Contribution of Socio-Demographic Factors on Antenatal Care in Bangladesh: Modeling Approach

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Abstract **Background:** Antenatal care (ANC) is essential for both mother and child health well-being. The risk of maternal mortality and morbidity as well as neonatal deaths can be reduced substantially through regular and proper antenatal care taken and delivery under safe and hygienic conditions. An attempt has been made to disclose how many times antenatal care (ANC) was taken by the pregnant mother and to find out the contribution of socio-demographic factors on ANC. Moreover, an effort is concentrated to find out a functional relationship between number of visits of ANC and the respondents. **Data and methods:** Data and necessary information of 4,921 reproductive women were obtained from the Bangladesh Demographic and Health Survey (BDHS) 2007. Multiple classification analysis (MCA) was used to identify the most important determinants of number of antenatal visit. Furthermore, negative exponential model was also employed here. **Results:** The results reveal that majority (37.83%) women have not taken any ANC during pregnancy and 15.18%, 12.68%, 11.22% and 6.24%, pregnant women have taken 1, 2, 3 and 4 times of ANC respectively. The result also reveal that only 1.67% pregnant women have taken 10 and above times ANC. MCA results showed that living condition, living place during pregnancy and TT injection before birth have been found to be the first, second and third contributing factors on number of ANC of pregnant mother. The grand mean of MCA result is 3.59 which indicate insufficient dose of ANC of pregnant mothers. Moreover, it is found that distribution of the respondents due to number of visits of ANC follows modified negative exponential model. **Conclusions:** This study demonstrates the low ANC service utilization. The utilization of the ANC service was influenced by various socio-demographic and health related factors. Hence there is a need to increase the availability and accessibility of health services to all women. Women's overall status (education, living condition, living place during pregnancy and preceding birth interval) need to be considered.

Keywords Antenatal care, Pregnant women, Multiple classification analysis (MCA), Modified negative exponential model, Cross validity prediction power (CVPP), F-test

1. Introduction

Antenatal care (ANC) is the significant determinants of maternal health and vital for the health of mothers and their infants (AbouZahr, 2003). Lack of such care is commonly associated with the premature delivery, maternal and neonatal mortality (Rahman et al., 2007). Also, ANC has a positive impact on the utilization of postnatal healthcare (PNC) services which can significantly help to reduce maternal mortality because most maternal deaths occur in the first week after delivery (Hurt et al., 2008).

Bangladesh has strengthened its ANC under the Directorate General of Health Services, through national and international collaborations (Islam et al., 2006). But the utilization of these services is very poor. It is reported that 55% of the pregnant women in Bangladesh make one ANC visit and about one-fourth (21%) of the pregnant women in Bangladesh make four ANC visit against four visits recommended by the World Health Organization (WHO) (NIPROT, 2009). About 63% of the pregnant women were not informed about the sign of pregnancy complication and only 10% of births are assisted by medically trained personnel (NIPROT, 2012). Again about 55% of the mothers received care from a medically trained provider, such as doctor, nurse, midwife, family welfare visitor, community skill birth attendant and medical assistant (Shahjaha et al., 2012). Efforts to address these issues have recently gained considerable attention with the formulation of the National Strategy for Maternal Health (MOHFW, 2011). This strategy emphasizes the provision of ANC and is predicated the framework of factors that affect safe motherhood service utilization (Carroli et al., 2004). These factors are related to decision to seek care, in reaching a medical facility and in receiving adequate treatment (Michael et al., 2007 and Dickstein et al., 2008). Improvement of these factors shows

the positive association to reduction of the maternal mortality (Sunil *et al.*, 2010).

Despite improvements, pregnancy related complications remain the leading cause of death and disability among women during pregnancy (Gill and Ahmed, 2004). Available information suggests that about 12,000 women in Bangladesh die due to pregnancy-related complications (Anwar *et al.*, 2009). So that, developing the ANC is importance which require the actual determinates of ANC services. There exists many studies into the determinants of ANC. Pervin *et al.* (2012) indicated the delivery facility as the important determinant of ANC. Nafisa *et al.* (2011) identified that maternal education was the significant determinants of ANC and paternal education played a more important role in the use of routine antenatal care than the conventional wisdom suggests. Islam and Odland (2011) identify that urban rural differences, level of education and distance of service centre are significantly associated with the total number of ANC during pregnancy. Rahman *et al.* (2008) explained that urban rural differentials were significant in receiving antenatal care. Abedin *et al.* (2008) observed that respondent's education, husband's education and occupation, place of residence, current use of contraception, frequently visit of health workers to the respondents have been statistically significantly associated with the utilization of antenatal care received during pregnancy. Rahman *et al.* (2010) found that demographic and socio-economic factors were associated with ANC seeking behaviour among slum mothers in Bangladesh. Similar results were also found in case of Azerbaijan (Habibov, 2011). Michael *et al.* (2007) identified that socio economic disparities is the major causes of variation of antenatal care and antenatal care services that was more improved high social class. But, the studies by covering the broad range of socio economic and demographic factors associated with ANC services received are scanty.

