**Title: Determinants of low birth weight and its effect on childhood health and nutritional outcomes in Bangladesh: Do home environmental factors matter?**

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**ABSTRACT**

**Background:** The high incidence of low birth weight (LBW) is associated with an increased risk of infant mortality, adverse pregnancy outcomes for mothers, and a decline in overall health and well-being. The current study aimed to identify the various determinants of LBW and its effect on adverse health and nutritional outcomes of children aged 0-23 months in Bangladesh.

**Methods:** Bangladesh Demography and Health Survey (BDHS) 2017-18 data was used. A chi-square test and multivariable logistic regression analysis were used to find out the associations between independent variables and outcomes (e.g., LBW, child illness and undernutrition).

**Results:** The overall prevalence of LBW among was 16.3%. Mother with no formal education (AOR=2.64, 95% CI= 0.55-3.30, p= 0.01), female child (AOR=1.31, 95% CI= 1.04-1.65, p=0.023); and poorest economic status (AOR= 1.69, 95% CI= 1.13-2.51, p=0.010), were identified significant determinants of LBW. In addition, children born with LBW were more likely to suffer fever (AOR=1.26, 95% CI= 1.05-1.60, p= 0.050), stunting (AOR=2.42, 95% CI= 1.86-3.15, p= <0.001), wasting (AOR=1.47, 95% CI= 1.02-2.25 p= 0.049), and underweight (AOR=3.19, 95% CI= 2.40-4.23, p= <0.001). Of home environmental factors, unimproved toilet facilities (AOR= 1.26, 95% CI= 1.02-1.63, p= 0.049) had a significant effect on LBW.

**Conclusion:**One out of five children was LBW in Bangladesh. Maternal education, sex of child, wealth index, and toilet facilities had significant effects on LBW. In addition, LWB contributed to children’s poor health and nutritional outcomes. To improve maternal, pregnancy, and child health outcomes, it is crucial to implement policies that tackle poverty, gender inequality, and social disparities. Women should be empowered to make informed choices regarding their reproductive health. Encouraging regular antenatal care visits and early medical intervention is essential, as is promoting education and awareness about reproductive health, hygiene and safe sanitation practices.

**KEYWORDS:** Low birth weight, child health, undernutrition, environmental factors, Bangladesh.

**Background**

Low birth weight (LBW) of children poses a serious public health problem in low- and middle-income countries [1]. Early childhood is a critical window for children’s physical and mental development and LBW contributes as a leading cause of illness and death among children during this period [2]. Two physiological conditions among others, Intrauterine Growth Restriction and/or preterm birth during pregnancy can basically lead to children’s born with LBW [3]. LBW is responsible for 60-80% of the total mortality in children under one month of age and one-third of total deaths among children aged less than one year [4, 5]. Further, the likelihood of infant mortality is 40 times higher among LBW children compared to normal children [4]. Apart from mortality, it hinders normal growth and raises the risk of developing chronic illnesses, such as ischemic heart disease, diabetes, dementia, osteoarthritis, stroke, and hypertension, later in life [6-8]. LBW also increases the chances of developing behavioral and psychological disorders, as well as sensory and learning disabilities [9, 10]. Furthermore, compared to normal infants, those who are born with LBW are at a greater risk of experiencing prolonged and intense infections, such as diarrhea and acute respiratory infection (ARI), which are the leading causes of child mortality [6].

Approximately 30 million children (which is equivalent to 23.4% of all births) each year globally are born with LBW which could lead to various short-term and long-term adverse health and nutritional outcomes [7]. The prevalence of LBW is considerably higher in low- and middle-income countries, with the estimation of South Asia (28%) and Sub-Saharan Africa (13%) was being most affected regions. This highlights the existing health inequalities between different parts of the world [11, 12]. In 2022, the prevalence of LBW in Bangladesh was recorded at 14.5%, indicating a decline from the 20% rate observed in 2012 [2, 9].

Despite substantial efforts were made to uncover the etiology of LBW in several research, yet the etiology of LBW is not well understood [13, 14]. Previous studies stated that LBW was determined by the complex interplay of several factors including biological, maternal, socio-demographic, socio-economic, environmental, and obstetric factors [2, 4, 5, 12-21]. Some previous studies in Bangladesh showed that maternal, child and contextual characteristics were significantly associated with LBW. Additionally, a previous study conducted in Bangladesh identified that LBW was a significant factor in the likelihood of stunting and being underweight among under-five children [22, 23]. Most of those studies that previous carried out considered maternal perceptions of baby size at birth as proxy indicator for birth weight. However, the current understanding of the determinants of LBW and its association with adverse health and nutritional outcomes has not been adequately studied using estimated weight of birth from more recent nationally representative sample of Bangladesh. Moreover, environmental factors other than household air pollution have not been broadly studied as potential risk factors for LBW in Bangladesh [24]. Hence, the current study aimed to identify various determinants, related to maternal factors, children characteristics, contextual factors and home environmental factors, of LBW and their effect on adverse health and nutritional outcomes of children months using a nationally representative cross-sectional survey.

