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Direct and indirect effects of COVID-19 on maternal and child health in Bangladesh

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Abstract

Bangladesh has been going through incremental trend of GDP growth rates for a long time. The GDP is the key aspect to measure the economic growth of a country. But the current world wide pandemic due to the COVID-19 hardly affects the world's economy as well as Bangladesh. The present lockdown make the wheel of the industries uncertain. The main source of the GDP of this country is ready made garment sector which has been shut down since mid of March 2020. Already 20 billion of cancellation of foreign order makes the situation worse. Also, the foreign remittance has been decline dramatically due to the loss of jobs of Bangladeshi workers in foreign countries. The overall economic situation declines in this country due to the COVID-19 which has huge impact on the health care system especially in maternal and child health. In this paper, the economic situation of Bangladesh before and during the COVID-19 has been shown. Also, how the COVID-19 would affect the condition

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of maternal and child health across the country directly as well as indirectly through the GDP has been discussed.

1. Introduction

Bangladesh has accomplished momentous advancement in population and health in the course of recent years and is one of the nations that are on target to accomplish the MDG for decreasing child mortality [1,2,3]. In the last 20 years from 1990 to 2011, the child mortality under five reduced from 151 to 53 in 1000 live births and the infant mortality rate dropped less promptly from 87 to 43 in 1000 live births. In the meantime, maternal mortality in Bangladesh declined from 574 to 194 in 10000 live births [4]. The maternal and child health system has a prodigious impact on the growth of the gross domestic product (GDP) of a country. Bangladesh is one of the countries in the South Asian region who has a tremendous GDP growth rate. But in the current pandemic due to the Corona Virus Disease 2019 (COVID-19) started from early March 2020 in Bangladesh plays a vital role in the economy of this country. The continuous lockdown started from 18th March of this year shutdown the whole economical activities in this country. Moreover, the health care system is mostly affected by this pandemic, which has great impact on the achievement of the maternal and child health system. From the history of the pandemics and epidemics in the past centuries, it is easily understandable the current threat on our economy.

The outbreak of the H5N1 (avian flu) in 2003 had a short term and long term impact on the Asian economy. In a short term effect, this pandemic was slow down the economic growth rate in Asia which was significantly declined the trade, production and services. And in the long run, the GDP growth was lower and poverty was increased [5]. The pandemic influenza on the UK in 2004 causes 0.5% and 1.0% cost of GDP for maintaining health system [6]. The Spanish flu epidemic in 1918 had an inordinate influence on economic performance in Sweden. This pandemic drops the economic growth 5% during the pandemic and an additional 6% afterwards. Also, the pandemic significantly increased the poorhouse rate by 11% in that year [7]. Due to the Pandemic influenza consequences in USA in the recent years the GDP of USA could losses

$25.4 billion, but that vaccination could reduce the losses to $19.9 billion. And, when the behavioral and resilience factors are considered, USA could losses their GDP in $45.3 billion without vaccination and $34.4 billion with vaccination [8]. Keogh-Brown et al. [9] reported that the 2003 SARS outbreak had notable macroeconomic impacts. United Kingdom, France, Belgium and The Netherlands had losses their GDP approximately 0.5–2% but school closure and prophylactic absence more than triples these effects. Dixon et al. [10] showed that HIV/AIDS have profound impact on Africa's economic development. In 2001, HIV/AIDS was the world's fourth biggest diseases after the heart disease, stroke, and acute lower respiratory infection and three million people have died due to this virus.

However, like the other pandemics COVID-19 pandemic may cause the economic disruption in Bangladesh. Amit [11] described that the economic recession will be worse in Bangladesh due to the COVID-19, but shorter than the global financial crisis of 2008. The lockdown duration is the key aspect for this economic crisis because the economic fortune of this country engaged with ready-made garments (RMG) sector and foreign remittance. Islam and Siddika [12] have a view on the COVID-19 situation that government of Bangladesh failed to measure the situation and necessary action should have been taken earlier. That is how the current pandemic situation may cause the disruption of the growth of the GDP of Bangladesh. Lalon [13] mentioned that Bangladeshi RMG sector is already lost their 50% of export revenue by the cancellation of order by USD 1.5 billion. Also, the foreign remittance fall from December 2019 to February 2020 is 143 billion to 123 billion. Not only in Bangladesh but also economic disruption happens all over the world. Maliszewska [14] shows that the gross domestic product fall by 2 percent below the benchmark for the world where 2.5 percent for developing countries, and 1.8 percent for industrial countries. Iacus et al. [15] shows that in the first Quarter of 2020, the world GDP reduced by 0.02% to 0.12% in 2020 due to the current COVID-19 pandemic and also, over 25-30 millions of people may lose their job in this aviation sector. The economic disruption in a specific region also depends on the longevity of the pandemic in that region and as well as over the world. Therefore, it is necessary to predict the duration of the existence of the pandemic. Different mathematical models are proposed to predict the COVID-19 world pandemic by Jewell et al. [16]. Singh et al. [17] proposed a prediction of COVID-19 pandemic based on the time series data. Bhatnagar et al. [18] performed an described analysis on the COVID-19 patients in India and found that age is not the key to affect the

