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# Univariate Poisson Regression Models for Analyzing Maternal Complications and Health Care Utilization in Bangladesh

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## *ABSTRACT*

*Bangladeshi women are facing many serious health problems at three stages of childbearing period, although there has been improvement during the recent past, the situation is still worse. In this study, our goal is to find some important risk factors associated with various stages of maternal complications using count data model. We have used Bangladesh Maternal Mortality and Health Care Survey 2010 data in this study and we have extracted a total of 17521 women where our selection criterion was women at age 13-49 and given a live birth from three years prior to the survey. We have applied both univariate and bivariate techniques along with chi-square test statistics in exploratory data analysis and Poisson regression model is used based on the data at three stages of maternal complications namely pregnancy, delivery, postpartum along with potential factors as covariates. We have revealed some important findings from this study. Higher number of parity is positively associated with higher number of complications. Women from Sylhet division are at high risk of facing maternal complications at all stages compared to all other divisions. Education is playing an important role in reducing maternal complication. Poor (poorer, poorest) people are the most vulnerable group among middle and rich (richer, richest) category of wealth index. Previous dismissed pregnancy record has a strong positive association with higher number of complications. We have also showed an important interrelation among treatment seeking behavior related factors (ANC visit number, ANC place, cost at three maternal stages, delivery attendant, delivery place) with higher number of maternal complications.*

***Keywords:*** *Poisson regression models, Pregnancy complications, Delivery complications, Postpartum complications, Bangladesh, Treatment seeking behavior.*

## INTRODUCTION

Count data models have been extensively used in a variety of fields such as health science, actuarial science, biostatistics, demography, economics, political science, sociology, etc. (Cameron and Trivedi, 2013). The Poisson distribution is the most commonly used regression model for count data which was derived as limiting case of binomial distribution (Poisson, 1837). Some examples for the Poisson distribution are number of road accidents occurred per day in Dhaka city, number of customers visited per hour in a market, etc. This discrete probability distribution represents the probability of a number of independent events occurring in a fixed interval of time or fixed time with a known average rate. Although the Poisson regression model does not follow the assumptions of a linear regression model properly, it can be expressed in the generalized linear model (GLM) framework which was formulated by Nelder and Wedderburn (1972). Cameron and Trivedi described four important characterizations (the law of rare events, Poisson process, waiting time distributions, binomial stopped by the Poisson) and various applications of the Poisson regression model in many sectors (health services, patents, recreational demand, takeover bids, bank failures, accident insurance, etc.) (Cameron and Trivedi, 2013). In this study we will apply Poisson regression models at three stages of maternal complications. There are few studies available on maternal complications based on Bangladesh maternal mortality survey data. Women who have faced more number of complications may have similarities in some phenomenon. The purpose of this paper is to find out factors that are related with higher number of complications during the childbearing period.

Maternal mortality reduction up to a standard level by 2015 was an important agenda of Millennium Development Goal (MDG) 5 for assessing progress in improving maternal health (WHO, 2010). Maternal mortality has been declined worldwide by almost 50 percent between 1990 and 2010. Although there is a remarkable progress in reducing maternal mortality, approximately 800 women die from various causes which are related to pregnancy, delivery and postpartum. In 2010, the World Health Organization (WHO) estimated that 287,000 women died in childbearing period. Among them 99 percent deaths occurred in developing countries (WHO, 2014). Bangladesh has made a significant progress in order to reach Millennium Development Goal (MDG) 5, which targets a 75 percent reduction of maternal mortality ratio (MMR) from 1990 to 2015. The WHO and UN estimate the latest Maternal Mortality Rate of Bangladesh is 176 per 100,000 live births in 2015 (WHO, 2015). A countdown to 2015 country case study

