7B-1

Life expectancy at birth in SAARC countries with the impact of domestic general government health expenditure, domestic private health expenditure, GDP per capita, urban population and CO2 emissions.

1. Md Tusher Ahmed, Directorate of Secondary and Higher Education (DSHE), Bangladesh
   Mobile: 080-9814-1619, Email- amdtusher@gmail.com
2. YUAN Lihui, Associate Professor, Faculty of Economics, Yamaguchi University, Japan
   Mobile: 090-2802-8066, Email: ylhenrei@yamaguchi-u.ac.jp

(We would like to attend in the conference in-person)

Abstract:

Life expectancy at birth in the SAARC countries is lower compare to developed countries which leads lower productivity of the population of this region. It is significant to understand the ways of the betterment of health outcomes of the people for economic and social development. World Bank's eighteen years (2002-2019) data set of SAARC countries was used for regression analysis with entity fixed effect model. This study finds that life expectancy at birth is positively related with domestic general government health expenditure, GDP per capita, urban population, CO_2 emissions whereas negatively related with domestic private health expenditure. Life expectancy at birth as health outcome can play vital role for more production and economic growth with the pace of growing economies of SAARC countries.

Key words: SAARC countries, Domestic general government health expenditure, Domestic private health expenditure, GDP per capita, Urban population, CO_2 Emissions, Life expectancy at birth.

1. Introduction:

Healthier people generally have longer life expectancy with the efficacy of productivity as human capital those who can contribute to the economic development of a country in the long run. According to the definition of World Bank, life expectancy at birth indicates as the number of years a newborn infant would live if prevailing patterns of mortality at the time of its birth were to stay the same throughout its life. Therefore, life expectancy at birth is significant to understand the public health and national development of a country [1]. To understand the linkage of life expectancy with domestic healthcare expenditure, CO_2 emission, urban population and Gross Domestic Products (GDP) per capita is essential for sustainable development of human capital of SAARC countries. Domestic healthcare expenditure is combined of domestic general government health expenditure as Public expenditure on health from domestic sources and domestic private health expenditure as Current private expenditures on health include funds from households, corporations and non-profit organizations which can be either prepaid to voluntary health insurance or paid directly to healthcare providers. SAARC (South Asian Association for Regional Cooperation) consists of eight countries namely Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan and Sri-Lanka. At the time of SAARC formation, in 1985, there were seven countries and Afghanistan became the eighth member of this regional cooperation in 2008. As on 2019, according to the world population review, in SAARC countries, total population was over 1.7 billion which was about 21% of the world's total population, total economy was $ 3.67 trillion which was 4.21% of global economy and total area was nearly 2 million square miles by consisting 3% of the world's area [2]. There is a objective in the SAARC charter at article no (1).(a) about the promotion of the welfare of the peoples of SOUTH ASIA and to improve their quality of life [3].

United Nations member states in 2015 set 17 goals for sustainable development of this world known as SDG (Sustainable Development Goals). Among these strategic goals for the prosperity and betterment of human being, SDG-3 is related with health to ensure healthy lives and promote well-being for all at all ages. This SDG-3 is one of the priority sectors of SAARC countries for the overall development of health

sector as well as economic development of the nation in view of the fact that healthier human capital can produce more output. Knowles, S., & Owen, P. D. (1995) found that health capital has more significant linkage with income per capita compare to educational human capital [4]. There are several studies focusing on the life expectancy at birth in SAARC countries and other regions of the world. These articles used different variables to study the life expectancy at birth. However there is hardly found any article combining together health expenditure, CO2 emissions, urban population and GDP per capita of eight SAARC countries to understand linkage with life expectancy at birth for the period of 2002 to 2019. The main objective of the present study is to find out the relationship of domestic general government health expenditure, domestic private health expenditure, CO_2 emission, urban population and GDP per capita with life expectancy at birth in SAARC countries. The findings of this study will assist SAARC countries to take necessary initiatives for sustainable development adding the health sustainability of this region.

This paper is consists of following parts as the present study commenced with the introduction section and followed by literature reviews denoting the background of the research. Third section is organized with methodology and framework by piling up the procedures. After that, this study shows result and discussion. Finally, the present research wraps up with the brief description of key research findings, contributions and further recommendation in the conclusion.

