

# Chapter 2

## Two-Level Logistic Regression Analysis of Factors Influencing Anemia Among Nonpregnant Married Women of Reproductive Age in Bangladesh

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### 2.1 Introduction

Anemia is a global health problem for women (Benoist et al. 2008). Numerous morbidities including miscarriage (Szerafin and Jakó 2010), preterm delivery (Scholl et al. 1992), abruption placenta (Arnold et al. 2009), and low birth weight (Rasmussen 2001) are associated with anemia of women during their reproductive age. The high risk of maternal and prenatal mortality is also related to anemia (Lee et al. 2006; Mulayim et al. 2008). In addition, anemic individuals are more likely to get infectious diseases (Ndyomugenyeni et al. 2008), and they loss their ability to do properly physical labor (Scholz et al. 1997). Study on rate of anemia among nonpregnant married women is mainly significant for rising countries, where health and medically related improvement are being actively applied.

In Bangladesh, USDHEW (1966) has reported the prevalence of anemia among of women and children since early 1960s as part of national nutrition surveys using small population samples. Helen Keller International (HKI) conducted anemia surveys in Bangladesh first in 1997–1998 and again in 2001 with collaboration of the Institute of Public Health Nutrition (IPHN), but these were restricted to inhabitants in rural environment (HKI/IPHN 2002). Three among the eight goals of Millennium Development Goals (MDGs) are related to health, and the Bangladesh government is working towards achieving these goals (NIPORT 2013).

In developing countries like Bangladesh, married women are often responsible for maintaining the family, and many are also contributing toward the workforce and productivity of the nation. Their outstanding role in the nation, it is important to

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examine the association between the anemia among nonpregnant married women and important variables such as residence, education level, toilet facilities at home, religion, contraceptive, breastfeeding, economical condition, age group, body mass index (BMI), and parity, in order to make sure remedial measures can be undertaken.

The aim of this study is to examine the association between various socioeconomic, demographic, and nutritional factors and anemia of Bangladeshi nonpregnant married women in reproductive age.

## 2.2 Materials and Methods

A total number of 5293 sample used in the present study, they were nonpregnant married Bangladeshi women in age range between 15–49 years. This study is a cross-sectional study and the secondary data was taken from Bangladesh Demographic and Health Survey (BDHS)-2011. Socio-demographic, anthropometric, health and lifestyle information were collected from 17,842 ever-married Bangladeshi by BDHS-2011, and they surveyed from July 8, 2011 to December 27, 2011 from overall Bangladesh. The average age of subject was  $30.78 \pm 9.27$  years at the measurement time. Bangladesh Bureau of Statistics (BBS) (Khan and Shaw 2011) created enumeration areas (EAs) for the 2011 Population and Housing Census as a sampling frame, and those EAs were used by BDHS-2011 for selecting house hold from Bangladesh. They utilized two-stage stratified cluster sampling for collecting data from Bangladeshi nonpregnant married women. All the information about the survey design, sampling technique, survey instruments, measuring system, ethical approval, subject consent, and quality control have been described in NIPORT (2013). Process of blood testing and the definition of anemia have been described elsewhere (NIPORT 2013). Pregnant women were excluded in this study. Informal statistical technique was used to detect the outliers from the data set (Dunn and Clark 1974). After removing results from women who were currently pregnant, outliers, and cases with incomplete information, finally 5293 samples were used in the present study. According hemoglobin level (HGL), the sample was classified into two groups (i) Anemic ( $HGL < 12.0$  g/dl) and (ii) Non-anemic ( $HGL \geq 12.0$  g/dl). Again, anemic women were subdivided into three subgroups according to hemoglobin level, (i) Mild ( $HGL$  lies between 10.0 and 11.9 g/dl), (ii) Moderate ( $HGL$  lies between 7.0 and 9.9 g/dl), and (iii) Severe ( $HGL < 7.0$  g/dl) (CDC 1998).

Since BDHS-2011 collected data from Bangladeshi women using two-stage clustered sampling and the sample came from several levels of the hierarchy, so there was a cluster effect of the data set. In the data set, the single-level statistical model is not appropriate (Khan and Shaw 2011). In this study, intra-class correlation coefficient,