revealed that Bangladesh was one of the nine countdown countries which were on track to achieve the primary goal of MDG 5 by 2015 and also said that Bangladesh is the only low or middle income country which has conducted two large, nationally representative maternal mortality surveys with treatment seeking behavior. That study used the Poisson regression model to estimate the change in risk of maternal death between two surveys (2001 and 2010 Bangladesh maternal mortality survey) (El Arifeen et al., 2014). There are some studies available on maternal health problems in Bangladesh, mostly using single outcome variable with a few exception. Goodburn et al. worked on delivery and postpartum maternal morbidity in rural Bangladesh (Goodburn et al., 1995). Chakraborty et al. worked on ante-partum maternal morbidity and they used multiple decrement life tables (Chakraborty et al., 2003). Analysis of postpartum complications in relation to selected delivery complications was obtained by Islam (2004). Islam et al. developed a multistage model for maternal morbidity during antenatal, delivery and postpartum periods (Islam et al., 2004). The GEE models for maternal morbidity in rural Bangladesh were applied by Gulshan et al. (2005). Utilization of maternal health care service (ANC, Skilled delivery attendant, etc.) is an important indicator in reducing maternal mortality. In recent years some studies have conducted in Bangladesh related to maternal health care services. Roy and Shengelia (2016) made a significant review about maternal health care situation of Bangladesh where they revealed that skilled attendance at birth, structured ANC, etc., will be helpful in reducing maternal morbidity. Tawabunnahar et al., (2021) demonstrated about Urban–rural differences in the utilization of maternal healthcare services in Bangladesh and also revealed the same thing with Roy and Shengelia (2016) about ANC and skilled delivery attendant. Some authors have applied the Poisson regression model in the study of maternal mortality and morbidity. Sarpong and Brobbey used the Poisson regression modeling approach in order to study the incidence of maternal deaths in Ghana and they considered the maternal death cases as the dependent variable and time (in years) as the independent variable (Sarpong and Brobbey 2013). Loquiha et al. applied some count data models for modeling heterogeneity of maternal mortality data in health facilities in Mozambique (Loquiha et al., 2013). Application of count data models on health data especially on maternal health data can be found in a low rate in Bangladesh. Most of the studies mentioned above have worked with every maternal complication differently, like reasons behind hemorrhage, oedema, pelvic pain etc. and these studies have applied logistic regression model in most of the cases. But there are less studies

available about finding the reasons behind the higher number of complications which is count type data and for this reason we need to apply Poisson regression model. For example, normally women who have faced higher number of complications during pregnancy they have high chance to face more complications at delivery and postpartum, but in real life these women may take health care services (such as ANC) during pregnancy and as a result they could face lower number of complications at next stage. We need to study these sectors thoroughly and try to reveal the factors which are helpful in reducing maternal complications.

Objectives of the study are:

- To use the Bangladesh Maternal Mortality and Health Care Survey 2010 data as count data.
- To apply both univariate and bivariate analysis in exploratory data analysis.
- To apply Poisson regression model for count outcome variables number of maternal complications at three stages (pregnancy, delivery, after delivery) and identify the potential risk factors which may be helpful in the future policy making of Bangladesh.
- To apply regression models using 3 outcome variables and 11 covariates, this is rare while maximum studies work with lower number of variables and covariates.
- To identify background risk factors (age, parity, division, educational level, household wealth index, etc.) and impact of using maternal healthcare services on higher number of maternal complications.

The remainders of this paper are organized as follows: In section 2, the materials and methods will be presented including data source and methods for statistical analysis. Section 3 will present results from exploratory data analysis and model fitting. A detailed discussion will be shown in section 4. In section 5 the conclusion will be presented.

## MATERIALS AND METHODS

### Data source

In this study we used the Bangladesh Maternal Mortality and Health Care Survey 2010 data. The study was conducted by the National Institute of Population Research and Training (NIPORT) in 2010. This is an open access data set which can be obtained from the web link: https://hdl.handle.net/1902.29/11389 (NIPORT, 2014). Data were collected for the survey during

the period 18 January to 6 August, 2010. A total of 175,000 households were considered as sample and ever-married women at their reproductive period (13-49) were interviewed. A multistage sampling procedure was used to collect data where the area frame was divided into three domains: urban areas, rural areas, other urban areas. The primary sampling unit for the urban areas was the ward. Rural unions formed the primary sampling unit for the rural domain and their wards formed the primary sampling unit (PSU) for the other urban domain. In each selected urban PSU, two mohallas were selected as the secondary sampling unit and in both of rural and other urban areas two mouzas were selected as the secondary sampling unit. Each selected mohalla and mouza was divided into clusters and one of these clusters was selected from each selected mohalla and mouza. From each selected cluster sixty five households were randomly selected and women in 23 of these households per PSU were randomly selected to receive the long questionnaire. The survey applied five questionnaires: household questionnaire, women's short questionnaire, women's long questionnaire, verbal autopsy questionnaire, CSBA questionnaire. The women's long questionnaire gathered information on the age, education, household assets, wealth index, division, residence, birth planning, antenatal care, delivery, postnatal care, experience with and treatment of maternal health problems during pregnancy, delivery and after delivery, treatment seeking behaviour, information about local CSBA's, exposure to media, etc.

