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Effect of National Income, Gross Domestic Product, Income Inequality and Education Expenditure on Adolescent Fertility of South Asia

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Sabina Islam, Anisa Ahmed Chowdhury, Mossamet Kamrun Nesa*

Department of Statistics, Shahjalal University of Science and Technology, Sylhet 3114, Bangladesh;

* Corresponding Author: Mossamet Kamrun Nesa (mknesa-sta@sust.edu)

Abstract

This study attempts to assess the trend and effect of national income, income inequality, gross domestic product (GDP) per capita, and government expenditure on education on adolescent fertility rate (AFR) of South Asian countries. The data for this study is extracted from the World Bank open database. K-nearest neighbor (KNN) imputation method is used to estimate the missing values in the datasets. Simple linear regression and multiple linear regression are used to examine the associations of dependent and various independent variables. It is observed from the study that both the unadjusted and adjusted models, both GDP per capita and national income have found significant negative impact on the AFR of South Asia. Income inequality is also found to have a significant negative impact on the AFR after adjusting for other factors. So, this study suggested overall economic growth of the country will have a positive and steady impact on AFR of South Asia.

Key words: Adolescent Fertility; South Asia, World Bank; KNN

Adolescence is the period of life in which both physiological and psychological growth occur rapidly in a person [1]. So, it is one of the most important stages of life. However, the female adolescent faces a higher health risk on mental and physical growth due to the lack of knowledge about reproductive health. Adolescent childbearing is an issue that affects the development of young girls worldwide including South Asia. Adolescent childbirth has been proven to be one of the important contributors that affects maternal and children health and mortality rates [2]. Moreover, children born from adolescent mothers were found to be more prone to repeat their parents' reproductive behaviors after they grown up [3]. For this reason, the adolescent childbearing cycle progresses to next generations and thus makes development among the youth a challenge. A lot of countries including Bangladesh (adolescent birth rate (ABR) = 81 births per thousand), Nepal (ABR= 63 births per thousand), Pakistan (ABR= 37 births per thousand) and Sri Lanka (ABR= 20 births per thousand) have a high rate of adolescent fertility [4]. Childbirth at an early age has a direct relationship with the poor health of the teen-age mothers. The World Health Organization (WHO) considered pregnancies before attaining the age 18 as the high risk for poor maternity care and subsequently causing teenagers to suffer more complications because of pregnancies [5]. Furthermore, early childbirth is a leading cause of death among adolescent mothers who may also not be emotionally matured enough to take the responsibility of childbearing [6]. Early childbirth also affects the socio-economic status of the women. Early childbearing may disrupt the education of girls and limit their human capital growth which in future lowers their productivity, opportunities for jobs, and earnings [7]. It was estimated that in India only, adolescent childbearing causes about $100 billion of loss in potential income [8]. Adolescent childbirth might cause loss of potential income, poverty, consistent gender gaps, and continuation of intergenerational poverty. Due to the complex and severe impact of adolescent fertility on the social, economic and health condition of the girls, it is now become a matter of great concern. Two global strategies: the United Nations Global Strategy for Women's, Children's, and Adolescents' Health [9] and the 2030 Agenda for Sustainable Development [10], emphasize in the reduction of adolescent fertility and so now the adolescent fertility rate is a key indicator and is likely to be monitored closely through 2030. As a result, adolescent fertility has become a matter of great concern among different countries.

Several different factors can influence the presence of high adolescent fertility rates in countries. That includes social, economic, and behavioral factors at both personal and national levels. Many studies have shown that at the national level, adolescent fertility rates of the countries were influenced by national income, parents' education attainment and socioeconomic disparities within the countries [11, 12]. Adolescent fertility rate within states and smaller areas in United States was found to be strongly related to the income per capita, income disparities, proportion of people living in poverty, and education attainment [13, 14, 15]. Even the presence of higher adolescent fertility in United States despite being a high-income country, was explained by the presence of high socio-economic disparities [11]. Study based on the municipalities in Brazil, a middle-income country which have substantial amount of income inequalities, reported a positive association of income inequality and negative association of poverty with the adolescent fertility rate [16]. Along with income inequality, per capita income was another national-level factor that was found to have an influence on the change of adolescent fertility rate [14]. It was further reported that increasing the government expenditure on education had a significant impact in reducing the adolescent fertility rate [17]. Moreover, another study conducted for the Asian countries found that education expenditure and gross enrolment ratio had a positive impact on the gross domestic product (GDP) per capita and a negative impact on the adolescent fertility rate of all Middle East and six countries of Southeast Asia [18].

