Impact of Limited-Service Availability and Preparedness

on Facility-Based Delivery in Bangladesh

by

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Abstract

Background: Globally, about 300,000 women die from childbirth per year with 94% of these deaths occurring in low- and middle-income countries, particularly in South Asia. The majority of these deaths are preventable if women receive proper treatment on time. In Bangladesh, there are several government initiatives to promote facility births as a safer alternative to homebirths. Despite these efforts, only 50% of births in the country take place in a health facility. Although there are a variety of factors that impact women's decisions to utilize childbirth services such as educational attainment, religious beliefs, financial status, and more. We focused on the issue of access to facilities and the preparedness of these facilities to provide childbirth services. This study investigate whether having access to facilities with childbirth services will increase women's uptake of these services in Bangladesh.

Methods: To do this we first linked, 2017 Bangladesh Health Facility Survey (BHFS) to 2017-18 Bangladesh Demographic and Health Survey (BDHS) dataset. Approximately 20,250 women from 675 clusters (enumeration areas) were selected in the BDHS. Of these, 5,012 women had a childbirth within the last 36 months of the survey and were considered in this study. In the BHFS, 818 facilities provided childbirth services and were considered in this study. By using geographical linkage, we linked facilities providing childbirth services that were accessible to a women cluster. The relationship between service availability, preparedness and facility birth was examined accounting for women characteristics using logistic regression analysis.

Results: The mean age of the women participants was 24.86 years (standard deviation: 5.56) and the majority of the women were Muslims (73.2%), resided in the rural areas (73.2%) and had secondary or higher education (66.1%). Of the 5,012 participants, 50.28% delivered at a heath facility. The mean age of women who delivered at a healthcare facility was significantly lower

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that observed for women who delivered elsewhere (24.67 vs. 25.05 years, p=0.001). The majority of the women (63.5%) who lived in the urban areas had the childbirth in a health facility whereas only 44.9% of rural women opted for childbirth in a health facility with the differences being statistically significant (p < 0.001). Of the 818 facilities considered in this study, (83.37%) are government-managed, with a higher proportion of rural facilities falling into this category (94.56%) compared to urban facilities (66.15%). A greater proportion of facilities offered some interventions (75.43%) compared to Comprehensive Emergency Obstetric Care (CEmOC) services (13.45%) and Basic Emergency Obstetric Care (BemOC) services (11.12%). The distribution of services provided was significantly different between urban and rural areas, with facilities in urban areas providing a higher percentage of CemOC services (32.30%) and BemOC services (17.08%). In the multivariable logistic regression, after adjusting other factors, there was a 3% significant increase in the odds of facility childbirth for a unit increase in age (adjusted odds ratio (AOR): 1.03, 95% CI: 1.002 – 1.05). Rural women were significantly less likely to utilize the facility service for childbirth in comparison to urban women (AOR: 0.62, 95% CI: 0.49 – 0.79). Women who completed their secondary school education were 62% more likely to utilize facility childbirth services in comparison to women with no formal education (AOR: 1.62, 95% CI: 1.02 – 2.59). In comparison to the women from poorer households, women from affluent ad middle income households were significantly more likely to utilize facility childbirth services. Childbirth cost was significantly associated with childbirth at a health facility. After adjusting for women characteristics, only the increased number of facilities in the service environment was significantly associated with facility birth. None of the other service environment variables including the management body of a facility, BEmOC preparedness, or distance to facility was statistically significant.

Conclusions: After adjusting for all other individual-level factors, this study found that rural women had 38% lower likelihood of giving birth at a health facility compared to urban women. Women who live in a high service environment (6 or more facilities) exhibited a significant association with facility childbirth compared to women who live in a low service environment (0-2 facilities). The study's findings could contribute to policymakers' effort to impose stricter regulations and improve preparedness of both private and public healthcare facilities. We recommend that efforts should be made to address barriers that prevent women, particularly those in rural areas, from accessing facility-based childbirth services. Targeted counseling, education campaigns, and making services affordable can improve maternal and neonatal health outcomes.

Preface

This thesis is an original work by Saad Ullah Al Amin. The thesis has been written in a traditional format according to the guidelines of the Faculty of Graduate Studies and Research at the University of Alberta. This research project utilizes unidentifiable secondary data obtained from Demographic Health Survey (DHS) program funded by USAID. Ethics approval for the thesis research project was obtained from the University of Alberta Health Research Ethics Board.

Saad Ullah Al Amin was responsible for the data analyses, and preparation of the thesis. Professor Sentil Senthilselvan provided guidance for the data merging, data analyses, and interpretation of the results. Professor Zubia Mumtaz provided guidance for the conceptual framework, methodological considerations, and preparation of the thesis.

Dedication

To my beloved family,

      I dedicate this thesis to you with all my heart. Your unwavering love, support, and encouragement have been the driving force behind my academic journey. You have always been there for me, cheering me on during the good times and providing comfort during the challenging ones.

      To my parents, thank you for instilling in me a love for learning and for always pushing me to strive for excellence. To my siblings, thank you for being my closest friends and for your constant inspiration. To my spouse, thank you for your unwavering support and for believing in me when I doubted myself.

      This achievement is not only mine, but it is also yours. I could not have made it this far without you. I hope that this thesis will make you proud, and that it will serve as a small token of my appreciation for all that you have done for me.

With love and gratitude,

Saad Ullah Al Amin

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List of Abbreviations

LMIC	Low and middle-income countries
ANC	Antenatal Care
BBS	Bangladesh Bureau of Statistics
BDHS	Bangladesh Demographic Household Survey
BEmOC	Basic Emergency Obstetric Care
BHFS	Bangladesh Health Facility Survey
CEmOC	Comprehensive Emergency Obstetric Care
DGFP	Directorates General of Family Planning
DGHS	Directorates General of Health Services
EAs	Enumeration areas
EmOC	Emergency Obstetric Care
FBC	Facility-Based Childbirth
ICF	Inner-City Fund
IMPAC	Integrated Management of Pregnancy and Childbirth
MaMoni	Maternal and Newborn Care Strengthening Project
MDG	Millennium Development Goal
MHVS	Maternal Health Voucher Scheme
MoHFW	Ministry of Health and Family Welfare
NCDs	Noncommunicable diseases
NIPORT	National Institute of Population Research and Training
SARA	Service availability and readiness assessment indicators
SBA	Skilled Birth Attendants
SDG	Sustainable Development Goal
SPA	Service Provisional Assessment
WHO	World Health Organization

Chapter 1

Introduction

1.1 Statement of Problem

Globally, an estimated 300,000 women die in childbirth each year (J. Lawn, Cousens, Zupan, & Team, 2005; Say et al., 2014; WHO, 2019). Over 94% of these maternal deaths occur in low- and middle-income countries (LMIC). Within this group, South Asian countries – India, Pakistan, Bangladesh and Nepal - remain the largest contributors to maternal deaths worldwide (World Health, 2019). The major causes of maternal deaths include postpartum hemorrhage, Puerperal sepsis, pre-eclampsia and eclampsia, complications from delivery, and obstructed labor (Feigin et al., 2017; Filippi, Chou, Ronsmans, Graham, & Say, 2016).

Most births are normal, but 15% of all pregnancies are likely to develop obstetric complications that require attention from a skilled health professional (UNFPA & UNICEF, 2009; World Health Organization, 2017). Since a large proportion of these complications can occur unexpectedly, experts recommend all births take place in a health facility (Callister & Edwards, 2017; O. M. R. Campbell & Graham, 2006; Organization, 2015b). The logic underlying facility births is that a well-equipped facility will put women and their babies in contact with skilled professionals who will manage uneventful pregnancy, labor, and birth, and either prevent, detect and treat, or appropriately refer complications. Evidence suggests such facility care has the potential to prevent 85% of intrapartum deaths (O. M. Campbell, Graham, & group, 2006; Doctor, Nkhana-Salimu, & Abdulsalam-Anibilowo, 2018; J. E. Lawn et al., 2009; Rubayet et al., 2012; R. Winter, J. Yourkavitch, W. Wang, & L. Mallick, 2017).

Despite the experts' recommendation, improving facility births rate remains a challenge. Globally, only 64% of births in Low and-Middle Income Countries (LMICs) take place in a facility (UNICEF, 2023). In Bangladesh, the focus of the present study, only 50% of births take place in a health facility (Anwar, Nababan, Mostari, Rahman, & Khan, 2015). The causes of these low rates are complex and rooted in both supply and demand for maternal health care services. In low and middle-income countries, the supply of services is limited due to insufficient infrastructure, and inadequate equipment, supplies, and drugs. There is also a paucity of skilled health care providers, who are sufficiently trained and supervised (El Arifeen et al., 2014; Organization, 2015c; Sarker et al., 2016). The demand for maternal health care services is also low, especially amongst older, rural mothers with low levels of education and whose husbands work in low-paying occupations. Women from poorer households are also less likely to give birth in a health facility (Adde, Dickson, & Amu, 2021; Afsana & Rashid, 2001; Akhter, Dasvarma, & Saikia, 2020; Asmare & Agmas, 2022; Bhowmik, Biswas, & Ananna, 2020; Chaka, 2020; Iftikhar Ul Husnain, Rashid, & Shakoor, 2018).

The Government of Bangladesh has been trying to improve facility birth rates, primarily by increasing service availability and preparedness, but also promoting facility births as a safer alternative to homebirths. An assumption underling the strategy of increasing service availability is that if a facility offers childbirth services, women will be encouraged to use them. This assumption is supported by some evidence, for Tegegne et al. 2020 found that in Ethiopia, a one unit increase in facility preparedness doubled the odds of utilization (aOR, 2.094, 95% CI 1.187–3.694) (Tegegne, Chojenta, Getachew, Smith, & Loxton, 2020). Nonetheless, there is limited empirical evidence showing that improving facilities readiness to provide delivery care will

encourage women to use them in the South Asian context. The present study aims to address this gap in knowledge in Bangladesh. It investigates if having access to a facility providing Basic Emergency Obstetric Care (BEmOC) will increase facility delivery rates in the country. Data from the two national surveys, Bangladesh Demographic Household Survey (BDHS) and Service Provisional Assessment (SPA) also known as Bangladesh Health Facility Survey (BHFS), are used to address the question (National Institute of Population Research and Training (NIPORT) & ICF, 2019; National Institute of Population Research Training (NIPORT) & ICF, 2020; The DHS Program, 2022a, 2022b).

1.2 Facility-based childbirth services

When maternity care service is provided by Skilled Birth Attendants (SBA) in a well-equipped healthcare facility, it is defined as a facility providing Facility-Based Childbirth (FBC) (Lee et al., 2016). The World Health Organization (WHO) has identified a basic set of services required for a safe, high-quality childbirth. For services provided at a first-level care facility, this is known as Basic Emergency Obstetric Care (BEmOC) package. An addition of Cesarean section and blood transfusion services categorizes the care as Comprehensive Emergency Obstetric Care (CEmOC) (Paxton, Bailey, Lobis, & Fry, 2006). Table 1 below lists the signal functions that constitute Basic and Comprehensive Emergency Obstetric Care.

Table 1.2.1 Components of basic and comprehensive emergency obstetric care services

Intervention Components	BEmOC	CEmOC
1. **Administer parenteral antibiotics**	✓	✓
2. **Administer uterotonic drugs**	✓	✓

3. **Administer parenteral anticonvulsants**	✓	✓
4. **Manually remove the placenta**	✓	✓
5. **Remove retained products**	✓	✓
6. **Perform assisted vaginal delivery**	✓	✓
7. **Perform Caesarean section**	✗	✓
8. **Perform blood transfusion**	✗	✓

*Adapted from Monitoring emergency obstetric care – A Hand Book (U. WHO & UNICEF, 2016).

1.3 BEmOC Service Availability & Facility Preparedness

The literature suggests inadequate facility preparedness is an important determinant of women's decision to give birth in a health facility. Facility preparedness to provide BEmOC is measured using a complex score formulated by combining multiple indicators recommended by WHO's service availability and readiness assessment indicators (SARA) (Sheffel, Karp, & Creanga, 2018). These include personnel (skilled employees with access to BEmOC guidelines and their continuous presence in facilities under good supervision), equipment (delivery packs, suction devices, and hand washing stations) and medications (uterotonic drugs and injectable antibiotics) amongst others (Organization, 2013).

According to the World Health Organization, there should be five fully prepared Emergency Obstetric Care (EmOC) facilities per 500,000 population. This includes four Basic Emergency Obstetric Care (BEmOC) facilities and one Comprehensive Emergency Obstetric Care (CEmOC) facility to ensure safe childbirth for all women (World Health Organization,

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United Nations Populatin Fund, & United Nations Children's Fund, 2009). Few countries in the Global South meet this recommendation. In Ethiopia, only 0.6 facilities per 500,000 population met the criteria (Admasu, Haile-Mariam, & Bailey, 2011; Gabrysch, Simushi, & Campbell, 2011; Ø. E. Olsen, S. Ndeki, & O. F. Norheim, 2005). In Zambia, 12% of the facilities could be classified as an EmOC facility (Gabrysch, Simushi, et al., 2011; O. E. Olsen, S. Ndeki, & O. F. Norheim, 2005). In addition to the shortage of EmOC facilities, there are also gaps in the service preparedness. In the southern province of Zambia, for example, none of the health centers performed all six signal functions of BEmOC due to lack of the necessary supplies, equipment, and trained personnel to provide these basic obstetric services. In Zambia, only six out of ten hospitals provided the full range of CEmOC services, while not one health center out of 90 health, provided the full set of BEmOC signal functions (S. Gabrysch, S. Cousens, J. Cox, & O. M. R. Campbell, 2011b).

Inadequate facility preparedness remains a key challenge in South Asia as well. Studies from India, Pakistan and Nepal found that availability of BEmOC services is well below the WHO recommended rates. Only 11.8%, 14.7% and 6.25% of the surveyed facilities provided all BEmOC services in India, Pakistan, and Nepal respectively (Ali, Bhatti, & Kuroiwa, 2008; Banstola et al., 2020; Biswas et al., 2005). In Pakistan, nearly half of all health institutions surveyed did not have assigned staff as advised by the health ministry (Ali et al., 2008). Not unexpectedly, BEmOC service preparedness was higher in private facilities compared to government facilities (Acharya, Subedi, Dahal, & Karkee, 2021).

1.4 Geographic variation

  Geographic variation in service availability is another factor that is assumed to determine facility use, but the relationship is not clear. One body of literature shows that odds of facility use for childbirth reduce with increasing distance from a mother's primary residence. For example, Tegegne et al. reported that longer distances to the nearest facility in Ethiopia had a negative impact on facility utilization (aOR 0.967, 95% CI 0.944–0.991) (Tegegne et al., 2020). In Zambia, less than a fourth of the population lived within 15 KM of a BEmOC facility and doubling the distance to the closest facility decreased the odds of delivering by 29% (Gabrysch, Cousens, et al., 2011b). In Nepal, a 30-minute increase in travel time to the nearest facility was associated with a 42% decrease in the odds of facility-based delivery (Shahabuddin et al., 2017). In Pakistan, Jain et al (2015) reported that a one km increase in distance to facility was associated with a 3% reduction in facility utilization for childbirth (Jain, Sathar, & ul Haque, 2015). Similarly, a study in India reported that the likelihood of facility delivery varied from 22% to 68% for women residing within 25 km and 1 km respectively (adjusted for confounders) (Barman, Roy, Zaveri, Saha, & Chouhan, 2020). However, studies from Ghana and Malawi reported somewhat contradictory findings. Doste et al. (2020) reported that service preparedness rather than distance was a stronger determinant of facility birth in Ghana (Dotse-Gborgbortsi, Tatem, et al., 2020). The same authors go on to report that in Eastern Ghana service preparedness was insignificant whereas each kilometer increase in facility distance reduced the facility birth rate by 6.7%. They also observed more than half of the women surveyed bypassed the nearest hospital and travelled an average of 4 km to deliver at a facility of their choice (Dotse-Gborgbortsi, Dwomoh, et al., 2020). Similarly, research from Malawi shows that while the average distance to the nearest referral facility for primary care is 35 km, there was no

association between distance to care and facility delivery, regardless of whether the results were adjusted for various confounding factors or not (OR=0.97; p-value of 0.89) (Lohela, Campbell, & Gabrysch, 2012).

1.5 Demand for facility births

Women-level factors play a significant role in determining whether or not a woman chooses to deliver her baby in a health facility. They include maternal age, education level, household wealth, previous pregnancy experiences, and access to facility. The evidence of the relationship between women's age and facility delivery is mixed. Generally younger women are more likely to give birth in a health facility than older women (Adedokun & Uthman, 2019; Agaba, Magadi, & Orton, 2022). However, some studies report that older women (above 35 years) were more likely to deliver in a health facility than younger women (25 to 34 years) in Ethiopia (Chaka, 2020).

Studies have consistently shown a positive association between women's education and facility delivery (Saifuddin Ahmed, Creanga, Gillespie, & Tsui, 2010; Bhowmik et al., 2020; H. Wang, Frasco, Takesue, & Tang, 2021). A recent meta-analysis of data from Afghanistan, Bangladesh, India, Pakistan showed that women with primary, secondary, and higher education were 1.65, 2.21, and 3.14 times more likely, respectively, to give birth in a facility compared to women with no education (Bhowmik et al., 2020).

Several studies show a positive association between women's occupation and their likelihood of accessing facility-based delivery. A meta-analysis on 12 East African countries

reported working for wages were 11% more likely to delivery at a facility compared to those not working for wages (Tesema & Tessema, 2021). Pooled DHS data from 54 LMICs found that unemployed women were 15% less likely to give birth in a health facility (Asmare & Agmas, 2022). Huda et. al. also reported, in Bangladesh working mothers used facility-based delivery services more frequently (Huda, Chowdhury, El Arifeen, & Dibley, 2019).

Previous pregnancy experiences such as birth order, parity, and desire for pregnancy can all influence a woman's decision to deliver in a health facility. Higher parity women are less likely to seek facility care compared to women giving birth for the first time (Bulto, Zewdie, & Beyen, 2014; Eklund, 2016; Kebede, Hassen, & Nigussie Teklehaymanot, 2016). Desire for pregnancy was another factor influencing facility birth. Women who reported planning their pregnancy were 42% more likely to give birth in a facility compared to women who had unplanned pregnancy (Suleman Hassen, Mulatu Teshale, & Abate Adulo, 2021).

Household wealth has been reported as one of more important factors determining childbirth in a medical facility (Aremu, Lawoko, & Dalal, 2011; Dotse-Gborgbortsi, Tatem, et al., 2020). Studies from South Asian and Sub-Saharan countries, including Bangladesh, report high costs of facility birth as a deterrent to its use in households with limited resources (Wilunda et al., 2015; Rebecca Winter, Jennifer Yourkavitch, Wenjuan Wang, & Lindsay Mallick, 2017; Ziraba, Mills, Madise, Saliku, & Fotso, 2009). Goli et al (2018) reported that women in India faced high out-of-pocket costs for a facility delivery, which acted as a barrier to use (Goli, Rammohan, & Moradhvaj, 2018). Most women who delivered at home in Pakistan cited the high cost of facility birth as a reason for not delivering in a health facility (Iftikhar Ul Husnain et al.,

2018). Not surprisingly, there is a positive association between women's financial status and facility birth. Pulok et. al. found that, in Bangladesh wealthy women were 5 times more likely to deliver at a facility compared to women in lowest wealth quintile (Pulok, Sabah, Uddin, & Enemark, 2016). Similarly women in Nepal who reported financial autonomy were more likely to give birth in a health facility (Gautam & Jeong, 2019).

In addition to these socio-demographic factors, a number of studies have explored the relationships between cultural and religious beliefs and facility births. These studies show that women who adhere to traditional beliefs and practices are less likely to use health facilities for childbirth (Doctor et al., 2012; Kebede et al., 2016). Similarly, there is some evidence that Muslim women were less likely to use a facility for childbirth compared to women form other religions (Huda et al., 2019).

1.6 Facility Birth in Bangladesh

Bangladesh, with a maternal mortality rate of 173 per 100,000 live births, is one of the 11 countries that achieved its Millennium Development Goal (MDG) targets in 2015 (El Arifeen et al., 2014; Sayem, Nury, & Hossain, 2011; Unicef, 2014). Nonetheless, this rate is still unacceptably high and the new target for the Sustainable Development Goal (SDG) No. 3.1 is 70 per 100,000 live births or less by 2030 (Callister & Edwards, 2017; National Institute of Population Research Training - NIPORT, 2020; Research, Training - NIPORT/Bangladesh, Mitra, Associates/Bangladesh, & Macro International, 2009). Room for improvement in the country's maternal mortality ratio lies in the fact that only 49% of all births took place in a health facility in Bangladesh (The DHS Program, 2022a). Although, this is an improvement in the 17%

facility birth rate reported in 2007, it is insufficient to achieve its targets of maternal mortality (Callister & Edwards, 2017; National Institute of Population Research Training - NIPORT, 2020; Research et al., 2009).

Four major stakeholders, - government, private sector, non-governmental organizations (NGOs), and donor organizations, define the structure and operation of Bangladesh's diversified health care system. The Ministry of Health and Family Welfare oversees a dual system of general health and family planning services through district hospitals, Upazila Health Complexes (with 10 to 50 beds) at the sub-district level, Union Health and Family Welfare Centers at the union level, and community clinics at ward level through the Directorates General of Health Services (DGHS) and Family Planning (DGFP) (Organization, 2015a; Rosen, Waitzberg, & Merkur, 2015).

Improving facility delivery by providing proper infrastructure and optimal service preparedness is one of the operational goals of the Government of Bangladesh (Directorate General of Health Services & Ministry of Health and Family Welfare 2019; HNPSP, 2017). The government has increased the number of healthcare facilities and skilled healthcare personnel. According to Alam et al. (2015) from a survey of 64 districts, there were 8.6 facilities providing obstetric care services per 500,000 population, which exceeds the WHO's recommended of 5 facilities per 500,000 population (B. Alam et al., 2015). Alam's sample included both public and private sector facilities. Chowdhury et al., surveying government facilities, found that only three out of 24 districts in Bangladesh met the WHO's criteria of having five BEmOC facilities per 500,000 population. Overall, only 41% of the population (considering 100,000 people per

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facility) had access to a BEmOC facility within a one- hour travel time (Chowdhury, Biswas, Rahman, Pasha, & Hossain, 2017). This indicates that although the number of facilities has increased, they are not fully prepared to provide BEmOC services as recommended by the WHO recommendations.

To increase demand for facility births, the government has launched numerous projects with varying degrees of effectiveness. Although too numerous to list here, some notable examples include the Maternal Health Voucher Scheme (MHVS) program. Launched in 2006, the program offers vouchers to expectant mothers that can be redeemed for obstetric care from qualified public and private sector providers (Nandi et al., 2022). Another example is the Maternal and Newborn Care Strengthening Project (MaMoni). Launched in 2018, MaMoni aims to increase equitable access to high-quality services, particularly for the underprivileged and marginalized groups (Salahuddin Ahmed et al., 2019). Despite all these initiatives, facility birth rates continue to hover around 50%.

The present study therefore aims to assess both facility preparedness and women's level factors influencing facility births in Bangladesh and how the supply and demand interact to ensure safe, facility births. A comprehensive understanding of both facility level and women's level factors and their interaction is essential to developing effective policies and strategies that will promote better access to healthcare and improved maternal health outcomes in Bangladesh.

References

Acharya, K., Subedi, R. K., Dahal, S., & Karkee, R. (2021). Basic emergency obstetric and newborn care service availability and readiness in Nepal: Analysis of the 2015 Nepal Health Facility Survey. *PloS one, 16*(7), e0254561.

Adde, K. S., Dickson, K. S., & Amu, H. (2021). Prevalence and determinants of the place of delivery among reproductive age women in sub–Saharan Africa. *PloS one, 15*(12), e0244875. Retrieved from https://doi.org/10.1371/journal.pone.0244875. doi:10.1371/journal.pone.0244875

Adedokun, S. T., & Uthman, O. A. (2019). Women who have not utilized health Service for Delivery in Nigeria: who are they and where do they live? *BMC Pregnancy and Childbirth, 19*(1), 93. Retrieved from https://doi.org/10.1186/s12884-019-2242-6. doi:10.1186/s12884-019-2242-6

Admasu, K., Haile-Mariam, A., & Bailey, P. (2011). Indicators for availability, utilization, and quality of emergency obstetric care in Ethiopia, 2008. *International Journal of Gynecology and Obstetrics, 115*(1), 101-105. Retrieved from https://www.elsevier.com/locate/ijgo. doi:https://dx.doi.org/10.1016/j.ijgo.2011.07.010

Afsana, K., & Rashid, S. F. (2001). The challenges of meeting rural Bangladeshi women's needs in delivery care. *Reproductive health matters, 9*(18), 79-89.

Agaba, P., Magadi, M., & Orton, B. (2022). Predictors of health facility childbirth among unmarried and married youth in Uganda. *PloS one, 17*(4), e0266657. doi:10.1371/journal.pone.0266657

Ahmed, S., Applegate, J. A., Mitra, D. K., Callaghan-Koru, J. A., Mousumi, M., Khan, A. M., . . . Baqui, A. H. (2019). Implementation research to support Bangladesh Ministry of Health

and Family Welfare to implement its national guidelines for management of infections in

    young infants in two rural districts. *Journal of health, population and nutrition, 38*(1), 41.

    Retrieved from https://doi.org/10.1186/s41043-019-0200-6. doi:10.1186/s41043-019-

    0200-6

Akhter, S., Dasvarma, G. L., & Saikia, U. (2020). Reluctance of women of lower socio-

    economic status to use maternal healthcare services - Does only cost matter? *PloS one,*

    15(9), e0239597. doi:10.1371/journal.pone.0239597

Alam, B., Mridha, M. K., Biswas, T. K., Roy, L., Rahman, M., & Chowdhury, M. E. (2015).

    Coverage of emergency obstetric care and availability of services in public and private

    health facilities in Bangladesh. *International Journal of Gynecology & Obstetrics,*

    131(1), 63-69.

Ali, M., Bhatti, M. A., & Kuroiwa, C. (2008). Challenges in access to and utilization of

    reproductive health care in Pakistan. *Journal of Ayub Medical College, Abbottabad :*

    JAMC, 20(4), 3-7.