**Variable**

In this study we consider women with long questionnaire and women at age 13-49 who had a live birth in the three years preceding the survey. For this study we have selected a total of 17521 women who had a live birth in the three years preceding the survey. This study attempts to address three count outcome variables $Y_1$, $Y_2$ and $Y_3$. Here outcome variables can be represented as:

1) $Y_1$ is the number of maternal complications during pregnancy.
2) $Y_2$ is the number of maternal complications at delivery.
3) $Y_3$ is the number of maternal complications after delivery.

Independently all of these outcome variables follow Poisson distribution. These three stages complications depend on several independent variables. First outcome variable number of complications during pregnancy depends on **age** (below 20, 24-24, 25-39, 40-49), **parity** (1, 2, 3, 4, 5+), **residence** (urban, rural), **division** (Barisal, Chittagong, Dhaka, Khulna, Rajshahi, Sylhet),

**level of education** (no education, incomplete primary, complete primary, higher), **household wealth index** (poorest, poorer, middle, richer, richest), **previous dismissed pregnancy** (no, yes), **antenatal care number** (no ANC, 1, 2, 3, 4+), **antenatal care place** (home, health facility center), **total cost at pregnancy** (nothing, $500 <$, $\geq 500$). Second and third outcome variables both depend on these independent variables along with some extra covariates: **delivery attendant** (medically trained, nonmedically trained or no one), **delivery place** (home, health facility center). In this study both **antenatal care place** and **delivery place** variables include health facility center category and this health facility center includes public medical sector, private medical sector, and NGO sector. Here delivery attendant variable is categorized similarly with Islam and Masud (2018) study, where medically trained category includes qualified doctor / nurse / midwife / paramedic / FWV / CSBA / MA / SACMO. We could not take some important variables such as delivery by caesarean section, postnatal care place because of missing values.

### Methodology

At first univariate and bivariate statistical analyses are used to explore the data set and important risk factors are identified. These background analyses are performed by SPSS software. From the bivariate analysis, a variable is said to be statistically significant when p-value is less than $0.05$ and then included in the final regression model. R software is implemented to fit Poisson regression models with selected covariates.

## RESULTS

### Exploratory data analysis

**Figure 1** represents the univariate percentage of outcome variables, here we can see that a large number of women had reported that they had no complications during pregnancy (60%). Women who had reported about complications among them most of the women faced one complication (29.0%) followed by two complications (8%) and three complications (2%). At delivery stage 72 percent women reported to have no complication compared to 21 percent with one complication and 5 percent with two complications. Similarly after delivery stage the percentage of respondents with no complication was 80 percent, with one complication was 15 percent and with two complications was 4 percent.

