

Mapping the prevalence and Covariates Associated with Home Delivery in Bangladesh: A Multilevel Regression Analysis

--Manuscript Draft--

Manuscript Number:	PONE-D-23-36533
Article Type:	Research Article
Full Title:	Mapping the prevalence and Covariates Associated with Home Delivery in Bangladesh: A Multilevel Regression Analysis
Short Title:	Prevalence and Covariates Associated with Home Delivery in Bangladesh using multilevel modeling approach
Corresponding Author:	UK Majumder Khulna University Khulna, BANGLADESH
Keywords:	Keywords: Home delivery, delivery care, multilevel modeling, MICS, Bangladesh.
Abstract:	<p>Introduction: Though Bangladesh had made an intense effort to improve maternal healthcare facilities among healthcare, the number of home delivery is still very high. However, reasons behind this need to be explored in community-level. The goal of this study is to find out district-wise prevalence and recognize the individual and community-level covariates related to home delivery in pregnant women in Bangladesh.</p> <p>Methods: Data were derived from the Multiple Indicator Cluster Survey (MICS) 2019, which is a nation-wide cross-sectional survey in Bangladesh. Final sample of 9,166 (weighted) women who gave birth in the two years preceding the survey were included in this study. Considering the two-stage cluster sampling strategy adopted by MICS, we used multilevel (2-level) logistic regression analysis to find out the correlates of home delivery.</p> <p>Results: The overall weighted prevalence of home delivery was 46.41%. The highest prevalence was observed in Bandarban district (84.58%), while the lowest was found in Meherpur district (6.95%). Women with higher education, higher wealth status, having ANC visit had lower odds of delivering child at home compared to their counterparts. While women from age group of 35-49 years, whose last pregnancy was unintended were more likely to deliver child at home. In addition, those respondents belong to a community that had higher ANC utilization, women education, and exposure to media showed lower odds of having delivery at home.</p> <p>Conclusions: The finding indicates that delivery at home is still high in Bangladesh. Targeted interventions to reduce home delivery are urgently needed in Bangladesh to tackle adversities during deliveries and save mothers from the consequences.</p>
Order of Authors:	Rakhi Dey Susmita Rani Dey Meem Haque Anushuya Binta Rahman Satyajit Kundu Sarmistha Paul Setu UK Majumder
Opposed Reviewers:	
Additional Information:	
Question	Response
Financial Disclosure	The author(s) received no specific funding for this work.
Enter a financial disclosure statement that	

describes the sources of funding for the work included in this submission. Review the [submission guidelines](#) for detailed requirements. View published research articles from [PLOS ONE](#) for specific examples.

This statement is required for submission and **will appear in the published article** if the submission is accepted. Please make sure it is accurate.

Funded studies

Enter a statement with the following details:

- Initials of the authors who received each award
- Grant numbers awarded to each author
- The full name of each funder
- URL of each funder website
- Did the sponsors or funders play any role in the study design, data collection and analysis, decision to publish, or preparation of the manuscript?

Did you receive funding for this work?

Competing Interests

Use the instructions below to enter a competing interest statement for this submission. On behalf of all authors, disclose any [competing interests](#) that could be perceived to bias this work—acknowledging all financial support and any other relevant financial or non-financial competing interests.

This statement is **required** for submission and **will appear in the published article** if the submission is accepted. Please make sure it is accurate and that any funding sources listed in your Funding Information later in the submission form are also declared in your Financial Disclosure statement.

View published research articles from [PLOS ONE](#) for specific examples.

The authors have declared no competing interests exists.

NO authors have competing interests

Enter: *The authors have declared that no competing interests exist.*

Authors with competing interests

Enter competing interest details beginning with this statement:

I have read the journal's policy and the authors of this manuscript have the following competing interests: [insert competing interests here]

* typeset

Ethics Statement

Enter an ethics statement for this submission. This statement is required if the study involved:

- Human participants
- Human specimens or tissue
- Vertebrate animals or cephalopods
- Vertebrate embryos or tissues
- Field research

Write "N/A" if the submission does not require an ethics statement.

General guidance is provided below.

Consult the [submission guidelines](#) for detailed instructions. **Make sure that all information entered here is included in the Methods section of the manuscript.**

This study did not require any ethical approval as the analysis used only de-identified existing unit record data from the secondary data source MICS.

Format for specific study types

Human Subject Research (involving human participants and/or tissue)

- Give the name of the institutional review board or ethics committee that approved the study
- Include the approval number and/or a statement indicating approval of this research
- Indicate the form of consent obtained (written/oral) or the reason that consent was not obtained (e.g. the data were analyzed anonymously)

Animal Research (involving vertebrate animals, embryos or tissues)

- Provide the name of the Institutional Animal Care and Use Committee (IACUC) or other relevant ethics board that reviewed the study protocol, and indicate whether they approved this research or granted a formal waiver of ethical approval
- Include an approval number if one was obtained
- If the study involved *non-human primates*, add *additional details* about animal welfare and steps taken to ameliorate suffering
- If anesthesia, euthanasia, or any kind of animal sacrifice is part of the study, include briefly which substances and/or methods were applied

Field Research

Include the following details if this study involves the collection of plant, animal, or other materials from a natural setting:

- Field permit number
- Name of the institution or relevant body that granted permission

Data Availability

Authors are required to make all data underlying the findings described fully available, without restriction, and from the time of publication. PLOS allows rare exceptions to address legal and ethical concerns. See the [PLOS Data Policy](#) and [FAQ](#) for detailed information.

Yes - all data are fully available without restriction

A Data Availability Statement describing where the data can be found is required at submission. Your answers to this question constitute the Data Availability Statement and **will be published in the article**, if accepted.

Important: Stating 'data available on request from the author' is not sufficient. If your data are only available upon request, select 'No' for the first question and explain your exceptional situation in the text box.

Do the authors confirm that all data underlying the findings described in their manuscript are fully available without restriction?

Describe where the data may be found in full sentences. If you are copying our sample text, replace any instances of XXX with the appropriate details.

- If the data are **held or will be held in a public repository**, include URLs, accession numbers or DOIs. If this information will only be available after acceptance, indicate this by ticking the box below. For example: *All XXX files are available from the XXX database (accession number(s) XXX, XXX).*
- If the data are all contained **within the manuscript and/or Supporting Information files**, enter the following: *All relevant data are within the manuscript and its Supporting Information files.*
- If neither of these applies but you are able to provide **details of access elsewhere**, with or without limitations, please do so. For example:

Data cannot be shared publicly because of [XXX]. Data are available from the XXX Institutional Data Access / Ethics Committee (contact via XXX) for researchers who meet the criteria for access to confidential data.

The data underlying the results presented in the study are available from (include the name of the third party

Data are available at <https://mics.unicef.org/surveys>

<p><i>and contact information or URL).</i></p> <ul style="list-style-type: none">• This text is appropriate if the data are owned by a third party and authors do not have permission to share the data. <p>* typeset</p>	
Additional data availability information:	

To

The editor

PLOS ONE

Subject: Manuscript submission

Dear Sir/Madam,

I am delighted to inform you that I, hereby, submit my original research paper titled “**Mapping the prevalence and Covariates Associated with Home Delivery in Bangladesh: A Multilevel Regression Analysis**” in your journal for possible publication. I confirm that the manuscript has not been previously published elsewhere and has not been submitted elsewhere. The main points of this manuscript are given below:

Highlights:

- This study took a fresh look at factors affecting home delivery at individual and community levels. It used Multiple Indicator Cluster Survey dataset (MICS-2019) in Bangladesh which is a reliable and large source of secondary data.
- Application of **Multilevel Modeling** made this study capable of drawing an inference on **different levels of the data** which will be beneficial for the policy makers to make their decision. Also fixed effects of several factors of different levels showed magnitude of their influence on home delivery of pregnant women in Bangladesh. This study tries to **find out the factors affecting home delivery at second level (i.e., community-level)**. This study also identifies if there is any **community-level (2nd level) variation among the risk factors** of home delivery in Bangladesh. This study also maps **the prevalence of home delivery in Bangladesh**.
- This research will add a new dimension to the field of safety of child birth and help in reducing risks during delivery by identifying the **individual as well as community-level factors** affecting home delivery of pregnant Bangladeshi women.