**Methods**

**Data and sampling**

A cross sectional nationally representative data from Bangladesh Demography and Health Survey (BDHS) 2017-2018 was used in this study. Demographic Health Survey (DHS) covers information regarding demographic and social factors as well as health and nutritional indicators for adults (both male and female) and children to monitor a wide range of the population. The BDHS 2017-18 was a multistage sampling. In the first stage, 675 primary sampling units (PSUs) were selected of which 250 PSUs were from urban and 425 PSUs were from rural areas. The PSUs were based on enumeration areas (clusters) listed in the population census 2011 conducted by the Bangladesh Bureau of Statistics. The second stage involved selecting an average of 30 households from each PSU using an equal probability systematic sampling technique. The multistage sampling and corresponding sampling weight might help to reduce potential sampling bias. In addition, all ever-married women aged 15–49 years (with or without children aged less than 5 years) from the preselected households were interviewed without replacement and change in the implementing stage to prevent selection bias. A total of 20,127 women aged 15-49 years were interviewed from 19,457 households with a response rate of 99% [25]. In BDHS 2017-18, a total of 8,759 children under-five were listed and birth weight was able to collect from a written record for 2,408 children age 0-23 months of age (see Additional file: Table S1).

**Outcome variables**

LBW, the child’s adverse health (e.g., fever, cough, acute respiratory infection (ARI), diarrhea), and child’s nutritional status (e.g., stunting, wasting and underweight) were considered outcome variables in this study. All outcome variables were coded as binary (1 for yes and 0 for no).

LBW: Child’s birth weight below 2.5 kilograms regardless of gestational age was considered LBW. If the child’s birth weight less than 2.5 kilograms coded as 1, otherwise coded as 0 [25].

Child’s adverse health outcomes:

Fever: Children who had a fever prior two weeks before the survey and received advice or treatment from health facilities or qualified health providers was categorized as 1; otherwise categorized as 0 [25].

Cough: Children who had a cough prior two weeks of the survey and received advice or treatment from health facilities or qualified health providers was categorized as 1; otherwise categorized as 0 [25].

ARI: Children had symptoms of ARI (short, rapid breathing which was chest-related, and/or difficult breathing which was chest-related) in the 2 weeks preceding the survey and received advice or treatment from health facilities or qualified health providers was categorized as 1; otherwise categorized as 0 [25].

Diarrhea: Children who had diarrhea in the 2 weeks preceding the survey and received oral rehydration solution (ORS), and advice or treatment from health facilities or qualified health providers was categorized as 1; otherwise categorized as 0 [25].

Had at least one illness: Children who had at least one of the conditions among fever, cough, ARI, and diarrhea in the 2 weeks preceding the survey was considered having at least one illness and categorized as 1; otherwise categorized as 0.

Child’s nutritional status:

Stunting: A child was considered to be stunted (short stature for age), if the height-for-age, index was 2 standard deviations or more below the respective median of the World Health Organization reference population and was categorized as 1; otherwise categorized as 0 [26].

Wasting: A child was considered wasted (perilously thin) if the weight-for-height index was 2 standard deviations or more below the respective median of the World Health Organization reference population and was categorized as 1; otherwise categorized as 0 [26].

Underweight: A child was considered to be underweight (low weight for age) if the weight-for-age index was 2 standard deviations or more below the respective median of the World Health Organization reference population and was categorized as 1; otherwise categorized as 0 [26].

At least one undernutrition condition: Children who had at least one of the conditions among stunting, wasting, and/or underweight were considered having at least one undernutrition condition and was categorized as 1; otherwise categorized as 0.