Anwar, I., Nababan, H. Y., Mostari, S., Rahman, A., & Khan, J. A. (2015). Trends and inequities

    in use of maternal health care services in Bangladesh, 1991-2011. *PloS one, 10*(3),

    e0120309.

Aremu, O., Lawoko, S., & Dalal, K. (2011). Neighborhood socioeconomic disadvantage,

    individual wealth status and patterns of delivery care utilization in Nigeria: a multilevel

    discrete choice analysis. *IJWH, 3*, 167–174. Retrieved from

    https://www.dovepress.com/neighborhood-socioeconomic-disadvantage-individual-

    wealth-status-and-p-peer-reviewed-fulltext-article-IJWH. doi:10.2147/ijwh.S21783

Asmare, A. A., & Agmas, Y. A. (2022). Determinants of health facility delivery among reproductive age women in low and middle income countries; evidence from most recent demographic health survey: Application of multilevel binary logistic regression model. In: Research Square.

Babineau, J. (2014). Product review: Covidence (systematic review software). *Journal of the Canadian Health Libraries Association/Journal de l'Association des bibliothèques de la santé du Canada, 35*(2), 68-71.

Banstola, A., Simkhada, P., van Teijlingen, E., Bhatta, S., Lama, S., Adhikari, A., & Banstola, A. (2020). The Availability of Emergency Obstetric Care in Birthing Centres in Rural Nepal: A Cross-sectional Survey. *Matern Child Health J, 24*(6), 806-816. doi:https://dx.doi.org/10.1007/s10995-019-02832-2

Barman, B., Roy, A., Zaveri, A., Saha, J., & Chouhan, P. (2020). Determining factors of institutional delivery in India: A study from National Family Health Survey-4 (2015–16). *Clinical Epidemiology and Global Health, 8*(4), 1335-1340. Retrieved from https://doi.org/10.1016/j.cegh.2020.05.007. doi:10.1016/j.cegh.2020.05.007

Bhowmik, J., Biswas, R. K., & Ananna, N. (2020). Women's education and coverage of skilled birth attendance: An assessment of Sustainable Development Goal 3.1 in the South and Southeast Asian Region. *PloS one, 15*(4), e0231489. doi:10.1371/journal.pone.0231489

Biswas, A. B., Das, D. K., Misra, R., Roy, R. N., Ghosh, D., & Mitra, K. (2005). Availability and use of emergency obstetric care services in four districts of West Bengal, India. *Journal of health, population and nutrition, 23*(3), 266-274.

Bulto, G. A., Zewdie, T. A., & Beyen, T. K. (2014). Demand for long acting and permanent

 contraceptive methods and associated factors among married women of reproductive age

 group in Debre Markos Town, North West Ethiopia. *BMC Women's Health, 14*(1), 46.

 Retrieved from https://doi.org/10.1186/1472-6874-14-46. doi:10.1186/1472-6874-14-46

Callister, L. C., & Edwards, J. E. (2017). Sustainable development goals and the ongoing process

 of reducing maternal mortality. *Journal of Obstetric, Gynecologic & Neonatal Nursing,
 46*(3), e56-e64.

Campbell, O. M., Graham, W. J., & group, L. M. S. S. s. (2006). Strategies for reducing maternal

 mortality: getting on with what works. *The Lancet, 368*(9543), 1284-1299.

Campbell, O. M. R., & Graham, W. J. (2006). Strategies for reducing maternal mortality: getting

 on with what works. *The Lancet, 368*(9543), 1284-1299. Retrieved from

 https://doi.org/10.1016/S0140-6736(06)69381-1. doi:10.1016/S0140-6736(06)69381-1

Chaka, E. E. (2020). Examining Individual- and Community-Level Factors Affecting Skilled

 Delivery Care among Women Who Received Adequate Antenatal Care in Ethiopia:

 Using Multilevel Analysis. *Biomed Res Int, 2020*, 2130585. doi:10.1155/2020/2130585

Davies, K. S. (2011). Formulating the evidence based practice question: a review of the

 frameworks. *Evidence Based Library and Information Practice, 6*(2), 75-80.

Directorate General of Health Services, & Ministry of Health and Family Welfare (2019).

 *Ministry of Health and Family Welfare (MOHFW). Bangladesh National Strategy for

 Maternal Health 2019–2030.* Retrieved from

 http://dgnm.portal.gov.bd/sites/default/files/files/dgnm.portal.gov.bd/page/18c15f9c_926

 7_44a7_ad2b_65affc9d43b3/2021-06-24-11-27-

 702ae9eea176d87572b7dbbf566e9262.pdf

Doctor, H. V., Findley, S. E., Ager, A., Cometto, G., Afenyadu, G. Y., Adamu, F., & Green, C. (2012). Using community-based research to shape the design and delivery of maternal health services in Northern Nigeria. *Reproductive health matters, 20*(39), 104-112.

Doctor, H. V., Nkhana-Salimu, S., & Abdulsalam-Anibilowo, M. (2018). Health facility delivery in sub-Saharan Africa: successes, challenges, and implications for the 2030 development agenda. *BMC public health, 18*(1), 1-12.

Dotse-Gborgbortsi, W., Dwomoh, D., Alegana, V., Hill, A., Tatem, A. J., & Wright, J. (2020). The influence of distance and quality on utilisation of birthing services at health facilities in Eastern Region, Ghana. *BMJ global health, 4*(Suppl 5), e002020.

Dotse-Gborgbortsi, W., Tatem, A. J., Alegana, V., Utazi, C. E., Ruktanonchai, C. W., & Wright, J. (2020). Spatial inequalities in skilled attendance at birth in Ghana: a multilevel analysis integrating health facility databases with household survey data. *Tropical medicine & international health : TM & IH, 25*(9), 1044-1054. doi:https://dx.doi.org/10.1111/tmi.13460

Eklund, L. (2016). Preference or Aversion? Exploring Fertility Desires among China's Young Urban Elite. *Intersections: Gender and Sexuality in Asia and the Pacific, July 2016*(39). Retrieved from https://portal.research.lu.se/en/publications/preference-or-aversion-exploring-fertility-desires-among-chinas-y.

El Arifeen, S., Hill, K., Ahsan, K. Z., Jamil, K., Nahar, Q., & Streatfield, P. K. (2014). Maternal mortality in Bangladesh: a Countdown to 2015 country case study. *The Lancet, 384*(9951), 1366-1374. Retrieved from https://doi.org/10.1016/S0140-6736(14)60955-7. doi:10.1016/S0140-6736(14)60955-7

Feigin, V. L., Abajobir, A. A., Abate, K. H., Abd-Allah, F., Abdulle, A. M., Abera, S. F., . . . Aichour, I. (2017). Global, regional, and national burden of neurological disorders during 1990–2015: a systematic analysis for the Global Burden of Disease Study 2015. *The Lancet Neurology, 16*(11), 877-897.

Filippi, V., Chou, D., Ronsmans, C., Graham, W., & Say, L. (2016). Levels and causes of maternal mortality and morbidity. *Disease control priorities, 2*, 51-70.

Gabrysch, S., Cousens, S., Cox, J., & Campbell, O. M. R. (2011). The influence of distance and level of care on delivery place in rural Zambia: a study of linked national data in a geographic information system. *PLoS Med, 8*(1), e1000394. doi:https://dx.doi.org/10.1371/journal.pmed.1000394

Gabrysch, S., Simushi, V., & Campbell, O. M. (2011). Availability and distribution of, and geographic access to emergency obstetric care in Zambia. *International Journal of Gynecology & Obstetrics, 114*(2), 174-179.

Gautam, S., & Jeong, H.-S. (2019). The Role of Women's Autonomy and Experience of Intimate Partner Violence as a Predictor of Maternal Healthcare Service Utilization in Nepal. *International Journal of Environmental Research and Public Health, 16*(5), 895. Retrieved from https://www.mdpi.com/1660-4601/16/5/895.

Goli, S., Rammohan, A., & Moradhvaj. (2018). Out-of-pocket expenditure on maternity care for hospital births in Uttar Pradesh, India. *Health Econ Rev, 8*(1), 5. doi:10.1186/s13561-018-0189-3

HNPSP. (2017). *4th Health Nutrition and Population Sector Program*. Retrieved from Dhaka: https://www.researchgate.net/publication/322750173_Program_Implementation_Report_2017_of_the_4th_Health_Population_and_Nutrition_Sector_Program_4th_HPNSP

Huda, T. M., Chowdhury, M., El Arifeen, S., & Dibley, M. J. (2019). Individual and community level factors associated with health facility delivery: A cross sectional multilevel analysis in Bangladesh. *PloS one, 14*(2), e0211113.

Iftikhar Ul Husnain, M., Rashid, M., & Shakoor, U. (2018). Decision-making for birth location among women in Pakistan: evidence from national survey. *BMC Pregnancy Childbirth, 18*(1), 226. doi:10.1186/s12884-018-1844-8

Islam, A. Z., Mondal, M. N., Khatun, M. L., Rahman, M. M., Islam, M. R., Mostofa, M. G., & Hoque, M. N. (2016). Prevalence and Determinants of Contraceptive use among Employed and Unemployed Women in Bangladesh. *Int J MCH AIDS, 5*(2), 92-102. doi:10.21106/ijma.83

Jain, A. K., Sathar, Z. A., & ul Haque, M. (2015). The constraints of distance and poverty on institutional deliveries in Pakistan: evidence from georeference-linked data. *Stud Fam Plann, 46*(1), 21-39. doi:10.1111/j.1728-4465.2015.00013.x

Kebede, A., Hassen, K., & Nigussie Teklehaymanot, A. (2016). Factors associated with institutional delivery service utilization in Ethiopia. *Int J Womens Health, 8*, 463-475. doi:10.2147/ijwh.S109498

Lawn, J., Cousens, S., Zupan, J., & Team, L. N. S. S. (2005). million deaths: When. *The Lancet Neonatal Survival Series*.

Lawn, J. E., Kinney, M., Lee, A. C., Chopra, M., Donnay, F., Paul, V. K., . . . Darmstadt, G. L. (2009). Reducing intrapartum-related deaths and disability: can the health system deliver? *International Journal of Gynecology & Obstetrics, 107*, S123-S142.

Lee, B. X., Kjaerulf, F., Turner, S., Cohen, L., Donnelly, P. D., Muggah, R., . . . MacGregor, L. S. (2016). Transforming our world: implementing the 2030 agenda through sustainable development goal indicators. *Journal of public health policy, 37*(1), 13-31.

Munn, Z., Aromataris, E., Tufanaru, C., Stern, C., Porritt, K., Farrow, J., . . . Lizarondo, L. (2019). The development of software to support multiple systematic review types: the Joanna Briggs Institute System for the Unified Management, Assessment and Review of Information (JBI SUMARI). *JBI Evidence Implementation, 17*(1), 36-43.

Nandi, A., Charters, T. J., Quamruzzaman, A., Strumpf, E. C., Kaufman, J. S., Heymann, J., . . . Harper, S. (2022). Health care services use, stillbirth, and neonatal and infant survival following implementation of the Maternal Health Voucher Scheme in Bangladesh: A difference-in-differences analysis of Bangladesh Demographic and Health Survey data, 2000 to 2016. *PLoS Med, 19*(8), e1004022.

National Institute of Population Research and Training (NIPORT), & ICF. (2019). *Bangladesh Health Facility Survey 2017*. Retrieved from Dhaka, Bangladesh:

National Institute of Population Research Training - NIPORT, M. o. H. F. W., ICF,. (2020). *Bangladesh Demographic and Health Survey 2017-18*. Retrieved from Dhaka, Bangladesh: https://www.dhsprogram.com/pubs/pdf/FR344/FR344.pdf

National Institute of Population Research Training (NIPORT), & ICF. (2020). *Bangladesh Demographic and Health Survey 2017-18*. Retrieved from Dhaka, Bangladesh, and Rockville, Maryland, USA:

Olsen, O. E., Ndeki, S., & Norheim, O. F. (2005). Availability, distribution and use of emergency obstetric care in northern Tanzania. *Health policy and planning, 20*(3), 167-175.

Olsen, Ø. E., Ndeki, S., & Norheim, O. F. (2005). Availability, distribution and use of emergency obstetric care in northern Tanzania. *Health policy and planning, 20*(3), 167-175.

Organization, W. H. (2013). *Service availability and readiness assessment (SARA): an annual monitoring system for service delivery: reference manual*. Retrieved from

Organization, W. H. (2015a). *Bangladesh health system review*: WHO Regional Office for the Western Pacific.

Organization, W. H. (2015b). Strategies towards ending preventable maternal mortality (EPMM).

Organization, W. H. (2015c). Success factors for women's and children's health: Bangladesh.

Paxton, A., Bailey, P., Lobis, S., & Fry, D. (2006). Global patterns in availability of emergency obstetric care. *International Journal of Gynecology & Obstetrics, 93*(3), 300-307.

Pulok, M. H., Sabah, M. N.-U., Uddin, J., & Enemark, U. (2016). Progress in the utilization of antenatal and delivery care services in Bangladesh: where does the equity gap lie? *BMC Pregnancy and Childbirth, 16*(1), 200. Retrieved from https://doi.org/10.1186/s12884-016-0970-4. doi:10.1186/s12884-016-0970-4

Research, N. I. o. P., Training - NIPORT/Bangladesh, Mitra, Associates/Bangladesh, & Macro International. (2009). *Bangladesh Demographic and Health Survey 2007*. Retrieved from Dhaka, Bangladesh: http://dhsprogram.com/pubs/pdf/FR207/FR207.pdf

Rosen, B., Waitzberg, R., & Merkur, S. (2015). Health Systems in Transition. *Israel: Health system review*.

Rubayet, S., Shahidullah, M., Hossain, A., Corbett, E., Moran, A. C., Mannan, I., . . . Mannan, I. (2012). Newborn survival in Bangladesh: a decade of change and future implications. *Health policy and planning, 27*(suppl_3), iii40-iii56.

Sarker, B. K., Rahman, M., Rahman, T., Hossain, J., Reichenbach, L., & Mitra, D. K. (2016). Reasons for Preference of Home Delivery with Traditional Birth Attendants (TBAs) in Rural Bangladesh: A Qualitative Exploration. *PloS one, 11*(1), e0146161. Retrieved from https://doi.org/10.1371/journal.pone.0146161. doi:10.1371/journal.pone.0146161

Say, L., Chou, D., Gemmill, A., Tunçalp, Ö., Moller, A.-B., Daniels, J., . . . Alkema, L. (2014). Global causes of maternal death: a WHO systematic analysis. *The Lancet Global Health, 2*(6), e323-e333.

Sayem, A. M., Nury, A. T., & Hossain, M. D. (2011). Achieving the millennium development goal for under-five mortality in Bangladesh: current status and lessons for issues and challenges for further improvements. *J Health Popul Nutr, 29*(2), 92-102. doi:10.3329/jhpn.v29i2.7813

Sheffel, A., Karp, C., & Creanga, A. A. (2018). Use of Service Provision Assessments and Service Availability and Readiness Assessments for monitoring quality of maternal and newborn health services in low-income and middle-income countries. *BMJ global health, 3*(6), e001011.

Suleman Hassen, S., Mulatu Teshale, B., & Abate Adulo, L. (2021). Identifying Factors Associated with Barriers in the Number of Antenatal Care Service Visits among Pregnant Women in Rural Parts of Ethiopia. *TheScientificWorldJournal, 2021*, 7146452. Retrieved from http://europepmc.org/abstract/MED/34733121

Tegegne, T. K., Chojenta, C., Getachew, T., Smith, R., & Loxton, D. (2020). Giving birth in
Ethiopia: a spatial and multilevel analysis to determine availability and factors associated
with healthcare facility births. *BJOG : an international journal of obstetrics and
gynaecology, 127*(12), 1537-1546. doi:https://dx.doi.org/10.1111/1471-0528.16275

Tesema, G. A., & Tessema, Z. T. (2021). Pooled prevalence and associated factors of health
facility delivery in East Africa: Mixed-effect logistic regression analysis. *PloS one, 16*(4),
e0250447. doi:10.1371/journal.pone.0250447

The DHS Program. (2022a, 2022/08/05/). Demographic and Health Survey (DHS). Retrieved
from https://dhsprogram.com/Methodology/Survey-Types/DHS.cfm

The DHS Program. (2022b, 2022/08/05/). Service Provision Assessments (SPA). Retrieved from
https://dhsprogram.com/Methodology/Survey-Types/SPA.cfm

Unicef. (2014). *Trends in maternal mortality: 1990 to 2013*: Geneva: World Health
Organization.

UNICEF. (2023). Global delivery care coverage and trends. In.

WHO. (2019). Maternal mortality. *Fact Sheets.* Retrieved from https://www.who.int/news-
room/fact-sheets/detail/maternal-mortality

WHO, U., & UNICEF. (2016). AMDD. Monitoring emergency obstetric care: a handbook.
Geneva: World Health Organization; 2009. In.

Winter, R., Yourkavitch, J., Wang, W., & Mallick, L. (2017). Assessment of health facility
capacity to provide newborn care in Bangladesh, Haiti, Malawi, Senegal, and Tanzania. *J
Glob Health, 7*(2), 020509. doi:10.7189/jogh.07.020509

World Health, O. (2019). *Trends in maternal mortality 2000 to 2017: estimates by WHO,*

  UNICEF, UNFPA, World Bank Group and the United Nations Population Division.

  Geneva: World Health Organization.

World Health Organization, United Nations Populatin Fund, & United Nations Children's Fund.

  (2009). Disability Program (AMDD): Needs Assessment of Emergency Obstetric and

  Newborn Care (EmONC): Facilitator's Guide. *New York: Averting Maternal Death and*

  Disability.

Chapter 2

Methods

2.1 Overview of Bangladesh's Administrative and Health System Structure

2.1.1 Bangladesh's Administrative Structure

Bangladesh is comprised of eight primary administrative divisions, namely Barishal, Chattogram, Dhaka, Khulna, Mymensingh, Rajshahi, Rangpur, and Sylhet.(Government Of Bangladesh (GoB), 2022a). As shown in Figure 2.1.1, These divisions are further sub-divided into districts, referred to as "Zilas," which are in turn comprised of sub-districts and known as "Upazilas." There are 12 metropolitan areas within some of the Zilas and the local governments in these metropolitan areas are referred to as "City Corporation". Upazilas are further divided in urban areas into "Municipalities" and in rural areas into Union Parishads" (Union Councils). The urban regions are comprised of smaller units known as "wards," which are part of both City Corporations and Municipalities. In rural areas, the smallest unit of administration is the village, which is part of the Union Council. These distinctions facilitate the division of the nation into urban and rural sectors (Ehsan, 2021).

2.1.2 Bangladesh's Health System Structure

The health system structure in Bangladesh is comprised of various levels of care, ranging from primary health care facilities to specialized hospitals. Additionally, non-governmental and private sector organizations also play a significant role in providing health services in the country (Ray-Bennett, Corsel, Goswami, & Ghosh, 2019). As shown in Figure 2.1.2, at the primary level, health care is provided through community clinics, union sub-centers, and Upazila health complexes. The secondary level of care is provided by district hospitals. Tertiary care is provided

by specialized hospitals and medical colleges located in major cities. The Ministry of Health and Family Welfare (MoHFW) is responsible for the overall management and development of the health system in Bangladesh, while the Directorate General of Health Services (DGHS) is responsible for implementing policies and programs at the field level. (Wangmo, Sarkar, Islam, Rahman, & Landry, 2021).
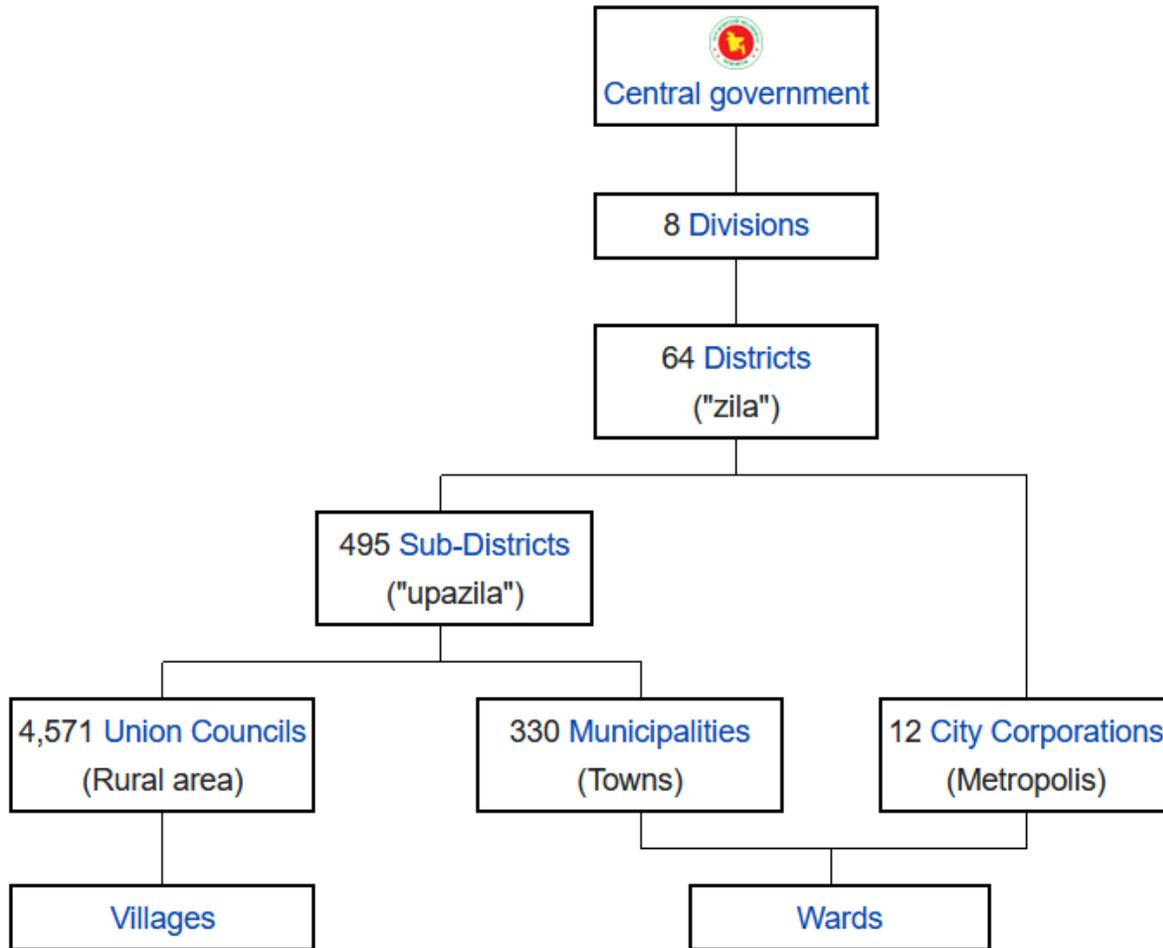
Figure 2.1.1 Administrative Units of Bangladesh [taken from Wikipedia. Administrative geography of Bangladesh (Wikipedia, 2022)].
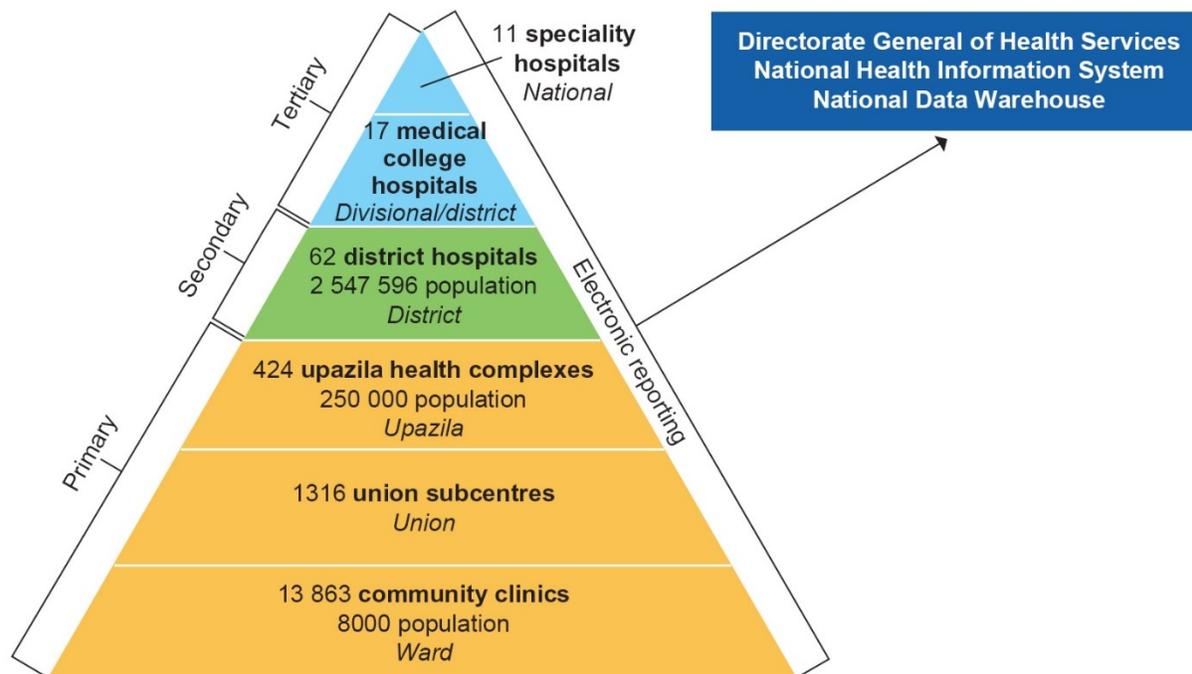
Figure 2.1.2 Health System in Bangladesh [Taken from Bangladesh's public health service delivery structure. Government of Bangladesh (GoB),2021 (Ministry of Health and Family Welfare (MOHFW) [Bangladesh], 2021)].

2.2 Study Setting

In this study, two data sources were utilized, namely the Bangladesh Health Facility Survey (BHFS) conducted during the period of 2017-2018 and the Bangladesh Demographic and Health Survey (BDHS) conducted in 2017. The National Institute of Population Research and Training (NIPORT) carried out these two national-level surveys with funding from the USAID(National Institute of Population Research and Training (NIPORT) & ICF, 2019; National Institute of Population Research Training (NIPORT) & ICF, 2020). The BDHS collected information on demographic and health status of women and children including maternal and child health and service utilization (National Institute of Population Research Training (NIPORT) & ICF, 2020). On the other hand, the BHFS evaluated Bangladesh's

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accredited health care systems. The latter survey gathered information on the accessibility of medical services and capacity of medical facilities to deliver quality services to patients (National Institute of Population Research and Training (NIPORT) & ICF, 2019).