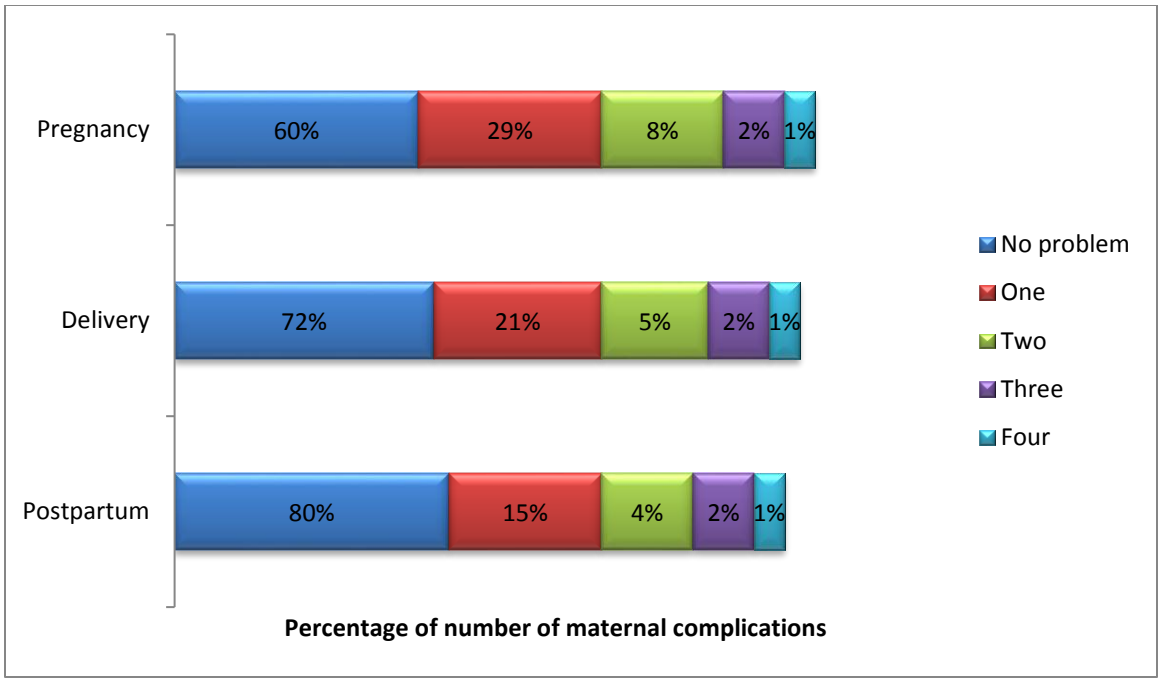


**Figure 1:** Number of maternal complications at different stages of child bearing period

Since age is an important demographic variable, mother's age during child birth is an important variable for this study. From the univariate frequency **table 1** we can say that most of the women (36.7%) are in the age group 20-39 and 14.8% are below 20 years of age. Majority of the women (76.8%) are from rural area. Again, educational level is an important determinant of female's opportunities. Here, while a large proportion of women (23.5%) are still in no education group, another large proportion of women (44.1%) are in higher education group. The household wealth index shows that 22.4 percent of women are from poorest category which is largest compared to remaining categories. Over the last decade there has been a significant improvement in family planning in our country. Most of the women are in parity 1 (33.1%) and parity 2 (29.6%) group, where there is a few women are in parity 4 (9.4%) and parity 5 or more (10.1%) group. Higher parity is considered as a risk factor for mother's health condition. Division is another important background characteristic. Because health facility, quality of health services, availability of health services, distance of health services may vary from place to place. Here highest proportions of women are from Dhaka division (33.3%) and lowest proportions of women are from Barisal division (5.9%). Previous dismissed pregnancy is an important variable because

dismissed pregnancy may have effect on mother's health, which may have a long run influence. It contains information on still birth, induced abortion, miscarriage and MR. Here, in our selected portion of dataset, only 6.6% women had previous dismissed pregnancy. Antenatal care is closely related with health problems, if there is less complication then woman may take less antenatal care. Women with higher number of complications will take more antenatal care. Highest number of women (30.1%) are in no antenatal care group it may be related with number of complications during pregnancy, delivery and postnatal. Antenatal care place is also an important factor because antenatal care outside the home will be better. From the table we can see 86.5% women have taken ANC from health facility center which reflects the awareness of people. Cost during pregnancy may indicate that higher number of complications may result in higher amount of cost. Still there are a significant percentage of women (28.0%) who did not spend any money during pregnancy. It may occur as a result of ignorance or less complication. Largest portion of women (47.2%) spent 500 or more cost during pregnancy. Here total cost at delivery and after delivery is also an important indicator of number of complications at delivery and postnatal. While 28.0% people did not spend any money during pregnancy, only 4.9% did not spend any money during delivery. Delivery place and delivery attendant, these two variables carry much importance in this study. Still now 75.5% delivery occurred in home and 73.8% delivery attendants are nomadically trained.

