

# BMJ Open Rural–urban differentials in the influences of individual and geospatial preparedness on institutional childbirth: a cross-sectional study in Bangladesh

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**To cite:** Rahman MM, Ara T, Aninda MHHMK, *et al*. Rural–urban differentials in the influences of individual and geospatial preparedness on institutional childbirth: a cross-sectional study in Bangladesh. *BMJ Open* 2022;**12**:e060718. doi:10.1136/bmjopen-2021-060718

► Prepublication history for this paper is available online. To view these files, please visit the journal online (<http://dx.doi.org/10.1136/bmjopen-2021-060718>).

Received 05 January 2022  
Accepted 18 August 2022



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## ABSTRACT

**Objective** This study aims to explore the rural–urban differentials in the influences of individual and geospatial preparedness on institutional childbirth in Bangladesh. A related aim of this paper is to derive estimates to measure geospatial preparedness for institutional births, through statistical modelling, when no data are available for measuring this areal indicator.

**Design, settings and participants** The paper used data from a large-scale nationally representative Bangladesh Multiple Indicator Cluster Survey 2019. The analytical sample included 9203 currently married women of reproductive age who had a live birth in the 2 years preceding the survey.

**Methods** Mixed effect logistic regression models were employed to explore the rural–urban differentials in influences of individual and geospatial preparedness on institutional childbirth. The district-level random effect estimation was done to measure geospatial preparedness. The conditional autoregressive model was used to examine the association of geospatial preparedness with areal variation in institutional births.

**Results** In rural settings, women who gave birth to a female newborn were 18% less likely to have facility births compared with women who gave birth to a male newborn. Also, women from households in the highest wealth quintile were twice as likely to have facility births compared with those from households in the poorest wealth quintile. In contrast, in urban areas, facility births did not vary by sex of the fetus or by households' socioeconomic status. The geospatial preparedness explained 8% and 9% of the variability in institutional births in rural and urban areas, respectively. Geospatial mapping revealed low preparedness in the hill tracts. Findings identified geospatial preparedness as a potential source of areal variation in facility births.

**Conclusion** Findings suggest improving district-level preparedness and developing differential programme strategies for urban and rural areas to increase the national prevalence and more equitable use of institutional childbirth in Bangladesh.

## INTRODUCTION

Whereas the Global North is on its way to making maternal and neonatal deaths

## STRENGTHS AND LIMITATIONS OF THIS STUDY

- ⇒ The Bangladesh Multiple Indicator Cluster Survey 2019 provides samples representative of administrative districts and rural and urban areas.
- ⇒ Mixed effect logistic regression considering women were nested within the districts is employed, as it can estimate random effects.
- ⇒ The Monte Carlo approaches are undertaken to test the spatial correlation, as it can make the decision based on a large number of permutations of the response variable.
- ⇒ The conditional autoregressive model is used to identify the source of geospatial variation, as it can capture the space dependency through assigning neighbours.
- ⇒ Specifying indicators for measuring district-level preparedness is beyond the scope of the study due to data being unavailable.

obsolete, such deaths are commonplace in the Global South. The burden is the heaviest in sub-Saharan Africa and South and South-East Asia.<sup>1</sup> About 94% of maternal deaths occur in low-income and middle-income countries (LMICs), most of which are preventable.<sup>1</sup> Postpartum haemorrhage, maternal infection and eclampsia are the leading causes of maternal morbidity and mortality.<sup>2</sup> These conditions are primarily manageable by providing access to emergency obstetric care including treatment of haemorrhage, infection, hypertension and obstructed labour.<sup>3,4</sup>

Examination of data on causes of maternal and neonatal deaths shows that most deaths are preventable if appropriate healthcare is sought in a timely manner. In the context of Bangladesh, women can only seek these services in institutional settings. Institutional delivery also helps reduce early neonatal mortality in LMICs<sup>5,6</sup>—earlier studies from Bangladesh<sup>7,8</sup> and India,<sup>9</sup> demonstrate

**Table 1** Facility births in Bangladesh from 1997 to 2017

Place	Births in health facilities (%)			Annual increase in facility births (%)		
	1997	2007	2017	1997–2017	1997–2007	2007–2017
Total Bangladesh	5	17	49	2.20	1.20	3.20
Urban	23	49	63	2.00	2.60	1.40
Rural	2	23	45	2.15	2.10	2.2
	Urban–rural gap in facility births (%)					
	21	26	18			

Data sources: Bangladesh Demographic and Health Survey 1996–97; 2007 and 2017–18.

the importance of institutional childbirth in reducing neonatal mortality.

Institutional delivery is crucial for ensuring that mothers and newborns receive immediate postnatal care. In Bangladesh, around 40% of maternal and neonatal deaths occur within 24 hours of birth.<sup>10 11</sup> For births that take place outside of health institutions, only 7% receive any postnatal care within 2 days.<sup>12</sup> Home births would be safe if facilitated by skilled providers who can recognise complications and refer complicated pregnancies to appropriate facilities, but nearly 94% of home births are currently facilitated by unskilled birth attendants.<sup>12</sup> While institutional births may not prevent all maternal and neonatal deaths in Bangladesh due to low health facility service readiness in the country, immediate postnatal care provided in health facilities makes births safer and may help prevent deaths that would otherwise occur in the home.<sup>3 13</sup>

Encouragingly, the proportion of facility births in Bangladesh has been increasing over time. Since 2007, institutional births have been increasing by 3.2% every year, rising from 17% in 2007 to 49% by 2017–2018 (table 1). Comparatively, in the period 1997–2007, facility births increased by only 1.2 percentage points per year. From the same 1997–2017 period, institutional childbirths in rural and urban areas increased by a similar rate, but during this period, rural areas lagged far behind urban areas in facility births. In 1997, for example, 23% of urban births took place in-facility compared with only 2% of rural births, meaning the urban–rural gap was 21 percentage points. This gap was 26 and 18 percentage points in 2007 and 2017, respectively.

What enabled the rapid increase in facility deliveries in recent years? Economic progress improved individual-level quality of life and affordability to seek services. Moreover, the government and its development partners implemented health programmes across the country, revolutionising health practices across rural and urban settings. Examples include demand-side financing for the rural poor (not scaled-up countrywide), health and family planning interventions, close-to-community health facilities (eg, Family Welfare Centres, community clinics), integrated management of childhood illness, expanded immunisation programmes, and focused reproductive, maternal, neonatal and child health interventions by the

Directorate General of Health Services and Directorate General of Family Planning.