people by this virus rather the gender and the transmission mode has a significant relation to spread this virus.

The economic disruption or fall of the growth of GDP has a direct impact on maternal and child health. In the late 1980s, the economic crisis of Peru increased the 2.5% of infant mortality which was 17000 more children had died than without the crisis [19]. Sobotka et al. [20] shows that how the decline of GDP due to the economic downturns in different centuries falling consumer confidence, and rising unemployment had affected fertility. Pérez-Moreno [21] reported that for the period 1990–2010 in the Least Developed Countries (LDCs) the decline of GDP per capita involves a substantial rise in child mortality rates where the increase of GDP did not affect the child mortality rate significantly. In early 1990, due to the economic disruption in Mongolia caused the food shortages and the widespread of unemployment which collapsed the public health and health care system and increased maternal mortality [22]. Gibbons and Garfield [23] reported that the economic disruption from 1991 to 1994 in Haiti affected the health care system, declined overall income, increased unemployment, and deteriorated infant mortality, increased mortality among the under-5 children. Furthermore, by the economic disruption the agriculture system of a country affect mostly which has a deep relation with the growth of GDP [24].

The status of maternal and child health is a crucial aspect of a country since it would determine the health quality of the upcoming generation [25]. Therefore, though COVID-19 has its impact on the health condition of people of every category, the objective of this study has been mainly circled around maternal and child health. In this study, the scenario of maternal and child health along with GDP growth rates over the years in Bangladesh prior to the arrival of COVID-19 has been displayed. Then, the existing condition of the COVID-19 situation in the country is shown. Also, a projection on COVID-19 for the upcoming days is made through polynomial regression since linear regression is not an ideal one for forecasting an epidemic. Finally, necessary analyses have been made and discussed to highlight how the COVID-19 would affect the maternal and child health status in the country directly as well as indirectly through GDP.
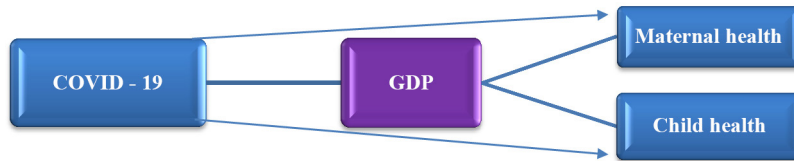
Figure 1

Conceptual framework

2. Materials and Methods

2.1 *Conceptual framework*

The conceptual framework of the study can be visualized through figure 1. COVID -19 would affect both maternal and child health directly as well as indirectly through GDP.

2.2 *Source of the data*

Other than the COVID -19 data, all other relevant information to serve the analytical purpose of the study have been extracted from the Sample Vital Registration System 2018 (SVRS) and the Bangladesh Demographic and Health Surveys (BDHS) led by Bangladesh Bureau of Statistics (BBS). Data on COVID -19 have been collected from the dataset published by Institute of Epidemiology, Disease Control and Research (IEDCR), Bangladesh.

2.3 *Correlation analysis*

Simple correlation coefficients have been calculated to evaluate the strength of relationship between two variables. Mathematically:

$$r \;=\; \frac{SP(xy)}{\sqrt{SS(x)SS(y)}}$$

$$SS(x) \;=\; \sum x^2 - \frac{(\Sigma x)^2}{n}$$

$$SP(xy) \;=\; \sum xy - \frac{\Sigma x\, \Sigma y}{n}$$

$$SS(y) \;=\; \sum y^2 - \frac{(\Sigma y)^2}{n}$$

The values of simple correlation coefficient range between -1 to 1, where $r = -1$ indicates perfect negative relationship, and $r = 1$ implies perfect positive relationship between the variables.

