491 (6.8)	20531 (93.2)	0.001
Nonimproved	814 (8.7)	8597 (91.4)		31 (4.1)	729 (95.9)		104 (9.8)	958 (90.2)	
Salt iodization									
Yes	1803 (6.9)	24430 (93.1)	< 0.001	591 (4.0)	14067 (96.0)	0.601	1141 (6.6)	16239 (93.4)	0.002
No	449 (8.6)	4793 (91.4)		199 (3.8)	5002 (96.2)		455 (8.0)	5244 (92.0)	
Mass media									
Yes	—	—	—	398 (4.3)	8845 (95.7)	0.817	851 (6.6)	11968 (93.4)	0.059
No	—	—		363 (4.2)	8250 (95.8)		634 (7.4)	7930 (92.6)	
Household size									
< 5	718 (6.9)	9708 (93.1)	0.322	426 (3.8)	10960 (96.3)	0.154	925 (6.7)	12865 (93.3)	0.191
5/5+	1536 (7.3)	19587 (92.7)		363 (4.3)	8111 (95.7)		671 (7.2)	8626 (92.8)	

(Continues)

TABLE 1 | (Continued)

Characteristics	2006			2012			2019		
	Diarrhea			Diarrhea			Diarrhea		
	Yes n (%)	No n (%)	p value	Yes n (%)	No n (%)	p value	Yes n (%)	No n (%)	p value
Livestock ownership									
Yes	—	—	—	452 (4.0)	10773 (96.0)	0.786	913 (6.9)	12329 (93.1)	0.858
No	—	—		336 (3.9)	8234 (96.1)		682 (6.9)	9116 (93.1)	
Source water type									
Improved	2216 (7.1)	28783 (92.9)	0.854	772 (4.0)	18590 (96.0)	0.687	1566 (6.90)	21122 (93.10)	0.537
Unimproved	38 (6.9)	508 (93.1)		17 (3.5)	481 (96.5)		30 (7.54)	370 (92.50)	
Source of water									
Direct from source	—	—	—	8 (3.7)	218 (96.3)	0.097	27 (8.7)	290 (91.4)	0.366
Covered container	—	—		113 (4.2)	2570 (95.8)		216 (7.4)	2706 (92.6)	
Uncovered container	—	—		32 (2.7)	1166 (97.3)		88 (6.3)	1304 (93.7)	
Water treatment									
Yes	170 (8.1)	1917 (91.9)	0.214	88 (4.6)	1828 (95.4)	0.256	168 (6.9)	2271 (93.1)	0.945
No	2078 (7.1)	27344 (92.9)		702 (3.9)	17238 (96.1)		1429 (6.9)	19214 (93.1)	
Total	2254 (7.1)	29295 (92.9)		825 (3.9)	20067 (96.1)		1596 (6.9)	21492 (93.1)	

TABLE 2 | Factors associated with the diarrhea status of children using univariate logistic regression model, MICS 2006, 2012–13, and 2019.