Non-governmental organisations (NGOs) have also played a significant role in promoting facility births. As demand for maternal health services increased over the years, the private sector has expanded widely, primarily in urban areas. In 2004, the proportion of institutional births in private facilities was 30%, increasing to 64% in 2017.<sup>12 14</sup> Various strategies to promote healthy behaviour and increase the utilisation of health services have been integrated into Health Sector Programmes since 1998.<sup>15</sup> In addition, governmental programmes facilitating stipends for female education in the early 1990s had a significant impact on raising women's education in the country that helped the adoption of healthy behaviour. These inter-related factors promoted enabling environments within households and communities for giving birth in institutions.

Despite the increase in institutional births in the country overall, the wide rural–urban gap remains a serious concern as almost three-fourths of children countrywide are born to rural mothers.<sup>12</sup> The rural–urban inequities in education levels, wealth status and other factors have been declining, but still remain.<sup>12 16</sup> Although health facilities providing childbirth services are quite well-spread across rural and urban areas, the availability of institutional childbirth services and facility readiness to provide quality childbirth care are disproportionately higher in the district and subdistrict-level facilities in (or near) urban areas.<sup>17</sup> In addition, poor road-transport infrastructure provides another barrier for rural women seeking access to health facilities for childbirth. Furthermore, while there is abundant literature on the role of individual and household-level factors influencing institutional childbirth in rural and urban settings, there is little research using a nationally representative sample.

A number of studies from Bangladesh and other countries show that women's education, media exposure, age at marriage, age at childbirth, parity, antenatal care (ANC) uptake and socioeconomic status influenced the decision to use facilities for childbirth.<sup>18–24</sup> These factors reflect individual-level preparedness that can influence facility births. On the other hand, areal-level geographical, infrastructural, societal and other conditions are likely to explain geospatial preparedness influencing the

use of facilities for childbirth. However, to the best of our knowledge, the association of geospatial preparedness with institutional births and its role in explaining the areal variation in facility births has never been studied in Bangladesh.

As such, this paper investigates the rural–urban differentials in the influences of individual and household factors on uptake of institutional childbirth in Bangladesh. This study also examines the role of geospatial preparedness for services in the use of health facilities for childbirth in both rural and urban settings. A related aim of this paper is to derive estimates to measure geospatial preparedness for institutional births, through statistical modelling, when no direct observations are available for measurement of this areal indicator. Finally, this paper examines the association of geospatial preparedness with observed areal variation in institutional births. These findings will provide guidance on whether programme strategies and interventions need to be tailored to urban and rural areas.

## MATERIALS AND METHODS

### Study area

Bangladesh, an LMIC in South Asia, is home to 166 million people, including 46 million women of reproductive age (WRA) who give birth to 2.3 children across reproductive life.<sup>12 25</sup> The first administrative unit of Bangladesh

is composed of eight divisions, which are further divided into 64 districts. These districts are then divided into upazilas (subdistricts), and each upazila is further divided into wards and unions. These wards form urban areas, and unions form the rural areas of Bangladesh.<sup>12</sup> For health service provisions, the unions are then divided into rural wards. Health policies are made at each administrative unit. **Table 2** presents the public sector health facilities providing childbirth services across the administrative units.

The public sector provides childbirth care through a variety of facilities available at the district level down to the union level as shown in **table 2**. In addition to these, an array of private sector facilities is available that accounts for 64% of facility births.<sup>12</sup> In addition, NGO sector health services are available for both rural and urban populations.

### Data

Data on women and households came from the Bangladesh Multiple Indicator Cluster Survey (BMICS) 2019,<sup>26</sup> a nationally representative cross-sectional survey based on a two-stage stratified cluster sampling. The sampling of BMICS 2019 was designed to produce estimates up to district levels and by rural–urban residents. The sampling strata were the rural and urban areas within each district. In the first stage, enumeration areas (PSUs) were systematically selected with probability proportional to size.

**Table 2** Healthcare facilities in the public sector

Administrative level	Type of facility	No of facilities	Availability of birth facility	Remark
District	District hospital	53	Yes	Mandated to provide delivery services (MPDS). <sup>*</sup> But due to lack of readiness, all may not provide services.
	General hospital	11	Yes	
	Medical college hospital	31	Yes	
	Mother and child welfare centre	62	Yes	
Upazila	Upazila health complex (50 bed)	297	Yes	
	Upazila health complex (31 bed)	112	Yes	
	Upazila health complex (10 bed)	11	Yes	
	Hospital outside health complexes		Yes	
	31 bed hospital	4	Yes	
	30 bed hospital	1	Yes	
	25 bed hospital	1	Yes	
	Mother and child welfare centre	12	Yes	
Union	20 bed hospital	32	Yes	
	Ten bed hospital	19	Yes	
	Union subcentre	1275	No	
	Union health and family welfare centre	4011	Yes	MPDS. But due to lack of readiness, all may not provide services.
	Mother and child welfare centre	24	Yes	
Rural ward	Community clinic	13442	No	

Source: Health Bulletin 2017; Ministry of Foreign Affairs, Government of the People's Republic of Bangladesh, List of Public medical colleges.  
<sup>\*</sup>Bangladesh Health Facility Survey 2017.

After carrying out the household listing for each of the selected PSUs, a systematic sample of 20 households was selected at the second stage. In total, 51 720 households were selected from 2586 PSUs in the rural areas, and 12 680 households were selected from 634 PSUs in the urban areas.

A total of 64 378 WRA, aged 15–49 years, from 64 400 households were interviewed. WRAs who had a live birth in the 2 years preceding the survey were asked about the birth services they got at the last childbirth (total of 9285 women). Household-level information such as the household head's sex, age and education were extracted from the 'household' data file and merged with the 'women' data file by the unique cluster and household number. After omitting the incomplete and missing observations, the study included a total of 9203 WRAs.

Areal data arise when an entire domain is partitioned into a finite number of subdomains. For each subdomain, there is a data point that represents the status of a specified indicator of that subdomain. The district-level estimates from BMICS 2019 formed such areal data. Finally, these areal data were linked to the publicly available district-level shape file.<sup>27</sup>

