Original Research

Antenatal care and skilled birth attendance in Bangladesh are influenced by female education and family affordability: BDHS 2014

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ABSTRACT

Objectives: Antenatal care (ANC) during pregnancy and skilled birth attendance (SBA) during delivery are important policy concerns to reduce maternal deaths. Bangladesh is one of the developing countries which has made remarkable progress in both services during the last couple of decades by improving the SBA service rate from 16% in 2004 to 42.1% in 2014. However, this rate remains below the targeted level (50%) of the Health Population and Nutrition Sector Development Program set by the Ministry of the Health and Family Welfare of Bangladesh. This article explored the sociodemographic factors associated with the ANC and SBA service attainment. Furthermore, the possible implication of using ANC on SBA was also investigated.

Study design: The study followed a cross-sectional design using the Bangladesh demographic and health survey 2014, with a sample of size 4603 women with at least one live birth 3 years preceding the survey.

Methods: Following a bivariate analysis, linear mixed-effect models were used to assess the relationship between sociodemographic factors and the outcome indicators (ANC and SBA). Finally, the association between SBA and ANC was evaluated through another mixed-effect model.

Results: Wealth index, participation in household decisions, and partner's and respondent's education were significant predictors of ANC; whereas, residence, age at first birth, wealth index, working status, participation in household decisions, and partner and respondent's education were significant for SBA. Female education and household affordability were the strongest predictors for both ANC and SBA. ANC showed significant association with SBA as women accessing essential ANC during delivery seemed to be 4 times more likely (95% confidence interval: 3.05–5.93) to avail SBA services.

Conclusions: Overall, four factors were significant: residence, wealth index, education, and ANC access. Women residing in urban areas, having higher financial solvency, completing higher education, and accessing ANC by skilled personnel were more likely to receive SBA at delivery than their counterparts. Accessibility to skilled care during pregnancy leads to increased professional care during delivery. Thus, policies to encourage women and heads

of families to seek skilled care during pregnancy would be beneficial to reach the maternal healthcare targets of Bangladesh.

Introduction

During the last couple of decades, Bangladesh has experienced remarkable success in public health sector despite being a low-income country.[1−3] Bangladesh also performed well with the targets of Millennium Development Goals (MDGs) 2015, particularly in reduction of maternal and child mortality. For example, the maternal mortality ratio (MMR) and infant mortality rate per 100,000 live births declined from 507 to 149 in 1990 to 209 and 53 in 2010, respectively.[4] As such, the country is also believed to be on the track to achieve the Sustainable Development Goals (SDGs).[5−8] One of the objectives of Bangladesh National Strategy for Maternal Health 2014−2024 is to bring down the current MMR of 176 per 100,000 live births to 50 by 2024.[9,10] However, according to the recent MDG progress report, Bangladesh performed poorly with scoring below the median point (36 on a scale from 0 to 100; details in Lim et al. [2016]) in skilled birth attendance (SBA) service performance.[11]

It is well-known that a part of the maternal service utilization is access to antenatal care (ANC) and skilled birth assistants during delivery.[12] Delivery assisted by a skilled birth attendant (SBA is aimed to reduce MMR and any other complication that could occur during delivery). Multiple public and non-governmental programs are currently active to train traditional birth attendants (TBAs) and increase the awareness in the population.[13−16] Bearing in mind that these training programs are running for decades, this study aimed to explore the sociodemographic factors associated with the attainment of these services in Bangladesh, which would help identify the vulnerable cohorts of women that require greater attention. The contribution of ANC in accessing SBA would be evaluated as well.

Skilled birth attendants generally refer to health professionals, particularly doctors, nurses, and midwives, who are trained to provide health care to mothers and newborn babies before and during delivery to manage normal deliveries and diagnose, manage, or refer obstetric complications.[17−20] ANC refers to the care given before delivery including medical interventions and advice to mothers during pregnancy.[21,22] In Bangladesh, the nurse and midwives who typically have 4 years of training through government or non-governmental organizations and instructed to provide skilled obstetric care including management of normal labor, medical treatment of problem pregnancies, and neonatal care are referred to as SBAs, in addition to the qualified doctors and gynecologists, who also provide these services.[23] According to the report of Bangladesh Demographic and Health Survey (BDHS) 2014, a qualified doctor, nurse, midwife, paramedic, family welfare visitor (FWV), community skilled birth attendant, or sub-assistant community medical officer (SACMO) is considered

as a qualified carer, which was considered as the definition of SBA in this study as well.[24] Contrarily, orthodox village doctors without academic qualifications, uncertified community workers, and untrained conventional midwives are considered as TBAs.