The purpose of this study was to determine the socio-demographic factors associated with ANC in Bangladesh. Moreover, an effort was given to find out a mathematical relationship between number of visits of ANC and the respondents. This can be helpful for the policy makers to initiate strategies in the aspect of improvement of ANC services.

2. Methods

2.1. Sources of Data

The study utilized a representative set of cross-sectional data extracted from the Bangladesh Demographic and Health Survey (BDHS) 2007 was the fifth national level Demographic and Health Survey. The surveys maintained all the protocols prescribed by the World Health Organization and written consent were taken individually from all respondents. The surveys were carried out to provide up-to-date information on fertility and childhood mortality levels; fertility preferences; awareness, approval, and use of family planning methods; maternal and child health; knowledge and attitudes toward sexually transmitted infections; community-level data on accessibility and availability of health and family planning services; and prevalence of non-communicable diseases. These were designed to produce representative results for the country as a whole, for urban and rural areas separately, and for each of the seven administrative divisions. All ever-married women 12-49 years who were usual members of the selected households and those who spent the night before the survey in the selected households were eligible to interview. The details of the sampling survey design, survey instruments and quality control are reported elsewhere (NIPORT, 2009). However, a brief description is given in the following subsections.

2.2. Sampling and Sample Size Selection

The sample for the survey was the nationally representative survey and covered the entire population residing in non-institutional dwelling units in the country. The survey used the lists of enumeration areas (EAs) prepared for the 2001 Population and Housing Censuses provided by the Bangladesh Bureau of Statistics as the sampling frames. An EA can include a group of small villages, or a village, or a part of large village. The primary sampling units for the surveys were the EAs that were created to have the average of about 100. The surveys contained location information, type of residences, the number of residential households, and number of males and females in the population. Administratively, Bangladesh has six administrative divisions: Barisal, Chittagong, Dhaka, Khulna, Rajshahi and Sylhet. Each division was subdivided into *zilas* (districts), and each *zila* into *upazilas* (sub-districts). Each urban area in an *upazila* was divided into wards, and into *mohallas* (an area of a town or village; a community) within a ward. A rural area in the *upazila* was divided into *Union Parishads* (UP) (the smallest rural administrative and local government units) and *mouzas* (a specific land area within which there may be one or more settlements) within a UP. These divisions allowed the country as a whole to be easily separated into rural and urban areas. The samples were stratified and selected in two stages. Each division was stratified into urban and rural areas. For analytical purposes, the data were restricted to ever-married women who were given birth within five year preceding the survey. So, non-pregnant women were excluded from this study to increase the specificity of the indicator because ANC services related to pregnant women. After excluding the women with missing information, finally data of 4,921 women were extracted from BDHS 2007.

2.3. Outcome and Explanatory Variables

Number of antenatal care taken by the mother during pregnancy was considered the outcome variable of this study. Living condition of the respondents, antenatal care taken by

the doctor or nurse/midwife, living place during pregnancy, antental: CS: family welfare visitor, respondents education, respondents husband occupation, preceding birth interval, age at marriage and TT injection before birth were considered the explanatory variable.

2.4. Statistical Analysis

2.4.1. Multiple Classification Analysis (MCA)

In this study, multiple classification analysis (MCA) was used as statistical tool to evaluate the contribution of socio-demographic and health related variables. In this section, numbers of ANC of mothers have taken during pregnancy considered as dependent variable. Others variable were considered as explanatory variables. The Statistical Package for Social Sciences version 16.0 (SPSS Inc, Chicago, IL, USA) was used for statistical analysis.

