**Title: Association between exclusive breastfeeding and common childhood diseases in Bangladesh**

**ABSTRACT**

Exclusive breastfeeding (EBF) is the biologically normal feeding method that was considered only the mothers breastfeed and who did not give any supplementary food during the first six months of her infant’s life, NOT even water. Several factors have an association between breastfeeding and common childhood diseases in Bangladesh. We are keen to determine the potential factors that are associated with exclusive breastfeeding and common childhood diseases. We have used Bangladesh Demographic & Health Survey (BDHS) data which is a nationally representative data. After inclusion and exclusion criteria, we considered 632 children aged between 0-5 months, in which 44.7% belong to non-EBF (non-exclusive breastfed) and 55.3% belong to EBF (exclusive breastfed). Prevalence was compared using chi-squared tests and association estimated between exclusive breastfeeding and childhood disease using zero-inflated negative binomial (ZINB) regression. Infants who were not exclusively breastfed, risk ratio (RR) 1.27 times (RR 1.27, 95% CI 1.01–1.60, p = 0.045) greater of having childhood diseases rather than who were exclusively breastfed. The risk of a child getting affected by diseases is more acute if the mothers' age lies between 15-19 years (1.27, 95% CI: 1.01-1.60). Infants belonging to mothers having higher education 35% (0.65, 95% CI: 0.41-1.03) are facing a decreasing rate than the uneducated mother. Children with overweight mothers are suffering more than the underweight mothers and the rate is (1.53,95%CI: 1.16,2.01). To reduce child disease, we have to more conscious about proper breastfeeding to the infants. Mothers’ working and the place of child’s residence has to be acknowledged properly.

**INTRODUCTION**

Breastfeeding a biological common diet has the most important interference which serves the entire range of childhood (Sankar et al., 2015). Breastfeeding has frequent health assistances for both the mother and child as it contains nutrients, antioxidants, hormones and antibodies (Oddy, 2017). Several national and international organizations (e.g. WHO) indorse exclusive breastfeeding for the first six months (Santos et al., 2016) and is also recommended for two or more years as it related to adolescent intelligence (Mortensen, Michaelsen, Sanders, & Reinisch, 2002; Victora et al., 2015). A recent cross-sectional study suggested that exclusively breastfed comparing the distributions of weight and length grounded on reference curves indicates satisfactory physical growth, directing to height and weight gain curves (Uwaezuoke, Eneh, & Ndu, 2017).

Breast-feeding can reduce bronchial asthma, atopic dermatitis (Gdalevich, Mimouni, David, & Mimouni, 2001), allergic rhinitis (Bloch, Mimouni, Mimouni, & Gdalevich, 2007), and type 1 diabetes mellitus (Bloch et al., 2007) and gastrointestinal infections as it contains lactating, secretary IGA, T and B lymphocytes, bacteriolytic lactoferrin, oligosaccharide, and human milk glycans (Bloch et al., 2007). Breastfeeding has advantages, for an inferior risk of acute otitis media, breathing contaminations, atopic dermatitis, necrotizing enterocolitis, unexpected infant death disorder, and maternal type 2 diabetes mellitus (T2DM) following gestational diabetes (Uwaezuoke et al., 2017). The defending consequence of breastfeeding is most significant in inhabitants with high newborn mortality, from head to foot illiteracy, nutritious status(overheavy and thinness in infantile), and commonly poor economic condition (Mihrshahi, Oddy, Peat, & Kabir, 2008; WHO, 2014).

The global rates of breastfeeding remain low and show only 43% of the world's newborns are put to the breast within 1 hour of birth whereas infants aged 6 months or less are completely breastfed (Sankar et al., 2015). A survey held in 2008 showed that 8.8 million global deaths in an infant under five occurred from pneumonia and diarrhea which are the leading reasons for infant death and morbidity. Breastfeeding has later developed Crohn disease (CD) and ulcerative colitis (UC) and inflammatory bowel disease (IBD) in developed countries (Chisti et al., 2011). Cultural practices embrace the feeding of prolateral diets, such as honey, sugar water, or mustard oil immediately after birth due to limited breastfeeding (Mihrshahi et al., 2007). Community‐level education and counseling program named Maternal, Neonatal, and Child Health and Integrated Management of Neonatal and Childhood Illness program had a huge effect on breastfeeding (Benedict, Craig, Torlesse, & Stoltzfus, 2018a; Nguyen et al., 2017). In a study, Bangladesh, India, and Nepal show a positive tendency for all types of breastfeeding, but Afghanistan and Pakistan are almost behind all breastfeeding habits (Benedict et al., 2018a). This has increased during the 60 days of exclusive breastfeeding (A. I. Khan et al., 2017).

According to the Nationally Representative Bangladesh Demographic and Health Survey (BDHS), the prevalence of exclusive breastfeeding was approximately 56%, whereas, in the developing world, the average difference was 39% (M. N. Khan & Islam, 2017; Kim et al., 2018). However, the exclusiveness of exclusive breast-feeding was reduced to the child's age (Khatun et al., 2018). Besides, the mother's age also influences on breeding practices. Breast-feeding mothers were more likely to be breastfed after 24 months of birth, but young mothers were less likely to have delivery and after the first year of childbirth, breastfeeding was stopped (Islam, Igarashi, & Kawabuchi, 2018).