2. Literature Review:

A study by Mahmud et al. (2013) stated that life expectancy is significant to understand the population health status and economics development of a nation where incremental life expectancy is directly related to real per capita income and higher expenditure of health. Researchers' staple objective was to identify the effect of economic growth and health spending on life expectancy. It is found that females have longer life span than males and life expectancy raises when the gross domestic product (GDP) per capita is higher. Although the reason of longer life expectancy is not identified fully, it is argued that males are prone to dangerous occupations, smoke and drinking alcohol more than females and simultaneously,

females' enrollment in education and jobs increased significantly. Average life expectancy year, increased by 33 days and 8 days in a year due to increase in one US dollar (USD) of GDP per capita and one unit Health Expenditure Per Capita (HEPC) respectively. In addition, with the increment of one unit direct private expenditure increases 13 days of life expectancy per year. Multiple regression model was used to analyze annual time series of Bangladesh from 1995 to 2011 [5]. Another study by Rahman et al. (2018) found that health expenditure has no effect on life expectancy at birth by using fixed and random effect models on 15 countries data of SAARC-ASEAN region over a period of 20 years (1995-2014). However, authors described that public and private health expenditure decreased the infant mortality rate. Though private health expenditure has positive effect of reducing crude death rate, public health expenditure was opposite in terms of it. It is also found that per capita income growth has positive effect on life expectancy of birth [6]. Edeme et al. (2017) observed that life expectancy at birth increases and infant mortality rate falls as health outcomes when the public health expenditure improves in Nigeria. In methodology for model specification they determined life expectancy at birth and infant mortality rate as dependent variable and public health expenditure, per capita income, urban population, HIV prevalence rate as independent variables [7]. Arthur, E., & Oaikhenan, H. E. (2017) accomplished a research to identify the relationship between health expenditure and health outcome in 40 sub-Sahara African (SSA) countries with World Bank data set. They analyzed the health demand with Grossman Human Capital Model (1972) further specified by Fayissa and Gutema (2005) and for empirical analysis they took the help of fixed effect model. They observed that fixed effect model is appropriate for empirical analysis compare to pooled least squares and the random effect models using Chow test, Lagrange Multiplier and Hausman tests. They found that private health expenditure has positive and strong effect with life expectancy at birth where public health expenditure has significant effect on infant and under-five mortality rates [8]. In these articles, carbon dioxide (CO2) emissions are not considered as a determinant of life expectancy. However, Polcyn et al. (2023) stated that CO2 is harmful for human being when emissions cross the certain tolerable limit of human body. With the increase of CO2 in the air decreases the amount of oxygen which leads to dangerous effect of human body. CO2 emissions impact negatively on health outcomes

either short run or long run [9]. Murthy et al. (2021) and Emodi et al. (2022) argue that CO2 has negative effect on life expectancy [10,11]. Furthermore, Emodi et al. (2022) showed that life expectancy falls with the increase of CO2 emissions and death rate also rises with more emissions [11]. According to Chen et al. (2019) CO2 has effect on Healthcare Expenditure (HCE) in China and over the time of the effect CO2 on HCE increases as inverted U shape as like as Environmental Kuznets Curve (EKC) [12]. Andreoni, J., & Levinson, A. (2001) stated that EKC is named for inverse U shape design between some countries' pollutants and incomes with the sameness of Kuznets (1995) narrated income inequality [13]. Das, S., & Debanth, A. (2023) used time series data of World Bank from 1991 to 2018 to identify impact on Life expectancy in India due to CO2 emissions. They found that there is non-linear linkage between CO2 emissions and life expectancy in the long- run by using ARDL (Auto-Regressive Distributed Lag) bound test approach [14]. Azam et al. (2023) also found that CO2 emissions negatively impact life expectancy at birth in Pakistan using autoregressive distributive lag (ARDL) approach in the long-run [1].

Both production and consumption based CO2 emissions may reduce the life expectancy at birth by producing harmful pollutants stated by Mahalik et al. (2022) on a study. It is also observed that there is a negative relationship between life expectancy at birth and CO2 emissions. It is described that the economic development like urbanization and industrialization are necessary for economic growth which can be accompanied by huge numbers of carbon dioxide emission and environmental degradation. These environmental problems hamper the healthy living and lessen the life expectancy at birth accordingly. It is also found that financial development helps to increase life expectancy by income, gender and education. They used panel-corrected standard errors (PCSE), Feasible General Least Square (FGLS) model and linear regression with Driscoll-Kraay(D_K) standard errors to estimate the baseline models [15]. Another study by Rahman, M. M., & Alam, K. (2022) showed that renewable energy, economic growth, good governance and urbanization has positive effect on life expectancy at birth where environment pollution has negative impact. It is observed that global life expectancy decreases about 2 years due to air pollution