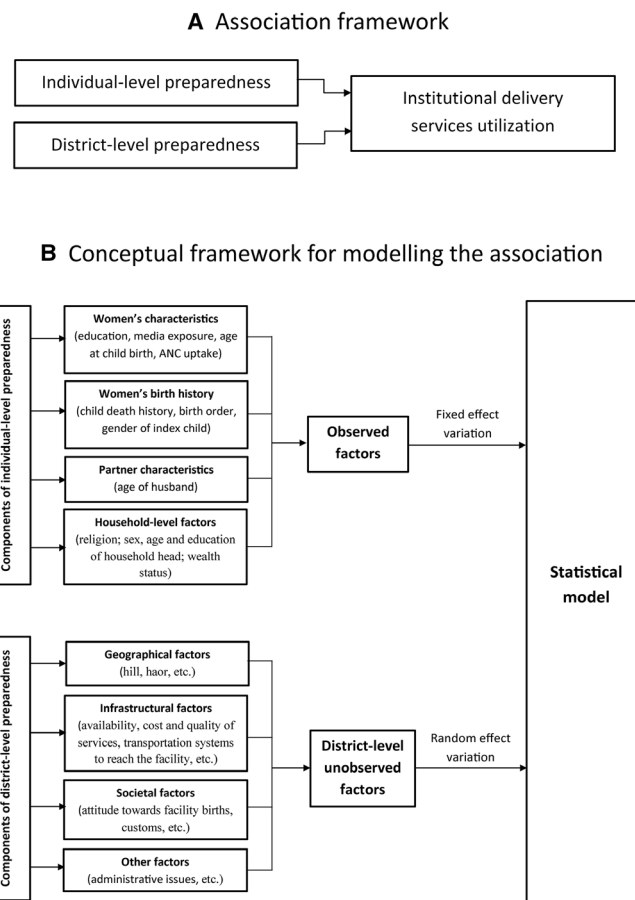
### Outcome measures

This study examined two outcome measures. The primary outcome variable was the place of birth of the index child. The index child was the most recent birth of women aged 15–49 in the 2 years preceding the survey. The reported place of birth was converted into two categories: (1) institutional births, for births occurring in a health facility and (2) non-institutional births, for births occurring in the home or non-health facilities.

The second outcome variable was at the areal level, which was the district level prevalence of institutional births. This variable was measured as the proportion of women in an administrative district whose last live birth in the 2 years preceding the survey occurred in a health facility.

### Explanatory variables

Individual and household characteristics that may influence facility births were selected based on the earlier literature from Bangladesh,<sup>18–21 24</sup> India,<sup>23 28</sup> Pakistan,<sup>20</sup> Nepal<sup>20 29</sup> and Nigeria.<sup>30 31</sup> Factors that are likely to reflect individual preparedness for facility birth were grouped under four broad categories: the woman's individual socio-demographic characteristics, her birth history, her partner's characteristics and her household's characteristics. Factors that possibly reflect district-level preparedness were conceptualised under four broad types: geographical, infrastructural, societal and other. **Figure 1** presents the conceptual framework where individual-level preparedness was measured through observed factors, and district-level preparedness was assessed through unobserved factors. A detailed description of assessing district-level preparedness is given in the 'Statistical analysis' section.



**Figure 1** Conceptual framework for statistical model construction. ANC, antenatal care.

The observed factors representing individual-level preparedness for facility births are presented in **table 3**. A woman's sociodemographic characteristics included educational attainment, age at last birth, exposure to media and the number of ANC visits she had during the pregnancy of the index child. Birth history included a woman's parity, the death history of all births she had and the sex of the index child. Death history of all births was included as an explanatory variable because it was anticipated that respondents who experienced death of any of their child before the birth of the index child may be more cautious to avoid childbirth-related health risks, and have a higher probability of using health facilities for the birth of the index child.

Partner characteristics were represented by only one variable: the age of the husband, since this was the only information available in the survey about partners that could be linked with the women's information. Five variables represented household factors: religion, sex, age, educational attainment of the household head and the household's wealth status. The household's wealth status was estimated based on the wealth quintiles constructed via principal component analysis by using 25 pieces of information on the ownership of consumer goods, dwelling characteristics, water and sanitation, and other factors connected to household wealth.<sup>32</sup> Three categories were

**Table 3** Description of observed explanatory variables

Explanatory variable	Categories	Description
<b>Women's characteristics</b>		
Educational attainment	None or primary	No formal education or 1–5 years of formal schooling
	Secondary	6–10 years of formal schooling
	Above secondary	More than 10 years of formal schooling
Media exposure: exposure to radio, television or newspaper	None	Respondent did not have exposure to any mass media
	Less than once a week	Has exposure to any media less than once a week
	At least once a week	Has exposure to any media at least once a week
	Almost every day	Has exposure to any media almost every day
Age at last childbirth	<18 years	Age of the respondent at her last childbirth was below 18 years
	18–22 years	Age of the respondent at her last childbirth was between 18 and 22 years
	23–27 years	Age of the respondent at her last childbirth was between 23 and 27 years
	28 years or above	Age of the respondent at her last childbirth was 28 years or above
Antenatal care visit during pregnancy of the index birth	None	Respondent did not receive ANC during her last childbirth
	1–3	Respondent had at most three ANC visits during her last childbirth
	4+	Respondent had at least four ANC visits during her last childbirth
<b>Women's birth history</b>		
Death history of children born	Had no death	Did not experience child death before the birth of the index child
	Had at least one death	Experienced child death before the birth of the index child
Birth order	First	Last child was the first birth of the respondent
	Second	Last child was the second birth of the respondent
	Third or higher	Last child was the third or following birth of the respondent
Sex of index child	Male	Index child is male
	Female	Index child is female
<b>Partner characteristics</b>		
Age of husband	≤30 years	Husband's age was thirty years or below
	Above 30 years	Husband's age was above 30 years
<b>Household-level factors</b>		
Religion	Islam	Respondent was from a Muslim household
	Other	Respondent was from a non-Muslim household
Sex of household head	Male	Respondent was from a male-headed household
	Female	Respondent was from a female-headed household
Age of household head	≤30 years	Household head's age was thirty years or below
	31–40 years	Household head's age was between 31 and 40 years
	41–50 years	Household head's age was between 41 and 50 years
	51–60 years	Household head's age was between 51 and 60 years
	61 years or above	Household head's age was 61 years or above
Education of household head	None or primary	No formal education or 1–5 years of formal schooling
	Secondary	6–10 years of formal schooling
	Above secondary	More than 10 years of formal schooling
Wealth status	Poor	Household belonged to the bottom two wealth quintile groups
	Middle	Household belonged to the third wealth quintile group
	Rich	Household belonged to the highest two wealth quintile groups

ANC, antenatal care.

considered—households in the two poorest wealth quintiles, the middle quintile and the two richest quintiles.

### Statistical analysis

Univariate and bivariate statistics were used to provide insight into factors influencing institutional births. Due to the unavailability of observed district-level data, no indicator could be constructed for measuring the absolute district-level preparedness. Thus, through statistical modelling, this paper derived a proxy for measuring district-level preparedness for facility births.

An earlier study used BMICS 2019 data to explore the influence of district-level readiness on women's mobile phone ownership in the context of rural Bangladesh.<sup>33</sup> That study used mixed-effect logistic regression model considering random intercept at the district level. It provided relative measures for district-level preparedness that enabled comparing the districts' preparedness, but did not allow for concluding the absolute preparedness of the districts. This paper adopted that framework and contextualised it according to the study objectives to explore the influence of district-level preparedness on the utilisation of institutions for birth and examine its association with variation in the prevalence of district-level facility births.

