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Prevalence of and factors associated with childhood diarrhoeal disease and acute respiratory infection in Bangladesh: an analysis of a nationwide cross-sectional survey

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ABSTRACT

Objectives This study aimed to estimate the prevalence of childhood diarrhoeal diseases (CDDs) and acute respiratory infections (ARIs) and also to determine the factors associated with these conditions at the population level in Bangladesh.

Setting The study entailed an analysis of nationally representative cross-sectional secondary data from the most recent Bangladesh Demographic and Health Survey conducted in 2017–2018.

Participants A total of 7222 children aged below 5 years for CDDs and 7215 children aged below 5 years for ARIs during the survey from mothers aged between 15 and 49 years were the participants of this study. In the bivariate and multivariable analyses, we used Pearson χ^2 test and binary logistic regression, respectively, for both outcomes.

Results The overall prevalence of CDD and ARI among children aged below 5 years was found to be 4.91% and 3.03%, respectively. Younger children were more likely to develop both CDDs and ARIs compared with their older counterparts. Children belonging to households classified as poorest and with unimproved floor materials had a higher prevalence of diarrhoea than those from households identified as richest and with improved floor material, respectively. Stunted children had 40.8% higher odds of diarrhoea than normal children. Being male and having mothers aged below 20 years were 48.9% and two times more likely to develop ARI than female counterparts and children of mothers aged 20–34 years, respectively. Children whose mothers had no formal education or had primary and secondary education had higher odds of ARI compared with children of mothers having higher education.

Conclusion This study found that children aged below 24 months were at higher risk of having CDDs and ARIs. Thus, programmes targeting these groups should be designed and emphasis should be given to those from poorest wealth quintile to reduce CDDs and ARIs.

Strengths and limitations of this study

- We used the most recent nationally representative data for this study which ensures that our findings are generalisable to children in Bangladesh.
- This study applied appropriate statistical analysis to assess the prevalence and analyse the associated factors concurrently for acute respiratory infection (ARI) and childhood diarrhoeal disease (CDD). Therefore, this is a major contribution to ARI and CDD literature in Bangladesh.
- Nevertheless, the use of secondary data that were based on cross-sectional design limits the analysis and the causal relationship cannot be ascertained between the outcome and independent variables.
- The information was self-reported by mothers, thereby putting at risk of recall bias.

INTRODUCTION

Protecting the health and well-being of children is a crucial component of public health and global health targets. This is exemplified in the ended Millennium Development Goals (MDGs) and the fairly new Sustainable Development Goals (SDGs), especially SDG 3.2 which seeks to reduce under-five mortality to as low as 25 per 1000 live births by 2030.[1] Nonetheless, diarrhoea and acute respiratory infection (ARI) remain a major cause of morbidity and mortality among children under-five worldwide,[2] with diarrhoeal disease constituting about 9% of under-five mortality (UNICEF, 2016). Available evidence also indicates that ARI constitutes one-fifth of all under-five mortality.[3]

The severity of diarrhoeal disease and ARI cannot be under-rated. Beyond its association with childhood mortality, both diarrhoeal disease and ARI among children have been linked with many child health outcomes.[4 5] In the first 2 years of a child where the incidence of ARI and diarrhoeal diseases is highest, it impedes the physical growth and development of the child, which may later translate

into further adverse health events later in their adult life, that is, if the child survives.[6]

Contextualising the study, it is important to note that Bangladesh was successful in achieving the MDGs, specifically target 4 by attaining a 74% decline in under-five deaths from 1990 to 2015.[7] However, the country remains among the top 15 countries with a high prevalence of childhood mortality attributable to ARI and diarrhoeal disease.[7] Furthermore, evidence from Bangladesh shows that about 39% of all paediatric hospital admissions, and between 40% and 60% of total paediatric outpatient department visits were as a result of ARI.[8] This situation calls the attention of researchers to investigate ARI and diarrhoeal disease among children from the Bangladesh context.

Existing body of literature from Ethiopia,[9] Nepal[10] and Uganda[11] have found ARI and diarrhoeal disease among children to be associated with household socioeconomic status. Evidence from Vietnam[12] also shows that childhood ARI and diarrhoeal disease were associated with rural residency. Other studies conducted elsewhere have also posited that the sex of the child and access to safe drinking water,[10] sanitation,[13] level of maternal education and maternal age,[11] complementary feeding practices,[14] breastfeeding practices,[15] waste disposal[9] and household cooking fuel[16] to be significantly associated with ARI and diarrhoeal disease among children.

Current evidence using nationally representative data to investigate ARI and diarrhoeal disease among children in Bangladesh is sparse. To the best of our knowledge, existing current evidence has not looked at ARI and diarrhoeal disease concurrently. For instance, the study by Sarker *et al*[17] was limited to only childhood diarrhoeal disease (CDD), whereas study by Sultana *et al*[7] was limited to ARI. Therefore, our study is the first current evidence using nationally representative data that investigates both CDD and ARI in Bangladesh. By assessing CDD and ARI concurrently, we would gain broader appreciation of childhood morbidity and mortality in Bangladesh, as well as facilitate a holistic contribution towards the attainment of SDG 3.2. Evidence shows that CDD and ARI are the major causes of morbidity and mortality among children under-five. Therefore, addressing only one aspect (say, CDD) will be like partially addressing the issue. Hence, our joint assessment of the prevalence and factors of CDD and ARI provides a holistic approach to the discourse, helping us to know the similarities in associated factors for CDD and ARI, as well as the exclusive factors for CDD and ARI. Hence, the aim of this study is to investigate the prevalence of ARI and CDD and to determine the factors associated with these two childhood morbidities in Bangladesh. Our findings are timely and relevant in preparing Bangladesh to achieve SDG 3.2 and facilitating the country's exit from the top 15 countries with a high prevalence of CDD. Knowing the prevalence of ARI and CDD will inform policy-makers in their policy formulation and target setting. Moreover, identifying the factors associated with ARI and CDD is critical to developing need-based strategies to combat ARI and CDD in Bangladesh.