Sincerely

Prof Dr. Uttam Kumar Majumder (UK Majumder)

Statistics Discipline, Khulna University Khulna-9208 Bangladesh

Email: majumderuk@ku.ac.bd

ORCID: <https://orcid.org/0000-0002-1036-4815>

Mapping the prevalence and Covariates Associated with Home Delivery in Bangladesh: A Multilevel Regression Analysis

Rakhi Dey¹, Susmita Rani Dey¹, Meem Haque¹, Anushuya Binta Rahman¹, Satyajit Kundu²,
Sarmistha Paul Setu¹, U. K. Majumder^{1*}

¹ Statistics Discipline, Science Engineering & Technology School, Khulna University, Khulna, Bangladesh.

² Global Health Institute, North South University, Dhaka, Bangladesh.

*Corresponding author

Prof Dr. Uttam Kumar Majumder (UK Majumder)

Statistics Discipline, Science Engineering & Technology School, Khulna University, Bangladesh

Email: majumderuk@ku.ac.bd

ORCID: <https://orcid.org/0000-0002-1036-4815>

Abstract

Introduction: Though Bangladesh had made an intense effort to improve maternal healthcare facilities among healthcare, the number of home delivery is still very high. However, reasons behind this need to be explored in community-level. The goal of this study is to find out district-wise prevalence and recognize the individual and community-level covariates related to home delivery in pregnant women in Bangladesh.

Methods: Data were derived from the Multiple Indicator Cluster Survey (MICS) 2019, which is a nation-wide cross-sectional survey in Bangladesh. Final sample of 9,166 (weighted) women who gave birth in the two years preceding the survey were included in this study. Considering the two-stage cluster sampling strategy adopted by MICS, we used multilevel (2-level) logistic regression analysis to find out the correlates of home delivery.

Results: The overall weighted prevalence of home delivery was 46.41%. The highest prevalence was observed in Bandarban district (84.58%), while the lowest was found in Meherpur district (6.95%). Women with higher education, higher wealth status, having ANC visit had lower odds of delivering child at home compared to their counterparts. While women from age group of 35-49 years, whose last pregnancy was unintended were more likely to deliver child at home. In addition, those respondents belong to a community that had higher ANC utilization, women education, and exposure to media showed lower odds of having delivery at home.

Conclusions: The finding indicates that delivery at home is still high in Bangladesh. Targeted interventions to reduce home delivery are urgently needed in Bangladesh to tackle adversities during deliveries and save mothers from the consequences.

Keywords: Home delivery, delivery care, multilevel modeling, MICS, Bangladesh

Background

In underdeveloped nations, home deliveries have been shown to have unfavorable effects, despite the ongoing discussion in wealthy nations regarding wellbeing and women's rights to select between home and institutional birth [1–5]. It is typical in wealthy nations to presume that women and newborns should get hospital treatment during birth [1,6]. In most, but not all, nations during the past few decades, there has been a marked decline in home births [7–10]. The expansion of institutional delivery coverage and the use of skilled birth attendants during deliveries are only a couple of the measures that have been put forth to lower this maternal, fetal, and newborn mortality [11,12].

According to the World Bank, Bangladesh attained a significant decline in maternal death between 1990 and 2017. The maternal mortality ratio (MMR) in Bangladesh decreased from 574 deaths per 100,000 live births in 1990 to 173 deaths per 100,000 live births in 2017. This represents a considerable reduction, although challenges remain in further reducing the MMR [13]. But as stated by the World Health Organization (WHO), an estimated 295,000 women faced a death due to pregnancy related reasons in 2017 [14]. In 2020, about 800 women per day died from gestation and delivery related avoidable reasons [15]. The maternal mortality rate is very high now a days. In 2020, there were over 2,87,000 deaths of women during and after pregnancy and delivery. In low and lower-middle income nations, around 95% of all maternal death which occurred in 2020, the majority could have been avoided [16]. By ensuring that there is emergency delivery care available when needed and advanced surveillance, it is possible to avoid more than 40% of stillbirths that occur at the moment of delivery [17–20].

The Millennium Development Goals (MDG) and the Sustainable Development Goals (SDG) were the first global goals and targets that attempted to establish, measure, and attain global progress in health and development before the turn of the era [21]. Reducing maternal death is a worldwide precedence, and it is one of the targets of the United Nations' SDG. Target 3.1 of SDG, aims to reduce the ratio of maternal death less than 70 per 100,000 live births within 2030 [22]. Efforts to achieve this target involve improving access to maternal healthcare, ensuring skilled attendance during childbirth, promoting family planning, strengthening health systems, and addressing the social and economic factors that contribute to maternal deaths [22].

Due to factors that are often avoidable, the majority of these fatalities (99%) and complications happen in low- and middle-income countries [18,23]. The discussion about the ideal location for delivery is frequently more emotional than fact-based because there haven't been many studies that carefully compare home versus hospital deliveries. However, little is known about the long-term effects of planned or unexpected home deliveries [4,24,25].

Bangladesh has implemented several initiatives to address maternal health. Despite progress, Bangladesh still faces challenges in reducing maternal mortality. Issues such as inadequate healthcare infrastructure, geographical barriers, limited access to skilled birth attendants, and socioeconomic disparities continue to affect maternal health outcomes. Our study's findings help in identifying the obstacles to health facility delivery and the variables influencing maternal fatalities during in-home birth in Bangladesh.

Methods

Data source

Our study analyzed a nationally representative data of the Multiple Indicator Cluster Survey (MICS 2019) in Bangladesh. The Bangladesh Bureau of Statistics (BBS) and UNICEF collaborated to undertake a six-round worldwide MICS. MICS has considered as the key source of trustworthy statistical evidence on women and children globally through a face-to-face interview method directed by skilled field worker. MICS covers a wide range of themes including information on maternal and child health through household survey [26].

Study Design

A cross-sectional survey was directed at the household (HH) level, where data were collected from 64 districts in Bangladesh. Data from the households were gathered by applying a two-stage stratified cluster sampling technique to guarantee national representation. The enumeration areas (Eas) from the last census in Bangladesh were considered as the primary sampling unit (PSU). A sample of 20 households was taken from each PSU systematically. Finally, a total of 3,220 PSUs yielded a total sample of 64,400 households. The detailed information on sampling technique, questionnaire, and study procedure can be found elsewhere [26]. Women's data file was used in this investigation where a total of 64,870 eligible ever-married reproductive-aged women aged between 15 and 49 years were interviewed. After excluding all missing cases, the final analysis included a total number of

9,166 (weighted) women who gave birth in the two years preceding the survey. The sample selection and case exclusion from MICS 2019 has been shown in **Figure 1**

Response variable

In our study, “place of delivery” was the response variable which was measured using the question “*Where did you give birth to [Name of the child]?*” The outcome variable was then dichotomized and recoded as ‘1’ for home delivery, and ‘0’ for facility-based delivery. ‘Home delivery’ was considered when the women gave birth at their own home or other’s home, and when the birth was at any health facility setting, it was considered as ‘facility based delivery’ [27].