Breastfeeding reduces the rate of childhood diseases in Bangladesh. Under-nutrition in Bangladesh is a major public health problem in the primary stage (Das & Gulshan, 2017), At least 50% of children are under the age of half-fifty years of age. Among them was the poorest of the urban poor (Muhammad, Chowdhury, Arifuzzaman, & Chowdhury, 2017). A cross-sectional study has been shown in Rangpur Medical College Hospital (RMCH) in the breastfeeding section that it is beneficial to reduce nutritional problems by promoting exclusive breastfeeding practices. ARI accounts for one-third of the deaths of children in many countries. Inadequate or delayed treatment in Bangladesh, about 400 children die every day from ARI (Debnath et al., 2018). ARI is a major cause of childhood deaths and diseases in Bangladesh (Azad, 2008; Stewart, Parker, Chakraborty, & Begum, 1993). A community-based longitudinal study on ARI conducted in Bangladesh has shown that children spent 60% with the ARI (Zaman et al., 1997). A joint survey conducted in Chittagong in Bangladesh has shown that children who are breastfed during the birth of six months of age are significantly less exposed to ARI than those of children who are not breastfeeding only (International Centre for Diarrhoeal Disease Research, 2000). For children under the age of 5, one of the most causes of death in developing countries like diarrhea (Anteneh, Andargie, & Tarekegn, 2017). The widely recommended diet of continuous breastfeeding during diarrhea provides much-needed nutrients for a nipple child. Breast milk should be supplied with excess fluid during diarrhea, which can help prevent dehydration (Faruque, Mahalanabis, Islam, Hoque, & Hasnat, 1992).

Furthermore, from the best aspect of our knowledge, there has been no extensive research to determine the relationship between breastfeeding and general childhood diseases nationwide. In Bangladesh, many studies have been conducted in anticipation of monitored breast milk, which has significantly contributed to many predictions such as family capital index, male child, age, region, etc. (Blackstone & Sanghvi, 2018; Kim et al., 2018). In this study, we inspect the association between EBF and common childhood diseases in Bangladesh. (e.g. diarrhea, blood in stools, fever, cough, breathing problem and problem in the chest).

**Ethics approval**

Our study was based on analysis of public domain health survey datasets obtained from BDHS 2014, which is freely available online, with all identifying information removed. Informed consent was obtained from participants while interviewing them. The BDHS 2014 was reviewed and approved by the ICF Macro Institutional Review Board and the National Research Ethics Committee of the Bangladesh Medical Research Council. This survey was conducted by the National Institute of Population Research and Training (NIPORT) of the Ministry of Health and Family Welfare and implemented by Mitra and Associates, Bangladesh (NIPORT & Associates, 2014).

**METHODS**

**Data source and Study design:**

We used the latest available BDHS 2014 data for our study. There 7886 number of mother-child pairs information was given which represents the seven divisions (Chittagong, Dhaka, Barisal, Sylhet, Rajshahi, Khulna, Rangpur) in Bangladesh. Districts are taken as the main sampling strata for the sample. Among them, the number of children living with their mother is 7500 and about 1236 children don’t live with their mother. Age between 0-5 months (632 children) is selected as a sample and 6868 children greater than six months are excluded (Figure 1).

**Total number of mother-child pairs in BDHS 2014 (n=7886)**

**Child lives with their mother were included (n= 7500)**

**Child were not living with their mother were excluded (n= 1236)**

**Child greater than six months were excluded (n=6868)**

**Child age (months) ≥ 7**

**Child age between 0-5 months were included (n= 632)**

Figure 1: Data selection flow chart of the study population

**Sampling:**

BDHS sample is stratified and selected into two stages. In the first stage, 600 enumeration areas (EAs) are selected with probability proportional to the EA’s size with 207 EAs in the urban areas and 393 EAs in rural areas. Then in the second stage of sampling, a systemic sample selection of 17989 households (6210 in urban and 11779 in rural) on an average of 30 households per EA was made using systematic sampling. Due to the difference in the proportional allocation of samples and response rate among samples in the division, urban and rural areas, the sample weight was adjusted to ensure the representativeness of the survey results at the national level. Eliminates the underestimation of variability in estimates by weighing data for under sampling and oversampling within the strata for clustering in the sample. A detailed description of the weighting procedure can be found in the BDHS report (NIPORT & Associates, 2014).