2.3 Study Design and Sample Size

2.3.1 2017-18 Bangladesh Demographic and Health Survey

The BDHS is a national level cross-sectional survey that gathered information on demographics, fertility rates, and trend knowledge and understanding and use of modern contraceptives, maternal and child health, including infant feeding and dietary patterns, newborn care, infant deaths and causes of death, female empowerment, selected noncommunicable diseases (NCDs), and ease of access to health facilities and family planning services at the grassroots level(DHS Program, 2022; National Institute of Population Research Training (NIPORT) & ICF, 2020).

To make the survey findings generalizable at the national level, BDHS survey took advantage of two-stage stratified cluster sampling performed by Bangladesh Bureau of Statistics (BBS) under the guidance of Inner-City Fund (ICF) International. At the first stage, a stratified sample of enumeration areas (EAs) were selected independently with probability proportional to the EA's measure of size. (Bangladesh Bureau of Statistics (BBS), 2011; Cheung, 2014; ICF, 2016; Statistics Canada, 2023). In BDHS, 250 urban and 425 rural EAs were selected at the first stage. In the second stage, all households within each EA were considered as the sampling frame and a systematic sample of 30 households on average was chosen from each EA to obtain statistically accurate estimates. The households chosen within each EA were referred to as a

cluster in the BDHS. In total, approximately 20,250 women from 675 clusters were chosen in the BDHS. Of these, 5,012 women had a childbirth within the last 36 months of the survey and were considered in this study. Further details regarding the survey design, questionnaire and quality control can be found in the BDHS related publications (DHS Program, 2022; National Institute of Population Research Training (NIPORT) & ICF, 2020; The DHS Program, 2022a).

2.3.2 2017 Bangladesh Health Facility Survey

Bangladesh established a vast network of facilities managed by the governmental, non-governmental and private agencies to provide healthcare services to its citizens (World Health Organization. Regional Office for the Western, 2015). The BHFS is a nationally conducted cross-sectional evaluation of Bangladesh's accredited medical facilities that focused on service availability and preparedness of the facilities to provide these services. Priority health services such as reproductive health, specific infectious diseases (TB, sexually transmitted infections), and maternal and child health were covered by the survey. It also assessed the overall facility preparedness including availability of essential amenities and medications, diagnostic facilities, infection control protocol, and adequate human resources (The DHS Program, 2022b).

The MoHFW provided a list of 19,811 registered facilities that made the sampling frame of the BHFS (Ministry of Health and Family Welfare (MOHFW) [Bangladesh], 2016; National Institute of Population Research and Training (NIPORT) & ICF, 2019). In total, a stratified sample of 1,600 facilities were chosen based on the facility type under each administrative division. Of the 1,600 facilities, 5% were not interviewed due to a variety of reasons and were not replaced as there was no suitable replacement for those facilities as per the study protocol. As

a result, only 1,524 facilities out of the 1,600 were surveyed. Among these facilities only 818 facilities provided childbirth services which were considered in this study. Facilities that did not provide childbirth services were excluded from the study. Further details regarding the study design, questionnaire, and quality control can be found in the BHFS related publications (ICF & THE DHS Program, 2022b; National Institute of Population Research and Training (NIPORT) & ICF, 2019; The DHS Program, 2022b). Access to the datasets from BDHS and BHFS were granted by the DHS program (ICF & THE DHS Program, 2021).

2.4 Conceptual Framework

The impact pathway formulated for this thesis was adapted from the conceptual framework for determinants of care seeking by Gabrysch et al. 2009 (Gabrysch & Campbell, 2009). This conceptual framework was originally adapted from the renowned three delays for emergency care-seeking by Haddeus and Maine (Thaddeus & Maine, 1994). As shown in Figure 2.3.1, the factors affecting service utilization were grouped into two key themes: Service Demand and Service Preparedness. This section focuses on the factors related to service demand (Individual Respondent Data) and Section 3.8 focuses on the factors related to service preparedness. Service Demand was further subdivided into the two broad scopes: Access to service environment and socio-cultural factors.
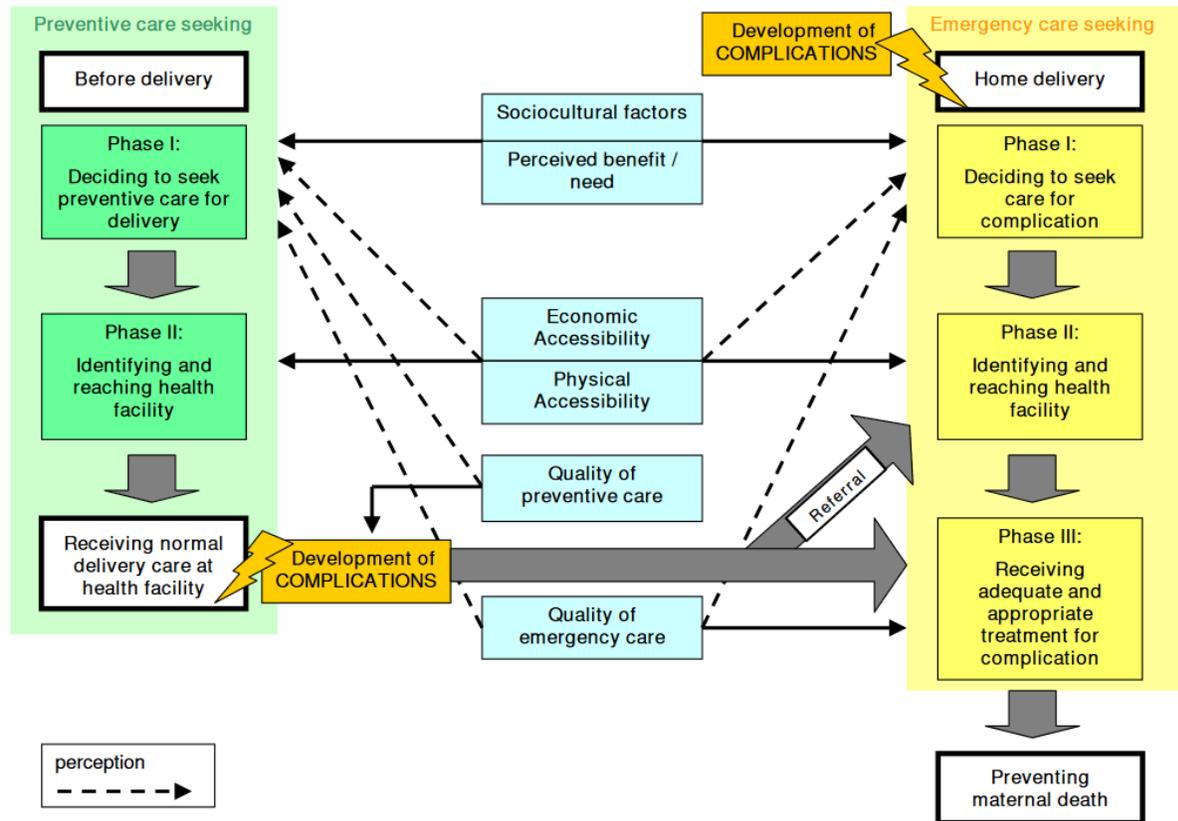
Figure 2.3.1 Delay phases and factors affecting use of delivery care and maternal mortality (Gabrysch & Campbell, 2009)

2.5 Individual Respondent Data

The women questionnaire from BDHS included a wide range of questions that covered varieties of theme such as respondent's background, reproduction history, family planning, antenatal care, and pregnancy. Each of these themes was covered in BDHS by including several sub-questionnaires in an attempt to be as comprehensive as possible (M. A. Bohren et al., 2014; Crissman et al., 2013; Dankwah, Zeng, Feng, Kirychuk, & Farag, 2019; Moyer & Mustafa, 2013). However, only the indicators relevant to the research questions in this study were selected based on the literature review.

2.5.1 Outcome of Interest:

The dependent variable in the study was a binary variable, which represented whether a woman had delivered her most recent child in a health facility or not. The term "health facility" refers to any medical setting such as a hospital, clinic, or health center. The negative outcome was delivery at a non-medical setting which could be a home birth or delivery in any location that is not a medical facility.

2.5.2 Individual Respondent Variables

A comprehensive review of relevant maternal factors was conducted and the relevant variables available from the 2017 Bangladesh Demographic and Health Survey (BDHS) were extracted. (Md Ashfikur Rahman et al., 2021; Reynolds, Wong, & Tucker, 2006; W. Wang & Mallick, 2019; Yaya, Bishwajit, & Ekholuenetale, 2017). The extracted variables are shown in Table 2.5.1. These factors were classified into respondent's background and socio-cultural influence. The extracted maternal variables included the mother's age, age at first birth, religion, and educational level. (Hamal, Dieleman, De Brouwere, & de Cock Buning, 2020; Huda et al., 2019; Navaneetham & Dharmalingam, 2002; Reynolds et al., 2006). While the mother's or family's preferred place of delivery, which were recognized as important socio-cultural factors in the literature, were not included in the 2017 BDHS data. The respondent's age was treated as a continuous variable, while the educational level was categorized based on the BDHS report. As the majority of Bangladeshi women are Muslims, religion was dichotomized into Muslim and Other (comprising of Hindu, Christian, and other religious affiliations).

Individual or cultural belief are related to factors such as desire for pregnancy, birth order, Antenatal care (ANC) service utilization, knowledge of pregnancy complication, and access to media & perceived quality of care (Pervin et al., 2021; Md Ashfikur Rahman et al., 2021; Yaya et al., 2017). The 2017 BDHS data did not include information on the respondent's knowledge of pregnancy complications or their perception of the quality of care in a health facility. In some countries, information on service provision assessment including perceived quality of care was collected as part of the client's exit interview the Health Facility Survey. However, the client's exit interview was not conducted in 2017 BHFS. Information of desire for pregnancy was collected in 2017 BDHS and was considered as a categorical variable which was similar to the categorization in the report on 2017 BDHS (ICF, 2018; The DHS Program, 2022a). ANC service utilization and access to media were also considered as binary variables. If the respondents had access to TV, Newspaper or Radio, they were considered to have access to media and a binary variable was defined to indicate whether the respondents had access to media or not. A categorical variable was defined to indicate the birth order which took the value 1 for the first child, 2 for second child and 3 for fourth or higher. The middle birth order of 2 corresponds to the average number of children per woman in Bangladesh according to 2017 BDHS (The DHS Program, 2022a).

Geographical access to health facility is dependent on the distance to facility and travel time to facility (Hierink, Okiro, Flahault, & Ray, 2021). However, travel time to facility from respondent's resident was not determined as the road network linkage technique required high quality road network and information on seasonal pass-ability and local transportation networks were not available. Another major concern for not using road networks to link the dataset as the

exact position of the clusters was not known because of the use of cluster displacement in 2017 BDHS. (Burgert & Prosnitz, 2014).

The factors related to financial burden in accessing health facility, were identified from the literature review, which included total delivery cost, financial status of the household, employment status of the respondent and respondent's husband (Doctor et al., 2018; Kabir & Biswas, 2018). The delivery cost was categorized into less than or equal to 10,000 taka or greater than 10000 taka. (Rahman, Kabir, Moon, Ame, & Islam, 2021). DHS defines the wealth index as a measurement of a household's standard of living based on assets such as TVs, bikes, housing materials, and access to water and sanitation facilities. The DHS categorized the wealth index score into quintiles with five equal segments, and this study combined the lowest two quintiles to represent poor households, the highest two quintiles to represent rich households, and the middle quintile to represent the average household's financial status (Croft et al., 2019).

Table 2.5.1 Individual Respondent Variables

Variable Name	Variable Type	BDHS Question/ Computed Variable	Options
Respondent Background			
Mother's Age	Continuous	How old were you at your last birthday?	
Area of Residence	Binary	Residence stratified to Urban or Rural based on location	
Religion	Binary	What is your religion?	Islam Others

Education	Categorical	What is the highest level of school you attended: primary, secondary, or higher?	
Socio-Cultural Influences			
Desire for Pregnancy	Categorical	When you got pregnant, did you want to get pregnant at that time?	
Birth Order	Categorical	This variable is calculated by DHS summing up multiple answers from BDHS questionnaire	First Child Had 2-3 Child 4 or More child
ANC Visits	Categorical	How many times did you receive antenatal care during this pregnancy?	0 1-3 4+
Access to Media	Binary	Do you read a newspaper or magazine, listen to the radio or watch television or owns a mobile phone at least once a week, less than once a week or not at all?	No Yes
Financial Access			
Employment Status	Binary	Whether the respondent worked in the last 12 months	Not Employed Employed
Socio-economic Status	Categorical	Calculated based on multiple questions from DHS	Poor Average Rich
Childbirth Cost	Binary	How much did you pay in total for your last delivery?	Less than 10000 tk More than 10000 tk
Geographical Access			
Distance between cluster and facility	Continuous	Computed using spatial analysis	

2.6 Health Service Environment and Measurements

All medical facilities that offer normal delivery services were referred to as health facilities. To address the challenge of data displacement in the study, the analysis of the service environment was conducted by measuring all available facilities within a reasonable distance of the displaced cluster, instead of solely considering the closest facility. This approach provided an estimation of the likely service environment at the actual cluster location. Although it is possible that the service environment where women gave birth may have been different from the surveyed location, or women may have sought better care outside of their service environment (Choulagai et al., 2013; Kinney et al., 2010; Yaffee et al., 2012). It was assumed that the proportion of women who gave birth in healthcare facilities had accessed their service environment for the purpose of this study.

To analyze the combined women and facility dataset, the health service environment concept introduced by Wang et al. was utilized (W. Wang, M. Winner, & C. R. Burgert-Brucker, 2017). This concept links each cluster to multiple facilities within a predefined buffer zone of 5km and 10km for urban and rural areas, respectively, to represent the service environment where women in that cluster can access childbirth services. The number of linked facilities was used to categorize the service environment for each cluster as low, medium, or high, corresponding to 0-2, 3-5, and 6 or more facilities, respectively. A few different variables were included such as average distance to health facility, Childbirth service availability, preparedness of the facility to provide BEmOC services. To maintain the sample size of women in the dataset, facility-level variables were collapsed by taking the mean, median, or count depending on the type of variable, since each woman was linked to one or more facilities. The indicators of basic

emergency obstetric care, and service environment were created using the WHO's service availability and readiness assessment (SARA) and reported by Wang (Organization, 2013; Wenjuan Wang, Michelle Winner, & Clara R. Burgert-Brucker, 2017). All the variables used to compute the service environment and preparedness are listed in Table 2.6.1.

Table 2.6.1 Facility based indicators for service environment and preparedness

Variable Name	Variable Type	BHFS Question/ Computed Variable	Options
Facilities offering Childbirth Services Signal Functions	Binary	Does this facility offer any of the following client services? Normal delivery	Yes No
Parenteral administration of antibiotics	Binary	if any of the following intervention has have ever been carried out in this Facility?	Yes No
Parenteral administration of Oxytocic Drug	Binary		Yes No
Parenteral administration of anticonvulsants	Binary		Yes No
Assisted Vaginal Delivery (AVD)	Binary		Yes No
Manual removal of	Binary		Yes No

placenta			
Manual removal of Retained products	Binary		Yes No
Trained Care Staff			
Presence of Medically trained professional 24/7	Binary	Is a person skilled in conducting deliveries present at the facility today or on call at all times (24 hours a day), including weekends, to provide care?	Yes No
Guideline Availability	Binary	Do you have the national guideline/protocol/manual for BEmOC available in this service site?	Yes No
Training Received	Binary	Have you received any in-service training, training updates or refresher training on Integrated Management of Pregnancy and Childbirth (IMPAC)?	Yes No
Performed under supervision	Binary	Now I would like to ask you some questions about supervision you have personally received. This supervision may have been from a supervisor either in this facility, or from outside the facility. Do you receive technical support or supervision in your work?	Yes No
Equipment Availability			
Emergency Transport	Binary		Yes No

Sterilization of Equipment	Binary	I would like to know if the following items are available in this delivery area and are functioning.	Yes No
Examination Light	Binary		Yes No
Delivery Pack	Binary		Yes No
Suction apparatus	Binary		Yes No
Manual vacuum extractor	Binary		Yes No
Vacuum aspirator or D&C kit	Binary		Yes No
Delivery Bed availability	Binary		Yes No
Partograph	Binary		Yes No
Blood pressure apparatus	Binary		Yes No
Soap and running water OR alcohol based hand rub	Binary		Yes No
Essential Medicine Availability			
Injectable antibiotic	Binary		Yes No
Injectable uterotonic	Binary		Yes

		Please tell me if any of the following medicines or	No
Injectable Magnesium	Binary	items are available at this service site today. I	Yes
sulphate		would like to see them.	No
Skin disinfectant	Binary		Yes
			No
Intravenous solution	Binary		Yes
with infusion set			No

2.7 BEmOC Preparedness Score

For healthcare facilities that have been listed as delivering normal delivery services, BEmOC preparedness score was calculated using the 4 items in the personnel domain, 11 items in the equipment domain and 5 items in the medical domain. Four items in the personnel domain were availability of BEmOC guidelines, employees trained in delivery care, presence of delivery care providers around-the-clock, and staff working under supervision. Eleven items in the equipment domain were delivery packs, suction devices, manual vacuum extractors, vacuum aspirator or D&C kit, delivery bed availability, blank partographs, blood pressure equipment, examination lights, and hand washing stations. Five items in the medication domain were injectable antibiotics, injectable uterotonic, injectable magnesium sulphate, skin disinfectant, and IV solution with infusion set. Within the domain, each item was a binary variable and was considered to have equal weight (Organization, 2013; Wenjuan Wang et al., 2017). The average of these items served as the domain score and the average of the domain scores was defined as the BEmOC preparedness score. After determining the BEmOC preparedness score for each facility, the average BEmOC score of all the facilities in each cluster was obtained and was assigned to the respondents in the cluster.
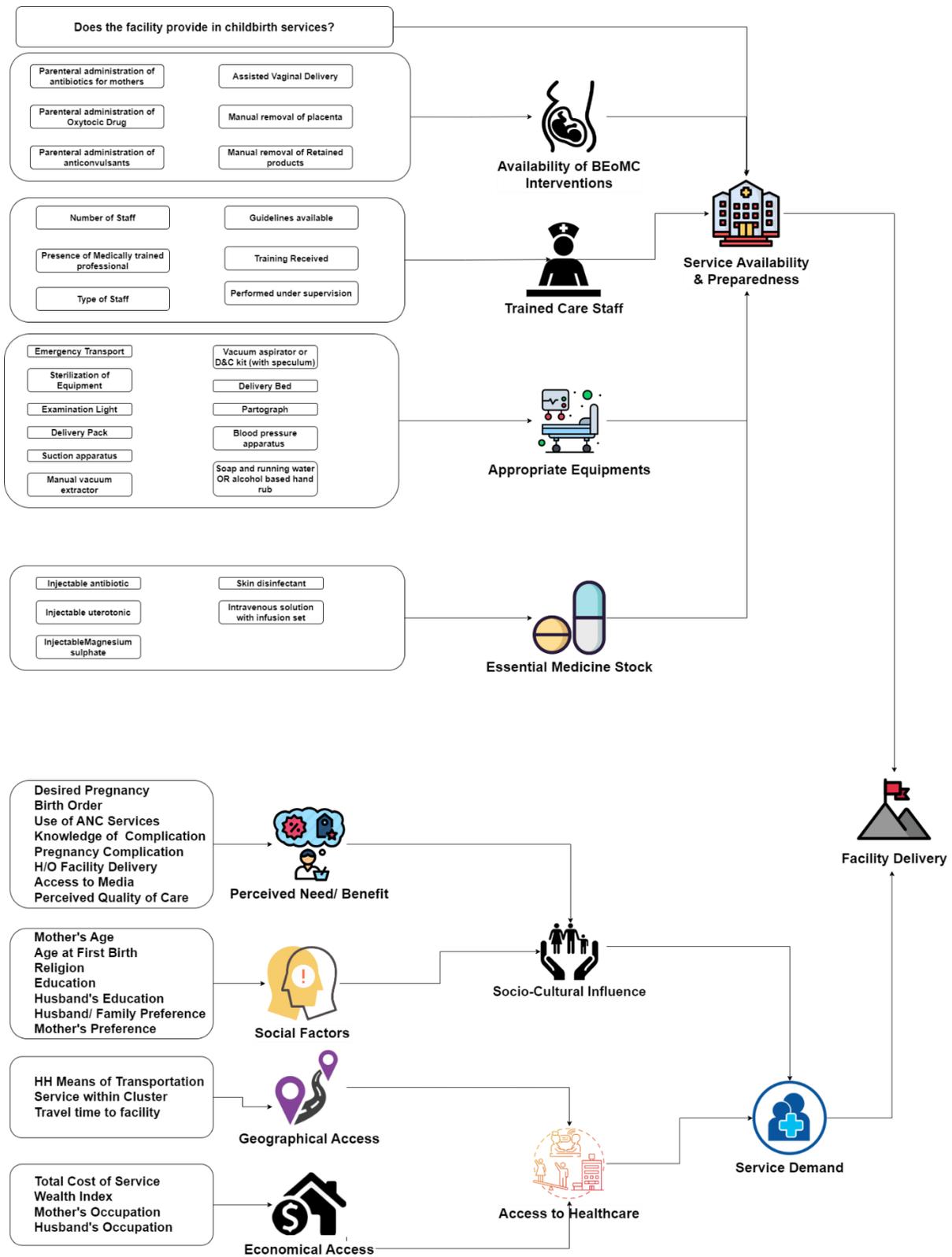
Figure 2.7.1 Conceptual framework for utilization of facility-based delivery Services

2.8 Data Linkage Methods and Data Harmonization

Geographic linking is an effective strategy that leverages the use of existing data since geographically referenced census and healthcare facilities data are becoming more widely available (Skiles, Burgert, Curtis, & Spencer, 2013). However, integrating these sources of data poses significant methodological limitations (Burgert & Prosnitz, 2014; Skiles et al., 2013). Geographic displacement of clusters and representativeness are the two keys methodological concerns in linking the DHS and SPA surveys. Firstly, statistically representative estimates at the lower administrative levels, such as at district levels, are not intended to be provided by the SPA and DHS surveys (ICF & THE DHS Program, 2022b). Therefore, our analysis was focused on first administrative level (Divisions) of Bangladesh. Secondly, due to confidentiality concerns, the exact locations of each DHS cluster were shifted randomly using an algorithm formulated by DHS, prior to providing the data to the researchers (ICF & The DHS Program, 2022a). The DHS cluster displacement refers to the tendency of some households to move from one survey cluster (defined geographic area) to another, resulting in classification error in survey data. DHS tries to minimize this bias with rigorous sampling design. Even with these limitations, it was important to link the datasets to analyze both the individual and facility factors of normal delivery service utilization.

DHS and SPA surveys could be linked using one of four spatial joining methods: sample domain, service environment, estimated surface area, or catchment area linkage (Burgert & Prosnitz, 2014; Colston & Burgert, 2014). Each approach has advantages and disadvantages (HOUSEHOLD, 2014; Skiles et al., 2013; W. Wang & Mallick, 2019). All possible methods for linking DHS and SPA datasets are covered in depth in the Spatial Analysis Reports published by

the DHS program (ICF & THE DHS Program, 2022b; Skiles et al., 2013). This study took

advantage of the service environment linkage, which links a composite SPA score, to the

respondents in the BDHS dataset (ICF & THE DHS Program, 2022b). The administrative

boundary, the Euclidean buffer, and the road network links were the techniques used by the

service environment linkage to reduce methodological flaws with sampled SPA survey facilities.

In the case of a census of health facilities, the Euclidean buffer link is the method of choice.

This study utilized Euclidean Buffer Linking method to merge BDHS and BHFS

datasets. The latitude and longitude coordinates of health facilities and DHS clusters were

collected in both surveys which were used to link the datasets. DHS clusters and health facilities

with missing geographic coordinates were excluded. The administrative polygons of Bangladesh

were obtained from the government website (GeoDASH) of Bangladesh, which have been

utilized by various government and non-government organization (Government Of Bangladesh

(GoB), 2022b). This method links all health facilities within a pre-defined buffer zone from the

cluster centroid without taking administrative boundaries into consideration. Some of the clusters

were not linked to any of the facilities. Other clusters were linked to 1 to 16 facilities. This

method avoids an unnecessary merging of health facilities that can result in loss of information at

the cluster level, which is a shortcoming of the administrative boundary link (Burgert & Prosnitz,

2014; Skiles et al., 2013).

2.9 Statistical Analysis

After linking the datasets, descriptive techniques were used to identify missing data and

check data consistency. All the missing data were examined to find the reasons for the data to be

missing including skip questions or absence of facilities within the buffer zone. After the data cleaning, facility variables were aggregated to the cluster level because facilities and respondents were linked using the cluster centroid. As a result, all facility variables in the final dataset were aggregated from the initial sources using mean or proportion. The association between personal care-seeking behaviors and the facility service environment were initially examined using chi-squared test. The primary explanatory variables of interest from facility data were women access to service environment, and facility preparedness. Service environment was a categorical variable with three categories: low service availability (cluster were linked to 0 to 2 facilities), medium service availability (cluster were linked to 3 to 6 facilities), and high service availability (cluster were linked to 6 or more facilities). This approach to measure service environment was introduced by Wang et al (Wenjuan Wang et al., 2017). The service preparedness score was a complex indicator which was the average of 20 different binary variables across 3 separate domains with each having equal weight. This score will indicate the level of preparedness for each facility. Our list of indicators to measure the service preparedness of the facility is adapted from the SARA reference manual by WHO with a slight modification in the staff and guideline section to include few more critical indicators in the context of Bangladesh (Organization, 2013).

After defining all the variables from our conceptual framework and aggregating the measure to an administrative level, a logistic regression model was fitted to assess the relationship between facility births and respondent's and facility factors. The variables which were significant at p=0.20 in the univariate analysis were considered in the multivariable analysis. STATA version 16 SE was used to conduct all the statistical analyses and python was used for spatial analyses in this study.