The healthcare system in a developing country like Bangladesh is compromised in multiple sectors, particularly for women who have limited physical and financial access to health facilities, small window for personal opinion and decision-making authority in the family, and almost no education or health awareness.[25−27] In developing countries, most of the women still have deliveries at home with the aid of uncertified TBAs.[28] Similar situation persists in Bangladesh where the rate is below the target (50%) set by the Ministry of the Health and Family Welfare of Bangladesh Government.[29] The latest BDHS 2014 revealed that the percentage of deliveries attended by SBA in Bangladesh increased from 16% in 2004 to 42% in 2014.[24] However, the coverage varied across different population groups; for example, rural women were disadvantaged from maternal health services because of financial hardship and lack of education.[12,30] There were solicited multiple stipend programs, both to educate mothers and train new SBAs, in rural Bangladesh.[31,32,15] However, there were multiple controversies regarding the effectiveness of these training programs and skill-set of the providers of ANC and SBAs (e.g. competence of SBAs in practical field and lack of community involvement).[33,13] Even then, SBAs are considered effective assets to reduce maternal mortality rate in Bangladesh.[10,9]

The deployment of SBAs at delivery is low in Bangladesh. This study aimed to analyze factors affecting utilization of ANC and SBA services during delivery in Bangladesh using the information from BDHS 2014. A limited number of studies assessed the sociodemographic determinants of delivery by SBAs and subsequent effect of ANC on SBA services in Bangladesh. For example, Islam et al. found that women's occupation, household income, ANC by SBAs, and complication during pregnancy have significant association with the delivery by SBA using a cohort from a subdistrict of Narsingdi district in Bangladesh.[34] A review of the existing literature on the subject also reveals a growing research focus on examining the factors that affect maternal healthcare−seeking behavior,[35] with previous studies indicating that such behavior is influenced by various personal, sociocultural, and environmental factors, such as individual perceptions of health, self-efficacy, motivation, social values, and belief systems.[36−38] Another study noted that women's education, religion, and household economic backgrounds are important predictors for SBAs service uptake.[39] Residence and educational status are key factors as well for SBA service uptake. This study noted that women living in urban areas and having higher education with greater financial capacity are more likely to access SBA services.[40] In addition to the effects of

these socio-economic factors, SBA services are further affected by the shortage of work force in the health sector, with approximately five physicians and two nurses per 10,000 population in Bangladesh, whereas countries like Australia and Germany have 120—140 nurses for similar population ratio.[41,9,42]

With the aim of addressing the individual, fertility, and contextual variables that could affect the service delivery of ANC and SBAs all over Bangladesh, this study warranted an evaluation of the most vulnerable households that lack the services of ANC providers and SBAs. Findings from this study should help to improve the health policy to achieve the goal of 50% of deliveries through SBAs set by Bangladesh and also to take Bangladesh one step closer to achieving the maternal mortality target of the United Nations SDGs.[29]

Methods

Data overview

BDHS, a nationally representative cross-sectional survey, has been conducted in Bangladesh since 1993 collaborating with the Demographic and Health Survey (DHS), operated by Measure DHS+.[43,24] A list of enumeration areas (EAs) from the census is used as the sampling frame.[24] Two-stage stratified cluster sampling techniques are used for this survey. In the first stage, 600 EAs (or clusters) are selected using probability proportional to size sampling method. In the second stage, an equal probability systematic sampling method is applied to draw an average of 30 households from each cluster. This study used the most recent BDHS of 2014, where only the females were considered as respondents and the temporary (de jure) residents were excluded in the sample. Of 17,863 women of reproductive health age group (15—49 years) surveyed in 2014, 4603 had at least one live birth 3 years preceding the survey.

Outcome and exposure variables

This study assessed predictors of ANC and SBA in Bangladesh. Both outcomes were binary. In grouping the service providers as to skilled and other providers, BDHS 2014 report as well as DHS VI standard recode manual were followed.[43] As explained earlier, a qualified doctor, nurse, midwife, paramedic, FWV, Medical Assistant (MA), and SACMO were considered as skilled ANC providers and SBAs. Based on previous literature and pre-analysis, the selected sociodemographic factors were as follows: age at first cohabitation (years); age at first birth (years); number of living children (numeric); number of children that died (numeric); residence (urban, rural); wealth index (poorest, poorest, middle, richer, richest); working status (yes, no); participation in family decisions (yes, no); education of both respondent and her partner (none, primary, secondary, higher); and birth order of children. 'Participation in family decisions' was based on four questions asked during interviews: whether the woman participates in decisions on how to spend respondent's earnings, respondent's health care, large household purchases, and visits to family or relatives. A participant who did not take any one of these decisions was considered that she did not participate in family decisions

('No'), and the rest who decided these herself or together with her husband was considered as participated in family decisions ('Yes').

Statistical analysis

In computing ANC and skilled birth attendance services indicators, multiple responses were managed by considering one provider for each indicator. In this regard, the one with the highest qualification was considered for those who reported more than one attendant during the course of their pregnancy and/or during delivery. Models were adjusted by the cluster-wise effects.[44]

As both outcomes (ANC and SBA services) were binary, a regression model with binomial family of distributions would be suitable. As BDHS data were collected from 600 clusters, there is a requirement to adjust these for generalization of the outcomes. A mixed-effect model where clusters were adjusted using random effect would be acceptable, which is used to assess applied research on DHS data sets.[45] This model is a common approach to fit multivariate distributions for non-normal data incorporating random effects into the linear predictors.[46] To express the basic model, let Y be the observed data vector and, conditional on the random effects, u, assume that the elements of Y are independent and drawn from a distribution in the exponential family; assuming a distribution for u depending on parameters, D[47]

$$f_{(yi|u)}\ (y|u,\beta,\varphi) = \exp\{(y\eta_i - c(\eta_i))/a(\varphi) + d(y,\varphi)\}u \sim f_u(u|D) \qquad (1)$$

Here, $\eta_i = x'_i\beta + z'_iu$, with x'_i represents ith row of the fixed effect X and z'_i is the same for random effect Z. The mixed-effect models were fitted using R − package glmer (lme4).

