Child Mortality and Economic Growth in Bangladesh: Evidence from ARDL Approach

Kazi Mohammed Kamal Uddin[1], Md. Farhad Hossain[2], Most. Shiulii Akter[3]
[1]*Department of Economics, Comilla University, Cumilla, Bangladesh*
[2]*Department of Statistics, Comilla University, Cumilla, Bangladesh*
[3]*Graduate student, Department of Economics, Comilla University, Cumilla, Bangladesh*

***Abstract:*-Child mortality rate is the most important indicator of child health, nutrition, implementation of key survival interventions, and the overall social and economic development of a population. The attempt of the paper is to investigate if there any relation between child mortality and economic growth and the direction and magnitude of these relationships in Bangladesh by analyzing data from 1985-2016. For analyzing the time series data Granger Causality test and ARDL model is used. By Granger Causality test it is investigated if there have any relation between the variables and by ARDL model it is analyzed what kind of relation between the variables (child mortality and GDP growth rate) exists. Our empirical evidence reveals that there is a significant and negative relationship between child mortality rate and real GDP growth rate. So, it is concluded that the GDP growth rate increase as child mortality rate decrease.**

***Keywords:* Child Mortality, Economic Growth, Life Expectancy, Bangladesh, Granger Causality, ARDL Model.**

I. INTRODUCTION

The level of development of a nation depends on many factors which are accounted for the well-being of the population as well as the economic and social state of the country. The child mortality rate has been considered as an acceptable indicator of socio-economic development and a reflection of a country's health care system and quality of life.

Over the past 25 years, the world has made a significant progress in saving young children's lives. The rate of child mortality fell 62% from 1990-2016, with under-five deaths dropping from 12.7 million to 5.6 million. In order to prevent child deaths and ensure healthy child survival, reducing under-five mortality to at least as low as 25 per 1,000 live births by 2030 are referred as the third Sustainable Development Goals (SDG).

Bangladesh is one of the developing countries of Asia with high under-five child mortality rate. Bangladesh has brought down the child mortality rate by 73% over the last 25 years along with achieving the target of reducing under-five mortality rates. Bangladesh has experienced a significant reduction of child mortality over the past decades which helped achieve the Millennium Development Goal 4 (MDG 4) target. Though Bangladesh is a developing country and struggling to overcome hundreds of problems, it can fulfill the MDG targets of reducing child mortality within a short time. It became possible because of many programs taken by the government to reduce child mortality. But the mortality among the under-5 children must be further reduced for a substantial effort to achieve the Sustainable Development Goal (SDG) target. For that it is necessary to address the factors which reduced the child mortality.

As child mortality is an indicator of socioeconomic condition of a nation, reduced rate of child mortality indicates a country with higher economic growth. As each of household incomes, public spending and education is likely to have a positive association with the level of aggregate income (GDP), the estimated effect of growth on mortality is expected to capture all of these relationships. Being a reduced form type of effect, it will also capture any interactions between these variables.

II. LITERATURE REVIEW

World-wide several studies have been undertaken that focused on the socio-economic determinants of infant and child mortality. Many researchers believe that the distribution of material well-being is improved by the increase in per capita GDP. Much research has been dedicated in recent years to identifying causes of cross-national variation in under five mortality. In the literature reviewed here, economic growth or growing average income played an important role in reducing under five mortality.

Some reviewed literatures have detected a positive effect of economic growth on under five mortality.

Hussain, Malik and Hayat (2009) showed reduction in infant mortality and total fertility will help in accelerating the pace of economic growth in positive direction by analyzing data for the period of 1972-2006 in Pakistan.

Pritchett and Summers (1996) estimate an income elasticity of child mortality developing countries concluding that the direction of this relation is from income to health status and there have a positive relation between them which means that increasing income will improve positively health status.

Bernadette O'Hare , Innocent Makuta , Levison Chiwaula and Naor Bar-Zeev(2013) found that Income is an important determinant of child survival which provides a pooled estimate for the relationship between income and child mortality.

Shen, Sarkisian, Tran. (2008) showed that GNI per capita demonstrate a strong direct effect on under five mortality and economic growth has a significant indirect effect on under five mortality via state commitment to health care and gender inequality, but not via class inequality.