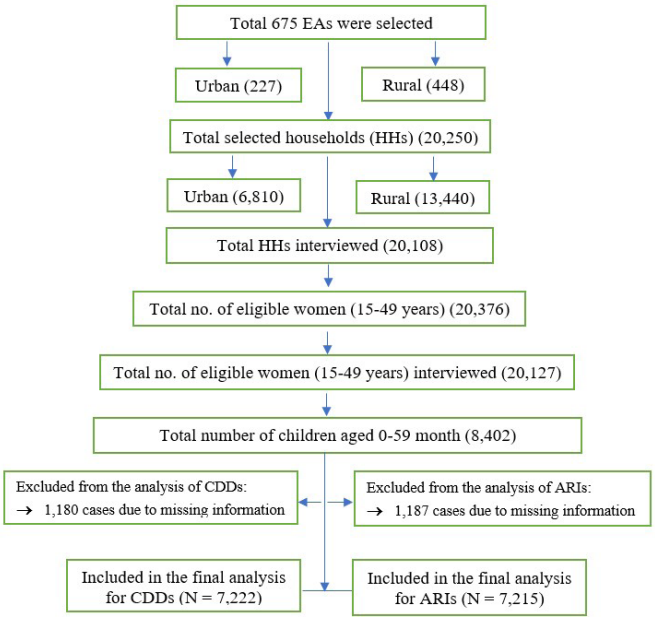

Figure 1 Flow chart for the participants' selection. ARI, acute respiratory infections; CDDs, childhood diarrhoeal diseases; EAs, enumeration areas.

METHODS

Data, sampling design and study population

In this study, the latest Bangladesh Demographic and Health Survey (BDHS) data 2017–2018 was used which is the eighth national survey conducted by the National Institute of Population Research and Training of Health Education and Family Welfare Division of the Ministry of Health and Family Welfare under Training, Research and Development operational plan of Fourth Health Population and Nutrition Sector Programme.[18] The BDHS 2017–2018 is a nationally representative cross-sectional household survey data, covering all the eight administrative divisions of Bangladesh. Two-stage stratified sampling design was used, where 675 (227 in urban areas and 448 in rural areas) enumeration areas (EAs) were selected with probability proportional to size at the first stage and then a systematic sample of 30 households was selected from each EA which constitute a sample of approximately 20 250 households (see figure 1). Detailed sampling and data collection procedures were given in the final BDHS report 2017–2018.[18] In this survey, ever-married women aged 15–49 years were approached for an interview to collect information on reproductive health, child health and nutritional status.

Variable specification

Outcome variable

The current study focuses on two binary outcome variables: CDD ('1' indicated the occurrence of diarrhoea for the indicated period and '0' indicated no occurrence) and ARI of children aged below 5 years ('1' indicated the experience of ARI for the indicated period and '0' indicated no experience). A child was considered to suffer from diarrhoea if the mother or primary caretaker

reported that the child had diarrhoea either in the last 24 hours or within the last 2 weeks. In the survey, CDD was determined if the children had three or more loose or watery stools per day, in the 2 weeks preceding the survey. Similarly, symptoms of ARI of children were identified by asking their mothers if their children were ill with cough and/or short rapid breathing and/or difficult breathing 2 weeks prior to the survey.[18–20] For analysis, we combined 'Yes, last 2 weeks' and 'Yes, last 24 hours' into 'Yes' for both ARI and diarrhoea.

Independent variables

Our variable selection was based on the previous studies[1 16 17 21 22] and available information in BDHS data 2017–2018. The exposure (explanatory variables) of the current study consisted of administrative division (Barisal, Chittagong, Dhaka, Khulna Mymensingh, Rajshahi, Rangpur, and Sylhet), sex of child (male and female), current age of child (in months), mothers' age (in years), educational qualification of the parent, occupation of parent, type of place of residence, number of household members, household wealth index, household access to television and refrigerator, household floor materials, type of cooking fuel, source of drinking water, type of toilet facilities, drugs for intestinal parasites in last 6 months, birth order and nutritional status of the children (wasting, stunting and weight for age). Nutritional status was measured by three child growth standards including stunting, wasting and weight for age proposed by WHO. A child was said to be stunted whose height-for-age Z-score is below −2 SD from the median. Similarly, a child was said to be wasted and underweighted whose weight for height Z-score and weight for age Z-score is below −2 SD from the median, respectively.[23] Both mother's occupation and father's occupation were categorised as 'home maker/no formal occupation (not working, unemployed, student, retired)', 'poultry/farming/cultivator (land owner, farmer, agricultural worker, fisherman, poultry raising, cattle raising, home-based handicraft)' and 'professional' (professional/big business/technical, small business/semiskilled and unskilled).[17]

The source of drinking water was categorised as 'improved (piped into dwelling, piped to yard/plot, public tap/standpipe, piped to neighbour, tube well or borehole, protected well, protected spring, rainwater, tanker truck, cart with small tank, bottled water)' and 'unimproved (unprotected well, unprotected spring, surface water (river/dam/lake/pond/stream/canal/irrigation channel and other))' for the current study.[1 17 24 25] Type of toilet facilities was recategorised into 'improved (flush—to piped sewer system, flush—to septic tank, flush—to pit latrine, flush—don't know where, pit latrine—ventilated improved pit, pit latrine—with slab, composting toilet)' and 'unimproved (flush—to somewhere else, pit latrine—without slab/open pit, bucket toilet, hanging toilet/latrine, others)'.[1 17 19] Children under the age of 5 years are the respondents of the current study whose ages were categorised into five: <12 months, 12–23 months, 24–35 months, 36–47 months and 48–59 months. Mother's age was coded as below 20 years, 20–34 years and above 34 years.[17] Father's and mother's education had four categories: no education, primary, secondary and higher education. Type of cooking fuel used was recategorised into 'clean fuel (electricity, liquefied petroleum gas, natural gas and biogas)' and 'polluted fuel (coal/lignite, charcoal, wood, straw/shrub/grass, agricultural crops and animal dung)'.[26] Birth order of the respondent was categorised as first child, second child and third and above. The household wealth index is a measure of living standard. Demographic and Health Survey calculated household wealth index using principal component analysis based on household's ownership of selected assets, such as televisions and bicycles; materials used for housing construction; and types of water access and sanitation facilities which had five wealth quintiles (poorest, poorer, middle, richer, richest).[27] Family size or number of household family members were divided into two categories (≤5 members and >5 members). Floor materials were categorised into 'improved (cement, ceramic tiles, vinyl asphalt strips, parquet, polished wood)' and 'unimproved (earth, sand, dung, wood planks, palm, bamboo)'.[28]

