EFFECTS OF COVID-19 ON MATERNAL, NEONATAL AND CHILD HEALTH SERVICES IN BANGLADESH

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Abstract

The global COVID-19 pandemic has adversely affected maternal and child health services and is likely to undermine the performances achieved in the last few decades. This study tried to identify the effects of COVID-19 on maternal, neonatal, and child health services including both home and facility delivery, antenatal and postnatal care, and births and deaths of neonates and mothers. Using secondary data of the 64 districts of Bangladesh from 2016 to 2020 (available at the Directorate General of Family Planning (DGFP) website), this study compared the data of 2020 with the average of 2016-2019 and analyzed the trends for several indicators from 2016 to 2020. Finally, a regression was performed to identify the determinants of facility delivery and the effects of COVID-19 on 4 ANCs. The study finds a declining trend in major indicators for maternal, neonatal, and child health services during the COVID-19 pandemic compared with the average of years 2016 to 2019. More specifically, during that period antenatal cares (ANCs) and post-natal cares (PNCs), home delivery with and without a trained person declined whereas facility delivery increased. Regression estimates a 5.3% decline in facility delivery in the districts with more than average COVID-19 cases (1,241 cases) compared to the districts with below-average COVID-19 cases. There was a significant ($p = 0.0014$) difference of 8.50% in facility delivery between the districts with above-average cases and below-average cases. The estimates may offer some guidance on how countries should react to such a pandemic to ensure continuity of care with adequate funding for prevention and control measures,

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supplies and services, and required equipment for healthcare workers, even though the study did not aim to project the post-COVID-19 effects.

Keywords: COVID-19, Facility Delivery, C-section, Home Delivery, ANC, PNC

Introduction

The global and national healthcare systems have undergone an extraordinary transformation resulting from COVID-19 pandemic. As a result, many countries imposed national or local lockdowns to limit the spread of the disease. Studies have shown that COVID-19 adversely affected maternal and newborn health services, particularly in countries having limited (Makoni, 2020; Roberton, *et al.*, 2020; Sochas, Channon, & Nam, 2017; Stein, Ward, & Cantelmo, 2020). Nearly 80 million women gave birth in medical institutions around the world in 2019, which is three times higher than in 2000 (Countdown to 2030 Collaboration, 2018). Maternal, neonatal, and stillbirth rates drastically decreased during the past 20 years as more women and their babies have access to quality, compassionate care before, during, and after pregnancy (WHO, UNICEF, UNFPA, World Bank Group and the United Nations Population Division, 2015; Blencowe, *et al*., 2016; UNICEF, 2019). Bangladesh is not an exception to this global trend. Maternal and neonatal health indicators improved substantially, and steps have been taken to create a pathway to achieve the SDG targets. On March 2020, Bangladesh's epidemiology institute announced the country's first COVID-19 cases (Dhaka Tribune, 2020). The pandemic has since spread across the entire nation, and the number of affected persons has been rising. From 26th March to 30th May 2020, the government declared a "lockdown" nationwide as a precaution against the pandemic and to safeguard the population (Dhaka Tribune, 2020). During this time, giving birth at facilities and accessing treatment for complications in health facilities were compromised. Assessing the number of institutional births, associated institutional stillbirth and neonatal mortality rate, and quality of intrapartum care, Ashish *et al.,* 2020 found that institutional childbirth was reduced by more than half during the lockdown, with increases in institutional stillbirth rate and neonatal mortality, and decreases in quality of care during the country-wide COVID-19 lockdown in Nepal. Throughout this pandemic time, there was a pressing need to safeguard access to high-quality intrapartum care and avoid unnecessary fatalities among those who were most dependent on the health system (Ashish, *et al.*, 2020).

In addition, during the pandemic, coverage of necessary maternal and child health services in low-income countries was also observed. A study by Roberton,

et al., 2020 revealed a decrease in the coverage of necessary maternal and child health services and an increased prevalence of wasting over 3, 6, and 12 months in countries with low and middle income (Roberton, *et al.*, 2020). Meanwhile, it would be alarming to see an increase in child and maternal deaths when normal healthcare is disturbed and access to fundamental rights is reduced (Roberton, *et al.*, 2020; Menendez, Gonzalez, Donnay, & Lekee, 2020; Sochas, Channon, & Nam, 2017).