Predictor variables

Different individual factors as well as community-level factors were scrutinized as predictor variables for employing the multilevel modeling. We included age of women (15-19, 20-34, 35-49 years), women’s educational qualification (pre-primary/no formal education, primary, secondary, higher secondary+), age at first marriage/union (≤ 18 years, > 18 years), wealth status (poorest, poorer, middle, richer, richest), number of ANC visit (no visit, 1-3 visits, 4 visit or above), last pregnancy intension (intended, unintended), and exposure to media (no, yes) as individual-level variables. All of these variables were selected after reviewing previous related literature [28–32].

In addition, type of place of residence (rural, and urban), administrative division (Barishal, Chattogram, Dhaka, Khulna, Mymenshingh, Rajshahi, Rangpur, and Sylhet), community-level wealth status (whether or not the cluster's top three wealth quintiles included more than 50% of respondents), Community-level women education (whether more than 50% of respondents in the cluster had at least a secondary education or less education, up to primary level), community-level ANC utilization (whether or not at least four ANC visits were made by more than 50% of cluster responders), and community-level media exposure (if more than 50% of respondents in the cluster have access to the media or not) [31,33,34].

Data analysis

In this study, we used descriptive statistics to present the basic features of respondents and the distribution of home delivery across different categories of the variables. Bivariate association between home delivery and other explanatory variables was tested using Pearson chi-square analysis. After allocating sample weight, utilizing clusters as the primary sampling

unit (PSU), and stratifying the sample, weighted calculations were performed using the "svy" command for all descriptive and bivariate analysis. Additionally, a nation-wide map is depicted to show the district-level distribution of home delivery in Bangladesh. Considering the complex sampling strategy (hierarchical) adopted by MICS, multilevel (2-level) logistic regression analysis was employed to find out the correlates of home delivery after adjusting the cluster effects [35]. For multilevel modeling, we constructed four regression models (Model 0 to Model 3). The intercept-only model (null model) was denoted in Model 0 without including any predictor to estimate the cluster-level variance in the outcome variable. Individual-level factors were the focus of Model 1, while community-level variables were incorporated into Model 2. Every explanatory variable both at individual and community levels, was incorporated into the final model (Model 3). For all regression models, we regarded the clusters as level-2 factors. Prior to constructing the regression models, multicollinearity among the explanatory variables was examined using the variance inflation factor (VIF). After employing the multilevel models, the intra-class correlation coefficient (ICC) was used to measure the community variation. Additionally, the median odds ratio (MOR) and proportionate change in variance (PCV) were utilized as indices of variation [36]. Akaike information criterion (AIC) were estimated to test the model fitness. The degree and intensity of association between the response and the predictors were determined using the adjusted odds ratio (AOR) and 95% confidence interval (CI). Statistical significance was considered at 5% level ($p < 0.05$). Stata (version 16.0) was used for all of the statistical analyses, and ArcGIS (version 10.8) was used to create the map.

Results

Background characteristics of the participants

In all, 9,166 (weighted) women who had at least one live delivery in the two years before to the survey were part of this investigation. Most of the women were from age group of 20-34 years (77.13%) and about 9.2% of women had no formal education. Around 72% of women have had their first marriage/union at below or equal to 18 years. Regarding the ANC visit, 17.20% women didn't receive any ANC, while only 36.89% of women received 4 or above ANC. About 25% of the children were unwanted, and almost 35% women didn't have any exposure to media. In this study, large number of women were from rural areas (78.07%), and highest number were from Dhaka division (24.16%) and least from Barishal division (5.53%) (**Table 1**).

Table 1: Bivariate distribution of home delivery by selected independent variables

Variables	Total n (%)	Home delivery		<i>P value</i>
		No; n (%)	Yes; n (%)	
Overall prevalence; % (95% CI)	9166 (100)	53.59 (52.26 – 54.92)	46.41 (45.08 – 47.74)	
Individual-level characteristics				
Age of women				<0.001
15-19 years	1246 (13.59)	675 (54.17)	571 (45.83)	
20-34 years	7069 (77.13)	3883 (54.92)	3187 (45.08)	
35-49 years	851 (9.28)	355 (41.69)	496 (58.31)	
Women's education level				<0.001
Pre-primary or none	841 (9.17)	206 (24.47)	635 (75.53)	
Primary	2129 (23.23)	762 (36.08)	1361 (63.92)	
Secondary	4587 (50.04)	2638 (57.52)	1949 (42.48)	
Higher secondary+	1609 (17.56)	1300 (80.78)	309 (19.22)	
Wealth status				<0.001
Poorest	1948 (21.25)	510 (26.18)	1438 (73.82)	
Second	1726 (18.83)	718 (41.59)	1008 (58.41)	
Middle	1744 (19.02)	943 (54.07)	801 (45.93)	
Fourth	1816 (19.81)	1192 (65.63)	624 (34.37)	
Richest	1932 (21.08)	1550 (80.2)	383 (19.8)	
Age at first marriage/union				<0.001
≤ 18 years	6632 (72.35)	3387 (51.08)	3244 (48.92)	
>18 years	2534 (27.65)	1525 (60.16)	1010 (39.84)	
ANC visit				<0.001
No visit	1576 (17.20)	307 (19.48)	1269 (80.52)	
1-3 visit	4209 (45.92)	2031 (48.25)	2178 (51.75)	
4 visit and above	3381 (36.89)	2574 (76.14)	807 (23.86)	
Last pregnancy intension				<0.001
Intended	6885 (75.12)	3849 (55.89)	3037 (44.11)	
Unintended	2280 (24.88)	1063 (46.63)	1217 (53.37)	
Exposure to media				<0.001
No	3181 (34.70)	1146 (36.04)	2035 (63.96)	
Yes	5985 (65.30)	3766 (62.92)	2219 (37.08)	
Community-level characteristics				
Place of residence				<0.001
Urban	2010 (21.93)	1362 (67.75)	648 (32.25)	
Rural	7156 (78.07)	3550 (49.61)	3606 (50.39)	
Administrative divisions				<0.001
Barishal	507 (5.53)	189 (37.3)	318 (62.7)	
Chattogram	1983 (21.63)	1026 (51.75)	957 (48.25)	
Dhaka	2214 (24.16)	1376 (62.16)	838 (37.84)	
Khulna	926 (10.11)	662 (71.45)	265 (28.55)	

Mymensingh	706 (7.70)	241 (34.17)	465 (65.83)	
Rajshahi	1071 (11.69)	613 (57.26)	458 (42.74)	
Rangpur	993 (10.84)	494 (49.73)	499 (50.27)	
Sylhet	766 (8.35)	310 (40.53)	455 (59.47)	
Community wealth status				<0.001
Low	4154 (45.32)	1558 (37.52)	2595 (62.48)	
High	5012 (54.68)	3354 (66.91)	1659 (33.09)	
Community women education level				<0.001
Low	4676 (51.01)	1914 (40.93)	2762 (59.07)	
High	4490 (48.99)	2999 (66.78)	1492 (33.22)	
Community ANC utilization				<0.001
Low	4454 (48.60)	1660 (37.28)	2794 (62.72)	
High	4712 (51.40)	3252 (69.01)	1460 (30.99)	
Community exposure to media				<0.001
Low	4498 (49.07)	1822 (40.52)	2675 (59.48)	
High	4668 (50.93)	3090 (66.18)	1579 (33.82)	
<i>CI = Confidence Interval</i>				

Prevalence and bivariate distribution of home delivery

The overall prevalence of home delivery in Bangladesh was 46.41% (95% confidence interval [CI]: 45.08% - 47.41%). **Table 1** displayed the percentage of women who used home delivery by both individual and community-level variables. A significant difference in having home delivery across different categories of the explanatory variables was found, and all the explanatory variables showed a significant association in the bivariate distribution of delivery place (all $p < 0.05$). While looking at the district-level prevalence, the peripheral districts had higher proportion of women who had home delivery. Home delivery was least common in Meherpur (6.95%), followed by Rajshahi (19.33%) and Chuadanga district (20.30%) in Bangladesh, and most common in Bandarban (84.58%), Sherpur (82.02), and Khagrachari district (76.06%) (**Figure 2**).