**Outcome variable:**

In this study, Child disease is taken as an outcome variable. A child is identified as suffering from diseases if their mother reported that the child had diarrhea, blood in stools, fever, cough, breathing problem, a problem in chest and problem in the nose in the two weeks before the survey. For study purposes, firstly, we put 1 if their mother reported that the child had a specific disease, otherwise 0. Then, we considered the outcome variable by counting all that early childhood diseases. Figure 2 presents the frequency plot of the outcome variable of childhood disease. Notice that this variable showed an extremely right-skewed distribution with a spike at zero.

|  |
| --- |
|  |

Figure 2: Distribution of outcome variables

**Exposure variable:**

The exposure variable was a binary variable that indicates types of breastfeeding: exclusive breastfeeding (EBF) versus non-exclusive breastfeeding (Non-EBF), within the first six months of a child’s life. The EBF was considered only mothers breastfed and who did not provide any supplements for the first six months of their child's life, NOT even water. BDHS collects exclusive breastfeeding from mothers by recall method (NIPORT & Associates, 2014). EBF variable is coded as 1 if the child takes EBF, otherwise 0 (Non-EBF). During the survey, respondents were asked: whether the baby is still breastfeeding; Breastfeeding period; And if other solid or liquid foods were given during the last 24 h rather than Breastfeed.

**Potential confounding variables:**

In this study, for identifying mother’s characteristics, maternal age (15–19 years, 20–24 years, 24–29 years, 30–34 years, ≥35 years), division (Barisal, Chittagong, Dhaka, Khulna, Rajshahi, Rangpur, Sylhet), place of residence (rural, urban), current employment status (yes/no), maternal educational level (no education, primary, secondary, higher), fathers’ occupation (farmer, agriculture worker, businessman, others), religion(Islam, others), mass media access (yes/no), wealth status (richest, richer, middle, poorer, poorest), mother’s body mass index (BMI; underweight, normal, obese), number of household members (less equal five, greater than five) are assumed as possible confounding variables.

For identifying child’s characteristics, C-section (yes/no), place of delivery (home/health facility), Sex (male/female), Size of the children (at birth; (very large, large, average, very small, small) and Age of children (0-2 months, 3-6 months) are also assumed as possible confounding variables.

The BDHS 2014, assessed the mass media by asking respondents if they listened to the radio, watched television, or read newspapers or magazines at least once a week. From the frequency of access mass media, this variable is categorized— “Yes” if they reported they access mass media “at least once a week” and “No” if they not— were considered. MI was calculated as the ratio of weight in kilograms to height in meters squared and classified according to most widely used categories of BMI for adults (Benedict, Craig, Torlesse, & Stoltzfus, 2018b); these were: underweight (BMI ≤ 18.5 kg/m2), normal weight (18.5 < BMI < 25 kg/m2), overweight (25 ≤ BMI < 30 kg/m2) and obese (BMI ≥ 30 kg/m2).

***Bivariate analysis***

Descriptive statistics of each of the selected confounding variables and distribution of EBF were shown by adjusting the sampling weight. Bivariate analysis was performed using cross-tabulation and Pearson's chi-square statistical test.

***Regression analysis***

To estimate the crude (unadjusted) risk ratio (CRR) and adjusted risk ratios (ARRs) for evaluating the causal association between EBF and childhood diseases, first, we developed a Poisson model as the outcome variable was a count data. Most of the time, the Poisson model displayed substantial overdispersion for the Poisson models (Dean & Lawless, 1989). Thus, we checked the validity of the Poisson model that fitted the data well.

***Identifying Overdispersion***

The goodness of statistics determining whether regression methods such as Poisson and logistic are applicable are very essential. The Poisson model was considered good to fit the data if the deviance and Pearson Chi-square goodness of statistics, equal to one. Deviance and Pearson Chi-square goodness of statistics greater than one indicate model misspecification or an over-dispersed (the variance larger than its mean) response variable. If it less than one may also indicate model misspecification or an under-dispersed (the variance is less than its mean) in the response variable (Muschelli, Betz, & Varadhan, 2014). So, we checked the deviance and Pearson Chi-square goodness of statistics of the model then fit the data with a negative binomial (NB) regression model. Negative binomial (NB) regression accounts for overdispersion by adding dispersion (variance) parameter to the Poisson model. This model can accommodate increased variability (Lenth & Dobler, 2005).

***Test of Excess Zeros***

Another common extension of Poisson regression can address when the outcome variable has excess zeros (figure 2). Although capable of addressing overdispersion, In the present context, NB is not suitable for modeling data with a high percentage of zero counts. A zero-inflated Poisson regression may be applied to the model with such excess of zeros (Xia et al., 2012). ZIP regression models originated in the econometrics literature, but their use has expanded more widely since the publication of Lambert (Lambert, 1992). The zero-inflated Poisson (ZIP) model relates a logistic regression model with excess zeros by associating it with a traditional anomalous Poisson model (Weaver, Ravani, Oliver, Austin, & Quinn, 2015). There is a formal test statistic, the Vung test which statistically determines whether the zero-inflation model is a significant improvement over the Poisson model or the NB model. Thus, the Vuong test was taken to judge whether there were excessive zero counts for the ZIP regression than the Poisson model (Vuong, 1989). Finally, the zero-inflated negative binomial (ZINB) models can accommodate the excess zeros and overdispersion due to the inclusion of the logistic model and an NB model.