2.4.2. Model Fitting

Using the scattered plot (Fig.1) of the respondents due to number of visits of ANC, it seems that the data can be fitted by modified negative exponential model. Therefore, a modified negative exponential model is considered and the form of the model is

$$y = c + \exp(a\text{-}b\text{*}x) + u.$$

where, x is the number of visits of ANC; y is the respondents; a. b. c are parameters but c is the modified term of the model and u is the disturbance term of the model. The software STATISTICA was used to fit the mathematical model.

2.4.3. Model Validation Technique

To check how much the model is stable over population, the cross validity prediction power (CVPP), ρ_{cv}^2, is applied. Here

$$\rho_{cv}^2 = 1 - \frac{(n-1)(n-2)(n+1)}{n(n-k-1)(n-k-2)}(1-R^2) \text{ (Stevens, 1996)}$$

where, n is the number of cases, k is the number of predictors in the model and the cross validated R is the correlation between observed and predicted values of the dependent variable. The shrinkage coefficient of the model is the positive value of (ρ_{cv}^2 - R^2); where ρ_{cv}^2 is CVPP and R^2 is the coefficient of determination of the model. 1-shrinkage is the stability of R^2 of the model. The information on model fittings and estimated CVPP have been demonstrated in the result section. This technique was also used as model validation technique (Islam et al., 2004; Islam, 2004, 2005a; 2005b; 2007a, 2007b; 2008; 2011, 2012a; 2012b; 2013; Islam & Hossain, 2013a; 2013b; 2014a, 2014b; Hossain & Islam, 2013; Islam et al., 2013; 2014; Islam & Hoque, 2015).

2.4.4. F-test

To verify the measure of overall significance of the model as well as the significance of R^2, the F-test is employed here. The formula for F-test is given below:

$$F = \frac{R^2 / (k-1)}{(1-R^2) / (n-k)}$$

With (k-1, n-k) degrees of freedom and k = the number of parameters is to be estimated, n = the number of cases and $\mathbf{R^2}$ is the coefficient of determination of the model.

3. Results

A total of 4,921 women who were given birth preceding five years of survey were included in this study. The study showed that majority (37.83%) women had not taken any ANC during pregnancy and only 1.67% women received ANC more than 10 times (Table 1).

Table 1. Percentage of number of antenatal care taken by the women aged 15-49 years of BDHS-2007 in Bangladesh

Number of visits of ANC	Frequency	Percentage
0 (No antenatal visits)	1862	37.83
1	747	15.18
2	624	12.68
3	552	11.22
4	307	6.24
5	240	4.88
6	174	3.54
7	146	2.97
8	126	2.56
9	61	1.24
10+	82	1.67
Total	4921	100.0

Intensity of the effects of various implied factors on the number of ANC taken by mother during pregnancy were assessed by MCA and the results were presented in Table 2. Moreover, grand mean, proportion of variation (R^2) have also presented in this table. About 13.1% (R^2 = 0.131) variation is explained by this model. The grand mean is 3.59.

Associated factors of the number of visits of ANC services were determined through the MCA presented in Table 2. According to this table respondents living condition, living place during pregnancy, taken TT injection before birth, preceding birth interval, respondent education, antenatal care taken by the nurse/midwife, husband occupation, antenatal care taken by the doctor, respondent's age at first marriage, antenatal care taken by the family welfare visitor have strongest influential factor successively for explaining the variation on number of antenatal care taken during pregnancy.

Living condition of the respondents has found to be strongest (β^2 = 0.291) influential factor for explaining the variation of the ANC and highest adjusted mean of ANC is found in the respondents having the rich living condition.

Lowest mean of ANC visit was observed in the poor living condition. Living place of the respondents was also important determinant of the number of ANC care during pregnancy. It is found to be second most important factor and have 17.6% contribution on the number of ANC. Again the respondents live in the town/city has the higher number of ANC (3.83) during pregnancy compared to the respondents in the village area. Respondents taken TT injection before birth had found to be third most important influential factors. It was about 8.6% contribution of the number of ANC taken and respondents were taken the ANC showed the higher mean values of ANC taken (3.70). On average similar contribution was also observed in the husband occupation (6.3%) and the higher mean duration of ANC taken observed among the respondents with the professional husband (3.86).

Respondents education also had the important effect on number of ANC and the higher educated respondents had the higher mean duration of ANC taken (4.04) than primary educated respondents (3.48). Similar difference was also observed among the respondents whose marriage taken early to late age. It is observed that, age at first marriage was about 5.4% contribution on number of ANC taken and highest mean value (5.05) of ANC taken observed in the respondents whose marriage take place at age 25 or more. Early marriage aged respondents showed the lowest mean value of ANC (3.49).