Factors associated with home delivery

Measures of variation (random-effects)

The intercept-only regression model (Model 0) indicated that the likelihood of women from various clusters using home birth varied significantly (variance: 1.47, SE: 0.117). The ICC value of Model 0 suggested that 30.8% of the total variation in using home delivery was a result of differences across clusters to clusters. Based on the model-fitness statistics, we selected Model 4 as our final model to interpret the findings. Significant variations were

found in the final model (Model 3), and the impact of community heterogeneity was shown by the MOR of 1.82. It implies that a woman's chances of utilizing home delivery would rise by 1.82-fold on average if she relocated to a cluster where home deliveries are more common. Furthermore, the PCV shows that both community- and individual-level variables account for 72.79% of the variance in the probabilities of home delivery within communities (Table 2).

Measures of associations (fixed-effects)

Compared to younger women, women in the 35–49 age range had a higher likelihood of giving birth at home (AOR: 1.28, 95% CI: 1.01–1.63). Compared to those with no formal education or pre-primary only, participants with at least secondary education and upper secondary+ education were 43% (AOR: 0.57, 95% CI: 0.46-0.71) and 69% (AOR: 0.31, 95% CI: 0.23-0.39) less likely to give birth at home, respectively. The likelihood of providing home delivery decreased as household wealth index increased, and there was a substantial correlation between household wealth status and home delivery. The results also showed that respondents having at least 1-3 ANC visit (AOR: 0.40, CI: 0.34-0.47), and 4 or above (AOR: 0.18, CI: 0.15-0.22) times were less likely to give home delivery compared to those having no ANC visit. Compared to women whose last pregnancy was planned, those whose previous children were undesired had 1.18 times greater chances of giving birth at home (AOR: 0.18, CI: 0.04-1.33). There was a 23% and 29% decrease in the likelihood of home births among women from communities with high ANC usage (AOR: 0.77, CI: 0.67-0.88) and high media exposure (AOR: 0.71, CI: 0.62-0.82). In the same way, those surveyed from communities where women had more educational attainment were less likely to give birth at home (AOR: 0.85, CI: 0.74-0.97). Women from Khulna and Rajshahi division had greater probabilities of giving birth at home than those from the Dhaka division, indicating a considerable variation in home delivery between divisions (Table 2).

Table 2: Multilevel binary logistic regression analysis of factors associated with home delivery

Variables	Model 0	Model 1		Model 2		Model 3	
		AOR (95% CI)	<i>P</i> value	AOR (95% CI)	<i>P</i> value	AOR (95% CI)	<i>P</i> value
Measures of association (fixed-effects)							
Individual-level factors							
Age of women							
15-19 years (Ref)		1				1	
20-34 years		1.11(0.95-1.29)	0.180			1.13(0.97-1.33)	0.102

35-49 years		1.26(0.99-1.59)	0.054			1.28(1.01-1.63)	0.037
Women's education level							
Pre-primary or none (Ref)		1				1	
Primary		0.82(0.66-1.03)	0.084			0.88(0.23-0.39)	0.269
Secondary		0.48(0.39-0.59)	<0.001			0.57(0.46-0.71)	<0.001
Higher secondary+		0.25(0.19-0.32)	<0.001			0.31(0.23-0.39)	<0.001
Wealth status							
Poorest (Ref)		1				1	
Second		0.67(0.57-0.79)	<0.001			0.73(0.62-0.86)	<0.001
Middle		0.53(0.45-0.62)	<0.001			0.59(0.49-0.71)	<0.001
Fourth		0.38(0.32-0.46)	<0.001			0.48(0.39-0.58)	<0.001
Richest		0.26(0.21-0.31)	<0.001			0.31(0.24-0.39)	<0.001
Age at first marriage/union							
≤ 18 years (Ref)		1				1	
>18 years		0.96(0.84-1.08)	0.477			0.88(0.77-0.99)	0.046
ANC visit							
No visit (Ref)		1				1	
1-3 visit		0.36(0.31-0.43)	<0.001			0.40(0.34-0.47)	<0.001
4 visit and above		0.14(0.12-0.17)	<0.001			0.18(0.15-0.22)	<0.001
Last pregnancy intention							
Intended (Ref)		1				1	
Unintended		1.11(0.99-1.26)	0.078			1.18(1.04-1.33)	0.008
Exposure to media							
No (Ref)		1				1	
Yes		0.68(0.60-0.76)	<0.001			0.89(0.78-1.02)	0.089
Community-level factors							
Place of residence							
Urban (Ref)				1		1	
Rural				1.19(1.04-1.38)	0.015	0.98(0.83-1.14)	0.769
Administrative divisions							
Barishal				1.46(1.18-1.81)	0.001	1.46(1.16-1.85)	0.002
Chattogram				1.48(1.26-1.75)	<0.001	1.47(1.23-1.76)	<0.001
Dhaka (Ref)				1		1	
Khulna				0.57(0.47-0.69)	<0.001	0.53(0.43-0.65)	<0.001
Mymensingh				1.86(1.45-2.39)	<0.001	1.75(1.33-2.29)	<0.001
Rajshahi				0.89(0.73-1.09)	0.287	0.80(0.65-0.99)	0.048
Rangpur				1.31(1.08-1.59)	0.006	1.28(1.04-1.57)	0.021
Sylhet				1.38(1.11-1.72)	0.004	1.36(1.07-1.72)	0.012
Community wealth status							
Low (Ref)				1		1	
High				0.56(0.49-0.64)	<0.001	0.87(0.75-1.03)	0.100
Community women education							
Low (Ref)				1		1	
High				0.56(0.49-0.63)	<0.001	0.85(0.74-0.97)	0.018
Community ANC utilization							

Low (Ref)				1		1	
High				0.44(0.39-0.49)	<0.001	0.77(0.67-0.88)	0.001
Community exposure to media							
Low (Ref)				1		1	
High				0.61(0.54-0.68)	<0.001	0.71(0.62-0.82)	<0.001
Measures of variation (random-effects)							
Variance (SE)	1.47 (0.117)	0.52 (0.077)		0.33 (0.059)		0.40 (0.070)	
PCV	Ref	64.63%		77.75%		72.79%	
ICC	30.80%	13.73%		9.03%		10.85%	
MOR	3.16	1.98		1.73		1.82	
Model fitness							
Log Likelihood	-6150.62	-5113.40		-5499.60		-4983.31	
AIC	12305.25	10258.80		11027.21		10022.62	
→ Ref = Reference category, AOR= Adjusted Odds Ratio, CI = Confidence Interval. → Model 0 was the null model (only intercept model) includes no independent variable. → Model 1 includes only individual-level factors (mean variance inflation factor [VIF] = 2.03). → Model 2 includes only community-level factors (mean VIF = 1.42). → Model 3 includes both individual and community-level factors (mean VIF = 1.99). → SE = Standard Error, PCV = Proportional Change in Variance, ICC = Intra-Class Correlation, MOR = Median Odds Ratio, AIC = Akaike Information Criterion.							

Discussion

The main objective of this study was to mapping the prevalence of home delivery practice and to determine its associated correlates among women at their last birth in Bangladesh using mixed-effect binary logistic regression model. The correlates of home delivery that were found to be significant were women's age and education level, household wealth status, ANC visit, last pregnancy intention, community women education level, community-level exposure to media, and community-level ANC visit.