2.4 *Regression analysis*

2.4.1 Simple linear regression

It is a method of setting a function of dependent variable y based on independent variable x so that for any value of x, value of y can be estimated. Mathematically: $Y = \alpha + \beta x + \varepsilon$, where

α = the value of y when $x = 0$

β = regression coefficient of y on x. It measures the rate of change of y for unit change in x.

ε = random error. It is used in the model to measure the influences of other variables which are not included in the model.

Our fitted model based on sample observations is: $\hat{y} = a + bx$, where a is the estimate of α and b is the estimate of β. Here,

$$b \;=\; \frac{SP(xy)}{SS(x)}$$

$$a \;=\; \bar{y} - b\bar{x} = \frac{\Sigma y}{n} - b\frac{\Sigma x}{n}$$

Statistical significance is determined through the p – values (p – value ≤ 0.05 means significant). In this study, simple regression models have been fitted considering GDP as independent variable and maternal health as well as child health as dependent variables separately.

2.4.2 Polynomial regression

To fit the COVID-19 data, polynomial regression model has been fitted to have a clear idea about the ongoing trend as well as the probable future trend since it does not follow linear trend. Here, the relationship between y and x is non-linear formed as n[th] degree polynomial in x, defined as:

$$Y \; = \; \alpha + \beta_0 + \beta_1 x^1 + \beta_2 x^2 + \beta_3 x^3 + \cdots\cdots + \beta_k x^k + \varepsilon$$

Here, β_i s are the corresponding regression coefficients.

2.5 *Analytical Tool*

Statistical Package for Social Sciences (SPSS) - version 20.0 has been used for statistical analyses.

3. Results and Discussion

3.1 *COVID-19 situation in Bangladesh*

COVID-19 has come into attention for the first time on 7th March 2020 in Bangladesh. Since then, the number of positive cases has been exponentially rising so far. As of 12th July 2020, a total of 183795 people have been detected as COVID-19 positive out of 943524 tests in the country. Highly significant strong positive correlation has been observed between number of daily tests and number of daily detected cases $(r = 0.981, p-\text{value} = 0.000)$ indicating that more the number of tests, more the detected cases will be and vice versa. But, due to poor infrastructure and skilled manpower limitations, number of daily tests has not been up to the required level. Hence, many people are being detected late and by the time they are detected, they have already infected many other people. This is doing nothing but making sure that the situation will only get worse over time and the country as a whole is heading towards a
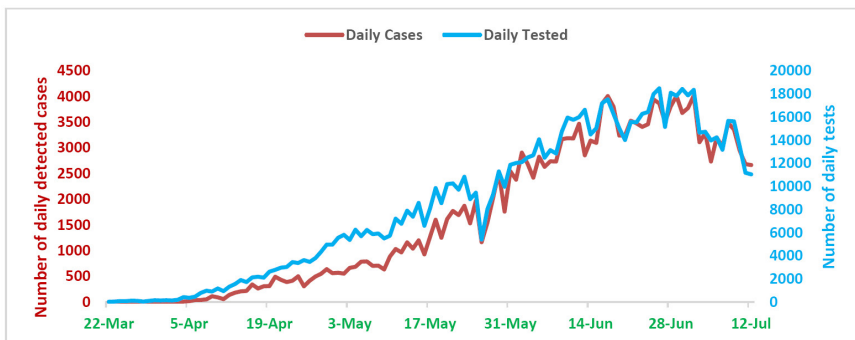

Figure 2

Trends of daily tests and detected COVID-19 cases in Bangladesh so far
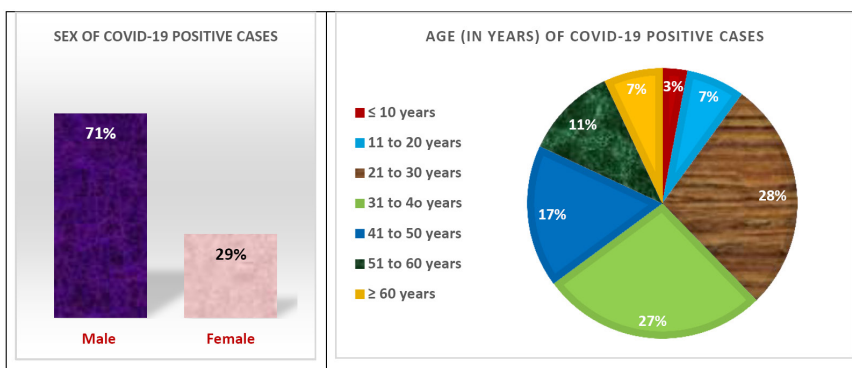
[Source: IEDCR]