Moreover, it is also observed that the number of mean value antenatal care taken during pregnancy varied among the various socio economic and demographic characteristics.

Table 2. Results of MCA of the number of visits of ANC taken by the mothers during pregnancy by some socio-demographic and health related characteristics

| Explanatory variables	Predicted mean		Correlation ratio	
	Unadjusted	Adjusted	η^2 (Unadjusted)	β^2 (Adjusted)
Living condition				
Poor	2.56	2.53	0.285	0.291
Middle	3.32	3.33		
Rich	4.39	4.40		
Antenatal care taken by the doctor				
No	3.05	3.40	0.132	0.048
Yes	3.85	3.68		
Antenatal care taken by nurse/midwife				
No	3.57	3.54	0.017	0.056
Yes	3.75	4.11		
Living place during pregnancy				
Village	2.33	2.56	0.217	0.176
Town/city	3.89	3.83		
Antenatal care seeking (family welfare visitor)				
No	3.83	3.50	0.022	0.008
Yes	3.57	3.59		
Respondents education				
Primary	3.74	3.48	0.081	0.056
Secondary	3.37	3.73		
Higher	2.97	4.04		
Husband occupation				
Professional	3.42	3.86	0.034	0.053
Non professional	3.64	3.51		
Preceding birth interval (in month)				
≤24	3.34	3.44	0.054	0.063
25-36	3.38	3.32		
≥37	3.71	3.73		
Age at first marriage				
<18 years	3.66	3.49	0.082	0.034
18-25 years	2.86	3.59		
>25 years	3.25	5.05		
TT injection before birth				
No	3.21	3.07	0.063	0.086
Yes	3.67	3.70		
Grand mean = 3.59, Multiple R^2 = 0.131 and Multiple R = 0.362				
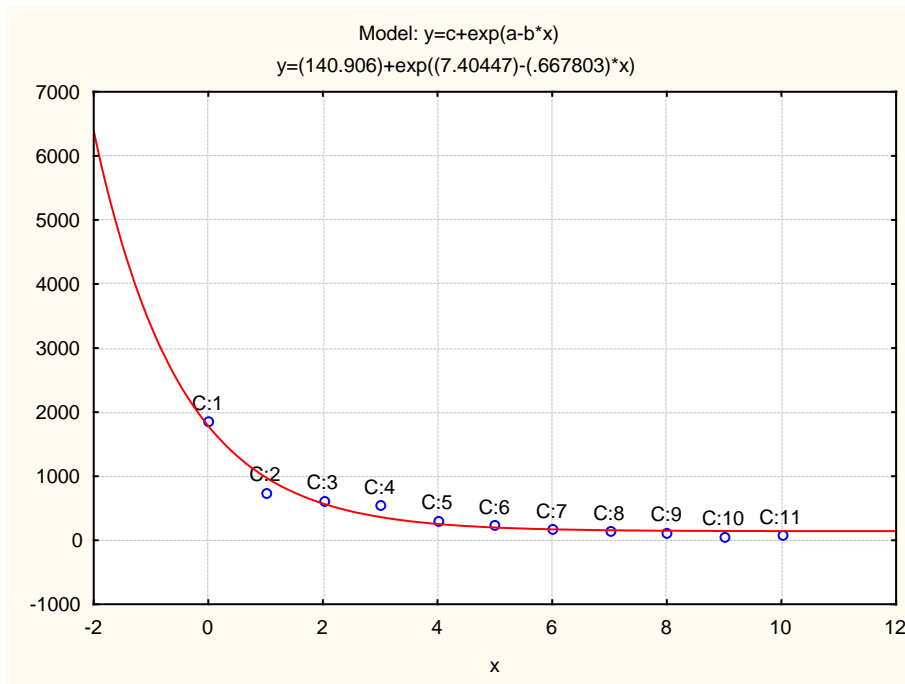
Figure 1. The graph of observed and fitted distribution of respondents due to number of visits of ANC

The required fitted model is addressed in the following along with information of model fittings:

$$Y = 140.906 + \exp(7.40447 - 0.667803x)$$

t-stat	2.3568	102.5445	4.630480
p-value	0.0462	0.0000	0.001687

with coefficient of determination (R^2) = 0.95765, CVPP = 0.94225, shrinkage coefficient = 0.0154 and stability of R^2 = 0.9846.