2.10 Research Ethics Approval

Ethics approval for the thesis research project was obtained from the University of Alberta Health Research Ethics Board.

References

Bangladesh Bureau of Statistics (BBS). (2011). *Report of the Post Enumeration Check (PEC) of the Population and Housing Census, 2011*. Retrieved from E-17, Agargaon, Sher-e-Bangla Nagar, Dhaka http://203.112.218.65:8008/WebTestApplication/userfiles/Image/LatestReports/PEC%20Report%202011.pdf

Bohren, M. A., Hunter, E. C., Munthe-Kaas, H. M., Souza, J. P., Vogel, J. P., & Gülmezoglu, A. M. (2014). Facilitators and barriers to facility-based delivery in low- and middle-income countries: a qualitative evidence synthesis. *Reproductive Health, 11*(1), 71. Retrieved from https://doi.org/10.1186/1742-4755-11-71. doi:10.1186/1742-4755-11-71

Burgert, C. R., & Prosnitz, D. (2014). *Linking DHS household and SPA facility surveys: Data considerations and geospatial methods*. Retrieved from Rockville, Maryland, USA: http://dhsprogram.com/pubs/pdf/SAR10/SAR10.pdf

Cheung, A. K. L. (2014). Probability Proportional Sampling. In A. C. Michalos (Ed.), *Encyclopedia of Quality of Life and Well-Being Research* (pp. 5069-5071). Dordrecht: Springer Netherlands.

Choulagai, B., Onta, S., Subedi, N., Mehata, S., Bhandari, G. P., Poudyal, A., . . . Krettek, A. (2013). Barriers to using skilled birth attendants' services in mid- and far-western Nepal: a cross-sectional study. *BMC Int Health Hum Rights, 13*, 49. doi:10.1186/1472-698x-13-49

Colston, J. M., & Burgert, C. R. (2014). Using Geospatial Analysis to Inform Decision Making In Targeting Health Facility-Based Programs.

Crissman, H. P., Engmann, C. E., Adanu, R. M., Nimako, D., Crespo, K., & Moyer, C. A. (2013). Shifting norms: pregnant women's perspectives on skilled birth attendance and facility–based delivery in rural Ghana. *African journal of reproductive health, 17*(1), 15-26.

Croft, T., Marshall, A. M., Allen, C. K., Arnold, F., Assaf, S., & Balian, S. (2019). Guide to DHS statistics. 2018. *ICF [Google Scholar]*.

Dankwah, E., Zeng, W., Feng, C., Kirychuk, S., & Farag, M. (2019). The social determinants of health facility delivery in Ghana. *Reproductive Health, 16*(1), 1-10.

DHS Program. (2022, 2022/09/06/). The DHS Questionnaires. Retrieved from https://dhsprogram.com/Methodology/Survey-Types/DHS-Questionnaires.cfm#CP_JUMP_16179

Doctor, H. V., Nkhana-Salimu, S., & Abdulsalam-Anibilowo, M. (2018). Health facility delivery in sub-Saharan Africa: successes, challenges, and implications for the 2030 development agenda. *BMC public health, 18*(1), 1-12.

Ehsan, S. M. A. (2021). The Local Government System in Bangladesh: An Anatomy of Perspectives & Practices. *South Asian Journal of Policy and Governance, 44*, 1-22.

Gabrysch, S., & Campbell, O. M. R. (2009). Still too far to walk: Literature review of the determinants of delivery service use. *BMC Pregnancy and Childbirth, 9*(1), 34. Retrieved from https://doi.org/10.1186/1471-2393-9-34. doi:10.1186/1471-2393-9-34

Government Of Bangladesh (GoB). (2022a). Bangladesh National Portal | People's Republic of Bangladesh. Retrieved from https://bangladesh.gov.bd/index.php

GeoDASH. (2022b). Government Of Bangladesh (GoB) [Mobile application software]. Retrieved from https://geodash.gov.bd

Hamal, M., Dieleman, M., De Brouwere, V., & de Cock Buning, T. (2020). Social determinants of maternal health: a scoping review of factors influencing maternal mortality and maternal health service use in India. *Public Health Reviews, 41*(1), 1-24.

Hierink, F., Okiro, E. A., Flahault, A., & Ray, N. (2021). The winding road to health: A systematic scoping review on the effect of geographical accessibility to health care on infectious diseases in low-and middle-income countries. *PloS one, 16*(1), e0244921.

HOUSEHOLD, L. D. (2014). DHS Spatial Analysis Reports 10. In.

Huda, T. M., Chowdhury, M., El Arifeen, S., & Dibley, M. J. (2019). Individual and community level factors associated with health facility delivery: A cross sectional multilevel analysis in Bangladesh. *PloS one, 14*(2), e0211113.

ICF. (2016). ICF implements the DHS program. Retrieved from https://www.icf.com/clients/health/demographic-health-surveys-technical-assistance

ICF. (2018). *Demographic and Health Surveys Standard Recode Manual for DHS7*. Retrieved from Rockville, Maryland, U.S.A.: ICF: https://www.dhsprogram.com/pubs/pdf/DHSG4/Recode7_DHS_10Sep2018_DHSG4.pdf

ICF, & THE DHS Program. (2021). The DHS Program - Request Access To Datasets. Retrieved from https://dhsprogram.com/data/new-user-registration.cfm

ICF, & The DHS Program. (2022a, 2022/08/06/). The DHS Program - GPS Data Collection. Retrieved from https://dhsprogram.com/methodology/gps-data-collection.cfm

ICF, & THE DHS Program. (2022b). The DHS Program - SPA Methodology. In.

Kabir, E., & Biswas, R. K. (2018). *Does income inequality matters for accessing health facility? Evidence from Bangladesh.* Paper presented at the Proceedings of the Melbourne International Business and Social Science Research Conference 2018.

Kinney, M. V., Kerber, K. J., Black, R. E., Cohen, B., Nkrumah, F., Coovadia, H., . . .

Weissman, E. (2010). Sub-Saharan Africa's mothers, newborns, and children: where and

why do they die? *PLoS Med, 7*(6), e1000294. doi:10.1371/journal.pmed.1000294

Ministry of Health and Family Welfare (MOHFW) [Bangladesh]. (2016). *Bangladesh National*

Health Accounts 1997-2015. Retrieved from Dhaka, Bangladesh:

Bangladesh's public health service delivery structure. (2021). Ministry of Health and Family

Welfare (MOHFW) [Bangladesh] [Mobile application software]. Retrieved from

https://www.who-seajph.org/viewimage.asp?img=WHOSouth-

EastAsiaJPublicHealth_2021_10_3_93_309884_f1.jpg

Moyer, C. A., & Mustafa, A. (2013). Drivers and deterrents of facility delivery in sub-Saharan

Africa: a systematic review. *Reproductive Health, 10*(1), 1-14.

National Institute of Population Research and Training (NIPORT), & ICF. (2019). *Bangladesh*

Health Facility Survey 2017. Retrieved from Dhaka, Bangladesh:

National Institute of Population Research Training (NIPORT), & ICF. (2020). *Bangladesh*

Demographic and Health Survey 2017-18. Retrieved from Dhaka, Bangladesh, and

Rockville, Maryland, USA:

Navaneetham, K., & Dharmalingam, A. (2002). Utilization of maternal health care services in

Southern India. *Social science & medicine, 55*(10), 1849-1869.

Organization, W. H. (2013). *Service availability and readiness assessment (SARA): an annual*

monitoring system for service delivery: reference manual. Retrieved from

Pervin, J., Venkateswaran, M., Nu, U. T., Rahman, M., O'Donnell, B. F., Friberg, I. K., . . .

Frøen, J. F. (2021). Determinants of utilization of antenatal and delivery care at the

community level in rural Bangladesh. *PloS one, 16*(9), e0257782.

Rahman, M., Kabir, M., Moon, M., Ame, A., & Islam, M. (2021). *Gender role on food security and consumption practices in Bangladesh.*

Rahman, M. A., Rahman, M. A., Rawal, L. B., Paudel, M., Howlader, M. H., Khan, B., . . . Rahman, M. S. (2021). Factors influencing place of delivery: Evidence from three south-Asian countries. *PloS one, 16*(4), e0250012.

Ray-Bennett, N. S., Corsel, D. M. J., Goswami, N., & Ghosh, A. (2019). Understanding reproductive health challenges during a flood: insights from Belkuchi Upazila, Bangladesh. *Gates Open Research, 3*(788), 788. Retrieved from https://gatesopenresearch.org/articles/3-788/v2. doi:10.12688/gatesopenres.12920.2

Reynolds, H. W., Wong, E. L., & Tucker, H. (2006). Adolescents' use of maternal and child health services in developing countries. *International family planning perspectives*, 6-16.

Skiles, M. P., Burgert, C. R., Curtis, S. L., & Spencer, J. (2013). Geographically linking population and facility surveys: methodological considerations. *Population health metrics, 11*(1), 1-13.

Statistics Canada. (2023). Probability Sampling Retrieved from https://www150.statcan.gc.ca/n1/edu/power-pouvoir/ch13/prob/5214899-eng.htm

Thaddeus, S., & Maine, D. (1994). Too far to walk: maternal mortality in context. *Social science & medicine, 38*(8), 1091-1110.

The DHS Program. (2022a, 2022/08/05/). Demographic and Health Survey (DHS). Retrieved from https://dhsprogram.com/Methodology/Survey-Types/DHS.cfm

The DHS Program. (2022b, 2022/08/05/). Service Provision Assessments (SPA). Retrieved from https://dhsprogram.com/Methodology/Survey-Types/SPA.cfm

Wang, W., & Mallick, L. (2019). Understanding the relationship between family planning method choices and modern contraceptive use: an analysis of geographically linked population and health facilities data in Haiti. *BMJ global health, 4*(Suppl 5), e000765.

Wang, W., Winner, M., & Burgert-Brucker, C. R. (2017). Limited Service Availability, Readiness, and Use of Facility-Based Delivery Care in Haiti: A Study Linking Health Facility Data and Population Data. *Glob Health Sci Pract, 5*(2), 244-260. doi:10.9745/ghsp-d-16-00311

Wang, W., Winner, M., & Burgert-Brucker, C. R. (2017). Limited Service Availability, Readiness, and Use of Facility-Based Delivery Care in Haiti: A Study Linking Health Facility Data and Population Data. *Global Health: Science and Practice, 5*(2), 244. Retrieved from http://www.ghspjournal.org/content/5/2/244.abstract. doi:10.9745/GHSP-D-16-00311

Wangmo, S., Sarkar, S., Islam, T., Rahman, M., & Landry, M. (2021). Maintaining essential health services during the pandemic in Bangladesh: the role of primary health care supported by routine health information system. *WHO South-East Asia Journal of Public Health, 10*(3), 93-99. Retrieved from http://www.who-seajph.org/article.asp?issn=2224-3151;year=2021;volume=10;issue=3;spage=93;epage=99;aulast=Wangmo. doi:10.4103/2224-3151.309884

Wikipedia. (2022, 2022/07/06/). Administrative geography of Bangladesh. Retrieved from https://en.wikipedia.org/w/index.php?title=Administrative_geography_of_Bangladesh&oldid=1096724142

World Health Organization. Regional Office for the Western, P. (2015). *Bangladesh health system review* (Vol. 5). Manila: WHO Regional Office for the Western Pacific.

Yaffee, A. Q., Whiteside, L. K., Oteng, R. A., Carter, P. M., Donkor, P., Rominski, S. D., . . . Cunningham, R. M. (2012). Bypassing proximal health care facilities for acute care: a survey of patients in a Ghanaian Accident and Emergency Centre. *Trop Med Int Health, 17*(6), 775-781. doi:10.1111/j.1365-3156.2012.02984.x

Yaya, S., Bishwajit, G., & Ekholuenetale, M. (2017). Factors associated with the utilization of institutional delivery services in Bangladesh. *PloS one, 12*(2), e0171573.

Chapter 3

Results

3.1 Women's socio-economic characteristics by facility birth

The distribution of women's characteristics by facility birth is shown in Table 3.1.1 and Table 3.2.1. Of the 5,012 women, 50.28% delivered at a healthcare facility. The mean age of the participants was 24.86 years. The mean age of women who delivered at a healthcare facility was significantly lower that observed for women who delivered elsewhere (24.67 vs. 25.05 years, p=0.001). The majority of the women (63.5%) who lived in the urban areas had the childbirth in a health facility whereas only 44.9% of rural women opted for childbirth in a health facility with the differences being statistically significant (p < 0.001). The majority of the participants were Muslims (91.8%) and the rest were mainly Hindus and Christians. However, facility childbirth was less common among Muslim (51.1%) women in comparison to women of other religions (51.1% vs. 60.9%, p=0.003). The proportion of childbirth in a health facility increased with the level of education completed by the women. Among the women without education, only 26.6% delivered in facility provided childbirth services, whereas 78.5% of those who completed higher studies gave birth in a health facility. The overall difference in the proportion in delivering in a health childbirth significantly varied between the levels of education (p <0.001). The childbirth in health facilities varied significantly between unemployed and employed women (55.4% vs. 41.3%; p<0.001). A statistically significant association was found in the proportion of childbirth in a health facility between the levels of socio-economic status (p<0.001). Compared to women from affluent households, women from poorer households had childbirth in facilities less often (69.1% vs. 31.8%).

Table 3.1.1 Women's Demographic and Socio-Economic Characteristics by Facility birth*

Background Characteristics	Distribution of characteristics [mean (± SD) or %]	Facility birth		p-value
		Health Facility (mean or %)	Other (mean or %)	
Age (years)	24.86 (5.56)	24.82 (5.48)	25.05 (5.65)	0.172
Area of Residence				
Urban	26.9	63.5	36.5	0.001
Rural	73.2	44.9	55.2	
Religion				
Muslim	91.8	51.1	48.9	0.003
Other	8.2	60.9	39.1	
Education				
No Education	6.3	26.6	73.4	
Primary	27.6	32.2	67.8	0.001
Secondary	49.0	52.8	47.2	
Higher	17.1	78.5	21.5	
Employment Status				
Not Employed	60.7	55.4	44.6	0.001
Employed	39.3	41.3	58.7	
Socio-economic Status				
Poor	41.1	31.8	68.2	
Average	19.2	48.8	51.2	0.001
Rich	39.7	69.1	30.9	

3.2 Distribution of obstetric characteristics of participants by facility birth

Age at first birth for participants ranged from 13 to 39 years and the mean age at first birth was 18.5 years (standard deviation: 3.2 years). As shown in Table 3.2, 79.7% of the women had the first childbirth before the age of 20 years. Women with four or more children was less likely to deliver at a health facility in comparison to those who delivered for the first time (26.9% vs. 60.9%, $p < 0.001$). Women with four or more ANC visits during the pregnancy period had the highest proportion of health facility utilization for childbirth (65.6%) and was followed by those who had one to three ANC visits (40.2%) and no ANC visits (12.7%) with the differences being statistically significant ($p < 0.001$). Women whose last pregnancy was desired were more likely to seek institutional childbirth than those who did not (52.2% vs. 31.1%). Participants who spent less than 10000 taka (25.7%) for childbirth were less likely to have childbirth at a healthcare facility compared to those who spent more than 10000 taka (98.7%). As shown in Table 3.2.1, the cost of childbirth exceeded 10,000 taka 98.7% of the time when the childbirth occurred in a health facility.

Table 3.2.1 Distribution of women's obstetric characteristics by the facility birth*

Background Characteristics	Relative Proportion (%)	Facility birth		p-value
		Health Facility (%)	Other (%)	
Age At First Birth				
<20	79.7	45.4	54.6	
20-34	20.1	32.8	67.2	0.095
35-49	0.2	22.99	77.01	
Birth Order				
First Child	38.2	60.9	39.1	
Had 2-3 Child	49.6	47.1	52.9	0.001
4 or More child	12.2	26.9	73.1	
ANC Visits				
0	8.0	12.7	87.3	
1-3	45	40.2	59.8	0.001
4+	47	65.5	34.5	
Desire for pregnancy				
Desired	79.1	52.2	47.8	
Desired later	12.9	46.9	53.1	0.001
Didn't Desire	8	31.1	68.9	
Childbirth Cost				
Less than 10000 tk	67.1	25.7	75.3	0.001
More than 10000 tk	32.9	98.7	1.3	

* Total number of women participants = 5,012

3.3 Factors associated with facility birth

Table 3.3.1 shows the association between various women's characteristics and facility childbirth from the univariate and multivariable logistic regression analyses. In the univariate logistic regression analysis, a significant association was observed between facility birth and all the characteristics of participants except for age. In the multivariable logistic regression, after adjusting other factors, there was a 3% significant increase in the odds of facility childbirth for a unit increase in age (adjusted odds ratio (AOR): 1.03, 95% CI: 1.002 – 1.05). Rural women were significantly less likely to utilize the facility service for childbirth in comparison to urban women (AOR: 0.62, 95% CI: 0.49 – 0.79). Women who completed their secondary school education were 62% more likely to utilize facility childbirth services in comparison to women with no formal education (AOR: 1.62, 95% CI: 1.02 – 2.59). Those who completed their higher education had almost two times the odds of availing facility-based childbirth in comparison to women with no formal education (AOR: 2.04, 95% CI: 1.23 – 3.37). Muslim women were 42% less likely to deliver in a facility compared to women of other religions (AOR: 0.58, 95% CI: 0.40 – 0.85). Women who had one to three ANC visits during pregnancy were 2.94 times more likely to opt for facility childbirth compared to women who did not have any ANC visits (AOR: 2.94, 95% CI: 1.82 – 4.75) after adjusting for other factors. The odds of facility childbirth utilization were approximately five times greater when the women had four or more ANC visits in comparison to those who had no ANC visits (AOR: 5.11, 95% CI: 3.12 – 8.34) after controlling for other variables. Women who had access to media were significantly more likely to have the childbirth in a health facility than those who did not have any access to media (AOR: 1.25, 95% CI: 1.01 – 1.56). Employed women were 19% significantly less likely to deliver at a

facility compared to unemployed women (AOR: 0.81, 95% CI: 0.67 – 0.97). In comparison to
the women from poorer households, women from affluent ad middle income households were
significantly more likely to utilize facility childbirth services. Childbirth cost was significantly
associated with childbirth at a health facility. Significant association was observed between birth
order and childbirth at a health childbirth (p<0.001). When the birth order of the last childbirth
was four or more, women were less likely to deliver at a health facility in comparison to those
whose last childbirth was the first one. (AOR: 0.45, 95% CI: 0.29 – 0.71).

Table 3.3.1 Factors associated with the facility birth

Determinant	Univariate Model		Final model	
	OR (95% CI)	P-value	AOR (95% CI)	P-value
Age	0.98 (0.977 -0.998)	0.2	1.03 (1.002 – 1.05)	0.036
Type of Residence				
Urban	1		1	
Rural	0.47 (0.39 – 0.56)	0.001	0.62 (0.49 – 0.79)	0.001
Education				
No Education	1		1	
Primary	1.31 (0.96 – 1.7)	0.089	1.08 (0.66 – 1.78)	0.77
Secondary	3.09 (2.29 – 4.15)	0.001	1.62 (1.02 – 2.59)	0.042
Higher	10.08 (7.26 – 13.99)	0.001	2.04 (1.23 – 3.37)	0.006
Religion				
Other	1		1	
Islam	0.61 (0.44 – 0.85)	0.004	0.58 (0.4 – 0.85)	0.005
Marital Status				

Unmarried/ Other	1			
Married	1.45 (0.83 – 2.52)	0.187		
Age At First Birth				
<20	1			
20-34	2.46 (2.09 – 2.88)	0.001		
35-49	4.02 (0.47 – 34.61)	0.204		
ANC Visits				
0	1		1	
1-3	4.61 (3.2 – 6.64)	0.001	2.94 (1.82 – 4.75)	0.001
4+	13.04 (8.9 – 19.1)	0.001	5.11 (3.12 – 8.34)	0.001
Access to Media				
No	1		1	
Yes	3.05 (2.57 – 3.61)	0.001	1.25 (1.01 – 1.56)	0.044
Owns Mobile				
No	1			
Yes	2.1 (1.8 – 2.4)	0.001		
Employment Status				
Not Employed	1		1	
Employed	0.56 (0.49 – 0.66)	0.001	0.81 (0.67 – 0.97)	0.025
Socio-economic Status				
Poor	1		1	
Average	2.04 (1.68 – 2.48)	0.001	1.2 (0.93 – 1.55)	0.16
Rich	4.78 (4.04 – 5.65)	0.001	1.6 (1.24 – 2.06)	0.001

Childbirth Cost					
Less than 10000 tk	1		1		
More than 10000tk	221.25 (134.39 – 364.23)	0.001	169.32 (101.25 - 283.16)	0.001	
Birth Order					
First Child	1		1		
Had 2-3 Child	0.57 (0.49 – 0.66)	0.001	0.57 (0.44 – 0.73)	0.001	
4 or More child	0.24 (0.17 – 0.3)	0.001	0.45 (0.29 – 0.71)	0.001	
Desire last pregnancy					
Desired	1				
Desired later	0.81 (0.67 – 0.97)	0.023			
Didn't Desire	0.41 (0.32 – 0.53)	0.001			

3.4 Distribution of facility characteristics by urban and rural area

Table 3.4.1 presents the distribution of facility characteristics in both urban and rural areas. The table provides the percentage breakdown of each characteristic and highlights the significance of the differences observed between urban and rural facilities, as determined by the p-value. The number of facilities in rural and urban areas were 496 and 322, respectively. The characteristics included in the table are facility management type, services provided, and specific interventions offered by facility.

As shown in Table 3.4.1, of the 818 facilities, (83.37%) are government-managed, with a higher proportion of rural facilities falling into this category (94.56%) compared to urban

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facilities (66.15%). These differences in facility management between urban and rural areas are statistically significant.

In terms of services provided, as shown in Table 3.4.1, a greater proportion of facilities offered some interventions (75.43%) compared to Comprehensive Emergency Obstetric Care (CEmOC) services (13.45%) and Basic Emergency Obstetric Care (BEmOC) services (11.12%). The distribution of services provided was significantly different between urban and rural areas, with facilities in urban areas providing a higher percentage of CEmOC services (32.30%) and BEmOC services (17.08%). In contrast, in rural areas, only 1.21% and 7.26% of the facilities provided CEmOC services BEmOC services, respectively.

As shown in Table 3.4.1, provision of parenteral antibiotics, uterotonic drugs, and manual removal of placenta varied significantly between the facilities in urban and rural areas, with facilities in urban areas offering a greater percentage of these interventions. For instance, 91.25% of the facilities in urban areas provided parental antibiotics, whereas only 43.18% of the facilities in rural areas provided the same service. Finally, the provision of other interventions, such as parenteral anticonvulsants, removal of retained products, and assisted vaginal childbirth, also differed significantly between the facilities in urban and rural areas with the majority of the facilities providing these services being located in urban area.

Table 3.4.1 Distribution of facility characteristics by urban and rural areas*

	Proportion (%)	Urban (%)	Rural (%)	P-Value
Facility Management Type				
Government	83.37	66.15	94.56	0.001
Private	16.63	33.85	5.44	0.001
Facilities Providing				
Complete set of CEmOC Services	13.45	32.30	1.21	0.001
Complete set of BEmOC Services	11.12	17.08	7.26	0.001
Some childbirth care	75.43	50.62	91.53	0.001
Childbirth care signal functions				
Parental Antibiotics				
Yes	62.15	91.25	43.18	0.001
No	37.85	8.75	56.82	0.001
Uterotonic Drugs				
Yes	74.29	95.63	60.45	0.001
No	25.71	4.38	39.55	0.001
Parenteral Anticonvulsants				
Yes	41.12	72.29	21.18	0.001
No	58.88	27.71	78.82	0.001
Manual removal of placenta				

Yes	80.12	92.52	72.06	0.001
No	19.88	7.48	27.94	0.001
Remove retained products				
Yes	60.12	80.31	46.94	0.001
No	39.88	19.69	53.06	0.001
Perform assisted vaginal childbirth				
Yes	60.44	75.31	50.81	0.001
No	39.56	24.69	49.19	0.001

* Total number of facilities: rural area = 496, urban area = 322.