Data processing and analyses

Data management and analyses were done using SPSS V.25.0, and R V.4.0.1 for the children's data set (KR file). Descriptive weighted prevalence was computed to show the prevalence of diarrhoea and ARI among children under 5 years of age accounting the stratification and sampling weights. The weights were obtained from the women's individual sample weight dividing by 1 000 000. Frequencies and category-based percentages were showed to present the descriptive characteristics of study participants. χ^2 test was performed to identify the association between considered risk factors and CDDs as well as ARIs. Binary logistic regression was carried out to assess the adjusted and crude effect of risk factors on CDDs and ARIs among children of age under 5 years. Both adjusted OR (aOR) and unadjusted OR with 95% CI were calculated in the analysis of the current study. A p value of less than 0.05 was considered to be statistically significant.

Patient and public involvement

No patient involved.

RESULTS

Background characteristics

After data cleaning, a total of 7222 mothers having children aged below 5 years were included in case of diarrhoeal disease, and 7215 mothers who had children aged below 5 years were included in case of ARI in the present study. The age of the children was categorised with an 11-month interval and was almost equally distributed for the age category. More than half of the mothers were homemaker who had no formal occupation. Most of the children (64.8%) in the study were from the rural area.

Considering the measurement of nutritional statuses, 30.2%, 22.4% and 8.2% of children were identified to be stunted, underweight and wasted, respectively. Most of the households had an improved toilet facility (68.2%) and an improved source of drinking water (97.7%) (tables 1 and 2).

The results and the associated χ^2 tests shown in table 1 indicate that the incidence of CDD in Bangladesh is significantly associated with the age of children, mothers' age, household wealth index and drug intake for intestinal parasites. The associated χ^2 tests regarding ARI of children in Bangladesh shown in table 2 reveal that region, age and sex of children, mothers' age and household having television and refrigerator were significantly associated with ARI.

Prevalence of diarrhoeal disease and ARI

The overall prevalence of diarrhoeal disease among children aged below 5 years was 4.91%. The highest diarrhoeal prevalence was found among children from Barisal region (6.78%), followed by Rajshahi region (5.93%) (figure 2). Among the age groups, children aged between 12 and 23 months (9.36%) were most vulnerable to diarrhoea, followed by <12 months (5.92%). Children of young mothers aged between 20 and 34 years suffered from diarrhoea more (6.50%) than those of older mothers aged above 34 years (2.91%). Children of mothers with no formal education (6.28%) were found to be more vulnerable to diarrhoeal disease. Based on the five quintiles of the household wealth index, the diarrhoeal prevalence was higher among children from the poorest families (6.52%). A high prevalence was observed in children (5.37% vs 4.27%) who did not intake drugs for intestinal parasites in the last 6 months prior to data collection, and who were stunted (5.01% vs 4.66%). A high prevalence was observed in households that had unimproved floor materials (5.40% vs 4.04%) (table 1).

The overall prevalence of ARI among children aged below 5 years was 3.03%. The highest prevalence of ARI was observed in Rangpur region (5.47%), followed by Barishal (4.11%) region of Bangladesh (figure 3). Children aged between 12 and 23 months (4.10%) were found to be more vulnerable to ARI, followed by <12 months (4.07%). A higher prevalence of ARI was found among children of mothers aged 20–34 years (5.28%). ARI prevalence was higher among male (3.63%) than female children (2.36%). The prevalence of ARI is highest (3.56%) among the children whose mothers had no formal education, and a similar pattern was also observed with the educational status of fathers. Based on the socioeconomic status of the households, ARI prevalence was higher (3.98%) in the households with lower socioeconomic status (table 2).

Factors associated with childhood diarrhoeal disease

Table 3 shows the factors influencing the diarrhoeal prevalence of children aged under 5 years in Bangladesh. Both unadjusted and adjusted (multivariable) logistic regression analyses were done, where adjusted regression model was employed to control for possible confounding effects. The adjusted model shows that male children were 11.5% more likely to experience diarrhoea, compared with female children (aOR=1.115, 95% CI=1.010 to 1.347). The diarrhoeal disease was significantly associated with the age of the children: below 12–23 months (aOR=4.193, 95% CI=2.916 to 6.029) were at the highest risk to develop diarrhoea, followed by those below 12 months (aOR=2.477, 95% CI=1.666 to 3.682), compared with the children aged 58–59 months. Children aged 24–35 months showed 2.241 times higher odds of experiencing diarrhoeal disease compared with their older counterparts (aOR=2.241, 95% CI=1.523 to 3.297). We also found a statistically significant association between CDD and household wealth index. Children belonging to the poorest household wealth index category were 2.21 times more likely to develop diarrhoea, compared with the children from the richest households (aOR=2.210, 95% CI=1.102 to 4.432). Children from households with unimproved floor materials were 2.168 times more likely to have diarrhoea than those from households with improved floor materials (aOR=2.168, 95% CI=1.369 to 3.435). It was also found that stunted children were 71.8% more prone to have diarrhoea than those who were normal (aOR=1.718, 95% CI=1.153 to 1.955). It was also found that children from Barisal region (aOR=1.762, 95% CI=1.157 to 2.198) were most diarrhoea prone than those in Dhaka region (table 3).