So, this study explores the relationship between the GDP per capita, income inequality, gross national income and government expenditure on education as percentage of GDP with adolescent fertility rates of the South Asian countries. The aim of this research paper is to learn about how GDP per capita, income inequality, national income and Governmental education expenditure of South Asian countries affect the adolescent fertility rate.

2. Data and Methodology

Data used for this study are taken from the World Development Indicators dataset of World Bank online open database [19]. The data that are presented in this dataset were collected from different official sources such as the regional or the national statistical organizations and from international studies like Demographic and Health Survey (DHS) or UNICEF Multiple Indicator Cluster Survey Among the variables used in this study, the World Bank data on adolescent fertility came from United Nations Population Division, World Population Prospects. The data about GDP per capita and GNI were collected from World Bank national accounts data, and OECD National Accounts data files. The source of Gini index was World Bank, Poverty and Inequality Platform and the data of government expenditure on education as a percentage of GDP, and school enrolment came from the UNESCO Institute for Statistics.

This dataset contains adolescent fertility rates for seven South Asian countries, which are measured as the number of births per 1,000 adolescent women (aged 15-19 years) during 1960 to 2019. Gross domestic product per capita (GDP per capita) and the gross national income (GNI) measured by current US dollars are used. The Gini index, the most commonly used measure of national income inequality, was also used for this study. A Gini index equal to indicates perfect equality, that is, everyone has equal income, and a Gini index of 100 indicate perfect inequality that is, and one person has possessed the whole income. So, a higher Gini index indicates that there is a larger income inequality present within the country. Educational expenditure is measured as the percentage of the GDP of the countries. One of the South Asian countries, Afghanistan, is omitted from the dataset as there was no available value of Gini index for Afghanistan.

The data used in this study has some missing values. However, as the Gini index and education expenditure do not change much over the years and other variables indicate change over the years. Only a few values missing are noticed in the dataset which are estimated by K-Nearest Neighbor (KNN) method with weighted mean. The aim of this study is to observe the effect of Gini index, GDP per capita, GNI and government educational expenditure (% of GDP) on AFR.

Since the data is a longitudinal data that contains repeated measure so linear regression with generalized estimating equation (GEE) is used. Generalized Estimating Equations (GEEs) is used to account for the correlation between observations.

According to the the notation of Zeger and Liang (1986) [20], assume that the observations are (y_{ij}, x_{ij}) at different time points t_{ij}, where $j = 1, ..., n_i$ and subjects are $i = 1, ..., K$. Here the outcome variable is denoted by y_{ij} and x_{ij} denotes a vector of covariates with dimension $p \times 1$.

Suppose y_i is defined as a $n_i \times 1$ vector $(y_{i1}, ..., y_{inj})'$ and x_i as a $n_i \times p$ matrix $(x_{i1}, ..., x_{inj},)'$ for the ith subject. Let's assume that μ_i is the expectation of y_i and $\mu_i = h(x_i\beta)$, where β is assumed to be a vector of parameters with dimension $p \times 1$ and the link function is inverse of h. The variance υ_i of y_i is represented by g which is a known function of the expectation, μ_i, such as, $\upsilon_i = g(\mu_i)/\Phi$, where Φ is an unknown scale parameter.