Moreover, mothers' access to timely and quality maternal healthcare was limited during the pandemic. According to Stein, Ward, and Cantelmo's estimates from 2020, containment and early preparedness of mother and newborn health could have a greater positive impact in countries with low and middle income (Stein, Ward, & Cantelmo, 2020). Before the emergence of COVID-19, millions of women lacked access to timely, high-quality maternal healthcare or could not afford it. Travel and gathering restrictions, health facilities with insufficient supplies for infection control and erratic infection control methods, and interrupted community health worker schedules all posed a threat to exacerbate limited healthcare access.

Mahtab and Chowdhury (2020) report that during COVID-19, pregnant women are at increased risk compared to their nonpregnant counterparts. Moreover, the risk of preterm birth is around three times higher for mothers who have COVID-19 (Mahtab & Chowdhury, 2020). According to Ehsan & Jahan's 2021 study, all mothers encounter difficulties when utilizing standard medical services. It also shows that COVID-19 has negative effects on mothers' family planning, seriously interfering with expectant mothers' and new mothers' prenatal and postnatal checks (Ehsan & Jahan, 2021). Mhajabin, *et al*., (2022) report that receiving ANC and skilled birth attendance during delivery declined while compared to the time before the pandemic (Mhajabin S., *et al.*, 2022). Rahman, Halder & Islam, 2021 found similar findings in Bangladesh. Following the lockdown's declaration on 26th March 2020, the percentage of pregnant women giving birth at home jumped from 50% to 73%, which demonstrates a dramatic reduction in normal and C-section deliveries at healthcare facilities (Rahman, Halder, & Islam, 2021).

COVID-19's long-term effects on healthcare services and public health undermine the years of progress in health outcomes. If the services drop, this progress may not be sustained in the future and the achievements may reverse. These encourage conducting this study to investigate the effects of COVID-19. This paper focuses on identifying the magnitude of the effects of COVID-19 on maternal, neonatal, and child health services including home and facility delivery, receiving antenatal

care (ANC) and postnatal care (PNC), birth and deaths of neonatal and mothers, and family planning services in Bangladesh.

This paper is arranged as follows. Section 2 presents data and estimation methods followed by the findings presented in Section 3. Section 4 provides some discussion and Section 5 presents the conclusion and policy recommendations.

Data and Estimation Methods

Data

In the empirical estimations, this study used data of ANC-1; ANC-2; ANC-3; ANC-4; home delivery with a trained person; home delivery with a non-trained person; facility delivery (normal); facility delivery (C- section); PNC- 1 (mother); PNC- 2 (mother); PNC- 3 (mother); PNC- 4 (mother); PNC- 1 (neonatal); PNC- 2 (neonatal); PNC- 3 (neonatal); PNC- 4 (neonatal; low birth weight (LBW), *i.e.,* newborn with less than 2.5 KG; immature newborn before 37 weeks; death of a child (child death) within 28 days; death of child between 29 and 365 days; death of child between 1 to 5 years; maternal death; and breastfeeding newborn in first 24 hours. These data were taken from the website of the Management Information System (MIS) of the Directorate General of Family Planning (DGFP).[5] The study analyzed data for the months of March through June 2020 as data of these four months were publicly available while conducting this study. Another reason for choosing these four months only is that as the first case was detected on 8th March 2020 in Bangladesh, COVID-19 infection was at its peak during this period and we tried to identify the effect of COVID-19 on maternal and neonatal health services when the spread was at its peak (Dhaka Tribune, 2020). If the study considered the average value of indicators for all months, this could overstate or understate the indicators' value. Another reason is that there is variations in service delivery throughout the months. For example, in monsoon, some districts perform lower due to having difficulties in reaching hard-to-reach areas, and their performance ability is underestimated. Thus, the data set of this study consists of monthly observations from March- June for each of the 64 districts of Bangladesh from 2016 to 2020. The study used COVID-19 infection data from the COVID-19 dashboard maintained by the Ministry of Health and Family Welfare (MOHFW).[6]

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5 Website of Management Information System (MIS) of Directorate General of Family Planning (DGFP) is https://dgfpmis.org/ss/ss_menu9.php#

6 The dashboard can be accessed at: www.corona.gov.bd

Estimation Method

This study reported the comparison of the average of months from March-June for the year 2020 and the average of March-June for 2016-2019. Hence, this study considered the average values of the indicators for the four months of 2016-2019.