Characteristics	2006 COR (95% CI)	p value	2012 COR (95% CI)	p value	2019 COR	p value
Child characteristics						
Age of child (in months)						
0–11	1.80 (1.51, 2.15)	< 0.001	3.96 (2.71, 5.77)	< 0.001	2.92 (2.36, 3.60)	< 0.001
12–23	2.16 (1.82, 2.56)	< 0.001	5.84 (4.14, 8.25)	< 0.001	3.27 (2.64, 4.03)	< 0.001
24–35	1.46 (1.23, 1.72)	< 0.001	2.42 (1.68, 3.48)	< 0.001	2.21 (1.76, 2.77)	< 0.001
36–47	1.17 (0.97, 1.42)	0.097	1.60 (1.05, 2.42)	0.027	1.57 (1.25, 1.97)	< 0.001
48–59	Reference	—	Reference	—	Reference	—
Child's sex						
Male	1.08 (0.98, 1.19)	0.107	0.99 (0.84, 1.18)	0.931	1.08 (0.96, 1.22)	0.178
Female	Reference	—	Reference	—	Reference	—
Inadequate supervision						
Yes	—		1.36 (0.99, 1.86)	0.058	1.20 (0.98, 1.46)	0.079
No	—		Reference	—	Reference	—
Underweight						
Yes	—		1.02 (0.84, 1.23)	0.879	1.35 (1.19, 1.54)	< 0.001
No	—		Reference	—	Reference	—
Stunned						
Yes	—		0.98 (0.81, 1.19)	0.867	1.10 (0.98, 1.25)	0.132
No	—		Reference	—	Reference	—
Wasted						
Yes	—		1.20 (0.94, 1.55)	0.148	1.20 (1.00, 1.43)	0.053
No	—		Reference	—	Reference	—
Overweight						
No	—		1.47 (1.00, 2.18)	0.051	1.30 (1.00, 1.70)	0.057
Yes	—		Reference	—	Reference	—
Community characteristics						
Place of residence						
Rural	1.43 (1.06, 1.92)	0.018	1.24 (0.96, 1.61)	0.099	1.01 (0.85, 1.19)	0.896
Urban	1.50 (1.10, 2.04)	0.011	Reference	—	Reference	—
Tribal	Reference	—	—	—	—	—
Division						
Barishal	1.21 (0.95, 1.55)	0.114	1.70 (1.22, 2.37)	0.002	2.43 (1.79, 3.30)	< 0.001
Chattogram	1.01 (0.82, 1.26)	0.893	1.20 (0.87, 1.66)	0.265	1.21 (0.90, 1.62)	0.213
Dhaka	0.94 (0.77, 1.16)	0.579	0.91 (0.65, 1.26)	0.559	0.99 (0.65, 1.21)	0.455
Khulna	0.57 (0.45, 0.74)	< 0.001	0.87 (0.62, 1.23)	0.429	1.02 (0.74, 1.42)	0.884
Mymensingh	—	—	—	—	1.41 (1.01, 1.97)	0.043
Rajshahi	0.99 (0.81, 1.21)	0.933	0.93 (0.65, 1.31)	0.666	1.04 (0.75, 1.45)	0.788
Rangpur	—	—	0.99 (0.71, 1.39)	0.955	0.70 (0.49, 0.98)	0.037
Sylhet	Reference	—	Reference	—	Reference	—
Parental characteristics						
Mother's education						
Nonstandard curriculum	2.69 (1.36, 5.31)	0.004	—	—	—	—

(Continues)

TABLE 2 | (Continued)

