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Preterm delivery and its associated factors among mothers in Bangladesh: survey in Rajshahi district

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ABSTRACT

Objectives Preterm delivery (PD) is a worldwide health burden particularly in low-income and middle-income countries such as Bangladesh. It is a key indicator of neonatal mortality and a risk of morbidity in later life. This study aimed to determine the prevalence of PD and its associated factors among mothers in Northern region of Bangladesh.

Setting and participants Multistage sampling technique was used to select samples covering all the population from 9 Upazilas in Rajshahi district with 233 community clinics. A total of 540 mothers and their under-5 children were enrolled for the study. Descriptive statistics, χ^2 test and logistic regression model were used to analyse the data.

Results Among all live births, the prevalence of PD was found to be 14.6%. Multiple binary logistic regression model suggested five factors of PD: (1) mothers who used contraceptive pill had lower chance of PD ($p<0.05$); (2) mothers with high fever during pregnancy period were more likely to have PD ($p<0.05$); (3) mothers who did not receive antenatal care service less than four times during pregnancy period had higher chance of PD ($p<0.01$); (4) mothers first married before 18 years who were more likely to have PD ($p<0.01$); (5) PD delivered mothers had more chance to get low birth weight children ($p<0.05$). In addition, unadjusted model demonstrated that mothers delivered first baby before their age<20 years were more risk to get PD ($p<0.05$).

Conclusion Approximately one in seven infants was born preterm in our study area. Family planning method, number of antenatal care visit, mothers' age at marriage and high fever during pregnancy were the most important predictors of PD, these factors could be considered to reduce PD among Bangladeshi mothers. PD risk could be reduced by counselling and encouraging women to take antenatal care facilities from trained health providers.

STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ Factors influencing outcome were adjusted by appropriate statistical method.
⇒ Gestational age records derived from maternal accounts of last menstrual period might sometimes be prone to errors.
⇒ Some of the risk factors such as previous preterm births, preterm stillbirth, cervical length, etc were not considered.
⇒ Some information were collected on the basis of recall method might subject to some bias.

INTRODUCTION

Globally, prevention of preterm delivery (PD) is one of the major public health issues.[1] Every year, on an average, 15.0 million offspring are preterm birth around the world,[1] among them 13.3% has occurred in South Asia.[2] Annually, worldwide 35% of neonatal mortality has caused due to preterm condition[1] and 1.055 million under-5 children die due to PD,[3] and most of the PD children are suffering from lifetime complications such as learning disability, hearing problems, sensory deficits, respiratory illness, diabetes, cardiovascular and renal disease in adulthood.[4 5] Burden of PD was disproportionately concentrated in Africa (31%) and Asia (54%). More than 70% of reported PD occurred in low-income and middle-income countries in South Asia and sub-Saharan Africa.[6 7] In 2015, UNICEF predicted that 23 600 under-5 children in Bangladesh would die due to complications related to PD in the year of 2019.[8] PD is one of the factors associated with adverse maternal outcomes, and also with morbidity and mortality among under-5 children.[9] Preterm babies have a higher risk of dying as reported by a multicountry study conducted in low-income and middle-income countries.[10] PD has been enhancing higher cost inference for health overhauls handling.[11]

Pregnancy period is a critical stage for mother's health, fetuses and neonates.[12] Various sociodemographic factors such as gender of the baby, maternal age, mother's education level, maternal nutritional status and birthweight of the child have been associated with PD.[13 14] Some pregnancy-related factors such as interval between pregnancies, place

of delivery, method of family planning, high fever during pregnancy, anaemia, vaginal bleeding during early pregnancy, no ante-natal care and use of iron–folic supplementation were also noted as risk factors for PD.[15–20]

For better understanding of these contributory factors of PD in a community, it is essential to conduct detailed risk assessment with more innovative strategies on the subject.[21] A few studies have reported risk factors of PD in Bangladesh.[22 23] Rahman *et al* studied time trends and social, reproductive and environmental determinants of PD using a population-based data from Health and Demographic Surveillance System.[22] Only a few determinants such as women's age at delivery, level of education, parity, household income and season were studied. In 2017, Khanum *et al* studied the outcome of PD and its association with pregnancy-related factors based on data from a single institution in Dhaka.[23] However, all studies were conducted in different regions of Bangladesh except Northern region.

Therefore, it is necessary to study on PD and its associated factors in this region. This study aimed to determine the prevalence of PD and its associated factors among women in Rajshahi district.

METHODS

Materials

The target area for the study was Rajshahi district, which belongs to the north part of Bangladesh. Rajshahi is one of the oldest districts, and it is one of the highest poverty zones of the country.[24] The total area of the district is 2425.37 km^2 and the population are 2 699 688 including the urban and rural area of the district.[24] In this study, the population was being considered all under-5 children and their mothers who were living in Rajshahi district, Bangladesh. The data was collected from the field survey conducted from October to December 2016.

Exclusion criteria

All currently pregnant or seriously sick mothers and those who did not receive antenatal care service and lived separately from their under-5 children were excluded from the study.

Sample size determination

The required sample size for this study was estimated using the formula, $n = \frac{z^2 p(1-p)}{d^2}$, where n=the required sample size, p=the prevalence of PD, here we considered p=11.0%=11/100=0.11 that was taken from a previous study with Bangladeshi population[22] and z=1.96 at 95% CI, and d=0.05 (margin of error). The formula provided that at least 149 samples were required for this study. We decided to cover a total of 540 samples for the purpose.

Patient and public involvement

Before we started to approach the selected families, we discussed on the questionnaire, methods of recruitment and methods of data collection procedure. A senior female community health worker and first and fourth authors of this study collected data from the selected households and conducted all the physical measurements. The results will be published in peer-reviewed journals and at conferences.