Linear mixed-effect model with binary outcome variable was used to assess the significance of the relationships between the sociodemographic factors and outcome indicators (ANC and SBA services). Following the mixed-effect models, association between SBA services and ANC was evaluated again through a mixed-effect model. All computations were conducted in SPSS (version 23) and R (3.5.0).

Results

Descriptive analysis

Table 1 shows the distribution of the women during their reproductive age across different sociodemographic factors. Among the 17,863 women with at least one live birth 3 years preceding the survey, the average age of the participants was 31 years (standard deviation [SD] = 9.2), whereas the average age at first marriage and first birth was 16 years (SD = 3) and 18 years (SD = 3.4), respectively. The mean number of living and deceased children per woman was 2.2 and 0.22, respectively. Table 2 presents distribution of SBA by different groups corresponding to the sociodemographic variables. More than two-thirds of the study participants (71%) resided in a rural area. With regard to wealth index, there was nearly equal distribution of participants across each quintile as designed by the survey through

Table 1 – The distribution of the women aged 15–49 years and those who had a live birth in the 3 years preceding the survey across the selected sociodemographic variables (continuous).

Sociodemographic variables	All women 15–49 years		Women with live birth	
	N	Mean (SD)	N	Mean (SD)
Respondent's current age (years)	17,863	30.8 (15.0)	4603	24.6 (8.0)
Age at first cohabitation (years)	17,863	15.8 (3.0)	4603	16.3 (4.0)
Age of respondent at 1st birth (years)	16,153	17.9 (3.0)	4603	18.3 (4.0)
Husband's age (years)	16,840	39.5 (18.0)	4538	32.9 (9.0)
Number of living children (n)	17,863	2.3 (2.0)	4603	2.0 (2.0)
Number of deceased children (n)	17,863	0.22 (0.0)	4603	0.15 (0.0)

SD, standard deviation.

Table 2 – The distribution skilled antenatal care and skilled birth attendance (for the most recent birth) by sociodemographic factors (categorical), among women aged 15–49 years who had a live-birth in 3 years preceding the survey, BDHS 2014.

Sociodemographic variables	Group	N (%) of all study participants	N (%) of women with live birth	% of skilled Antenatal care	% of skilled delivery
Residence	Rural	12,816 (71.1)	3302 (65.5)	63.0	36.3
	Urban	5047 (28.3)	1201 (34.5)	82.1	61.3
Wealth index	Poorest	3359 (18.8)	998 (18.2)	39.8	18
	Poorer	3408 (19.1)	870 (18.8)	60.1	30.1
	Middle	3560 (19.9)	880 (20.3)	69.6	39.3
	Richer	3758 (21.0)	949 (21.1)	78.8	52.8
	Richest	3778 (21.1)	906 (21.6)	92.3	75.2
Division	Barisal	1111 (6.2)	268 (12.0)	65.2	36.9
	Chittagong	3301 (18.5)	1007 (16.0)	69.1	43.3
	Dhaka	6223 (34.8)	1626 (17.3)	68.7	45.2
	Khulna	1838 (10.3)	369 (14.5)	80.4	58.8
	Rajshahi	2103 (11.8)	463 (14.1)	68.9	41.9
	Rangpur	2056 (11.5)	443 (14.2)	66.7	38.6
	Sylhet	1232 (6.9)	427 (12.0)	54.9	27.6
Working status	No	11,950 (66.9)	3517 (76.4)	61.6	45.5
	Yes	5912 (33.1)	1086 (23.6)	70.1	34.1
Participated in household decisions	No	9000 (77.6)	2537 (70.6)	71.8	41.9
	Yes	2600 (22.4)	502 (29.4)	58.2	41.5
Respondent's education	None	4455 (24.9)	652 (23.6)	43.5	17.5
	Primary	5209 (29.2)	1286 (29.3)	55.5	29.9
	Secondary	6679 (37.4)	2194 (37.6)	76.8	50.1
	Higher	1520 (8.5)	471 (9.6)	93.3	79.6
Husband/partner's education	None	5189 (29.1)	1097 (28.3)	48.6	21.9
	Primary	4879 (27.3)	1383 (27.2)	59.3	33.2
	Secondary	5325 (29.8)	1456 (29.5)	79.8	51.8
	Higher	2467 (13.8)	664 (15.0)	90.9	77.6
Order of birth	First	3960 (22.2)	1837 (22.3)	74.7	53.1
	Second	4746 (26.6)	1388 (26.4)	70.3	44.5
	Third	3392 (19.0)	743 (18.6)	64.0	34.5
	Forth and above	5764 (32.3)	635 (32.7)	48.9	18.9
ANC	No	1415 (31.9)	1407 (31.9)		17.5
	Yes	3015 (68.1)	3000 (68.1)		55.2

BDHS, Bangladesh Demographic and Health Survey; ANC, antenatal care.

principal component analysis (PCA),[43] ranging between 18.8% (poorest) and 21.1% (richest).

The distribution of women who participated in the survey and who had at least one live birth 3 years preceding the survey across the six divisions (regions) ranged from 12% both in Barisal and Sylhet to 17% in Dhaka (Table 2). Only 22% of women responded that they participated in all four major family management decisions regarding respondent's earnings, respondent's health care, large household purchases,

and visits to family or relatives. Education status of participants and their partners showed that while about 74% of women succeeded in completing primary school, about 72% of the husbands achieved the same level of education. About 80% of Bangladesh women who participated in the survey were multipara, having more than one live birth or having twins.