$ICC = \frac{\text{Variation of constant}}{\text{Variation of constant} + \text{variation of residual}}$  was used to determine whether or not multilevel is even necessary for our data, the value of ICC ranges from 0–1. If ICC is greater than 0, only when multilevel regression model is needed for

the analysis (Park and Lake 2005). Two-level multiple logistic regression model was utilized to remove the cluster effect for investigating the association between anemia and socioeconomic, demographic, and nutritional factors among married women. The category of anemia level was used as dependent variable. Multilevel logistic regression model is a powerful statistical tool to remove the cluster effect for finding association between dependent (category) and independent variables at different levels of the hierarchy data. Sometimes in multiple logistic model, there is multicollinearity problem that is the explanatory variables are dependent of each other. We need to remove the multicollinearity problem otherwise we cannot get accurate results. The magnitude of the standard error (SE) was used in the present study to detect the multicollinearity problem. If the magnitude of the SE lies between 0.001 and 0.5, there is no evidence of multicollinearity (Chan 2004). Chi-square test was utilized in this study for selecting independent factors for multilevel logistic regression model. The p-values less than 0.05 were used to accept the result. All Statistical analyses were approved using STATA (version 11) and SPSS software (version IBM 19).

## 2.3 Results and Discussion

Bangladeshi nonpregnant married women in reproductive age were investigated their anemia level and factors associated with anemia. It was noted that the prevalence of anemia among nonpregnant married women was 41.29%, among them in urban 37.18% and in rural 43.51%. The prevalence of mild, moderate, and severe anemia among anemic women were 35.5% (urban 31.9% and rural 37.5%), 5.6% (urban 5.2% and rural 5.9%), and 0.2% (urban 0.1% and rural 0.2%) respectively (Table 2.1).

In this study, we evaluated the cause of socioeconomic, demographic, and nutritional factors on anemia of Bangladeshi nonpregnant married women. The study allowed us to provide a more comprehensive analysis of the target population, because the sample population was derived from various geographical regions of the country. Previous studies reported prevalence and factors associated of anemia for women from rural population (Merrill et al. 2011), among university students in

**Table 2.1** Prevalence of anemia among Bangladeshi nonpregnant married women

|                      |          | Total frequency (%) | Urban        | Rural        |
|----------------------|----------|---------------------|--------------|--------------|
| Anemia               | No       | 3108 (58.71)        | 1167 (62.82) | 1941 (56.51) |
|                      | Yes      | 2185 (41.29)        | 690 (37.18)  | 1495 (43.51) |
| Categories of anemia | Severe   | 8 (0.20)            | 2 (0.10)     | 6 (0.20)     |
|                      | Moderate | 298 (5.60)          | 96 (5.20)    | 202 (5.90)   |
|                      | Mild     | 1880 (35.50)        | 592 (31.90)  | 1288 (37.50) |

Source Data extracted from BDHS-2011

a particular region (Shill et al. 2014), infants (Rawat et al. 2014), students of a particular medical college (Bari et al. 2013), etc. BDHS-2011 collected data from different level using cluster sampling, in this study those cluster effects were minimized using by multilevel logistic regression analysis.

The present study showed high prevalence (41.29%) of anemia among nonpregnant Bangladeshi married nonpregnant women, and was this worse among those from the rural area (43.5% in rural area compared to 37.2% in urban area). A previous study reported that the prevalence of anemia among Bangladeshi rural women was 73%, and this result was higher than what we found (41.29%) even if we only considered women from the rural area (43.5%). In 2003, BBS reported that the prevalence of anemia among Bangladeshi urban women was 34% (BBS 2003), and this was relatively similar to our findings (37.2% among urban population). The prevalence (41.29%) of anemia among nonpregnant Bangladeshi women in reproductive age was higher than that of many countries like Iran, 14.5% (Sadeghian et al. 2013), Europe [Serbia, 27.7% (Rakic 2013), Belgium, 7.7% (Massot and Vanderpas 2003)], Japan, 15.7% (Takimoto et al. 2003), South America [Brazil, 32.7% (Coimbra et al. 2013), Mexico, 15.5% (Shamah-Levy et al. 2009)], Kazakhstan, 39% (Smagulova et al. 2013), Turkey, 32.8% (Pala and Dundar 2008), China, 15.1% (Liao 2004), also in Global, 29% (Stevens et al. 2013), and rather similar to countries in west and central Africa, 40% (Ayoya et al. 2012). However, the prevalence was less than that of India, 56% (Balarajan et al. 2013) and Tanzania, 49% (Massawe et al. 2002).

We used chi-square ( $\chi^2$ ) test to investigate the association between anemia status and some selected factors.  $\chi^2$ -test demonstrated that the association between anemia and residence, education level, currently breastfeeding, currently amenorrheic, contraceptive, toilet facility, religion, economic condition (wealth index), BMI, age group and parity were statistically significant ( $p < 0.01$ ). On the other hand, current working status, source of drinking water, and age at their first marriage did not show significant association between anemia ( $p > 0.05$ ) (Table 2.2).