Let's consider $R_i(\alpha)$ working correlation matrix for each y_i with dimension $n_i \times n_i$ and suppose $R_i(\alpha)$ is entirely defined by vector of unknown parameters, α, with dimension the $s \times 1$, which is the same for all subjects. The quasi-likelihood estimator is obtained by solving the score equations for β. To achieve this, given estimate of $R_i(\alpha)$ and Φ are used to calculate an updated estimate of β by iteratively reweighted least square. The estimation of β is obtained by solving the generalized estimating equation,

$$S_k(\beta) = \sum_{i=1}^{k} \frac{\partial \mu' i}{\partial \beta k} V_i^{-1}(\alpha)(y_i - \mu_i) = 0. \; K=1, ..., p.$$

Here $V_i(\alpha) = A^{1/2}{}_i R_i(\alpha) A^{1/2}{}_i / \Phi$, with A representing an $n_i \times n_i$ diagonal matrix with $g(\mu_{ij})$ as it's jth diagonal element and S_k represents the sum over observations, and μ_i is denoted by the matrix $(\mu_{i1}, ..., \mu_{ni})'$. V is diagonal for independent correlation structure. Except independent correlation structure, other commonly used correlation structures are exchangeable, auto regressive, and unstructured. In this study, Quasi likelihood information criterion (QIC) is used to determine the more suitable correlation structure for GEE [21]. In the present study, QIC values for independent correlation structure is lowest so this correlation structure is selected here. Independent correlation structure is equivalent to an identity matrix and the values are estimated using the assumption that there is no correlation within the clusters of repeated observations.

3. Results

3.1. The Trend of Adolescent fertility rate in South Asian countries:

The Figure-3.1 shows the trend of adolescent fertility rate for the south Asian countries over 1960-2019. From the graph, it is found that Maldives has the highest and the lowest adolescent fertility rate among these countries in 1960 and 2019. However, Sri Lanka has the lowest and Bangladesh has the highest AFR in 1960 and 2019 respectively.

From Table-3.1, we have found that the adolescent fertility rate of Bangladesh increases during 1960-1969 but after that decade it starts decreasing from 1970 and continued till 2019. In case of Bhutan a consistent decrease of adolescent fertility is observed over the period of 1960-2019. During 1960-1969 and 1970-1979, the adolescent fertility rate in India increases, however it starts decreasing from 1980-1989 and continues till 2019. Maldives experiences an increase of adolescent fertility rate from 1960-1969 but for next few decades it has been decreasing. In 1960-1969 and 1980-1989, Nepal's adolescent fertility rate experienced an increase. However, a noticeable trend reversal occurred from 1990-1999, with a continuous decline observed until 2019. Both Pakistan and Sri Lanka have witnessed a continuous decrease of adolescent fertility rate over the study period.

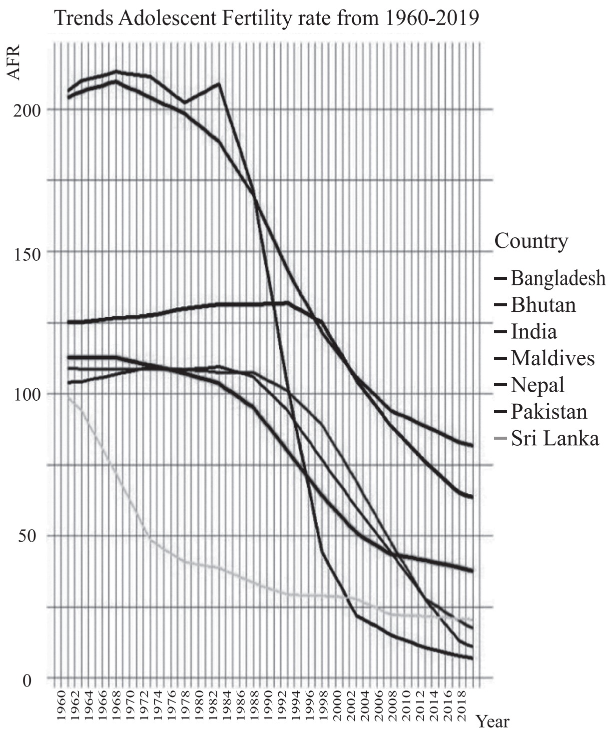

Figure 3.1. The trend of AFR in 1960-2019 for South Asian Countries.