Characteristics	2006 COR (95% CI)	p value	2012 COR (95% CI)	p value	2019 COR	p value
Primary incomplete	1.48 (1.18, 1.86)	0.001	1.07 (0.76, 1.50)	0.706	1.34 (1.06, 1.69)	0.013
Primary complete	1.23 (0.94, 1.60)	0.133	0.93 (0.62, 1.37)	0.701	1.27 (1.04, 1.55)	0.019
Secondary incomplete	1.12 (0.88, 1.41)	0.353	0.99 (0.69, 1.41)	0.937	1.18 (0.99, 1.42)	0.067
Secondary complete or higher	Reference	—	Reference	—	Reference	—
Mother's age						
15–19	1.08 (0.92, 1.25)	0.355	1.75 (1.22, 2.50)	0.002	1.00 (0.85, 1.18)	0.952
20–34	0.98 (0.86, 1.10)	0.694	1.43 (1.10, 1.86)	0.007	1.00 (0.87, 1.13)	0.895
35+	Reference	—	Reference	—	Reference	—
Household characteristics						
Wealth index						
Poorest	1.42 (1.17, 1.74)	0.001	1.22 (0.89, 1.67)	0.224	1.55 (1.28, 1.89)	< 0.001
Poor	1.25 (1.01, 1.53)	0.037	0.90 (0.65, 1.25)	0.539	1.52 (1.24, 1.86)	< 0.001
Middle	1.16 (0.94, 1.43)	0.164	0.83 (0.59, 1.17)	0.303	1.11 (0.90, 1.37)	0.347
Rich	0.89 (0.71, 1.12)	0.322	0.92 (0.65, 1.32)	0.666	1.13 (0.91, 1.41)	0.271
Richest	Reference	—	Reference	—	Reference	—
Religion						
Islam	1.22 (0.99, 1.51)	0.061	1.02 (0.76, 1.37)	0.904	1.29 (1.03, 1.62)	0.026
Others	Reference	—	Reference	—	Reference	—
Household head sex						
Male	1.14 (0.89, 1.47)	0.285	1.06 (0.79, 0.03)	0.704	1.24 (0.98, 1.56)	0.068
Female	Reference	—	Reference	—	Reference	—
Ethnicity						
Bengali	1.28 (0.92, 1.77)	0.145	1.07 (0.59, 1.95)	0.814	0.66 (0.47, 0.94)	0.020
Other	Reference	—	Reference	—	Reference	—
Toilet facilities shared						
Yes	1.14 (1.02, 1.27)	0.016	0.81 (0.66, 0.99)	0.038	1.22 (1.08, 1.38)	0.001
No	Reference	—	Reference	—	Reference	—
Toilet facility type						
Nonimproved	1.36 (1.22, 1.52)	< 0.001	1.04 (0.63, 1.73)	0.868	1.49 (1.17, 1.91)	0.002
Improved	Reference	—	Reference	—	Reference	—
Salt iodization						
No	1.27 (1.12, 1.45)	< 0.001	0.95 (0.77, 1.16)	0.601	1.24 (1.08, 1.41)	0.002
Yes	Reference	—	Reference	—	Reference	—
Mass media						
No	—		0.98 (0.81, 1.19)	0.817	1.12 (1.00, 1.27)	0.059
Yes	—	—	Reference	—	Reference	—
Household size						
5/5+	1.06 (0.94, 1.19)	0.322	1.15 (0.95, 1.40)	0.154	0.92 (0.82, 1.04)	0.191
< 5	Reference	—	Reference	—	Reference	—
Livestock ownership						
Yes	—	—	1.03 (0.85, 1.25)	0.786	0.99 (0.88, 1.11)	0.858
No	—	—	Reference	—	Reference	—

(Continues)

TABLE 2 | (Continued)

Characteristics	2006 COR (95% CI)	p value	2012 COR (95% CI)	p value	2019 COR	p value
Source water type						
Improved	1.04 (0.69, 1.57)	0.854	1.15 (0.58, 2.31)	0.688	0.91 (0.67, 1.23)	0.537
Unimproved	Reference	—	Reference	—	Reference	—
Source of water						
Direct from source	—	—	1.39 (0.61, 3.15)	0.431	1.40 (0.83, 2.35)	0.205
Covered container	—	—	1.60 (1.04, 2.48)	0.033	1.18 (0.87, 1.60)	0.281
Uncovered container	—	—	Reference	—	Reference	—
Water treatment						
Yes	1.17 (0.91, 1.49)	0.214	1.18 (0.89, 1.58)	0.257	0.99 (0.81, 1.22)	0.945
No	Reference	—	Reference	—	Reference	—

Abbreviations: AOR, adjusted odds ratio; CI, confidence interval.

Using the composite toilet, bucket, hanging toilet/latrine, and going to bush/field causes the unsafe disposal of stools in the neighborhood, which is connected to the chance of having diarrhea among children [45]. Accessing improved toilet facilities can reduce the unsafe disposal of stools and the transmission of the virus from one human to another, which ultimately reduces the prevalence of diarrhea, supported by the findings from Ethiopia, Ghana and India [46–49].

After controlling the effects of several factors, we found that no factors were influencing the prevalence of diarrhea in 2012 but children from households that used shared toilet facilities had a lower chance of diarrhea in 2012. This finding contradicts the idea that sharing one facility with multiple families increases the chance of affecting each other by the viruses causing diarrhea [50]. We found from 2019 data that children from households that used shared toilet facilities were more at risk of experiencing diarrhea. Similar to our findings, the shared toilet facility caused a significantly increased risk of diarrhea [51] and the unhygienic toilet facility contains pathogens like norovirus, which caused diarrhea also [50]. The toilet facility, whether shared or private, must be clean, and the people using the toilet must practice hand washing after using the toilet [52]. Households using shared toilet facilities might prioritize hand washing practices over other households, which could cause the findings.