**Table 1: Univariate frequency table of explanatory variables**

| Background characteristics | Percent | Frequency | Background Characteristics | Percent | Frequency |
|---|---|---|---|---|---|
| **Mother's age at birth** | | | **Parity** | | |
| Below 20 | 14.8 | 2594 | 1 | 33.1 | 5797 |
| 20-24 | 36.7 | 6424 | 2 | 29.6 | 5188 |
| 25-39 | 46.4 | 8137 | 3 | 17.7 | 3108 |
| 40-49 | 2.1 | 366 | 4 | 9.4 | 1655 |
| **Residence** | | | 5+ | 10.1 | 1772 |
| Urban | 23.2 | 4056 | **Division** | | |
| Rural | 76.8 | 13465 | Barisal | 5.9 | 1027 |
| **Previous dismissed pregnancy** | | | Chittagong | 22.5 | 3950 |
| No | 93.4 | 16362 | Dhaka | 33.3 | 5830 |
| Yes | 6.6 | 1159 | Khulna | 9.5 | 1668 |
| Mother's education | | | Rajshahi | 21.3 | 3735 |
| No education | 23.5 | 4123 | Sylhet | 7.5 | 1311 |
| Incomplete primary | 16.3 | 2847 | **Household wealth index** | | |
| Complete primary | 16.1 | 2819 | Poorest | 22.4 | 3924 |
| Higher | 44.1 | 7733 | Poorer | 19.9 | 3484 |
| **Number of ANC** | | | Middle | 20.0 | 3498 |
| No ANC | 30.1 | 5260 | Richer | 19.2 | 3358 |
| 1 | 17.5 | 3068 | Richest | 18.6 | 3256 |
| 2 | 15.8 | 2770 | **ANC place** | | |
| 3 | 13.9 | 2433 | Home | 13.5 | 2359 |

| | | | | | |
|---|---|---|---|---|---|
| 4+ | 22.7 | 3970 | Health facility center | 86.5 | 15162 |
| **Pregnancy cost** | | | **Delivery & postnatal cost** | | |
| Nothing | 28.0 | 4449 | Nothing | 4.9 | 774 |
| <500 | 24.9 | 3961 | <500 | 31.6 | 5545 |
| 500>= | 47.2 | 7505 | 500>= | 54.7 | 9596 |
| **Delivery place** | | | **Delivery attendant** | | |
| Home | 75.5 | 13238 | Medically trained | 24.8 | 3943 |
| Health facility center | 22.8 | 4003 | Non medically trained or no one | 75.2 | 11954 |

**Univariate Poisson regression model**

We have applied univariate Poisson regression models on Bangladesh Maternal Mortality and Health Care Survey 2010 data. We have considered three count outcome variables (number of maternal complications during pregnancy, number of maternal complications at delivery, number of maternal complications after delivery). In this section we have conducted univariate Poisson regression, where the outcome variables are number of complications during pregnancy, delivery and postpartum.

From the **Table 2**, it appears that age less than 25 year is significantly associated with number of complications during pregnancy (p-value<0.05) as compared to age 40-49. Here number of complications at delivery is higher for all age groups than reference category and its direction is totally opposite with number of complications during pregnancy. But all age groups show insignificant difference with the reference category. Number of complications after delivery is higher in high age group, but all categories show insignificant association with number of complications after delivery. Parity 4 and parity 5 are almost similar and compared to parity 5, parity 2 and parity 3 are significant at 10 percent level during three stages of child bearing period. So, lower number of parity result less complications at any stages of child bearing period. At pregnancy urban group have 5% more chances of having complications than rural group and it is significant at 5 percent level. In division, high risk group is Sylhet which is the reference category, compared to Sylhet respondents from Chittagong division do not show significant association during pregnancy and postpartum. On the other hand remaining all other division show significant association compared to respondents from Sylhet division (p-value<0.001). This information may be useful for Bangladesh government that Sylhet division's women are facing higher number of complications at all maternal stages than any other division. Here higher category in education has less chance to face complication than others. Complete primary category shows nearly alike result as reference category and this is not significant. In wealth