**Independent variables**

Various maternal and child characteristics and contextual and environmental factors found significant in previous literature and/or available in BDHS 2017-18 dataset were used as independent variables in this study [2, 4, 5, 12-20]. Maternal factors included mother’s age in years (15-19, 20-24, 25-29, 30-34, 35 and above); parents’ educational status (both parents were uneducated, only father was uneducated, only mother was uneducated, both parents were educated); mother currently working (no, yes); underweight mother (no, yes); mothers’ decision-making autonomy (not practiced, practiced); mother’s attitudes towards violence (not justified, justified); mothers received antenatal care (ANC) (no, yes); the number of living children (≤ 2, ≥ 3); age at first sex in years (<15, 15-24, 25-34); wanted last child (wanted then, wanted later, wanted no more); ever had terminated pregnancy (no, yes); last birth with a caesarean section (no, yes); and a sign of pregnancy complication (no, yes). Sex of child (male, female) was listed as child characteristics. Contextual factors included mass media exposure (no, yes); wealth index (poorest, poorer, middle, richer, richest), and place of residence (urban, rural). Home environmental factors were types of drinking water (improved, unimproved); type of toilet facility (improved, unimproved); solid waste used for cooking (nonsolid, solid); main floor material (improved, unimproved); main wall material (improved, unimproved) and main roof materials (improved, unimproved) (see Additional file: Table S1).

**Statistical analysis**

Descriptive statistics were used to evaluate the background characteristics of the respondents. A Chi-square test was used to find out the association between outcome and independent variables. The statistical significance was set at p < 0.25 (two-tailed), rather than the typical cut-off point of 0.05, which may aid to include the factors that are considered to be important [27]. Multivariable logistic regression analyses were used to find out the effects of independent variables on outcome measures. Factors found significant in the Chi-square test were simultaneously entered into the Multivariable logistic regression model. The magnitude of the association was assessed using adjusted odds ratio (AOR) and confidence interval (CI) in multivariable logistic regression. The significance level for multivariable logistic regression analyses was set at p < 0.05 (two-tailed). Stata version 14.2 (StataCorp LP, College Station, Texas) was used for all analyses. To adjust the complex nature of the sampling, such as, sampling weight, cluster, and strata; the Stata command 'svyset' was prepared and used.

**Results**

**Background characteristics**

More than one-third (36.6%) of all mothers belong to the age group 20-24 years. Only 2.9% of mothers of children were uneducated (only mother 1.6% and both parents 1.3%). Approximately one out of ten mothers (12.1%) were underweight, and 98% of mothers received antenatal care. About two-thirds (65.5%) of the total mothers were rural dwellers, and only 10.9% were from the poorest section the society. Around 38.1% of children living in households had unimproved toilet facilities and 59.2% of children in households used solid waste for cooking. The detailed background characteristics are presented elsewhere (see Table 1).

According to Figure 1, around 15.7% and 6.7% of children aged 0-23 months suffered from ARI and diarrhea respectively. More than half of the children (51.5%) had at least one illness among fever, cough, ARI and Diarrhea. Around 24.1% of children had stunting, 7.9% had wasting and 15.2% were underweight. Around 29.8% of children had at least one under-nutritional condition (see Figure 1).

**Prevalence and determinants of LBW**

The prevalence of LBW was significantly higher among children of mothers with no formal education (fathers were educated) (41.5%), children from the poorest socioeconomic status (22.4%), mothers who had more than 3 living children (18.8%), wanted child later (19.8%), and children were born by normal delivery (18.6%) (Table 1).

From regression analysis results, mothers with no formal education (fathers were educated), female children, and children from the poorest socio-economic status had significant effect on the LBW. Children were 2.64 times (AOR = 2.64, 95% CI = 0.55-3.30, p = 0.010) more likely to born with LBW among mothers with no formal education than educated mothers. Female children had 1.3 times (AOR = 1.31, 95% CI = 1.04-1.65, p = 0.023) higher chances of being LBW than their counterparts. Children from the poorest socioeconomic background (AOR = 1.69, 95% CI = 1.13-2.51, p = 0.010) were more likely to born LBW than the children from the richest socio-economic status (Table 2). The unadjusted regression models were presented in Table S2 (see Additional file: Table S2).

**Effects of LBW on adverse health and nutritional status**

The prevalence of LBW was significantly higher among children who had at least one under-nutritional condition (48.1%), had stunting (40%), being underweight (30.4%), and wasting (10.7%) (see Table 2).