Figure 1 presents the conceptual framework for modelling the association of individual and district-level preparedness with the utilisation of institutions for childbirth. If there exists significant variation in district-level preparedness, the intercepts of the districts will vary significantly in the district-level random intercept model where geographical, infrastructural, societal and other district-level factors will be considered as district-level unobserved factors. Thus, a two-level model considering women were nested within the administrative districts was used while fitting the mixed-effect logistic regression model. This empirical model can be expressed as follows:

$$\text{logit}(\pi_{ij}) = \beta_0 + \beta_j + \sum_{k=1}^K \beta_k X_{kij}, \quad \beta_j \sim N(0, \sigma^2)$$

where  $\pi_{ij}$  is the probability of using an institutional facility for  $i^{\text{th}}$  woman ( $i = 1, 2, \dots, n$ ) of  $j^{\text{th}}$  district ( $j = 1, 2, \dots, 64$ ),  $\beta_j$  is the random intercept for  $j^{\text{th}}$  district, and  $\beta_k$  is the coefficient of covariate  $X_k$ . According to the distributional assumption of random intercepts, the district-level random intercepts were estimated by considering the average random effect equal to zero.

It was anticipated that the main driving force of any district-level random intercept is the combined effect of district-level unobserved factors that reflect the district-level preparedness for institutional birth services. Thus, in the context of this study, these district-level random intercepts could serve as a proxy of district-level preparedness for services that relatively compare the preparedness of the districts by setting the average preparedness of all the districts equal to zero. To avoid misleading conclusions, results should be interpreted with care. For example, random intercept 'M' of district 'X' could not

be interpreted as X district is M unit prepared. Interpretation should be made in terms of comparison. For example: if districts X and Y have random intercepts M and N ( $M > N$ ), respectively, then it can be said that the X district is more prepared than Y.

First, null models (model I for rural, model III for urban) were fitted with random intercepts to estimate the degree of correlation in institutional births at the administrative district level. Finally, to identify the determinants of facility births and estimate the district-level random effects, the full models were constructed (model II for rural, model IV for urban) by including all the covariates mentioned earlier.

Global Moran's I was estimated to explore the existence of spatial dependency in the district-level prevalence of institutional birth service utilisation.<sup>34</sup> The Monte Carlo approach was undertaken to test the spatial dependency through implementing the permutation test of the significance of Moran's I.<sup>35</sup>

The conditional autoregressive (CAR), a geospatial model for areal data, was employed to investigate whether district-level preparedness for services is a source of areal variation in institutional births.<sup>36</sup> The CAR model was implemented as it can capture the space dependency of the outcome of interest while measuring the association between an explanatory variable and the outcome of interest. In this study, the CAR model was specified by the district-level prevalence of institutional birth (outcome of interest) and district-level random effects (explanatory variable) estimated from full models (model II, model IV).

Appropriate sampling weights were incorporated while conducting the analyses by using Stata V.14.0 (Stata SE V.14, Stata Corp) and 'spdep', 'ggplot2', 'gpubr' packages of R (V.3.6.2, RStudio V.1.1.383).

### Patient and public involvement

Research questions, outcome measurement and study design were constructed without involving any patients. Thus, study findings could not be disseminated to the respondents.

## RESULTS

### Rural–urban socioeconomic and demographic differences: univariate analysis

Table 4 presents the demographic and socioeconomic distribution of the analytical sample, which contains information on 7103 women from rural areas and 1992 women from urban areas. Urban women were more educated, had more frequent exposure to media, and were more likely to seek ANC during pregnancy of the index child compared with rural women. The distribution of the sex of the index child did not vary much across the place of residence. Household heads from urban areas were more educated than their rural counterparts. Urban women were economically better off than those who resided in rural areas, with 76% of urban women compared with

**Table 4** Demographic and socioeconomic status of women who gave birth in the 2 years preceding the survey by place of residence

Factors	Rural		Urban		
	n	Percent	n	Percent	
Total		7103	78.1	1992	21.9
<b>Women's characteristics</b>					
Educational attainment					
None or primary		2370	33.4	564	28.3
Secondary		3659	51.5	904	45.4
Above secondary		1074	15.1	524	26.3
Media exposure					
None		2824	39.8	329	16.5
Less than once a week		364	5.1	64	3.2
At least once a week		597	8.4	148	7.5
Almost everyday		3318	46.7	1450	72.8
Age at childbirth					
<18 years		453	6.4	115	5.8
18–22 years		2373	33.4	619	31.1
23–27 years		2002	28.2	635	31.9
28+ years		2275	32.0	622	31.3
ANC visit					
None		1382	19.5	173	8.7
1–3		3445	48.5	733	36.8
4+		2276	32.0	1086	54.5
<b>Women's birth history</b>					
Death history of children born					
Had no death		6385	89.9	1841	92.4
Had at least one death		718	10.1	151	7.6
Birth order					
First		2377	33.5	768	38.6
Second		2407	33.9	698	35.1
Third or higher		2320	32.7	526	26.4
Sex of index child					
Male		3705	52.2	1042	52.3
Female		3398	47.8	950	47.7
<b>Partner characteristics</b>					
Age of husband					
≤30 years		2711	38.2	751	37.7
>30 years		4392	61.8	1241	62.3
<b>Household-level factors</b>					
Religion					
Islam		6496	91.5	1849	92.8
Other		607	8.5	144	7.2
Sex of household head					
Male		6614	93.1	1842	92.5
Female		489	6.9	150	7.5
Age of household head					

Continued

**Table 4** Continued

Factors	Rural		Urban	
	n	Percent	n	Percent
≤30 years	1587	22.3	513	25.7
31–40 years	2402	33.8	722	36.3
41–50 years	1078	15.2	283	14.2
51–60 years	881	12.4	236	11.8
>60 years	1156	16.3	239	12.0
Education of household head				
None or primary	4546	64.0	891	44.7
Secondary	1881	26.5	660	33.1
Above secondary	676	9.5	442	22.2
Wealth status				
Poor	3393	47.8	249	12.5
Middle	1500	21.1	226	11.4
Rich	2210	31.1	1517	76.2
<b>Institutional childbirth</b>				
No	3588	50.5	644	32.3
Yes	3515	49.5	1348	67.7

ANC, antenatal care.

31% of rural women coming from households in the two richest wealth quintiles. Women in urban areas were much more likely to have facility births compared with those in rural areas.

#### Variation in prevalence of institutional childbirth by individual and household characteristics in rural and urban areas: bivariate analysis

Table 5 shows the variation in facility births across socioeconomic and demographic groups separately for women residing in rural and urban areas. In both places of residence, institutional births were higher among women who had higher education, frequent media exposure, and who sought more ANC during the pregnancy of the index child. Rural women who gave birth to a male child were more likely to give birth at health facilities compared with those who gave birth to a female child. However, in urban areas, no such difference in facility births was noticed by the newborn's gender. Education of the head of household had a positive influence on facility birth both in rural and urban areas. Wealthier households in both settings were more likely to seek institutional births.