3.2. The Trend of GDP per capita in South Asian countries:

Figure 3.2 shows the trend of GDP per capita for seven South Asian countries over 1960-2019. All the seven countries have significant increase in the GDP per capita over the given time. Among these countries, Maldives has the highest GDP per capita in both 1960 and 2019. Nepal, on the other hand, has the lowest GDP per capita in 1960 and 2019.

From Table -3.1, it is found that Pakistan has the highest increase and Sri Lanka has lowest increase in GDP per capita over 1960-1969. In 1970-1979, India has the highest increase and Bhutan has the lowest increase of GDP per capita. Maldives has the highest increase and Bangladesh has the lowest increase of GDP per capita during 1980-1989. Maldives still has the highest increase over 1990-1999 and 2000-2009, however, Nepal has the lowest increase during 1990-1999 and Pakistan has the lowest increase during 2000-2009. From 2010 to 2019, Bangladesh has the highest growth and Pakistan has the lowest growth in GDP per capita.

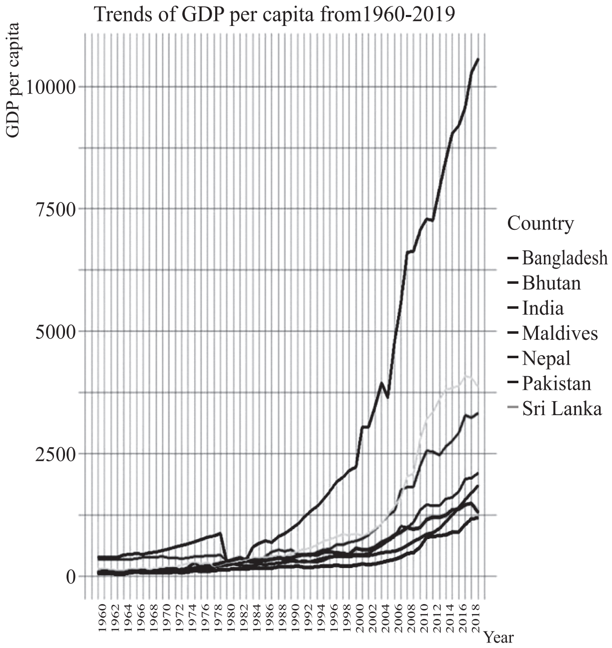

Figure 3.2. The trend of GDP per capita in 1960-2019 for South Asian Countries.

3.3. The Trend of Gini index in South Asian countries:

Figure 3.3 shows the trend of the Gini index for seven (except Afghanistan) South Asian countries over 1960-2019. The values of Gini index for all of the countries did not change much. Among the countries, Maldives has the highest Gini index in 1960 and 2019 and Bangladesh has the lowest Gini index in 1960 and 2019.

From Table-3.1, it is found that Bangladesh, India, and Sri Lanka have a slight increase and Bhutan, Maldives, and Pakistan has a slight decrease in the Gini index during 1960-1969. The Gini index of Pakistan increased during 1970-1979 and decreased during 1990-1999.Sri Lanka has a significant increase of the Gini index during 1990-1999 and decreased during 2000-2009 along with Bangladesh and Maldives. From 2010-2019, the Gini index of Pakistan and Nepal have increased, whereas it decreased for Bangladesh.

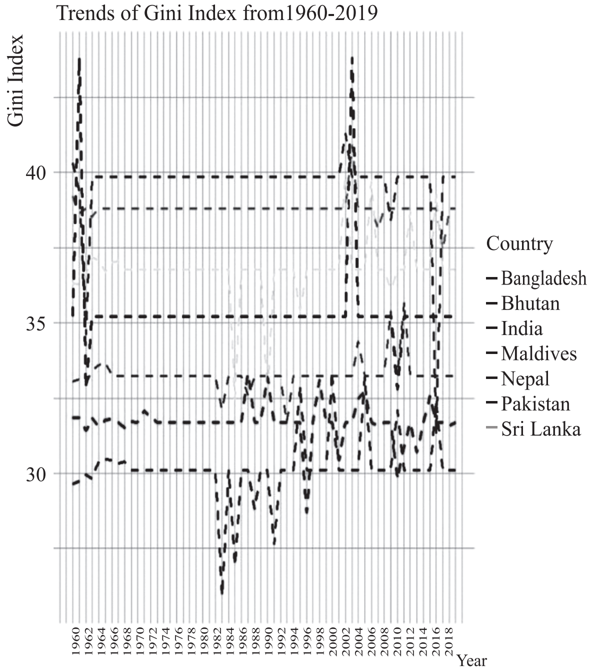

Figure 3.3. The trend of Gini index in 1960-2019 for South Asian countries.