originated from fossil energy. Authors used Driscoll and Kraay standard error techniques and the feasible generalized least square (FGLS) model to interpret ANZUS-BENELUX (Australia, New Zealand, USA, Belgium, Netherlands and Luxemburg) countries 24 years panel data [16]. Delavari et al. (2016) observed that GDP per capita has significant and positive relationship whereas no significant effect of urbanization and CO2 emission with life expectancy at birth. As data source they used 28 years data from 1985 to 2013 of Iran during the study. Augmented Dickey Fuller (ADF) and Banergy, Dolado, and Master (BDM) tests, Engle Granger approach and ordinary laest-square (OLS) was used to achieve the target study outcome. It is observed that Stata v.12 was used to analyze the data [17]. However, these articles did not analyze health expenditure to their study. Jaba et al. (2014) found a significant positive relationship between healthcare expenditure and life expectancy at birth. They analyzed four groups of countries namely: high income, upper middle income, middle income and lower income and found positive relationship between two variables for all types of countries [18]. Fauzi, F. D., & Bakar, A. S. A. (2022) took life expectancy as dependent variable and health expenditure as independent variable to analyze data of Southeast Asian nine countries and observed strong positive relationship between these two variables [19]. Another research by Owumi, B. E., & EBOH, A. (2021) showed 1% increase in domestic general government health expenditure, out-of-pocket expenditure and external health expenditure would raise life expectancy 6%, 63% and 11% respectively in Nigeria. They found that the impact of out-of-pocket expenditure on life expectancy is more than 10 times higher than domestic general government health expenditure [20]. According to Zaman et al. (2017) there is no significant relationship in multivariable analysis ($p>0.05$) between total health expenditure and life expectancy whereas, they found strong connection between GDP and health expenditure. In this study they used STATA version 13 SE to analyze data of Bangladesh from 1996 to 2006. To use only 10 years data is one of the limitations of this study [21]. Kim et al. (2013) analyzed 27 years data of 17 OECD countries from 1973 to 2000 using mixed effect model in Statistical Package for Social Science (SPSS) version 19.0. They found negative linkage between infant mortality rate and health expenditure where infant mortality falls by .077 with 1% increase in health expenditure. There is also found that health expenditure has positive effect on life expectancy at birth with a rate

of .026 due to one percent increases in health expenditure [22]. Linden, M., & Ray, D. (2017) analyzed panel data of 34 OECD nations during the period 1970- 2012 dividing into three groups in terms of GDP's share in public health expenditure. They found that life expectancy has positive linkage with both public and private health expenditures when the share of public expenditures higher in relation to GDP. It is also observed that private expenditures impact negatively to life expectancy as share is smallest in public health expenditures. However, major outcome of this study did not changed with robustness analysis which was life expectancy increases with higher public expenditures. In methodology, panel time series methods were used to examine the connection between life expectancy and health expenditures [23].

Radmehr, M., & Adebayo, T. S. (2022) uncovered that health expenditure has positive effect and CO2 emissions has negative effect on life expectancy by covering the period 2000-2018 with Method of Moments Quantile Regression (MMQR) approach in Mediterranean countries. They observed that healthcare expenditure significantly contribute on life expectancy which indicates that increasing healthcare expenditures would raise life expectancy. It is also demonstrated that CO2 emissions reduces longevity of Mediterranean people [24]. Another study by Polcyn et al. (2023) showed that health expenditure, energy consumption and GDP per capita are positively correlated with life expectancy while CO2 estimated opposite relation by analyzing data of 46 Asian countries from 1997 to 2019. They used the inter autoregressive distributive lag (CS-ARDL) model to find out the results. It is recommended that Asian countries should increase health expenditure, energy consumption and long-run economic growth for the betterment of health outcomes [9].

This research did not consider urban population to measure life expectancy at birth. Life Expectancy at birth may be different due to location. Depending on urban or rural areas due to numerous environmental and socio-economics elements like clean air, green environment, free space and physical exercise. Kyte, L., & Wells, C. (2010) found that life expectancy of rural people is higher comparatively to urban people [25]. Another article by Singh, G. K., & Siahpush, M. (2014) showed that there is discord in the United stated in terms of life expectancy at birth between urban and rural areas using standard life-table

methodology of data from 1969 to 2009. They found life expectancy at birth of rural people is lower than urban areas. Life expectancy at birth in large metropolitan areas, small urban areas and rural areas were 79.1 years, 76.9 years and 76.7 years respectively [26]. Kalediene, R., & Petrauskiene, J. (2000) performed a study at 55 administrative regions combining 11 towns and 44 rural areas of Lithunia to find out the imbalance among these regions during 1988-1996. Linear regression was used to examine life expectancy at birth with 95% confidence interval using data of Lithunian statistics department organizing three years framework of 1988-1990, 1991-1993 and 1994-1996. The longest life expectancy was noted for males in town area and the shortest life expectancy was found for women in rural regions of Lithunia analyzing the data set. However, opposite scenario also observed in many articles that life expectancy is better in rural regions comparing to urban areas [27].