From these statistics it is found that the fitted model is highly cross validated and the shrinkage is also very small. Moreover, it is observed that all the parameters of the fitted model are statistically significant with large proportion of variation explained and the proportion of variation is more than 95%. And the stability of the model is more than 94%. The stability of R^2 of this model is also more than 99%.

Moreover, calculated F-test is 90.45 with (2, 8) degrees of freedom but its tabulated value is only 8.65 at 1% level of significance. Therefore, from these statistics it is found that fitted model is highly statistically significant. Hence, the fit of the model is very well.

4. Discussions

The antenatal period is important for the health of mother and her up-coming baby. It is considered an important factor for improving infant survival. By considering this fact every region has initiated the program and policies and extends antenatal care coverage. However due to many factors women poorly recognize child bearing is problematic and therefore seek care (Chandhiok et al., 2006). The result of the present study showed that 37.83% mothers not received ANC services and only 6.24% mothers received ANC services four times. About 15.18% mothers received ANC services at least one times and about 12% received ANC service at least two (12.68%) and three (11.22%) times during the entire period of pregnancy. These findings are consistent with the recent study of India (Agrawal, 2010) and North Godar zone in Ethiopia (Nigussie et al., 2004) where about 60% and 45.7% mothers had antennal visit. The result of our study showed that living condition of the mothers was the most important strongest influential factor for the ANC service received. Mothers in poor live setting is less likely to received ANC services than that of rich. This finding is consistent with the others findings in Ghana (Arthur, 2012). Difference also observed among the mothers in rural and urban area. This is due to the improved medical facilities in urban area with good transportation system (Arthur, 2012). The findings of present study is consistent with the others findings in Vietnam (Tran et al., 2011; Tran et al., 2012) and Haiti (Alexander et al., 2005). Again mothers with the higher education had the highest percentage of adequate ANC use compared to those with primary education. The average number of ANC visit was higher in higher educated mothers (4.04) than the primary (3.48) and secondary educated mothers (3.73). The higher educated mother was higher than the four times minimum visits prior to delivery recommended by WHO, while that of the primary and secondary educated mothers was lower than the recommended average by WHO. This findings is consistent with others findings of Indonesia (Erlindawati et al., 2008), Bangladesh (Shahjahan et al., 2012), Vietnam (Tran et al., 2011), Haiti (Alexander et al., 2005) and Ghana (Arthur, 2012). Husband occupation is also considered importance influential factors for the ANC service received. The living

standard of the mothers is mainly depended upon the husband occupation in the traditional families setting (Islam and Odland, 2011). This result is also consistent with findings of Ethiopia (Gedefaw *et al.,* 2014), Nigeria (Onasoga *et al.,* 2012) and Bangladesh (Islam and Odland, 2011).

Age at first marriage is another strongest influential factor of ANC services. The present study shows that the mothers with low age at first marriage (<18 years) have the higher mean value of ANC service received. The possible reasons may be mothers with the low age at first marriage have faced greatest pregnancy complication (Sumon, 2014). This facts contribute to the higher mean value of ANC visit and consistent with the findings of Nepal (Pradhan *et al.,* 2013) and the cross sectional study of South Asia (Godha *et al.,* 2013). Similar result was also observed among the mother with highest birth interval. Mothers whose duration of childbearing at least 3 years has the highest mean value of ANC service received (3.73) than the mothers having at least two years birth interval (3.34). The findings of the present study is consistent with the others findings of Nigeria (Uthman *et al.,* 2013) and Bangladesh (Islam and Odland, 2011).

5. Conclusions

The present study highlights the relationship with ANC and some socio-demographic and health related factors. Living condition of the respondents, living place during pregnancy, taken TT injection before birth, preceding birth interval, respondent education, antenatal care taken by the nurse/midwife, husband occupation, antenatal care taken by the doctor, respondent's age at first marriage, antenatal care taken by the family welfare visitor are the most strongest influential factors for the ANC services. It is also investigated that distribution of subjects due to ANC visit follows the modified exponential model. Therefore, improvement of the socio economic status of the mothers must be intensified in order to increasing ANC services. In a long run, informal education to raise the awareness about necessary of ANC services and involvement of husband in this process are recommended. Furthermore, it is also recommended that this negative exponential model should convert to positive exponential model for better health of the mothers and their child.