Figure 3.4.1 introduces the administrative divisions using choropleth map highlighting divisional boundaries. All the 818 facilities providing childbirth services were plotted on the map with each facility being denoted by a circle in the figure. Moreover, these circles (facilities) were labeled using color codes with gray color representing the facilities managed by the government and green color representing the privately managed facilities.
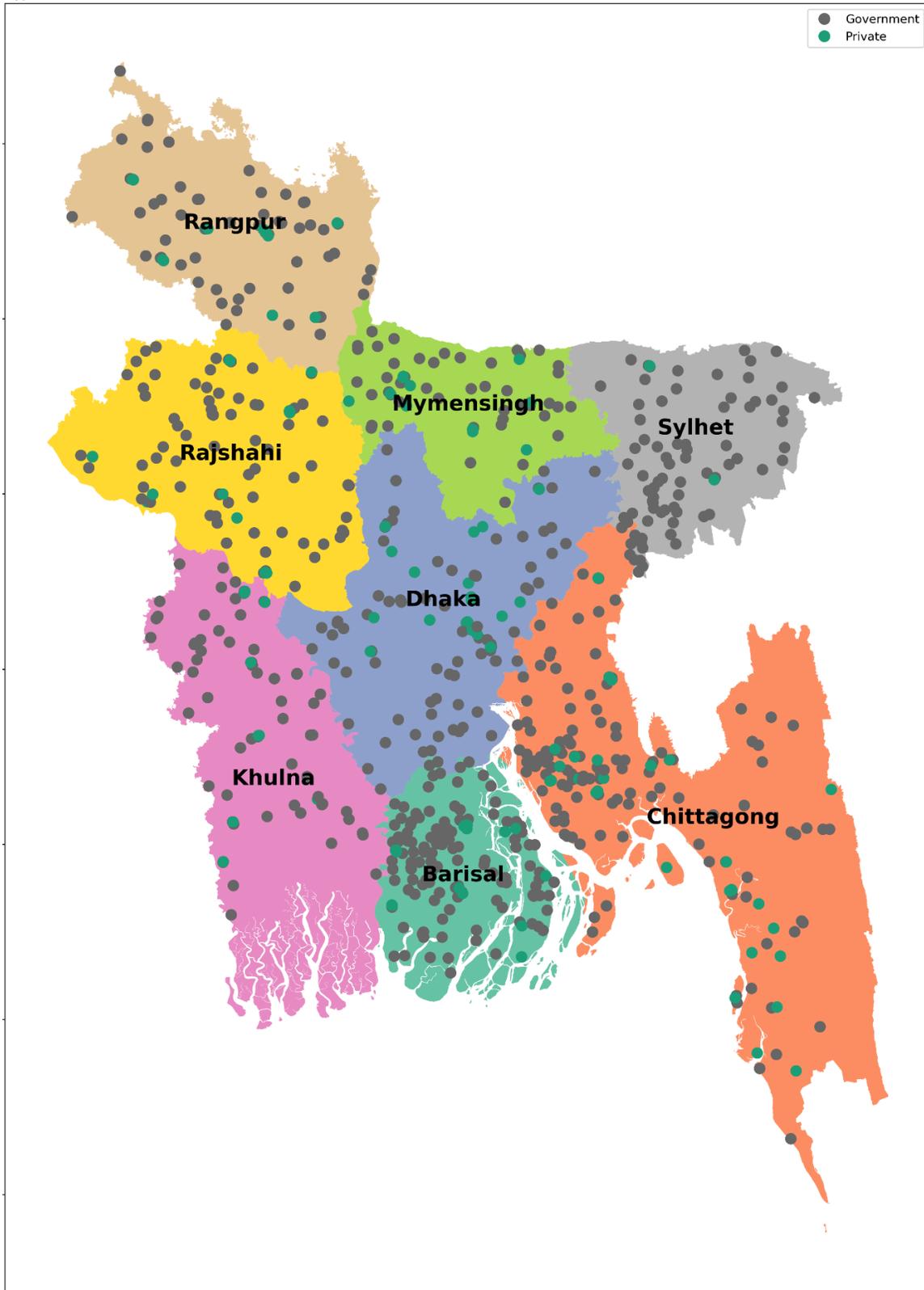
Figure 3.4.1 Distribution of facility by management type across all the divisions of Bangladesh

3.5 BEmOC preparedness score of facilities by urban and rural area

This section focuses on the facility's capability to offer BEmOC services. A facility's readiness to deliver BEmOC services was measured using a BEmOC preparedness score. This was a multifaceted metric derived from various variables across three distinct domains, environment of skilled staff, equipment, and medicine. The box and whisker plot (Figure 3.5.1) displays the distribution of BEmOC preparedness scores for rural and urban areas. The median score for health facilities in the rural area was 40 (range: 9 to 88) and in the urban area was 70 (range: 30 to 100). The plot shows the presence of outliers in both areas. The differences in median facility preparedness score between rural and urban areas were statistically significant (p=0.001). Overall, the mean preparedness score is approximately 53 ($\pm$ 22) out of 100.
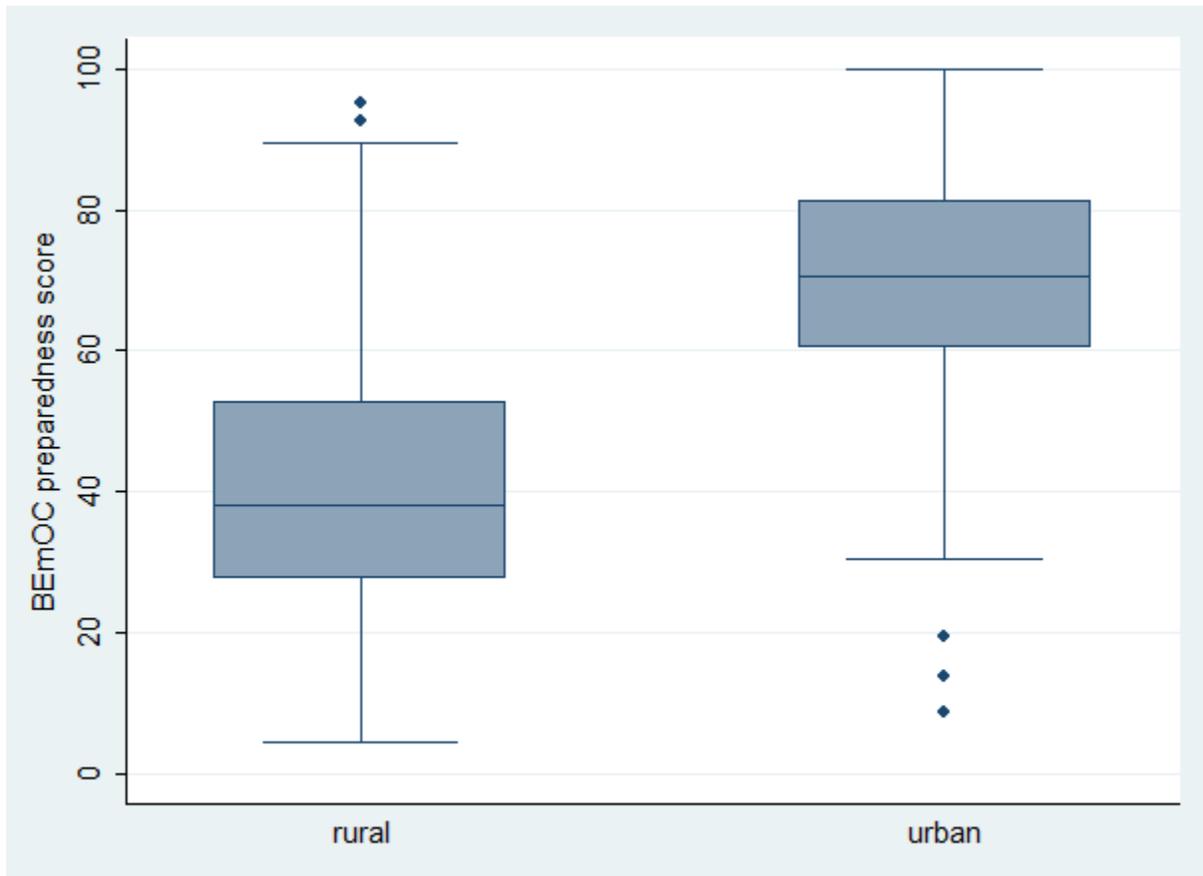

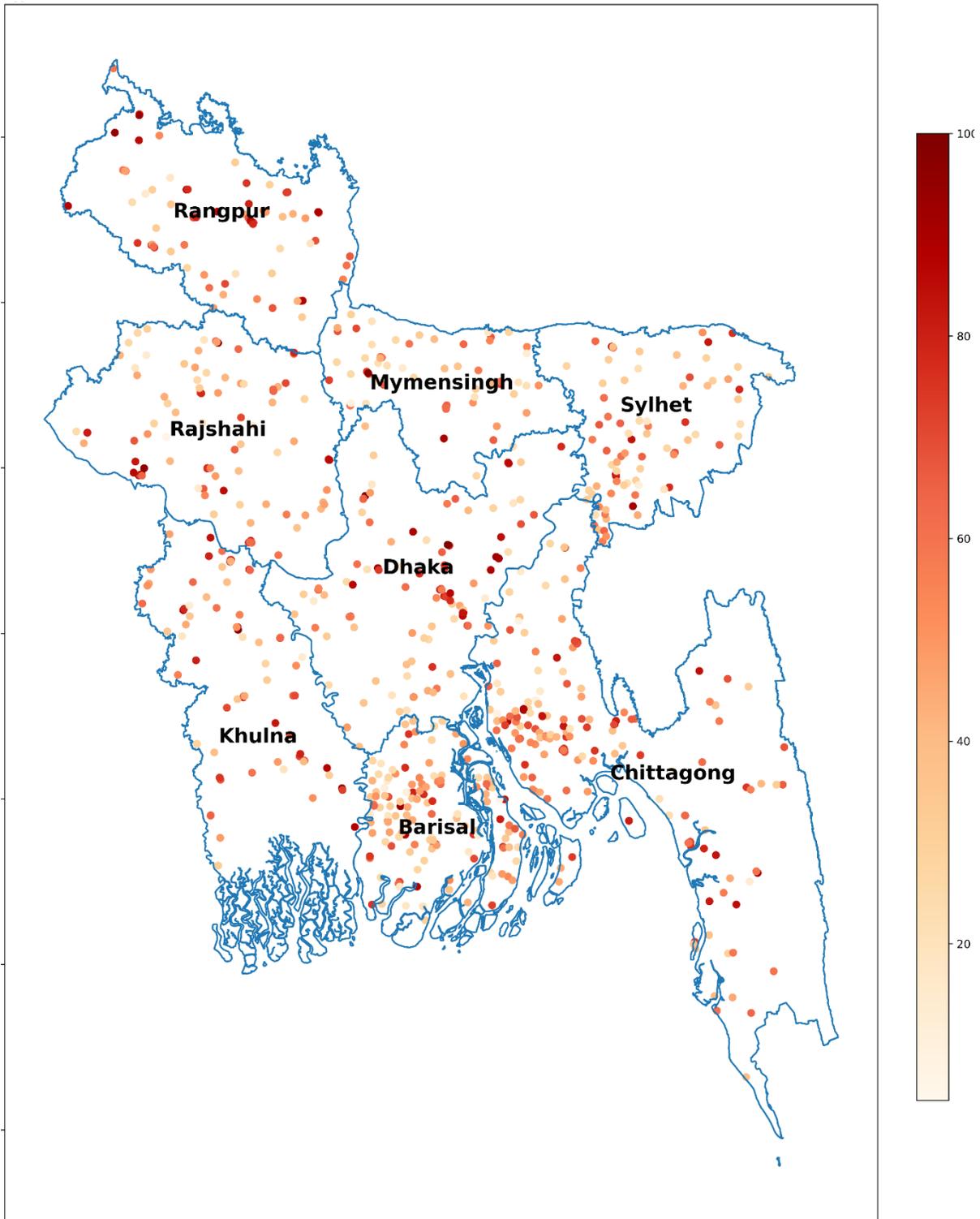Figure 3.5.1 Distribution of BEmOC preparedness score by urban and rural area

Figure 3.5.2 Distribution of BEmOC preparedness score in facilities across division

Figure 3.5.2 displays a choropleth map of Bangladesh, which illustrates the distribution of 818 facilities across all divisions of the country. The map employs a color gradient that corresponds to 0 to 100 scale representing the BEmOC preparedness score of each facility. Facilities with higher BEmOC preparedness scores are indicated by a darker shade of red, while those with lower scores are represented by a lighter shade of red.

3.6 Distribution of Childbirth Service Environment by Division

Figure 3.6.1 presents a stacked bar graph that shows the accessibility of women to different levels of service environment across the eight divisions of Bangladesh. The study tried to minimize misclassification error due to cluster displacement by analyzing the service environment through measuring all available facilities within a reasonable distance of the displaced cluster instead of finding the nearest facility. The health service environment concept was employed to analyze the linked dataset of women and facilities. This concept links each cluster to multiple facilities within a predefined buffer zone of 5 km and 10 km for urban and rural areas, respectively. The service environment for each cluster was categorized based on the number of linked facilities and was used to represent the service environment where women can access childbirth services.

As shown in Figure 3.6.1, except for Barisal, a significant proportion of women in all divisions resided in clusters where the childbirth service environment was inadequate. Barisal is a partial exception, with about one-third of women having access to each level of service environment. Khulna had the highest percentage of women, 82%, living in clusters with low service environment, among all the divisions.

3.7 Women's Geographic accessibility to Childbirth Facility

A facility within 5km and 10 km distance from the centroid of the urban and rural clusters was identified and was assumed to be the facility that women in the clusters would have chosen for their childbirth. Of the 672 clusters, no facilities were linked with 164 clusters in the predefined buffer zone and women residing in these clusters were excluded from the results reported in this section except for the results for the childbirth service score which was assumed to be 0 for the clusters without a facility being identified. The mean distance to the facility varied between these two groups. Women who did not deliver at a facility lived approximately 6.1 km away, on average, from a facility. Whereas women who delivered at a facility lived 5.4 km away, on average from a facility. The number if clusters that were linked with one or more facilities were 332 and 176 in the rural and urban areas, respectively. This resulted in 3287 women in rural areas and 1725 women in the urban areas in the service environment dataset.
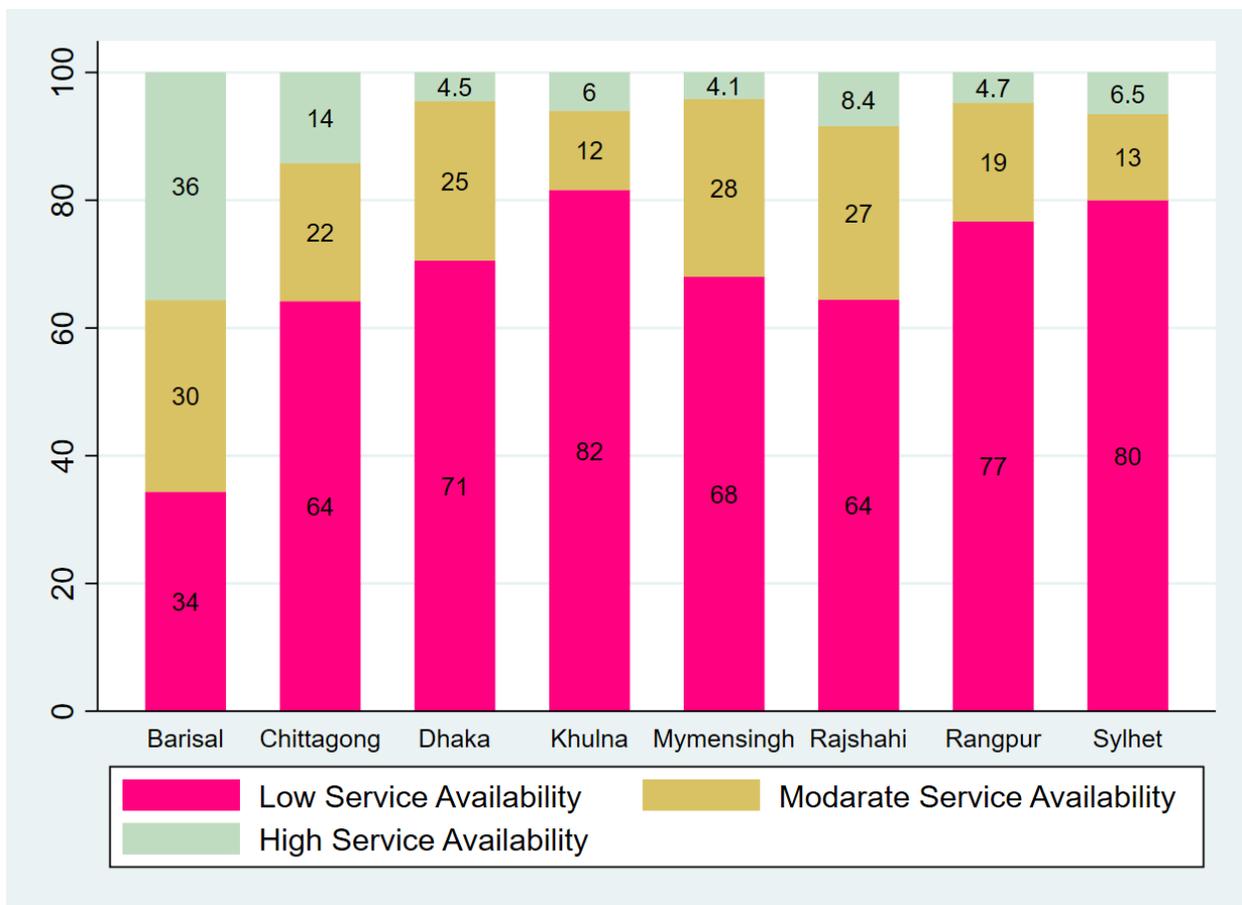
Figure 3.6.1 Proportion of women who gave birth at a facility by availability of service environment within the butter zone by division (Low Service Availability: 0 to 2 facilities; Medium Service Availability: 3 to 5 facilities; High Service Availability: 6 or more facilities).
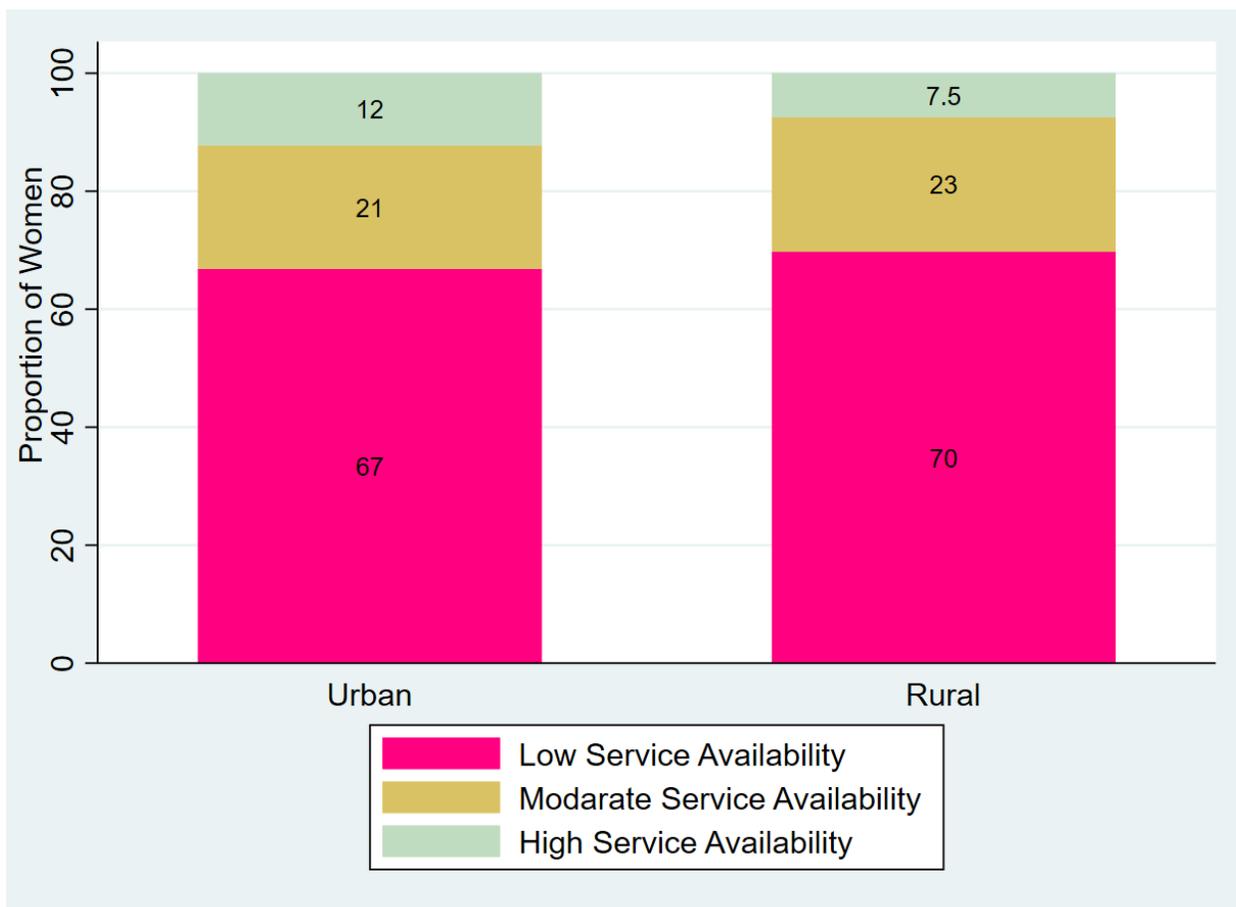
Figure 3.6.2 Proportion of women who gave birth at a facility by availability of services within the butter zone by urban/rural area (Low Service Availability: 0 to 2 facilities; Medium Service Availability: 3 to 5 facilities; High Service Availability: 6 or more facilities).

As shown in Figure 3.6.2, the distribution of women's access to areas with low, medium, or high service environment vary across urban and rural regions. These results align with the distribution depicted Fig 3.6.1, showing that most women live in cluster with limited-service availability, in both urban and rural areas.

Furthermore, women's access to facilities offering the full range of BEmOC and CEmOC services is unevenly distributed across urban and rural areas. (Figure 3.6.3). Specifically, the results indicate that although the majority of women had access to facilities providing some childbirth services, only 9% and 12% of women had access to facilities offering the full range of BEmOC services. Similarly, women's access to CEmOC facilities also varied significantly, with only 12% and 18% of women having access to facilities providing the full range of CEmOC services in rural and urban areas, respectively.
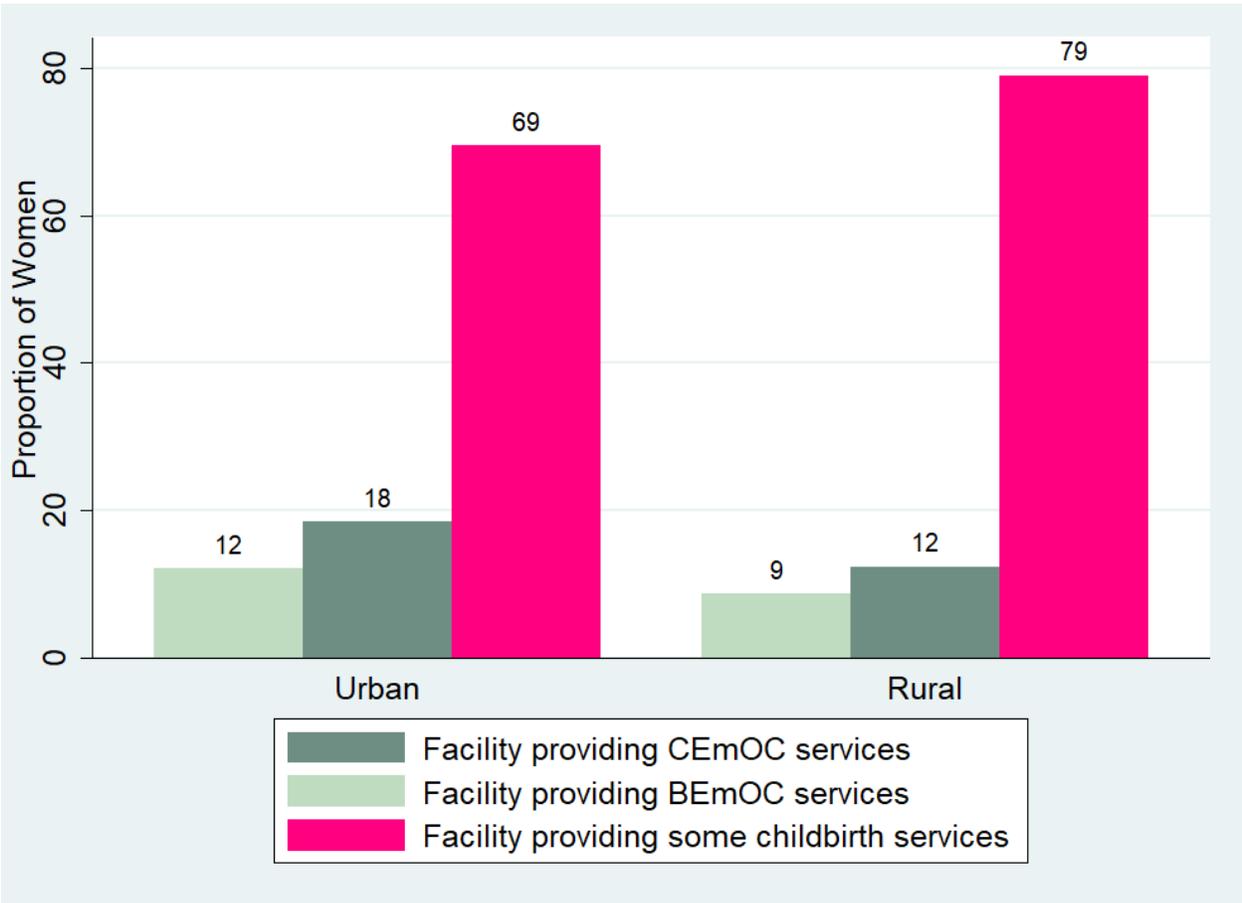

Figure 3.6.3 The percentage of women who have access to facilities providing varying services by urban and rural area.

3.8 Women and facility determinants of facility birth

As shown in Table 3.8.1, in the univariate logistic regression analysis (Model 2), women were likely to have facility birth if there were privately managed facilities and increased number of facilities in the service environment. The distance from the facilities to cluster centroid had an inverse relationship with the facility birth. BEmOC service preparedness score was not significantly associated with the facility birth in the univariate logistic regression analysis.

A multivariable logistic regression analysis was conducted to examine the joint effects of individual and facility variables on the facility birth, with the results being presented in Table 3.8.1. In the combined model (Model 3), all individual characteristics and number of facilities in the service environment were significantly associated with the facility birth. However, apart from the number of facilities in the service environment, none of the other facility variables such as the management body of a facility, BEmOC preparedness, or distance to facility showed any statistical significance and were excluded from the final model.