***Model assessment***

We used four models to assess the relative performance that fits our data for evaluating the causal association between EBF and childhood diseases with the best model. To find the best model, first, we used deviance and Pearson Chi-square goodness of statistics to examine whether the NB model provided a significantly better fit of the data than the Poisson model. A deviance and Pearson Chi-square goodness of statistics greater than 1 indicated that the data were over dispersed and that the NB model (or ZINB model) was preferred. Second, we used a Vuong test to compare Poisson and NB regression to check the outcome variable has excessive zero. A P-value of less than 0.05 indicates that the ZIP or ZINB regression model fits the data better. Third, we used -2\*Log-likelihood, AIC, AICc and BIC values to compare all models; the lowest value of AIC, AICc, BIC and the largest value of -2\*Log-likelihood indicates a better fit of the data after accounting for model complexity (i.e. the number of model parameters). Using the best model, we reviewed the variability of the results from the models.

In the crude model, only the Exclusive-breastfeeding was used and for the adjusted model, other confounding variables with Exclusive-breastfeeding were considered. All statistical analyses were performed by SAS and SPSS (IBM SPSS 25). In SAS, the survey analysis procedures command was used to allow for the adjustments of the cluster sampling design used in the BDHS 2014 and to estimate weighted frequency for all explanatory variables.

**RESULTS**

***Bivariate analysis***

Table 1 shows the frequency distribution of different confounding factors between exclusive and Non-EBF including p-value from the Chi-Square test. We selected 632 children age between 0 to 5 months and 44.7% belong to Non-EBF and 55.3% belong to EBF. We found that 58.15% of women belonging to the age group greater than 25 years, were more likely to give exclusive breastfeeding to their children. Khulna division had the highest exclusive breastfeeding babies among all other divisions, with a percentage of 70.79%. The lowest percentage was recorded for EBF in the Barisal division, 35.71%. If mothers’ educational level is higher 57.87% are keen to provide exclusive breastfeeding whereas primarily educated mothers 53.67% were lowest to provide exclusive breastfeeding. Comparing mothers’ currently working situation it can be said that 58.86% of working women and about 54.56% of women staying in the house are more interested to give her child exclusive breastfeeding. If the fathers’ occupation is an agricultural worker the highest rate of exclusive breastfeeding for the child and it is 70.38%. Calculating body mass index, it can be said that 48.54% of children are raised in underweight mother and they got the lowest exclusive breastfeeding according to obese and normal-weight mothers. If the family size is less than five then 57% of children are exclusively breastfed and 53.89% are non-exclusively breastfed if the family size is greater equal to five.

**Table 1: Chi-Square test for identifying maternal characteristics associate with exclusive breastfeeding among infant in Bangladesh**

|  |  |  |  |
| --- | --- | --- | --- |
| Characteristics | EBF (%) | Non-EBF (%) | P-Value\* |
| Number |  |  |  |
|  | 375 (55.30) | 257 (44.70) | - |
| Age | | |  |
| 15-19 | 107 (51.41) | 91 (48.59) | 0.542 |
| 20-24 | 120 (56.35) | 73 (43.65) |  |
| 25+ | 148 (58.15) | 93 (41.85) |  |
| Division | | |  |
| Barisal | 37 (35.71) | 52 (64.29) | 0.000 |
| Chittagong | 76 (62.55) | 50 (37.45) |  |
| Dhaka | 48 (41.97) | 56 (58.03) |  |
| Khulna | 47 (70.79) | 23 (29.21) |  |
| Rajshahi | 40 (56.33) | 31 (43.67) |  |
| Rangpur | 60 (70.12) | 16 (29.88) |  |
| Sylhet | 67 (69.74) | 29 (30.26) |  |
| Residence | | |  |
| Rural | 260 (55.71) | 168 (44.29) | 0.790 |
| Urban | 115 (54.08) | 89 (45.92) |  |
| Educational level | | |  |
| Higher | 67 (57.87) | 40 (42.13) | 0.955 |
| Secondary | 166 (55.35) | 110 (44.65) |  |
| Primary | 93 (53.67) | 72 (46.33) |  |
| No education | 49 (56.18) | 35 (43.82) |  |
| Current employment status | | |  |
| Yes | 59 (58.86) | 37 (41.14) | 0.535 |
| No | 316 (54.56) | 220 (45.44) |  |
| Father’s Occupation | | |  |
| Farmer | 46 (49.40) | 32 (50.60) | 0.389 |
| Agriculture Worker | 33 (70.38) | 18 (29.62) |  |
| Businessman | 80 (56.20) | 60 (43.80) |  |
| Others (Labor, Entrepreneur, Driver, etc.) | 216 (54.73) | 144 (45.27) |  |
| Religion | | |  |
| Islam | 342 (54.73) | 244 (45.27) | 0.438 |
| Others (Hinduism and Buddhism) | 33 (62.62) | 13 (37.38) |  |
| Mass Media (at least once in a week) | | |  |
| Yes | 237 (55.11) | 153 (44.89) | 0.923 |
| No | 138 (55.67) | 104 (44.43) |  |
| Wealth Status | | |  |
| Poorest | 67 (46.12) | 55 (53.88) | 0.083 |
| Poorer | 83 (68.81) | 47 (31.19) |  |
| Middle | 73 (52.50) | 48 (47.50) |  |
| Richer | 74 (57.80) | 46 (42.20) |  |
| Richest | 78 (53.38) | 61 (46.62) |  |
| Body Mass Index | | |  |
| Obese | 80 (57.49) | 50 (42.51) | 0.383 |
| Normal weight | 231 (57.16) | 148 (42.84) |  |
| Under weight | 63 (48.54) | 58 (51.46) |  |
| Household members | | |  |
| ≤ 5 | 164 (57.00) | 113 (43.00) | 0.509 |
| > 5 | 211 (53.89) | 144 (46.11) |  |

\*p-value obtained from chi-square test of contingency table

Data are in (weighted %).