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Abbreviations

ANC: Antenatal care, PNC: Postnatal care, WHO: World Health organization, MCA: Multiple classification analysis, BDHS: Bangladesh Demographic and Health Survey.

REFERENCES

[1] Abou Zahr C (2003). Safe motherhood: a brief history of the global movement 1947-2002. *Br Med Bull*, 67:13-25.

[2] Abedin S, Islam MR and Hossain T (2008). Antenatal Care During Pregnancy: A Study on Naogaon District of Bangladesh, The Social Sciences, Vol. 3(8): 537-541.

[3] Agrawal PK (2010). How much the Indigenous Women of Jharkhand, India are in disadvantageous condition: finding's from India's National Family Health Survey. *Asian Ethnicity*, 11(1):61-80.

[4] Alexander PK, Saint-Jean G, Crandall L, Fevrin E (2005). Prenatal care utilization in rural areas and urban areas of Haiti. *Rev Panam Salud Publica*, 18(2): 84 - 92.

[5] Anwar I, Kalim N, Koblinsky M (2009). Quality of obstetric care in public-sector facilities and con-straints to implementing emergency obstetric care services: evidence from high- and low-performing districts of Bangladesh. *J Health Popul Nutr,* 27:139-55.

[6] Arthur E (2012). Wealth and antenatal care use: implications for maternal health care utilization in Ghana. *Health Economics Review*, 2:14.

[7] Carroli G, Rooney C, Villar J (2004). How effective is antenatal care in preventing maternal mortality and serious morbidity? An overview of the evidence. *Paediatr Perinat Epidemiol*, 15(1):1–42.

[8] Chandhiok N, Dhillon BS, Kambo I, Saxena NC (2006). Determinants of antenatal care utilization in rural areas of India: a cross-sectional study from 28 districts (an ICMR task force study). *J Obstet Gynecol India*, 56:47-52.

[9] Dickstein Y, Ohel I, Levy A, Holcberg G, Sheiner E (2008). Lack of prenatal care: an independent risk factor for perinatal mortality among macrosomic newborns. *Arch Gynecol Obstet*, 277(6):511-514.

[10] Erlindawati , Chompikul J, Isaranurug S (2008). Factors related to the utilization of antenatal care services among pregnant women at health centers in Aceh Besar district, Nanggroe Aceh Darussalam prov-ince, Indonesia. *J Public Health Dev*, 6:99-108.

[11] Gedefaw M, Muche B, Aychiluhem M (2014). Current Status of Antenatal Care Utilization in the Context of Data Conflict: The Case of Dembecha District, Northwest Ethiopia. *Open Journal of Epidemiology*, 4:208-216.

[12] Gill Z, Ahmed JU (2004). Experience from Bangladesh:

implementing emergency obstetric care as part of the reproductive health agenda. *International Journal of Gynecology and Obstetrics,* 85: 213-220.

[13] Godha D, Hotchkiss DR, Gage AJ (2013). Association between child marriage and reproductive health outcomes and service utilization: a multi-country study from South Asia. Journal of Adolescent Health, 52(5):552–558.

[14] Habibov NN (2011). On the socio-economic determinants of antenatal care utilization in Azerbaijan: evidence and policy implications for reforms. *Health Economics, Policy and Law*, 6(2):175 - 203.

[15] Hossain MS & Islam M R (2013) Age Specific Participation Rates of Curacao in 2011: Modeling Approach. *American Open Computational and Applied Mathematics Journal*, 1(2):08 - 21.

[16] Hurt LS, Alam N, Dieltiens G, Aktar N, Ronsmans C (2008). Duration and magnitude of mortality after pregnancy in rural Bangladesh. *International Journal of Epidemiology*, 37(2): 1-8.

[17] Islam MR, Odland JO (2011). Determinants of antenatal and postnatal care visits among Indigenous people in Bangladesh: a study of the Mru Community. *Rural and Remote Health,* 11:1-13

[18] Islam MT, Haque YA, Waxman R, Bhuiyan AB (2006). Implementation of Emergency Obstetric Care Training in Bangladesh: Lessons Learned. *Reproductive Health Matters*, 14(27): 61-72.

[19] Islam MR (2004). Mathematical Modeling of Age Specific Fertility Rates in the Rural Area of Bangladesh. *J. of Science, Rajshahi University Studies*, 32 (B):211-227.