Table 3.8.1 Comparison between individual and combined determinants of facility childbirth

Determinant	Model 1* (Individual)	Model 2† (Facility)	Model 3‡ (Combined)
	OR (95% CI)		OR (95% CI)
Age	1.03 (1.002 – 1.05)		1.02 (0.99 – 1.04)
Type of Residence			
Urban	1		
Rural	0.52 (0.39 – 0.69)		
Education			
No Education	1		1

Primary	1.08 (0.66 – 1.78)	1.35 (0.73 – 2.52)
Secondary	1.62 (1.02 – 2.59)	1.76 (0.97 – 3.16)
Higher	2.04 (1.23 – 3.37)	2.5 (1.35 – 4.62)
Religion		
Other	1	1
Islam	0.58 (0.4 – 0.85)	0.5 (0.33 – 0.78)
ANC Visits		
0	1	1
1-3	2.94 (1.82 – 4.75)	2.16 (1.26 – 3.7)
4+	5.11 (3.12 – 8.34)	3.76 (2.17 – 6.52)
Access to Media		
No	1	1
Yes	1.25 (1.01 – 1.56)	1.38 (1.06 – 1.8)
Employment Status		
Not Employed	1	1
Employed	0.81 (0.67 – 0.97)	0.77 (0.62-0.96)
Socio-economic Status		
Poor	1	1
Average	1.2 (0.93 – 1.55)	1.24 (0.91 – 1.68)
Rich	1.6 (1.24 – 2.1)	1.41 (1.04 – 1.92)
Childbirth Cost		
Less than 10000 tk	1	1
More than 10000tk	169.32 (101.25 - 283.16)	196.78 (103.64 – 373.67)
Birth Order		
First Child	1	1
Had 2-3 Child	0.57 (0.44 – 0.73)	0.58 (0.43 – 0.77)
4 or More child	0.45 (0.29 – 0.71)	0.58 (0.34 – 0.99)
Facility Management		
Government	1	
Private	1.6 (1.23 – 2.1)	

Service Environment (number of facilities)		
0-2 facilities in buffer zone	1	1
3-5 facilities in buffer zone	1.41 (1.1 – 1.82)	1.22 (0.94 – 1.59)
More than 6 facilities in buffer zone	1.67 (1.23 – 2.25)	1.31 (0.89 – 1.93)
BEmOC service preparedness Score	1.01 (0.99 – 1.01)	
Distance between cluster and facility	0.92 (0.89 – 0.95)	

* Model 1: Results from the final model in Table 3.3.1
† Model 2: Results from the unadjusted logistic regression for facilities
‡ Model 3: Results from the adjusted logistic regression for women and facilities

Chapter 4

DISCUSSION

The government of Bangladesh is striving to increase facility birth rates and work towards universal health coverage by providing incentives and expanding healthcare facilities to enhance accessibility (Government Of Bangladesh (GoB), 2015; Hasan, Rose, & Khair, 2015; Nuruzzaman et al., 2022). However, Bangladesh still faces challenges in improving facility birth rates, as only 50% of births occur in healthcare facilities (The DHS Program, 2022a). The objective of this study is to identify the factors associated with higher facility births. Specifically, we explored what women level factors and facility –level factors are associated with facility childbirths. Geospatial and statistical methods were used to examine the impact of individual and institutional factors on the utilization of facility childbirth services. The study utilized two different models, one focused solely on individual factors and the other analyzing both individual and institutional factors to gain a comprehensive understanding of their impact.

Overall, data show that Bangladesh is characterized by a paucity of health facilities providing childbirth services with vast rural/urban inequities. There is a greater preponderance of government health facilities in rural areas, with private facilities being more common in urban areas. Women's access to higher levels of service within the 5-10 km buffer zone was significantly associated with a facility childbirth. The average distance to a facility did not significantly affect facility childbirth. There was also no association between facility preparedness score and facility childbirth. At the individual level, women with higher education, occupation as unemployed, higher socio-economic status, a non-Muslim religion, and greater exposure to media were associated with facility childbirth. The number of antenatal care visits, and higher childbirth costs

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were also linked to increased facility childbirth. These findings provide valuable insights into the factors that influence women's decisions to seek facility childbirth services and can inform policies and interventions aimed at improving maternal health outcomes. The findings are discussed in greater detail below.

4.1 Effect of Facility Factors on Facility Childbirth

Analysis of the facility data revealed that the majority of facilities in Bangladesh are government-managed, with a higher proportion of rural facilities being government-managed compared to urban facilities. The distribution of services provided is significantly different between urban and rural areas, with a greater percentage of facilities in urban areas offering Comprehensive Emergency Obstetric Care (CEmOC) and Basic Emergency Obstetric Care (BEmOC) services compared to rural areas. These findings are at odds with a 24 districts study from Bangladesh which reported that 71% of their surveyed facilities were private facilities providing childbirth services (Roy, Biswas, & Chowdhury, 2017). The disparity could be attributed to the presence of unregistered private facilities. The current study sampled facilities from registered private facilities only. According to another study from Bangladesh, private facilities lack accountability and they are not part of the national EmOC policy (Chowdhury et al., 2017). One national newspaper reported that, approximately 35% of the private facilities are not registered and 90% of the private facilities do not comply with regulations (Desk, 2022). Considering these facts, DHS program made a just decision including only a proportion of private facilities that are registered.

Nonetheless, private facilities play a significant role in the healthcare system of Bangladesh and cater to a large segment of the population. (J. Hossain et al., 2020). Analysis of facility factors only revealed, women who had access to a privately managed facility were 60% more likely to utilize facility childbirth services after adjusting for other factors such as – service environment, BEmOC preparedness score and distance to facility. These findings align with a study from Tanzania which reported that women's access to private health care facilities was significantly associated with facility childbirth compared to the same access to government facilities (Bintabara, Ernest, & Mpondo, 2019). Therefore, it is imperative for policymakers and the government of Bangladesh to regulate the private sector to ensure increase in access to facility providing childbirth services.

Women who live in a high service environment (6 or more facilities) exhibited a significant association with facility childbirth compared to women who live in a low service environment (0-2 facilities) after adjusting for other relevant factors. However, nearly 70% of the women resided in clusters characterized as low service environment. These findings indicate there is unmet demand for facility childbirth services as only 10% of women resided in high service environment. Study from Haiti, found women's odds of utilizing childbirth services doubled in a high service environment area (Wenjuan Wang et al., 2017). Inadequate availability of facility childbirth services is a common issue in South Asian countries.(Ali et al., 2008; Banstola et al., 2020; Biswas et al., 2005).

Analysis of BEmOC preparedness shows significant statistical difference between the mean preparedness scores of health facilities in rural and urban areas. Overall, the mean

preparedness score is approximately 53 out of 100. After adjusting for other facility factors, facility childbirth was not associated with women access to a facility with high preparedness score. Facility preparedness score for childbirth services in Bangladesh are low but fall somewhere between 40.3 reported from Tanzania and 74.2 and 76.8 in Ethiopia and Nepal, respectively (Alemayehu, Yakob, & Khuzwayo, 2022; Banstola et al., 2020; Bintabara et al., 2019). After analyzing the preparedness of healthcare facilities, it is evident that rural areas have a significantly lower average preparedness score of 40, compared to urban areas which have a score of 70. This suggests that there is a lack of resources primarily in rural areas, resulting in a lower overall mean preparedness score. To address this issue, policymakers should prioritize allocating sufficient resources to the existing facilities rather than expanding the number of inadequately resourced facilities.

Distance to facility is an important variable reported in many previous studies. Our analysis showed that for each one-kilometer increase in distance to a facility significantly decreased the likelihood of a facility childbirth by 8 percent. This finding is consistent with the previous studies conducted in Bangladesh, Malawi & Zambia (N. Alam et al., 2016; S. Gabrysch, S. Cousens, J. Cox, & O. M. Campbell, 2011a; Lohela et al., 2012). However, the relationship between facility distance and facility childbirth was not strong and lost significance when individual and facility factors were combined in one model. The lack of association can be explained by the data linkage method. Since all the clusters were linked to a facility within pre-defined buffer zone the variation in distance is limited within this zone which is evident by the narrow confidence interval. Improved road and transportation systems may also have reduced the effect of distance (A. Hossain, 2021).

4.2 Effect of Individual Factors on Facility Childbirth

In this study, several women characteristics, including age, place of residence, religion, education, ANC visits, access to media, employment status, socio-economic status, birth order and childbirth cost were associated with the facility childbirth. For each year increase in the maternal age, there was a 3% increase in the likelihood of delivering at a healthcare facility, which is consistent with several previous studies. An analysis of demographic health surveys across 34 sub-Saharan African countries reported that women aged 25 years or older were approximately twice more likely to deliver at a healthcare facility as women aged 15 to 19 years old (Dunlop, Benova, & Campbell, 2018).

After adjusting for all other individual-level factors, this study found that rural women had 38% lower likelihood of giving birth at a health facility compared to urban women. This pattern has also been reported in Nigeria, Ghana and in a multicounty study from 17 different country (20-22)(23). This disparity may be influenced by factors such as geographic and financial barriers to accessing facilities, as well as cultural barriers (Yaya, Uthman, Okonofua, & Bishwajit, 2019).

Women's education had a positive impact in utilizing facilities for childbirth services. This study demonstrated that women with higher education were twice the likelihood of availing facility-based childbirth services compared to women with lower education. This is consistent with studies across many countries such as Uganda, Nepal, and Pakistan (Haines, Rubertsson, Pallant, & Hildingsson, 2012; M. A. Rahman et al., 2021).

Religious and cultural beliefs have often been identified as obstacles to facility-based childbirth (Haines et al., 2012; Song et al., 2016). The study found that Muslim women were 62% less likely to deliver at a facility compared to women of other religious beliefs. This finding may be attributed to the conservative nature of some Islamic practices, as well as the belief that childbirth is a natural process and should not be interfered with (Preis, Gozlan, Dan, & Benyamini, 2018).

Existing evidence suggests that antenatal care (ANC) visits have a positive correlation with the use of facility-based childbirth, making ANC a crucial entry point for promoting facility-based childbirth services. Based on the finding of this study, women who had four or more ANC visits were five times more likely to use facility childbirth services than those with no ANC visits. Studies from other LMIC such as Ethiopia, Uganda and Nepal confirmed that sufficient ANC visits were significantly linked to a higher likelihood of facility-based childbirth, indicating that better utilization of facility-based services (Atuhaire, Atuhaire, Wamala, & Nansubuga, 2020; Hailemariam, Atnafu, Gezie, & Tilahun, 2023; Shahabuddin et al., 2017).

Generally, access to media is positively associated with facility childbirth, indicating that increased exposure to media can lead to improved utilization of health services for childbirth in healthcare facilities. A recent study conducted in South Asian countries including Bangladesh, India, Nepal and Pakistan, using DHS data, found that women were 24% to 86% more likely to utilize healthcare services if exposed to mass media (Fatema & Lariscy, 2020). After adjusting for other individual factors, this study found women exposed to media were 25% more likely to utilize facility birth services than those who were not exposed.

This study found working women were 19% less likely to use facility service, women from affluent household were six times more likely to use facility as facility-based childbirth, and if cost of childbirth were more than 10,000 taka it was 169 times more likely to be a facility birth compared to a childbirth cost of 10,000 taka or less. To a working women healthcare expense, including consultations, medication, and hidden costs, may be unaffordable (Organization, 2010). Taking time off work to seek care can also be challenging due to income loss and job insecurity (Schultz, 2014). Disparity between rich and poor in seeking proper health care is a proven fact across a large body of literature (Baciu et al., 2017). Childbirth cost at a health facility often associated with travel, accommodation and ancillary fees exceeds the budget of many lower income households (Glickman & Weiner, 2020). Despite Bangladesh government's initiative in achieving universal health coverage, out of pocket expenditure for healthcare by an individual is still 67% whereas global standard lies below 32% (Fahim et al., 2019).

Existing scientific evidence has consistently reported an inverse relationship between birth order and the likelihood of facility-based childbirth utilization (Raymondville et al., 2020; Sserwanja, Mukunya, Musaba, Kawuki, & Kitutu, 2021; Zenbaba, Sahiledengle, Dibaba, & Bonsa, 2021). This study also found similar findings, with women with four children or more 55% less likely to deliver at facility compared to women pregnant with their first child. Current body of evidence suggests that a combination of factors including maternal age, previous experiences with healthcare facilities, and financial constraints may contribute to the observed association between birth order and facility-based childbirth utilization (Akhter et al., 2020; M. Bohren et al., 2014; Bohren et al., 2015).

4.3 Effect of Individual and Facility Factors and Facility Childbirth

This study also assessed the joint effect health facility and women factors. Interestingly, all the women factors were still statistically significant after allowing for the health facility factors. However, the level of childbirth service availability within the buffer zone was the only facility factor that remained statistically significant after controlling for the women factors. This finding may indicate either the individual factors are more dominant predictors of facility childbirth, or there is a considerable paucity of facilities and that they are not prepared to provide childbirth services. Research from Nigeria suggests that community perceptions regarding the poor preparedness of service providers and the inadequacy of available services are significant factors contributing to the low utilization of facility services (Sule et al., 2008). The Bangladesh data we used did not explore client's opinion or level of satisfaction with the health services availability or preparedness and is an area for further research.

Additionally, the study discovered that the effect of distance on utilizing facility childbirth services is insignificant when controlling for all other facility and individual level factors. This finding contrasts with prior studies, which reported a strong association between facility distance and facility birth. One possible explanation for this discrepancy is that the present study combined facility and individual level data, which identified other factors like facility availability that better explain this variability. Another possibility is that Bangladesh is a densely populated, flatland country where distances are short. The impact of distance may have also decreased due to improved road and transport systems.

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4.4 Policy Implications

Based on the findings of this study, several policy implications can be drawn. Firstly, the government and policymakers should consider taking control of the private sector to improve the quality of care provided to citizens. This could involve implementing stricter regulations and increasing oversight to ensure that private facilities comply with regulations and are registered. Additionally, efforts could be made to improve the quality of care provided by public facilities to increase their utilization.

Secondly, efforts should be made to address the barriers that prevent women, particularly those residing in rural areas, from utilizing facility-based childbirth services. Policy makers should focus on providing incentives such as free transportation to facilities, subsidies for childbirth costs, and education campaigns aimed at addressing cultural and social beliefs that discourage facility-based childbirth.

Thirdly, antenatal care (ANC) visits should focus on targeted counseling, particularly to women who are less likely to use facility-based childbirth services such as Muslim women and those with lower education by utilizing religious leaders and respected members of the local community such as schoolteacher, doctors, and health workers. Efforts should also be made to increase exposure to media among women, as this has been shown to increase the likelihood of facility-based childbirth.

Lastly, efforts should be made to ensure that facility childbirth services are affordable, particularly for women from poorer households and those with multiple children. This can be achieved by introducing fee exemption policies or health insurance schemes that cover childbirth-

related costs. By implementing these policies, the likelihood of facility-based childbirth can be increased, which can ultimately lead to improved maternal and neonatal health outcomes.

4.5 Limitations

DHS data analysis can be limited due to cluster displacement, where the location of households is shifted for privacy or security reasons. This can lead to inaccurate geospatial analyses of healthcare access and disparities, as the actual locations of households may not be accurately represented. Therefore, interpreting results from DHS data should be done with caution, and additional validation may be required to ensure the accuracy of the results. However, DHS utilizes a rigorous sampling technique to minimize this bias due to cluster displacement.

Misclassification errors can also occur in geospatial linkage of DHS and SPA surveys, which can affect the accuracy of the results that rely on linked data. For example, incorrect geocoding or linking of survey data to facility data can lead to the misclassification of women's exposure to health facilities and service availability, resulting in biased estimates. To account for data displacement, the study analyzed the service environment of all available facilities within a reasonable distance of the displaced cluster, instead of only looking at the nearest facility. This approach aimed to represent the probable service environment of the actual cluster location.

Client exit interviews are an essential component of health facility surveys as they provide direct feedback from clients about their experiences and satisfaction with the services received. However, the Bangladesh Health Facility Survey (BHFS) currently does not include client exit interviews, which limits the ability to fully understand the quality of care and identify areas for

improvement. By including client exit interviews, the BHFS could gain valuable insight into the needs and expectations of clients, as well as their perceptions of the quality of care received.

4.6 Conclusions

This study aimed to identify the factors influencing access to facility childbirth services in Bangladesh. Overall, Bangladesh is characterized by poor availability of childbirth services, both on terms of numbers of facilities available and how prepared they are to provide the care. As expected, service availability was higher in urban areas compared to rural areas. A high service environment was associated with facility childbirth, indicating unmet demand for services in low service environments. At the same time, women-level factors remained important determinants of facility births. Together the data suggest that a comprehensive approach that addresses both supply and demand factors is necessary to improve facility births and maternal health outcomes in Bangladesh.

References

Akhter, S., Dasvarma, G. L., & Saikia, U. (2020). Reluctance of women of lower socio-economic status to use maternal healthcare services - Does only cost matter? *PloS one, 15*(9), e0239597. doi:10.1371/journal.pone.0239597

Alam, N., Chowdhury, M. E., Kouanda, S., Seppey, M., Alam, A., Savadogo, J. R., . . . Fournier, P. (2016). The role of transportation to access maternal care services for women in rural Bangladesh and Burkina Faso: A mixed methods study. *International Journal of Gynecology & Obstetrics, 135*, S45-S50. Retrieved from https://www.sciencedirect.com/science/article/pii/S0020729216304118. doi:https://doi.org/10.1016/j.ijgo.2016.09.003

Alemayehu, M., Yakob, B., & Khuzwayo, N. (2022). Quality of emergency obstetric and newborn care services in Wolaita Zone, Southern Ethiopia. *BMC Pregnancy and Childbirth, 22*(1), 686. doi:https://dx.doi.org/10.1186/s12884-022-05019-w

Ali, M., Bhatti, M. A., & Kuroiwa, C. (2008). Challenges in access to and utilization of reproductive health care in Pakistan. *Journal of Ayub Medical College, Abbottabad : JAMC, 20*(4), 3-7.

Atuhaire, R., Atuhaire, L. K., Wamala, R., & Nansubuga, E. (2020). Interrelationships between early antenatal care, health facility delivery and early postnatal care among women in Uganda: a structural equation analysis. *Glob Health Action, 13*(1), 1830463. doi:10.1080/16549716.2020.1830463

Baciu, A., Negussie, Y., Geller, A., Weinstein, J. N., National Academies of Sciences, E., & Medicine. (2017). The root causes of health inequity. In *Communities in action: Pathways to health equity*: National Academies Press (US).

Banstola, A., Simkhada, P., van Teijlingen, E., Bhatta, S., Lama, S., Adhikari, A., & Banstola, A. (2020). The Availability of Emergency Obstetric Care in Birthing Centres in Rural Nepal: A Cross-sectional Survey. *Matern Child Health J, 24*(6), 806-816. doi:https://dx.doi.org/10.1007/s10995-019-02832-2

Bintabara, D., Ernest, A., & Mpondo, B. (2019). Health facility service availability and readiness to provide basic emergency obstetric and newborn care in a low-resource setting: evidence from a Tanzania National Survey. *BMJ open, 9*(2), e020608.

Biswas, A. B., Das, D. K., Misra, R., Roy, R. N., Ghosh, D., & Mitra, K. (2005). Availability and use of emergency obstetric care services in four districts of West Bengal, India. *Journal of health, population and nutrition, 23*(3), 266-274.

Bohren, M., Hunter, E., Munthe-Kaas, H., Souza, J., Vogel, J., & Gülmezoglu, A. (2014). Facilitators and Barriers to Facility-Based Delivery in Low- and Middle-Income Countries: A Qualitative Evidence Synthesis. *BMC Reproductive Health, 11*. doi:10.1186/1742-4755-11-71

Bohren, M. A., Vogel, J. P., Hunter, E. C., Lutsiv, O., Makh, S. K., Souza, J. P., . . . Gülmezoglu, A. M. (2015). The Mistreatment of Women during Childbirth in Health Facilities Globally: A Mixed-Methods Systematic Review. *PLoS Med, 12*(6), e1001847; discussion e1001847. doi:10.1371/journal.pmed.1001847

Chowdhury, M. E., Biswas, T. K., Rahman, M., Pasha, K., & Hossain, M. A. (2017). Use of a geographic information system to assess accessibility to health facilities providing emergency obstetric and newborn care in Bangladesh. *Int J Gynaecol Obstet, 138*(2), 164-170. doi:https://dx.doi.org/10.1002/ijgo.12196

Desk, E. (2022, 2022/09/02/). Unregistered clinics, hospitals: Close monitoring required. *Prothomalo*. Retrieved from https://en.prothomalo.com/opinion/editorial/bmxuzt34tc

Dunlop, C. L., Benova, L., & Campbell, O. (2018). Effect of maternal age on facility-based delivery: analysis of first-order births in 34 countries of sub-Saharan Africa using demographic and health survey data. *BMJ open, 8*(4), e020231. Retrieved from https://bmjopen.bmj.com/content/bmjopen/8/4/e020231.full.pdf. doi:10.1136/bmjopen-2017-020231

Fahim, S. M., Bhuayan, T. A., Hassan, M. Z., Abid Zafr, A. H., Begum, F., Rahman, M. M., & Alam, S. (2019). Financing health care in Bangladesh: Policy responses and challenges towards achieving universal health coverage. *Int J Health Plann Manage, 34*(1), e11-e20. doi:10.1002/hpm.2666

Fatema, K., & Lariscy, J. T. (2020). Mass media exposure and maternal healthcare utilization in South Asia. *SSM Popul Health, 11*, 100614. doi:10.1016/j.ssmph.2020.100614

Gabrysch, S., Cousens, S., Cox, J., & Campbell, O. M. (2011). The influence of distance and level of care on delivery place in rural Zambia: a study of linked national data in a geographic information system. *PLoS Med, 8*(1), e1000394.

Glickman, A., & Weiner, J. (2020). Health care cost drivers and options for cost control. *Penn LDI Issue Brief, 23*(4).

Government Of Bangladesh (GoB). (2015). *Bangladesh Health Workforce Strategy-2015*. Retrieved from http://hospitaldghs.gov.bd/wp-content/uploads/2019/11/Bangladesh-Health-Workforce-Strategy-2015-min.pdf

Hailemariam, T., Atnafu, A., Gezie, L. D., & Tilahun, B. (2023). Utilization of optimal antenatal care, institutional delivery, and associated factors in Northwest Ethiopia. *Scientific*

Reports, 13(1), 1071. Retrieved from https://doi.org/10.1038/s41598-023-28044-x. doi:10.1038/s41598-023-28044-x

Haines, H. M., Rubertsson, C., Pallant, J. F., & Hildingsson, I. (2012). The influence of women's fear, attitudes and beliefs of childbirth on mode and experience of birth. *BMC Pregnancy Childbirth, 12*, 55. doi:10.1186/1471-2393-12-55

Hasan, M., Rose, J., & Khair, S. (2015). Background paper for the 7th five year plan of the government of Bangladesh: Governance and justice. In: Draft. Available at: http://www. plancomm. gov. bd/wp-content/uploads/2015 ….

Hossain, A. (2021). Bangladesh in new era of transport and communication. *Prothomalo*. Retrieved from https://en.prothomalo.com/bangladesh/bangladesh-in-new-era-of-transport-and-communication.

Hossain, J., Laterra, A., Paul, R. R., Islam, A., Ahmmed, F., & Sarker, B. K. (2020). Filling the human resource gap through public-private partnership: Can private, community-based skilled birth attendants improve maternal health service utilization and health outcomes in a remote region of Bangladesh? *PloS one, 15*(1), e0226923. doi:10.1371/journal.pone.0226923

Lohela, T. J., Campbell, O. M., & Gabrysch, S. (2012). Distance to care, facility delivery and early neonatal mortality in Malawi and Zambia. *PloS one, 7*(12), e52110. doi:10.1371/journal.pone.0052110

Nuruzzaman, M., Zapata, T., McIsaac, M., Wangmo, S., Islam, M. J., Almamun, M., . . . Dussault, G. (2022). Informing investment in health workforce in Bangladesh: a health labour market analysis. *Human Resources for Health, 20*(1), 73. Retrieved from https://doi.org/10.1186/s12960-022-00769-2. doi:10.1186/s12960-022-00769-2

Organization, W. H. (2010). *Why urban health matters*. Retrieved from

Preis, H., Gozlan, M., Dan, U., & Benyamini, Y. (2018). A quantitative investigation into women's basic beliefs about birth and planned birth choices. *Midwifery, 63*, 46-51.

Rahman, M. A., Rahman, M. A., Rawal, L. B., Paudel, M., Howlader, M. H., Khan, B., . . . Islam, S. M. S. (2021). Factors influencing place of delivery: Evidence from three south-Asian countries. *PloS one, 16*(4), e0250012. doi:10.1371/journal.pone.0250012

Raymondville, M., Rodriguez, C. A., Richterman, A., Jerome, G., Katz, A., Gilbert, H., . . . Ivers, L. C. (2020). Barriers and facilitators influencing facility-based childbirth in rural Haiti: a mixed method study with a convergent design. *BMJ global health, 5*(8), e002526. Retrieved from https://gh.bmj.com/content/bmjgh/5/8/e002526.full.pdf. doi:10.1136/bmjgh-2020-002526

Roy, L., Biswas, T. K., & Chowdhury, M. E. (2017). Emergency obstetric and newborn care signal functions in public and private facilities in Bangladesh. *PloS one, 12*(11), e0187238. doi:https://dx.doi.org/10.1371/journal.pone.0187238

Schultz, C. (2014). World Migration Report. *Migartion, Health, and Cities Migration, Health and Urbanization: Interrelated Challenges Berlin. Berlin: International Organization for Migration (IOM)*.

Shahabuddin, A., De Brouwere, V., Adhikari, R., Delamou, A., Bardaj, A., & Delvaux, T. (2017). Determinants of institutional delivery among young married women in Nepal: Evidence from the Nepal Demographic and Health Survey, 2011. *BMJ open, 7*(4), e012446. Retrieved from https://bmjopen.bmj.com/content/bmjopen/7/4/e012446.full.pdf. doi:10.1136/bmjopen-2016-012446

Song, P., Kang, C., Theodoratou, E., Rowa-Dewar, N., Liu, X., & An, L. (2016). Barriers to Hospital Deliveries among Ethnic Minority Women with Religious Beliefs in China: A Descriptive Study Using Interviews and Survey Data. *Int J Environ Res Public Health, 13*(8). doi:10.3390/ijerph13080815

Sserwanja, Q., Mukunya, D., Musaba, M. W., Kawuki, J., & Kitutu, F. E. (2021). Factors associated with health facility utilization during childbirth among 15 to 49-year-old women in Uganda: evidence from the Uganda demographic health survey 2016. *BMC health services research, 21*(1), 1160. Retrieved from https://doi.org/10.1186/s12913-021-07179-5. doi:10.1186/s12913-021-07179-5

Sule, S., Ijadunola, K., Onayade, A., Fatusi, A., Soetan, R., & Connell, F. (2008). Utilization of primary health care facilities: lessons from a rural community in southwest Nigeria. *Nigerian journal of medicine, 17*(1), 98-106.