Arshia Amiri, Ulf-G Gerdtham(2013) found that there have both side relation between the variables where the impact of maternal and child mortality on GDP is greater than the impact of GDP on maternal and child mortality. they also found thal this impact is much in LICs and LMICs relative to HICs and UMICs[1] which may reflect that the effect of marginal health investments on health outcomes is stronger at low GDP levels, i.e. in countries where generally the level of health is lower

On the other hand some researchers found that there have no relation between child mortality and GDP growth rate. Zakir and Wunnava (1999) concluded that fertility rates, female participation in the labor force, per capita GNP and female literacy rates significantly affect infant mortality rates. But, government expenditure on health as a percentage of GNP does not play an important role in explaining infant mortality.

Angus Deaton and Christina Paxson (2001) using data over 1950-2000 concerning with an age-specific and time-series analysis of mortality and income in Britain and compared with the results with the United States's mortality and income found a negative relation between income and mortality and concluded that Controlling for income, they find that higher inequality is associated with lower mortality in the United States in the late 1970s and early 1980s.

Anand and Ravallion (1993) concluded that GDP has no effect on health indicators once poverty and public expenditure are held constant.

Fuchs (1974) asserts that a minimum income level is quiet important in people's health care, however, when it is exceeded this income level, especially in developed countries, there hasn't been a high correlation between health indicators and income.

Brady, Kaya, Beckfield (2007) showed that increased GDP does not have robust effects for infant and under five mortality. Total fertility rate, urbanization, and secondary school enrollment have large effects than GDP on reduction of under-five mortality. The more powerful effects of fertility, urbanization, and secondary schooling cannot simply be attributed to an indirect effect of GDP. Over time, GDP has become much less effective at improving caloric consumption and under five years mortality.

Kalim and Shahbaz (2010) and Susan Foster and Malcolm Bryant (2013) conclude that the effect of social development on economic growth is much greater than the effect of economic growth on social development.

Jamison, Jamison and Hanushek (2006) concluded that improved education quality increases the rate of decline in infant mortality in open economies than in closed economies.

After having read these studies, one conclusion from these empirical studies is that economic growth has effect to the under-five mortality. For the developing countries, the strength of association between the economic growth and under five mortality will depend on the social services provision, income inequality and other factors.

Objectives of the study

The objectives of this study are:

1. to examine whether there are relationships between life expectancy and child mortality and economic growth .
2. to estimate the direction and magnitude of these relationships.

III. METHODOLOGY AND DATA COLLECTION

In order to show the relation between the variables data on the under-five mortality rate (probability of dying by age 5 per 1,000 live births), which is a commonly used indicator to measure progress on child health and data on life expectancy is used. As a measure of economic growth we use GDP. All these data are collected from World Bank from 1985 to 2016.

For the analysis the econometric software Eviews 9 are used. For showing if there any relation between the variables Granger Causality test is used. Thus in the analysis we use Granger causality analysis to identify the direction of relationships between child mortality and GDP and also to perform an approximate estimate of the magnitude of the effects involved by employing advanced econometric techniques. The selection of the lags that need to be used in the ARDL model is one of the most crucial procedures. The first task in the ARDL approach to Co-integration is estimating the general ARDL model is lag-length selection criteria. The Bound test for co-integration is run to check the joint significant of the coefficients in the specified conditional ARDL model. The Wald test is conducted for this equation by imposing restrictions on the estimated long run coefficients of all lagged level variables.

Model Specification

To examine the relationship between focused variables, this study employed the autoregressive distributed lag model (ARDL) suggested by Pesaran, Shin and Smith (2001), for co-integration investigation data and error correction analysis. The ARDL has been chosen since it can be applied for a small sample size.

$$GDP_t = \beta_0 + \beta_1 Child\_mor_t + \beta_2 Life\_exp_t + \mu_t. \quad (1)$$

[1] LIC= low income country
LMIC= low middle income country
HIC= high income country
UMIC= upper middle income country

where,

GDP_t = Gross Domestic Product;

$Child\_mor_t$ = Child Mortality Rate

$Life\_exp_t$ = Life expectancy

T = period of time;

β_0 = the constant;

β_1&B_2 = the coefficient

andμ_t = the stochastic disturbance term.

This test method of co integration has certain econometric advantages in comparisons to other co integration methods Dritsakis (2012). The autoregressive distributed lag (ARDL) model has several advantages in comparison with other co-integration techniques. First, ARDL model avoids endogeneity problems. Second, it estimates the long run and short run parameters simultaneously. Third, pre-testing for unit roots is not required because the methodology is appropriate whether the variables are I (0), I (1) or mutually integrated.