3.4. The Trend of GNI in South Asian countries:

Figure-3.4 shows the increase of GNI for south Asian countries during 1960-2019. All the countries displayed a significant increase of GNI in this time. Among these countries, India has the highest and Bhutan has the lowest GNI in 1960 and 2019.

From Table-3.1, it is concluded that, Bangladesh has highest (153.69%) increase during 2010-2019 and lowest (13.26%) increase in 1970-1979.Bhutan has an 179.01% increase in 2000-2009 and 10.68% increase of GNI during 1970-1979.In case of India, there is a maximum increase of 187.87% and minimum increase of 43.72% GNI over the period of 2000-2009 and 1990-1999 respectively. Maldives recorded the highest increase in GNI at 251.67% over the period from 2000 to 2009, while its lowest increase of 18.22% in the period of 1960-1969. Nepal experienced a substantial 135.94% increase in GNI in the decade of 2000-2009 but had 38.63% increases during the 1990-1999 periods. Pakistan witnessed the highest increase in GNI, with an impressive increase of 129.91% during the decade spanning 1960-1969, and the lowest increase of 56.68%, occurred in the period from 1990 to 1999. Sri Lanka has an 159.55% increase in 2000-2009 and 38.97% increase of GNI during 1960-1969.

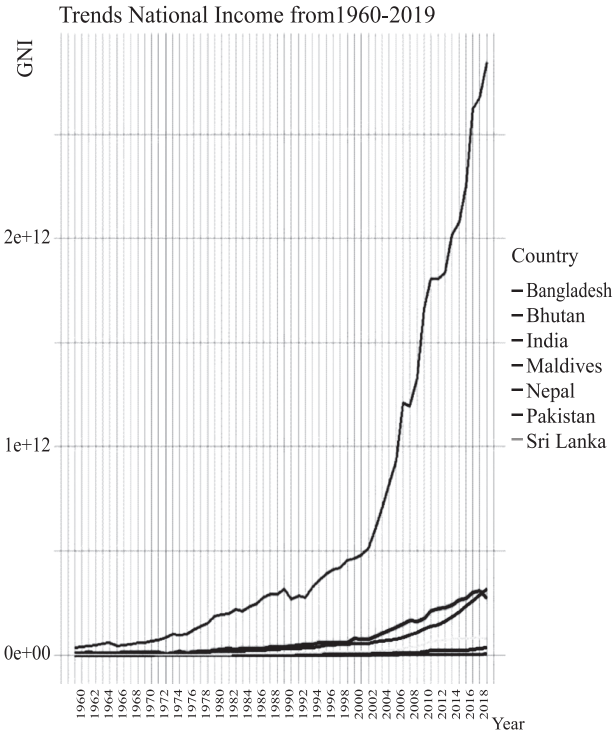

Figure 3.4. The trend of GNI in 1960-2019 for South Asian countries.

3.5. The Trend of Education Expenditure in South Asian countries:

The Figure-3.5 shows the trend of government educational expenditure as a percentage of GDP for the south Asian countries over 1960-2019. From the graph it is observed that, in both 1960 and 2019, Nepal shows the highest educational expenditure. In 2019, Bhutan exhibits the second highest educational expenditure. Bangladesh holds the lowest educational expenditure in the study period.