Absolute number of participants does not perfectly correspond to percentages presented because weighted analyses were used.

Table 2 represents the percentage distribution of the child’s characteristics by type of Exclusive-Breastfeeding. Among 632 children it can be shown that 54.91% child born by C-section delivery and they get EBF and about 45.09% Non-EBF. On the other hand, the highest prevalence of EBF was 55.42% are the more fortunate and lowest prevalence of EBF were 44.58% are unfortunate to get EBF if they are born by vaginal delivery rather than home. There shows no difference between child sex, EBF in the female child was 55.53% and 55.10% was in males. On another side, 58.57% of children were EBF and 41.43% of children are Non-EBF having a large size at birth. It is the lowest (48.81%) in a child whose births very small in size. As expected, as age increases EBF was decreasing in a significant rate, 80.33% of children in our country are of 0-1 months are exclusively breastfed somewhere it can be shown that 61.83% of children having 2-3 months age are exclusively breastfed and this percentage (31.74) is lowest in higher age group 4-5 months of child.

**Table 2: Chi-Square test for identifying child’s characteristics associate with exclusive breastfeeding among infant in Bangladesh**

|  |  |  |  |
| --- | --- | --- | --- |
| Characteristics | EBF (%) | Non-EBF (%) | P-Value\* |
| Number |  |  |  |
|  | 375 (55.30) | 257 (44.70) | - |
| C-section | | |  |
| Yes | 102 (54.91) | 76 (45.09) | 0.934 |
| No | 273 (55.42) | 181 (44.58) |  |
| Children’s sex | | |  |
| Female | 174 (55.53) | 116 (44.47) | 0.925 |
| Male | 201 (55.10) | 141 (44.90) |  |
| Size of child (at birth) | | |  |
| Very large | 4 (53.71) | 2 (46.29) | 0.875 |
| Large | 39 (58.57) | 27 (41.43) |  |
| Average | 260 (56.40) | 170 (43.60) |  |
| Small | 44 (50.84) | 42 (49.16) |  |
| Very small | 28 (48.81) | 16 (51.19) |  |
| Age of child (in months) | | |  |
| 4-5 | 83 (31.74) | 147 (68.26) | 0.000 |
| 2-3 | 144 (61.83) | 79 (38.17) |  |
| 0-1 | 148 (80.33) | 31 (19.67) |  |

\*p-value obtained from chi-square test of contingency table

Data are in (weighted %).

Absolute number of participants does not perfectly correspond to percentages presented because weighted analyses were used.

***Identifying Overdispersion***

In PR analysis, the mean number of diseases was 0.89 and the variance was 1.55. The variance was greater than the mean. Furthermore, the Deviance and Chi-square were 1.80 and 1.77, respectively. The goodness of statistics was larger than 1 shows that the number of diseases was over-dispersed in the data set and a Negative Binomial model would be appropriate.

***Test of Excess Zeros***

We tested for excess zeros by comparing the Poisson and NB models to the ZIP and ZINB models, respectively, using the Vuong test. The test statistics, Z = -7.56, and the P-value was <0.001 for ZIP versus Poisson and Z = -5.49, and the P-value was <0.001 for ZINB versus NB, which suggested that there were too many zero counts to be accounted for with Poisson regression and traditional negative binomial distribution and also show that both ZIP and ZINB provide a better fit than their one-component counterparts.

***Model assessment***

Table 3 demonstrates the fitting goodness of four regression models (PR, NB, ZIP, and ZINB). The model with the smallest Log-likelihood, AIC, AICc, and BIC was ZINB regression among the four models considered. ZINB model had the largest log-likelihood and the smallest AIC and BIC, suggesting the best goodness of fit. Therefore, the ZINB model shown in Table 1 with bold letters was chosen as the best model and the Poisson regression model fitted the data worst.

**Table 3: Model selection criteria for PR, NB, ZIP and ZINB**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Model | -2 (Log-likelihood) | AIC | AICc | BIC |
| PR | 1264.08 | 1870.50 | 1870.52 | 1879.40 |
| NB | 1116.32 | 1659.14 | 1659.17 | 1672.48 |
| ZIP | 1078.36 | 1686.79 | 1686.82 | 1700.13 |
| ZINB | **1590.16** | **1598.15** | **1598.22** | **1615.95** |



As ZINB was the best model, we used this model to estimate the crude (unadjusted) risk ratio (CRR) and adjusted risk ratios (ARRs) for evaluating the causal association between EBF and childhood diseases. Table 4 shows the crude risk ratio (CRR) for developing diseases. Here we found that the EBF was significantly associated the childhood diseases (CRR 1.24; 95% CI 1.01-1.57).