Reviewing the above literatures it is observed that there is lack of studies to examine the relationship of life expectancy at birth as dependent variable with domestic general government health expenditure, domestic general private health expenditure, CO2 emission, urban population and Gross Domestic Products (GDP) per capita as independent variables in SAARC countries. This is the vital literature gap of existing researches and our current research is to complete the space with standard methods of data analysis. In addition, it is crucial to understand the connectivity between these two groups of variables for future policy implications of health sectors of SAARC countries.

3. Methodology:

Theoretical framework: According to Grossman (1972), health is a durable capital stock which produces an output of healthy time [28]. Therefore, this life expectancy as healthy time is a framework for health production. For the health production function, here, life expectancy at birth is the output. On the other hand, domestic general government health expenditure, domestic private health expenditure, CO_2 emission, urban population and GDP per capita are inputs of this function. In consequences,

$LE = f$ (DGGHE, DPHE, GDPPC, UP, CO_2)

In this production function LE is Life expectancy at birth, DGGHE is Domestic general government health expenditure per capita, DPHE is Domestic private health expenditure per capita, GDPPC is GDP per capita, UP is Urban population and CO_2 is carbon dioxide emissions.

Objective: The main objective of this study is to know the relationship of life expectancy at birth with Domestic general government health expenditure per capita, Domestic private health expenditure per capita, CO_2 emissions, urban population and GDP per capita in SAARC region.

Data: Panel data is analyzed to this article for the time period 2002-2019. This secondary data is collected from world development indicators (2022) of The World Bank website. Data set of eight SAARC countries is used to analyze the relationship between dependent and independent variables. In this study, life expectancy at birth, total (years) is dependent variable and domestic general government health expenditure per capita (current US $), domestic private health expenditure per capita (current US $), urban population, GDP per capita (current US $), CO_2 emissions (kt) are independent variables.

Model Specification: Following model is used to investigate the connection between dependent and independent variables.

$$ln\text{LE}_t = \beta_0 + \beta_1\, ln\text{DGGHE}_t + \beta_2\, ln\text{GDPPC}_t + \beta_3\, ln\text{DPHE}_t + \beta_4\, ln\text{UP}_t + \beta_5\, ln\text{CO}_{2t} + \varepsilon_t$$

Where, t=1,2,3……,18; i=1,2,3,…,18 and $\varepsilon \sim N(0, \sigma^2)$

Table-1. Definition of the variables:

Variable Types	**Variable Name**	**Variable Definition**
Dependent Variable	*ln*LE	life expectancy at birth, total (years) in terms of natural logarithms
	*lnDG*GHE	Domestic general government health expenditure per capita (current US $) in terms of natural logarithms

Independent Variables	*ln*GDPPC	GDP per capita (current US $) in terms of natural logarithms
	*lnD*PHE	domestic private health expenditure per capita (current US $) in terms of natural logarithms
	*ln*UP	urban population in terms of natural logarithms
	lnCO_2	CO_2 emissions (kt) in terms of natural logarithms

Determine the most appropriate model: According to previous studies, the model suitable for this study may be random effect model or fixed effect model, and the fixed effect model includes entity fixed effect model, time fixed effect model, and entity and time fixed effect model. In order to choose an appropriate model, we used the above models for regression analysis, and then did F Test. Finally we conducted Hausmen test, and this Hausman test is used to detect whether random effect model or entity fixed effect model is more appropriate for this study. The rejection or acceptance of null hypothesis attributes that the entity fixed effect or the random effect more compatible for this study. Here null hypothesis H0, is random effect model. After data analysis of this Hausman test we find that null hypothesis is rejected. Therefore, alternative hypothesis H1, entity fixed effect model is more favorable.