Year-wise trends for some important performance indicators (*e.g.,* percentage of facility delivery, home delivery with a trained person, PNC-1 (mother), and PNC-1 (neonatal), taking ANC-1 by pregnant women, ANC-1, home delivery with a trained person, PNC-1 (mother), PNC-1 (neonatal) etc. for different years (2016-2020) are presented in the findings section.

The districts were divided into two categories: those with more than average COVID-19 cases (the average case was 1,241 on 22nd September 2021 on the day of analysis) and those with less than average COVID-19 cases. We used t-test to determine whether the facility delivery rate across the two kinds of districts varied significantly.

A simple regression was performed to identify the determinants of facility delivery and the effect of COVID-19 on them. Random effect (RE) and fixed effect (FE) estimators were used along with pooled OLS estimators. In choosing between RE and FE for coefficients, the Hausman test was performed.

Let's assume an equation for a percentage of facility delivery is as follows:

$$\alpha_{it} + \boldsymbol{\beta}_{it} X_{it} + \ldots (1)$$

where is the percentage of facility delivery; α_{it} is the constant term; is the vector of explanatory variables (regressors) including log of ANC-1, log of ANC-2, log of ANC-3, log of ANC-4, and a dummy variable for districts with above-average COVID-19 cases; is the error term; the number of districts, N; and the number of periods,.

So, the regression equation can be rewritten as follows:

$\alpha_{it} + \boldsymbol{\beta}_{it}$ *(log of ANC-1)*$_{it} + \boldsymbol{\beta}_{it}$ *(log of ANC-2)*$_{it} + \boldsymbol{\beta}_{it}$ *(log of ANC-3)*$_{it} + \boldsymbol{\beta}_{it}$ *(log of ANC-4)*$_{it} + \boldsymbol{\beta}_{it}$ *(Dummy variable for districts with above average COVID-19 cases)*$_{it} + \ldots (2)$

Findings

This section presents findings for maternal, neonatal, and child health (MNCH) care provided by the DGFP.

Trends of performance indicators between 2016 and 2020 are presented in Table 1. The use of ANC-1 by pregnant women decreased. A declining trend is observed for home delivery with a trained person, PNC-1 (mother), and PNC-1 (neonatal). Among the four ANCs, ANC-1 showed a sharp decline of 25%, home delivery with a trained person declined by 17%, PNC-1 (mother) declined by 9.26%, and PNC-1 (neonatal) declined by 20% in 2020 compared to the previous year. Normal delivery and C-section rates in facilities rose throughout the years 2016-2019 but drops by 13% and 14% respectively in 2020. Breastfeeding newborns in the first 24 hours had an upward trend but dropped by 16.5% in 2020 (see Table 1).

Table 1: Trends of antenatal care, delivery care, postnatal care, birth and deaths, and other indicators

Year	2016	2017	2018	2019	2020
ANC-1	678,038	697,531	719,711	661,913	495,888
Delivery at home with trained personnel	178,152	162,301	158,004	164,692	136,671
Delivery at Facility-Normal	119,213	118,991	120,560	184,954	160,887
Delivery at Facility-C-Section	86,866	94,294	95,478	162,292	139,426
PNC- 1 (Mother)	151,760	172,334	191,966	179,718	133,084
PNC- 1 (Neonatal)	134,290	170,320	184,596	150,847	121,930
Newborn breastfed within 24 hours	91,237	119,341	129,997	149,774	125,087
Newborn with low birth weight <2.5 KG	6,939	4,970	3,715	3,303	3,064
Immature newborn (before 37 weeks)	2,740	1,818	1,905	1,658	1,147
Death of childbirth (0 days to 1 year)	2,456	1,798	1,368	2,485	1,327
Death of childbirth (1 year to 5 years)	906	824	715	77	44
Maternal death	500	316	204	451	256

In contrast, some indicators including low birth weight newborns, immature newborns, stillbirths, deaths of childbirths (<1 year), deaths of childbirths (1-5 years), and maternal deaths showed better performance in 2020 and had an upward trend for the years 2016-2020 (see Table 1). This could result from increased

facility delivery.