**Table 4: Influence of EBF on the early childhood diseases**

|  |  |  |  |
| --- | --- | --- | --- |
|  | Zero-inflated Negative Binomial Regression | | |
|  | **CRR** | **95% CI** | **P-value** |
| EBF | | | |
| No | 1.24 | [1.01,1.57] | 0.045 |
| Yes | Ref. | - | - |



Table 5 shows the association between EBF and early childhood diseases when models adjusted for possible confounding factors. For instance, after adjusting all other factors Non-EBF babies were 1.27 times (ARR 1.27, 95% CI 1.01–1.60) more likely to be affected by diseases. The risk of the children getting affected by diseases whose mothers aged between 15-19 years and 25-24 years were 1.10 (ARR 1.10, 95% CI: 0.85-1.42) more likely and 0.95 (ARR 0.95, 95% CI: 0.73-1.22) less likely than those aged above years. Mother’s education has also been found as an important factor for childhood diseases. It shows that children belonging to mothers who completed higher education was less risk of childhood diseases than the children of uneducated mothers. That is, they were 35% less likely to suffer from it with a risk ratio of 0.65 times (ARR 0.65, 95% CI: 0.41-1.03). It is worthwhile to mention that children of the mother with technologically advanced were 0.33% less likely (ARR 0.77, 95% CI 0.59-1.01) to having diseases compared to the children who raise in technologically lagging behind mothers. The results also show that the risk of diseases for the children of the poorest household was 1.38 times (ARR: 1.38, 95% CI: 0.88-2.16) more likely than those who have a family with richest wealth status. The results also show that the risk of diseases for the children of the overweight mother were 1.53 times (ARR: 1.53, 95% CI: 1.16-2.01) more likely than those who are normal weight.

Children living in households where household members less equal five were 6% less likely to develop the disease with a Risk ratio of 0.94 (ARR 0.94, 95% CI: 0.76-1.17) as compared to those children living in the family whose household members were greater than five. The results also show that the risk of diseases for the children delivered by C-section was 1.03 times (ARR: 1.03, 95% CI: 0.80-1.32) more likely than those who not delivered by C-section. Female children have a 9% (ARR 0.91, 95% CI 0.74-1.12) lower chance to have diseases compared to the male children, similarly, the risk of having diseases is 1.97 times (ARR 1.97, 95% CI: 1.42-2.74) more likely for 4-5 months of the child compared to 0-1 months of the child.

**Table 5: Association between EBF and childhood diseases 0-6 months aged children in Bangladesh when possible confounding variables adjusted to the models**

|  |  |  |  |
| --- | --- | --- | --- |
|  | Zero-inflated Negative Binomial Regression | | |
|  | **ARR** | **95% CI** | **P-value** |
| EBF | | | |
| No | 1.27 | [1.01,1.60] | 0.037 |
| Yes | Ref. | - | - |
| Maternal age | | | |
| 15-19 | 1.10 | [0.85,1.42] | 0.483 |
| 20-24 | 0.95 | [0.73,1.22] | 0.671 |
| 25+ | Ref. | - | - |
| Division | | | |
| Barisal | 0.58 | [0.37,0.90] | 0.016 |
| Chittagong | 0.99 | [0.71,1.40] | 0.971 |
| Dhaka | 0.79 | [0.54,1.15] | 0.219 |
| Khulna | 0.71 | [0.46,1.10] | 0.122 |
| Rajshahi | 0.69 | [0.44,1.09] | 0.112 |
| Rangpur | 0.80 | [0.54,1.19] | 0.274 |
| Sylhet | Ref. | - | - |
| Residence | | | |
| Rural | 0.99 | [0.77,1.27] | 0.949 |
| Urban | Ref. | - | - |
| Educational level | | | |
| Higher | 0.65 | [0.41,1.03] | 0.069 |
| Secondary | 0.88 | [0.61,1.26] | 0.489 |
| Primary | 0.93 | [0.65,1.34] | 0.714 |
| No education | Ref. | - | - |
| Current employment status | | | |
| Yes | 1.02 | [0.75,1.38] | 0.906 |
| No | Ref. | - | - |
| Fathers’ occupation | | | |
| Farmer | 1.00 | [0.72,1.41] | 0.981 |
| Agriculture Worker | 0.88 | [0.59,1.31] | 0.530 |
| Businessman | 0.81 | [0.62,1.07] | 0.137 |
| Others (Labor, Driver, Entrepreneur, etc.) | Ref. | - | - |
| Religion |  |  |  |
| Islam | 1.39 | [0.86-2.18] | 0.145 |
| Others | Ref. | - |  |
| Mass media (at least once in a week) | | | |
| Yes | 0.77 | [0.59,1.01] | 0.062 |
| No | Ref. | - | - |
| Wealth status | | | |
| Poorest | 1.38 | [0.88,2.16] | 0.164 |
| Poorer | 1.26 | [0.83,1.90] | 0.273 |
| Middle | 1.26 | [0.87,1.83] | 0.216 |
| Richer | 1.10 | [0.64,1.37] | 0.542 |
| Richest | Ref. | - |  |
| Body mass index | | | |
| Over weight | 1.53 | [1.16,2.01] | 0.003 |
| Under weight | 1.07 | [0.74,1.55] | 0.724 |
| Normal weight | Ref. | - |  |
| Household members | | | |
| ≤ 5 | 0.94 | [0.76,1.17] | 0.591 |
| > 5 | Ref. | - |  |
| C-section | | | |
| Yes | 1.03 | [0.80,1.32] | 0.804 |
| No | Ref. | - |  |
| Sex of child | | | |
| Female | 0.91 | [0.74,1.12] | 0.368 |
| Male | Ref. | - |  |
| Size of child (at birth) | | | |
| Very large | 0.93 | [0.62,1.41] | 0.743 |
| Large | 0.85 | [0.51,1.41] | 0.523 |
| Average | 0.79 | [0.22,2.80] | 0.717 |
| Small | 0.96 | [0.61,1.52] | 0.872 |
| Very small | Ref. | - |  |
| Age of child (months) | | | |
| 4-5 | 1.97 | [1.42,2.74] | 0.000 |
| 2-3 | 1.69 | [1.20,2.37] | 0.003 |
| 0-1 | Ref. | - |  |