From Table-3.1, it is observed that Government expenditure on education in Bangladesh, Bhutan and Pakistan have increase from 1960-1969, whereas it decreases for India, Maldives, Nepal, and Sri Lanka. During 1970-1979, Bangladesh, Maldives, and Nepal have witnessed an increase, but Bhutan, India, Pakistan, and Sri Lanka have witnessed a decrease of education expenditure. The education expenditure of Bangladesh and Pakistan increase and decrease respectively in the decade of 1980-1989. From 1990 to 1999, Bangladesh, India and Pakistan have experienced a growth in education expenditure. Moving forward to 2000-2009, the education expenditure increased for Nepal, and Pakistan, while it decreased for rest of the countries. During 2010-2019, Bhutan, India, Maldives, Nepal, and Sri Lanka have experienced an increase, however, Bangladesh and Pakistan have experienced a decrease of education expenditure.

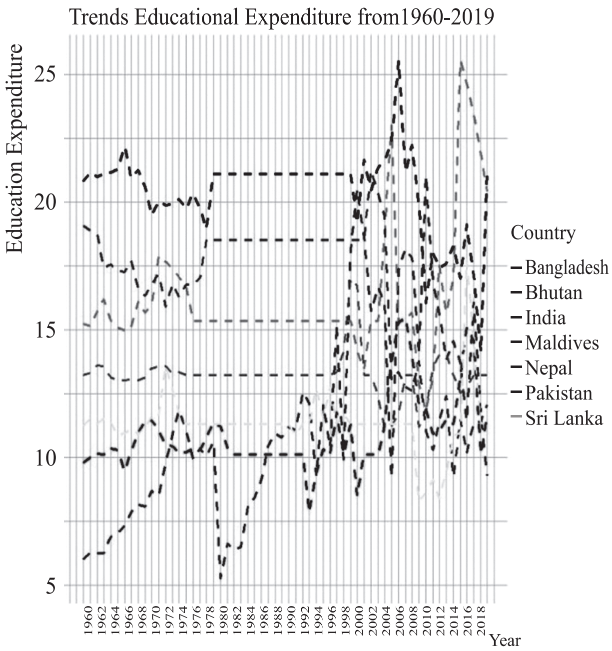

Figure 3.5. The trend of educational expenditure in 1960-2019 for South Asian countries.

Table 3.1. AFR, GDP per capita, Gini index, GNI and Educational expenditure in 1960 and 2019 for South Asia countries and change over time by Country.

Country	1960	2019	% Change (1960-1969)	% Change (1970-1979)	% Change (1980- 1989)	% Change (1990-1999)	% Change (2000- 2009)	% Change (2010-2019)
Adolescent fertility rate (AFR) (births per thousand women)								
Bangladesh	204.00	81.66	1.69% increase	5.73% decrease	17.3% decrease	25.06% decrease	18.13% decrease	10.07% decrease
Bhutan	108.99	17.61	0.42% decrease	0.36% decrease	2.83% decrease	21.64% decrease	48.25% decrease	51.01% decrease
India	103.92	10.96	3.73% increase	0.42% increase	7.16% decrease	28.96% decrease	43.21% decrease	68.37% decrease