Performance of antenatal care, delivery care, postnatal care, birth and deaths, and other indicators of 2020 is compared with 2016-2019 and the results are presented in Table 2.

The DGFP primarily provides four antenatal care services. Table 2 compares the months of March-June of 2020 with that of 2016- 2019. It is evidenced that the spread of COVID-19 in 2020 reduced the recipients of ANCs in 2020 and rate declined for ANC-1 by 28% and ANC-3 by 37%.

Table 2: Performance of antenatal, delivery, and postnatal care, birth and deaths, and other indicators

Variable	2020 (during COVID-19)	2016-2019 (before COVID-19)	Difference between 2020 and 2016-2019
ANC-1	495,888	689,298	-28.06%
ANC-2	379,177	596,312	-36.41%
ANC-3	319,356	505,821	-36.86%
ANC-4	273,760	400,779	-31.69%
Home delivery with a trained person	136,671	165,787	-17.56%
Home delivery with a non-trained person	46,397	53,741	-13.67%
Facility delivery-normal	160,887	135,930	18.36%
Facility delivery-C- section	139,426	109,733	27.06%
PNC- 1 (Mother)	133,084	173,945	-23.49%
PNC- 2 (Mother)	114,951	157,124	-26.84%
PNC- 3 (Mother)	124,029	180,678	-31.35%
PNC- 4 (Mother)	145,400	225,213	-35.44%
PNC- 1 (Neonatal)	121,930	160,013	-23.80%
PNC- 2 (Neonatal)	102,297	139,244	-26.53%
PNC- 3 (Neonatal)	109,404	154,105	-29.01%
PNC- 4 (Neonatal)	122,209	190,797	-35.95%
Newborn with LBW <2.5 KG	3,064	4,732	-35.25%
Immature newborn before 37 weeks	1,147	2,030	-43.50%

Variable	2020 (during COVID-19)	2016-2019 (before COVID-19)	Difference between 2020 and 2016-2019
Death of childbirth (<28 days)	982	1,519	-35.35%
Death of childbirth (29 days to 365 days)	345	508	-32.09%
Death of childbirth (1 year to 5 years)	44	631	-93.03%
Maternal death	256	368	-30.43%
Breastfeeding newborn in first 24 hours	125,087	122,587	2.04%

Table 2 shows that home deliveries fell in 2020 (17.6% by a trained person, and 13.7% by a non-trained person). C-sections in the facility rose more than normal deliveries (27% and 18.4% respectively). All the PNCs for mothers and neonatal dropped during the pandemic. Among the PNCs for mothers, PNC-1 declined by 23.5% whereas PNC-4 decreased by 35.4%. The reduction in PNC care for neonatal was highest for PNC-4 which was 35.95% and lowest for PNC-1 was 23.8%.

Table 2 shows that low birth weight (LBW) newborns with less than 2.5 kilograms dropped by 35.3%, immature newborns before 37 weeks by 43.5%, stillbirth by 32.9%, and maternal death by 30.4%. Death of childbirth dropped by 35.4%, 32.1%, and 93% within 28 days, 29 to 365 days, and 1 to 5 years respectively. The performance of breastfeeding newborns in the first 24 hours increased by 2% in 2020 (see Table 2).

This study reports the regression estimates in this section using the random effect (RE) and fixed effect (FE) estimators, along with pooled OLS estimates. It is important to note that the Hausman test was used to select between RE and FE for coefficients (see Table 3). Hausman test reports that FE is the preferred estimation method in eliciting long-run coefficients as value is 16.10 with p-value of 0.0066 indicating the initial hypothesis that the effects of COVID-19 are adequately modeled by a random-effects model is rejected. So, the model should be a fixed-effect model.