The DHS Program. (2022, 2022/08/05/). Demographic and Health Survey (DHS). Retrieved from https://dhsprogram.com/Methodology/Survey-Types/DHS.cfm

Wang, W., Winner, M., & Burgert-Brucker, C. R. (2017). Limited Service Availability, Readiness, and Use of Facility-Based Delivery Care in Haiti: A Study Linking Health Facility Data and Population Data. *Global Health: Science and Practice, 5*(2), 244. Retrieved from http://www.ghspjournal.org/content/5/2/244.abstract. doi:10.9745/GHSP-D-16-00311

Yaya, S., Uthman, O. A., Okonofua, F., & Bishwajit, G. (2019). Decomposing the rural-urban gap in the factors of under-five mortality in sub-Saharan Africa? Evidence from 35 countries. *BMC public health, 19*(1), 616. Retrieved from https://doi.org/10.1186/s12889-019-6940-9. doi:10.1186/s12889-019-6940-9

Zenbaba, D., Sahiledengle, B., Dibaba, D., & Bonsa, M. (2021). Utilization of Health Facility-Based Delivery Service Among Mothers in Gindhir District, Southeast Ethiopia: A Community-Based Cross-Sectional Study. *Inquiry, 58*, 469580211056061. doi:10.1177/00469580211056061

Bibliography

Acharya, K., Subedi, R. K., Dahal, S., & Karkee, R. (2021). Basic emergency obstetric and newborn care service availability and readiness in Nepal: Analysis of the 2015 Nepal Health Facility Survey. *PloS one, 16*(7), e0254561.

Adde, K. S., Dickson, K. S., & Amu, H. (2021). Prevalence and determinants of the place of delivery among reproductive age women in sub–Saharan Africa. *PloS one, 15*(12), e0244875. Retrieved from https://doi.org/10.1371/journal.pone.0244875. doi:10.1371/journal.pone.0244875

Adedokun, S. T., & Uthman, O. A. (2019). Women who have not utilized health Service for Delivery in Nigeria: who are they and where do they live? *BMC Pregnancy and Childbirth, 19*(1), 93. Retrieved from https://doi.org/10.1186/s12884-019-2242-6. doi:10.1186/s12884-019-2242-6

Admasu, K., Haile-Mariam, A., & Bailey, P. (2011). Indicators for availability, utilization, and quality of emergency obstetric care in Ethiopia, 2008. *International Journal of Gynecology and Obstetrics, 115*(1), 101-105. Retrieved from https://www.elsevier.com/locate/ijgo. doi:https://dx.doi.org/10.1016/j.ijgo.2011.07.010

Afsana, K., & Rashid, S. F. (2001). The challenges of meeting rural Bangladeshi women's needs in delivery care. *Reproductive health matters, 9*(18), 79-89.

Agaba, P., Magadi, M., & Orton, B. (2022). Predictors of health facility childbirth among unmarried and married youth in Uganda. *PloS one, 17*(4), e0266657. doi:10.1371/journal.pone.0266657

Ahmed, S., Applegate, J. A., Mitra, D. K., Callaghan-Koru, J. A., Mousumi, M., Khan, A. M., . . . Baqui, A. H. (2019). Implementation research to support Bangladesh Ministry of Health

and Family Welfare to implement its national guidelines for management of infections in young infants in two rural districts. *Journal of health, population and nutrition, 38*(1), 41. Retrieved from https://doi.org/10.1186/s41043-019-0200-6. doi:10.1186/s41043-019-0200-6

Ahmed, S., Creanga, A. A., Gillespie, D. G., & Tsui, A. O. (2010). Economic status, education and empowerment: implications for maternal health service utilization in developing countries. *PloS one, 5*(6), e11190.

Akhter, S., Dasvarma, G. L., & Saikia, U. (2020). Reluctance of women of lower socio-economic status to use maternal healthcare services - Does only cost matter? *PloS one, 15*(9), e0239597. doi:10.1371/journal.pone.0239597

Alam, B., Mridha, M. K., Biswas, T. K., Roy, L., Rahman, M., & Chowdhury, M. E. (2015). Coverage of emergency obstetric care and availability of services in public and private health facilities in Bangladesh. *International Journal of Gynecology & Obstetrics, 131*(1), 63-69.

Alam, N., Chowdhury, M. E., Kouanda, S., Seppey, M., Alam, A., Savadogo, J. R., . . . Fournier, P. (2016). The role of transportation to access maternal care services for women in rural Bangladesh and Burkina Faso: A mixed methods study. *International Journal of Gynecology & Obstetrics, 135*, S45-S50. Retrieved from https://www.sciencedirect.com/science/article/pii/S0020729216304118. doi:https://doi.org/10.1016/j.ijgo.2016.09.003

Alemayehu, M., Yakob, B., & Khuzwayo, N. (2022). Quality of emergency obstetric and newborn care services in Wolaita Zone, Southern Ethiopia. *BMC Pregnancy and Childbirth, 22*(1), 686. doi:https://dx.doi.org/10.1186/s12884-022-05019-w

Ali, M., Bhatti, M. A., & Kuroiwa, C. (2008). Challenges in access to and utilization of reproductive health care in Pakistan. *Journal of Ayub Medical College, Abbottabad : JAMC, 20*(4), 3-7.

Anwar, I., Nababan, H. Y., Mostari, S., Rahman, A., & Khan, J. A. (2015). Trends and inequities in use of maternal health care services in Bangladesh, 1991-2011. *PloS one, 10*(3), e0120309.

Aremu, O., Lawoko, S., & Dalal, K. (2011). Neighborhood socioeconomic disadvantage, individual wealth status and patterns of delivery care utilization in Nigeria: a multilevel discrete choice analysis. *IJWH, 3*, 167–174. Retrieved from https://www.dovepress.com/neighborhood-socioeconomic-disadvantage-individual-wealth-status-and-p-peer-reviewed-fulltext-article-IJWH. doi:10.2147/ijwh.S21783

Asmare, A. A., & Agmas, Y. A. (2022). Determinants of health facility delivery among reproductive age women in low and middle income countries; evidence from most recent demographic health survey: Application of multilevel binary logistic regression model. In: Research Square.

Atuhaire, R., Atuhaire, L. K., Wamala, R., & Nansubuga, E. (2020). Interrelationships between early antenatal care, health facility delivery and early postnatal care among women in Uganda: a structural equation analysis. *Glob Health Action, 13*(1), 1830463. doi:10.1080/16549716.2020.1830463

Babineau, J. (2014). Product review: Covidence (systematic review software). *Journal of the Canadian Health Libraries Association/Journal de l'Association des bibliothèques de la santé du Canada, 35*(2), 68-71.

Baciu, A., Negussie, Y., Geller, A., Weinstein, J. N., National Academies of Sciences, E., & Medicine. (2017). The root causes of health inequity. In *Communities in action: Pathways to health equity*: National Academies Press (US).

Bangladesh Bureau of Statistics (BBS). (2011). *Report of the Post Enumeration Check (PEC) of the Population and Housing Census, 2011*. Retrieved from E-17, Agargaon, Sher-e-Bangla Nagar, Dhaka http://203.112.218.65:8008/WebTestApplication/userfiles/Image/LatestReports/PEC%20 Report%202011.pdf

Banstola, A., Simkhada, P., van Teijlingen, E., Bhatta, S., Lama, S., Adhikari, A., & Banstola, A. (2020). The Availability of Emergency Obstetric Care in Birthing Centres in Rural Nepal: A Cross-sectional Survey. *Matern Child Health J, 24*(6), 806-816. doi:https://dx.doi.org/10.1007/s10995-019-02832-2

Barman, B., Roy, A., Zaveri, A., Saha, J., & Chouhan, P. (2020). Determining factors of institutional delivery in India: A study from National Family Health Survey-4 (2015–16). *Clinical Epidemiology and Global Health, 8*(4), 1335-1340. Retrieved from https://doi.org/10.1016/j.cegh.2020.05.007. doi:10.1016/j.cegh.2020.05.007

Bhowmik, J., Biswas, R. K., & Ananna, N. (2020). Women's education and coverage of skilled birth attendance: An assessment of Sustainable Development Goal 3.1 in the South and Southeast Asian Region. *PloS one, 15*(4), e0231489. doi:10.1371/journal.pone.0231489

Bintabara, D., Ernest, A., & Mpondo, B. (2019). Health facility service availability and readiness to provide basic emergency obstetric and newborn care in a low-resource setting: evidence from a Tanzania National Survey. *BMJ open, 9*(2), e020608. Retrieved from

http://bmjopen.bmj.com/content/9/2/e020608.abstract.   doi:10.1136/bmjopen-2017-020608

Biswas, A. B., Das, D. K., Misra, R., Roy, R. N., Ghosh, D., & Mitra, K. (2005). Availability and use of emergency obstetric care services in four districts of West Bengal, India. *Journal of health, population and nutrition, 23*(3), 266-274.

Bohren, M., Hunter, E., Munthe-Kaas, H., Souza, J., Vogel, J., & Gülmezoglu, A. (2014). Facilitators and Barriers to Facility-Based Delivery in Low- and Middle-Income Countries: A Qualitative Evidence Synthesis. *BMC Reproductive Health, 11*. doi:10.1186/1742-4755-11-71

Bohren, M. A., Hunter, E. C., Munthe-Kaas, H. M., Souza, J. P., Vogel, J. P., & Gülmezoglu, A. M. (2014). Facilitators and barriers to facility-based delivery in low- and middle-income countries: a qualitative evidence synthesis. *Reproductive Health, 11*(1), 71. Retrieved from https://doi.org/10.1186/1742-4755-11-71. doi:10.1186/1742-4755-11-71

Bohren, M. A., Vogel, J. P., Hunter, E. C., Lutsiv, O., Makh, S. K., Souza, J. P., . . . Gülmezoglu, A. M. (2015). The Mistreatment of Women during Childbirth in Health Facilities Globally: A Mixed-Methods Systematic Review. *PLoS Med, 12*(6), e1001847; discussion e1001847. doi:10.1371/journal.pmed.1001847

Bulto, G. A., Zewdie, T. A., & Beyen, T. K. (2014). Demand for long acting and permanent contraceptive methods and associated factors among married women of reproductive age group in Debre Markos Town, North West Ethiopia. *BMC Women's Health, 14*(1), 46. Retrieved from https://doi.org/10.1186/1472-6874-14-46. doi:10.1186/1472-6874-14-46

Burgert, C. R., & Prosnitz, D. (2014). *Linking DHS household and SPA facility surveys: Data considerations and geospatial methods*. Retrieved from Rockville, Maryland, USA: http://dhsprogram.com/pubs/pdf/SAR10/SAR10.pdf

Callister, L. C., & Edwards, J. E. (2017). Sustainable development goals and the ongoing process of reducing maternal mortality. *Journal of Obstetric, Gynecologic & Neonatal Nursing, 46*(3), e56-e64.

Campbell, O. M., Graham, W. J., & group, L. M. S. S. s. (2006). Strategies for reducing maternal mortality: getting on with what works. *The Lancet, 368*(9543), 1284-1299.

Campbell, O. M. R., & Graham, W. J. (2006). Strategies for reducing maternal mortality: getting on with what works. *The Lancet, 368*(9543), 1284-1299. Retrieved from https://doi.org/10.1016/S0140-6736(06)69381-1. doi:10.1016/S0140-6736(06)69381-1

Chaka, E. E. (2020). Examining Individual- and Community-Level Factors Affecting Skilled Delivery Care among Women Who Received Adequate Antenatal Care in Ethiopia: Using Multilevel Analysis. *Biomed Res Int, 2020*, 2130585. doi:10.1155/2020/2130585

Cheung, A. K. L. (2014). Probability Proportional Sampling. In A. C. Michalos (Ed.), *Encyclopedia of Quality of Life and Well-Being Research* (pp. 5069-5071). Dordrecht: Springer Netherlands.

Choulagai, B., Onta, S., Subedi, N., Mehata, S., Bhandari, G. P., Poudyal, A., . . . Krettek, A. (2013). Barriers to using skilled birth attendants' services in mid- and far-western Nepal: a cross-sectional study. *BMC Int Health Hum Rights, 13*, 49. doi:10.1186/1472-698x-13-49

Chowdhury, M. E., Biswas, T. K., Rahman, M., Pasha, K., & Hossain, M. A. (2017). Use of a geographic information system to assess accessibility to health facilities providing

emergency obstetric and newborn care in Bangladesh. *Int J Gynaecol Obstet, 138*(2), 164-170. doi:https://dx.doi.org/10.1002/ijgo.12196

Colston, J. M., & Burgert, C. R. (2014). Using Geospatial Analysis to Inform Decision Making In Targeting Health Facility-Based Programs.

Crissman, H. P., Engmann, C. E., Adanu, R. M., Nimako, D., Crespo, K., & Moyer, C. A. (2013). Shifting norms: pregnant women's perspectives on skilled birth attendance and facility–based delivery in rural Ghana. *African journal of reproductive health, 17*(1), 15-26.

Croft, T., Marshall, A. M., Allen, C. K., Arnold, F., Assaf, S., & Balian, S. (2019). Guide to DHS statistics. 2018. *ICF [Google Scholar]*.

Dankwah, E., Zeng, W., Feng, C., Kirychuk, S., & Farag, M. (2019). The social determinants of health facility delivery in Ghana. *Reproductive Health, 16*(1), 1-10.

Davies, K. S. (2011). Formulating the evidence based practice question: a review of the frameworks. *Evidence Based Library and Information Practice, 6*(2), 75-80.

Desk, E. (2022, 2022/09/02/). Unregistered clinics, hospitals: Close monitoring required. *Prothomalo*. Retrieved from https://en.prothomalo.com/opinion/editorial/bmxuzt34tc

DHS Program. (2022, 2022/09/06/). The DHS Questionnaires. Retrieved from https://dhsprogram.com/Methodology/Survey-Types/DHS-Questionnaires.cfm#CP_JUMP_16179

Directorate General of Health Services, & Ministry of Health and Family Welfare (2019). *Ministry of Health and Family Welfare (MOHFW). Bangladesh National Strategy for Maternal Health 2019–2030*. Retrieved from http://dgnm.portal.gov.bd/sites/default/files/files/dgnm.portal.gov.bd/page/18c15f9c_926

7_44a7_ad2b_65affc9d43b3/2021-06-24-11-27-702ae9eea176d87572b7dbbf566e9262.pdf

Doctor, H. V., Findley, S. E., Ager, A., Cometto, G., Afenyadu, G. Y., Adamu, F., & Green, C. (2012). Using community-based research to shape the design and delivery of maternal health services in Northern Nigeria. *Reproductive health matters, 20*(39), 104-112.

Doctor, H. V., Nkhana-Salimu, S., & Abdulsalam-Anibilowo, M. (2018). Health facility delivery in sub-Saharan Africa: successes, challenges, and implications for the 2030 development agenda. *BMC public health, 18*(1), 1-12.

Dotse-Gborgbortsi, W., Dwomoh, D., Alegana, V., Hill, A., Tatem, A. J., & Wright, J. (2020). The influence of distance and quality on utilisation of birthing services at health facilities in Eastern Region, Ghana. *BMJ global health, 4*(Suppl 5), e002020.

Dotse-Gborgbortsi, W., Tatem, A. J., Alegana, V., Utazi, C. E., Ruktanonchai, C. W., & Wright, J. (2020). Spatial inequalities in skilled attendance at birth in Ghana: a multilevel analysis integrating health facility databases with household survey data. *Tropical medicine & international health : TM & IH, 25*(9), 1044-1054. doi:https://dx.doi.org/10.1111/tmi.13460

Dunlop, C. L., Benova, L., & Campbell, O. (2018). Effect of maternal age on facility-based delivery: analysis of first-order births in 34 countries of sub-Saharan Africa using demographic and health survey data. *BMJ open, 8*(4), e020231. Retrieved from https://bmjopen.bmj.com/content/bmjopen/8/4/e020231.full.pdf. doi:10.1136/bmjopen-2017-020231

Ehsan, S. M. A. (2021). The Local Government System in Bangladesh: An Anatomy of Perspectives & Practices. *South Asian Journal of Policy and Governance, 44*, 1-22.

Eklund, L. (2016). Preference or Aversion? Exploring Fertility Desires among China's Young Urban Elite. *Intersections: Gender and Sexuality in Asia and the Pacific, July 2016*(39). Retrieved from https://portal.research.lu.se/en/publications/preference-or-aversion-exploring-fertility-desires-among-chinas-y.

El Arifeen, S., Hill, K., Ahsan, K. Z., Jamil, K., Nahar, Q., & Streatfield, P. K. (2014). Maternal mortality in Bangladesh: a Countdown to 2015 country case study. *The Lancet, 384*(9951), 1366-1374. Retrieved from https://doi.org/10.1016/S0140-6736(14)60955-7. doi:10.1016/S0140-6736(14)60955-7

Fahim, S. M., Bhuayan, T. A., Hassan, M. Z., Abid Zafr, A. H., Begum, F., Rahman, M. M., & Alam, S. (2019). Financing health care in Bangladesh: Policy responses and challenges towards achieving universal health coverage. *Int J Health Plann Manage, 34*(1), e11-e20. doi:10.1002/hpm.2666

Fatema, K., & Lariscy, J. T. (2020). Mass media exposure and maternal healthcare utilization in South Asia. *SSM Popul Health, 11*, 100614. doi:10.1016/j.ssmph.2020.100614

Feigin, V. L., Abajobir, A. A., Abate, K. H., Abd-Allah, F., Abdulle, A. M., Abera, S. F., . . . Aichour, I. (2017). Global, regional, and national burden of neurological disorders during 1990–2015: a systematic analysis for the Global Burden of Disease Study 2015. *The Lancet Neurology, 16*(11), 877-897.

Filippi, V., Chou, D., Ronsmans, C., Graham, W., & Say, L. (2016). Levels and causes of maternal mortality and morbidity. *Disease control priorities, 2*, 51-70.

Gabrysch, S., & Campbell, O. M. R. (2009). Still too far to walk: Literature review of the determinants of delivery service use. *BMC Pregnancy and Childbirth, 9*(1), 34. Retrieved from https://doi.org/10.1186/1471-2393-9-34. doi:10.1186/1471-2393-9-34

Gabrysch, S., Cousens, S., Cox, J., & Campbell, O. M. (2011a). The influence of distance and level of care on delivery place in rural Zambia: a study of linked national data in a geographic information system. *PLoS Med, 8*(1), e1000394.

Gabrysch, S., Cousens, S., Cox, J., & Campbell, O. M. R. (2011b). The influence of distance and level of care on delivery place in rural Zambia: a study of linked national data in a geographic information system. *PLoS Med, 8*(1), e1000394. doi:https://dx.doi.org/10.1371/journal.pmed.1000394

Gabrysch, S., Simushi, V., & Campbell, O. M. (2011). Availability and distribution of, and geographic access to emergency obstetric care in Zambia. *International Journal of Gynecology & Obstetrics, 114*(2), 174-179.

Gautam, S., & Jeong, H.-S. (2019). The Role of Women's Autonomy and Experience of Intimate Partner Violence as a Predictor of Maternal Healthcare Service Utilization in Nepal. *International Journal of Environmental Research and Public Health, 16*(5), 895. Retrieved from https://www.mdpi.com/1660-4601/16/5/895.

Glickman, A., & Weiner, J. (2020). Health care cost drivers and options for cost control. *Penn LDI Issue Brief, 23*(4).

Goli, S., Rammohan, A., & Moradhvaj. (2018). Out-of-pocket expenditure on maternity care for hospital births in Uttar Pradesh, India. *Health Econ Rev, 8*(1), 5. doi:10.1186/s13561-018-0189-3

Government Of Bangladesh (GoB). (2015). *Bangladesh Health Workforce Strategy-2015*. Retrieved from http://hospitaldghs.gov.bd/wp-content/uploads/2019/11/Bangladesh-Health-Workforce-Strategy-2015-min.pdf

Government Of Bangladesh (GoB). (2022a). Bangladesh National Portal | People's Republic of Bangladesh. Retrieved from https://bangladesh.gov.bd/index.php

GeoDASH. (2022b). Government Of Bangladesh (GoB) [Mobile application software]. Retrieved from https://geodash.gov.bd

Hailemariam, T., Atnafu, A., Gezie, L. D., & Tilahun, B. (2023). Utilization of optimal antenatal care, institutional delivery, and associated factors in Northwest Ethiopia. *Scientific Reports, 13*(1), 1071. Retrieved from https://doi.org/10.1038/s41598-023-28044-x. doi:10.1038/s41598-023-28044-x

Haines, H. M., Rubertsson, C., Pallant, J. F., & Hildingsson, I. (2012). The influence of women's fear, attitudes and beliefs of childbirth on mode and experience of birth. *BMC Pregnancy Childbirth, 12*, 55. doi:10.1186/1471-2393-12-55

Hamal, M., Dieleman, M., De Brouwere, V., & de Cock Buning, T. (2020). Social determinants of maternal health: a scoping review of factors influencing maternal mortality and maternal health service use in India. *Public Health Reviews, 41*(1), 1-24.

Hasan, M., Rose, J., & Khair, S. (2015). Background paper for the 7th five year plan of the government of Bangladesh: Governance and justice. In: Draft. Available at: http://www. plancomm. gov. bd/wp-content/uploads/2015 ….

Hierink, F., Okiro, E. A., Flahault, A., & Ray, N. (2021). The winding road to health: A systematic scoping review on the effect of geographical accessibility to health care on infectious diseases in low-and middle-income countries. *PloS one, 16*(1), e0244921.

HNPSP. (2017). *4th Health Nutrition and Population Sector Program*. Retrieved from Dhaka: https://www.researchgate.net/publication/322750173_Program_Implementation_Report_2017_of_the_4th_Health_Population_and_Nutrition_Sector_Program_4th_HPNSP

Hossain, A. (2021). Bangladesh in new era of transport and communication. *Prothomalo*. Retrieved from https://en.prothomalo.com/bangladesh/bangladesh-in-new-era-of-transport-and-communication.

Hossain, J., Laterra, A., Paul, R. R., Islam, A., Ahmmed, F., & Sarker, B. K. (2020). Filling the human resource gap through public-private partnership: Can private, community-based skilled birth attendants improve maternal health service utilization and health outcomes in a remote region of Bangladesh? *PloS one, 15*(1), e0226923. doi:10.1371/journal.pone.0226923

HOUSEHOLD, L. D. (2014). DHS Spatial Analysis Reports 10. In.

Huda, T. M., Chowdhury, M., El Arifeen, S., & Dibley, M. J. (2019). Individual and community level factors associated with health facility delivery: A cross sectional multilevel analysis in Bangladesh. *PloS one, 14*(2), e0211113.

ICF. (2016). ICF implements the DHS program. Retrieved from https://www.icf.com/clients/health/demographic-health-surveys-technical-assistance

ICF. (2018). *Demographic and Health Surveys Standard Recode Manual for DHS7*. Retrieved from Rockville, Maryland, U.S.A.: ICF: https://www.dhsprogram.com/pubs/pdf/DHSG4/Recode7_DHS_10Sep2018_DHSG4.pdf

ICF, & THE DHS Program. (2021). The DHS Program - Request Access To Datasets. Retrieved from https://dhsprogram.com/data/new-user-registration.cfm

ICF, & The DHS Program. (2022a, 2022/08/06/). The DHS Program - GPS Data Collection. Retrieved from https://dhsprogram.com/methodology/gps-data-collection.cfm

ICF, & THE DHS Program. (2022b). The DHS Program - SPA Methodology. In.

Iftikhar Ul Husnain, M., Rashid, M., & Shakoor, U. (2018). Decision-making for birth location among women in Pakistan: evidence from national survey. *BMC Pregnancy Childbirth, 18*(1), 226. doi:10.1186/s12884-018-1844-8

Jain, A. K., Sathar, Z. A., & ul Haque, M. (2015). The constraints of distance and poverty on institutional deliveries in Pakistan: evidence from georeference-linked data. *Stud Fam Plann, 46*(1), 21-39. doi:10.1111/j.1728-4465.2015.00013.x

Kabir, E., & Biswas, R. K. (2018). *Does income inequality matters for accessing health facility? Evidence from Bangladesh.* Paper presented at the Proceedings of the Melbourne International Business and Social Science Research Conference 2018.

Kebede, A., Hassen, K., & Nigussie Teklehaymanot, A. (2016). Factors associated with institutional delivery service utilization in Ethiopia. *Int J Womens Health, 8*, 463-475. doi:10.2147/ijwh.S109498

Kinney, M. V., Kerber, K. J., Black, R. E., Cohen, B., Nkrumah, F., Coovadia, H., . . . Weissman, E. (2010). Sub-Saharan Africa's mothers, newborns, and children: where and why do they die? *PLoS Med, 7*(6), e1000294. doi:10.1371/journal.pmed.1000294

Lawn, J., Cousens, S., Zupan, J., & Team, L. N. S. S. (2005). million deaths: When. *The Lancet Neonatal Survival Series*.

Lawn, J. E., Kinney, M., Lee, A. C., Chopra, M., Donnay, F., Paul, V. K., . . . Darmstadt, G. L. (2009). Reducing intrapartum-related deaths and disability: can the health system deliver? *International Journal of Gynecology & Obstetrics, 107*, S123-S142.

Lee, B. X., Kjaerulf, F., Turner, S., Cohen, L., Donnelly, P. D., Muggah, R., . . . MacGregor, L. S. (2016). Transforming our world: implementing the 2030 agenda through sustainable development goal indicators. *Journal of public health policy, 37*(1), 13-31.

Lohela, T. J., Campbell, O. M., & Gabrysch, S. (2012). Distance to care, facility delivery and early neonatal mortality in Malawi and Zambia. *PloS one, 7*(12), e52110. doi:10.1371/journal.pone.0052110

Ministry of Health and Family Welfare (MOHFW) [Bangladesh]. (2016). *Bangladesh National Health Accounts 1997-2015*. Retrieved from Dhaka, Bangladesh:

Bangladesh's public health service delivery structure. (2021). Ministry of Health and Family Welfare (MOHFW) [Bangladesh] [Mobile application software]. Retrieved from https://www.who-seajph.org/viewimage.asp?img=WHOSouth-EastAsiaJPublicHealth_2021_10_3_93_309884_f1.jpg

Moyer, C. A., & Mustafa, A. (2013). Drivers and deterrents of facility delivery in sub-Saharan Africa: a systematic review. *Reproductive Health, 10*(1), 1-14.

Munn, Z., Aromataris, E., Tufanaru, C., Stern, C., Porritt, K., Farrow, J., . . . Lizarondo, L. (2019). The development of software to support multiple systematic review types: the Joanna Briggs Institute System for the Unified Management, Assessment and Review of Information (JBI SUMARI). *JBI Evidence Implementation, 17*(1), 36-43.