In multilevel regression model, the above significantly associated factors were considered as independent variables. The intra-class correlation coefficient (ICC) of this model was 0.069, multilevel model was appropriate for this study. Multilevel logistic regression model showed that women who were living in rural area (AOR = 0.0.86, 95% CI: 0.74–1.00;  $p < 0.05$ ), living in poor family (AOR = 0.79, 95% CI: 0.66–0.93;  $p < 0.01$ ), being uneducated (AOR = 0.69, 95% CI: 0.48–0.88;  $p < 0.01$ ), non-Muslims (AOR = 1.52, 95% CI: 1.25–1.83;  $p < 0.01$ ), currently not using contraceptive (AOR = 0.89, 95% CI: 0.78–0.99;  $p < 0.05$ ), currently breastfeeding (AOR = 1.34, 95% CI: 1.13–1.59;  $p < 0.01$ ), currently amenorrheic (AOR = 1.65, 95% CI: 1.23–2.21;  $p < 0.01$ ), underweight (AOR = 0.73, 95% CI: 0.63–0.84;  $p < 0.01$ ), and those from 30–49-year age group (AOR = 1.48, 95% CI: 1.26–1.73;  $p < 0.01$ ) (Table 2.3).

There are two important factors poverty and lack of education which are related to having anemia among married women in Bangladesh. Household wealth index is another risk factor for anemia, and women living in poor families are more likely to be anemic than women living in rich family. Education is also risk factor that

**Table 2.2** Association between anemia and socioeconomic, demographic, and nutritional factors

| Variables                    | Group (N)                 | Anemic (%) | $\chi^2$ -value | p-value |
|------------------------------|---------------------------|------------|-----------------|---------|
| Residence                    | Urban (1855)              | 37.18      | 20.14           | 0.001   |
|                              | Rural (3438)              | 43.51      |                 |         |
| Education level              | No (1401)                 | 45.91      | 32.95           | 0.001   |
|                              | Primary (1621)            | 43.01      |                 |         |
|                              | Secondary (1872)          | 38.11      |                 |         |
|                              | Higher (399)              | 33.21      |                 |         |
| Breastfeeding                | No (3936)                 | 39.71      | 16.30           | 0.002   |
|                              | Yes (1359)                | 45.90      |                 |         |
| Currently amenorrhea         | No (5005)                 | 40.42      | 28.13           | 0.008   |
|                              | Yes (288)                 | 56.23      |                 |         |
| Contraceptive                | No (2025)                 | 44.18      | 10.63           | 0.007   |
|                              | Yes (3266)                | 39.60      |                 |         |
| Currently working            | No (4550)                 | 40.91      | 1.92            | 0.1681  |
|                              | Yes (745)                 | 43.65      |                 |         |
| Drinking water source        | Non-improved (458)        | 41.01      | 0.02            | 0.9091  |
|                              | Improved (4835)           | 41.29      |                 |         |
| Toilet facility              | Unhygienic (2465)         | 43.30      | 7.88            | 0.006   |
|                              | Hygienic (2828)           | 39.51      |                 |         |
| Religion                     | Muslim (4667)             | 40.20      | 19.34           | 0.001   |
|                              | Non-Muslim (626)          | 49.42      |                 |         |
| Wealth index                 | Poor (1891)               | 47.50      | 57.37           | 0.006   |
|                              | Middle (1017)             | 42.11      |                 |         |
|                              | Rich (2385)               | 36.01      |                 |         |
| Body mass index              | Underweight (1301)        | 50.51      | 94.33           | 0.005   |
|                              | Normal weight (3036)      | 40.80      |                 |         |
|                              | Overweight (788)          | 31.01      |                 |         |
|                              | Obese (168)               | 27.42      |                 |         |
| Age group                    | 15–29 years (2411)        | 38.60      | 13.59           | 0.001   |
|                              | 30–49 years (2882)        | 43.61      |                 |         |
| Age at first marriage        | Less than 18 years (4138) | 41.93      | 2.54            | 0.1131  |
|                              | 18 years and above (1155) | 39.30      |                 |         |
| Number of ever born children | No (423)                  | 37.71      | 27.56           | 0.001   |
|                              | 1–2 (2410)                | 38.40      |                 |         |
|                              | 3–6 (2220)                | 44.12      |                 |         |
|                              | 7 and more (240)          | 51.01      |                 |         |

Source Data extracted from BDHS-2011

influences anemia especially among married women. Particularly among women, education level is directly related with positive socioeconomic reimbursement, but more 27% women in Bangladesh is uneducated (NIPORT 2013). To increase the literacy rate among women, several steps towards including taking on the national