Although ANC and SBA services in Bangladesh reached 68% and 43%, respectively, of those with live births 3 years

preceding the survey, the coverage significantly varied across different background variables. While 82% and 61% of urban dwellers received ANC and SBA services, respectively, only 63% and 36% of rural residents had access to these services. The highest improvement in the services uptake was observed across increasing educational status and wealth index of the participant. Even though only 10% of women completed higher education, 93% of these women received ANC and 77% received SBA service, while only 18% of those with no education accessed SBA service. Similarly, the coverage increased significantly from the lower quartile to upper quintile from below 40% to over 75%. Over 68% women had at least one ANC service from a skilled provider during the course of their pregnancy, and the coverage of skilled delivery among those was 55%. However, only 17% of the pregnant women who never received ANC service were attended by skilled personnel during delivery.

Mixed-effect model

The association of each sociodemographic variable with ANC and SBA services are presented in Table 3. Wealth index, participation in household decisions, and partner and respondent's education were significant for ANC; however, residence, age at first birth, wealth index, working status, participation in household decisions, and partner and respondent's education were significant for SBA. Women living in urban areas had higher likelihood to attain SBA services (1.69 times) compared with rural residents, as expected. Similarly, a greater age at child birth lead to skilled medical attendance. The richest households had 5.08- and 4.31-times greater odds of seeking ANC and SBA, respectively, in reference to the poorest households. However, both ANC and SBA services showed a negative association with women's participation in household decisions. Education of the women was observed as a significant positive indicator, with women who received higher education were over 3 times more likely to attain these services (Table 3). Similarly, husband or partner's education was not significant for attaining ANC and SBA services.

Association between SBA service and ANC

As ANC is acquired by women during pregnancy and before delivery, there is a natural expectation that women who seek SBA might already have received ANC services. As the 2 × 2 Table 4 shows, women who attained ANC, almost 56% of them had SBAs during delivery. Both ANC and SBA had a significant association ($\chi^2(1) = 561.93$, $P < 0.001$). It was interesting to find a cohort of 249 women with live births who received SBA services but not the skilled ANC. A further analysis on the distribution of this cohort showed that the mean age of the participants (mean = 24.7, SD = 6.1) was about 8 years lower than the overall study participants—women with a live birth 3

Table 3 — Mixed-effect model fitted with antenatal care and skilled birth attendance to the sociodemographic factors, where cluster-wise variations were considered as random effect.				
Sociodemographic factors	Antenatal care		Skilled birth attendance	
	Odds ratio (95% CI)	P-value	Odds ratio (95% CI)	P-value
Random effect (variance)	1.914		1.789	
Residence (ref: Rural)				
Urban	1.10 (0.86, 1.42)	0.439	1.69 (1.35, 2.11)	<0.001
Age at first cohabitation	0.98 (0.94, 1.03)	0.467	0.96 (0.92, 1.00)	0.061
Age at first birth	1.05 (1.01, 1.09)	0.027	1.09 (1.05, 1.13)	<0.001
Wealth index (ref: poorest)				
Poorer	1.52 (1.21, 1.90)	<0.001	1.47 (1.14, 1.91)	0.003
Middle	2.04 (1.59, 2.60)	<0.001	1.91 (1.47, 2.49)	<0.001
Richer	2.61 (1.98, 3.42)	<0.001	2.46 (1.87, 3.24)	<0.001
Richest	5.08 (3.50, 7.38)	<0.001	4.31 (3.13, 5.93)	<0.001
Number of living children	0.88 (0.75, 1.02)	0.095	0.83 (0.66, 1.03)	0.093
Number of children died	1.00 (0.81, 1.24)	0.992	0.98 (0.74, 1.28)	0.861
Working status (ref: No)				
Yes	0.92 (0.76, 1.11)	0.377	0.76 (0.63, 0.92)	0.004
Participation in household decisions (ref: No)				
Yes	0.81 (0.68, 0.96)	0.015	0.78 (0.66, 0.93)	0.005
Respondents education (ref:none)				
Primary	1.30 (1.02, 1.66)	0.035	1.33 (1.00, 1.77)	0.051
Secondary	1.98 (1.52, 2.58)	<0.001	1.87 (1.40, 2.51)	<0.001
Higher	3.45 (2.05, 5.83)	<0.001	3.33 (2.20, 5.04)	<0.001
Partners education (ref: none)				
Primary	1.04 (0.85, 1.28)	0.699	1.20 (0.96, 1.50)	0.118
Secondary	1.74 (1.37, 2.21)	<0.001	1.48 (1.17, 1.89)	0.001
Higher	2.81 (1.87, 4.23)	<0.001	2.52 (1.82, 3.50)	<0.001
Order of birth (ref: First)				
Second	1.15 (0.78, 1.69)	0.482	1.04 (0.65, 1.67)	0.862
Third	1.03 (0.63, 1.70)	0.894	0.93 (0.49, 1.76)	0.817
Fourth	1.08 (0.57, 2.01)	0.821	1.00 (0.43, 2.32)	0.999
CI, confidence interval.				

Table 4 – 2 × 2 table for SBA and ANC with Chi-squared test of association.