Table 3: Hausman test for regression modeling of facility delivery

Variable	Coefficients			
	(b)	(B)	(b-B)	SE
	Fixed	Random	Difference	0.524886
Log of ANC-1	5.907654	7.858404	-1.95075	.8714555
Log of ANC-2	-.3838087	2.382445	-2.766254	1.040311
Log of ANC-3	-28.47456	-27.13865	-1.335915	1.196958
Log of ANC-4	15.70929	15.54063	.1686607	1.517753
Dummy variable for districts with above-average COVID-19 cases	-5.342817	-7.385982	2.043166	.6187567
16.10 Prob> = 0.0066				

Table 4 reports the estimates of FE, RE, and pooled OLS estimators for the recipient of the log of ANC-1, log of ANC-2, log of ANC-3, log of ANC-4, and a dummy variable for districts with above-average COVID-19 cases while considering robust standard error. A 1% increase in ANC-1 receiver resulted in a significant increase in facility delivery by 5.9% for FE estimators ($p<0.10$), 7.9% for RE estimators ($p<0.01$), and 5% for pooled OLS estimators. 1% increase in the recipient of ANC-2 increases the facility delivery by 2.4% and 18.5% for RE, and pooled OLS estimators, respectively, but reduces by 0.4% for the FE model. 1% increase in ANC-4 recipients results in a significant rise in facility delivery by 15.7%, and 15.5% respectively ($p<0.01$) for RE, and FE estimators.

Table 4: Regression estimates

Variables	Fixed Effect	Random Effect	Pooled OLS
Log of ANC-1	5.91*	7.86***	5.04
	(3.09)	(3.02)	(4.76)
Log of ANC-2	-0.38	2.38	18.46*
	(6.22)	(6.25)	(10.76)
Log of ANC-3	-28.47***	-27.14***	-18.99*
	(6.63)	(6.64)	(11.17)

Variables	Fixed Effect	Random Effect	Pooled OLS
Log of ANC-4	15.71***	15.54***	0.21
	(5.47)	(5.36)	(7.84)
Dummy variable for districts with above-average COVID-19 cases	-5.34***	-7.39***	-9.79***
	(1.70)	(1.61)	(2.84)
Constant	122.00***	71.82***	16.47
	(21.67)	(16.26)	(13.58)
Observations	320	320	320
Adjusted R^2	0.11		0.07

Notes: Standard errors in parentheses; ANC= Antenatal care; * $p < .10$, ** $p < .05$, *** $p < .01$

Surprisingly, a 1% increase in recipients of ANC-3 reduces facility delivery significantly ($p<0.01$) by 28.5%, and 27.1% respectively, for FE, and RE, and 19% ($p<0.10$) for pooled OLS estimator. Facility delivery is significantly ($p<0.01$) reduced for districts with above-average COVID-19 cases by 5.3%, 7.4%, and 9.8% respectively, for FE, RE, and pooled OLS estimators.

Discussion

This study found that antenatal care was less accessible during the COVID-19 pandemic than in previous years. All of the ANC visits dropped during the pandemic ranging from 28% to 37%. In addition, all of the PNC visits (both mother and neonatal) dropped in 2020 compared to the previous years where the rate of decline of PNC visits ranged from 23% to 36%. This undoubtedly resulted from limited access to care. Restrictions on travel and gatherings, lack of readiness of health facilities for infection prevention, and interrupted community health worker visits restrained people from getting institutional care during the postpartum situation. Makoni, 2020; Roberton, *et al.,* 2020; Sochas, Channon, & Nam, 2017; and Stein, Ward, & Cantelmo, 2020 also found a similar effect of COVID-19 on maternal and neonatal health services, particularly in countries with limited resources like Bangladesh.

Home delivery with a trained person fell by 14% this year and facility deliveries (both normal and C-section) rose by 18%-27% despite the pandemic situation which diverges from the findings of Ashish, *et al.,* 2020 where during the lockdown,

institutional childbearing dropped by more than half. One of the major reasons behind this is that trained persons for home delivery were not available during the lockdown and it encouraged mothers to deliver at the health facility. However, C-sections also increased with the increase in facility delivery as the prevalence of C-sections is higher throughout the country (Ahmed, Islam, Jahan, & Shaon, 2022).