4. **Results:**

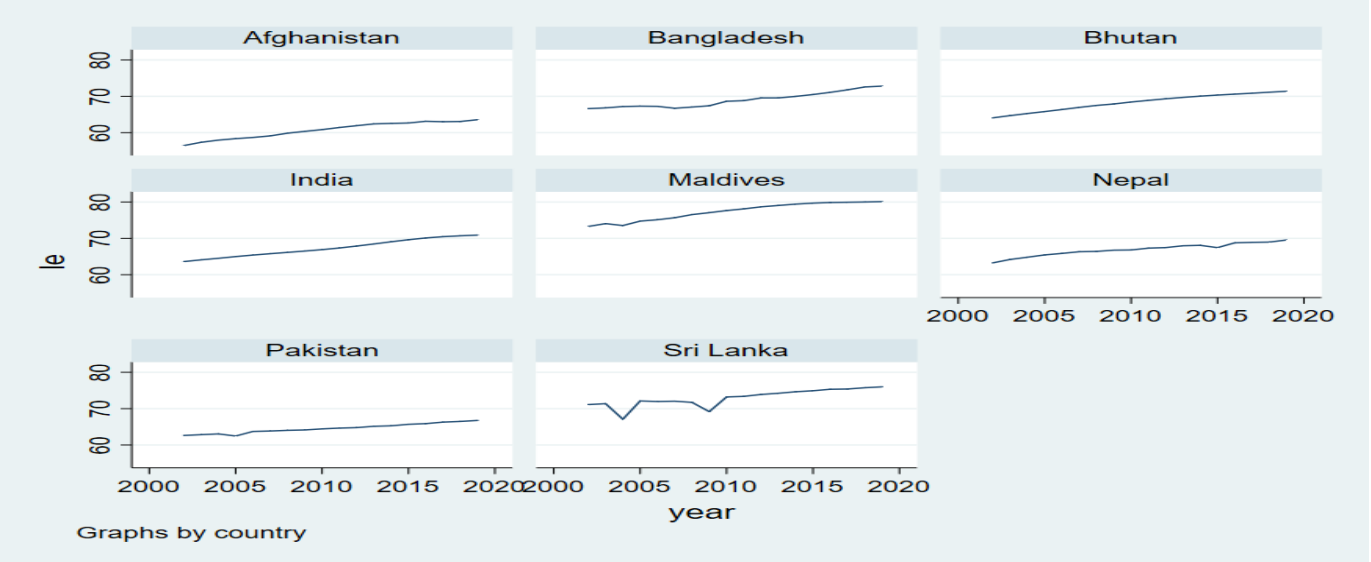
Table-2 shows the descriptive statistics of SAARC countries denoting the mean, standard deviation, maximum and minimum values of variables. In this study, variables of eight SAARC countries have total 144 observations. The average, maximum and minimum Life expectancy of birth are 68.39533 years, 80.116 years and 56.454 years respectively. The difference between maximum and minimum life expectancy of birth is 5.18833 which focuses on the variation of longevity among the people of the SAARC countries. Whereas the standard deviation for domestic private health expenditure is lower than domestic general government health expenditure, the values are 73.3034 and 134.008 respectively. The

mean vale of CO_2 emissions is 242576.8 kt. However the variation of minimum and maximum value of CO_2 is noticeable. There is the difference in per capita GDP of SAARC countries with a mean value of 2051.756.

Table-2. Descriptive statistics of SAARC countries:

Variables	Mean	Standard deviation	Minimum	Maximum
LE	68.39533	5.18833	56.454	80.116
DGGHE	60.53551	134.008	0.1408732	683.8731
GDPPC	2051.756	2330.939	183.5328	11118.56
UP	6.52e+07	1.27e+08	87808	4.77e+08
DPHE	53.70608	73.3034	6.08329	314.0118
CO_2	242576.8	585962.6	240	2456300

Fig.1 Life expectancy status of SAARC countries:



Regression result: The effects of domestic general government health expenditure per capita, GDP per capita, domestic private health expenditure per capita (current US $),urban population,CO2 emissions (kt)

on life expectancy was investigated using the entity fixed effect model, and the results are reported in Table 3.

Table-3. Effects of DGGHE, GDPPC, DPHE, UP, CO_2 on life expectancy at birth (LE)

Model	**Entity Fixed Effect Model**		
LNDGGHE	0.00323 [0.0034]	N	144
LNGDPPC	0.0329* [0.0133]	Adj. R-sq	0.9007
LNUP	0.0743* [0.0257]	AIC	-922.5
LNDPHE	-0.001 [0.0114]	BIC	-907.6
LN CO_2	0.00256 [0.0052]		
_cons	2.788*** [0.3315]		

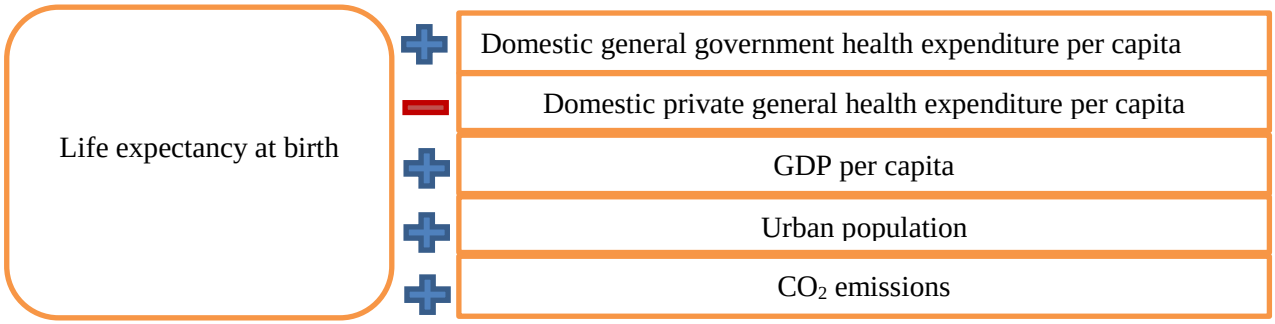
Standard errors in brackets. *p<0.05 **p<0.01 ** *p<0.001