An ARDL representation of equation can be formulated as follows:

$$GDP_t = \beta_0 + \sum_{i=1}^{n} \beta_{1i} \Delta GDP_{t-i} + \sum_{i=1}^{n} \beta_{2i} \Delta Child\_mor_{t-i} + \sum_{i=1}^{n} \beta_3 \Delta Life\_exp_{t-i} + \alpha_1 GDP_{t-1} + \alpha_2 Child\_mor_{t-1} + \alpha_3 Life\_exp_{t-1} + \mu_t; \quad (3)$$

Where, Δ denotes the first difference operator, B_0 is the drift component, and μ_t is the usual white noise residuals. The left hand side is the gross domestic product. The first until third expression ($\beta_1 - \beta_3$) on the right hand side correspond to the short-run dynamics of the model. The remaining expression with the summation ($\alpha_1 - \alpha_3$) represent the long- run relationship of the model. The co-integration testing procedure is based on the F-test. According to Dritsakis (2012), the F-test is actually a test of the hypothesis of no co integration among the variables against the existence or presence of co integration among the variable.

In this case we can denote it as:

$$H_0: \beta_1 = B_2 = \beta_3 = 0$$

$$H_1: \beta_1 \neq \beta_2 \neq \beta_3 \neq 0$$

Co-integration tests have a short fall in analyzing and establishing long-run relationships because it is not applicable in cases of variables that are integrated of different orders i.e. I(1) or I(0). According to Shittu, Yemitan and Yaya (2012), it is concerned with the analysis of long run relationships between variable integrated of the same order and the speed of return to equilibrium after a deviation is measured by the error correction model (ECM).

$$\Delta GDP_t = \beta_0 + \sum_{i=1}^{n} \beta_{1i} \Delta GDP_{t-i} + \sum_{i=1}^{n} \beta_{2i} \Delta Child\_mor_{t-i} + \sum_{i=1}^{n} \beta_3 \Delta Life\_exp_{t-i} + \eta ECT_{t-1} + e_t \quad (4)$$

where,

η is the speed of adjustment parameter and $ECT_t$is the residuals.

Hence, by differencing and forming a linear combination of the non-stationary data, all variables in an ARDL model are transformed equivalently into an ECM with stationary series only (Shittu et al 2012).

An ARDL model is implemented using upper bound critical values for determination of co integration. Before proceeding with checking for Co-integration, the model is checked for optimal lag length, serial correlation and stability.

IV. RESULTS AND DISCUSSION

Table1: Unit root test

Variable	Level, Intercept		First difference, Intercept		First difference, Trend& Intercept		Results
	t-statistics	p-value	t-statistics	p-value	t-statistics	p-value	
GDP growth rate	-2.464246	0.1336	-4.909826	0.0005	-4.884168	0.0029	I(1)
Child Mortality	-4.715809	0.0008					I(0)
Life expectancy	-7.097216	0.0000					I(0)

The ADF test results shown in the table 1 reveal that GDP growth rate is non-stationary and have a unit root in its level. Child mortality & Life expectancy which can be rejected at level 5% that is; both of them are integrated of order I (0). However the ADF test results shown that GDP growth rate in the first difference form are stationary at 5% level of significance which means that it is integrated of order I(1).

Table 2: Lag selection

lag	LogL	LR	FPE	AIC	SC
0	-156.9569	NA	18.39267	11.42549	11.56823
1	46.58748	348.9332	1.71e-05	-2.470534	-1.899589
2	112.7803	99.28927	2.95e-07	-6.555738	-5.556584
3	153.2778	52.06814*	3.32e-08	-8.805555	-7.378193*
4	167.4258	15.15856	2.62e-08*	-9.173269*	-7.317698