Sample selection procedure

There were 9 subdistricts (or Upazilas) in Rajshahi district and those were covered by 233 community clinics. Multistage sampling technique was used to select the sample populations that represented this region. In the first stage, two community clinics were selected from each Upazila by simple random sampling. In the second stage, two villages were selected from the catchment area (one was the nearest, and the other the furthest from the community clinics). In the third stage, 17 households were selected from each village by simple random sampling. We identified the households with children under-5 years and their mothers from the community clinics database. Initially, a total number of 612 households were selected, but 72 (12%) households did not agree to participate in the study. If there was more than one mother with under-5 children in a household, we selected one mother with her child randomly. If the selected mother had more than one under-5 children, last born child was considered.

Questionnaire

A partially structured questionnaire was duly pretested before data collection. We prepared the original questionnaire in English, and it was sent to five public health experts for their opinions, comments, and suggestions. After the questionnaire had been revised, we translated it to Bangla (mother tongue of Bangladesh) for better understanding by the respondents (Bangladeshi mothers). The researchers checked the translated questionnaire to ensure that the translated questions reflected the actual meaning of the initial questions. Completed questionnaires were checked by senior researchers for accuracy and completeness. The data was tabulated and coded and subsequently transferred on to a spreadsheet before further analyses.

Measurement

A portable stadiometer and digital weighing scale were used to measure the height and weight of the mothers. The measurements were obtained using the techniques recommended by Martin and Saller.[25] For measuring the height, the mother would stand on the stadiometer without shoes, look straight ahead while keeping the shoulders level; for measuring the weight, they would be wearing thin clothes. Weight and height were measured using kilogram (kg) and centimetre (cm), respectively. We calculated the body mass index (BMI) based on the standard formula used by WHO: BMI=weight (kg)/height $(m)^2$. In 2016, WHO has recommended the use of mid-upper arm circumference (MUAC) to identify undernourished pregnant women. MUAC was measured with Talc insertion tape and the readings were classified

into two categories: <22 cm indicates malnutrition and ≥22 cm indicates normal nutrition.[25]

Outcome variable

PD was the outcome variable of this study. Children were born before 37 completed weeks of gestation, or fewer than 259 days since the first day of the women's last menstrual period was considered preterm birth.[26] It was classified into two classes such as (1) PD (children born before 37 completed weeks of gestation, code, 1) and (2) Full-term birth (children born between 37 and 42 completed weeks of gestation, code, 0). We subtracted date of conception from date of birth of their children for calculating gestational age, the information of conception date is available in participant antenatal card.

Exposure variables

Most of these exposure variables had been identified from the prior studies.[17–20] All variables were described in below.

Pregnancy-related variables of mother

Birth interval (in months) (<25, 25–48, ≥49), antenatal care visit (<4 times, ≥ 4 times), family planning method (no, condom, pill, IUD copper T), anaemic mother (no, yes), high fever (no, yes), vaginal bleeding problems (no, yes), iron–folic supplementary (no, yes), calcium supplementary (no, yes), taking bed rest during pregnancy (yes, no). We asked mothers about these variables, some information such as number of antenatal care visit, anaemic, bed rest, fever, vaginal bleeding, iron–folic and calcium supplementary were available in participants antenatal card, for double checking we also looked the card.

Maternal and other variables

Mother's MUAC (normal weight (≥22 cm), malnourish (<22 cm)), Mother's nutritional status measured by BMI (underweight<18.5 kg/m^2, normal weight (18.5≤BMI<25 kg/m^2, overweight (BMI≥25 kg/m^2), age at first marriage (years) (<18, ≥18), age at first birth (years) (<20, ≥20), mother's educational level (no education, primary, secondary, higher), mother's occupation (housewife, others), husband's educational level (no education, primary, secondary, higher), husband's occupation (Farmer, others), child birth weight (normal (≥2500 gm), low (<2500 gm)),[27 28] type of family (nuclear, joint), family member (≤3, 4–5, ≥6), religion (Muslim, others), decision-making for household treatment (only husband, only wife, both), mothers age at present children birth (years) (≤20, 20–29,≥30), order of birth of present children (1st, 2nd–3rd, 4th and above), total number of ever born children (1, 2, ≥3), monthly family income (BDT) (≤15 000, >15 000).

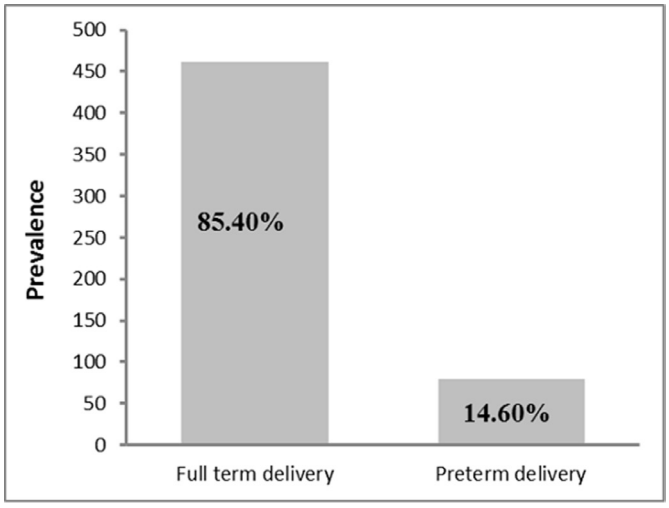

Figure 1 Prevalence of preterm delivery

Statistical analysis

Descriptive statistics were used to find the basic information of the selected variables used in the study. Chi-square test was used to detect the association between PD and sociodemographic, pregnancy, health and child-related factors. Binary logistic regression was used to determine the effect of selected independent factors on PD. There is no exact method to detect the multicollinearity problem among exposure factors for multiple logistic regression models. We used the magnitude of the SE to detect the multicollinearity problem, and considered there was no multicollinearity if the magnitude of the SE lied between 0.001 and 0.5.[29] Stepwise logistic regression with backward elimination method was subsequently used to find the best subset model for PD. Backward elimination procedure may have the advantage that it takes into consideration suppressor effects that might be lost in forward inclusion.[30] The procedure starts the full equation and successively drops one variable at a time. The variables are dropped on the basis of their contribution to the reduction of error sum of squares. The contribution of an individual variable for each step is checked by the Wald statistic. If all the Wald test values are significant, the full set of variables is retained in the final step.