When examining the district-level prevalence, home delivery was more common in Bangladesh's periphery districts. Regression model also showed a significant divisional variation in home delivery in Bangladesh. The populations studied were from a wide range of geographic areas with varying characteristics and social norms. Socioeconomic factors, health care coverage, accessibility, and the availability of high-quality maternal health services all have a significant impact on the choice of delivery location [37–39]. In this study, the highest prevalence was observed in Bandarban district (84.58%), which is a hill tract region in Bangladesh. Shahabuddin et al. found similar results with young women in Nepal's mountainous areas vs those in the Terai area regarding the likelihood of institutional delivery [40]. This implies that health facility delivery will be challenging for the majority of Bangladeshi women who reside in the nation's impoverished areas unless there is an

equitable distribution of health facilities and the removal of accessibility barriers, such as the provision of efficient and effective referral services.

According to age of mothers, women from 35-49 age group had higher probability of delivery at home compared to women who were aged between 15 and 19 years. Previous research from Tanzania [5] and Nepal [41,42] also revealed consistent findings. These results collectively showed that older women were more likely to give birth at home than younger women. This outcome could be the result of older women believing they have enough expertise to deliver babies on their own without the help of trained professionals. But because they have no prior experience giving birth, young women often anticipate difficulties associated with pregnancy and childbirth [43].

A woman's likelihood of giving birth at home decreased with education. A greater level of education among women in the same community impacts their decision to give birth in a health facility, in addition to the favorable effects of individual education levels on their usage of health facilities for delivery. Similar results were also found in research carried out in Ghana [44], and Malawi [45], where the authors found that women who had finished secondary or higher education were less likely than those who had no formal education to give birth at home. According to a recent study, having education makes it more likely that a woman will choose to give birth in a hospital or maternity home rather than at home or somewhere else [46]. This may be as a result of education raising people's knowledge of health in its whole and exposing them to the advantages of complication prevention [46]. Additionally, education may contribute to women's overall empowerment by enhancing their ability to make decisions for themselves, obtain information, and be financially independent enough to support themselves, travel to a medical facility and pay for services when needed, as well as to easily absorb health-related messages from the media and from medical professionals [47]. When considered collectively, these factors may motivate women to look for improved medical treatment, which may include giving birth in a hospital.

Compared to women from lower-income houses, we discovered that women from wealthier households were less likely to give birth at home. Our findings also aligns according to earlier research conducted in other LMICs such as Nepal [40,48], Malawi [45], Ghana [44] and Guinea-Bissau [49]. In contrast to the women from less wealthy households, it is recognized that wealthy women are more likely to give birth in healthcare facilities [50–52]. Financial situations may have contributed to the difference in place of delivery between the affluent and the poor. When a poor woman needs to give birth at a healthcare facility, she

may face financial difficulties due to the expense of transportation and other delivery-related expenses [44]. Additionally, women with higher socioeconomic class may be more empowered, involved in decision-making, and interested in improved maternal health care services [53].

It is well known that the use of ANC affects mothers' decisions about where to give birth, with ANC users often favoring institutional deliveries under the supervision of health professionals [54,55]. Thus, it was not surprising that women who had no ANC visits had a greater rate of home birth than those who had at least one ANC visit in the current research. It is shown that receiving enough ANC can increase a pregnant woman's awareness of probable challenges and safe delivery techniques, which will motivate her to give birth in an institution [55–58]. Furthermore, it has been argued that women who visit medical facilities for ANC check-ups could get guidance and counseling from medical staff [59]. Both instances educate them regarding the risks associated with home delivery. It is also argued that women who have received important information during ANC may choose to give birth in a healthcare facility as a safeguard against unanticipated difficulties that may arise with a home delivery [59–61]. Furthermore, there exists a negative correlation between clusters with greater levels of ANC usage and women's choice to give birth at home. A greater community level of ANC usage may persuade women in the same community to give birth in a health facility, in addition to the favorable effects of ANC utilization on the use of health facilities for delivery. The knowledge that ANC-acquired women in a cluster acquire through their visits is likely to spread to their neighbors, encouraging them to seek out better health care services, including institutional delivery [47].

Although unintended pregnancies have been linked to pregnancy-related complications like poor weight gain, pregnancy-induced hypertension, and anemia that require hospital delivery [62,63], women in this study who had unintended pregnancies were more likely to give birth at home than those whose pregnancies were planned. This supports the findings of earlier research [64,65]. Given this situation, the high prevalence of home births attributable to unplanned pregnancies may be explained by the sociocultural stigma and restrictions that prevent some women from accessing maternal healthcare services, including facility deliveries [66,67]. Furthermore, the results highlight the significance of encouraging pregnant women about the risks of home delivery for unplanned pregnancies in order to encourage them to have facility delivery [68].

We found that higher levels of community exposure to media significantly reduced the odds of home delivery. Given that women have access to more health information and may obtain knowledge from the media, this is not unexpected as they are more likely to make informed decisions. These might help mothers by providing them with the information they need to seek out better maternal health care services [69]. The phenomenon may be explained by the fact that the majority of media outlets frequently promote institutional delivery, which may persuade mothers to adopt favorable attitudes on giving birth in a health facility [47].

Policy implications

The study's conclusions may have a significant impact on interventions and policy decisions meant to lower the prevalence of home birth in Bangladesh. Targeted efforts should focus on improving education and awareness among women regarding the benefits of skilled birth attendance and the potential risks associated with home delivery. Additionally, interventions should address socioeconomic barriers by providing financial support for transportation and improving the affordability of maternal health services. Enhancing the availability and quality of healthcare facilities in rural areas is crucial to reducing the reliance on home delivery in these regions.

Strengths and limitations

The application of multilevel regression analysis, which enabled the investigation of both individual and community-level factors impacting home delivery, was one of the study's strengths. Large sample sizes were also used in the study, which improved the findings' generalizability to Bangladesh's larger population. However, there are some limitations to consider. First of all, because the study depended on self-reported data, it might be biased toward social desirability and recollection. Second, because the data are cross-sectional, it is more difficult to demonstrate causation and ascertain the time course of the association between the variables and home delivery. Longitudinal studies would provide more robust evidence in this regard. Finally, the study did not explore certain potential factors, such as cultural beliefs and attitudes towards home delivery, which could have influenced the findings.

Conclusion

In Bangladesh, home births accounted for over half of all births, where women with greater levels of education, affluence, and ANC visits had a much lower rate of home deliveries, but women in the 35–49 age range, and who had an unplanned pregnancy experienced a higher

rate. Target-specific interventions aimed at reducing home births should prioritize addressing disparities related to maternal education, family socioeconomic status, media access, and closing the wealth gap between affluent and poor households as well as between rural and urban locations. The results of this study might help Bangladeshi stakeholders who are in charge of maternal and child healthcare in order to plan interventions that would decrease home births and improve maternity care facilities during delivery. The Government need to think about making investments in creative strategies to increase pregnant women's access to healthcare facilities. To decrease home delivery in Bangladesh, more subsidies or easier access to free services for institutional delivery could be useful tactics.

Acknowledgments

We would like to show our gratitude to the Multiple Indicator Cluster Survey (MICS-2019) Program for providing data access used in this research. We would also like to gratefully acknowledge the study's participants, reviewers and the academic editors of our manuscript.

Disclosures

Ethics approval: This study did not require any ethical approval as the analysis used only de-identified existing unit record data from the secondary data source MICS.

Consent for publication: Not applicable.

Funding: Not applicable.

Conflicts of interest/ Competing interests: Not applicable.