#### Rural–urban differentials in the influence of individual-level preparedness on institutional childbirth: multivariable analysis

The findings from the mixed effect logistic regression on the association between individual-level preparedness (measured by a number of individual and household characteristics) and facility birth are presented in table 6.

#### Association of women's characteristics with institutional childbirth

Women's educational attainment significantly contributed to the use of institutions for childbirth in both rural and urban areas (table 6). Notably, in urban areas, the influence of maternal education on facility birth was more pronounced than in rural areas. For example, urban women with above secondary level education were 3.9 times more likely to have institutional childbirths compared with those with primary complete or less educational attainment. This OR was 1.9 for rural women.

Media exposure was not associated with institutional childbirth in urban areas; but in rural areas, the likelihood of having childbirth in health facilities was almost 1.5 times higher among women who had media exposure almost every day compared with those with no media exposure. There was a strong association between the number of ANC visits during pregnancy and the likelihood to give birth in health facilities in both rural and urban areas.

#### Association of women's birth history with institutional childbirth

Women who experienced child death were more likely to have institutional birth in rural areas but not in urban areas. In both urban and rural settings, first births were much more likely to occur in health facilities compared with higher parity births. The influence of fetal gender on women's decision to have childbirth in a facility varied by rural–urban settings. In rural areas, the likelihood of having facility delivery was 18% lower among women who gave birth to a female child (aOR 0.82, 95% CI 0.70 to 0.97) compared with those who gave birth to a male child.



**Table 5** Prevalence of institutional delivery by individual and household characteristics in rural and urban areas of Bangladesh

Factors	Percentage of institutional births among women in	
	Rural areas	Urban areas
<b>Women's characteristics</b>		
Educational attainment		
None or primary	29.3	45.6
Secondary	54.8	68.5
Above secondary	76.2	90.1
Media exposure		
None	34.2	48.8
Less than once a week	45.0	60.6
At least once a week	47.1	54.7
Almost everyday	63.4	73.6
Age at last childbirth		
<18 years	51.7	65.2
18–22 years	54.6	64.1
23–27 years	50.7	66.2
28+ years	42.6	73.2
ANC visit		
None	18.5	25.7
1–3	46.6	54.9
4+	72.7	83.0
<b>Women's birth history</b>		
Death history of children born		
Had no deaths	50.2	67.9
Had at least one death	43.4	65.2
Birth order		
First	61.8	74.1
Second	51.1	69.6
Third or higher	35.2	55.8
Sex of index child		
Male	51.4	67.3
Female	47.4	68.1
<b>Partner characteristics</b>		
Age of husband		
≤30 years	49.0	59.7
>30 years	49.8	72.5
<b>Household-level factors</b>		
Religion		
Islam	48.2	66.8
Other	62.8	79.7
Sex of household head		
Male	49.2	67.2
Female	53.4	74.2

Continued

**Table 5** Continued

Factors	Percentage of institutional births among women in	
	Rural areas	Urban areas
Age of household head		
≤30 years	45.4	56.6
31–40 years	47.1	68.2
41–50 years	45.0	73.3
51–60 years	56.1	68.9
>60 years	59.2	82.2
Education of household head		
None or primary	41.3	54.0
Secondary	60.0	73.4
Above secondary	75.2	86.9
Wealth status		
Poor	32.9	37.6
Middle	53.4	57.2
Rich	72.3	74.2

ANC, antenatal care.

Interestingly, in urban areas, the differential in facility delivery by sex of the fetus was not observed.

#### Association of household factors with institutional childbirth

Institutional childbirth was not associated with the household head's gender and age, but their education emerges as a strong predictor in both rural and urban areas (table 6). In both rural and urban areas, women whose household heads had above secondary level education were around 1.7 times more likely to have facility births compared with those with primary or less education levels. The influence of household heads' educational attainment appeared to be more pronounced in rural than in urban areas. For example, in urban areas, there was no difference in facility births among women whose household heads had secondary level education and primary or less education. In rural areas, facility births were 1.3 times higher among women whose household heads had secondary education compared with those who had primary or less education.

The role of household wealth on giving birth in health facilities varied across rural–urban settings. In rural areas, the likelihood of facility delivery varied significantly by women's household socioeconomic status. Rural women from households in the two richest wealth quintiles were twice as likely to have institutional births compared with those in the two poorest wealth quintiles (aOR 2.04, 95% CI 1.49 to 2.80). Even those from households in the middle quintile were 1.36 times more likely to use facilities for childbirth compared with those from the two poorest wealth quintiles. In contrast, there was no significant difference in seeking institutional childbirth by socioeconomic status of women in the urban areas.

**Table 6** Association of individual-level preparedness with institutional childbirth in Bangladesh: results from mixed effect logistic regression

Factors	Rural (Model II)	Urban (Model IV)
	aOR (95% CI)	aOR (95% CI)
<b>Women's characteristics</b>		
Educational attainment		
None or primary	Reference	Reference
Secondary	<b>1.40*</b> (1.16 to 1.69)	<b>1.82**</b> (1.24 to 2.66)
Above secondary	<b>1.93*</b> (1.37 to 2.72)	<b>3.85*</b> (2.11 to 7.05)
Media exposure		
None	Reference	Reference
Less than once a week	1.24 (0.86 to 1.79)	1.33 (0.39 to 4.53)
At least once a week	1.31 (0.99 to 1.74)	1.05 (0.42 to 2.68)
Almost everyday	<b>1.45*</b> (1.23 to 1.73)	1.34 (0.76 to 2.35)
Age at last childbirth		
<18 years	Reference	Reference
18–22 years	1.25 (0.89 to 1.77)	0.86 (0.43 to 1.69)
23–27 years	1.39 (0.92 to 2.12)	1.04 (0.46 to 2.33)
28+ years	1.43 (0.88 to 2.32)	1.89 (0.74 to 4.85)
ANC visit		
None	Reference	Reference
1–3	<b>2.52*</b> (2.00 to 3.17)	<b>2.72**</b> (1.29 to 5.76)
4+	<b>5.81*</b> (4.49 to 7.51)	<b>6.78*</b> (2.27 to 20.24)
<b>Women's birth history</b>		
Death history of children born		
Had no death	Reference	Reference
Had at least one death	<b>1.69**</b> (1.19 to 2.39)	2.24 (0.95 to 5.30)
Birth order		
First	Reference	Reference
Second	<b>0.48*</b> (0.38 to 0.59)	0.66 (0.37 to 1.18)
Third or higher	<b>0.30*</b> (0.21 to 0.43)	<b>0.32***</b> (0.13 to 0.77)
Sex of index child		
Male	Reference	Reference
Female	<b>0.82***</b> (0.70 to 0.97)	1.06 (0.79 to 1.41)
<b>Partner characteristics</b>		
Age of husband		
≤30 years	Reference	Reference
>30 years	<b>1.46**</b> (1.13 to 1.88)	1.31 (0.61 to 2.77)
<b>Household-level factors</b>		
Religion		
Islam	Reference	Reference
Other	<b>2.03*</b> (1.51 to 2.73)	<b>1.88***</b> (1.02 to 3.46)
Sex of household head		
Male	Reference	Reference
Female	0.84 (0.55 to 1.29)	1.30 (0.50 to 3.40)
Age of household head		
≤30 years	Reference	Reference