The p value of less than 0.05 was considered the level of significance. The whole analysis of this study was conducted with the Statistical Package for Social Sciences (SPSS, IBM V.20).

RESULTS

In this study, 540 mothers were selected to find the prevalence of PD and its associated factors. The prevalence of PD was 14.6% in Rajshahi district during the survey period (figure 1).

The mean maternal age was 26.38±5.13 years, and the mean child age was 29.72±14.58 months. It was observed that the mean height and weight of mothers were 152.79±6.48 cm and 50.91±8.76 kg, respectively. The mean monthly income of respondents' family was 8254.07±6123.99 BDT (table 1).

The univariate and bivariate distributions of PD according to the maternal sociodemographic and pregnancy-related factors are shown in table 2. There was

Table 1 Descriptive statistics of maternal and child age, maternal weight, height and family income

Variables	N	Mean	SD	95% CI for mean	
				Lower bound	Upper bound
Child age (month)	540	29.72	14.58	28.49	30.95
Mother age (year)	540	26.38	5.13	25.95	26.82
Mother weight (kg)	540	50.91	8.76	50.17	51.65
Mother height (cm)	540	152.79	6.48	152.24	153.34
Monthly family income (BDT)	540	8254.07	6123.99	7736.39	8771.75

a significant (p<0.01) association observed between PD and mother's age at marriage. PD was higher (55.7%) among mothers who married at age<18 years (early age at first marriage) than mother age at marriage≥18 years. Similarly, proportion of PD was higher (62.0%) among mothers who delivered at early age (< 20 years) and the difference was statistically significant (p<0.05). We noted that respondent's husband occupation was statically significant with PD (p<0.01). Lower (6.8%) proportion of PD was observed among mothers who used oral contraceptives (pills) to avoid conception. Chi-square test provided that association between PD and family planning method was significant (p<0.01). About 31% of mothers who had high fever during pregnancy had PD, while for those without history of fever it was only 12%. The difference was statistically significant (p<0.01). About 82% of mothers did not visit antenatal care clinic at least four times as recommended by WHO, and the rate of PD among them was significantly higher (16.4%) compared with those who attended the clinic four or more times (p<0.01). About 30% of PD babies had low birth weight (<2500 g), and this was significantly higher than that of full-term babies (p<0.01). Other selected variables did not show significant association with PD (table 2).

The value of SE of each independent variable was less than 0.5, suggesting that there was no multicollinearity problem among these variables. Adjusted OR (AOR), 95% CI and p value were used to interpret the multiple logistic regression results. After adjusting the effect of other independent variables, the model demonstrated that mothers who did not practice family planning had (1–0.45) X 100=55% higher chances of having PD compared with those who used oral contraceptives pills (AOR=0.45, 95% CI:0.19 to 0.99, p<0.05). Mothers who had high fever during their pregnancy had 2.40 times higher chance of having PD compared with those who had no fever (AOR=2.40, 95% CI: 1.19 to 4.97, p<0.05). Mothers who attended less than 4 antenatal care visits had 2.80 times higher chance of having PD than their counterparts who attended antenatal care service 4 times or more (AOR=2.80, 95% CI: 1.12 to 6.98, p<0.05). We also noted that mothers having PD was more likely to get low birth-weight baby compared to those who did not have PD (AOR=2.59, 95% CI: 1.22 to 5.47, p<0.05). Mothers with age at marriage<18 years were more likely to have preterm delivery compared to those with age at marriage≥18 years (AOR=2.08, 95% CI: 1.28 to 2.99, p<0.01). Hosmer and Lemeshow test showed that the model was good fitted (χ^2 value=5.60; p>0.05). In addition, unadjusted model demonstrated that mothers delivered first baby before their age<20 years were more risk to get PD than mothers who got first baby at age≥20 years (OR=1.75, 95% CI: 1.07 to 2.86, p<0.05) (table 3).

The overall accuracy of the model to predict subjects having preterm delivery (with a predicted probability of 0.5 or greater) was 85.6% (table 4). The sensitivity was given by 10/79=12.7% and the specificity was 452/461=98.0%. We found the area under the receiver operating characteristic curve was 0.77 which indicated that it was the best model at correctly classifying observations into categories (figure 2).

In the first step of stepwise logistic regression (backward elimination), the least significant variable based on the Wald statistic was vaginal bleeding problems and the corresponding change in −2LR was also insignificant. Hence, vaginal bleeding problem was the variable which excluded from the model in the second step. In the second step, nutritional status of mothers was least significant and the change in −2LR was insignificant; therefore, this variable was excluded from the model in the third step. The other variables, husband's educational qualification, anaemic mother, respondent's educational qualification, respondent's occupation, iron–folic supplementary, birth interval (months), age at first birth (years), MUAC of the mothers, calcium supplementary, taking bed rest during pregnancy, type of family, family member, religion, decision-making for household treatment, mother's age at present children birth, order of birth, total number of ever born children and monthly family income were excluded from the model by repeating the same procedure. The final step included the variables age at marriage (years), family planning method, high fever during pregnancy, number of antenatal care visit and child birth weight that was the best subset model of PD among mothers living in Rajshahi district (table 5).