We found from 2019 data that the chance of having diarrhea was significantly higher for underweight children. Being underweight depicts the malnourished status of a child, and malnourished children are prone to infectious diseases due to the lack of proper nutrition and weak immune systems. Underweight children were more likely to have diarrhea due to their malnourished condition, and previous studies conducted in Bangladesh supported these findings [53, 54].

In 2006, Children from Khulna had a significantly lower chance of diarrhea than Children from Sylhet. Compared with Sylhet, children from Barisal were significantly more at risk, but children from Rangpur were less at risk of having diarrhea in 2019. Water-borne diseases like diarrhea are more observed in water-prone areas like the northeastern and southern parts of Bangladesh [55]. Sylhet division always faces sudden floods during the rainy season, and the water gets stuck in several areas of Sylhet for a long time, providing a favorable state to increase the infection of diarrhea among people. Moreover, some districts of the Khulna, Barisal, and Chittagong divisions are part of the southern coastal region with salty water [56, 57]. The chance of having diarrhea was higher for children from these places than in other parts of Bangladesh.

We found that Muslim children were more at risk of having diarrhea in 2019. More than 90 percent of children were from Muslim families, and due to the unbalanced status of this factor, the finding related to this lack's accuracy [57]. To accurately assess the effect of religion on the prevalence of diarrhea through logistic regression require balanced data in terms of this factor or application of modified machine learning methods.

MICS data, according to our knowledge, known to be perfectly comparable with Demographic Health Survey data and used for global statistics, were analyzed to fulfill the research purpose. The findings of this study represent the scenario of under-five children at various times of the survey years. This study observed a significant increase in the prevalence of diarrhea, nearly double that of the previous survey. Several variables were assessed during the analysis, which may influence diarrhea. Additionally, we examined the association of different covariates over time that have the greatest impact, and the recent survey clarified the current situation regarding other factors contributing to the rise in diarrhea prevalence. Despite these benefits, there were a few flaws with our research. The main limitation of this paper is to use a cross-sectional study and hence it may produce selection and information bias, and this study such as the information was derived from a secondary source. There was no control over the definition of variables and their measurement scales and criteria. Additionally, the survey was conducted in 2006, 2012, and 2019. Therefore, the diarrheal status may have changed since the survey's midpoint or at that time. In addition, information about children's food habits also needed to be given. Furthermore, the cross-sectional

TABLE 3 | Factors associated with the diarrhea status of children using multivariable logistic regression model, MICS 2006, 2012–13, and 2019.