Availability of data and material: Data are available at <https://mics.unicef.org/surveys>

References

1. Sørensen HT, Steffensen FH, Rothman KJ, Gillman MW, Fischer P, Sabroe S, et al. Effect of home and hospital delivery on long-term cognitive function. *Epidemiology*. 2000;11: 706–708.
2. Walraven GEL, Mkanje RJB, Roosmalen J, Van Dongen PWJ, Dolmans WM V. Perinatal mortality in home births in rural Tanzania. *Eur J Obstet Gynecol Reprod Biol*. 1995;58: 131–134.
3. Wagle RR, Sabroe S, Nielsen BB. Socioeconomic and physical distance to the maternity hospital as predictors for place of delivery: an observation study from Nepal. *BMC Pregnancy Childbirth*. 2004;4: 1–10.
4. Ackermann-Liebrich U, Voegeli T, Gunter-Witt K, Kunz I, Zullig M, Schindler C, et al. Home versus hospital deliveries: follow up study of matched pairs for procedures and outcome. *Bmj*. 1996;313: 1313–1318.
5. Mrisho M, Schellenberg JA, Mushi AK, Obrist B, Mshinda H, Tanner M, et al. Factors affecting home delivery in rural Tanzania. *Trop Med Int Heal*. 2007;12: 862–872.

- 399 6. Davies J, Hey E, Reid W, Young G. Prospective regional study of planned home
400 births. *BMJ*. 1996;313: 1302–1306.
- 401 7. Mehl LE, Peterson GH, Whitt M, Hawes WE. Outcomes of elective home births: a
402 series of 1,146 cases. *J Reprod Med*. 1977;19: 281–290.
- 403 8. Eskes M, Van Alten D, Treffers PE. The Wormerveer study; perinatal mortality and
404 non-optimal management in a practice of independent midwives. *Eur J Obstet Gynecol*
405 *Reprod Biol*. 1993;51: 91–95.
- 406 9. Campbell R, Davies IM, MacFarlane A, Beral V. Home births in England and Wales,
407 1979: perinatal mortality according to intended place of delivery. *Br Med J (Clin Res*
408 *Ed)*. 1984;289: 721–724.
- 409 10. Shearer JM. Five year prospective survey of risk of booking for a home birth in Essex.
410 *Br Med J (Clin Res Ed)*. 1985;291: 1478–1480.
- 411 11. Starrs AM. Safe motherhood initiative: 20 years and counting. *Lancet*. 2006;368:
412 1130–1132.
- 413 12. World Health Organization. Trend in maternal mortality: 1990 to 2010: WHO,
414 UNICEF, UNFPA and The World Bank estimates. 2012.
- 415 13. World Health Organization. Trends in maternal mortality 2000 to 2017: estimates by
416 WHO, UNICEF, UNFPA, World Bank Group and the United Nations Population
417 Division. 2019.
- 418 14. Pan American Health Organization. Maternal Health. 2017 [cited 23 Jun 2023].
419 Available: <https://www.paho.org/en/topics/maternal-health>
- 420 15. World Health Organization. Trends in Maternal Mortality 2000 to 2020: Estimates by
421 WHO, UNICEF, UNFPA, World Bank Group and UNDESA/Population Division.
422 WHO; 2023.
- 423 16. World Health Organization. Maternal mortality. 2023 [cited 23 Jun 2023]. Available:
424 <https://www.who.int/news-room/fact-sheets/detail/maternal-mortality>
- 425 17. Setu SP, Majumder UK. A multilevel analysis to determine the factors affecting WHO
426 recommended quantity antenatal care utilizations of pregnant women in Bangladesh.
427 *Heliyon*. 2023.
- 428 18. Moller A, Patten JH, Hanson C, Morgan A, Say L, Diaz T, et al. Monitoring maternal
429 and newborn health outcomes globally: a brief history of key events and initiatives.
430 *Trop Med Int Heal*. 2019;24: 1342–1368.
- 431 19. Hug L, Mishra A, Lee S, You D, Moran A, Strong KL, et al. A neglected tragedy The
432 global burden of stillbirths: report of the UN inter-agency group for child mortality
433 estimation, 2020. United Nations Children’s Fund; 2020.
- 434 20. Phukan D, Ranjan M, Dwivedi LK. Impact of timing of breastfeeding initiation on
435 neonatal mortality in India. *Int Breastfeed J*. 2018;13: 1–10.

21. Sachs JD. From millennium development goals to sustainable development goals. *Lancet*. 2012;379: 2206–2211.
22. World Health Organization. SDG Target 3.1 Reduce the global maternal mortality ratio to less than 70 per 100 000 live births. 2016 [cited 23 Jun 2023]. Available: <https://www.who.int/data/gho/data/themes/topics/sdg-target-3-1-maternal-mortality>
23. World Health Organization. Trends in maternal mortality: 1990-2015: estimates from WHO, UNICEF, UNFPA, World Bank Group and the United Nations Population Division. World Health Organization; 2015.
24. Wiegers TA, Keirse MJNC, van der Zee J, Berghs GAH. Outcome of planned home and planned hospital births in low risk pregnancies: prospective study in midwifery practices in the Netherlands. *Bmj*. 1996;313: 1309–1313.
25. Northern Region Perinatal Mortality Survey Coordinating Group. Collaborative survey of perinatal loss in planned and unplanned home births. *BMJ*. 1996;313: 1306–1309.
26. Bangladesh Bureau of Statistics (BBS) and UNICEF Bangladesh. Progotir Pathey, Bangladesh Multiple Indicator Cluster Survey 2019, Survey Findings Report. Dhaka, Bangladesh: Bangladesh Bureau of Statistics (BBS). 2019.
27. Budu E. Predictors of home births among rural women in Ghana: analysis of data from the 2014 Ghana Demographic and Health Survey. *BMC Pregnancy Childbirth*. 2020;20: 1–8.
28. Chowdhury MAH, Hasan MM, Ahmed S, Darwin C, Hasan MS, Haque MR. Socio-demographic factors associated with home delivery assisted by untrained traditional birth attendant in rural Bangladesh. *Am J Public Heal Res*. 2013;1: 226–230.
29. Siyoum M, Astatkie A, Mekonnen S, Bekele G, Taye K, Tenaw Z, et al. Home birth and its determinants among antenatal care-booked women in public hospitals in Wolayta Zone, southern Ethiopia. *PLoS One*. 2018;13: e0203609.
30. Sarker BK, Rahman M, Rahman T, Hossain J, Reichenbach L, Mitra DK. Reasons for preference of home delivery with traditional birth attendants (TBAs) in rural Bangladesh: a qualitative exploration. *PLoS One*. 2016;11: e0146161.
31. Setu SP, Islam MA, Halim SF Bin. Individual and community-level determinants of institutional delivery services among women in Bangladesh: a cross-sectional study. *Int J Clin Pract*. 2022;2022.
32. Hailegebreal S, Gilano G, Simegn AE, Seboka BT. Spatial variation and determinant of home delivery in Ethiopia: Spatial and mixed effect multilevel analysis based on the Ethiopian mini demographic and health survey 2019. *PLoS One*. 2022;17: e0264824.
33. Huda TM, Chowdhury M, El Arifeen S, Dibley MJ. Individual and community level factors associated with health facility delivery: A cross sectional multilevel analysis in Bangladesh. *PLoS One*. 2019;14: e0211113.
34. Kundu S, Kundu S, Seidu A-A, Okyere J, Ghosh S, Hossain A, et al. Factors influencing and changes in childhood vaccination coverage over time in Bangladesh: a