Factors associated with ARI of children

Our multivariate regression analysis on ARI revealed that children aged <12 months (aOR=1.883, 95% CI=1.206 to 2.939) and 12–23 months (aOR=1.780, 95% CI=1.141 to 2.776) had 88.3% and 78%, respectively, higher prevalence of ARI compared with children aged 48–59 months old. In the present study, male children were 48.9% more likely to have ARI than female children (aOR=1.489, 95% CI=1.132 to 1.960). Children of mothers aged <20 years had two times higher odds of having ARI compared with those of mothers aged between 20 and 34 years (aOR=2.166, 95% CI=1.403 to 3.344). We also found that the educational qualification of mothers had a great influence on ARI of children. Children of mothers having no formal education (aOR=2.331, 95% CI=1.139 to 4.771), primary education (aOR=2.488, 95% CI=1.190 to 5.202) and secondary education (aOR=2.654, 95% CI=1.102 to 6.392) had higher prevalence of ARI compared with those whose mothers had above secondary or higher education. Children of professional mothers were 68.4% more likely to have ARI compared with those of mothers who were homemaker or had no formal occupation (aOR=1.684, 95% CI=1.121 to 2.53). Similar to the diarrhoeal prevalence, geographical location was one of the emergent influential factors for ARI of children. From the distribution of ARI cases, it was found that children who lived in Rangpur region (aOR=2.710, 95% CI=1.474 to 4.982) were most diarrhoea prone, followed by Barisal

Table 1 Demographic characteristics and distribution of prevalence of childhood diarrhoeal disease (N=7222)

Variables	Categories	Weighted prevalence (%)	Total, n (%)	Had diarrhoea, yes, n (%)	P value
Region	Barisal	6.78	732 (10.1)	50 (6.8)	0.139
	Chittagong	5.54	1147 (15.9)	64 (5.6)	
	Dhaka	3.81	1089 (15.1)	42 (3.9)	
	Khulna	4.08	758 (10.5)	32 (4.2)	
	Mymensingh	5.14	872 (12.1)	46 (5.3)	
	Rajshahi	5.93	745 (10.3)	44 (5.9)	
	Rangpur	4.92	810 (11.2)	38 (4.7)	
	Sylhet	4.89	1069 (14.8)	56 (5.2)	
Sex of child	Male	5.23	3780 (52.3)	212 (5.6)	0.065
	Female	4.56	3442 (47.7)	160 (4.6)	
Current age of child (months)	<12	5.92	1453 (20.1)	95 (6.5)	**<0.001**
	12–23	9.36	1441 (20.0)	139 (9.6)	
	24–35	5.39	1432 (19.8)	77 (5.4)	
	36–47	2.40	1375 (19.0)	36 (2.6)	
	48–59	1.43	1521 (21.1)	25 (1.6)	
Mothers' age (years)	Below 20	6.50	806 (11.2)	53 (6.6)	**0.013**
	20–34	4.89	5776 (80.0)	299 (5.2)	
	Above 34	2.91	640 (8.9)	20 (3.1)	
Educational level of mothers	No education	6.28	548 (7.6)	31 (5.7)	0.956
	Primary	4.61	2131 (29.5)	108 (5.1)	
	Secondary	4.87	3378 (46.8)	173 (5.1)	
	Higher	4.92	1165 (16.1)	60 (5.2)	
Education level of fathers	No education	4.08	1110 (15.4)	45 (4.1)	0.244
	Primary	5.64	2575 (35.7)	146 (5.7)	
	Secondary	4.68	2255 (31.2)	116 (5.1)	
	Higher	4.53	1282 (17.8)	65 (5.1)	
Mother's occupation	Homemaker/no formal occupation	5.38	3988 (55.2)	224 (5.6)	0.124
	Poultry/farming/ cultivator	4.19	2330 (32.3)	104 (4.5)	
	Professional	4.70	904 (12.5)	44 (4.9)	
Father's occupation	Homemaker/no formal occupation	1.11	60 (0.8)	1 (1.7)	0.103
	Poultry/farming/ cultivator	4.33	1491 (20.6)	64 (4.3)	
	Professional	5.11	5671 (78.5)	307 (5.4)	
Type of place of residence	Urban	4.62	2543 (35.2)	132 (5.2)	0.910
	Rural	5.02	4679 (64.8)	240 (5.1)	
No of household members	≤5	4.81	4108 (56.9)	210 (5.1)	0.863
	>5	5.05	3114 (43.1)	162 (5.2)	
Wealth index	Poorest	6.52	1253 (17.3)	84 (6.7)	**0.022**
	Poorer	5.11	1474 (20.4)	80 (5.4)	
	Middle	5.07	1620 (22.4)	82 (5.1)	
	Richer	4.74	1428 (19.8)	70 (4.9)	
	Richest	3.24	1447 (20.0)	56 (3.9)	

Continued

Table 1 Continued

Variables	Categories	Weighted prevalence (%)	Total, n (%)	Had diarrhoea, yes, n (%)	P value
Household has: television	No	4.93	3789 (52.5)	195 (5.1)	0.986
	Yes	4.89	3433 (47.5)	177 (5.2)	
Household has: refrigerator	No	4.94	5009 (69.4)	258 (5.2)	0.999
	Yes	4.85	2213 (30.6)	114 (5.2)	
Floor materials	Improved	4.04	2666 (36.9)	120 (4.5)	0.056
	Unimproved	5.40	4556 (63.1)	252 (5.5)	
Source of drinking water	Improved	4.96	7059 (97.7)	368 (5.2)	0.148*
	Unimproved	2.48	163 (2.3)	4 (2.5)	
Type of toilet facilities	Improved	4.84	4926 (68.2)	252 (5.1)	0.843
	Unimproved	5.07	2296 (31.8)	120 (5.2)	
Drugs for intestinal parasites in last 6 months	No	5.37	4219 (58.4)	241 (5.7)	**0.011**
	Yes	4.27	3003 (41.6)	131 (4.4)	
Birth order	First child	5.07	2590 (35.9)	137 (5.3)	0.429
	Second child	5.27	2359 (32.7)	129 (5.5)	
	Third and so	4.35	2273 (31.5)	106 (4.7)	
Stunting status	Normal	5.01	5044 (69.8)	269 (5.3)	0.287
	Stunted	4.66	2178 (30.2)	103 (4.7)	
Weight for age	Normal	4.77	5603 (77.6)	287 (5.1)	0.838
	Underweight	5.41	1619 (22.4)	85 (5.3)	
Wasting status	Normal	4.84	6631 (91.8)	341 (5.1)	0.914
	Wasted	5.77	591 (8.2)	31 (5.2)	
Total		4.91	7222 (100)	372 (5.2)	

The bolded p values indicate the statistical significance.
*This p value is obtained from Fisher's exact test.

region (aOR=2.143, 95% CI=1.127 to 4.077). In addition, children from Sylhet region were 93.2% more likely to develop ARI, compared with those from Khulna region (aOR=1.932, 95% CI=1.021 to 3.653) (table 4).