index variable, reference category richest is in the safest position and remaining all other group show significant positive association compared to women from reference category. Women who have previous dismissed pregnancy are in high risk of having complications during pregnancy and postpartum than who have no previous dismissed pregnancy. Interpretation of ANC number needs the bivariate frequency distribution of ANC number with number of complications during pregnancy, univariate percentage of number of complications during pregnancy and bivariate association of number of antenatal care during pregnancy. From the **Table 3** and **Figure 1,** we can see 60% women reported no complication and 30.1% did not take any antenatal care. These two variables, number of complications during pregnancy and number of antenatal care, are closely interrelated. We get clear idea from the bivariate distribution those 67.0% women who had no complication they did not take any ANC. So, women who faced more complications received more ANC. Estimates for number of antenatal care from the **Table 2** gives us same scenario. Total cost at pregnancy variables all categories are significant compared to reference category (p-value<0.001). This variable also tells us women who had more complications they spent more money than others. Total cost at delivery and postpartum also give us same interpretation. One important variable here is delivery place which tells us that women whose delivery occurred at home faced more complications and this variable is significant (p-value<0.001). We can interpret the delivery attendant variable by using a bivariate frequency distribution (**Table 4**). From the **Table 4** we can see that 65% women from no problem category went to medically trained delivery attendant, which is smaller than remaining category. In 1 complication percentage of women have chosen medically trained person as delivery attendant is 26.4 percent, where nonmedically trained person was chosen by 19.3 percent women. So, women who had more complications went to medically trained person.

Table 2: Univariate Poisson model for number of maternal complication at three stages of child bearing period (Pregnancy, Delivery, Postpartum)

| | Pregnancy | | | Delivery | | | Postpartum | | |
|---|---|---|---|---|---|---|---|---|---|
| Parameter | Coeff | S.E. | p-value | Coeff | S.E. | p-value | Coeff | S.E. | p-value |
| Intercept | -0.72 | 0.09 | 0.00 | -1.43 | 0.15 | 0.00 | -2.04 | 0.17 | 0.00 |
| Age | | | | | | | | | |
| Ref:40-49 | | | | | | | | | |
| Below 20 | -0.17 | 0.08 | 0.04 | 0.19 | 0.11 | 0.08 | -0.01 | 0.11 | 0.97 |
| 20-24 | -0.18 | 0.08 | 0.02 | 0.11 | 0.10 | 0.26 | -0.17 | 0.10 | 0.11 |
| 25-39 | -0.11 | 0.07 | 0.12 | 0.04 | 0.10 | 0.69 | -0.14 | 0.10 | 0.15 |
| Parity | | | | | | | | | |
| Ref:5>= | | | | | | | | | |
| Parity 1 | -0.04 | 0.05 | 0.41 | -0.15 | 0.06 | 0.02 | -0.40 | 0.07 | 0.00 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Parity 2 | -0.25 | 0.05 | 0.00 | -0.33 | 0.06 | 0.00 | -0.33 | 0.06 | 0.00 |