**Table 2.3** Impact of socio-demographic factors and BMI on anemia of married women in reproductive age

| Variable   | Coefficients | <i>p</i> -value | Adjusted odds ratio (AOR) | 95% CI of AOR |       |
|--|--------------|-----------------|---------------------------|---------------|-------|
|  |              |                 |                           | Lower         | Upper |
| Residence, urban versus rural                      | -0.036       | <i>p</i> < 0.05 | 0.86                      | 0.74          | 1.01  |
| Education level                                    |              |                 |                           |               |       |
| Primary versus no                                  | -0.024       | 0.179           | 0.91                      | 0.77          | 1.05  |
| Secondary versus no                                | -0.058       | <i>p</i> < 0.01 | 0.78                      | 0.64          | 0.92  |
| Higher versus no                                   | -0.098       | <i>p</i> < 0.01 | 0.69                      | 0.48          | 0.88  |
| Type of toilet at home, Unhygienic versus hygienic | -0.024       | 0.099           | 0.91                      | 0.80          | 1.02  |
| Religion, Non-Muslim versus muslim                 | 0.935        | <i>p</i> < 0.01 | 1.52                      | 1.25          | 1.83  |
| Currently contraceptive, Yes versus no             | -0.294       | <i>p</i> < 0.05 | 0.89                      | 0.78          | 0.99  |
| Currently breastfeeding, Yes versus no             | 0.066        | <i>p</i> < 0.01 | 1.34                      | 1.13          | 1.59  |
| Currently amenorrhea, Yes versus no                | 0.113        | <i>p</i> < 0.01 | 1.65                      | 1.23          | 2.21  |
| Wealth index,                                      |              |                 |                           |               |       |
| Middle versus poor                                 | -0.034       | 0.086           | 0.88                      | 0.73          | 1.03  |
| Rich versus poor                                   | -0.056       | <i>p</i> < 0.01 | 0.79                      | 0.66          | 0.93  |
| Age group, (30–49) years versus (15–29) years      | 0.084        | <i>p</i> < 0.01 | 1.48                      | 1.26          | 1.73  |
| Body mass index,                                   |              |                 |                           |               |       |
| Normal versus under weight                         | -0.077       | <i>p</i> < 0.01 | 0.73                      | 0.63          | 0.84  |
| Over versus under weight                           | -0.159       | <i>p</i> < 0.01 | 0.42                      | 0.37          | 0.61  |
| Obese versus under weight                          | -0.189       | <i>p</i> < 0.01 | 0.41                      | 0.27          | 0.58  |
| Number of ever born children,                      |              |                 |                           |               |       |
| 1–2 versus no                                      | -0.023       | 0.426           | 0.93                      | 0.71          | 1.15  |
| 3–6 versus no                                      | 0.002        | 0.980           | 0.99                      | 0.76          | 1.29  |
| 7 and more versus no                               | 0.029        | 0.508           | 1.13                      | 0.77          | 1.63  |
| Constant   | 0.484        | <i>p</i> < 0.01 |                           |               |       |

Source Data extracted from BDHS-2011

education policy has been enhanced by the Government of Bangladesh (NIPORT 2013), openly stipulated that education in primary and secondary school level would be free of cost. The government of Bangladesh also provides subsidies for the poor girl students to increase education level among especially Bangladeshi

women. Elimination of poverty and increasing the level of education among women can able to reduce the prevalence of anemia in Bangladesh. The information about the prevalence of anemia among Bangladeshi married women that has been got from this study would be used by the health authorities of Bangladesh Government as indicators to assess the effectiveness of these programs, and they can also provide a reference for future assessment. Nutritional status (BMI) is important predictors of anemia. This study demonstrated women who were using oral contraceptive method had lower chance to get anemia than women who were using intra-uterine device, this result also supported to the finding of Massawe et al. (2002) and Heck et al. (2008) studies. Our study also showed that lactating women had more risk to be anemic than their counterpart, the same result was found by Pei et al. (2013). It was noted that amenorrheic women had also more risk to get anemia compared to non-amenorrheic women. Amenorrhea is a multifactorial condition that can be due to undiagnosed pregnancy, prolonged lactation and poor general health. We also noted that underweight women were more likely to have anemia than normal weight women, overweight and obese women. Dangour et al. (2001) reported that the positive association between level of serum hemoglobin and body mass index (BMI).

## 2.4 Conclusions

In this study, we found that prevalence of anemia among married women in Bangladesh was 41.29%. Uneducated women living in rural environment have significantly higher rates of anemia. Unhygienic toilet, non-Muslim, currently not using contraceptive method, currently breastfeeding, amenorrheic, older (30–49-years old) and underweight were also important factors of anemia. In addition to identifying modifiable risk factors of anemia among women, results from this study provide useful baseline information for reference on ongoing socioeconomic development by the Bangladesh Government.

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