The result delineates of the regression analysis of entity fixed effect model to investigate the linkage between dependent and independent variables of this study. GDP per capita has significantly positive impact on life expectancy with a rate of 0.0329%. Life expectancy at birth is significantly and closely associated with numbers of urban population. As 1% increase in urban population will lead to 0.0743% increase in life expectancy at birth. Life expectancy at birth is positively related with domestic general government health expenditure in eight countries of SAARC region of Southeast Asia. Result shows increase in the percentage of government health expenditure will increase life expectancy at birth by 0.00323%. However, private health expenditure in the SAARC countries is negatively related with life expectancy at birth. The result of this study indicates that life expectancy will decrease with a rate of 0.001% with the increase in the percentage of private health expenditure. This study finds a positive relation between life expectancy at birth and carbon dioxide emissions which denotes that one percent increase in CO2 emissions may increase life expectancy at birth by 0.00256%.

5. Discussion:

This research aims to understand the relationship of life expectancy at birth in SAARC countries with five independent variables. The most significant finding of this study is that the dependent variable is linked with the independent variables either positively or negatively.

Fig.2 The relationship of LE in SAARC countries with five independent variables:



We observed that life expectancy at birth is positively connected with domestic general government health expenditure which indicates that higher domestic general government health expenditure may improve life expectancy at birth. This expected result that life expectancy of the citizens improves with the increment of government health expenditure is consistent with previous studies of both Kim, T. K., & Lane, S. R. (2013) and Linden, M., & Ray, D. (2017) [22,23]. Aísa et al. (2014) findings also bolster that public health expenditure has significant effect to enhance the longevity [29]. However, this result contradict with another study of Rahman, M. M., Khanam, R., & Rahman, M. (2018) by describing that both the private and public health expenditure have no impact on life expectancy [6].

However, domestic private health expenditure has negative impact on life expectancy at birth, implying that an increment in the domestic private health expenditure may reduce the life expectancy. Domestic private health expenditure generally delineates the picture of out of pocket expenditure for health. As most of the SAARC countries' per capita income is under the middle income countries line which is a big issue for the people to make an investment to improve their health. To make an investment for health improvement from out of pocket expenditure most of the people go through different types of difficulties like bank loan and borrowing from others. Therefore, people need overwork to repay the loans which may

increase physical and mental stress. These types of health inconveniences of physical and mental stress may decrease the life expectancy of the citizens of SAARC countries. Another issue is that usually many people do not go to the hospital for treatment at the early and curable stage of their disease due to shortage of money. However, people eventually reach to the hospital at the severe stage of disease which may be even more costly. To tackle this situation government should provide primary healthcare facilities more accessibly so that the people can be benefited. Linden, M., & Ray, D. (2017) found that the effects of private and public health expenditure on life expectancy at birth is not the same. Public health expenditure may increase the life expectancy at birth whereas private health expenditure exactly does not increase the life expectancy [23]. Rahman et al. (2018) found that private general health has no effect on life expectancy at birth which was unexpected [6]. Owumi, B. E., & EBOH, A. (2021) got the result of their study that out of pocket expenditure has more positive impact on life life expectancy at birth [20].

GDP per capita has positive impact on increasing life expectancy at birth. This result was expected as GDP per capita improves people's living standard and healthy diet. With the increment of GDP per capita overall economy of a country improve which may lead the overall health status of its citizens. In addition, increasing GDP per capita helps people to invest more in healthy life style and treatment. This study supports the result of Mahmud et al. (2013) that life expectancy is higher when the GDP per capita increases in Bangladesh [5]. Delavari et al. also found that there is significant and positive relation between GDP per capita and life expectancy at birth in Iran [17]. Shkolnikov et al. (2019) finding is support with this study that life expectancy increases with the increment of GDP per capita along with the increase in life standards and health expenditure in Russia [30]. Bilas et al. (2014) found similar positive relation between these two variables like this study [31]. However, Hansen, C. W., & Lønstrup, L. (2015) found that GDP per capita and initial level of life expectancy is negatively related [32].

Life expectancy at birth may increase with the increment of urban population. Urban population has the chance to get modern facilities in lifestyle like modern health technologies, modern amenities in offices and houses, better educational institutions and comparative better income to improve health status.