| Parity 3 | -0.08 | 0.04 | 0.06 | -0.23 | 0.06 | 0.00 | -0.16 | 0.06 | 0.01 |
| Parity 4 | 0.02 | 0.05 | 0.70 | -0.11 | 0.06 | 0.07 | 0.03 | 0.06 | 0.59 |
| Residence | | | | | | | | | |
| Ref:rural | | | | | | | | | |
| Urban | 0.05 | 0.02 | 0.04 | -0.02 | 0.03 | 0.47 | 0.04 | 0.03 | 0.25 |
| Division | | | | | | | | | |
| Ref:Sylhet | | | | | | | | | |
| Barisal | -0.71 | 0.05 | 0.00 | -0.76 | 0.06 | 0.00 | -0.60 | 0.07 | 0.00 |
| Chittagong | -0.03 | 0.03 | 0.35 | -0.15 | 0.04 | 0.00 | -0.08 | 0.05 | 0.10 |
| Dhaka | -0.12 | 0.03 | 0.00 | -0.13 | 0.04 | 0.00 | -0.23 | 0.05 | 0.00 |
| Khulna | -0.78 | 0.05 | 0.00 | -0.89 | 0.06 | 0.00 | -0.92 | 0.07 | 0.00 |
| Rajshahi | -0.90 | 0.05 | 0.00 | -0.96 | 0.06 | 0.00 | -1.03 | 0.07 | 0.00 |
| Education | | | | | | | | | |
| Ref:Higher | | | | | | | | | |
| No education | 0.14 | 0.04 | 0.00 | 0.22 | 0.04 | 0.00 | 0.09 | 0.05 | 0.07 |
| Incomplete primary | 0.12 | 0.04 | 0.00 | 0.15 | 0.04 | 0.00 | 0.17 | 0.05 | 0.00 |
| Primary | 0.02 | 0.04 | 0.50 | 0.09 | 0.04 | 0.04 | 0.05 | 0.05 | 0.27 |
| Wealth index | | | | | | | | | |
| Ref:richest | | | | | | | | | |
| Poorest | 0.27 | 0.04 | 0.00 | 0.35 | 0.05 | 0.00 | 0.44 | 0.06 | 0.00 |
| Poorer | 0.26 | 0.04 | 0.00 | 0.34 | 0.05 | 0.00 | 0.39 | 0.06 | 0.00 |
| Middle | 0.14 | 0.04 | 0.00 | 0.27 | 0.05 | 0.00 | 0.35 | 0.06 | 0.00 |
| Richer | 0.08 | 0.04 | 0.03 | 0.20 | 0.04 | 0.00 | 0.25 | 0.05 | 0.00 |
| Previous dismis-sed pregnancy | | | | | | | | | |
| Ref:no | | | | | | | | | |
| Yes | 0.10 | 0.04 | 0.02 | 0.04 | 0.05 | 0.44 | 0.16 | 0.06 | 0.00 |
| Number of ANC | | | | | | | | | |
| Ref:no ANC | | | | | | | | | |
| ANC number 1 | 0.01 | 0.04 | 0.76 | 0.10 | 0.05 | 0.06 | 0.09 | 0.06 | 0.12 |
| ANC number 2 | 0.07 | 0.04 | 0.10 | 0.17 | 0.05 | 0.00 | 0.03 | 0.06 | 0.67 |
| ANC number 3 | 0.05 | 0.05 | 0.25 | 0.06 | 0.06 | 0.30 | 0.08 | 0.06 | 0.18 |
| ANC number 4+ | 0.08 | 0.04 | 0.06 | 0.10 | 0.05 | 0.06 | 0.16 | 0.06 | 0.01 |
| ANC place | | | | | | | | | |
| Ref:home | | | | | | | | | |
| Health facility center | -0.04 | 0.05 | 0.41 | 0.04 | 0.05 | 0.46 | 0.02 | 0.06 | 0.70 |
| Pregnancy cost | | | | | | | | | |
| Ref:nothing | | | | | | | | | |
| >500 | 0.26 | 0.04 | 0.00 | 0.02 | 0.05 | 0.63 | 0.05 | 0.06 | 0.32 |
| 500>= | 0.59 | 0.04 | 0.00 | 0.11 | 0.05 | 0.02 | 0.25 | 0.05 | 0.00 |
| Delivery & post-partum cost | | | | | | | | | |
| Ref:nothing | | | | | | | | | |
| >500 | | | | 0.14 | 0.08 | 0.09 | 0.47 | 0.11 | 0.00 |
| 500>= | | | | 0.69 | 0.08 | 0.00 | 1.26 | 0.11 | 0.00 |
| Delivery attendant | | | | | | | | | |
| Ref: Nonmedically trained or no one | | | | | | | | | |
| Medically trained (Doctor/ Nurse/Midwife/ Paramedic/FWV /CSBA/MA/SA CMO) | | | | 0.13 | 0.06 | 0.04 | -0.36 | 0.08 | 0.00 |
| Delivery place | | | | | | | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Ref:home | | | | | | | |
| Health facility center | | -0.15 | 0.06 | 0.01 | -0.01 | 0.08 | 0.85 |