Maldives	206.43	7.02	2.92% increase	3.42% decrease	30.26% decrease	72.69% decrease	56.45% decrease	44.35% decrease
Nepal	125.24	63.68	1.32% increase	2.75% increase	0.55% increase	11.13% decrease	25.84% decrease	21.58% decrease
Pakistan	112.67	37.62	0.96% decrease	4.75% decrease	15.16% decrease	31.43% decrease	24.19% decrease	11.15% decrease
Sri Lanka	98.64	20.45	36.43% decrease	31.08% decrease	19.56% decrease	7.49% decrease	22.17% decrease	7.13% decrease
GDP per capita (current U.S. dollar)								
Bangladesh	89.03	1855.74	51.79% increase	43.41% increase	25.50% increase	33.72% increase	67.98% increase	137.56% increase
Bhutan	336.92	3322.86	14.66% increase	10.75% increase	60.29% increase	27.49% increase	153.3% increase	47.15% increase
India	82.19	2100.75	30.94% increase	99.23% increase	29.83% increase	20.25% increase	148.57% increase	54.74% increase
Maldives	384.29	10561.61	30.16% increase	64.75% increase	226.24% increase	123.57% increase	196.99% increase	49.24% increase
Nepal	50.30	1194.96	32.48% increase	75.86% increase	47.48% increase	11.58% increase	108.36% increase	101.71% increase
Pakistan	83.34	1288.56	84.09% increase	51.07% increase	26.83% increase	22.22% increase	66.26% increase	30.5% increase
Sri Lanka	142.78	3852.26	12.67% increase	23.71% increase	52.6% increase	80.95% increase	140.36% increase	37.60% increase
Gini index								
Bangladesh	29.63	30.10	1.59% increase	0% increase	0% increase	0% increase	9.88% decrease	6.23% decrease
Bhutan	39.22	38.80	1.07% decrease	0% increase	0% increase	0% increase	0% increase	0% increase
India	33.05	33.24	0.57% increase	0% increase	0% increase	0% increase	6.49% increase	0% increase
Maldives	40.33	39.85	1.19% decrease	0% increase	0% increase	0% increase	3.64% decrease	0% increase
Nepal	35.20	35.10	0% increase	0% increase	0% increase	0% increase	0% increase	7.01% increase
Pakistan	31.86	31.70	0.41% decrease	0.03% increase	0% increase	4.52% decrease	0% increase	6.38% increase
Sri Lanka	36.31	36.79	1.32% increase	0% increase	0% increase	13.55% increase	1.87% decrease	0% increase
Gross National Income (current U.S. dollar)								
Bangladesh	1.159018 e+10	3.160916e+ 11	20.19% increase	13.26% increase	62.00% increase	63.95% increase	100.73% increase	153.69% increase
Bhutan	1.126386 e+08	2.306109e+ 09	34.46% increase	10.68% increase	143.66% increase	21.82% increase	179.01% increase	57.94% increase
India	3.687868 e+10	2.843265e+ 12	57.51% increase	146.93% increase	56.64% increase	43.72% increase	187.87% increase	71.47% increase
Maldives	1.614071 e+08	5.047936e+ 09	18.22% increase	88.11% increase	53.88% decrease	188.03% increase	251.67% increase	121.69% increase
Nepal	5.083344 e+08	345397916 22	55.14% increase	114.78% increase	80.39% increase	38.63% increase	135.94% increase	114.27% increase
Pakistan	3743805 557	273446605 819	129.91% increase	95.79% increase	68.09% increase	56.68% increase	104.62% increase	57.22% increase
Sri Lanka	1406432 689	815726994 17	38.97% increase	56.77% increase	70.54% increase	92.75% increase	159.55% increase	45.37% increase
Government Expenditure on Education (% of GDP)								
Bangladesh	6.01	9.27	34.58% increase	22.14% increase	104.88% increase	62.01% increase	31.53% decrease	55.84% decrease
Bhutan	15.21	20.38	2.96% increase	3.94% decrease	0% increase	0% increase	9.12% decrease	72.86% increase
India	13.22	13.21	0.68% decrease	2.00% decrease	0% increase	28.39% increase	33.11% decrease	11.66% increase
Maldives	19.06	12.06	14.32% decrease	10.43% increase	0% increase	0% increase	25.7% decrease	9.64% increase
Nepal	20.80	21.08	1.15% decrease	8.32% increase	0% increase	0% increase	3.71% increase	31.5% increase
Pakistan	9.77	11.30	16.76% increase	0.95% decrease	9.7% decrease	11.9% increase	42.3% increase	2.30% decrease
Sri Lanka	11.24	11.30	0.39% decrease	2.56% decrease	0% increase	0% increase	26.79% decrease	31.27% increase

3.6. Unadjusted linear regression with GEE for South Asia:

Unadjusted regression models are used to find the individual effect of GDP per capita, GNI, Income inequality and government expenditure on education (% of GDP) on the adolescent fertility rate of South Asia.

The findings in Table-3.2 show that income inequality and government expenditure on education have no significant effect on the adolescent fertility rate of South Asia. However, GDP per capita and GNI have a significant negative effect on AFR. Among these, GDP per capita has the highest effect. For one unit increase in log GDP per capita, the AFR will on average decrease by 30.8 times. The AFR will decrease by 7 times for one unit increase in log GNI.