DISCUSSION

PD is one of the significant public health issues in the 21st century around the world. This study would provide important information on the prevalence, maternal sociodemographic and pregnancy-related risks of PD among

Table 2 Preterm delivery according to the maternal sociodemographic and pregnancy-related factors

Study variables	Total, N (%)	Gestational age at delivery		P value
		Preterm delivery (<37 weeks), N (%)	Full-term delivery (≥37 weeks), N (%)	
Mid-upper arm circumference of the mothers				
Normal weight (≥22 cm)	17 (3.1)	74 (14.1)	449 (85.9)	
Malnourish (<22 cm)	523 (96.9)	5 (29.4)	12 (70.6)	0.08
Body mass index of mothers				
Underweight (<18.5 kg/m^2)	96 (17.8)	16 (16.7)	80 (83.3)	
Normal weight (18.5–24.99 kg/m^2)	341 (63.1)	46 (13.5)	295 (86.5)	
Over weight (≥ 25 kg/m^2)	103 (19.1)	17 (16.5)	86 (83.5)	0.618
Age at marriage (years)				
<18	217 (40.2)	44 (55.7)	173 (37.5)	
≥18	323 (59.8)	35 (44.3)	288 (62.5)	0.002
Age at first birth (years)				
<20	271 (50.2)	49 (62.0)	222 (48.2)	
≥20	269 (49.8)	30 (38.0)	239 (51.8)	0.015
Respondent's educational qualification				
No education	76 (14.1)	8 (10.5)	68 (89.5)	
Primary	121 (22.4)	21 (17.4)	100 (82.6)	
High school	252 (46.7)	41 (16.3)	211 (83.7)	
Higher education	91 (16.9)	9 (9.9)	82 (90.1)	0.27
Respondent's occupation				
Housewife	520 (96.3)	77 (14.8)	443 (85.2)	
Others	20 (3.7)	2 (10.0)	18 (90.0)	0.55
Husbands educational qualification				
No education	102 (18.9)	15 (19.0)	87 (18.9)	
Primary	184 (34.1)	28 (35.4)	156 (33.8)	
High school	140 (25.9)	22 (27.8)	118 (25.6)	
Higher education	114 (21.1)	14 (17.7)	100 (21.7)	0.876
Husbands occupation				
Farmer	225 (41.7)	21 (26.6)	204 (44.3)	
Labour	192 (35.6)	44 (55.7)	148 (32.1)	
Business	83 (15.4)	9 (11.4)	74 (16.1)	
Service	40 (7.4)	5 (6.3)	35 (7.6)	0.001
Birth interval (months)				
<25	296 (54.8)	41 (13.9)	255 (86.1)	0.808
25–48	78 (14.4)	13 (16.7)	65 (83.3)	
>49	166 (30.7)	25 (15.1)	141 (84.9)	
Family planning method				
No	109 (20.2)	18 (16.5)	91 (83.5)	0.001
Condom	85 (15.7)	17 (20.0)	68 (80.0)	
Pill	205 (38.0)	14 (6.8)	191 (93.2)	
IUD Copper T	141 (26.1)	30 (21.3)	111 (78.7)	
Anaemic mother				
No	529 (98.0)	78 (14.7)	451 (85.3)	0.599
Yes	11 (2.0)	1 (9.1)	10 (90.9)	
High fever				
No	465 (86.1)	56 (12.0)	409 (88.0)	0.001
Yes	75 (13.9)	23 (30.7)	52 (69.3)	
Vaginal bleeding problems				
No	524 (97.0)	76 (14.5)	448 (85.5)	0.636
Yes	16 (3.0)	3 (18.8)	13 (81.2)	

Continued

Table 2 Continued

Study variables	Total, N (%)	Gestational age at delivery		P value
		Preterm delivery (<37 weeks), N (%)	Full-term delivery (≥37 weeks), N (%)	
Iron–folic supplementary				
No	51 (9.4)	12 (23.5)	39 (76.5)	0.059
Yes	489 (90.6)	67 (13.7)	422 (86.3)	
Calcium supplementary				
No	69 (12.8)	15 (21.7)	54 (78.3)	
Yes	471 (87.2)	64 (13.6)	407 (86.4)	0.074
Number of antenatal care visit				
<4 times	440 (81.5)	72 (16.4)	368 (83.6)	
≥4 times	100 (18.5)	7 (7.0)	93 (93.0)	0.017
Taking bed rest during pregnancy				
Yes	440 (81.5)	70 (88.6)	370 (80.3)	
No	100 (18.5)	9 (11.4)	91 (19.7)	0.078
Child birth weight				
Normal birth weigh (≥2500 g)	486 (90.0)	63 (13.0)	423 (87.0)	
Low birth weight (<2500 g)	54 (10.0)	16 (29.6)	38 (70.4)	0.001
Type of family				
Nuclear	375 (69.44)	58 (15.5)	317 (84.5)	
Joint	165 (30.56)	21 (12.7)	144 (87.3)	0.407
Family member				
≤3	115 (21.30)	13 (11.3)	102 (88.7)	
4–5	291 (53.89)	46 (15.8)	245 (84.2)	
≥6	134 (24.81)	20 (14.9)	114 (85.1)	0.509
Religion				
Muslim	483 (89.44)	73 (15.1)	410 (84.9)	
Others	57 (10.56)	6 (10.5)	51 (89.5)	0.354
Decision-making for household treatment				
Only husband	243 (45.0)	37 (15.2)	206 (84.8)	
Only wife	30 (5.56)	5 (16.7)	25 (83.3)	
Both	267 (49.44)	37 (13.9)	230 (86.1)	0.862
Mother's age at present children birth (years)				
<20	117 (21.67)	20 (17.1)	97 (82.9)	
20–29	346 (64.7)	50 (14.5)	296 (85.5)	
≥30	77 (14.26)	9 (11.7)	68 (88.3)	0.574
Order of birth of present children				
1st	233 (43.15)	30 (12.9)	203 (87.1)	
2nd–3rd	292 (54.07)	47 (16.1)	245 (83.9)	
4th and above	15 (2.78)	2 (13.3)	13 (86.7)	0.578
Total number of ever born children				
1	233 (43.15)	30 (12.9)	203 (87.1)	
2	234 (43.33)	34 (14.5)	200 (85.5)	
≥3	73 (13.52)	15 (20.5)	58 (79.5)	0.269
Monthly family income (BDT)				
≤15 000	481 (89.07)	74 (15.4)	407 (84.6)	
>15 000	59 (10.93)	5 (8.5)	54 (91.5)	0.156

mothers staying in the northern part of Bangladesh. The overall PD rate among pregnant women in this region was 14.6% of all life births. Similar results have been reported by other developing countries such as India (15%)[31] and Philippines (14.9%).[2] A systematic analysis on demeanour with data accessible from 107 countries in 2014 showed the global PD rate of 10.6%.[32] A multinational study of six low-income and low middle-income countries