		Skilled birth attendance		P-value ($\chi^2(1)$ test)
		No	Yes	
Antenatal care	No	1158 (82.3%)	249 (17.7%)	<0.001
	Yes	1331 (44.4%)	1670 (55.6%)	

years preceding the survey; however, their age at first marriage (mean = 18.7, SD = 3.1) was 1 year higher than the overall participants (Tables A and B in supplementary file - see Appendix). Among the participants in this cohort, most of the women resided in rural areas (78.1%) and were reported not being engaged in any paid work (73.6%). 43% of this sample had no education or only attained primary education and were part of the poor quarter in the wealth index.

To test the association between ANC and SBA services, another mixed-effect model (cluster as random effect), where ANC was a covariate fitted to SBAs, and the model was adjusted by previous significant sociodemographic factors (Table 5). ANC showed significant association with SBAs, as mothers who availed appropriate ANC seemed to be four times more likely to opt for SBAs, which indicated the possible roll-out of skilled care from pregnancy to delivery.

Table 5 – Mixed-effect model fitted skilled birth attendance to ANC adjusted by other sociodemographic factors, where cluster-wise variations were considered as random effect.

Sociodemographic factors	Odds ratio (95% CI)	P-value
Random effect (variance)	1.441	
Residence (ref: Rural)		
Urban	1.68 (1.23, 2.31)	0.001
Age at first birth	1.05 (1.00, 1.10)	0.037
Working status (ref: No)		
Yes	0.73 (0.52, 1.01)	0.056
Wealth index (ref: poorest)		
Poorer	1.39 (0.88, 2.20)	0.155
Middle	1.90 (1.21, 2.97)	0.005
Richer	2.26 (1.43, 3.55)	<0.001
Richest	3.58 (2.17, 5.91)	<0.001
Participation in household decisions (ref: No)		
Yes	0.73 (0.54, 0.97)	0.030
Respondents education (ref: none)		
Primary	0.86 (0.50, 1.48)	0.588
Secondary	1.28 (0.76, 2.15)	0.357
Higher	2.91 (1.45, 5.81)	0.002
Partners education (ref: none)		
Primary	0.73 (0.43, 1.27)	0.269
Secondary	1.15 (0.70, 1.88)	0.582
Higher	0.76 (0.46, 1.26)	0.285
Antenatal care (ref: No)		
Yes	4.25 (3.05, 5.93)	<0.001

ANC, antenatal care; CI, confidence interval.

Discussion

It is well-established that MMR and utilization of SBA services are two of the most important metrics of weighing the progress toward the achievement of the maternal goals of SDGs. Bangladesh registered great headway with the target of MDGs, particularly as the countrywide coverage of SBAs increased from 5% in 1991 to 42.1% in 2014.[3,48] However, despite such advancement, the coverage is still lagging behind the target fixed by the Ministry of Health.[39,38] Furthermore, in a recent MDG assessment,[11] Bangladesh scored only 36 out of 100 in SBA performance, which demands more attention on SBAs. Part of the maternal healthcare target as MDG assessment is also to provide ANC to pregnant women all over the nation.[49] The presence of SBAs is crucial in childbirth to reduce the MMR and to achieve the maternal mortality target of the United Nations SDG.

The concept of SBA is not new in Bangladesh; in fact, it was introduced back in 2004.[33,50] However, the application of SBA seems to be limited to the privileged and informed part of the society. The results of this study ascertain the point that women belonging to the richer households and with higher education (along with an educated partner) were more likely to access SBAs. Furthermore, those of who already received ANC from skilled personnel were more likely to receive SBA service during delivery. Therefore, the sociodemographic variables are required to assess the overall public health scenario of Bangladesh to identify and understand the reasons behind vulnerable households' lack of access to essential delivery service through SBA.

Household economic condition is one of the primary factors contributing to the access of various health services in Bangladesh. The households belonging to the lower wealth quintile do not have the capacity to bear the cost of services like ANC and SBA. Two different mindsets generally bar these families from accessing SBA; first, they do not go to hospitals or access any means of health care as it would be a financial trade-off for basic necessities like food and clothing. These compel them to use services from TBAs providing cheap service in the locality for a long time. TBAs are often referred by friends and neighbors, encouraging them to choose the cheaper unprofessional service.[51,39,52,50] Second, with limited trained professionals working in the distant villages (rural and remote areas) of Bangladesh, the SBAs would prefer to serve those households where they are paid handsomely.[10] All these add to the travel cost to access SBA services, which again is cheaper through home delivery by a TBA.[53] Thus, the gap is filled by TBAs, and the poor cohort remains devoid of essential delivery care.

Another important factor associated with awareness of health services is education, both women and their husband/partner's. Women, who completed their secondary and higher education, are generally well-informed of the various health issues, particularly the problems of seeking traditional unscientific cheap treatments.[31,54,55] It compels them to rethink before availing the same service their ancestors did, a time when modern medical services were rare in rural Bangladesh.[39] Further awareness from the household head or the husband/partner is important because in the patriarchal society of Bangladesh, a man usually makes most of the decisions for the family, particularly in circumstances that involve spending money. Hence, a highly educated partner would be aware of the risk from an unskilled carer or TBA and

comprehend the worth of spending the money on ANC and SBA services.[54,56,57] It takes a highly educated family to rise above the long-established mindset of the community and go against the flow to seek modern medical help.[58]

The results of this study also revealed that ANC from a skilled professional during the period of pregnancy increased the likelihood of seeking delivery from an SBA. Al Kibria et al. reasonably argues that the duration of pregnancy is the perfect intervention period for skilled delivery services as the medical personnel could explain the complexities associated with a delivery and the consequence of inefficient deliveries by TBAs.[29] A high number of complications following delivery are found to be associated with traditional delivery services at home.[59] However, a trained provider of ANC could be an intervention to encourage the women and their families to access the modern services in a health facility.[60] As of BHDS 2014 report,[24] 37% of births are delivered in a health facility, which is an increasing trend (12%, 17%, and 29% in 2004, 2007, and 2011, respectively). These results support the necessity of reaching appropriate ANC and SBA visits throughout the period of pregnancy to ensure essential assistance for delivery and postnatal care.