Figure 3

Age and sex distribution of COVID-19 cases in Bangladesh so far

[Source: IEDCR]

long-time mild infection state which will only curb the regular functions of individuals, organizations and so on. Figure 2 displays the number of daily tests and identified cases in the country so far.

According to IEDCR, a significant portion of the affected cases (20.85%) have been detected in Dhaka city, the capital Bangladesh, followed by Chittagong (5.57%), Narayanganj (3%), Cumilla (2.27%) and Gazipur (2.12%) up to the 12th July 2020. It is important to note that these areas are the main center of the economic activities of the country. The Ready-Made Garments (RMG) sector is mainly spread out in these regions, making them highly densely populated urban centers, increasing the risk of the virus being infected from person to person more rapidly.

Figure 3 shows that in Bangladesh, males are more vulnerable than females to be affected by COVID-19, while people of ages between 21 to 40 have mostly been affected.

3.2 *Projection of COVID-19 in Bangladesh*

Figure 4 shows the projection of COVID-19 situation in Bangladesh based on observed data so far. Polynomial regression of order 3 has been applied to fit the model.

According to the projection of figure 4, number of COVID-19 cases in Bangladesh should reach its peak in first week of July and decline afterwards. The observed data provided by the IEDCR validates our projection as the peak has occurred on 2nd July and has been lessening thereafter.
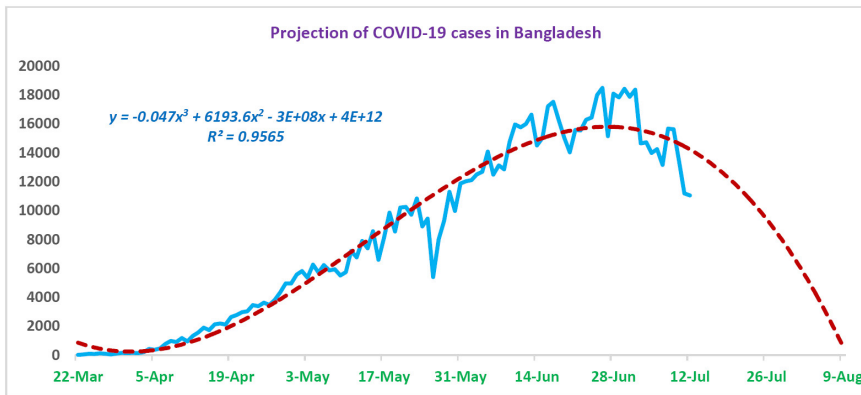
Projection of COVID-19 cases in Bangladesh

$y = -0.047x^3 + 6193.6x^2 - 3E+08x + 4E+12$
$R^2 = 0.9565$

Figure 4

Projection of COVID-19 cases in Bangladesh

[Source: IEDCR]

3.3 *GDP growth rate in Bangladesh*

Trend of GDP growth rates in Bangladesh over the years can be visualized through figure 5.

Bangladesh as a country has done stupendous growth in GDP over the years, thanks to expanding exports and remittances, enlarging investments, more women immersion in job, industrialization, education, enhanced career prospects, political constancy, elevated communication systems, more electrification coverage etc.
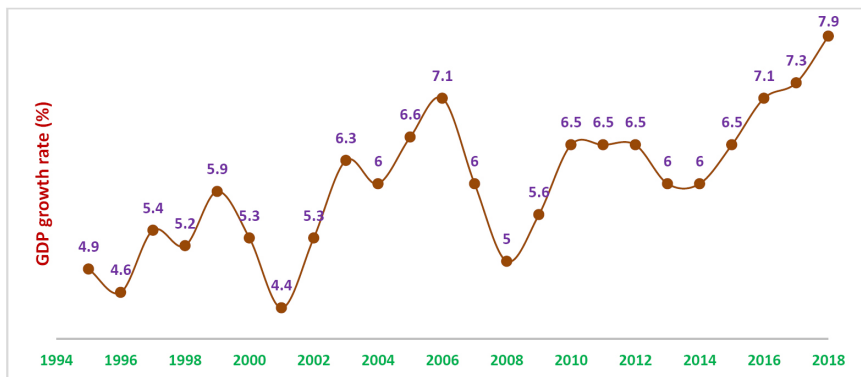
Figure 5