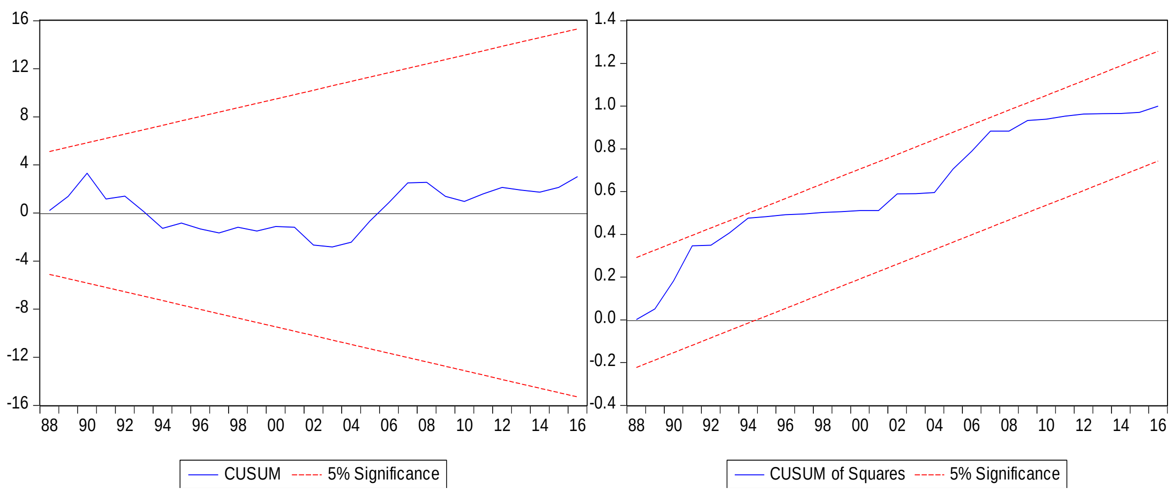
Table 2shows different criterion of lag selection, this paper used the Akaike information criterion (AIC) to select the lag length to be used. Lag length four is chosen by the software based on the AIC criteria because of minimum AIC.

Table 3: Bounds Tests for Co-integration

Statistics	F-statistic	Bound critical values		
		Statistically significant level	Lower bound I(0)	Upper bound I(1)
F-statistic	7.589748	10%	3.17	4.14
		5%	3.79	4.85
		2.5%	4.41	5.52
		1%	5.15	6.36

Table3 reports the Bounds Tests for Co-integration and F-statistic is found 7.589748 which indicate that the computed F-statistic is greater than the upper critical bound at 1%, 2.5%, 5% and 10% level of significance. This implies that there is co-integration between the series, and it confirms that investment, real interest rate and GDP are co-integrated over the study period. Therefore, there is Co-integration among the variables used in this study.

Figure1: Stability and Correlation Test



By using the Cumulative Sum of Recursive Residuals (CUSUM) and the Cumulative Sum of Squares of Recursive Residuals (CUSUMQ) respectively, it is found infigure1 that both models are stable and confirm stability of the long-run coefficients for the regressor's at the 5% level of significance.

Figure 2: Model Selection Criteria

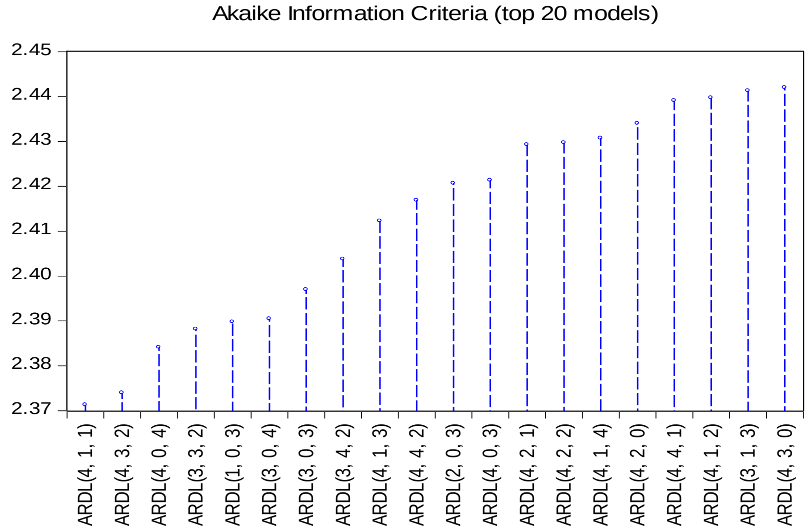


Figure 2shows the confirmation of co-integration, the optimal lag selected, based on the Akaike information criterion (AIC), is ARDL (4, 1, 1) for Model.