This study analyzed the latest available nationwide health data on Bangladesh and identified the most vulnerable households, where women still lack skilled delivery assistance. However, this study was limited by a few factors. First, although the geographical clusters were adjusted, it is limited by district-wise data. A spatial analysis would have identified the most compromised regions of the country, and a follow-up policy intervention on these areas could be discussed. Second, some qualitative analyses could have portrayed women's opinion regarding their position to choose TBA or SBA during delivery. These would have verified whether there is a causal relationship between patriarchy and access to health services. Third, as the data were cross-sectional, the study could only reflect on the association of the factors, and it should not be interpreted in a causal manner. Further studies with SBA interventions in a controlled environment (e.g. different training schemes for SBAs and community engagement programs) could warrant the validation of the findings. Future studies can also investigate the cohort of 249 individuals who received no ANC but availed SBA services, which could potentially decipher issues like lack of community engagement of ANCs or insufficient ANC services in the locality.

Conclusion

During the last two decades, the financial development in Bangladesh has led to an improved public health scenario including ANC and SBA services. Foreign aid and locally active NGOs patronized by Bangladesh Government are continuously strengthening this sector. These resulted in increased setup of local health facilities and consequently more trained SBAs in local communities. This study analyzed the most recent BDHS 2014 data to investigate the determinants of ANC and SBA service utilization at delivery including wealth index, education of women, and their participation in household decision making. The findings demonstrate that interventions are required for the poor and uneducated women. Several intervention strategies are warranted to ensure Bangladesh attains the targets of the SDGs set by United Nations. This study concludes that focusing on women's education, increasing affordability by poverty reduction, minimizing the gaps of the SBA services between the rich and the poor, and increasing ANC services for smoother access to SBAs, with particular attention to rural and poor communities, could substantially contribute to the national maternal health services during delivery, which would enhance the national mortality prevention programs.

Author statements

Author's contribution

J.B. conceptualized the study, structured the manuscript, conducted literature review, and edited the manuscript. R.K.B. developed the analysis plan, aided in variable selection, and drafted the manuscript. M.W. compiled the data, synthesized the analysis plan, and performed statistical analysis. The final manuscript was read and approved by all the authors.

Ethical approval

This article does not contain any studies with human participants performed by any of the authors. The Bangladesh demographic and health Surveys were approved by ICF Macro Institutional Review Board and the National Research Ethics Committee of the Bangladesh Medical Research Council. A written consent about the survey was given by participants before interview. All identification of the respondents was disidentified before publishing data. The secondary data sets analyzed during the current study are freely available upon request from the DHS website at http://dhsprogram.com/data/available-datasets.com.

Competing interest

There is no conflict of interest among the authors.

REFERENCES

1. Chowdhury AMR, Bhuiya A, Chowdhury ME, Rasheed S, Hussain Z, Chen LC. The Bangladesh paradox: exceptional health achievement despite economic poverty. *Lancet* 2013;**382**(9906):1734—45.

2. Ahmed SM, Evans TG, Standing H, Mahmud S. Harnessing pluralism for better health in Bangladesh. *Lancet* 2013;**382**(9906):1746—55.

3. El Arifeen S, Christou A, Reichenbach L, Osman FA, Azad K, Islam KS, Ahmed F, Perry HB, Peters DH. Community-based approaches and partnerships: innovations in health-service delivery in Bangladesh. *Lancet* 2013;**382**(9909):2012—26.

4. Islam A, Biswas T. Bangladesh health system and the millennium development goals: strategic policy options for sustained progress in maternal and child health. *Eur J Prev Med* 2015;**3**(3):63—70.

5. Lozano R, Wang H, Foreman KJ, Rajaratnam JK, Naghavi M, Marcus JR, Dwyer-Lindgren L, Lofgren KT, Phillips D, Atkinson C, et al. Progress towards millennium development goals 4 and 5 on maternal and child mortality: an updated systematic analysis. *Lancet* 2011;**378**(9797):1139—65.

6. Chowdhury S, Banu L, Chowdhury T, Rubayet S, Khatoon S. Achieving millennium development goals 4 and 5 in Bangladesh, BJOG. *An Int J Obstet Gynaecol* 2011;**118**(s2):36—46.

7. El Arifeen S, Hill K, Ahsan KZ, Jamil K, Nahar Q, Streatfield PK. Maternal mortality in Bangladesh: a countdown to 2015 country case study. *Lancet* 2014;**384**(9951):1366—74.

8. Kumar S, Kumar N, Vivekadhish S. Millennium development goals (mdgs) to sustainable development goals (sdgs): addressing unfinished agenda and strengthening sustainable development and partnership. *Indian J Community Med Off Publ Indian Assoc Prev Soc Med* 2016;**41**(1):1.