Continued

**Table 6** Continued

Factors	Rural (Model II)	Urban (Model IV)
	aOR (95% CI)	aOR (95% CI)
31–40 years	0.99 (0.77 to 1.28)	1.19 (0.44 to 3.20)
41–50 years	0.99 (0.70 to 1.41)	1.45 (0.49 to 4.32)
51–60 years	1.12 (0.75 to 1.66)	1.18 (0.38 to 3.66)
>60 years	1.00 (0.73 to 1.38)	2.57 (0.90 to 7.33)
Education of household head		
None or primary	Reference	Reference
Secondary	<b>1.33*</b> (1.12 to 1.58)	1.68 (0.84 to 3.38)
Above secondary	<b>1.70**</b> (1.21 to 2.37)	<b>1.75**</b> (1.22 to 2.51)
Wealth index		
Poor	Reference	Reference
Middle	<b>1.36**</b> (1.11 to 1.68)	1.22 (0.64 to 2.34)
Rich	<b>2.04*</b> (1.49 to 2.80)	1.46 (0.73 to 2.93)

aOR with  $p < 0.05$  are in bold font  
 $*$  $p < 0.05$ ,  $**p < 0.01$ ,  $***p < 0.001$   
 aOR, Adjusted odds ratio; CI, Confidence interval.

### Rural–urban differentials in the influence of geospatial preparedness on institutional childbirth: multivariable and spatial analysis

#### Role of district-level preparedness on use of institutions for childbirth

As described in the Methods section, the influence of district-level preparedness on facility births was assessed by exploring the variation in institutional childbirths through district-level unobserved factors. [Table 7](#) illustrates the extent of administrative district-level variation in institutional birth. First, the intercept-only models without covariates were constructed to justify the decision for assessing random effects at the administrative district levels. Results obtained from these models (model I and model III) indicate that in both rural and urban areas, there was a significant variation in the odds of having facility births across the administrative districts (model I: variance=0.59, 95% CI 0.40 to 0.86 and model III: variance=0.46, 95% CI 0.19 to 1.10).

The intraclass correlation coefficients (ICCs) indicate substantial district-level clustering. In rural and urban settings, respectively, 15.2% and 12.3% of the total

variation in institutional childbirth were attributable to the differences in preparedness across districts. Variation in facility births due to district-level unobserved factors remained statistically significant even after controlling for the covariates. ICCs of model II and model IV indicate that in both rural and urban settings about 8%–9% of the variability in facility births was explained through district-level unobserved factors. These statistically significant district-level random variations and ICCs support the findings on the influence of district-level preparedness on the utilisation of facilities for childbirth.

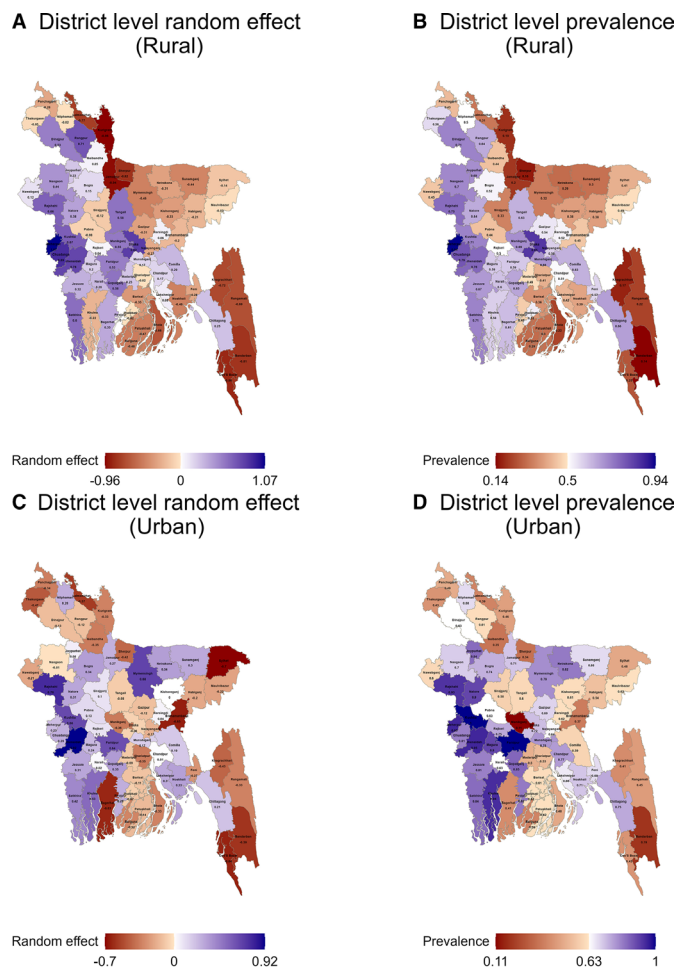
#### Association of geospatial preparedness with areal variation in institutional childbirth

[Figure 2](#) presents the geospatial mapping of the prevalence of institutional childbirth and the district-level random effects estimated from model II and model IV. A positive random effect indicates a more favourable effect of district-level unobserved factors on the use of facilities for childbirth, while a negative effect is interpreted vice versa. The absolute value of the random effect stands for the extent of the effect of district-level unobserved factors.

**Table 7** Influence of district level unobserved variation on institutional childbirth: results from mixed effect logistic regression

Random effects	Rural	Rural	Urban	Urban
	Model I*	Model II†	Model III†	Model IV†
	Estimate (95% CI)	Estimate (95% CI)	Estimate (95% CI)	Estimate (95% CI)
Variance	0.59 (0.40 to 0.86)	0.29 (0.20 to 0.43)	0.46 (0.19 to 1.10)	0.32 (0.11 to 0.90)
ICC	0.152	0.082	0.123	0.088

\*Without covariates.  
 †Includes all the covariates.  
 ICC, intraclass correlation coefficient.