- multilevel mixed-effects analysis. *BMC Public Health*. 2023;23: 862.
doi:10.1186/s12889-023-15711-x
35. Khan HR, Shaw E. Multilevel logistic regression analysis applied to binary contraceptive prevalence data. *J Data Sci*. 2011;9: 93–110.
 36. Merlo J, Chaix B, Ohlsson H, Beckman A, Johnell K, Hjerpe P, et al. A brief conceptual tutorial of multilevel analysis in social epidemiology: using measures of clustering in multilevel logistic regression to investigate contextual phenomena. *J Epidemiol Community Heal*. 2006;60: 290–297.
 37. Gebrehiwot T, San Sebastian M, Edin K, Goicolea I. Health workers' perceptions of facilitators of and barriers to institutional delivery in Tigray, Northern Ethiopia. *BMC Pregnancy Childbirth*. 2014;14: 1–10.
 38. Morrison J, Thapa R, Basnet M, Budhathoki B, Tumbahangphe K, Manandhar D, et al. Exploring the first delay: a qualitative study of home deliveries in Makwanpur district Nepal. *BMC Pregnancy Childbirth*. 2014;14: 1–7.
 39. De Brouwere V, Richard F, Witter S. Access to maternal and perinatal health services: lessons from successful and less successful examples of improving access to safe delivery and care of the newborn. *Trop Med Int Heal*. 2010;15: 901–909.
 40. Shahabuddin ASM, De Brouwere V, Adhikari R, Delamou A, Bardaj A, Delvaux T. Determinants of institutional delivery among young married women in Nepal: Evidence from the Nepal Demographic and Health Survey, 2011. *BMJ Open*. 2017;7: e012446.
 41. Bolam A, Manandhar DS, Shrestha P, Ellis M, Malla K, Costello AM. Factors affecting home delivery in the Kathmandu Valley, Nepal. *Health Policy Plan*. 1998;13: 152–158.
 42. Dhakal P, Shrestha M, Baral D, Pathak S. Factors affecting the place of delivery among mothers residing in Jhorahat VDC, Morang, Nepal. *Int J community based Nurs midwifery*. 2018;6: 2.
 43. Chernet AG, Dumga KT, Cherie KT. Home delivery practices and associated factors in Ethiopia. *J Reprod Infertil*. 2019;20: 102.
 44. Ahinkorah BO, Seidu A-A, Budu E, Agbaglo E, Appiah F, Adu C, et al. What influences home delivery among women who live in urban areas? Analysis of 2014 Ghana Demographic and Health Survey data. *PLoS One*. 2021;16: e0244811.
 45. Palamuleni M. Determinants of non-institutional deliveries in Malawi. *Malawi Med J*. 2011;23: 104–108.
 46. Ovikuumagbe O. Determinants of maternal healthcare utilization in Nigeria. *African Res Rev*. 2017;11: 283–294.
 47. Yebyo H, Alemayehu M, Kahsay A. Why do women deliver at home? Multilevel modeling of Ethiopian National Demographic and Health Survey data. *PLoS One*. 2015;10: e0124718.

- 514 48. Koduah A, van Dijk H, Agyepong IA. The role of policy actors and contextual factors
515 in policy agenda setting and formulation: maternal fee exemption policies in Ghana
516 over four and a half decades. *Heal Res Policy Syst.* 2015;13: 1–20.
- 517 49. Yaya S, Bishwajit G, Gunawardena N. Socioeconomic factors associated with choice
518 of delivery place among mothers: a population-based cross-sectional study in Guinea-
519 Bissau. *BMJ Glob Heal.* 2019;4: e001341.
- 520 50. Eason E, Labrecque M, Marcoux S, Mondor M. Effects of carrying a pregnancy and of
521 method of delivery on urinary incontinence: a prospective cohort study. *BMC*
522 *Pregnancy Childbirth.* 2004;4: 1–6.
- 523 51. Agha S, Carton TW. Determinants of institutional delivery in rural Jhang, Pakistan. *Int*
524 *J Equity Health.* 2011;10: 1–12.
- 525 52. Kitui J, Lewis S, Davey G. Factors influencing place of delivery for women in Kenya:
526 an analysis of the Kenya demographic and health survey, 2008/2009. *BMC Pregnancy*
527 *Childbirth.* 2013;13: 1–10.
- 528 53. Regassa LD, Tola A, Weldesenbet AB, Tusa BS. Prevalence and associated factors of
529 home delivery in Eastern Africa: Further analysis of data from the recent Demographic
530 and Health Survey data. *SAGE open Med.* 2022;10: 20503121221088084.
- 531 54. Lukonga E, Michelo C. Factors associated with neonatal mortality in the general
532 population: evidence from the 2007 Zambia Demographic and Health Survey (ZDHS);
533 a cross sectional study. *Pan Afr Med J.* 2015;20.
- 534 55. Pervin J, Moran A, Rahman M, Razzaque A, Sibley L, Streatfield PK, et al.
535 Association of antenatal care with facility delivery and perinatal survival—a
536 population-based study in Bangladesh. *BMC Pregnancy Childbirth.* 2012;12: 1–12.
- 537 56. Banke-Thomas OE, Banke-Thomas AO, Ameh CA. Factors influencing utilisation of
538 maternal health services by adolescent mothers in Low-and middle-income countries:
539 a systematic review. *BMC Pregnancy Childbirth.* 2017;17: 1–14.
- 540 57. Rahman M. Deliveries among adolescent mothers in rural Bangladesh: who provides
541 assistance? *World Health Popul.* 2009;11: 5–14.
- 542 58. Kamal SMM. Preference for Institutional Delivery and Caesarean Sections in
543 Bangladesh. *J Health Popul Nutr.* 2013;31: 96–109.
- 544 59. Ghimire U. The effect of maternal health service utilization in early initiation of
545 breastfeeding among Nepalese mothers. *Int Breastfeed J.* 2019;14: 1–8.
- 546 60. Bandura A. Self-efficacy: toward a unifying theory of behavioral change. *Psychol Rev.*
547 1977;84: 191.
- 548 61. Floyd DL, Prentice- Dunn S, Rogers RW. A meta- analysis of research on protection
549 motivation theory. *J Appl Soc Psychol.* 2000;30: 407–429.
- 550 62. Campos CAS, Malta MB, Neves PAR, Lourenço BH, Castro MC, Cardoso MA.
551 Gestational weight gain, nutritional status and blood pressure in pregnant women. *Rev*

Saude Publica. 2019;53: 57.

63. Patel A, Prakash AA, Das PK, Gupta S, Pusdekar YV, Hibberd PL. Maternal anemia and underweight as determinants of pregnancy outcomes: cohort study in eastern rural Maharashtra, India. *BMJ Open*. 2018;8: e021623.
64. Wado YD, Afework MF, Hindin MJ. Unintended pregnancies and the use of maternal health services in southwestern Ethiopia. *BMC Int Health Hum Rights*. 2013;13: 1–8.
65. Spierling T, Shreffler KM. Tough decisions: exploring Women’s decisions following unintended pregnancies. *Front Sociol*. 2018;3: 11.
66. Lowe M, Chen D-R, Huang S-L. Social and cultural factors affecting maternal health in rural Gambia: an exploratory qualitative study. *PLoS One*. 2016;11: e0163653.
67. Smith MS, Lawrence V, Sadler E, Easter A. Barriers to accessing mental health services for women with perinatal mental illness: systematic review and meta-synthesis of qualitative studies in the UK. *BMJ Open*. 2019;9: e024803.
68. Ahinkorah BO. Non-utilization of health facility delivery and its correlates among childbearing women: a cross-sectional analysis of the 2018 Guinea demographic and health survey data. *BMC Health Serv Res*. 2020;20: 1–10.
69. Ganle JK, Mahama MS, Maya E, Manu A, Torpey K, Adanu R. Understanding factors influencing home delivery in the context of user- fee abolition in Northern Ghana: Evidence from 2014 DHS. *Int J Health Plann Manage*. 2019;34: 727–743.