Characteristics	2006 AOR (95% CI)	p value	2012 AOR (95% CI)	p value	2019 AOR (95% CI)	p value
Child characteristics						
Age of child (in months)						
0–11	1.81 (1.50, 2.18)	< 0.001	4.35 (2.10, 9.01)	< 0.001	3.32 (2.63, 4.19)	< 0.001
12–23	2.22 (1.86, 2.65)	< 0.001	5.24 (2.51, 10.95)	< 0.001	3.36 (2.67, 4.22)	< 0.001
24–35	1.45 (1.22, 1.73)	< 0.001	1.59 (0.71, 3.59)	0.261	2.26 (1.76, 2.89)	< 0.001
36–47	1.17 (0.97, 1.42)	0.108	2.11 (0.92, 4.82)	0.077	1.52 (1.18, 1.95)	0.001
48–59	Reference	—	Reference	—	Reference	—
Child's sex						
Male	1.05 (0.95, 1.16)	0.351	—	—	1.04 (0.92, 1.19)	0.526
Female	Reference	—	—	—	Reference	—
Inadequate supervision						
Yes	—	—	1.37 (0.69, 2.73)	0.368	1.18 (0.94, 1.48)	0.148
No	—	—	Reference	—	Reference	—
Underweight						
Yes	—	—	—	—	1.44 (1.20, 1.73)	< 0.001
No	—	—	—	—	Reference	—
Stunned						
Yes	—	—	—	—	0.93 (0.77, 1.10)	0.385
No	—	—	—	—	Reference	—
Wasted						
Yes	—	—	1.61 (0.92, 2.84)	0.097	0.89 (0.72, 1.10)	0.294
No	—	—	Reference	—	Reference	—
Overweight						
No	—	—	3.46 (0.40, 29.65)	0.310	1.43 (0.86, 2.38)	0.165
Yes	—	—	Reference	—	Reference	—
Community characteristics						
Place of residence						
Rural	1.16 (0.65, 2.06)	0.610	1.29 (0.75, 2.23)	0.363	—	—
Urban	1.46 (0.81, 2.62)	0.206	Reference	—	—	—
Tribal	Reference	—	—	—	—	
Division						
Barishal	1.27 (0.99, 1.63)	0.063	0.67 (0.27, 1.63)	0.375	2.51 (1.74, 3.63)	< 0.001
Chattogram	1.09 (0.87, 1.36)	0.439	1.01 (0.47, 2.20)	0.973	1.33 (0.94, 1.90)	0.112
Dhaka	0.96 (0.78, 1.19)	0.724	1.01 (0.46, 2.16)	0.999	0.91 (0.64, 1.30)	0.597
Khulna	0.65 (0.50, 0.85)	0.002	0.93 (0.41, 2.13)	0.862	1.05 (0.72, 1.53)	0.814
Mymensingh	—	—	—	—	1.22 (0.84, 1.79)	0.296
Rajshahi	1.04 (0.83, 1.28)	0.754	0.90 (0.36, 2.22)	0.811	0.93 (0.64, 1.35)	0.702
Rangpur	—	—	1.42 (0.63, 3.17)	0.397	0.59 (0.40, 0.88)	0.010
Sylhet	Reference	—	Reference	—	Reference	—
Parental characteristics						
Mother's education						
Nonstandard curriculum	2.58 (1.21, 5.51)	0.015	—	—	—	—

(Continues)

TABLE 3 | (Continued)

Characteristics	2006 AOR (95% CI)	p value	2012 AOR (95% CI)	p value	2019 AOR (95% CI)	p value
Primary incomplete	1.29 (0.98, 1.69)	0.064	—	—	1.21 (0.91, 1.61)	0.188
Primary complete	1.19 (0.87, 1.63)	0.266	—	—	1.08 (0.86, 1.36)	0.518
Secondary incomplete	1.11 (0.86, 1.44)	0.421	—	—	1.09 (0.88, 1.34)	0.426
Secondary complete or higher	Reference	—	—	—	Reference	—
Mother's age						
15–19	—	—	1.57 (0.69, 3.57)	0.280	—	—
20–34	—	—	1.46 (0.77, 2.74)	0.243	—	—
35+	—	—	Reference	—	—	—
Household characteristics						
Wealth index						
Poorest	1.30 (1.01, 1.65)	0.038	—	—	1.14 (0.90, 1.44)	0.277
Poor	1.13 (0.89, 1.44)	0.325	—	—	1.32 (1.04, 1.66)	0.020
Middle	1.12 (0.89, 1.41)	0.331	—	—	0.95 (0.75, 1.20)	0.667
Rich	0.90 (0.71, 1.14)	0.373	—	—	1.03 (0.81, 1.32)	0.791
Richest	Reference	—	—	—	Reference	—
Religion						
Islam	1.05 (0.82, 1.35)	0.684	—	—	1.39 (1.02, 1.88)	0.036
Others	Reference	—	—	—	Reference	—
Household head sex						
Male	—	—	—	—	1.20 (0.92, 1.55)	0.174
Female	—	—	—	—	Reference	—
Ethnicity						
Bengali	1.27 (0.76, 2.13)	0.684	—	—	0.59 (0.34, 1.01)	0.056
Other	Reference	—	—	—	Reference	—
Toilet facilities shared						
Yes	1.07 (0.96, 1.20)	0.210	0.60 (0.36, 0.99)	0.047	1.23 (1.07, 1.42)	0.004
No	Reference	—	Reference	—	Reference	—
Toilet facility type						
Nonimproved	1.23 (1.08, 1.40)	0.002	—	—	1.49 (1.08, 2.05)	0.015
Improved	Reference	—	—	—	Reference	—
Salt iodization						
No	1.13 (0.98, 1.30)	0.103	—	—	1.15 (0.99, 1.34)	0.065
Yes	Reference	—	—	—	Reference	—
Mass media						
No	—	—	—	—	0.99 (0.87, 1.14)	0.920
Yes	—	—	—	—	Reference	—
Household size						
5/5+	—	—	1.13 (0.72, 1.77)	0.595	0.91 (0.79, 1.04)	0.171
< 5	—	—	Reference	—	Reference	—
Source of water						
Direct from source	—	—	1.28 (0.53, 3.08)	0.580	—	—