[20] Islam MR, Islam MN, Rahman MM (2004). Trends and Patterns of Reproductivity Decline in Bangladesh: 1956-1998. *Man in India*, 84(1 & 2): 85-97.

[21] Islam MR (2005a). Construction of Abridged Life Tables and Indirect Estimation of Some Mortality Measures of Bangladesh in 2005. *Journal of Population, Indonesia*, 11(2): 117-130.

[22] Islam MR (2005b). Mathematical Modeling of Age Specific Marital Fertility Rates in Urban Area of Bangladesh. *Pakistan J. of Statistics*, 21(3):289-295.

[23] Islam MR (2007a) Construction of Abridged Life Tables and Indirect Estimation of Some Mortality Measures of Bangladesh in 2005. *Journal of Population, Indonesia*, 11(2): 117-130.

[24] Islam MR (2007b) Predicting Population for Male of Rural Area in Bangladesh. *J. of Statistical Research of Iran*, 4(2):227-238.

[25] Islam MR (2008) Modeling Age Structure for Female Population in Rural Area of Bangladesh. *J. of Interdisciplinary Mathematics*, 11(1):29-37.

[26] Islam MR (2011) Modeling of Diabetic Patients Associated with Age: Polynomial Model Approach. *International Journal of Statistics and Applications*, 1(1):1-5.

[27] Islam MR (2012a) Mathematical Modeling of Age and of Income Distribution Associated with Female Marriage Migration in Rajshahi, Bangladesh. Research *Journal of Applied Sciences, Engineering and Technology*, 4(17): 3125-3129.

[28] Islam MR (2012b) Modeling and Projecting Population for Muslim of Urban Area in Bangladesh. *International Journal of Probability and Statistics,* 1(1):4-10.

[29] Islam MR & Hossain MS (2013a) Mathematical Modeling of Age Specific Adult Literacy Rates of Rural Area in Bangladesh. *American Open Demography Journal*, 1(1): 1-12.

[30] Islam MR and Hossain MS (2013b) Mathematical Modeling of Age Specific Participation Rates in Bangladesh. *International Journal of Scientific and Innovative Mathematical Research*, 1(2):150-159.

[31] Islam MR (2013) Modeling Age Structure and ASDRs for Human Population of Both Sexes in Bangladesh. International Journal of Anthropology, Vol. 28, No. 1, pp: 47-53.

[32] Islam MR, Ali MK & Islam MN (2013) Construction of Life Table and Some Mathematical Models for Male Population of Bangladesh. *American Journal of Computational and Applied Mathematics,* 3(6): 269-276.

[33] Islam MR and Hossain MS (2014a). Some Models Associated with Age Specific Adult Literacy Rates of Urban Area in Bangladesh. *International Journal of Ecosystem,* 4(2): 66-74.

[34] Islam, M. R. and Hossain, M. S. (2014b). Mathematical Modeling of Age Specific Adult Literacy Rates in Bangladesh, *Advances in Life Sciences, Vol.* 4(3): 106-113.

[35] Islam, M.R., Hossain, M.S. and Faroque, O. (2014). U-Shaped Pattern of Employees' Job Satisfaction: Polynomial Model Approach, International Journal of Ecosystem, Vol. 4(4): 170-175.

[36] Islam, M. R. and Hoque, M.N. (2015). Mathematical Modeling and Projecting Population of Bangladesh by Age and Sex from 2002 to 2031. *Emerging Techniques in Applied Demography*, *Applied Demography* Series 4, Chapter 5: 53-60.

[37] Magadi, M, A., Madise, N, J., Rodrigues, R, N. (2000). Frequency and timing of antenatal care in Kenya: explaining variations between women of different communities, *Social Science and Medicine,* 51(4): 551-561.21.

[38] Michael A, Koenig, Jamil K, Peter KS, Saha T, Sabir A, Arifeen SH, Hill K, Haque Y (2007). Maternal Health and Care-Seeking Behavior In Bangladesh: Findings from a National Survey. *International Family Planning Perspectives*, 33(2):75–82

[39] Ministry of Health and Family Welfare (MOHFW), *Bangladesh National Strategy for Maternal Health,* Dhaka, Bangladesh: MOHFW, 2011.

[40] Nafisa Halim, Alok K Bohara and Xiaomin Ruan (2011). Healthy mothers, healthy children: does maternal demand for antenatal care matter for child health in Nepal. *Health Policy and Planning*, 26:242–256.