Furthermore, LBW had significant effect on children who had a fever, with stunting, wasting, being underweight and with at least one under-nutritional condition (see Table 2). Children who were LBW had 1.26 times (AOR = 1.26, 95% CI = 1.02-1.60, p = 0.047) higher chance of getting fever than a normal child. Children born with LBW were 2.4 times (AOR = 2.42, 95% CI = 1.86-3.15, p <0.001); 3 times (AOR = 3.19, 95% CI = 2.40-4.23, p <0.001) and 1.49 times (AOR = 1.49, 95% CI = 1.02-2.25, p = 0.049) respectively, more likely of being stunted, wasted and underweight than normal children. Similarly, LBW had a significant effect on children with at least one undernutrition condition (AOR = 2.39, 95% CI = 1.83-3.03, p <0.001) (see Table 3). The unadjusted regression models were presented in Table S3 (see Additional file: Table S3).

**Association between home environmental factors and LBW**

The prevalence of LBW was significantly higher in household with unimproved toilet facilities (18.3%). Similarly, the likelihood of being LBW at birth was 1.26 times (AOR = 1.26, 95% CI = 1.02-1.63, p = 0.049) higher among children living in household with unimproved toilet facilities (see Table 4). The unadjusted regression models were presented in Table S4 (see Additional file: Table S4).

**Discussion**

The current study extensively assessed determinants of LBW and determined its effect on health and nutritional outcome of children using a nationally represented sample in Bangladesh. This study found that the overall prevalence of LBW in Bangladesh was 16.3%, as compared to some neighboring countries, such as 16.4% in India and 16.9% in Pakistan [10, 14, 28, 29]. The prevalence of LBW was slightly lower in Nepal, and Sri Lanka which accounted for 15.4%, and 14.6%, respectively [14, 30]. Countries in South Asia exhibited comparable patterns of prevalence for LBW; it is perhaps due to similarities between countries in terms of geography, culture, economy, and quality of life [31].

The study showed that the likelihood of being LBW was higher among children of mothers with no formal education and children from the poorest socio-economic status. Additionally, children of mothers with no formal education, being a female child and children from the poorest socio-economic status were more likely of being LBW. Findings of the present study were consistent with previous studies [5, 10, 14, 19, 32]. Mothers who belonged to poor socio-economic background may also lack an educational profile, often experience difficulties in accessing nutrition and health care, which can result in inadequate maternal nutrition during pregnancy leading to maternal undernutrition and consequently LBW [13, 33]. Lack of education can also limit access to prenatal care, which might hinder the mother's ability to receive proper medical care [21, 34]. Although Bangladesh has gained substantial improvement in female education over the past few decades, unfortunately approximately 36% of females still remain illiterate [35]. Female dropout rates were very high including 13.3% in primary and 40.29% in secondary school level [36]. The government of Bangladesh has taken initiatives such as stipends, allowances, and free education facilities to reduce the female dropout rate at school. Still, it needs to strengthen administrative coordination, establish a monitoring and evaluation framework, and increase multidimensional investment in education to improve female education and consequently health status. Furthermore, no preference for female children is often responsible for poor ANC visits and inadequate nutritional practice among mothers during pregnancy results in adverse birth outcome like LBW [37]. Despite substantial progress in primary health care over the last decades, only 47% of pregnant women in Bangladesh receive at least four ANC visits [38]. A lack of access to health providers and facilities has contributed to nearly one in two mothers in Bangladesh not receiving four or more ANC visits from skilled health professionals [39]. In addition, gender inequality, cultural and religious behavior and restrictions among women; illiteracy and poverty are often considered the preference of male child as well as poor ANC visit in Bangladesh [40]. Improving access to quality ANC and sustaining its implementation must be prioritized for the country to achieve better health sustainability.

The study also revealed that the children with LBW were more likely to suffer from fever and undernutrition than normal children. Previous studies based on data from Bangladesh showed that LBW was identified as an important risk factor for various forms of undernutrition [22, 23]. Several neighboring countries like India, and Pakistan found comparable results [41, 42]. Another study in Africa (Malawi) also found higher odds of stunting, wasting, and being underweight among LBW children [43]. LBW infants often had difficulties in feeding due to underdeveloped digestive systems or a weak sucking reflex, which can lead to inadequate intake of nutrients [41, 44]. Moreover, LBW infants may have higher metabolic rates, which means they require more energy and nutrients per kilogram of body weight than a normal infant and this supply-demand imbalance leads to undernourishment [45]. The children of LBW had lower immune substances and improper formation of the respiratory tract which lead to various infectious diseases like pneumonia and often suffer from fever, and cough [46, 47]. LBW children and their mothers need adequate parenteral care and nutritional education including regular checkup and nutritional counselling, initiation of early and exclusive breast feeding, and nutrient-dense complementary foods to reduce the incidence of child morbidity and undernutrition in children born with LBW.