GDP growth rates in Bangladesh between 1995 to 2018

[Source: World Bank]

Table 1

Distribution (%) of selected factors of maternal health in Bangladesh

		BDHS 1994	BDHS 1997	BDHS 2000	BDHS 2004	BDHS 2007	BDHS 2011	BDHS 2014	BDHS 2018
Mother's education	Illiterate	58.1	54.6	47	40	34	28	25	16.6
	Primary	17.4	17.2	29	30	30	29	29	31.2
	Secondary	9.6	10	18	22	24	30	32	35.5
	Higher	14.9	18.2	5	7	12	12	14	16.7
Place of delivery	Home	96	95	97	91	82	72	65	50
	Outside	4	5	3	9	18	28	35	50
Skilled delivery		9	8	10	13	21	32	42	53
Antenatal care		27	29	37	56	63	68	79	92

3.4 *Maternal health in Bangladesh*

The percentage distribution of some selected relevant factors associated with maternal health in Bangladesh over the years is shown in table 1. Visible improvement over the years concerning the stated factors associated with maternal health can be seen from table 1. Mother's
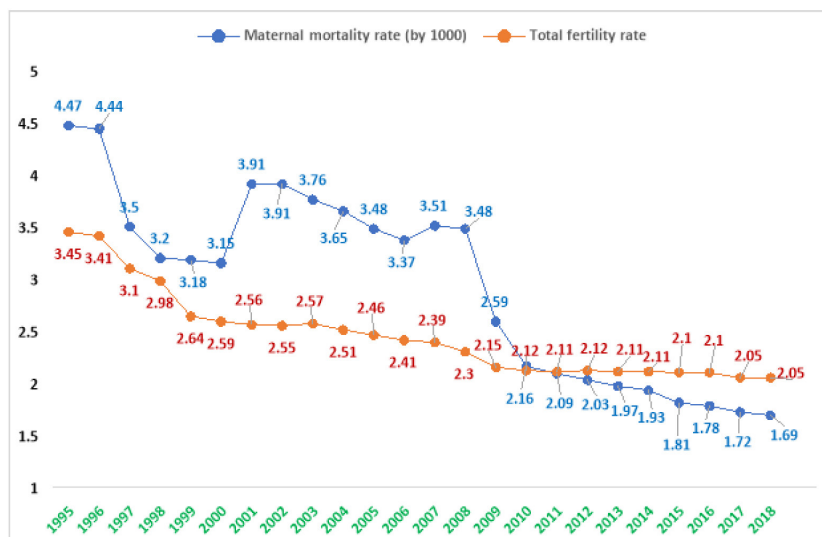

Figure 6

Trends of MMR and TFR in Bangladesh between 1995 to 2018

[Source: SVRS-2018]

education is a key determinant of maternal health as educated mothers are more aware about various aspects of reproductive health. According to table 1, most of the childbirths in Bangladesh happen at home where skilled attendant is absent most of the time, leading to higher risk of perilous childbirths. Fortunately, proportion of delivery being happened outside home is increasing over the years. The proportions of skilled delivery as well as antenatal care have also been on the rising trend over the years in the country, clearly indicates that the status of maternal health has been on a rising trend.

Figure 6 shows the trends of maternal mortality rate (MMR) per 1000 live births along with total fertility rate (TFR) in Bangladesh over the years (between 1995 to 2018). Both the TFR and MMR indicates decreasing trend over the years which is unswervingly related to maternal health as it will ensure higher female life expectancy as well as life of better quality.

Highly significant strong positive correlation has been observed between TFR and MMR $(r = 0.984, p - \text{value} = 0.002)$ indicating that lower the TFR, lower will be the MMR and vice versa.

3.5 *Child health in Bangladesh*

Children's nutritional status is a crucial part of their overall health condition. Figure 7 shows the nutritional status of children in Bangladesh over the years.