DISCUSSION

Although Bangladesh met the MDG targets, it still remains among the top 15 countries with high cases of CDD and ARI.[7] Therefore, to ensure that there is a greater understanding of the situation of ARI and CDD in Bangladesh, as well as to facilitate its potential to achieve SDG 3.2, we investigated the prevalence of ARI and CDD and determined the factors that are associated with these two childhood health outcomes. Our study indicates that the prevalence of CDD and ARI was 4.91% and 3.03%, respectively, with the prevalence for both outcomes being highest for children born to younger mothers (20–34 years), mothers with no formal education and those in lower socioeconomic status. The ARI prevalence observed reflects a trend of decline in the prevalence of ARI from previous rounds of the BDHS survey reports.[7 29 30]

Concerning the factors associated with ARI and CDD, the results of our study show that it was significantly associated with the sex of the child, with male children being at higher risk of ARI or CDD. This finding is in line with earlier studies from Bangladesh,[7] Ethiopia,[14] Nepal,[10] Sudan[31] and Thailand[32] that have reported higher risk of ARI and CDD among male children. A plausible explanation could be due to higher reporting for male children, which is reinforced by mothers' preference for the male child.[33 34] As such, they are able to notice changes in the health status of the male child early and report to the hospital accordingly.

There is a myriad of evidence suggesting that ARI and CDD are most prevalent in the first 2 years of a child's life, thus making children aged <12 months and those between 12 and 23 months being at higher risk of ARI or CDD.[13 17 35] Our finding provides confirmation of this association. Moreover, the finding from this study indicates that although the prevalence of ARI and CDD is higher within the first 2 years of a child's life, the risk of developing ARI or CDD is highest in children between 12 and 23 months, which support Sarker *et al*[17] findings that

Table 2 Demographic characteristics and distribution of prevalence of acute respiratory infection (N=7215)

Variables	Categories	Weighted prevalence (%)	Total, n (%)	Had ARI, yes, n (%)	P value
Region	Barisal	4.11	730 (10.1)	30 (4.1)	**0.001**
	Chittagong	2.82	1145 (15.9)	31 (2.7)	
	Dhaka	2.12	1089 (15.1)	23 (2.1)	
	Khulna	1.89	758 (10.5)	15 (2.0)	
	Mymensingh	2.53	872 (12.1)	22 (2.5)	
	Rajshahi	3.91	744 (10.3)	27 (3.6)	
	Rangpur	5.47	810 (11.2)	43 (5.3)	
	Sylhet	3.10	1067 (14.8)	35 (3.3)	
Sex of child	Male	3.63	3778 (52.4)	138 (3.7)	**0.008**
	Female	2.36	3437 (47.6)	88 (2.6)	
Current age of child (months)	<12	4.07	1452 (20.1)	65 (4.5)	**<0.001**
	12–23	4.10	1439 (19.9)	61 (4.2)	
	24–35	2.13	1429 (19.8)	30 (2.1)	
	36–47	2.81	1374 (19.0)	37 (2.7)	
	48–59	2.03	1521 (21.1)	33 (2.2)	
Mothers' age (years)	Below 20	2.70	806 (11.2)	44 (5.5)	**<0.001**
	20–34	5.28	5769 (80.0)	163 (2.8)	
	Above 34	2.93	640 (8.9)	44 (5.5)	
Educational level of mothers	No education	3.56	547 (7.6)	19 (3.5)	0.085
	Primary	3.22	2130 (29.5)	70 (3.3)	
	Secondary	2.16	3374 (46.8)	88 (2.6)	
	Higher	1.40	1164 (16.1)	18 (1.6)	
Education level of fathers	No education	3.56	1110 (15.4)	40 (3.6)	0.177
	Primary	3.24	2573 (35.7)	85 (3.3)	
	Secondary	3.15	2251 (31.2)	73 (3.2)	
	Higher	1.82	1281 (17.8)	28 (2.2)	
Mother's occupation	Homemaker/no formal occupation	2.53	3982 (55.2)	109 (2.7)	0.089
	Poultry/farming/cultivator	3.59	2329 (32.3)	82 (3.5)	
	Professional	3.74	904 (12.5)	35 (3.5)	
Father's occupation	Homemaker/no formal occupation	0.0	60 (0.8)	0 (0.0)	0.190
	Poultry/farming/cultivator	3.63	1488 (20.6)	54 (3.6)	
	Professional	2.89	5495 (78.5)	172 (3.0)	
Type of place of residence	Urban	2.74	2541 (35.2)	77 (3.0)	0.714
	Rural	3.14	4674 (64.8)	149 (3.2)	
No of household members	≤5	2.90	4105 (56.9)	127 (3.1)	0.829
	>5	3.20	3110 (43.1)	99 (3.2)	
Wealth index	Poorest	3.98	1618 (22.4)	61 (3.8)	0.166
	Poorer	3.35	1429 (19.8)	49 (3.4)	
	Middle	2.72	1251 (17.3)	38 (3.0)	
	Richer	3.03	1444 (20.0)	45 (3.1)	
	Richest	1.90	1473 (20.4)	33 (2.2)	
Household has: television	No	3.63	3786 (52.5)	137 (3.6)	**0.013**
	Yes	2.37	3429 (47.5)	89 (2.6)	
Household has: refrigerator	No	3.38	5004 (69.4)	172 (3.4)	**0.025**
	Yes	2.22	2211 (30.6)	54 (2.4)	