Nandi, A., Charters, T. J., Quamruzzaman, A., Strumpf, E. C., Kaufman, J. S., Heymann, J., . . . Harper, S. (2022). Health care services use, stillbirth, and neonatal and infant survival following implementation of the Maternal Health Voucher Scheme in Bangladesh: A difference-in-differences analysis of Bangladesh Demographic and Health Survey data, 2000 to 2016. *PLoS Med, 19*(8), e1004022.

National Institute of Population Research and Training (NIPORT), & ICF. (2019). *Bangladesh Health Facility Survey 2017*. Retrieved from Dhaka, Bangladesh:

National Institute of Population Research Training - NIPORT, M. o. H. F. W., ICF,. (2020). *Bangladesh Demographic and Health Survey 2017-18*. Retrieved from Dhaka, Bangladesh: https://www.dhsprogram.com/pubs/pdf/FR344/FR344.pdf

National Institute of Population Research Training (NIPORT), & ICF. (2020). *Bangladesh Demographic and Health Survey 2017-18*. Retrieved from Dhaka, Bangladesh, and Rockville, Maryland, USA:

Navaneetham, K., & Dharmalingam, A. (2002). Utilization of maternal health care services in Southern India. *Social science & medicine, 55*(10), 1849-1869.

Nuruzzaman, M., Zapata, T., McIsaac, M., Wangmo, S., Islam, M. J., Almamun, M., . . . Dussault, G. (2022). Informing investment in health workforce in Bangladesh: a health labour market analysis. *Human Resources for Health, 20*(1), 73. Retrieved from https://doi.org/10.1186/s12960-022-00769-2. doi:10.1186/s12960-022-00769-2

Olsen, O. E., Ndeki, S., & Norheim, O. F. (2005). Availability, distribution and use of emergency obstetric care in northern Tanzania. *Health policy and planning, 20*(3), 167-175.

Olsen, Ø. E., Ndeki, S., & Norheim, O. F. (2005). Availability, distribution and use of emergency obstetric care in northern Tanzania. *Health policy and planning, 20*(3), 167-175.

Organization, W. H. (2010). *Why urban health matters*. Retrieved from

Organization, W. H. (2013). *Service availability and readiness assessment (SARA): an annual monitoring system for service delivery: reference manual*. Retrieved from

Organization, W. H. (2015a). *Bangladesh health system review*: WHO Regional Office for the Western Pacific.

Organization, W. H. (2015b). Strategies towards ending preventable maternal mortality (EPMM).

Organization, W. H. (2015c). Success factors for women's and children's health: Bangladesh.

Paxton, A., Bailey, P., Lobis, S., & Fry, D. (2006). Global patterns in availability of emergency obstetric care. *International Journal of Gynecology & Obstetrics, 93*(3), 300-307.

Pervin, J., Venkateswaran, M., Nu, U. T., Rahman, M., O'Donnell, B. F., Friberg, I. K., . . . Frøen, J. F. (2021). Determinants of utilization of antenatal and delivery care at the community level in rural Bangladesh. *PloS one, 16*(9), e0257782.

Preis, H., Gozlan, M., Dan, U., & Benyamini, Y. (2018). A quantitative investigation into women's basic beliefs about birth and planned birth choices. *Midwifery, 63*, 46-51.

Pulok, M. H., Sabah, M. N.-U., Uddin, J., & Enemark, U. (2016). Progress in the utilization of antenatal and delivery care services in Bangladesh: where does the equity gap lie? *BMC Pregnancy and Childbirth, 16*(1), 200. Retrieved from https://doi.org/10.1186/s12884-016-0970-4. doi:10.1186/s12884-016-0970-4

Rahman, M., Kabir, M., Moon, M., Ame, A., & Islam, M. (2021). *Gender role on food security and consumption practices in Bangladesh.*

Rahman, M. A., Rahman, M. A., Rawal, L. B., Paudel, M., Howlader, M. H., Khan, B., . . . Rahman, M. S. (2021). Factors influencing place of delivery: Evidence from three south-Asian countries. *PloS one, 16*(4), e0250012.

Rahman, M. A., Rahman, M. A., Rawal, L. B., Paudel, M., Howlader, M. H., Khan, B., . . . Islam, S. M. S. (2021). Factors influencing place of delivery: Evidence from three south-Asian countries. *PloS one, 16*(4), e0250012. doi:10.1371/journal.pone.0250012

Ray-Bennett, N. S., Corsel, D. M. J., Goswami, N., & Ghosh, A. (2019). Understanding reproductive health challenges during a flood: insights from Belkuchi Upazila, Bangladesh. *Gates Open Research, 3*(788), 788. Retrieved from https://gatesopenresearch.org/articles/3-788/v2. doi:10.12688/gatesopenres.12920.2

Raymondville, M., Rodriguez, C. A., Richterman, A., Jerome, G., Katz, A., Gilbert, H., . . . Ivers, L. C. (2020). Barriers and facilitators influencing facility-based childbirth in rural Haiti: a mixed method study with a convergent design. *BMJ global health, 5*(8), e002526. Retrieved from https://gh.bmj.com/content/bmjgh/5/8/e002526.full.pdf. doi:10.1136/bmjgh-2020-002526

Research, N. I. o. P., Training - NIPORT/Bangladesh, Mitra, Associates/Bangladesh, & Macro International. (2009). *Bangladesh Demographic and Health Survey 2007*. Retrieved from Dhaka, Bangladesh: http://dhsprogram.com/pubs/pdf/FR207/FR207.pdf

Reynolds, H. W., Wong, E. L., & Tucker, H. (2006). Adolescents' use of maternal and child health services in developing countries. *International family planning perspectives*, 6-16.

Rosen, B., Waitzberg, R., & Merkur, S. (2015). Health Systems in Transition. *Israel: Health system review*.

Roy, L., Biswas, T. K., & Chowdhury, M. E. (2017). Emergency obstetric and newborn care signal functions in public and private facilities in Bangladesh. *PloS one, 12*(11), e0187238. doi:https://dx.doi.org/10.1371/journal.pone.0187238

Rubayet, S., Shahidullah, M., Hossain, A., Corbett, E., Moran, A. C., Mannan, I., . . . Mannan, I. (2012). Newborn survival in Bangladesh: a decade of change and future implications. *Health policy and planning, 27*(suppl_3), iii40-iii56.

Sarker, B. K., Rahman, M., Rahman, T., Hossain, J., Reichenbach, L., & Mitra, D. K. (2016). Reasons for Preference of Home Delivery with Traditional Birth Attendants (TBAs) in Rural Bangladesh: A Qualitative Exploration. *PloS one, 11*(1), e0146161. Retrieved from https://doi.org/10.1371/journal.pone.0146161. doi:10.1371/journal.pone.0146161

Say, L., Chou, D., Gemmill, A., Tunçalp, Ö., Moller, A.-B., Daniels, J., . . . Alkema, L. (2014).
Global causes of maternal death: a WHO systematic analysis. *The Lancet Global Health,*
2(6), e323-e333.

Sayem, A. M., Nury, A. T., & Hossain, M. D. (2011). Achieving the millennium development goal
for under-five mortality in Bangladesh: current status and lessons for issues and challenges
for further improvements. *J Health Popul Nutr, 29*(2), 92-102.
doi:10.3329/jhpn.v29i2.7813

Schultz, C. (2014). World Migration Report. *Migartion, Health, and Cities Migration, Health and*
Urbanization: Interrelated Challenges Berlin. Berlin: International Organization for
Migration (IOM).

Shahabuddin, A., De Brouwere, V., Adhikari, R., Delamou, A., Bardaj, A., & Delvaux, T. (2017).
Determinants of institutional delivery among young married women in Nepal: Evidence
from the Nepal Demographic and Health Survey, 2011. *BMJ open, 7*(4), e012446.
Retrieved from https://bmjopen.bmj.com/content/bmjopen/7/4/e012446.full.pdf.
doi:10.1136/bmjopen-2016-012446

Sheffel, A., Karp, C., & Creanga, A. A. (2018). Use of Service Provision Assessments and Service
Availability and Readiness Assessments for monitoring quality of maternal and newborn
health services in low-income and middle-income countries. *BMJ global health, 3*(6),
e001011.

Skiles, M. P., Burgert, C. R., Curtis, S. L., & Spencer, J. (2013). Geographically linking population
and facility surveys: methodological considerations. *Population health metrics, 11*(1), 1-
13.

Song, P., Kang, C., Theodoratou, E., Rowa-Dewar, N., Liu, X., & An, L. (2016). Barriers to Hospital Deliveries among Ethnic Minority Women with Religious Beliefs in China: A Descriptive Study Using Interviews and Survey Data. *Int J Environ Res Public Health, 13*(8). doi:10.3390/ijerph13080815

Sserwanja, Q., Mukunya, D., Musaba, M. W., Kawuki, J., & Kitutu, F. E. (2021). Factors associated with health facility utilization during childbirth among 15 to 49-year-old women in Uganda: evidence from the Uganda demographic health survey 2016. *BMC health services research, 21*(1), 1160. Retrieved from https://doi.org/10.1186/s12913-021-07179-5. doi:10.1186/s12913-021-07179-5

Statistics Canada. (2023). Probability Sampling Retrieved from https://www150.statcan.gc.ca/n1/edu/power-pouvoir/ch13/prob/5214899-eng.htm

Sule, S., Ijadunola, K., Onayade, A., Fatusi, A., Soetan, R., & Connell, F. (2008). Utilization of primary health care facilities: lessons from a rural community in southwest Nigeria. *Nigerian journal of medicine, 17*(1), 98-106.

Suleman Hassen, S., Mulatu Teshale, B., & Abate Adulo, L. (2021). Identifying Factors Associated with Barriers in the Number of Antenatal Care Service Visits among Pregnant Women in Rural Parts of Ethiopia. *TheScientificWorldJournal, 2021*, 7146452. Retrieved from http://europepmc.org/abstract/MED/34733121

https://doi.org/10.1155/2021/7146452

https://europepmc.org/articles/PMC8560300

https://europepmc.org/articles/PMC8560300?pdf=render doi:10.1155/2021/7146452. (Accession No. 34733121)

Tegegne, T. K., Chojenta, C., Getachew, T., Smith, R., & Loxton, D. (2020). Giving birth in Ethiopia: a spatial and multilevel analysis to determine availability and factors associated with healthcare facility births. *BJOG : an international journal of obstetrics and gynaecology, 127*(12), 1537-1546. doi:https://dx.doi.org/10.1111/1471-0528.16275

Tesema, G. A., & Tessema, Z. T. (2021). Pooled prevalence and associated factors of health facility delivery in East Africa: Mixed-effect logistic regression analysis. *PloS one, 16*(4), e0250447. doi:10.1371/journal.pone.0250447

Thaddeus, S., & Maine, D. (1994). Too far to walk: maternal mortality in context. *Social science & medicine, 38*(8), 1091-1110.

The DHS Program. (2022a, 2022/08/05/). Demographic and Health Survey (DHS). Retrieved from https://dhsprogram.com/Methodology/Survey-Types/DHS.cfm

The DHS Program. (2022b, 2022/08/05/). Service Provision Assessments (SPA). Retrieved from https://dhsprogram.com/Methodology/Survey-Types/SPA.cfm

UNFPA, W., & UNICEF, A. (2009). Monitoring emergency obstetric care: a handbook. *Geneva, Switzerland: World Health Organization*.

Unicef. (2014). *Trends in maternal mortality: 1990 to 2013*: Geneva: World Health Organization.

UNICEF. (2023). Global delivery care coverage and trends. In.

Wang, H., Frasco, E., Takesue, R., & Tang, K. (2021). Maternal education level and maternal healthcare utilization in the Democratic Republic of the Congo: an analysis of the multiple indicator cluster survey 2017/18. *BMC Health Serv Res, 21*(1), 850. doi:10.1186/s12913-021-06854-x

Wang, W., & Mallick, L. (2019). Understanding the relationship between family planning method choices and modern contraceptive use: an analysis of geographically linked population and health facilities data in Haiti. *BMJ global health, 4*(Suppl 5), e000765.

Wang, W., Winner, M., & Burgert-Brucker, C. R. (2017). Limited Service Availability, Readiness, and Use of Facility-Based Delivery Care in Haiti: A Study Linking Health Facility Data and Population Data. *Global Health: Science and Practice, 5*(2), 244. Retrieved from http://www.ghspjournal.org/content/5/2/244.abstract. doi:10.9745/GHSP-D-16-00311

Wang, W., Winner, M., & Burgert-Brucker, C. R. (2017). Limited Service Availability, Readiness, and Use of Facility-Based Delivery Care in Haiti: A Study Linking Health Facility Data and Population Data. *Glob Health Sci Pract, 5*(2), 244-260. doi:10.9745/ghsp-d-16-00311

Wangmo, S., Sarkar, S., Islam, T., Rahman, M., & Landry, M. (2021). Maintaining essential health services during the pandemic in Bangladesh: the role of primary health care supported by routine health information system. *WHO South-East Asia Journal of Public Health, 10*(3), 93-99. Retrieved from http://www.who-seajph.org/article.asp?issn=2224-3151;year=2021;volume=10;issue=3;spage=93;epage=99;aulast=Wangmo. doi:10.4103/2224-3151.309884

WHO. (2019). Maternal mortality. *Fact Sheets.* Retrieved from https://www.who.int/news-room/fact-sheets/detail/maternal-mortality

WHO, U., & UNICEF. (2016). AMDD. Monitoring emergency obstetric care: a handbook. Geneva: World Health Organization; 2009. In.

Wikipedia. (2022, 2022/07/06/). Administrative geography of Bangladesh. Retrieved from https://en.wikipedia.org/w/index.php?title=Administrative_geography_of_Bangladesh&oldid=1096724142

Wilunda, C., Putoto, G., Riva, D. D., Manenti, F., Atzori, A., Calia, F., . . . Tarmbulini, G. (2015). Assessing coverage, equity and quality gaps in maternal and neonatal care in sub-Saharan Africa: An integrated approach. *PloS one, 10*(5), e0127827. Retrieved from http://www.plosone.org/article/fetchObject.action?uri=info:doi/10.1371/journal.pone.0127827&representation=PDF. doi:https://dx.doi.org/10.1371/journal.pone.0127827

Winter, R., Yourkavitch, J., Wang, W., & Mallick, L. (2017). Assessment of health facility capacity to provide newborn care in Bangladesh, Haiti, Malawi, Senegal, and Tanzania. *J Glob Health, 7*(2), 020509. doi:10.7189/jogh.07.020509

Winter, R., Yourkavitch, J., Wang, W., & Mallick, L. (2017). Assessment of health facility capacity to provide newborn care in Bangladesh, Haiti, Malawi, Senegal, and Tanzania. *J Glob Health, 7*(2).

World Health, O. (2019). *Trends in maternal mortality 2000 to 2017: estimates by WHO, UNICEF, UNFPA, World Bank Group and the United Nations Population Division*. Geneva: World Health Organization.

World Health Organization. (2017). *Managing complications in pregnancy and childbirth: a guide for midwives and doctors*: World Health Organization.

World Health Organization, United Nations Populatin Fund, & United Nations Children's Fund. (2009). Disability Program (AMDD): Needs Assessment of Emergency Obstetric and Newborn Care (EmONC): Facilitator's Guide. *New York: Averting Maternal Death and Disability*.

World Health Organization. Regional Office for the Western, P. (2015). *Bangladesh health system review* (Vol. 5). Manila: WHO Regional Office for the Western Pacific.

Yaffee, A. Q., Whiteside, L. K., Oteng, R. A., Carter, P. M., Donkor, P., Rominski, S. D., . . . Cunningham, R. M. (2012). Bypassing proximal health care facilities for acute care: a survey of patients in a Ghanaian Accident and Emergency Centre. *Trop Med Int Health, 17*(6), 775-781. doi:10.1111/j.1365-3156.2012.02984.x

Yaya, S., Bishwajit, G., & Ekholuenetale, M. (2017). Factors associated with the utilization of institutional delivery services in Bangladesh. *PloS one, 12*(2), e0171573.

Yaya, S., Uthman, O. A., Okonofua, F., & Bishwajit, G. (2019). Decomposing the rural-urban gap in the factors of under-five mortality in sub-Saharan Africa? Evidence from 35 countries. *BMC public health, 19*(1), 616. Retrieved from https://doi.org/10.1186/s12889-019-6940-9. doi:10.1186/s12889-019-6940-9

Zenbaba, D., Sahiledengle, B., Dibaba, D., & Bonsa, M. (2021). Utilization of Health Facility-Based Delivery Service Among Mothers in Gindhir District, Southeast Ethiopia: A Community-Based Cross-Sectional Study. *Inquiry, 58*, 469580211056061. doi:10.1177/00469580211056061

Ziraba, A. K., Mills, S., Madise, N., Saliku, T., & Fotso, J.-C. (2009). The state of emergency obstetric care services in Nairobi informal settlements and environs: results from a maternity health facility survey. *BMC health services research, 9*(101088677), 46. doi:https://dx.doi.org/10.1186/1472-6963-9-46

Appendices

1.1   Appendix 1 Method used to search for the literature on facility birth

Primary literature for this review was search in four major databases Medline, Embase, Global Health & Scopus. Search strategy was discussed and formulated with the help of librarian and my supervisors from University of Alberta. This strategy for identifying relevant literature takes advantage of a systematic approach and PICO formula to extract search terms from the research question (Davies, 2011). Then combinations of these search terms (i.e., facility delivery, Facility preparedness, Service provision assessment etc.), and their synonyms were used with Boolean operators to get an extensive list of literature relevant to this research. Database search was conducted between the following period January 2000 to January 2022.
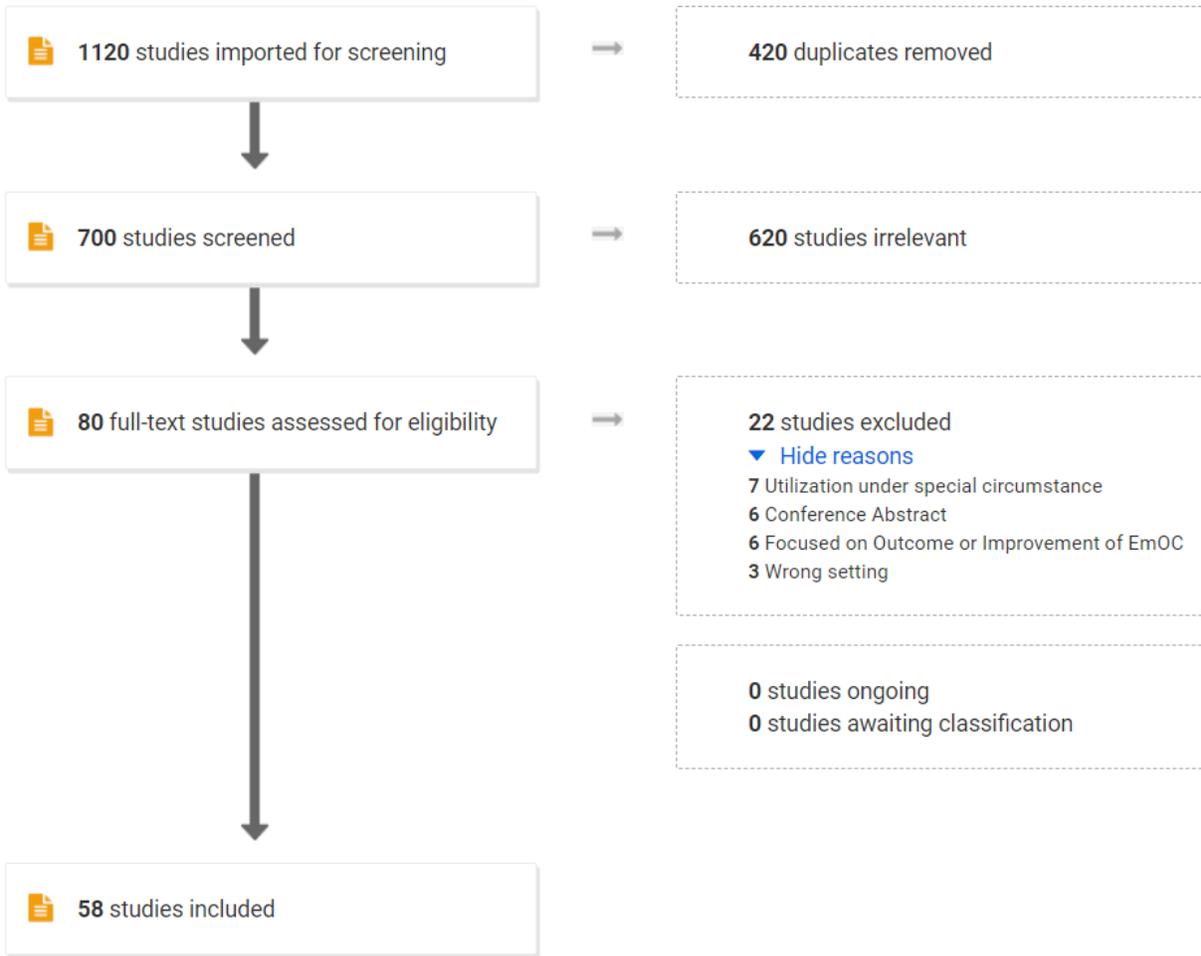
Figure 1: PRISMA Checklist

Citation of all literature from the database search was imported into the Covidence review management software (Babineau, 2014). A total of 1120 articles were imported for screening. 420 duplicate articles were removed. A list of inclusion and exclusion criteria (Appendix 1) were developed to screen the remaining 700 articles and 80 relevant articles were identified by combing through the title and the abstracts. Full text screening was conducted on 80 articles using same criteria and included 58 articles for this literature review. After completing the screening, JBI Quality assessment tool was used to assess quality of each of the finalized articles (Munn et al., 2019). This assessment yielded 10 articles of poor quality, which were excluded from the final

review (Appendix 2). Finally, the 48 remaining articles were reviewed to understand the key factors that can impact the utilization of the delivery services in addition to exploring the current rate of utilization of this service in Bangladesh. Although this review follows all the steps of systematic review, due to resource constraints the screening and review was conducted by an individual instead of two people where all the processes are finalized by consensus of two reviewers. This could introduce selection bias and a key limitation of this review. The systematic search strategy, inclusion exclusion criteria and the JBI Quality assessment tool played an important role in minimizing this bias.

1.2 Appendix 2 Inclusion & Exclusion criteria for article screening

Traits	Inclusion Criteria	Exclusion Criteria
Study Focus	1. Studies focusing on utilization of Emergency Obstetric Care (Both basic and Comprehensive) 2. Studies focusing on facility birth & factors influencing 3. Studies focusing on Facility Assessment specifically Service availability and preparedness)	1. Studies focusing on outcome or improvement of Emergency obstetric care 2. Studies focusing on Neonatal health 3. Studies focusing on facility referral or home birth in presence of skilled birth attendant 4. Effect on facility utilization due to special circumstances (i.e. Covid-19)
Study Location	Study conducted in LMICs	Any other study location
Study Types & Design	All forms of Qualitative, quantitative and review studies matching study focus	Any reports/ Experimental Trials
Study Timeline	January 2000 to January 2022	
Study Language	English literatures only	

1.3 Appendix 3 Quality Assessment of Screened Literature

Stud y ID	Title	Study Population Described	Inclusion Exclusion Criteria Defined	Study Design Justified	Exposure defined & measured	Identified & Adjusted for Confounder Y/N	Outcome defined & measured	Sample Size & Sampling technique Justified	Analysis Justified	Assessment Score
1	Availability, utilization, and quality of emergency obstetric care servicesin Bauchi State, Nigeria	Yes	No	Yes	Yes	No	Yes	No	Yes	62.50
2	Basic emergency obstetric and newborn care service availability and readiness in Nepal: Analysis of the 2015 Nepal Health Facility Survey	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	87.50
3	Mapping the quality of basic and comprehensive emergency obstetric care services in Haiti	Yes	No	Yes	Yes	No	Yes	Yes	Yes	75.00
4	Indicators for availability, utilization, and quality of emergency obstetric care in Ethiopia, 2008	Yes	Yes	Yes	NA	NA	Yes	Yes	No	83.33
5	Coverage of emergency obstetric care and availability of services in public and private health facilities in Bangladesh	Yes	Yes	Yes	NA	NA	Yes	Yes	No	83.33
6	Quality of emergency obstetric and newborn care services in Wolaita Zone, Southern Ethiopia	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	87.50
7	CHALLENGES IN ACCESS TO AND UTILIZATION OF REPRODUCTIVE HEALTH CARE IN PAKISTAN	Yes	No	Yes	Yes	No	Yes	Yes	Yes	75.00
8	Measuring facility capability to provide routine and emergency childbirth care to mothers and newborns: An appeal to adjust for delivery caseload of facilities	Yes	No	Yes	NA	NA	Yes	Yes	Yes	83.33

Stud Quality Assessment Score Guide

Assessment Score	Study Quality	# Of Studies
>75%	High	33
50% - 75%	Moderate	16
<50%	Low	9

1.4 Appendix 4 Ethics approval for the study from the University of Alberta

Notification of Approval

Date:	May 26, 2022
Study ID:	Pro00120845
Principal Investigator:	Ambikaipakan Senthilselvan
Study Title:	Impact assessment of Basic Emergency Obstetric Care service availability and preparedness on facility-based delivery in Bangladesh
Approval Expiry Date:	May 25, 2023

Thank you for submitting the above study to the Research Ethics Board 2. Your application has been reviewed and approved on behalf of the committee.

Approved Documents:

Protocol/Research Proposal
Research Proposal

Any proposed changes to the study must be submitted to the REB for approval prior to implementation. A renewal report must be submitted next year prior to the expiry of this approval if your study still requires ethics approval. If you do not renew on or before the renewal expiry date, you will have to re-submit an ethics application.

Approval by the REB does not constitute authorization to initiate the conduct of this research. The Principal Investigator is responsible for ensuring required approvals from other involved organizations (e.g., Alberta Health Services, Covenant Health, community organizations, school boards) are obtained, before the research begins.

Sincerely,

Theresa Garvin, Ph.D, MUA, BA
Chair, Research Ethics Board 2

Note: This correspondence includes an electronic signature (validation and approval via an online system).