**Figure 2** Geospatial mapping of district-level random effect and district-level facility births.

A more favourable effect of district-level unobserved factors was noticed in Western regions and an opposite scenario was observed in the Eastern region, particularly in the hill tracts. The prevalence of institutional childbirth was higher in western and lower in eastern Bangladesh, particularly in the hill tracts region. On average, a higher prevalence was noticed where the random effect was positive and high. In contrast, a lower prevalence was noticed where the random effect was negative and high in absolute terms. These findings indicate that in both rural and urban settings, district-level unobserved factors play a role in geospatial variation in seeking institutional childbirth care. Further, a CAR model was employed to

statistically investigate the association between district-level random effect and the prevalence of institutional childbirth.

Moran's I estimate and its p value presented in [table 8](#) confirm the geospace dependency in the district-level prevalence of facility birth. This significant Moran's I estimate justifies the decision for choosing the CAR model in investigating the association of district-level random effect with the district-level prevalence of institutional childbirth. The estimated coefficients and p values confirm a significant and positive association between district-level random effect and district-level prevalence of facility birth. This supports that the district-level preparedness for facility births was a potential source of areal variation in facility births.

## DISCUSSION

### Main findings

Although Bangladesh has achieved phenomenal strides in improving maternal and child healthcare services utilisation over the past two decades, further improvements in reducing both maternal and neonatal mortality require more wider and equitable use of institutional childbirth care. For this to happen, the urban–rural gap in institutional births, which currently is in favour of urban women, needs to be eliminated. In rural settings, women who had greater media exposure and gave birth to a female child were less likely to have facility births. In contrast, in the urban areas, facility births did not vary by these factors. Urban areas exhibited socioeconomic equity in the use of institutions for childbirth, while the degree of inequity was more intense in rural areas. In both rural and urban settings, the choice of birth-giving place was explained through district-level preparedness. Geospatial mapping revealed less preparedness in the hill tracts, particularly in Southeastern regions. The district-level preparedness was a potential source of observed areal-variation in the use of institutions for childbirth in Bangladesh.

### Demographic and socioeconomic differences across residences translate into inequity in use of institutions for childbirth

Urban women were more likely to have facility births than rural women. The urban–rural gap in the prevalence of facility births is currently 18 percentage points.<sup>32</sup> A

**Table 8** Association between district-level random effect and prevalence of district-level facility births: results from CAR model

Coefficient	Rural	Urban
	Estimate (95% CI)	Estimate (95% CI)
Moran's I (for district-level prevalence of facility births)	0.40** (0.25 to 0.55)	0.21** (0.06 to 0.36)
District-level random effect	0.34* (0.30 to 0.37)	0.45* (0.39 to 0.52)

\*P<0.05, \*\*p<0.01.  
CAR, conditional autoregressive.

number of demographic and socioeconomic differentials between urban and rural dwellers may be partially responsible for the differential use of facilities for childbirth by place of residence. Earlier studies established women's education as one of the elementary correlates of maternal mortality<sup>37–39</sup> and their healthcare-seeking behaviour.<sup>40 41</sup> Education is considered a predisposing factor that determines the choice of medical facility for childbirth as well. In order to make women more informed in their choice of facility or non-facility births, women should be educated on available healthcare opportunities and enabled to make better choices regarding the birth-giving place.<sup>42 43</sup>

Consistent with earlier studies,<sup>18 19 44 45</sup> this paper finds that maternal educational attainment is positively associated with seeking institutional childbirth care, both in urban and rural areas. Findings demonstrate that urban women have higher educational attainment than their rural counterparts. For example, in this study, 26% of sampled mothers in the urban areas have above secondary education compared with 15% of those in rural areas. This itself can be a source of urban–rural differential in the prevalence of facility births.

However, the education of expectant mothers can play its full-length role in choosing the birth-giving place if women enjoy autonomy, and the decision to use healthcare facilities is made with their consent. In a society like Bangladesh where the concept of family is broader than just husband, wife and their children, the head of the household often plays a powerful role in decision-making that concerns all individuals in the household. Another way factor influencing facility births is the educational attainment of the household head, which shapes their understanding of the benefits of institutional childbirth on the health of the mother and newborn, and indirectly influences whether a household member can seek facility childbirth.

Study results show that urban household heads have higher educational attainment than their rural counterparts, and the educational attainment of the household head has a significant positive association with the decision to have childbirth in health facilities. This influence is more pronounced in rural than urban areas. This signifies that without integrating the household heads, it may be difficult to achieve a remarkable improvement in facility births only by improving women's education. Interventions to improve facility birth need awareness-building activities on the benefits of institutional childbirth care that reach not only the pregnant mothers but also influential members of the household.

The likelihood of having institutional childbirth increases substantially for those with more frequent exposure to mass media in rural areas. This finding suggests that promoting awareness about the benefits of facility births through mass media can be an effective approach for rural dwellers. However, in urban areas, exposure to media is not a potential source of variation in facility births. Mass media campaign promoting institutional birth is missing or minimal in the country. In the absence

of a specific mass media awareness programme, improving healthcare-seeking behaviour only by exposing people to regular media content is tough. It becomes even harder when the practice is already optimal in the community. The high prevalence of institutional birth in urban areas and limited mass media campaign targeting institutional births could be the possible reasons for observing no association between mass media exposure and facility births in urban areas.

#### **Fetal-sex differences in the use of institutions for childbirth**

The paper finds that the sex of the index child plays a crucial role in determining the birth-giving place in rural areas, while it is not a significant factor in urban areas. In rural settings, the prevalence of facility births is higher among women who gave birth to a male child, compared with those who gave birth to a female child. The parental gender bias against girls in rural areas and complicity during the birth of a male child could explain this finding.

Gender discrimination against girls in Bangladesh is rooted in its patrilocal and patrilineal societal structure. In addition, poverty, the tradition of patrilineal inheritance and conservative religious beliefs further reinforce inequalities. In rural Bangladesh, parental desire for a son is pervasive.<sup>46 47</sup> Therefore, in rural settings, knowing the fetal sex may influence parental decision-making for facility delivery. In recent years, Bangladesh has achieved a considerable improvement in the usage of ANC.<sup>32</sup> According to the Bangladesh Demographic and Health Survey (BDHS) report 2017, 77% of rural mothers underwent an ultrasonogram during pregnancy.<sup>12</sup> In government hospitals of Bangladesh, the cost of a lower abdominal ultrasonogram test is only 100 Bangladeshi taka, equivalent to US\$1.<sup>48</sup> The increasing practice of ANC and the lower cost of the ultrasonogram test may increase the likelihood of knowing the sex of the index child before birth. Thus, knowing that the fetus is female may hinder the utilisation of institutions for childbirth since there are substantial cost differences between home births and institutional births.