(Continues)

TABLE 3 | (Continued)

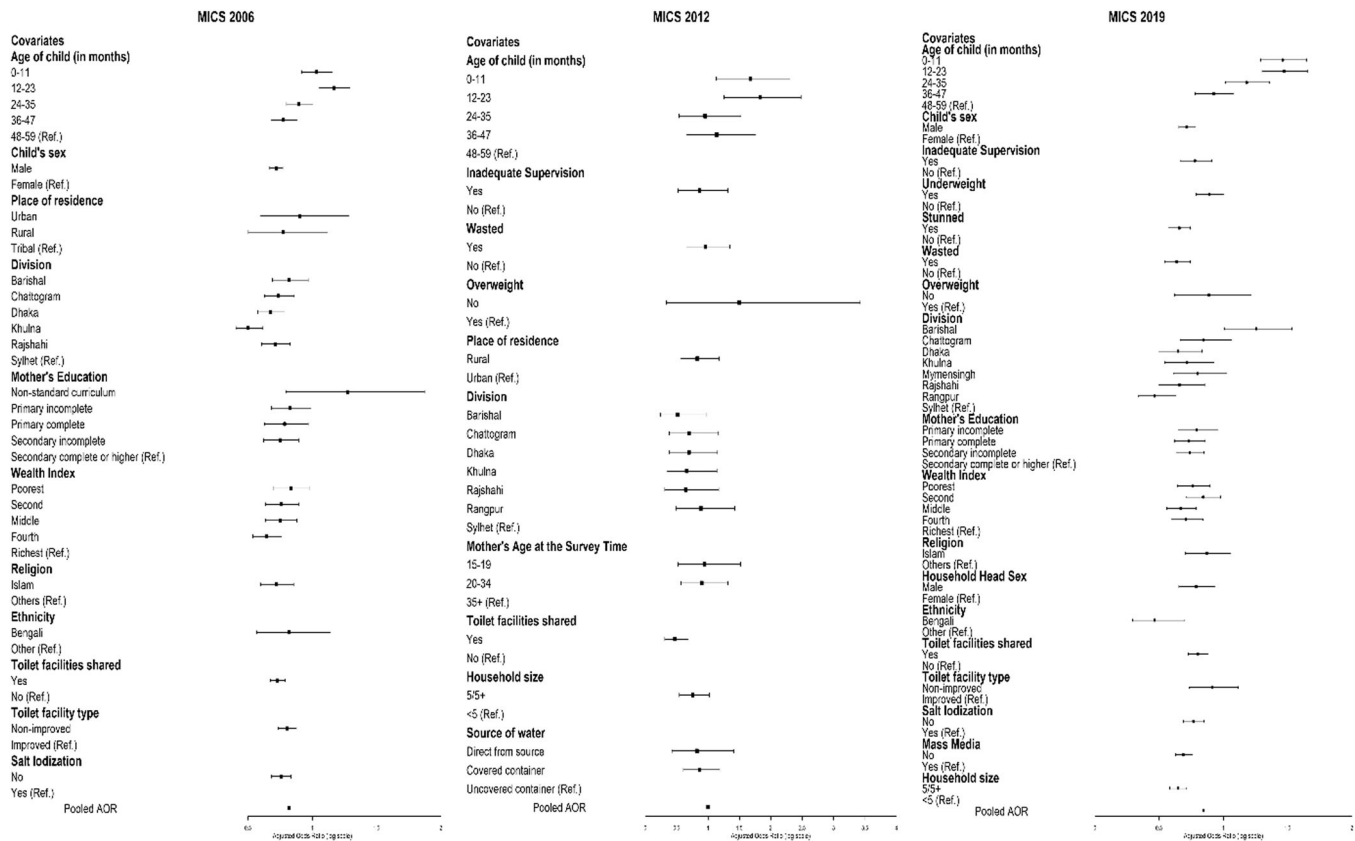| Characteristics	2006 AOR (95% CI)	*p* value	2012 AOR (95% CI)	*p* value	2019 AOR (95% CI)	*p* value
Covered container	—	—	1.37 (0.83, 2.27)	0.218	—	—
Uncovered container	—	—	Reference	—	—	—