Continued

Table 2 Continued

Variables	Categories	Weighted prevalence (%)	Total, n (%)	Had ARI, yes, n (%)	P value
Floor materials	Improved	2.49	2662 (36.9)	76 (2.9)	0.301
	Unimproved	3.33	4553 (63.1)	150 (3.3)	
Type of cooking fuel	Clean fuel	2.16	1492 (20.7)	36 (2.4)	0.073
	Polluted fuel	3.26	5723 (79.3)	190 (3.3)	
Birth order	First child	2.89	2588 (35.9)	73 (2.8)	0.460
	Second child	2.65	2358 (32.7)	81 (3.4)	
	Third and so	3.40	2269 (31.4)	72 (3.2)	
Stunting status	Normal	3.06	5039 (69.8)	153 (3.0)	0.476
	Stunted	2.90	2176 (30.2)	73 (3.4)	
Weight for age	Normal	3.32	5597 (77.6)	176 (3.1)	0.912
	Underweight	3.03	1618 (22.4)	50 (3.1)	
Wasting status	Normal	3.03	6624 (91.8)	204 (3.1)	0.390
	Wasted	2.99	591 (8.2)	22 (3.7)	
Total		3.03	7215 (100)	226 (3.1)	

The bolded p values indicate the statistical significance.

the prevalence of CDD is highest for children aged 1–2 years compared with those less than a year old. However, our findings that younger child age is associated with higher prevalence and risk of ARI and CDD could be explained from the point that the immune system of the child is delicate at that early age, thereby putting them at increased risk of infections.[36] Furthermore, children in such early years tend to be heavily dependent on their

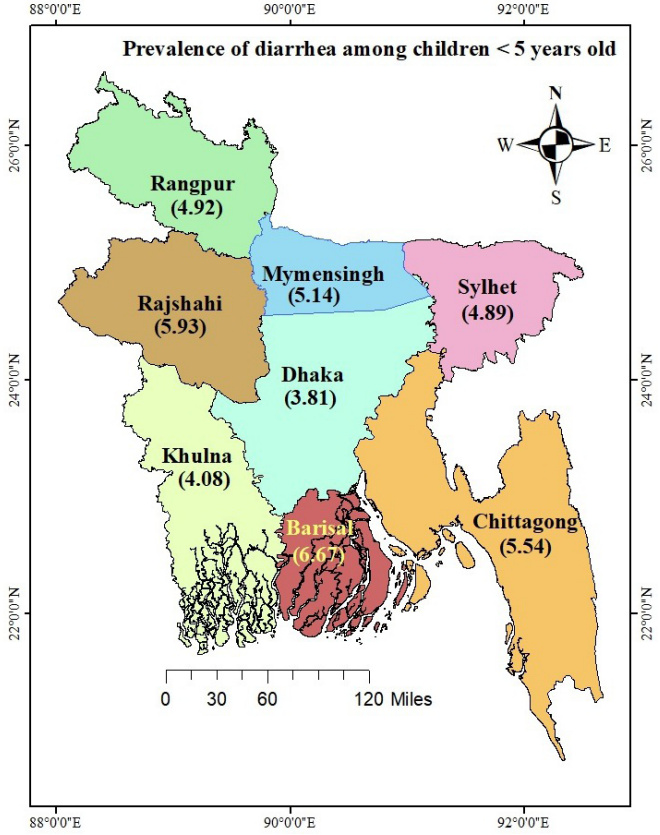

Figure 2 Division-wise distribution of prevalence (weighted) of diarrhoeal disease among children aged under 5 years in Bangladesh.

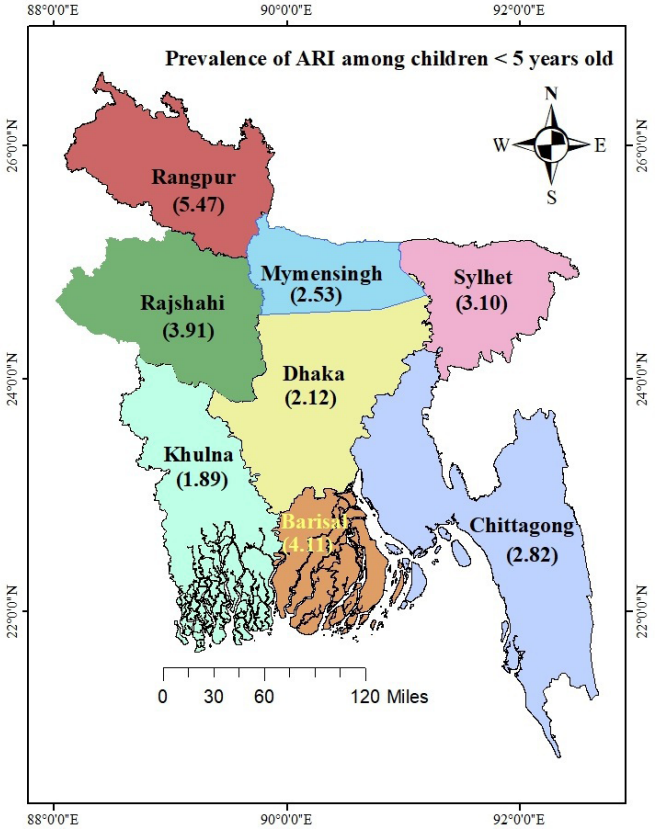

Figure 3 Division-wise distribution of prevalence (weighted) of acute respiratory infection (ARI) among children aged under 5 years in Bangladesh.