The odds of being LBW was higher in household with unimproved toilet facility as well as it was estimated higher prevalence of LBW in those households in Bangladesh. Open defecation and unsafe bowel disposal negatively affect the nutrition and health status of pregnant women and promote chronic infections [48]. Due to unimproved toilet facilities, especially in urban slums and rural areas, women also suffer from diarrhea and hookworm infestation which lead to maternal anemia, undernutrition, and infectious diseases that results in poor pregnancy outcomes like LBW [8, 10, 13, 48, 49]. Sufficient budget allocation and ensuring effective implementation of resources under national sanitation program can provide a framework for addressing sanitation issues and improving access to clean water and hygienic toilet facilities. In addition, promoting good sanitation practices and increasing awareness about the importance of sanitation and hygiene can help prevent the spread of disease and improve maternal and child health outcomes.

The main strength of this study was the utilization of nationally representative cross-sectional sample which covers both rural and urban areas of all districts of the country as well as aids to generalize the findings. Additionally, BDHS 2017-2018 data was collected by using a standard questionnaire, designing a complex survey strategy, and global study model to provide credible results. Despite these advantages, we acknowledged several limitations of this study. As the data was collected based on the mother’s self-reported information, the information might be affected by recall bias. This differential misclassification could cause either an overestimation or underestimation of the study findings. The cross-sectional nature of the data interferes with drawing causal associations between dependent and independent variables. This study might limit to generalize the findings only for low- and middle- income countries.

**Conclusion**

One out of five children were born with LBW in Bangladesh. Poor maternal education, female child, poorest socio-economic status, and unimproved toilet facilities were significantly associated with LBW. Further, the likelihood of gaining illness and being undernutrition was higher in LBW children. To improve maternal, pregnancy, and child health outcomes, it is crucial to implement policies that tackle poverty, gender inequality, and social disparities. Women should be empowered to make informed choices regarding their reproductive health. Encouraging regular antenatal care visits and early medical intervention is essential, as is promoting education and awareness about reproductive health, hygiene and safe sanitation practices.

**List of abbreviations**

ANC: Antenatal care; AOR: adjusted odds ratio; ARI: Acute respiratory infection; BDHS: Bangladesh Demography and Health Survey; CI: Confidence interval; LBW: Low birth weight

PSU: Primary sampling unit

**Ethics approval and consent to participate**

The BDHS 2017-18 dataset is a publicly available data and authors do not need ethical approval for using it. Informed consent was obtained verbally from each mother of children (every married woman aged 15–49 years) before being enrolled into the study.

**Availability of data and materials**

The BDHS 2017-18 data is publicly available on the DHS Program's page at https://dhsprogram.com/data/

**Competing interests**

None to declare.

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**Authors' contributions**

MZI and MRKC designed the concept of the study. MRKC prepared the dataset for analysis, and carried out the analyses. MZI prepare the first draft. MRKC and MSI edited the first draft. MK, BB and MR critically reviewed the manuscript. All authors reviewed the study findings and read and approved the final version before submission. MZI and MRKC are responsible for the overall content as guarantor.

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**Table 1** Background characteristics of the respondents (weighted frequency)