As shown in figure 7, the underweight level has dropped from 48 percent in 2000 to 22 percent in 2017 in Bangladesh. Declining trends can be seen in case of stunting and wasting as well.
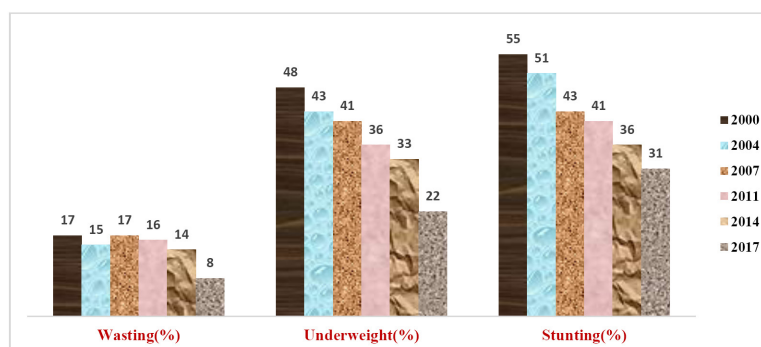

Figure 7

Children's nutritional status in Bangladesh between 2000 to 2017
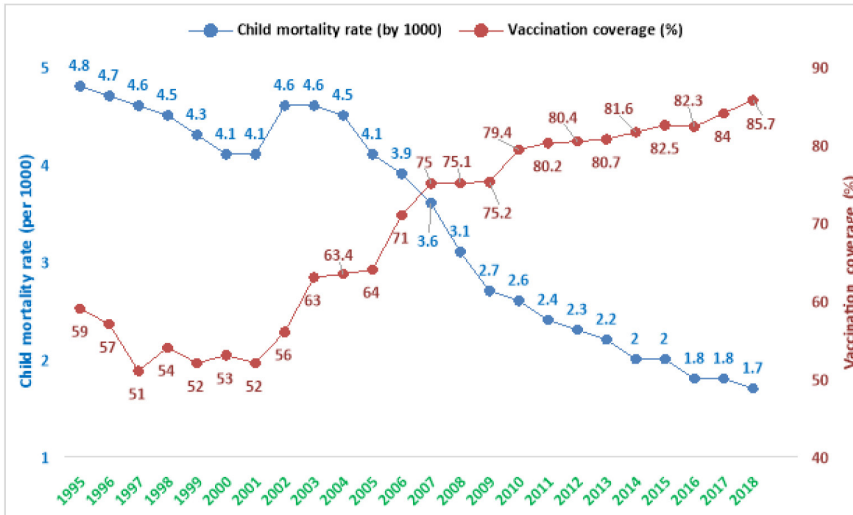
[Source: BDHSs]

Figure 8

Trends of vaccination coverage and child mortality in Bangladesh

[Source: SVRS 2018]

Figure 8 shows a rising trend of vaccination coverage (%) of children over the years in Bangladesh. Conversely, it shows a declining trend of child mortality rate (per 1000) falling from 4.8 in 1995 to 1.7 in 2018. Significant strong negative correlation has been observed between vaccination coverage and child mortality rate ($r = -0.923$, $p-\text{value} = 0.025$) indicating that more vaccination coverage will lower the child mortality rate further and vice versa.

3.6 *Impact of COVID-19 on GDP growth rate in Bangladesh*

Bangladesh has been going through incremental trend of GDP growth rates for a long time. Yet, there has been an obvious threat inside the economy of the country owing to non-performing loans in a number of banks. Ongoing COVID-19 pandemic will do nothing but make the situation more awful. Orders are being cancelled by the buyers which indeed is affecting the Ready-Made Garments (RMG) sector badly. RMG sector is considered as the backbone of the country's economy. Flow of remittances have also been sojourned for the time being since the countries where Bangladeshi migrants have been working have also been affected severely by COVID-19.

3.7 Impact of COVID-19 on maternal health in Bangladesh

3.7.1 Direct impact

Ever since the COVID-19 came into scenario in Bangladesh, a huge portion of doctors, nurses, and midwives have stopped practicing not only in hospitals but also in their private chambers. This indeed has affected the essential health facilities needed for women, specially the pregnant women. Moreover, because of the restrained situation, certain number of deliveries are taken place at home without the support of skilled birth attendants. Consequently, it has increased the risk of maternal death during childbirth. Furthermore, disruption in the whole educational system will impact maternal and child health in the long run as women education is a significant determinant of maternal health along with safe delivery practices [26, 27]. The lockdown state has made people to get into sexual intercourse more frequently than normal time risking unexpected pregnancy as contraceptives are not readily available as before.