9. S. Munabi-Babigumira, C. Glenton, S. Lewin, A. Fretheim, H. Nabudere, Factors that influence the provision of intrapartum and postnatal care by skilled birth attendants in low-and middle-income countries: a qualitative evidence synthesis, The Cochrane Library.

10. M. Saha, E. N. Odjidja, Access to a skilled birth attendant in Bangladesh: what we know and what health system framework can teach us, Health Sys Pol Res 4 (4).

11. Lim SS, Allen K, Bhutta ZA, Dandona L, Forouzanfar MH, Fullman N, Gething PW, Goldberg EM, Hay SI, Holmberg M, et al. Measuring the health-related sustainable development goals in 188 countries: a baseline analysis from the global burden of disease study 2015. *Lancet* 2016;**388**(10053):1813—50.

12. Ahmed S, Creanga AA, Gillespie DG, Tsui AO. Economic status, education and empowerment: implications for maternal health service utilization in developing countries. *PLoS One* 2010;**5**(6):e11190.

13. Harvey SA, Blandón YCW, McCaw-Binns A, Sandino I, Urbina L, Rodŕiguez C, Ǵomez I, Ayabaca P, Djibrina S. Are skilled birth attendants really skilled? a measurement method, some disturbing results and a potential way forward. *Bull World Health Organ* 2007;**85**(10):783—90.

14. Baqui AH, El-Arifeen S, Darmstadt GL, Ahmed S, Williams EK, Seraji HR, Mannan I, Rahman SM, Shah R, Saha SK, et al. Effect of community-based newborn-care intervention package implemented through two service-delivery strategies in sylhet district, Bangladesh: a cluster-randomised controlled trial. *Lancet* 2008;**371**(9628):1936—44.

15. Ahmed T, Jakaria S. Community-based skilled birth attendants in Bangladesh: attending deliveries at home. *Reprod Health Matters* 2009;**17**(33):45—50.

16. Byrne A, Morgan A. How the integration of traditional birth attendants with formal health systems can increase skilled birth attendance. *Int J Gynecol Obstet* 2011;**115**(2):127—34.

17. World Health Organization and others, Making pregnancy safer: the critical role of the skilled attendant: a joint statement by who, icm and figo.

18. Yanagisawa S, Oum S, Wakai S. Determinants of skilled birth attendance in rural Cambodia. *Trop Med Int Health* 2006;**11**(2):238—51.

19. Kruk ME, Prescott MR, Galea S. Equity of skilled birth attendant utilization in developing countries: financing and policy determinants. *Am J Public Health* 2008;**98**(1):142—7.

20. Shimamoto K, Gipson JD. The relationship of womens status and empowerment with skilled birth attendant use in Senegal and Tanzania. *BMC Pregnancy Childbirth* 2015;**15**(1):154.

21. Kamal SM, Hassan CH, Islam MN. Factors associated with the timing of antenatal care seeking in Bangladesh. *Asia Pac J Public Health* 2015;**27**(2):NP1467—80.

22. G. Saad-Haddad, J. DeJong, N. Terreri, M. C. Restrepo-Méndez, J. Perin, L. Vaz, H. Newby, A. Amouzou, A. J. Barros, J. Bryce, Patterns and determinants of antenatal care utilization: analysis of national survey data in seven countdown countries, J Glob Health 6 (1).

23. Blum LS, Sharmin T, Ronsmans C. Attending home vs. clinic-based deliveries: perspectives of skilled birth attendants in matlab, Bangladesh. *Reprod Health Matters* 2006;**14**(27):51—60.

24. DHS. *Bangladesh demographic and health survey*. National institute of population research and training(niport); 2014.

25. Matsuoka S, Aiga H, Rasmey LC, Rathavy T, Okitsu A. Perceived barriers to utilization of maternal health services in rural Cambodia. *Health Policy* 2010;**95**(2):255—63.

26. Dupas P. Health behavior in developing countries. *Annu Rev Econ* 2011;**3**(1):425—49.

27. Bhalotra S, Rawlings SB. Intergenerational persistence in health in developing countries: the penalty of gender inequality? *J Public Econ* 2011;**95**(3—4):286—99.

28. Montagu D, Yamey G, Visconti A, Harding A, Yoong J. Where do poor women in developing countries give birth? a multi-country analysis of demographic and health survey data. *PLoS One* 2011;**6**(2):e17155.

29. Al Kibria GM, Ghosh S, Hossen S, Barsha RAA, Sharmeen A, Uddin SI. Factors affecting deliveries attended by skilled birth attendants in Bangladesh, Maternal health. *Neonatol Perinatol* 2017;**3**(1):7.

30. Nguyen HT, Hatt L, Islam M, Sloan NL, Chowdhury J, Schmidt J-O, Hossain A, Wang H. Encouraging maternal health service utilization: an evaluation of the Bangladesh voucher program. *Soc Sci Med* 2012;**74**(7):989—96.

31. Paul BK, Rumsey DJ. Utilization of health facilities and trained birth attendants for childbirth in rural Bangladesh: an empirical study. *Soc Sci Med* 2002;**54**(12):1755—65.

32. Bhuiyan A, Mukherjee S, Acharya S, Haider S, Begum F. Evaluation of a skilled birth attendant pilot training program in Bangladesh. *Int J Gynecol Obstet* 2005;**90**(1):56—60.