Table 4: ARDL Short run model results

Variable	Coefficient	Std. Error	t-Statistic	Probability
C	-0.045302	0.755889	-0.059932	0.9528
GDP(-1)	0.573930	0.348881	1.645061	0.1148
GDP(-2)	0.441545	0.273770	1.612835	0.1217
GDP(-3)	0.337639	0.197405	1.710388	0.1019
D(LIFE_EXP)	-0.004744	0.339695	-0.013967	0.9890
D(CHILD_MOR)	-0.006039	3.542711	-0.001705	0.9987
ECT(-1)	-0.527394	0.429013	-3.560256	0.0018

R-squared	0.550902	Mean dependent var	0.167750
Adjusted R-squared	0.422588	S.D.dependentvar	1.021701
S.E. of regression	0.776367	Akaike info criterion	2.543935
Sum square resid	12.65765	Schwarz criterion	2.876986
Log likelihood	-28.61508	Hannan-Quinn criter	2.645752
F- statistic	4.293394	Durbin-Watson stat	2.053602
Prob(F- statistic)	0.005616		

Table 4shows that the error correction coefficient, estimated at (-0.527394) is highly significant, has the correct negative sign, and imply a low speed of adjustment to equilibrium and meaning that there is a long run causality running from independent variables to dependent variable. It also confirms that all the variables are co-integrated or have long run relationship. According to Banerjee et al. (2003) as cited in Kidanemarim (2014), the highly significant error correction term further confirms the existence of a stable long-run relationship. Moreover, the coefficient of the error term (ECM-1) implies that the deviation from long run equilibrium level of (dependent variable) of the current period is corrected by 52.73% in the next period to bring back equilibrium.

The key regression statistics shows that R^2 is high implying that overall goodness of fit of the ARDL models is satisfactory.

TABLE 5: LONG RUN COEFFICIENT OF ARDL MODEL

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LIFE_EXP	-2.009817	0.979835	-2.051179	0.0443
CHILD_MOR	-0.217481	0.107483	-2.023404	0.0473
C	161.921925	75.425656	2.146775	0.0449

Table 5 produces the equilibrium relationship among the variables and shows that the Life expectancy (LIFE_EXP) has a negative impact on Gross Domestic Product(GDP) , and is highly significant, where it is found that an increase in life expectancy (LIFE_EXP) by 1% reduces GDP growth rate (GDP) by 2.009%. The impact of Child mortality rate on GDP growth rate is also negative and highly significant, where it is found that an increase in child mortality (CHILD_MOR) by 1% reduce GDP growth rate (GDP) by 0.217%.

If the probability value is greater than 5%, then we cannot reject the null hypothesis. Here all the Probability value is greater than 0.05, so we cannot reject the null hypothesis. That is, we accept the null hypothesis. Therefore there is no serial correlation.

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob*
. *| . |	. *| . |	1	-0.077	-0.077	0.1833	0.669
. | . |	. | . |	2	0.019	0.013	0.1944	0.907
***| . |	***| . |	3	-0.359	-0.358	4.5178	0.211
. *| . |	.**| . |	4	-0.136	-0.217	5.1613	0.271
. | . |	. *| . |	5	-0.066	-0.123	5.3183	0.378
. | . |	.**| . |	6	-0.034	-0.239	5.3628	0.498
. *| . |	.**| . |	7	-0.070	-0.330	5.5567	0.592
. | . |	.**| . |	8	0.060	-0.220	5.7066	0.680
. |* . |	.**| . |	9	0.081	-0.223	5.9961	0.740
. |* . |	. *| . |	10	0.172	-0.173	7.3783	0.689
. |* . |	. |* . |	11	0.211	0.085	9.5852	0.568
. *| . |	.**| . |	12	-0.185	-0.246	11.381	0.497