In contrast, all of the neonatal and maternal death indicators show a sharp decline in 2020 despite the pandemic. This may result from underreporting of the actual scenario because of limited visits performed by community health workers as well as institutional workers during the general holidays declared by the government from 26th March 2020 to 30th May 2020. Again, underreporting of maternal and child health service utilization could also be possible during COVID-19 Though routine healthcare was interrupted and access to basic healthcare was limited, the decline in child and maternal deaths contrasts with the findings of Roberton, *et al*., 2020; Menendez, Gonzalez, Donnay, & Lekee, 2020; Sochas, Channon, & Nam, 2017, and Stein, Ward, & Cantelmo, 2020. This decline in child and maternal deaths may be explained by increased facility delivery.

Regression analysis estimates a 5.3% decline in facility delivery in the districts with more than average COVID-19 cases. There was a significant ($p=0.0014$) difference of 8.50% in facility delivery between the districts with above-average cases and below-average cases. These findings are similar to Roberton, *et al*., 2020; Menendez, Gonzalez, Donnay, & Lekee, 2020; Sochas, Channon, & Nam, 2017; and Stein, Ward, & Cantelmo, 2020. All of the studies found that the COVID-19 pandemic would have an adverse effect and limit access to family planning services.

There could be multicollinearity among the ANC visits. Allen (1997) discussed multicollinearity as a "problem because it undermines the statistical significance of an independent variable. Other things being equal, the larger the standard error of a regression coefficient, the less likely it is that this coefficient will be statistically significant" (Allen, 1997). However, in this study, four out of five regression estimates are statistically significant. Hence, the authors were not concerned about multicollinearity.

Conclusion and policy recommendation

This study found that maternal, neonatal, and child healthcare was less accessible during the COVID-19 pandemic compared to previous years. Despite the restricted availability of family planning services and access across the nation during the

pandemic, the government provided funding for COVID-19 infection prevention and control, supplies, and equipment for healthcare personnel. Preparedness should be integrated with regular healthcare provision. Continuity of standard MNCH care should be made easily available along with prioritizing MNCH care provision. Couples should be discouraged from having children during such a pandemic. COVID-19 instruments like personal protective equipment (PPE), sanitizers, etc. should be made easily available at the root level so that regular healthcare provision is not hampered. Mitigation plans and strategies should be such that COVID-19 cases can be handled separately, especially MNCH care provision should be made available in a separate building. Regular monitoring of MNCH indicators and uninterrupted supplies should be ensured. A telemedicine approach can be used where applicable.

It might be possible to establish a pandemic fund to ensure that funding for other services is not interrupted. Women must continue to have physical and financial access to healthcare, particularly those with low household incomes and little access to physicians. Hospitals must be strengthened to adequately screen, isolate, and treat pregnant women with infections. Referral pathways and transportation must continue to function as they are to handle obstetric emergencies. During the pandemic, there should be different guidelines for women of reproductive age including pregnant women, and these guidelines need to be adequately disseminated to women in their native languages. In summary, the government should prepare a separate guideline along with adequate preparation, including preparing the health workforce, healthcare centers, and other relevant logistics, for uninterrupted MNCH service delivery during any emergencies like the COVID-19 pandemic.

One of the study's limitations is worth mentioning and that is, this paper investigated the effect of COVID-19 on MNCH services in Bangladesh using data recorded by the Directorate General of Family Planning (DGFP) only. However, the Directorate General of Health Services (DGHS), as well as several NGOs, also provide MNCH services throughout the country. Due to the unavailability of data recorded by the DGHS and other providers, this study results represent a partial scenario. Besides, the study used only 5 years' data for the trend analysis as these years' data were available while conducting the study. Again, it would be better if findings could be compared with post-pandemic data. Moreover, other socioeconomic variables were not included in the study as district-wise observations were not available for these variables. These limitations can be addressed by future studies by incorporating the limitations of the current study.

References

Ahmed, M., Islam, M., Jahan, I., & Shaon, I. F. (2022). Multilevel analysis to identify the factors associated with caesarean section in Bangladesh: evidence from a nationally representative survey. *International Health, 15*(1). doi:https://doi.org/10.1093/inthealth/ihac006

Allen, M. P. (1997). *The problem of multicollinearity. In: Understanding Regression Analysis.* Boston, MA: Springer. doi:https://doi.org/10.1007/978-0-585-25657-3_37

Ashish, K., Gurung, R., Kinney, M., Sunny, A., Moinuddin, M., Basnet, O., . . . Malqvist, M. (2020, August 10). Effect of the COVID-19 pandemic response on intrapartum care, stillbirth, and neonatal mortality outcomes in Nepal: a prospective observational study. *The Lancet Global Health*. doi:https://doi.org/10.1016/S2214-109X(20)30345-4

Blencowe, H., Cousens, S., Jassir, F., Say, L., Chou, D., Mathers, C., . . . Lawn, J. (2016). National, regional, and worldwide estimates of stillbirth rates in 2015, with trends from 2000: a systematic analysis. *Lancet Global Health, 4*(2), e98-e108. doi:10.1016/S2214-109X(15)00275-2.