Table 3 Binary logistic regression analysis of factors associated with childhood diarrhoea

Variables	Categories	Unadjusted		Adjusted	
		OR	95% CI	OR	95% CI
Region (ref: Dhaka)	Chittagong	1.473	0.989 to 2.194	1.089	0.747 to 1.589
	Barisal	**1.828****	1.199 to 2.785	**1.762****	1.157 to 2.198
	Khulna	1.099	0.687 to 1.757	0.901	0.569 to 1.425
	Mymensingh	1.388	0.905 to 2.130	1.156	0.756 to 1.768
	Rajshahi	**1.565***	1.014 to 2.414	1.270	0.830 to 1.944
	Rangpur	1.227	0.784 to 1.922	1.028	0.656 to 1.611
	Sylhet	1.378	0.915 to 2.075	1.015	0.685 to 1.505
Sex of child (ref: female)	Male	1.219	0.987 to 1.505	**1.115***	1.010 to 1.374
Current age of child (ref: 48–59 months)	<12	**4.186*****	2.678 to 6.543	**2.477*****	1.666 to 3.682
	12–23	**6.388*****	4.147 to 9.843	**4.193*****	2.916 to 6.029
	24–35	**3.401*****	2.153 to 5.371	**2.241*****	1.523 to 3.297
	36–47	1.609	0.961 to 2.694	1.009	0.644 to 1.581
Mothers' age (ref: 20–34 years)	Below 20	1.289	0.953 to 1.744	0.920	0.646 to 1.311
	Above 34	0.591	0.373 to 0.936	0.600	0.366 to 1.130
Educational level of mothers (ref: higher)	No education	1.104	0.707 to 1.725	0.897	0.530 to 1.517
	Primary	0.983	0.711 to 1.359	**0.708***	0.477 to 0.989
	Secondary	0.994	0.735 to 1.344	0.714	0.511 to 0.998
Education level of fathers (ref: no education)	Primary	**1.423***	1.011 to 2.002	0.918	0.668 to 1.262
	Secondary	1.283	0.903 to 1.825	0.727	0.510 to 1.035
	Higher	1.264	0.857 to 1.865	1.058	0.727 to 1.479
Mother's occupation (ref: homemaker/no formal occupation)	Poultry/farming/cultivator	**0.785***	0.619 to 0.996	0.850	0.650 to 1.110
	Professional	0.860	0.617 to 1.198	0.880	0.625 to 1.239
Father's occupation (ref: homemaker/no formal occupation)	Poultry/farming/cultivator	2.646	0.36 to 19.402	1.105	0.360 to 17.182
	Professional	3.377	0.466 to 24.45	1.120	0.474 to 20.117
Type of place of residence (ref: urban)	Rural	0.988	0.794 to 1.228	0.871	0.677 to 1.122
No of household members (ref: ≤5)	>5	1.019	0.825 to1.257	0.907	0.726 to 1.131
Wealth index (ref: richest)	Poorest	1.076	0.784 to 1.477	**2.210***	1.102 to 4.432
	Poorer	1.348	0.985 to 1.844	1.214	0.907 to 2.426
	Middle	0.967	0.697 to 1.341	0.963	0.204 to 1.669
	Richer	0.755	0.533 to 1.069	1.157	0.534 to 2.385
Household has: television (ref: no)	Yes	1.002	0.813 to 1.235	0.771	0.588 to 1.010
Household has: refrigerator (ref: no)	Yes	1.000	0.798 to 1.254	0.662	0.480 to 1.131
Floor materials (ref: improved)	Unimproved	1.242	0.994 to 1.552	**2.168****	1.369 to 3.435
Source of drinking water (ref: improved)	Unimproved	0.457	0.169 to 1.241	0.496	0.180 to 1.367
Type of toilet facilities (ref: improved)	Unimproved	1.023	0.818 to 1.279	0.980	0.745 to 1.288
Drugs for intestinal parasites in last 6 months (ref: no)	Yes	**0.753***	0.605 to 0.936	0.935	0.731 to 1.196
Birth order (ref: first child)	Second child	1.036	0.809 to 1.136	0.922	0.703 to 1.211
	Third and so	0.876	0.675 to 1.136	0.832	0.606 to 1.141
Stunting status (ref: normal)	Stunted	0.881	0.698 to 1.112	**1.718***	1.153 to 1.955
Weight for age (ref: normal)	Underweight	1.026	0.800 to 1.316	1.234	0.893 to 1.705
Wasting status (ref: normal)	Wasted	1.021	0.700 to 1.490	0.904	0.594 to 1.375

The bolded values (ORs) indicate the statistical significance.
*p<0.05; **p<0.01; ***p<0.001.

Table 4 Binary logistic regression analysis of factors associated with acute respiratory infection of children