Therefore, urban population gets proper health facilities and treatments whenever they need because of availability of health services in the urban areas. On the other hand, rural population has lack of adequate numbers of doctors and health facilitators those who would provide better treatment. In addition, most rural areas of the SAARC countries have not enough transportation facilities to go hospitals within convenient time at any emergency. This finding corroborates with Singh, G. K., & Siahpush, M. (2014) that life expectancy are higher at the urban areas compare to rural areas [26]. However, Kyte, L., & Wells, C. (2010) found opposite result that life expectancy in the rural people is more than urban [25].

The variable of CO_2 emissions is positively related with life expectancy at birth which indicates that life expectancy at birth may increase as the emissions of CO_2 increase. This may happen because of the relation of the improvement of the life style with CO_2 emissions and increasing awareness among the people about ecological protection. CO_2 emissions mainly related with the industrialization which helps people to consume good products and amenities that may help people to improve their living standard to increase the life expectancy at birth. This result supports a study of Mahalik et al. (2022) which found that life expectancy increases with the increment of CO_2 emissions in the developing countries [15].An study by Delavari et al. (2016) found that there is no significant relation between CO2 emissions and life expectancy at birth in Iran [17]. However, Radmehr, M., & Adebayo, T. S. (2022) found that life expectancy at birth is negatively related with CO_2 emissions in Mediterranean countries [24].

6. Conclusion:

This chapter has put an end the study by summarizing the key research findings in relation to research aim and contributions. It is also review the limitations of the research and propose opportunities for future study in this sector. The study aims to find out the relationship of domestic general government health expenditure, domestic private health expenditure, GDP per capita, urban population and CO_2 emissions

with life expectancy at birth in the SAARC countries. The result indicates that life expectancy at birth is positively related with all variables except domestic private health expenditure. In consequence with, life expectancy at birth may increase with increment domestic general government health expenditure, GDP per capita, urban population and CO_2 emissions whereas life expectancy at birth may decrease with the increment of domestic private health expenditure. The findings of this study are really important for the SAARC countries to understand the relationships of the discussed variables with life expectancy at birth and to take further initiative by reflecting in annual budgets to improve the health status of their citizens. The present study has followed by some limitations like availability of long period of data set for all SAARC countries beyond the period of 2002 to 2019 and implying of different variables. Long time periods and more variables such as nutritional food, life style and educational level as explanatory variables may produce more appropriate result. Based on the present study, future research can be done by addressing the limitations of present study.

Acknowledgement: This article has sincerely read and approved as final manuscript by the authors. This study neither published nor under consideration for publication by another journal.

Availability of data: Panel data for the time period 2002-2019 is used for this article which is collected from World Development Indicators (2022), World Bank. These data is publicly available in the following website: https://data.worldbank.org/indicator

Funding: Authors received no funding from any source to do this study.

7. References:

1. Azam, M., Uddin, I., & Saqib, N. (2023). The determinants of life expectancy and environmental degradation in Pakistan: evidence from ARDL bounds test approach. *Environmental Science and Pollution Research*, *30*(1), 2233-2246.
2. SAARC Countries (2023). Retrieved April 20, 2023, from

https://worldpopulationreview.com/country-rankings/saarc-countries

3. SAARC Charter (2020). Retrieved April 22, 2023, from https://www.saarc-sec.org/index.php/about-saarc/saarc-charter
4. Knowles, S., & Owen, P. D. (1995). Health capital and cross-country variation in income per capita in the Mankiw-Romer-Weil model. *Economics letters*, *48*(1), 99-106.
5. Mahumud, R. A., Rawal, L. B., Hossain, G., Hossain, R., & Islam, N. (2013). Impact of life expectancy on economics growth and health care expenditures: a case of Bangladesh. *Universal Journal of Public Health*, *1*(4), 180-186.
6. Rahman, M. M., Khanam, R., & Rahman, M. (2018). Health care expenditure and health outcome nexus: new evidence from the SAARC-ASEAN region. *Globalization and health*, *14*(1), 1-11.
7. Edeme, R. K., Emecheta, C., & Omeje, M. O. (2017). Public health expenditure and health outcomes in Nigeria. *American Journal of Biomedical and Life Sciences*, *5*(5), 96-102.
8. Arthur, E., & Oaikhenan, H. E. (2017). The effects of health expenditure on health outcomes in Sub-Saharan Africa (SSA). *African Development Review*, *29*(3), 524-536.
9. Polcyn, J., Voumik, L. C., Ridwan, M., Ray, S., & Vovk, V. (2023). Evaluating the Influences of Health Expenditure, Energy Consumption, and Environmental Pollution on Life Expectancy in Asia. *International Journal of Environmental Research and Public Health*, *20*(5), 4000.
10. MURTHY, U., SHAARI, M. S., MARIADAS, P. A., & ABIDIN, N. Z. (2021). The relationships between CO 2 emissions, economic growth and life Expectancy. *The Journal of Asian Finance, Economics and Business*, *8*(2), 801-808.
11. Emodi, N. V., Inekwe, J. N., & Zakari, A. (2022). Transport infrastructure, CO2 emissions, mortality, and life expectancy in the Global South. *Transport Policy*, *128*, 243-253.
12. Chen, L., Zhuo, Y., Xu, Z., Xu, X., & Gao, X. (2019). Is carbon dioxide (CO2) emission an important factor affecting healthcare expenditure? Evidence from China, 2005–2016. *International journal of environmental research and public health*, *16*(20), 3995.