|  |  |  |
| --- | --- | --- |
| **Factors** | **Number** | **Frequency** |
| **Maternal factors** |  |  |
| **Mother’s age (in years)** |  |  |
| 15-19 | 445 | 18.5 |
| 20-24 | 882 | 36.6 |
| 25-29 | 604 | 25.1 |
| 30-34 | 354 | 14.7 |
| 35 and over | 123 | 5.1 |
| **Parents’ education** |  |  |
| Both parents were uneducated | 30 | 1.3 |
| Only father was uneducated | 148 | 6.2 |
| Only mother was uneducated | 38 | 1.6 |
| Both parents were educated | 2168 | 90.9 |
| **Mother currently working** |  |  |
| No | 1656 | 68.8 |
| Yes | 752 | 31.2 |
| **Underweight mother** |  |  |
| No | 2117 | 87.9 |
| Yes (<18.5 kg/m2) | 291 | 12.1 |
| **Mothers’ decision-making autonomy** |  |  |
| Not practiced | 339 | 14.2 |
| Practiced | 2046 | 85.8 |
| **Mother’s attitudes towards violence** |  |  |
| Not justified | 2030 | 84.3 |
| Justified | 378 | 15.7 |
| **Mothers received antenatal care** |  |  |
| No | 43 | 1.9 |
| Yes | 2261 | 98.1 |
| **Number of living children** |  |  |
| ≤ 2 | 1997 | 82.9 |
| ≥ 3 | 411 | 17.1 |
| **Age at first sex (in years)** |  |  |
| < 15 | 381 | 15.8 |
| 15-24 | 1949 | 80.9 |
| 25-34 | 78 | 3.2 |
| **Wanted last child** |  |  |
| Wanted then | 1968 | 81.8 |
| Wanted later | 307 | 12.7 |
| Wanted no more | 133 | 5.5 |
| **Ever had terminated pregnancy** |  |  |
| No | 2002 | 83.1 |
| Yes | 406 | 16.9 |
| **Last birth a caesarean section** |  |  |
| No | 894 | 37.2 |
| Yes | 1507 | 62.8 |
| **Sign of Pregnancy complication** |  |  |
| No | 1310 | 58.0 |
| Yes | 951 | 42.1 |
| **Child characteristics** |  |  |
| **Sex of child** |  |  |
| Male | 1291 | 53.6 |
| Female | 1117 | 46.4 |
| **Low birth weight** |  |  |
| No | 2,016 | 83.7 |
| Yes | 392 | 16.3 |
| **Contextual factors** |  |  |
| **Mass media exposure** |  |  |
| No | 512 | 21.3 |
| Yes | 1896 | 78.8 |
| **Wealth index** |  |  |
| Poorest | 262 | 10.9 |
| Poorer | 354 | 14.7 |
| Middle | 458 | 19.0 |
| Richer | 570 | 23.7 |
| Richest | 764 | 31.7 |
| **Place of residence** |  |  |
| Urban | 831 | 34.5 |
| Rural | 1577 | 65.5 |
| **Environmental factors** |  |  |
| **Type of drinking water** |  |  |
| Improved | 2020 | 83.9 |
| Unimproved | 388 | 16.1 |
| **Type of toilet facility** |  |  |
| Improved | 1490 | 61.9 |
| Unimproved | 918 | 38.1 |
| **Solid waste used in cooking** |  |  |
| No | 981 | 40.8 |
| Yes | 1424 | 59.2 |
| **Main floor material** |  |  |
| Improved | 1,037 | 43.1 |
| Unimproved | 1371 | 56.9 |
| **Main wall material** |  |  |
| Improved | 1833 | 76.1 |
| Unimproved | 575 | 23.9 |
| **Main roof materials** |  |  |
| Improved | 2035 | 84.5 |
| Unimproved | 373 | 15.5 |
| **Total** | **2408** | **100.0** |