3.7.2 Indirect impact through GDP

Simple linear regression model has been fitted to assess the impact of GDP on maternal death.

The overall model has been found to be significant according to findings in Table 2. The value of R^2 equaling to 0.708 indicates that 70.8 percent variation of MMR has been explained by GDP. The coefficients of the regression model along with their significance is presented in Table 3.

Mathematically, the model can be written as: $MMR = 7.316 - 0.728$ (GDP). A regression coefficient of -0.728 indicates that one unit decrease in GDP would result in 0.728 unit increase in MMR on average. The coefficient is highly significant as well (p-value = 0.000). So, as the COVID-19 situation

Table 2

Analysis of Variance (ANOVA)

Sources of Variation	Sum of Squares	df	Mean Square	F	P - value	R^2
Regression	9.569	1	9.569			
Residual	9.516	22	0.433	22.122	0.000	0.708
Total	19.085	23				

Table 3

Effects of GDP on maternal mortality rate (MMR)

	Unstandardized Coefficients		t	p – value	95% C.I for β	
	β	Std. Error			Lower Limit	Upper Limit
Constant	7.316	0.938	7.801	0.000	5.371	9.261
GDP	-0.728	0.155	-4.703	0.000	-1.049	-0.407

prolongs in the country, the GDP will continuously fall which in turn will lead into higher risk of maternal death.

3.8 *Impact of COVID-19 on child health in Bangladesh*

3.8.1 Direct impact

Recently, the government has postponed its measles and rubella immunization campaign for this year due to COVID-19. Owing to the ongoing COVID-19 situation across the country, utilization of important health services needed for the children has decreased considerably, consequently, increasing the risk of child mortality. Financial adversity experienced by families resulting from COVID-19 would threaten the improving trend of children's nutritional status in the country prior to COVID-19 as mentioned in figure 7. Moreover, they are also being demoralized psychologically due to the interruption in their education and prolonging constricted life in their residences, impacting their mental health as well.

3.8.2 Indirect impact through GDP

Simple linear regression model has been fitted to assess the impact of GDP on child mortality.

Table 4

Analysis of Variance (ANOVA)

Sources of Variation	Sum of Squares	df	Mean Square	F	P - value	R^2
Regression	12.303	1	12.303			
Residual	17.871	22	0.812	15.146	0.001	0.639
Total	30.173	23				

Table 5

Effects of GDP on child mortality rate (CMR)

	Unstandardized Coefficients		t	$p-value$	95% C.I for β	
	β	Std. Error			Lower Limit	Upper Limit
Constant	8.333	1.285	6.484	0.000	5.668	10.999
GDP	-0.826	0.212	-3.892	0.001	-1.266	-0.386

The overall model has been found to be significant according to findings in Table 4. The value of R^2 equaling to 0.639 indicates that 63.9 percent variation of CMR has been explained by GDP. The coefficients of the regression model along with their significance is presented in Table 5.

Mathematically, the model can be written as: $CMR = 8.333 - 0.826$ (GDP). A regression coefficient of -0.826 indicates that one unit decrease in GDP would result in 0.826 unit increase in CMR on average. The coefficient is highly significant as well (p-value = 0.001). Hence, the stretching COVID-19 situation in the country resulting in continuous GDP decline will lead into higher risk of child mortality.

4. Conclusion

The outcomes of this study have given an idea about how the ongoing COVID-19 would affect the maternal and child health status in Bangladesh directly as well as indirectly through GDP. The condition of maternal and child health has continuously been improving over the years prior to the arrival of COVID-19. But the spread of COVID-19 across the country would definitely slow down the progress. The government has already given its focus concerning issues regarding maternal and child health facilities during this critical period. The government along with the renowned NGOs must ensure more effectual projects safe maternal and child health. The vaccination campaign needed to be fulfilled through safe and meaningful steps. Life of a huge number of children would fall into danger if they are not given the essential vaccines on time. The hospital authorities must ensure that proper utilization of maternal and child health care facilities is being provided. Further research is needed to identify other possible moderating factors through which the COVID-19 would affect maternal and child health in Bangladesh. These recommendations must be taken into careful consideration by the respective authorities not only

to ensure the safety of maternal and child health in the country during this crisis period, but also to comply with the sustainable development goal (SDG) 3.

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