Another factor contributing to the higher rates of facility births for males may be a biological one. Earlier research showed that pregnancies with a male fetus experience more complications during pregnancy and labour than a female fetus,<sup>49–53</sup> which may lead to a higher likelihood of facility births. The pathways through which sex of the index child influences facility births could not be fully uncovered in this paper, due to data unavailability. Thus, further research is required on this issue.

#### **Socioeconomic equity in use of institutions for childbirth**

Interestingly, in urban areas, there are no significant differences in facility births by household wealth status, reflecting desired equitable use of institutions for childbirth by all socioeconomic groups. However, in rural areas, there is substantial inequity in seeking facility delivery by households' economic status. Several factors can explain this finding. First, three out of four urban dwellers belong

to the two richest household wealth quintiles, compared with one in three in rural areas. Thus, institutional care is likely more affordable for those in urban areas. Second, in Bangladesh, healthcare facilities and transportation systems are far better in urban settings,<sup>54</sup> reducing the resource cost of seeking services. Hence, urban women from comparatively poor households and with less education may have better access to maternal health services. Moreover, the decision of where to give birth may be influenced by social norms around facility births in the birthgiver's place of residence—another reason for more equitable use of facilities for childbirth by socioeconomic groups of urban areas compared with rural areas. Considering that institutional births help improve infant survival, this study also justifies the findings of previous literature showing evidence of socioeconomic equity in infant survival in urban areas, while inequity was prominent in rural areas.<sup>55</sup>

### District-level preparedness influences prevalence of institutional childbirth

Along with women's individual-level and household-level factors, geographical characteristics can also influence healthcare-seeking behaviours.<sup>56</sup> Findings show that in both rural and urban settings, about 8%–9% of the variability in the choice of birth-giving place is attributable to the geospatial preparedness for facility births. Geospatial mapping reveals that the bottom five rural areas in terms of preparedness are the hill tract areas, mostly located in Southeastern regions where the transportation system is poor. A quite similar pattern is also observed in urban areas.

In Bangladesh, formal and informal sectors do not provide the same level of maternal healthcare facilities due to shortages of trained professionals, equipment, medicines and unpleasant behaviour of their staff.<sup>19</sup> In rural and urban settings, the primary determinant of choosing a treatment facility is 'short distance'.<sup>54</sup> This evidence indicates that poor transportation allowing women to reach health facilities, as well as costly and low-quality services in a district, could lead to a lower district-level infrastructural preparedness for facility births, which might in turn result in lower utilisation of facilities during childbirth. In the long run, this lower prevalence of facility births could solidify into a social norm, resulting in poor societal preparedness for facility births. Therefore, improving infrastructural preparedness is of critical importance, as poor infrastructural preparedness in any area can also act as a hidden layer of poor societal preparedness in that area.

The study findings also indicate that district-level variation in the use of institutions for childbirth also prevails in urban areas due to variation in geospatial preparedness for institutional birth services in those areas. This implies that women in urban areas are not guaranteed greater access to health facilities. The study findings highlight that any district's rural and urban areas can have different levels of preparedness. For instance, rural areas

of the Manikganj district have a higher level of district-level preparedness compared with other rural areas of Bangladesh, while its urban areas experience a lower level of district-level preparedness compared with other urban areas of Bangladesh. Hence, strategies—tailored to a given place of residence—should be undertaken to improve district-level preparedness. Further research is recommended to investigate the extent of preparedness of each district and the impact of unmeasured district-level factors on the use of institutions for childbirth in Bangladesh.

### LIMITATIONS

This study used cross-sectional data, which limits the scope of establishing any causal relationship between the examined factors and place of delivery. Secondary data type limits the scope of investigating the role of household-level factors such as household heads' beliefs towards institutional birth and family history of using institutional services for childbirth. BMICS collects individual data on men but was not linkable to women's data in such a way that one can know the relationship between men and women. Therefore, this study was confined to only one partner-related factor which limits the extent of investigating how husbands' characteristics shape women's use of institutional services for childbirth. Data unavailability restricted the examination of some crucial district-level factors such as distance and transportation systems for reaching the nearest birth-giving place, cost and quality of that facility, and attitudes of service providers. The COVID-19 pandemic has majorly changed human mobility patterns and healthcare-seeking behaviour all around the globe. Being an LMIC, healthcare-seeking behaviour in Bangladesh is not up to the mark, which may be further lowered during the COVID-19 pandemic. As this study was conducted in a prepandemic setting, findings might not be fully applicable for the postpandemic scenario if healthcare-seeking behaviour during birth substantially varies between prepandemic and postpandemic periods in Bangladesh.

### CONCLUSION

Individual and household characteristics act differently in institutional birth in urban and rural settings in Bangladesh. While mass media exposure influences institutional birth in rural areas, they have no association in urban areas. A son was likelier to be born in a health institute in rural areas. Still, this study can not conclude a gender bias in institutional birth without further research, as higher pregnancy complications for male children were evident in other studies. The positive association of the household head's level of education in determining the place of childbirth warrants inclusive public health programmes that consider the household heads, primarily the woman's husband. Intervention strategies in rural settings should focus on the poor, whereas it

may not be prudent to consider wealth status in urban settings. However, the individual-level and household-level factors are insufficient unless there is a regional level enabling environment which may include improved transportation infrastructure, quality services, a friendly atmosphere in the health institutes and social awareness. Without a multisectoral approach, improvement in institutional birth and its benefits may remain unmet, and the related Sustainable Development Goals unachieved.

**Acknowledgements** We thank Professor Dr. Syed Shahadat Hossain for guiding us to complete the spatial modeling/modelling. Our special gratitude to Dr. Kanta Jamil, who helped us reshape the storyline of the paper and improve the discussion of the findings. As an enthusiastic public health researcher, Shusmita Khan read the manuscript and provided valuable suggestions. Avita Streatfield generously supported us improve the manuscript's language by English editing. UNICEF and the Bangladesh Bureau of Statistics provided free access to the Bangladesh MICS 2019 data which made this study possible. icddr.b acknowledges the core/unrestricted support of the Government of the People's Republic of Bangladesh, Canada, Sweden and the UK for its operations and research.

**Contributors** MMR and TA conceptualised the research problem, MMR and TA compiled data and performed the formal analysis; MMR, TA, MHHMKA prepared the original draft; AN and MMH critically reviewed and edited the manuscript. All authors read and approved the final version. MMR is responsible for the overall content as the guarantor.

**Funding** The authors have not declared a specific grant for this research from any funding agency in the public, commercial or not-for-profit sectors.

**Competing interests** None declared.

**Patient and public involvement** Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

**Patient consent for publication** Not applicable.

**Provenance and peer review** Not commissioned; externally peer reviewed.

**Data availability statement** Data are available in a public, open access repository. This study used secondary survey data from UNICEF MICS. Data are publicly available on reasonable request. The dataset used for this study was obtained from the MICS website (<https://mics.unicef.org/surveys>).

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