Abbreviations: AOR, adjusted odds ratio; CI, confidence interval.

FIGURE 2 | Forest plot of adjusted odds ratios (ORs) and 95% confidence intervals (CIs) for factors associated with the diarrhea status of children, MICS 2006, 2012–13, and 2019.
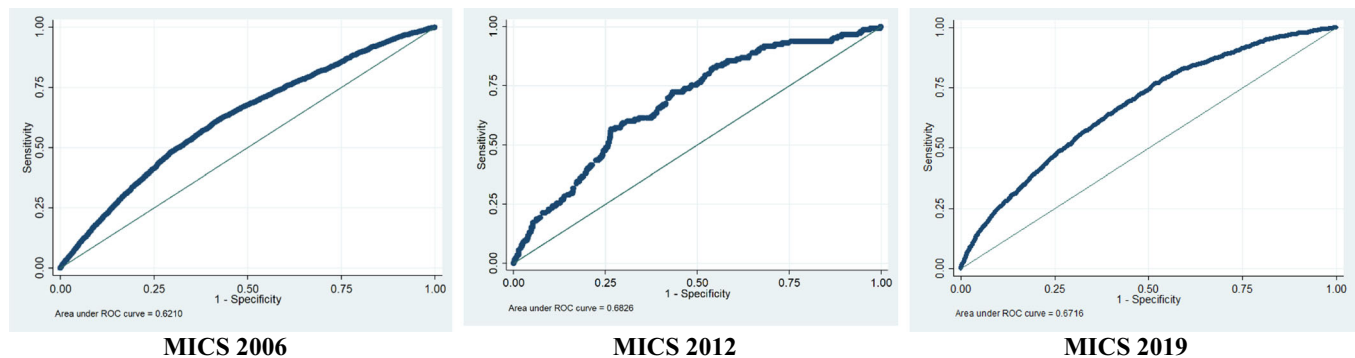
FIGURE 3 | Sensitivity analysis of fitted final multivariable logistic regression model.

data only provide the power to analyze the association of the factors with the outcome variables. While the data provide valuable insights into the factors contributing to childhood diarrhea, they do not establish causality. Future research with longitudinal or experimental designs is needed to explore causal relationships more definitively. More information was needed about mothers' health to depict the actual picture.

TABLE 4 | Area under ROC curve, AIC, and BIC for the final logistic regression model.