**Discussion:**

Based on the study, greater than five out of every ten newborns has exclusively breastfed, approximately similar result was observed in a previous cross-sectional study was conducted in Popular Medical College, Dhanmondi, Dhaka, were found that the exclusive breastfeeding was exactly half of their sample (Chowdhury, Yasmeen, & Rahman, 2018). This finding is comparable with studies done in Chittagong, Bangladesh (61.4%) (Mihrshahi et al., 2008), Pakistan (38%) (Noh et al., 2019) and India (56.0%) (Nishimura et al., 2018).

Once he/she was born, a symbolic procedure was done with the baby, and people strongly believe that only breast milk is not enough for growth without giving porridge. Common reasons for starting a supplemental diet were inadequate breast milk, and mothers' perceptions that the child was thirsty, given to women, were observed in different settings. The result of the bivariate analysis showed that exclusive breastfeeding practice was associated with division, age of child and childhood diseases. In this study of mother-infant pairs from an urban region of Bangladesh, more than half of the mothers exclusive breastfed to their child, which is similar to the national rate of 55.0% represented by the global population (NIPORT & Associates, 2014). The variations persisting in EBF rate in different regions worldwide might be due to cultural, economic and socio-demographic differences across areas.

Mothers over 25 years of age had higher EBF practice. However, maternal age was not significantly associated with EBF as was also found in other studies. These studies were similar to other studies that proved that maternal age was not related to EBF practice (Jones, Kogan, Singh, Dee, & Grummer-Strawn, 2011). The study found that EBF practice is less in C-section delivery compared to a child who had not delivered by C-section, and this type of delivery impacted early initiation of breastfeeding, colostrum administration, and exclusive breastfeeding. In addition, mothers who delivered by C-section qualitatively explained their inability to feed early-stage infants due to ignorance, illness, pain, and post-surgical treatment of prescription drugs and delayed or inadequate milk production. An analysis conducted in the Dhaka slum area showed that cesarean delivery was one of the risk factors for delayed breastfeeding. (Khatun et al., 2018).

This study found that childhood diseases were significantly associated with EBF, division, mother’s education level, father’s occupation, mother’s age, mother’s BMI, mode of delivery, child’s gender and age of the child. This study has shown that infants of Bangladesh who were exclusively breastfed for six months had a significantly lower chance of diseases than infants who were not exclusively breastfed. After adjusting several confounders this effect was significant and remained high. In a recent study with data from India, Peru and Ghana showed that non-exclusive breastfed infants were substantially higher risk of getting diseases and dying compared with those who had been exclusively breastfed, with the most common causes being diarrhea, ARI (Bahl et al., 2005).

Not surprisingly, this analysis showed that children were more likely to have diseases whose mothers were older. The reason for these findings is easily explained. Most mothers usually continued exclusive breastfeeding up to six months but with the increasing of infant age, they give other food rather than breastfeed which increases the risk to get diseases. This provides evidence that not only breastfeeding but also the short duration of breastfeeding provides some protection against childhood diseases. These findings are in line with a study conducted by Bowatte et al., (2015) on infants’ acute otitis media (AOM) which showed that the majority of the infants who were less given exclusive breastfeeding have a higher risk to getting that diseases. Infants with higher educated mothers will less likely to get childhood diseases compared to mothers with lower educational attainment or no education. This might happen as educated mothers understand and be better informed of the benefits of EBF thus delay the introduction of other feeds. This study clearly showed that mothers with higher levels of education were more likely to practice EBF compared to lower education levels. This was similar to a study conducted in Ibadan, southwestern Nigeria (Lawoyin, Olawuyi, & Onadeko, 2001).

Mode of delivery also had a strong influence on childhood diseases. Delivery by cesarean section was associated with more diseases. It will not be related to the limited co-morbidities associated with such a procedure. These mothers usually take a long time to recover from anesthesia before thinking about the recommended infant feeding practice. Also, increased maternal stress after operative delivery may delay the onset time for lactation (Sakha & Behbahan, 2005).