Table 3 Effect of socioeconomic, demographic and other factors on preterm delivery

	Unadjusted		Adjusted	
Study variables	**OR (95% CI)**	**P value**	**AOR (95% CI)**	**P value**
Mid-upper arm circumference of the mothers				
Malnourish	2.52 (0.87 to 7.38)	0.090	1.47 (0.35 to 6.03)	0.592
Normal (ref)				
Body mass index of mothers				
Underweight	0.97 (0.51 to 1.84)	0.928	0.91 (0.40 to 2.08)	0.831
Over weight	0.89 (0.47 to 1.69)	0.732	1.15 (0.56 to 2.36)	0.699
Normal weight (ref)				
Age at marriage (years)				
<18	2.09 (1.29 to 3.39)	0.003	2.08 (1.28 to 2.99)	0.008
≥18 (ref)				
Age at first birth (years)				
<20	1.75 (1.07 to 2.86)	0.024	1.25 (0.580 to 2.72)	0.563
≥20 (Ref)				
Respondent's educational qualification				
No education	1.07 (0.39 to 2.92)	0.892	1.34 (0.52 to 5.14)	0.665
Primary	1.91 (0.83 to 4.40)	0.127	1.97 (0.68 to 5.71)	0.209
High school	1.77 (0.82 to 3.80)	0.143	1.66 (0.68 to 4.05)	0.260
Higher education (ref)				
Respondent's occupation				
Farmer	0.72 (0.25 to 2.03)	0.537	0.74 (0.20 to 2.63)	0.642
Labour	2.08 (0.76 to 5.63)	0.149	1.97 (0.55 to 7.04)	0.296
Business	0.85 (0.26 to 2.72)	0.787	0.95 (0.25 to 3.64)	0.948
Service (ref)				
Husbands educational qualification				
No education	1.23 (0.56 to 2.69)	0.602	0.72 (0.24 to 2.17)	0.562
Primary	1.28 (0.64 to 2.55)	0.480	0.61 (0.24 to 1.52)	0.291
High school	1.33 (0.64 to 2.73)	0.436	0.72 (0.29 to 1.76)	0.475
Higher education (ref)				
Husbands occupation				
Farmer	1.43 (0.77 to 2.66)	0.248	1.15 (0.53 to 2.48)	0.717
Others (ref)				
Birth interval (months)				
<25	1.17 (0.67 to 2.05)	0.576	1.74 (0.68 to 4.47)	0.246
25–48	1.64 (0.79 to 3.39)	0.179	1.37 (0.57 to 3.31)	0.479
>49 (ref)				
Family planning method				
Condom	1.26 (0.60 to 2.63)	0.531	1.63 (0.66 to 3.98)	0.281
Pill	0.37 (0.17 to 0.77)	0.009	0.45 (0.19 to 0.99)	0.045
IUD Copper T	1.36 (0.71 to 2.60)	0.344	1.38 (0.67 to 2.86)	0.377
No (Ref)				
Anaemic mother				
Yes	0.57 (0.07 to 4.58)	0.604	0.72 (0.08 to 6.42)	0.770
No (Ref)				
High fever				
Yes	3.23 (1.8 to 5.68)	0.001	2.40 (1.19 to 4.97)	0.014
No (ref)				
Vaginal bleeding problems				
Yes	1.36 (0.37 to 4.88)	0.637	1.20 (0.25 to 5.70)	0.812
No (ref)				

Continued

Table 3 Continued

Study variables	Unadjusted OR (95% CI)	Unadjusted P value	Adjusted AOR (95% CI)	Adjusted P value
Iron–folic supplementary				
Yes	0.66 (0.26 to 1.61)	0.36	0.77 (0.27 to 2.20)	0.635
No (ref)				
Calcium supplementary				
Yes	0.66 (0.29 to 1.51)	0.334	0.72 (0.28 to 1.86)	0.505
No (ref)				
Number of antenatal care visit				
<4 times	2.59 (1.15 to 5.83)	0.021	2.80 (1.12 to 6.98)	0.027
≥4 times (ref)				
Taking bed rest during pregnancy				
Yes	1.99 (0.95 to 4.17)	0.065	1.84 (0.82 to 4.09)	0.135
No (ref)				
Child birth weight				
Low birth weight	2.82 (1.48 to 5.36)	0.001	2.59 (1.22 to 5.47)	0.012
Normal birth weight (ref)				
Type of family				
Nuclear	1.25 (0.73 to 2.14)	0.407	1.79 (0.61 to 5.23)	0.288
Joint (ref)				
Family member				
≤3	0.72 (0.34 to 1.53)	0.402	0.35 (0.08 to 1.47)	0.154
4–5	1.07 (0.60 to 1.89)	0.816	0.73 (0.26 to 2.05)	0.559
≥6 (ref)				
Religion				
Muslim	1.51 (0.62 to 3.65)	0.357	1.82 (0.57 to 5.76)	0.306
Others (ref)				
Decision-making for household treatment				
Only husband	1.11 (0.68 to 1.82)	0.661	0.97 (0.53 to 1.76)	0.935
Only wife	1.24 (0.44 to 3.45)	0.676	0.84 (0.25 to 2.82)	0.782
Both (ref)				
Mother's age at present children birth (years)				
<20	1.55 (0.66 to 3.62)	0.304	1.19 (0.28 to 4.97)	0.811
20–29	1.27 (0.59 to 2.72)	0.528	1.25 (0.45 to 3.44)	0.661
≥30 (ref)				
Order of birth of present children				
1st	0.96 (0.20 to 4.46)	0.959	0.72 (0.09 to 5.80)	0.764
2nd–3rd	1.24 (0.27 to 5.70)	0.776	0.84 (0.12 to 5.54)	0.857
4th and above (ref)				
Total number of ever born children				
1	0.57 (0.28 to 1.13)	0.109	0.76 (0.28 to 1.34)	0.765
2	0.65 (0.33 to 1.29)	0.223	0.82 (0.33 to 2.06)	0.675
≥3				
Monthly family income (BDT)				
≤15 000	1.96 (0.76 to 0.5.07)	0.164	1.58 (0.51 to 4.91)	0.427
>15 000 (ref)				
Hosmer and Lemeshow Test		Chi-square value=5.60; p-value=0.692		

from South America, Africa and Asia reported an overall rate of PD of 12.6%.[33] Pakistan with reported 21.4% rate of PD was considered as an outlier in the study and the possible reason provided was low antenatal care. There was a study on rural cohort in Bangladesh that reported high rate of PD (19.4%),[34] and poor antenatal service in