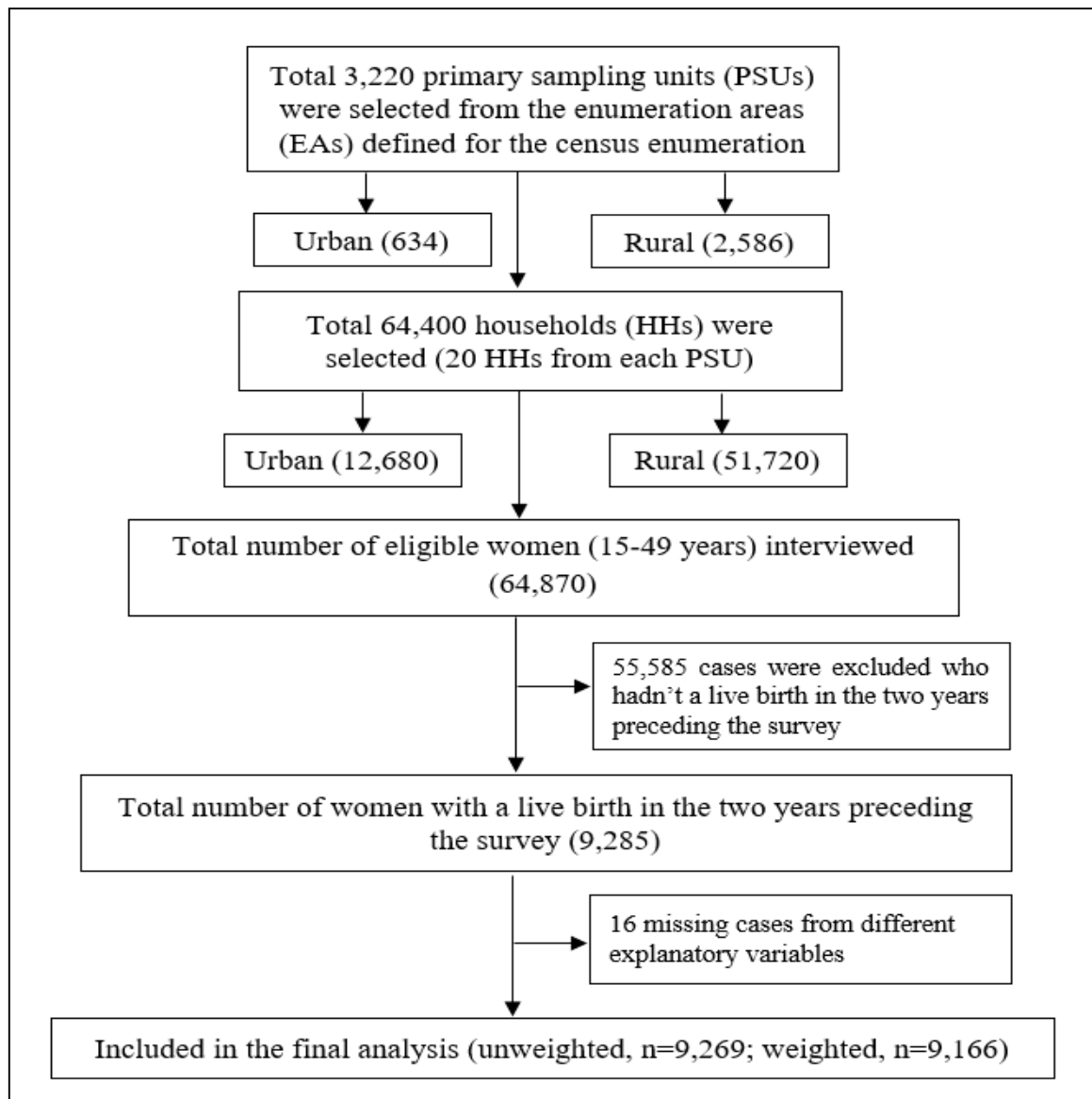


Figure 1. Flow chart of the participants selection from MICS 2019 data (women file)

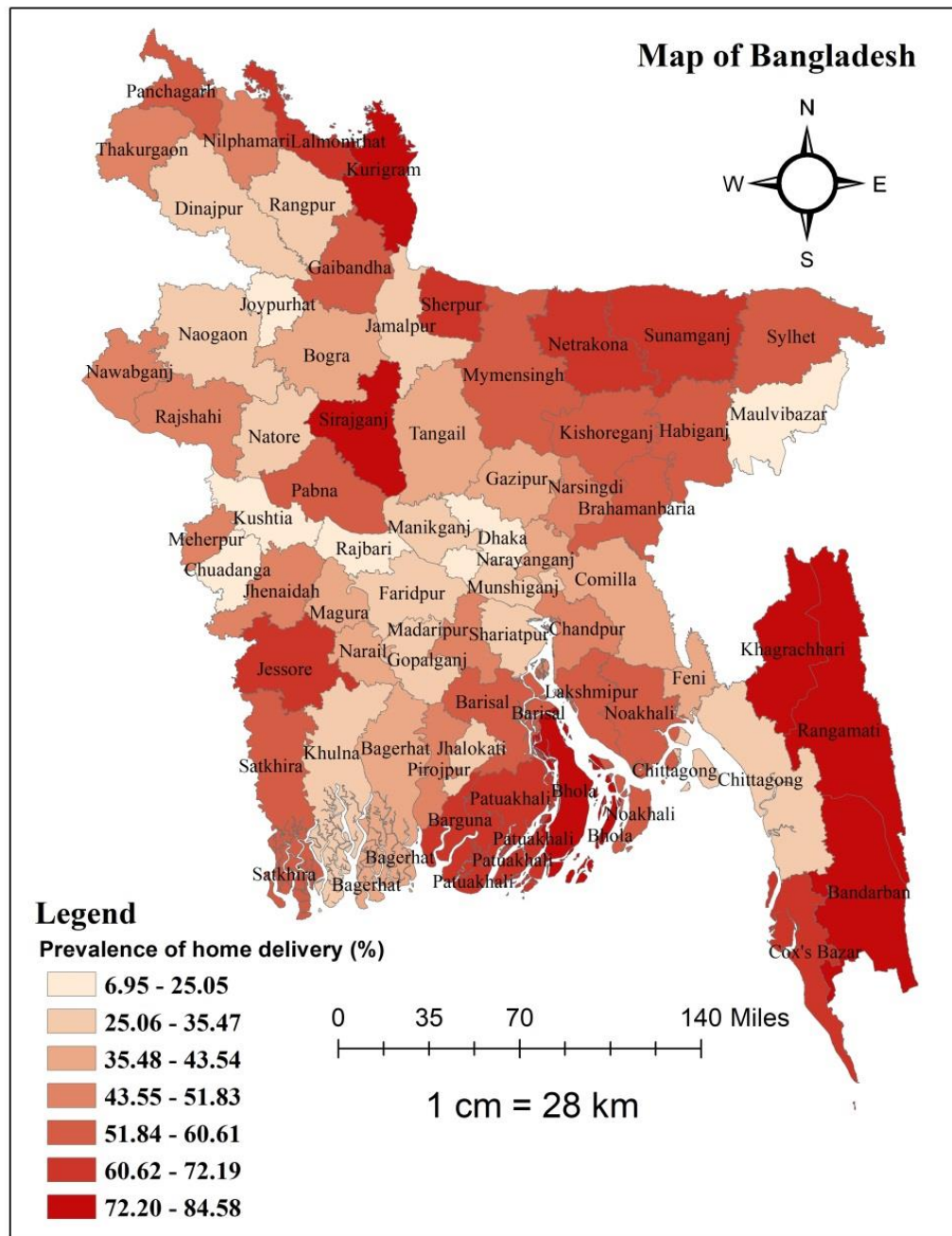


Figure 2. Map showing the district level distribution of prevalence of home delivery in Bangladesh