**Table 2** Prevalence and determinants of LBW

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Factors** | **Prevalence of LBW** | | | **Determinants** | |
| **Number** | **Prevalence (95% CI)** | ***p* values** | **AOR (95% CI)** | ***p* values** |
| **Mother’s age (in years)** |  |  |  |  |  |
| 15-19 | 70 | 17.2 (13.4, 21.8) | 0.863 |  |  |
| 20-24 | 139 | 16.7 (13.9, 19.8) |  |  |  |
| 25-29 | 91 | 14.6 (11.5, 18.3) |  |  |  |
| 30-34 | 56 | 16.8 (12.3, 22.5) |  |  |  |
| 35 and over | 25 | 16.9 (11.1, 24.9) |  |  |  |
| **Parents’ education** |  |  |  |  |  |
| Both parents were uneducated | 5 | 21.8 (9.0, 44.0) | 0.001 | 1.35 (0.55-3.30) | 0.517 |
| Only father was uneducated | 27 | 20.4 (13.8, 29.1) |  | 1.13 (0.71-1.81) | 0.597 |
| Only mother was uneducated | 17 | 41.5 (26.1, 58.8) |  | 2.64 (1.27-5.50) | 0.010 |
| Both parents were educated | 330 | 15.6 (13.8, 17.5) |  | 1.00 |  |
| **Mother currently working** |  |  |  |  |  |
| No | 265 | 16.6 (14.5, 19.0) | 0.589 |  |  |
| Yes | 116 | 15.6 (12.9, 18.7) |  |  |  |
| **Underweight mother** |  |  |  |  |  |
| No | 332 | 16.3 (14.5, 18.3) | 0.892 |  |  |
| Yes (BMI <18.5 kg/m2) | 49 | 16.0 (11.9, 21.1) |  |  |  |
| **Mothers’ decision-making autonomy** |  |  |  |  |  |
| Not practiced | 50 | 13.9 (10.2, 18.5) | 0.227 |  |  |
| Practiced | 329 | 16.8 (14.9, 18.8) |  |  |  |
| **Mother’s attitudes towards violence** |  |  |  |  |  |
| Not justified | 326 | 16.4 (14.5, 18.5) | 0.818 |  |  |
| Justified | 55 | 15.8 (12.2, 20.3) |  |  |  |
| **Mothers received antenatal care** |  |  |  |  |  |
| No | 5 | 13.1 (5.2, 29.6) | 0.711 |  |  |
| Yes | 337 | 15.5 (13.9, 17.3) |  |  |  |
| **Number of living children** |  |  |  |  |  |
| ≤ 2 | 300 | 15.7 (14.0, 17.7) | 0.163 | 1.00 |  |
| ≥ 3 | 81 | 18.8 (14.8, 23.7) |  | 1.16 (0.82-1.63) | 0.399 |
| **Age at first sex (in years)** |  |  |  |  |  |
| < 15 | 59 | 15.9 (12.3, 20.4) | 0.633 |  |  |
| 15-24 | 313 | 16.5 (14.6, 18.6) |  |  |  |
| 25-34 | 9 | 11.8 (5.4, 24.0) |  |  |  |
| **Wanted last child** |  |  |  |  |  |
| Wanted then | 301 | 15.9 (14.1, 17.9) | 0.191 | 1.00 |  |
| Wanted later | 60 | 19.8 (15.2, 25.5) |  | 1.31 (0.94-1.82) | 0.109 |
| Wanted no more | 20 | 13.2 (8.2, 20.7) |  | 0.75 (0.42-1.36) | 0.345 |
| **Ever had terminated pregnancy** |  |  |  |  |  |
| No | 313 | 16.1 (14.3, 18.1) | 0.711 |  |  |
| Yes | 68 | 16.9 (13.2, 21.4) |  |  |  |
| **Last birth a caesarean section** |  |  |  |  |  |
| No | 161 | 18.6 (15.8, 21.9) | 0.035 | 1.00 |  |
| Yes | 219 | 14.9 (12.9, 17.1) |  | 0.85 (0.66-1.08) | 0.179 |
| **Sign of pregnancy complication** |  |  |  |  |  |
| No | 204 | 16.8 (14.5, 19.3) | 0.064 | 1.00 |  |
| Yes | 133 | 13.7 (11.5, 16.1) |  | 0.82 (0.64-1.04) | 0.094 |
| **Sex of child** |  |  |  |  |  |
| Male | 190 | 14.8 (12.7, 17.1) | 0.056 | 1.00 |  |
| Female | 191 | 18.0 (15.5, 20.8) |  | 1.31 (1.04-1.65) | 0.023 |
| **Mass media exposure** |  |  |  |  |  |
| No | 86 | 17.5 (14.0, 21.6) | 0.466 |  |  |
| Yes | 295 | 15.9 (14.0, 18.1) |  |  |  |
| **Wealth index** |  |  |  |  |  |
| Poorest | 55 | 22.4 (17.1, 28.8) | 0.087 | 1.69 (1.13-2.51) | 0.010 |
| Poorer | 49 | 15.6 (11.4, 21.0) |  | 1.16 (0.79-1.70) | 0.461 |
| Middle | 79 | 18.1 (14.5, 22.4) |  | 1.41 (1.01-1.98) | 0.046 |
| Richer | 85 | 15.4 (12.1, 19.3) |  | 1.17 (0.84-1.62) | 0.356 |
| Richest | 113 | 14.1 (11.3, 17.4) |  | 1.00 |  |
| **Place of residence** |  |  |  |  |  |
| Urban | 166 | 16.5 (13.9, 19.4) | 0.863 |  |  |
| Rural | 215 | 16.2 (14.0, 18.6) |  |  |  |
| **Total** | 381 | 16.3 (14.6, 18.1) |  |  |  |