33. Murakami I, Egami Y, Jimba M, Wakai S. Training of skilled birth attendants in Bangladesh. *Lancet* 2003;**362**(9399):1940.

34. Islam N, Islam MT, Yoshimura Y. Practices and determinants of delivery by skilled birth attendants in Bangladesh. *Reprod Health* 2014;**11**(1):86.

35. Woldemicael G, Tenkorang EY. Women's autonomy and maternal health-seeking behavior in Ethiopia. *Matern Child Health J* 2010;**14**(6):988—98.

36. Steinberg L. A social neuroscience perspective on adolescent risk-taking. *Dev Rev* 2008;**28**(1):78—106.

37. El Mhamdi S, Salah AB, Bouanene I, Hlaiem I, Hadhri S, Maatouk W, Soltani M. Obstetric and psychological characteristics of women seeking multiple abortions in the region of Monastir (Tunisia): results of a cross-sectional design. *BMC Women's Health* 2015;**15**(1):40.

38. Yaya S, Bishwajit G, Ekholuenetale M. Factors associated with the utilization of institutional delivery services in Bangladesh. *PLoS One* 2017;**12**(2):e0171573.

39. Kamal SM, Hassan CH, Kabir M. Inequality of the use of skilled birth assistance among rural women in Bangladesh:

facts and factors. *Asia Pac J Public Health* 2015;**27**(2):NP1321—32.

40. Hajizadeh M, Alam N, Nandi A. Social inequalities in the utilization of maternal care in Bangladesh: have they widened or narrowed in recent years? *Int J Equity Health* 2014;**13**(1):120.

41. Ahmed SM, Hossain MA, RajaChowdhury AM, Bhuiya AU. The health workforce crisis in Bangladesh: shortage, inappropriate skill-mix and inequitable distribution. *Hum Resour Health* 2011;**9**(1):3.

42. The World Bank. *Nurses and midwives (per 1,000 people.* 2017. URL, https://data.worldbank.org/indicator/SH.MED.NUMW. P3. [Accessed 2 May 2019].

43. Rutstein SO, Johnson K, MEASURE OM, et al. *The DHS wealth index.* ORC Macro, MEASURE DHS; 2004.

44. Measure D. *Icf international, demographic and health surveys methodology: standard recode manual for DHS 6. Demographic and health survey toolkit of methodology for the MEASURE DHS phase III.* 2008—2013.

45. Biswas RK, Kabir E. Influence of distance between residence and health facilities on non-communicable diseases: an assessment over hypertension and diabetes in Bangladesh. *PLoS One* 2017;**12**(5):e0177027.

46. McCulloch CE, Neuhaus JM. *Generalized linear mixed models.* Wiley Online Library; 2013.

47. McCulloch CE. Maximum likelihood algorithms for generalized linear mixed models. *J Am Stat Assoc* 1997;**92**(437):162—70.

48. United Nations Development Programme, MDG. *Bangladesh progress report 2015, general economics division (GED), planning commission.* Government of the People's Republic of Bangladesh; 2015.

49. R. Kabir, H. Khan, Utilization of antenatal care among pregnant women of urban slums of Dhaka city, Bangladesh.

50. S. Talukder, D. Farhana, B. Vitta, T. Greiner, In A rural area of Bangladesh, traditional birth attendant training improved early infant feeding practices: a pragmatic cluster randomized trial, Maternal & child nutrition 13 (1).

51. Shah N, Rohra DK, Shams H, Khan NH. Home deliveries: reasons and adverse outcomes in women presenting to a tertiary care hospital. *JPMA (J Pak Med Assoc)* 2010;**60**(7):555.

52. 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**(1):e0146161.

53. Shahabuddin A, Delvaux T, Abouchadi S, Sarker M, De Brouwere V. Utilization of maternal health services among adolescent women in Bangladesh: a scoping review of the literature. *Trop Med Int Health* 2015;**20**(7):822—9.

54. Gabrysch S, Campbell OM. Still too far to walk: literature review of the determinants of delivery service use. *BMC Pregnancy Childbirth* 2009;**9**(1):34.

55. Akter T, Dawson A, Sibbritt D. The determinants of essential newborn care for home births in Bangladesh. *Publ Health* 2016;**141**:7—16.

56. Anastasi E, Borchert M, Campbell OM, Sondorp E, Kaducu F, Hill O, Okeng D, Odong VN, Lange IL. Losing women along the path to safe motherhood: why is there such a gap between womens use of antenatal care and skilled birth attendance? a mixed methods study in northern Uganda. *BMC Pregnancy Childbirth* 2015;**15**(1):287.

57. McDougal L, Rusch ML, Silverman JG, Raj A. Linkages within the reproductive and maternal health continuum of care in Bangladesh. *Asia Pac J Public Health* 2016;**28**(5):423—37.

58. Mullany BC, Becker S, Hindin M. The impact of including husbands in antenatal health education services on maternal health practices in urban Nepal: results from a randomized controlled trial. *Health Educ Res* 2006;**22**(2):166—76.

59. Islam MA, Chowdhury RI, Akhter HH. Complications during pregnancy, delivery, and postnatal stages and place of delivery in rural Bangladesh. *Health Care Women Int* 2006;**27**(9):807—21.

60. Rahman M. Deliveries among adolescent mothers in rural Bangladesh: who provides assistance? *World Health Popul* 2009;**11**(2):5—14.

Appendix A. Supplementary data

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