Variables	Categories	Unadjusted		Adjusted	
		OR	95% CI	OR	95% CI
Region (ref: Khulna)	Barisal	**2.123***	1.133 to 3.979	**2.143***	1.127 to 4.077
	Chittagong	1.378	0.739 to 2.571	1.454	0.767 to 2.754
	Dhaka	1.069	0.554 to 2.062	1.163	0.584 to 2.318
	Sylhet	1.680	0.911 to 3.098	**1.932***	1.021 to 3.653
	Mymensingh	1.282	0.660 to 2.489	1.322	0.673 to 2.596
	Rajshahi	1.865	0.984 to 3.536	1.851	0.971 to 3.528
	Rangpur	**2.777****	1.530 to 5.041	**2.710****	1.474 to 4.982
Sex of child (ref: female)	Male	**1.443****	1.100 to 1.893	**1.489****	1.132 to 1.960
Current age of child (ref: 48–59 months)	<12	**2.113****	1.381 to 3.233	**1.883****	1.206 to 2.939
	12–23	**1.996****	1.299 to 3.068	**1.780***	1.141 to 2.776
	24–35	0.967	0.587 to 1.594	0.900	0.542 to 1.496
	36–47	1.248	0.776 to 2.007	1.226	0.759 to 1.979
Mothers' age (ref: 20–34 years)	Below 20	**1.986*****	1.411 to 2.794	**2.166*****	1.403 to 3.344
	Above 34	1.052	0.650 to 1.704	1.095	0.649 to 1.847
Educational level of mothers (ref: higher)	No education	**2.182***	1.086 to 4.384	**2.331***	1.139 to 4.771
	Primary	**2.052***	1.034 to 4.072	**2.488***	1.190 to 5.202
	Secondary	1.581	0.746 to 3.354	**2.654***	1.102 to 6.392
Education level of fathers (ref: higher)	No education	**1.673***	1.025 to 2.730	1.816	0.961 to 3.433
	Primary	1.529	0.992 to 2.356	1.471	0.840 to 2.578
	Secondary	1.500	0.965 to 2.332	1.495	0.888 to 2.518
Mother's occupation (ref: homemaker/no formal occupation)	Poultry/farming/ cultivator	1.297	0.969 to 1.735	1.184	0.852 to 1.643
	Professional	1.431	0.971 to 2.109)	**1.684***	1.121 to 2.53
Father's occupation (ref: professional)	No formal occupation	0.0	0.0 to 0.0	0.0	0.0 to 0.0
	Poultry/farming/ cultivator	1.203	0.881 to 1.642	1.094	0.777 to 1.540
Type of place of residence (ref: urban)	Rural	1.054	0.797 to 1.393	0.866	0.620 to 1.210
No of household members (ref: ≤5)	>5	1.030	0.789 to 1.435	1.021	0.768 to 1.358
Wealth index (ref: richest)	Poorest	**1.710***	1.113 to 2.627	1.439	0.524 to 3.951
	Poorer	1.549	0.990 to 2.424	1.459	0.548 to 3.886
	Middle	1.367	0.852 to 2.193	1.384	0.593 to 3.229
	Richer	1.404	0.890 to 2.213	1.186	0.664 to 2.119
Household has: television (ref: no)	Yes	0.710	0.541 to0.931	0.803	0.561 to 1.150
Household has: refrigerator (ref: no)	Yes	**0.703***	0.516 to 0.959	1.039	0.659 to 1.639
Floor materials (ref: improved)	Unimproved	1.159	0.876 to 1.534	0.653	0.366 to 1.164
Type of cooking fuel (ref: clean fuel)	Polluted fuel	1.389	0.968 to 1.992	1.098	0.661 to 1.823
Birth order (ref: third and so)	First child	0.886	0.636 to 1.233	0.705	0.457 to 1.088
	Second child	1.085	0.786 to 1.499	1.076	0.754 to 1.535
Stunting status (ref: stunted)	Normal	0.902	0.679 to 1.198	0.896	0.637 to 1.260

Continued

Table 4 Continued

Variables	Categories	Unadjusted		Adjusted	
		OR	95% CI	OR	95% CI
Weight for age (ref: underweight)	Normal	1.018	0.740 to 1.401	1.119	0.746 to 1.679
Wasting status (ref: wasted)	Normal	0.822	0.525 to 1.286	0.797	0.486 to 1.306

The bolded values (ORs) indicate the statistical significance.
*p<0.05; **p<0.01; ***p<0.001.

mothers and therefore require appropriate feeding that is proportional to their age.[17] Hence, when mothers slack in their responsibilities to provide safe and appropriate feeding to the children at that age, then their risk of ARI and CDD increases.

We found a significant association between household wealth status and risk of CDD, with children belonging to the poorest household having greater likelihood of developing the diarrhoeal disease. This corroborates previous related studies from Bangladesh[16 17] and Nepal[10] that also reported higher risk of CDD among children belonging to poor households. This could be justified from the perspective that poorer households have difficulty in meeting their nutritional needs and adopting appropriate feeding practices which may exacerbate their risk of diarrhoeal infection.[10] This is further iterated in our finding that stunted children had a higher risk of CDD.

Congruent to existing literature,[3 11] our study indicates that there is significant association between formal education and ARI, with lower odds of ARI being reported among children whose mothers had formal education compared with those whose mothers had no formal education. A plausible justification for this finding could be that children spend more time with their mothers; therefore, the mother's educational attainment will reflect in the quality of care that they will provide to their child, which may either increase the risk or protect against ARI.[37] Hence, emphasising the need to promote formal education among women.

Beyond these individual and household factors, we found statistically significant association between geographical region and the risks of ARI and CDD. It was found that children who lived in Rangpur region and Barisal region were at higher risk of developing ARI or CDD. This is consistent with previous studies from Bangladesh[17] that also found similar findings in relation to the regional differences in the prevalence of ARI and CDD. Begum and her colleagues also reported a higher diarrhoeal prevalence among children aged below 5 years in the similar setting and found that water, sanitation and hygiene education to the mothers was effective to reduce the burden of diarrhoea.[38] According to Sarker *et al*[17] regions like Barisal are densely populated and is also characterised by the existence of more rivers and water reservoirs that create an enabling environment for diarrhoeal disease to spread among the population. Perhaps, this could be the reason for the high prevalence of ARI and CDD within the Barisal region.

Strengths and limitations

The strength of this study lies in the use of the most recent nationally representative data for this study which ensures that our findings are generalisable to children in Bangladesh. Also, the study applied appropriate statistical analysis to assess the prevalence and analyse the associated factors concurrently for ARI and CDD. Hence, our findings are valid and reliable. Nevertheless, there were some limitations to our study which are noteworthy. First, the use of secondary data that were based on cross-sectional design limits the analysis. As such, causal relationship cannot be ascertained between the outcome and independent variables. The information was self-reported by mothers, thereby putting at risk of recall bias. Perhaps, a longitudinal study that seeks to assess the factors that influence CDD and ARI could establish some sort of causality. Notwithstanding, these limitations do not override the validity and reliability of our findings.

CONCLUSION

We also conclude that there are individual, household and geographic factors that exacerbate the risk of ARI and CDD (children born to mothers of younger age, mothers with no formal education, belonging to lower socioeconomic households, being a male child, being stunted and residing in Barisal and Rangpur regions). Therefore, we recommend that the government of Bangladesh commit resources, policies and interventions geared towards ARI and CDD reduction to the identified at-risk groups. Also, there is the need to augment formal education for women in Bangladesh to accelerate the realisation of SDG 3.2, and complete eradication of ARI- and CDD-related child mortality in the country. Further studies can be conducted to explore how culture also permeates the dynamics of ARI and CDD in Bangladesh to ensure that interventions and policies developed are culturally sensitive to facilitate acceptance and adherence.

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