Interestingly, this study observed that women in the poorest, poor, middle wealth status were more likely associated with childhood diseases than the richest. Infants who lived with the poorest mothers will more likely to get childhood diseases compared to mothers who lived in the richest family. This may be related to the knowledge of breastfeeding practices. This poorest mother is also more likely to engage for household work thereby hampering to some extent the preconditions for EBF practice. As a result, their infant has more likely to risk to get diseases.

They may need better education on the ability of breastfeeding while they are at work or away. Poverty and rural women were cited EBF by many respondents. Many respondents in poverty and rural women identified as some of the impediments against EBF. Previous studies have shown that breastfeeding affects by wealth index or income of the household (Muchacha & Mtetwa, 2015). Mothers who worked after pregnancy in the time of infants’ EBF period have a higher chance to held diseases, this may occur because after giving birth for working, they didn’t get the opportunity to stay at home and compromising exclusive breastfeeding. Our findings are supported by other studies which revealed that mother’s occupation was negatively associated with EBF; thus, they may be busy with work and spend less time at home (Khoury, Moazzem, Jarjoura, Carothers, & Hinton, 2005).

The study has several strengths. The nationally representative data used in this study was collected from different levels of Bangladesh. This data set is collected through a reliable and uniform procedure, which provide an important source of information on infant feeding practices and infant diseases with minimize the measurement error and bias. The response rates of this study were high. One of the strengths of the present study was to remove this clustering effect to attain accurate risk factors by considering the effect of cluster variation. It is also ensuring that the standard errors of coefficients have been accurately estimated. We used Zero-inflated negative binomial regression for analyzing the data.

**Conclusions and Recommendations**

The best starter to an infant’s life is breastfeeding. It safeguards appropriate nutrition for the baby and ensures development. Profits of breastfeeding in terms of infant nutrition, immunity, and maternal welfare are emphasized in breastfeeding counseling. This study reveals that there is an association between EBF and children's healthy development. Common childhood infectious diseases can do rare harm in infants’ bodies because of EBF other than infants who are not-EBF. So, to ensure better health for 0-6-month infants there is no alternative of EBF. Children from six to 12 months of age veteran frequent episodes of child diseases and hospitalization than children under six months of age. EBF infant offered a lower prevalence of severe childhood diseases than the non-EBF. Mother's concentration, Family’s cooperation can play a vital role to create an atmosphere for EBF.

So, it is recommended that steps should be taken to improve the existing situation. It is so crucial that EBF has to be promoted a lot to reduce infant diseases. For this realization, the Federal Ministry of Health and Family Welfare of Bangladesh, local and international NGOs working on health areas, and health institutions should play their role to enhance exclusive breastfeeding practice of mothers with training during antenatal and postnatal visits for women. Health personnel who are working in the clinics should advise mothers to have a spontaneous vaginal delivery and should not insist on performing C-Section delivery unless and otherwise medically justified. It is high time to create a facility for breastfeeding in the workplace and to take steps for the uniform duration of maternity leave (6months) all over the country.

**Limitations**

Bangladesh Demographic and Health Survey (BDHS) is the nationally representative household survey of Bangladesh. However, 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. Due to financial and time constraints, the paper could not add primary data in supporting the BDHS data. The definition of EBF used here according to the 24 h-recall periods is subject to bias and misreporting. We are also aware of the risk of recall bias considering the nature of some questions which may not be recorded in any document. Although EBF was statistically significant, most other factors were not for infant diseases. The problem of reverse causality may be a limitation to this study. For example, if mothers tended to breastfeed exclusively because the child was ill, the effect of exclusive breastfeeding on an illness would have been underestimated. Conversely, if mothers stopped breastfeeding as a result of illness this would have biased the results towards an overestimation of an effect.

**Supporting information**

**S1 Table: Unadjusted LR statistics for type 3 analysis**

|  |  |  |
| --- | --- | --- |
|  | Zero-inflated Negative Binomial Regression | |
| Source | **Chi-Square** | **P-value** |
| EBF | 5.45 | 0.020 |

**S2 Table: Adjusted LR Statistics for Type 3 Analysis**

|  |  |  |
| --- | --- | --- |
|  | Zero-inflated Negative Binomial Regression | |
| Covariates | **Chi-Square** | **P-value** |
| EBF | 4.37 | 0.037 |
| Mother’s Age | 1.39 | 0.499 |
| Division | 9.83 | 0.132 |
| Residence | 0.00 | 1.000 |
| Mother’s Education | 4.02 | 0.259 |
| Mothers’ Currently Working | 0.02 | 0.896 |
| Fathers’ Occupation | 2.59 | 0.460 |
| Mass Media (in week) | 3.38 | 0.066 |
| Wealth Status | 5.84 | 0.212 |
| Mother’s BMI | 13.24 | 0.001 |
| Household members | 0.29 | 0.589 |
| C-Section | 0.07 | 0.798 |
| Child’s Sex | 0.79 | 0.375 |
| Size of child (at birth) | 0.57 | 0.966 |
| Age of child (months) | 15.72 | 0.000 |
| Religion | 2.20 | 0.138 |

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