13. Andreoni, J., & Levinson, A. (2001). The simple analytics of the environmental Kuznets curve. *Journal of public economics*, *80*(2), 269-286.
14. Das, S., & Debanth, A. (2023). Impact of CO2 emission on life expectancy in India: an autoregressive distributive lag (ARDL) bound test approach. *Future Business Journal*, *9*(1), 1-9.
15. Mahalik, M. K., Le, T. H., Le, H. C., & Mallick, H. (2022). How do sources of carbon dioxide emissions affect life expectancy? Insights from 68 developing and emerging economies. *World Development Sustainability*, *1*, 100003.
16. Rahman, M. M., & Alam, K. (2022). Life expectancy in the ANZUS-BENELUX countries: The role of renewable energy, environmental pollution, economic growth and good governance. *Renewable Energy*, *190*, 251-260.
17. Delavari, S., Zandian, H., Rezaei, S., Moradinazar, M., Delavari, S., Saber, A., & Fallah, R. (2016). Life expectancy and its socioeconomic determinants in Iran. *Electronic physician*, *8*(10), 3062.
18. Jaba, E., Balan, C. B., & Robu, I. B. (2014). The relationship between life expectancy at birth and health expenditures estimated by a cross-country and time-series analysis. *Procedia Economics and Finance*, *15*, 108-114.
19. Fauzi, F. D., & Bakar, A. S. A. (2022). The Relationship Between Life Expectancy at Birth and Health Expenditures: A Panel Data Analysis in Southeast Asia Countries. *International Journal of Advanced Management and Business Intelligence*, *3*(2).
20. Owumi, B. E., & EBOH, A. (2021). An assessment of the contribution of healthcare expenditure to life expectancy at birth in Nigeria. *Journal of Public Health*, 1-9.
21. Zaman, S. B., Hossain, N., Mehta, V., Sharmin, S., & Mahmood, S. A. I. (2017). An association of total health expenditure with GDP and life expectancy. *Journal of Medical Research and Innovation*, *1*(2), AU7-AU12.

22. Kim, T. K., & Lane, S. R. (2013). Government health expenditure and public health outcomes: A comparative study among 17 countries and implications for US health care reform. *American International Journal of Contemporary Research*, *3*(9), 8-13.
23. Linden, M., & Ray, D. (2017). Life expectancy effects of public and private health expenditures in OECD countries 1970–2012: Panel time series approach. *Economic Analysis and Policy*, *56*, 101-113.
24. Radmehr, M., & Adebayo, T. S. (2022). Does health expenditure matter for life expectancy in Mediterranean countries?. *Environmental Science and Pollution Research*, *29*(40), 60314-60326.
25. Kyte, L., & Wells, C. (2010). Variations in life expectancy between rural and urban areas of England, 2001–07. *Health Statistics Quarterly*, *46*, 27-52.
26. Singh, G. K., & Siahpush, M. (2014). Widening rural–urban disparities in life expectancy, US, 1969–2009. *American journal of preventive medicine*, *46*(2), e19-e29.
27. Kalediene, R., & Petrauskiene, J. (2000). Regional life expectancy patterns in Lithuania. *The European Journal of Public Health*, *10*(2), 101-104.
28. Grossman, M. (1972). On the concept of health capital and the demand for health. *Journal of Political economy*, *80*(2), 223-255.
29. Aísa, R., Clemente, J., & Pueyo, F. (2014). The influence of (public) health expenditure on longevity. *International journal of public health*, *59*, 867-875.
30. Shkolnikov, V. M., Andreev, E. M., Tursun-Zade, R., & Leon, D. A. (2019). Patterns in the relationship between life expectancy and gross domestic product in Russia in 2005–15: a cross-sectional analysis. *The Lancet Public Health*, *4*(4), e181-e188.
31. Bilas, V., Franc, S., & Bošnjak, M. (2014). Determinant factors of life expectancy at birth in the European Union countries. *Collegium antropologicum*, *38*(1), 1-9.
32. Hansen, C. W., & Lønstrup, L. (2015). The rise in life expectancy and economic growth in the 20th century. *The Economic Journal*, *125*(584), 838-852.