Survey year	The area under the ROC Curve		AIC	BIC
	AUC	*p* value		
MICS 2006	0.6210	< 0.001	14,320.83	14,545.55
MICS 2012	0.6826	< 0.001	1167.66	1295.21
MICS 2019	0.6717	< 0.001	9610.21	9870.85

11 | Conclusion

This study aimed to identify the factors contributing to diarrheal diseases in children aged 0–5 years in Bangladesh from 2006 to 2019, to understand the recent rise in this serious health issue. Our study indicates that several factors significantly influence the likelihood of diarrhea among children aged 0–5 years in Bangladesh. These addition to all contributing factors lower age categories), underweight status, place of residence (both urban and rural), divisions (Barisal and Rangpur), mother's education (incomplete and complete primary), mother's age (15–19 and 20–34 years), wealth status (poorest and poor), religion (Islam), ethnicity (Bengali), use of shared toilet facilities, type of nonimproved toilet facilities, usage of iodized salt, and consumption of water from covered containers. Younger children, particularly those aged 12–23 months, as well as underweight children, children from rural areas, and those from Barisal, were found to have a higher risk of diarrhea. Additionally, children whose parents have only a primary education, mothers aged 15–19 or 20–34 years, and those from poorer or poorest households were also at greater risk. Other contributing factors include being of Islamic faith, sharing toilet facilities, using non-improved toilet types, not using iodized salt, and consuming water from uncovered containers also at higher risk of diarrhea. In addition, we also noticed that the age of the child, Division, and shared toilet facilities are significantly associated in all survey years. However, underweight status, division, mother's education, wealth index, religion, ethnicity, type of toilet facility, and salt iodization were significant factors in 2019 but not in the previous survey. So, the findings of our study have some potential implications for our policymakers. Different government and nongovernment organizations, international agencies, and public health professionals work to improve children's health. Implementation of programs regarding basic hygiene practices and child nutrition along with existing programs can make substantial changes in childhood diarrhea.

Governments, international organizations, nongovernmental organizations, and public health professionals should consider the results of this study when making decisions about how to improve child health over time and prevent diarrhea in Bangladesh. Hopefully, this study will help policymakers to focus on interventions that are feasible and can be implemented to reduce the risk. In addition, with the usual development standards, expanding nutrition programs and direct diarrhea interventions, water, sanitation, and hygiene initiatives, along with promoting basic sanitation practices such as handwashing with soap, can reduce the incidence of childhood diarrhea and ultimately hospital burden. Additionally, efforts should be reassessed and intensified to improve sanitary infrastructure, personal and food hygiene, and home waste management. Policymakers should prioritize immediate actions to address key factors contributing diarrhea through promoting maternal education, reducing poverty and improving wealth status, culturally and religiously sensitive and inclusive interventions, salt iodization programs and focusing on regional disparities, particularly in areas like Barisal and Chattogram, to effectively reduce the increasing prevalence of diarrhea in Bangladesh. These factors were significant in 2019 but not in the previous survey, and they play a role in the overall increasing prevalence of diarrhea in Bangladesh. Another choice, though pricy, is the creation and widespread distribution of vaccinations against Bangladesh's most prevalent diarrheagenic pathogens. Clinicians and caregivers may be better equipped to intervene when an illness is still in its early stages if they can identify children becoming extremely dehydrated.

Author Contributions

Mohammad Nayeem Hasan: conceptualization, methodology, software, data curation, writing – original draft, writing – review and editing, resources, formal analysis. **M. Noor-e-alam Siddiqui:** conceptualization, methodology, data curation, writing – original draft, writing – review and editing. **Mst. Farzana Akter:** conceptualization, methodology, data curation, writing – original draft, writing – review and editing. **Sabikunnaher Mitu:** conceptualization, methodology, data curation, writing – review and editing, writing – original draft. **Muhammad Abdul Baker Chowdhury:** conceptualization, methodology, data curation, writing – review and editing, writing – original draft. **Md. Jamal Uddin:** conceptualization, methodology, data curation, writing – original draft, writing – review and editing, supervision, resources.

Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

The datasets were accessible to the public free of charge (https://mics.unicef.org/surveys).

Transparency Statement

The lead author Md Jamal Uddin affirms that this manuscript is an honest, accurate, and transparent account of the study being reported; that no important aspects of the study have been omitted; and that any

discrepancies from the study as planned (and, if relevant, registered) have been explained.

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Supporting Information

Additional supporting information can be found online in the Supporting Information section.