Countdown to 2030 Collaboration. (2018). Countdown to 2030: tracking progress towards universal coverage for reproductive, maternal, newborn, and child health. *The Lancet, 391*(10129), 1538-1548. doi:10.1016/S0140-6736(18)30104-1

Dhaka Tribune. (2020, March 23). *Dhaka Tribune.* Retrieved from https://archive.dhakatribune.com/bangladesh/2020/03/23/govt-offices-to-remain-closed-till-april-4

Ehsan, S. M., & Jahan, F. (2021). Analysing the impact of COVID-19 on the mothers of Bangladesh: hearing the unheard. *Journal of Public Health, 30*, 2869–2882. doi:https://doi.org/10.1007/s10389-021-01501-5

Mahtab, N. T., & Chowdhury, T. S. (2020). Clinical outcomes of women with COVID 19 during pregnancy: an update. *Birdem Medical Journal, 10*, 93-102.

Makoni, M. (2020). Africa Prepares for Coronavirus. *Lancet, 395*(10223), 483. doi:https://doi.org/10.1016/S0140-6736(20)30355-X

Menendez, C., Gonzalez, R., Donnay, F., & Lekee, R. (2020). Avoiding indirect effects of COVID-19 on maternal and child health. *The Lancet Global Health, 8*(7), e863–e864. doi:https://doi.org/10.1016/S2214-109X(20)30239-4

Mhajabin S., Hossain, A. T., Nusrat. N., Jabeen, S., Ameen, S., Banik, G., . . . Rahman, A. E. (2022). Indirect effects of the early phase of the COVID- 19 pandemic on the coverage of essential maternal and newborn health services in a rural subdistrict in Bangladesh: results from a cross-sectional household survey. *BMJ Open, 12*(e056951). doi:doi:10.1136/ bmjopen-2021-056951

Rahman, M. A., Halder, H. R., & Islam, S. M. (2021). Effects of COVID-19 on maternal institutional delivery: Fear of a rise in maternal mortality. *Journal of Global Health, 11*(03041), 1-3. Retrieved from https://www.jogh.org/documents/2021/jogh-11-03041.pdf

Roberton, T., Carter, E., Chou, V., Stegmuller, A., Jackson, B., Tam, Y., . . . Walker, N. (2020). Early estimates of the indirect effects of the COVID-19 pandemic on maternal and child mortality in low-income and middle-income countries: a modelling study. *The Lancet, 8*(e901-08). doi:https://doi.org/10.1016/S2214-109X(20)30229-1

Sochas, L., Channon, A., & Nam, S. (2017). Counting indirect crisis-related deaths in the context of a low-resilience health system: the case of maternal and neonatal health during the Ebola epidemic in Sierra Leone. *Health policy Plan, 1*(32), iii-32-iii39. doi:10.1093/heapol/czx108

Stein, D., Ward, K., & Cantelmo, C. (2020). Estimating the Potential Impact of COVID-19 on Mothers and Newborns in Low- and Middle-Income Countries. Retrieved from http://www.healthpolicyplus.com/covid-mnh-impacts.cfm

UNICEF. (2019). *Levels and trends in child mortality 2019: Estimates developed by the UN Inter-agency group for child mortality estimation.* UNICEF. Retrieved from https://www.unicef.org/reports/levels-and-trends-child-mortality-report-2019

WHO, UNICEF, UNFPA, World Bank Group and the United Nations Population Division. (2015). *Trends in maternal mortality: 1990 to 2015.* The World Health Organization. Retrieved from https://www.who.int/reproductivehealth/publications/monitoring/maternal-mortality-2015/en/