Table 3: Bivariate percentage distribution of number of maternal complications during pregnancy and number of antenatal care

| Background characteristics | Number of maternal complications during pregnancy | | | | | |
|---|---|---|---|---|---|---|
| | 0 | 1 | 2 | 3 | 4 | Total |
| Number of ANC | | | | | | |
| No ANC | 67.0 | 25.7 | 6.1 | 1.0 | 0.2 | 5260(100.0%) |
| 1 | 57.8 | 31.0 | 9.3 | 1.7 | 0.1 | 3068(100.0%) |
| 2 | 57.6 | 30.6 | 8.5 | 2.8 | 0.4 | 2770(100.0%) |
| 3 | 59.5 | 29.7 | 8.3 | 2.3 | 0.2 | 2433(100.0%) |
| 4+ | 57.0 | 30.2 | 10.3 | 2.3 | 0.2 | 3971(100.0%) |

Table 4: Bivariate percentage distribution of number of maternal complications at delivery and delivery attendant

| Background Characteristics | Number of maternal complications at delivery | | | | | |
|---|---|---|---|---|---|---|
| | 0 | 1 | 2 | 3 | 4 | Total |
| Delivery attendant | | | | | | |
| Medically trained | 65% | 26.4% | 6.8% | 1.4% | 0.2% | 4265(100.0%) |
| Nonmedically trained or no one | 75.4% | 19.3% | 4% | 1% | 0.2% | 11631(100.0%) |

## DISCUSSION

Age variable has significant influence only during pregnancy stage. Young mothers (age below 25 years) have faced less complications compared with others. Although Bangladeshi women are lacking of education, socioeconomic status, etc., but Bangladesh has achieved a tremendous success in family planning programs within a very short period. According to macrotrends.net total fertility rate (TFR) of Bangladeshis is 2.0 which is the benchmark of standard TFR (source: https://www.macrotrends.net/countries/BGD/bangladesh/fertility-rate ). We can see from our results that which mothers have 2 children they have faced less complications at all stages than others. Here, higher number of parity is positively associated higher number of complications. In this study urban-rural difference didn't visible that much. Previous study (Tawabunnahar et al., 2021) showed that, women from Sylhet division are less likely to utilize maternal healthcare services (antenatal care, skilled delivery attendant) than women from other division. So, there is a high chance for these women (Sylhet division) to face more number of complications. Our study also revealed the same scenario about Sylhet division that women from this division are more likely to face higher number of complication at all maternal stages compared to their counterparts. The observed regional differences may be due to quality, availability, accessibility, etc. of services. Our government needs to find out a solution to improve this situation at Sylhet division. Bangladesh government has taken many policies to increase literacy rate of girls

because girls literacy is closely related with many sectors like early marriage, women empowerment (Matsumura and Gubhaju, 2001), improvement of women's socioeconomic status, increase awareness about maternal health (Fagbamigbe and Idemudia, 2015), etc. We can see from this study that treatment seeking behavior of primary completed and higher educated women is impressive. From the result it is clearly evident that women who are at least primary completed have faced less number of maternal complications. Wealth index is a predisposing factor which is interrelated with many other issues. Economic dividation could be a barrier to receive medical treatment at various stages of child bearing period (Meh et al., 2019). We can see an increasing trend of strong positive association of wealth index categories with higher number of complications from the result. Dismissed pregnancy is close to biological factor which can impact on future. Women who have the past record of dismissed pregnancy have high risk at facing maternal complications compared to their counterparts. Islam et al. (2004) had reported at their studies that ANC visit is positively associated with number of complications at pregnancy and delivery but negatively associated at postpartum. Our study also got the similar results about ANC visit. This result is not surprising at all. Actually there is a high chance that women who have faced more complications, they sought higher number of ANC visit from health facility center and also went to trained person at health facility center for their delivery. As a result they have spent money. Consequently these women faced less complication at postpartum period who went to trained delivery attendant. So, ANC visit, ANC place, delivery attendant, cost at various maternal stages and delivery place, these variables are very closely related. In a summary, we have found 5 important factors significantly associated with higher number of maternal complications: parity, division, education, wealth index and previous dismissed pregnancy. We have also found an important relationship among maternal complications and treatment seeking behavior related factors. In this study we have applied univariate Poisson regression model. Here we did not consider correlation among three maternal stages. In the future we will apply conditional marginal Poisson or negative binomial regression model to analyze this type of count data.

**Conclusion**

This study applied univariate Poisson regression model for analyzing count data. These models are expressed as Generalized Linear Model (GLM) and maximum likelihood method was used for estimation. Here model fitting procedure has been carried out by using the Newton Raphson

algorithm. At first we explored the data by univariate frequency table. Here number of complications at three stages of childbearing process, pregnancy, delivery and after delivery and background characteristics are explained. We have applied univariate count regression model (Poisson regression model) on maternal health data. From these results 10 important factors are identified which are parity, division, education, wealth index, previous dismissed pregnancy, ANC visit number, ANC place, cost at three stages of child bearing period, delivery attendant and delivery place. In a summary, women from higher number of parity group, Sylhet division, incomplete primary or no education group, poorer and poorest category, have previous dismissed pregnancy record are at high risk of facing more number of complications at different maternal stages. Women who have faced more problems at pregnancy they are more likely to take higher number of ANC at health facility center and also chosen medically trained person as delivery attendant. As a result they have faced less complications at postpartum stage.

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**Conflict of interest**

None

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