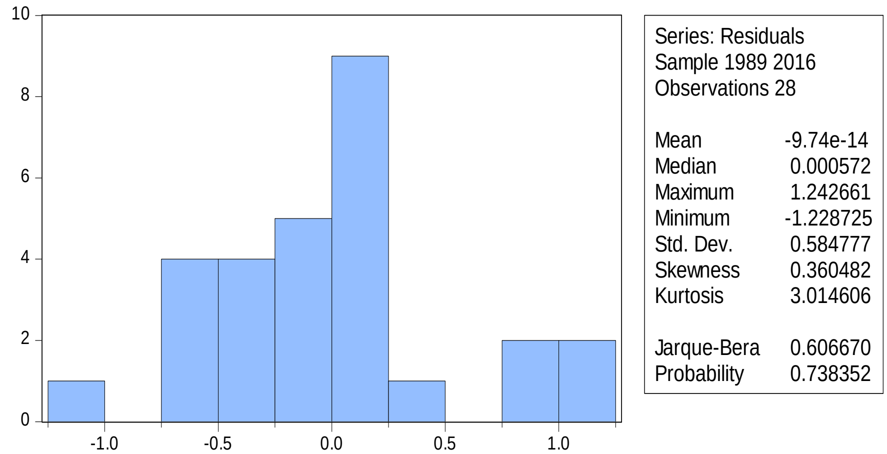
Table 6: Granger Causality Test

Null Hypothesis:	Obs	F-Statistic	Prob.
LIFE_EXP does not Granger Cause GDP	30	6.06985	0.0071
GDP does not Granger Cause LIFE_EXP		2.67126	0.0888
CHILD_MOR does not Granger Cause GDP	30	6.27215	0.0062
GDP does not Granger Cause CHILD_MOR		1.18451	0.3225
CHILD_MOR does not Granger Cause LIFE_EXP		39.9276	2.E-08
LIFE_EXP does not Granger Cause CHILD_MOR	3 0	8.49767	0.0015

Here from the table6, the Probability value of Obs*R-squared is greater than 0.05, so we cannot reject the null hypothesis. That is, we accept the null hypothesis. Therefore there is no serial correlation. The test does not reject the hypothesis of no serial correlation up to order four. The Q-statistic and the LM test both indicate that the residuals are not serially correlated.

Obs*R-squared	0.515693	Prob. Chi-Square(2)	0.7727
F-statistic	0.159487	Prob. F(2,17)	0.8538

Here the Probability value of Obs*R-squared is greater than 0.05, so we cannot reject the null hypothesis. That is, we accept the null hypothesis. Therefore there is no serial correlation. The test does not reject the hypothesis of no serial correlation up to order four. The Q-statistic and the LM test both indicate that the residuals are not serially correlated.



Here the Probability value of Jarque-Bera is greater than 0.05, so we cannot reject the null hypothesis. That is, we accept the null hypothesis. Therefore the residuals are normally distributed.

Here the Probability value of Obs*R-squared is greater than 0.05, so we cannot reject the null hypothesis. That is, we accept the null hypothesis. Therefore there is no Heteroskedasticity.

Results

Table 7: Heteroskedasticity Test: Breusch-Pagan-Godfrey

F-statistic	0.783371	Prob. F(8,19)	0.6228
Obs*R-squared	6.944840	Prob. Chi-Square(8)	0.5426
Scaled explained SS	3.221170	Prob. Chi-Square(8)	0.9197

The first objective of the thesis is to examine whether there are relationships between life expectancy and child mortality rate and economic growth. In the case of causality it is found from table 7that from GDP does not Granger Cause CHILD_MOR is not rejected as the P value is 0.3225 is higher than 5%. The null hypothesis that CHILD_MOR does not Granger Causes GDP is rejected as the P value is 0.0062 is greater than 5%.

The second objective is to estimate the direction and magnitude of these relationships. The equilibrium relationship among the variables shows that the Life expectancy (LIFE_EXP) has a negative impact on Gross Domestic Product (GDP), and is highly significant, where it is found that an increase in life expectancy (LIFE_EXP) by 1% reduces GDP growth rate (GDP) by 2.009%. The impact of Child mortality rate on GDP growth rate is also negative and highly significant, where it is found that an increase in child mortality (CHILD_MOR) by 1% reduce GDP growth rate (GDP) by 0.217%.

V. CONCLUSION

The analysis of the causal relationship between maternal and child health and GDP and the magnitude of effect is vital since this indicates potential economic and social returns on investments. The objectives of this study were to examine if there is a relationship between child mortality and GDP and to estimate the direction and the magnitude of any such relationships.

In the analysis we use time series data Granger analysis based on a simple model to provide some initial evidence. After this, the analysis focuses on the causal relationship on the impact of child mortality on GDP based on ARDL model. From the Granger Causality test it can be found that GDP growth rate has no effect on child mortality and life expectancy but both life expectancy and child mortality affect the GDP growth rate.

However, in contrast, the causal relationship among the variables shows that the Life expectancy (LIFE_EXP) has a negative impact on Gross Domestic Product (GDP), and is highly significant, where it is found that an increase in life expectancy (LIFE_EXP) by 1% reduces GDP growth rate (GDP) by 2.009%. The impact of Child mortality rate on GDP growth rate is also negative and highly significant, where it is found that an increase in child mortality (CHILD_MOR) by 1% reduce GDP growth rate (GDP) by 0.217%.

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