Table 4 Classification of subject by logistic model

Observed	Predicted		
	Gestational age		
	≥37 week (full term)	<37 week (preterm)	Percentage correct
Gestational age			
≥37 week (full term)	452	9	98.0
<37 week (preterm)	69	10	12.7
Overall percentage			85.6

the rural area may also be the contributing factor. Our study was conducted on both rural and urban population of the northern region of Bangladesh, and our finding was more in line with those reported by other developing countries.

Our study showed that the risk of PD was lower among mothers who used oral contraceptive pills for family planning. This is different from the findings of a recently published systematic review and meta-analysis that reported higher risk of PD among women with previous oral contraceptive use.[35] It is possible that mothers with access to oral contraceptive pills were more likely from urban since they would require frequent supply of the medication, as compared with those using other methods or not practicing contraception at all. A study from Canada reported that the use of oral contraceptives within 30 days of conception may be associated with an increased risk PD, but its use between 31 and 90 days prior to the last menstrual period may decrease.[36] Most of our respondents could not recall the actual time of usage of family planning method before conception, therefore we were unable to further analyse our findings.

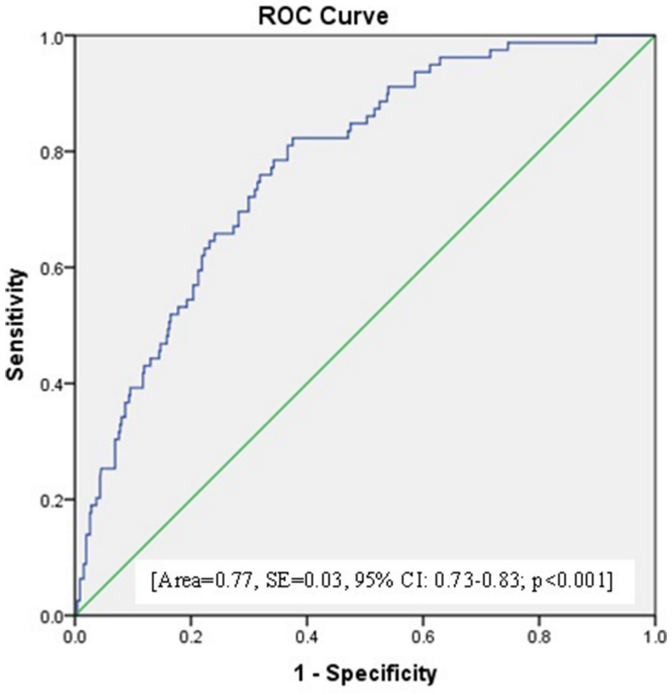

Figure 2 Receiver operating characteristic (ROC) curve estimate the goodness of logistic model.

Our study showed that PD was higher among the mothers who had history of high fever during their pregnancy. A recent study of India also reported that fever during pregnancy was associated with PD.[37] NICH Neonatal Research network reported that 26% of infants were born preterm among mother who recorded body temperature of ≥38.0°C, and attributed this to chorioamnionitis.[38] We did not have adequate information to study the potential source of fever for the mothers.

We also found that women who visited antenatal care clinic less than four times during their pregnancy were at higher risk of PD compared with those who had four or more visits. A cohort study is focusing on rural Bangladesh reported similar findings for women with one or less antenatal care visits compared with those who had more frequent visits.[39] A recent observational study conducted in 12 government hospitals in Nepal also reported similar findings.[18] A cluster study conducted in USA showed that risk of adverse birth outcomes were two to four times higher for those who did not receive any prenatal care.[40] Bangladesh Health and Demographic Survey in 2018 reported that 48% of pregnant women had <4 antenatal care visits.[41] Antenatal care would help to identify risk factors that might adversely affect the progress of pregnancy, and allow early intervention including prescription of antibiotics for infection, or dietary supplementation for malnutrition.[42] Since 2002, WHO had suggested that for resource-limited countries every mother should have at least four antenatal care visits.[12] A systematic review published by Cochrane Library showed that for these countries, reducing the number of antenatal care visits were associated with increased perinatal mortality.[43]

We found that 40.2% of participants had married at <18 years and 50.2% had their first pregnancy at <20 years. Mothers married at <18 years had higher odds of PD than those married ≥18 years. Same results have been found in Nepal, authors reported that participants married earlier had higher chance to have PD compared with women who married at ≥18 years.[44] Usually, early married mothers are more likely to have early age at first birth, our unadjusted model showed that mothers got first baby at <20 years were more likely to have PD than mothers who had first delivered at ≥2–0 years.