AOR, adjusted odds ratio, CI, Confidence interval

**Table 3** Effects of LBW on child’s adverse health and nutritional status

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Factors** |  | **Prevalence** | | | **Determinants** | |
| **Category** | **Number** | **Prevalence**  **(95% CI)** | ***p* values (ᵡ2)** | **AOR (95% CI)** | ***p* values** |
| **Children’s adverse health status** | | | | | | |
| **Fever** |  |  |  |  |  |  |
| Low birth weight | No | 688 | 34.9 (32.6, 37.3) |  | 1.00 |  |
|  | Yes | 137 | 39.6 (33.6, 46.0) | 0.150 | 1.26 (1.02-1.60) | 0.047 |
| **Cough** |  |  |  |  |  |  |
| Low birth weight | No | 794 | 40.4 (37.8, 43.0) |  |  |  |
|  | Yes | 133 | 37.0 (31.2, 43.1) | 0.311 |  |  |
| **ARI** | |  |  |  |  |  |
| Low birth weight | No | 286 | 15.2 (13.4, 17.1) |  | 1.00 |  |
|  | Yes | 59 | 18.6 (14.4, 23.6) | 0.156 | 1.25 (0.92-1.71) | 0.144 |
| **Diarrhea** |  |  |  |  |  |  |
| Low birth weight | No | 140 | 6.6 (5.5,8.0) |  |  |  |
|  | Yes | 28 | 7.3 (4.8, 10.8) | 0.689 |  |  |
| **Had at least one illness** |  |  |  |  |  |  |
| Low birth weight | No | 1017 | 51.6 (49.0, 54.1) |  |  |  |
|  | Yes | 182 | 51.1 (44.5, 57.7) | 0.898 |  |  |
| **Children’s adverse health status** | | | | | | |
| **Stunting** |  |  |  |  |  |  |
| Low birth weight | No | 391 | 21.2 (19.2, 23.4) |  | 1.00 |  |
|  | Yes | 140 | 40.0 (34.1, 46.2) | <0.001 | 2.42 (1.86-3.15) | <0.001 |
| **Wasting** |  |  |  |  |  |  |
| Low birth weight | No | 132 | 7.3 (5.9, 8.9) |  | 1.00 |  |
|  | Yes | 34 | 10.7 (7.4, 15.3) | 0.047 | 1.49 (1.02-2.25) | 0.049 |
| **Underweight** |  |  |  |  |  |  |
| **Low birth weight** | No | 244 | 12.4 (10.7, 14.3) |  | 1.00 |  |
|  | Yes | 112 | 30.4 (25.4, 35.9) | <0.001 | 3.19 (2.40-4.23) | <0.001 |
| **At least one under-nutrition condition** | |  |  |  |  |  |
| **Low birth weight** | No | 520 | 28.2 (25.8, 30.8) |  | 1.00 |  |
|  | Yes | 165 | 48.1 (42.1, 54.2) | <0.001 | 2.36 (1.83-3.03) | <0.001 |

AOR, adjusted odds ratio, ARI, acute respiratory infections, CI, Confidence interval

For each outcome, model was adjusted for children’s age, children’s sex, parental educational status, wealth index and place of residence

**Table 4** Associations between environmental factors and LBW

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Factors** | **Prevalence** | | | **Determinates** | |
| **Number** | **Prevalence (95% CI)** | ***p* values (ᵡ2)** | **AOR (95% CI)** | ***p* values** |
| **Type of drinking water** |  |  |  |  |  |
| Improved | 320 | 16.4 (14.5, 18.5) | 0.805 |  |  |
| Unimproved | 61 | 15.7 (11.8, 20.7) |  |  |  |
| **Type of toilet facility** |  |  |  |  |  |
| Improved | 222 | 15.0 (12.9, 17.4) | 0.078 | 1.00 |  |
| Unimproved | 159 | 18.3 (15.6, 21.5) |  | 1.26 (1.02-1.63) | 0.047 |
| **Solid waste used in cooking** |  |  |  |  |  |
| No | 146 | 15.1 (12.5, 18.1) | 0.363 |  |  |
| Yes | 233 | 16.9 (14.6, 19.4) |  |  |  |
| **Main floor material** |  |  |  |  |  |
| Improved | 156 | 14.8 (12.3, 17.6) | 0.163 | 1.00 |  |
| Unimproved | 225 | 17.4 (15.1, 20.0) |  | 1.05 (0.77-1.45) | 0.736 |
| **Main wall material** |  |  |  |  |  |
| Improved | 287 | 15.8 (13.8, 17.9) | 0.375 |  |  |
| Unimproved | 94 | 17.8 (14.1, 22.2) |  |  |  |
| **Main roof materials** |  |  |  |  |  |
| Improved | 321 | 16.3 (14.4, 18.4) | 0.944 |  |  |
| Unimproved | 60 | 16.1 (12.1, 21.2) |  |  |  |

AOR, adjusted odds ratio, CI, Confidence interval

Model was adjusted for children’s age, children’s sex, parental educational status, wealth index and place of residence

**Figure 1.** Children’s adverse health and nutritional outcomes (0-23 months of age)