Table 3.2. Unadjusted regression estimate of the factors on adolescent fertility rate of South Asia.

Factor	Estimate	Robust S.E.	p-value
Log GDP per capita	-30.8	4.6	2.2e-11
Gini index	-2.76	3.65	0.45
Log GNI	-7.00	3.03	0.0208
Education expenditure	1.45	3.69	0.70

3.7. Adjusted linear regression with GEE for South Asia:

Adjusted linear regression model is used to find the effect of GDP per capita, GNI, and Income inequality and government expenditure on education (% of GDP) on the adolescent fertility rate of South Asia. Adjusted linear regression model assesses the relationship between two variables while controlling the influence of other variables. This approach allows controlling the impact of additional variables, effectively isolating and assessing the relationship between the variables of interest.

From Table-3.3, it is found that income inequality, GDP per capita and GNI have significant effect in changing the AFR of the South Asia region. Considering other factors constant, for one unit increase in Gini index, the AFR of south Asian countries, on average, will decrease by 7.65 times. For each unit increase in log GDP per capita, the average AFR will decrease by 18.96 times, provided other factors are constant. And one unit change in log GNI will result in 12.71 times decrease in average AFR of south Asian countries. Government expenditure on education as percentage of GDP seems to have no significant effect on AFR in case of adjusted linear regression.

Table 3.3. Adjusted regression estimate of the factors on adolescent fertility rate of South Asia.:

Factors	Estimate	Robust S.E.	p-value
Gini Index	-7.65	4.52	0.0903
Education Expenditure	1.02	2.13	0.6320
Log GDP per capita	-18.96	6.50	0.0035
Log GNI	-12.71	4.28	0.0030

4. Discussion and Conclusion

Adolescent fertility is independently associated with both GDP per capita and GNI. The Gini index also seems to influence adolescent fertility after controlling GDP per capita, national income, and education expenditure. So, increasing the national income and GDP per capita can be an important factor in the decline of adolescent fertility in South Asian region.

The findings of this study demonstrate that GDP per capita and gross national income individually have a significant association with adolescent fertility in South Asia. The findings of this study also showed the effect of these factors in south Asia when they are adjusted for other factors. GDP per capita and GNI are significantly negatively associated with adolescent fertility after adjusting for the other variables. Both GDP per capita and GNI have a profound effect in decreasing rate of the adolescent fertility. Previous studies also drawn similar conclusion that is increasing national income is associated with different factors which can lead to decrease of adolescent fertility, such as improving educational and occupational opportunities for women, rising access to contraception, urbanization, delayed marriage, and childbearing, and decrease in fertility among young adults [22, 23, 24, 25, 26]. However, the Gini index and education expenditure are individually found to have no significant relationship with adolescent fertility in South Asia. But after adjusting for the other factors, Gini index seems to have a significant negative relationship with the adolescent fertility of South Asia. This indicates that increasing income inequality will lower adolescent fertility. Though contradictory, this negative relationship between adolescent fertility and income inequality have been reported previously [27] and may be due to the reason as in sort run, lower fertility can increase growth but increase income inequality [28]. Income inequalities have weak relationship with different dimensions which are the determinants of adolescent health and thus increases the chance of erroneous association between income inequality and adolescent fertility [29,30]. However, education expenditure is found to be insignificant which is also found for some other Asian countries in short run [18]. Among the factors, GDP per capitas' still has the highest effect on the adolescent fertility rate. The per capita GDP and the national income have the most significant impact on decreasing the adolescent fertility rate. It is found from this research that GDP per capita and national income are important determinants for the adolescent fertility rate in South Asia.

So, it can be concluded that overall economic situation of the countries has immense influence on the adolescent fertility rate of the countries. Therefore, an increased initiative should be taken to address the root cause of poverty, a crucial reason of higher adolescent childbirth, and policies regarding improvement of overall economic growth of the countries. Along with promoting the economic development of the countries, the presence of income inequalities and disparities within the countries should be addressed. Actions should be taken to remove the inequalities within the countries as this will have an important effect in improving the health and social outcomes for the adolescents.

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