Table 5 Summary of the stepwise (backward elimination) logistic regression analysis (final step)

Step	Study variables	B	SE	P value	AOR	95% CI for AOR		Change in –2LR
						Lower	Upper	
Final step	Age at marriage (years)							5.193*
	<18	0.65	0.26	0.011	1.93	1.60	3.21	
	≥18 (ref)							
	Family planning method			0.005				14.413**
	Condom	0.53	0.39	0.180	1.71	0.79	3.72	
	Pill	–0.74	0.40	0.061	0.48	0.22	1.03	
	IUD Copper T	0.31	0.35	0.370	1.37	0.69	2.70	
	No (ref)							
	High fever							5.870*
	Yes	0.99	0.31	0.002	2.69	1.46	4.99	
	No (ref)							
	Number of antenatal care visit							0.002**
	<4 times	1.14	0.44	0.010	3.13	1.32	7.48	
	≥4 times (ref)							
	Child birth weight							0.004**
	Normal birth weight	1.05	0.34	0.002	2.85	1.45	5.63	
	Low birth weight (ref)							
	Constant	–3.37	0.54	0.000	0.03			

Note: B, Regression coefficients; CI, Confidence interval; AOR, Adjusted odds ratio; SE, Standard error; LR, Likelihood ratio

Many low birth weighted infants were born before term. In low-income and middle-income countries, approximately half of all low birth weighted infants were born preterm.[45] The finding is substantiated by a Bangladeshi study, and it also reported that 75% of all neonatal mortalities occurred in low birth weight babies.[46]

It is essential to prevent PD and improve the care of premature babies, accelerating the progress towards the goal of halving deaths due to preterm birth by 2025.[47] This may also contribute towards reducing maternal and child mortality rate which is an important health indicator of Millennium Development Goal for child survival (Sustainable Development Goal 3 (SDG-3)).[48] Family planning, increasing empowerment of women, especially the adolescents, and improving quality of care before, between and during pregnancy, can help to reduce the rate of PD. Strategic investments in innovation and research are required to accelerate progress to achieve this goal. For these reasons, in 2012 WHO created the World Prematurity Day on 17 November, and set a goal to reduce the mortality due to PD by 50% between 2020 and 2025.[1]

Strengths and limitations

Perhaps this was the first time we attempted to investigate PD among mothers living in northern part of Bangladesh. The associated factors of PD were determined using appropriate statistical models. However, we had some limitations. First, this was a cross-sectional study; it was not possible to determine the temporal link between the outcome and independent variables. Second, gestational age was calculated from parental accounts of last menstrual period might sometimes be prone to errors. Third, some potential confounders such as previous preterm births, preterm stillbirth, cervical length, maternal malaria, infections, biological and genetic markers, etc were not included in the study. Fourth, some information was collected on the basis of recall bias method.

CONCLUSIONS

The prevalence of preterm birth is high in the northern district of Bangladesh. It is a big concern related to child mortality. We found that family planning method, fever, antenatal care visit during pregnancy and mother's age at first marriage were the important predictors of PD in Rajshahi district, Bangladesh. This study focused on maternal and child health related indicators of Sustainable development goals (SDGs). Our findings could be considered to achieve maternal and child health related goals under SDGs. Based on the study findings recommended the government of Bangladesh needs to strengthen its maternal health programmes to address the focus on the modifiable factors associated with preterm birth. Such efforts can be supplemented by GOs and NGOs. Pregnant women and their household members have a role to avoid the preterm birth consequence by maintaining more antenatal care.

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Patient consent for publication Consent obtained from parent(s)/guardian(s)

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REFERENCES

1 WHO. Born Too Soon. In: Howson CP, Kinney MV, Lawn JE, eds. *The global action report on preterm birth*. World Health Organization. Geneva, 2012.
2 Blencowe H, Cousens S, Oestergaard MZ, *et al*. National, regional, and worldwide estimates of preterm birth rates in the year 2010 with time trends since 1990 for selected countries: a systematic analysis and implications. *Lancet* 2012;379:2162–72.
3 Liu L, Oza S, Hogan D, *et al*. Global, regional, and national causes of under-5 mortality in 2000-15: an updated systematic analysis with implications for the sustainable development goals. *Lancet* 2016;388:3027–35.
4 Howson CP, Kinney MV, McDougall L, *et al*. Born too soon: preterm birth matters. *Reprod Health* 2013;10:1–9.
5 Gluckman PD, Hanson MA, Pinal C. The developmental origins of adult disease. *Matern Child Nutr* 2005;1:130–41.
6 Harrison MS, Goldenberg RL. Global burden of prematurity. *Semin Fetal Neonatal Med* 2016;21:74–9.
7 Beck S, Wojdyla D, Say L, *et al*. The worldwide incidence of preterm birth: a systematic review of maternal mortality and morbidity. *Bull World Health Organ* 2010;88:31–8.
8 Bangladesh: profile of preterm and low birth weight prevention and care, 2015. Available: https://reliefweb.int/sites/reliefweb.int/files/resources/Bangladesh_4.PBf
9 Blencowe H, Cousens S, Chou D, *et al*. Born too soon: the global epidemiology of 15 million preterm births. *Reprod Health* 2013;10:1–4.
10 Katz J, Lee AC, Kozuki N, *et al*. Mortality risk in preterm and small-for-gestational-age infants in low-income and middle-income countries: a pooled country analysis. *Lancet* 2013;382:417–25.
11 Petrou S, Mehta Z, Hockley C, *et al*. The impact of preterm birth on hospital inpatient admissions and costs during the first 5 years of life. *Pediatrics* 2003;112:1290–7.