[41] National Institute of Population Research and Training (NIPORT), Mitra and Associates, and Macro International, 2009. Bangladesh Demographic and Health Survey 2007. Dhaka, Bangladesh and Calverton, Maryland, USA. Mitra

and Associ-ates, and ICF International, 2009.

[42] National Institute of Population Research and Training (NIPORT), Mitra and Associates, and ICF International. Bangladesh Demographic and Health Survey 2011. Dhaka, Bangladesh and Calverton, Maryland, USA: Mitra and Associ-ates, and ICF International, 2013.

[43] Nigussie M, Haile Mariam D, Mitike G (2004). Assess-ment of safe delivery service utilization among women of childbearing age in north Gondar zone, northwest Ethiopia. *Ethiop J Health Dev*, 18:45-52.

[44] Onasoga, Olayinka A. Afolayan, Joel A, Oladimeij, Bukola D (2012). Factors influencing utilization of antenatal care services among pregnant women in Ife Central Lga, Osun State Nigeria. *Adv. Appl. Sci. Res.,* 3(3):1309-1315.

[45] Pervin J, Moran A, Rahman M, Razzaque A, Sibley L,Streatfield PK, Reichenbach LJ, Koblinsky M, Hruschka D, Rahman A (2012). Association of antenatal care with facility delivery and perinatal survival – a population-based study in Bangladesh. *BMC Pregnancy and Childbirth*, 12: 1-12.

[46] Pradhan PM, Bhattarai S, Paudel IS, Gaurav K, Pokharel PK (2013). Factors contributing to antenatal care and delivery practices in Village Development Committees of Ilam district, Nepal. *Kathmandu Univ Med J.,* 11(41):60-5.

[47] Rahman MM, Islam MR, Islam AZ (2008). Rural-Urban Differentials of Antenatal Health Care Service in Bangladesh. *Health Policy and Development*, 6(3):117-125.

[48] Rahman, MM, Islam MR and Rahman, MM (2010) Antenatal Care Seeking Behavior among Slum Mothers: A Study of Rajshahi City Corporation, Bangladesh, Sultan Qaboos University Medical Journal, Vol. 10, No. 1, pp. 50-56.

[49] Rahman, MM., Islam, MN. and Islam, MR. (2007). Effects of Antenatal and Delivery Care on Neonatal Mortality: A Study

of Rajshahi District, Bangladesh, J. of Population, 13 (2):165-177.

[50] Shahjaha M, Chowdhury HK, Akter J, Afroz A, Rahman MM, MA Hafez MA (2012). Factors associated with use of antenatal care services in a rural area of Bangladesh *South East Asia Journal of Public Health*, 2(2):61-66.

[51] Sumon MNK (2014). Differentials and Determinants of Early Marriage and Child Bearing: A study of the Northern Region of Bangladesh. *Int. j. sci. footpr*. 2(1): 52–65.

[52] Sunil T, Spears W, Hook L, Castillo JCT (2010). Initiation of and barriers to prenatal care use among low-income women in San Antonio, Texas. *Matern Child Health J*, 14(1):133-140.

[53] Stevens, J. (1996) Applied Multivariate Statistics for the Social Sciences. Third Edition, Lawrence Erlbaum Associates, Inc., Publishers, New Jersey.

[54] Tran TK, Gottval K, Nguyen HD, Ascher H, Petzold M (2012). Factors associated with antenatal care adequacy in rural and urban- results from two health and demographic surveillance sites in Vietnam. *BMC Health Services Research*, 12: 40-51.

[55] Tran TK, Nguyen CTK, Nguyen HD, Eriksson B, Bondjers G, Gottval K, Ascher H, Petzold N (2011). Urban-rural disparities in antenatal care utilization: a study of two cohorts of pregnant women in Vietnam. *BMC Health Services Research*, 11: 12-130.

[56] Uthman SG, Garba MA, Danazumi AG, Mandara MU, Sylvester NH (2013). How Birth Interval and Antenatal Care Affects Postpartum Haemorrhage Prevention in Maiduguri, Nigeria. *Journal of Applied Pharmaceutical Science*, 3(3): 036-039.

[57] WHO (2007). Maternal mortality in 2005: Estimates developed by WHO, UNICEF, UNFPA and the World Bank. Geneva: World Health Organization, 2007.