12 World Health Organization. *WHO recommendations on antenatal care for a positive pregnancy experience*. Geneva: World Health Organization, 2016.
13 Poulsen G, Strandberg-Larsen K, Mortensen L, *et al*. Exploring educational disparities in risk of preterm delivery: a comparative study of 12 European birth cohorts. *Paediatr Perinat Epidemiol* 2015;29:172–83.
14 Delnord M, Blondel B, Prunet C, *et al*. Are risk factors for preterm and early-term live singleton birth the same? A population-based study in France. *BMJ Open* 2018;8:e018745.
15 Kildea SV, Gao Y, Rolfe M, *et al*. Risk factors for preterm, low birthweight and small for gestational age births among Aboriginal women from remote communities in northern Australia. *Women Birth* 2017;30:398–405.
16 Kalengo NH, Sanga LA, Philemon RN, *et al*. Recurrence rate of preterm birth and associated factors among women who delivered at Kilimanjaro Christian medical centre in northern Tanzania: a Registry based cohort study. *PLoS One* 2020;15:e0239037.
17 Shah R, Mullany LC, Darmstadt GL, *et al*. Incidence and risk factors of preterm birth in a rural Bangladeshi cohort. *BMC Pediatr* 2014;14:112.
18 Gurung A, Wrammert J, Sunny AK, *et al*. Incidence, risk factors and consequences of preterm birth – findings from a multi-centric observational study for 14 months in Nepal. *Arch Public Health* 2020;78:1–9.
19 Hackney DN, Glantz JC. Vaginal bleeding in early pregnancy and preterm birth: systemic review and analysis of heterogeneity. *J Matern Fetal Neonatal Med* 2011;24:778–86.
20 Hegaard HK, Pedersen BK, Nielsen BB, *et al*. Leisure time physical activity during pregnancy and impact on gestational diabetes mellitus, pre-eclampsia, preterm delivery and birth weight: a review. *Acta Obstet Gynecol Scand* 2007;86:1290–6.
21 Kramer MS. Intrauterine growth and gestational duration determinants. *Pediatrics* 1987;80:502–11.
22 Rahman A, Rahman M, Pervin J, *et al*. Time trends and sociodemographic determinants of preterm births in pregnancy cohorts in Matlab, Bangladesh, 1990-2014. *BMJ Glob Health* 2019;4:e001462.
23 Khanum MA, Lavereen S, Moniruzzaman -, *et al*. Risk factors and outcome of preterm labour in tertiary health centre. *Bangladesh J Obstet Gynaecol* 2017;32:90–3.
24 Bangladesh Bureau of Statistics. Population census reports; 2011.
25 Martin R, Saller K. Lehrbuch Der anthropologie. Stuttgart Gustav Fischer Verlag; 1957.
26 Sen J, Roy A, Mondal N. Association of maternal nutritional status, body composition and socio-economic variables with low birth weight in India. *J Trop Pediatr* 2010;56:254–9.
27 WHO. International classification of diseases and related health Problems-10th revision. Geneva World Health Organization; 2004.
28 Gill SV, May-Benson TA, Teasdale A, *et al*. Birth and developmental correlates of birth weight in a sample of children with potential sensory processing disorder. *BMC Pediatr* 2013;13:1–8.
29 Chan YH. Biostatistics 202: logistic regression analysis. *Singapore Med J* 2004;45:149–53.
30 Menard S. *Applied logistic regression analysis*. Sage, 2002.
31 Shubhada SA, Kambale SV, Phalke BD. Determinants of preterm labour in a rural medical college hospital in Western Maharashtra. *NJOG* 2013;8:31–3.
32 Chawanpaiboon S, Vogel JP, Moller A-B, *et al*. Global, regional, and national estimates of levels of preterm birth in 2014: a systematic review and modelling analysis. *Lancet Glob Health* 2019;7:e37–46.
33 Pusdekar YV, Patel AB, Kurhe KG, *et al*. Rates and risk factors for preterm birth and low birthweight in the global network sites in six low- and low middle-income countries. *Reprod Health* 2020;17:1–6.
34 Baqui AH, Rosen HE, Lee ACC, *et al*. Preterm birth and neonatal mortality in a rural Bangladeshi cohort: implications for health programs. *J Perinatol* 2013;33:977–81.
35 Tang R, Ye X, Chen S, *et al*. Pregravid oral contraceptive use and the risk of preterm birth, low birth weight, and spontaneous abortion: a systematic review and meta-analysis. *J Womens Health* 2020;29:570–6.
36 Chen X-K, Wen SW, Sun L-M, *et al*. Recent oral contraceptive use and adverse birth outcomes. *Eur J Obstet Gynecol Reprod Biol* 2009;144:40–3.
37 More VS. Fever in pregnancy and its maternal and fetal outcomes. *Int J Reprod Contracept Obstet Gynecol* 2017;6:5523–7.
38 Wortham JM, Hansen NI, Schrag SJ, *et al*. Chorioamnionitis and culture-confirmed, early-onset neonatal infections. *Pediatrics* 2016;137:e20152323.
39 Pervin J, Rahman SM, Rahman M, *et al*. Association between antenatal care visit and preterm birth: a cohort study in rural Bangladesh. *BMJ Open* 2020;10:e036699.
40 Taylor CR, Alexander GR, Hepworth JT. Clustering of U.S. women receiving no prenatal care: differences in pregnancy outcomes and implications for targeting interventions. *Matern Child Health J* 2005;9:125–33.
41 National Institute of Population Research and Training (NIPORT), and ICF. *Bangladesh demographic and health survey 2017-18: key indicators*. Dhaka, Bangladesh, and Rockville, Maryland, USA: NIPORT, and ICF, 2019.
42 Requejo J, Merialdi M, Althabe F, *et al*. Born too soon: care during pregnancy and childbirth to reduce preterm deliveries and improve health outcomes of the preterm baby. *Reprod Health* 2013;10:1–5.
43 Dowswell T, Carroli G, Duley L, *et al*. Alternative versus standard packages of antenatal care for low-risk pregnancy. *Cochrane Database Syst Rev* 2015;2015.
44 Miller FA, Marphatia AA, Wells JC, *et al*. Associations between early marriage and preterm delivery: evidence from lowland Nepal. *Am J Hum Biol* 2022;34:e23709.
45 Barros FC, Barros AJD, Villar J, *et al*. How many low birthweight babies in low- and middle-income countries are preterm? *Revista de Saúde Pública* 2011;45:607–16.
46 Yasmin S, Osrin D, Paul E, *et al*. Neonatal mortality of low-birth-weight infants in Bangladesh. *Bull World Health Organ* 2001;79:608–14.
47 Black RE, Cousens S, Johnson HL, *et al*. Global, regional, and national causes of child mortality in 2008: a systematic analysis. *Lancet* 2010;375:1969–87.
48 Darmstadt GL, Bhutta ZA, Cousens S, *et al*. Evidence-based, cost-effective interventions: how many newborn babies can we save? *Lancet* 2005;365:977–88.