Journal of Business Insight and Innovation
Volume 5 Issue 9, 2026
ISSN-p: 3006-2284, ISSN-e: 3006-0982
https://insightfuljournals.com/

GROWTH, CARBON EMISSIONS, AND PUBLIC HEALTH SPENDING: LONG-RUN EVIDENCE FROM SOUTH ASIA

Ayesha Siddiqui [1], Taskeen Rubab [2], Barera Arshad [3], Zanira Tahir [4]

DOI: https://doi.org/10.63544/jbii.v5i9.230

Affiliations:

[1] School of Economics, University of the Punjab, Lahore, Pakistan
Email: siddiquiayesha1115@gmail.com

[2] Department of Economics, Government College University, Faisalabad, Pakistan
Email: taskeenrubab700@gmail.com

[3] Center for Integrated Mountain Research, University of the Punjab, Lahore, Pakistan
Email: breeramehar59@gmail.com

[4] School of Economics, University of the Punjab, Lahore, Pakistan
Email: zunairatahir7051862@gmail.com

Corresponding Author's Email:

[1] siddiquiayesha1115@gmail.com

Article History:
Received: 20.08.2026
Accepted: 13.09.2026
Published: 26.09.2026

Abstract

Rising public healthcare expenditure in South Asia reflects not only pressures within health systems but also broader patterns of economic growth, investment, trade, and environmental degradation. This study examines the long-run effects of economic growth and carbon emissions on government health expenditure in Bangladesh, Bhutan, India, Nepal, Pakistan, and Sri Lanka using annual panel data for 1995–2023. Gross fixed capital formation and trade openness are incorporated as control variables. The empirical strategy applies the Im–Pesaran–Shin panel unit root test, the Pedroni panel cointegration test, and Fully Modified Ordinary Least Squares estimation. The unit root results show that all variables are non-stationary at level but stationary after first differencing, indicating integration of order one. The cointegration results provide sufficient evidence of a stable long-run relationship among government health expenditure, gross domestic product, CO_2 emissions, gross fixed capital formation, and trade openness. FMOLS estimates indicate that all four explanatory variables have positive and statistically significant long-run effects on government health expenditure. Specifically, economic growth expands fiscal capacity to finance public healthcare, whereas higher CO_2 emissions are associated with additional health-system pressures arising from pollution-related risks. Capital formation also strengthens public spending capacity, while trade openness has a positive but comparatively small effect. These findings show that public health expenditure is shaped jointly by economic opportunity and environmental pressure. The study concludes that South Asian governments should integrate health planning with cleaner growth strategies, stronger environmental regulation, sustainable investment, and trade policies that improve access to health-related goods and technologies while limiting pollution-intensive development.

Keywords: Government Health Spending, Economic Growth, CO_2 Emissions, Environmental

1. Introduction

Public health expenditure is a serious policy issue in South Asia. Despite the economic development of the region, health systems continue to be under strain due to population growth, limited public budgets, increasing urbanization, pollution, and inequity in access to care. An increase in such pressures can result in higher spending by governments on hospitals, medicines, disease control, and basic health services. Economic growth also benefits public health systems as increased income typically translates to increased fiscal space for public health institutions to provide medical services, trained staff, sanitation, and preventive health care. Growth can also lead to health-system pressure, however, if it relies on fossil fuels, extensive transport, and polluting industry.

Environmental degradation is a key to this relationship. While CO_2 emissions are not a measure of all pollutants that impact health, they are a key proxy for carbon-intensive production, fossil fuel consumption, transport activity, and demand for energy. These processes often occur in conjunction with local air pollutants and other environmental hazards. More empirical studies, therefore, focus on the relationship between economic growth, environmental pressure, and expenditure on health. The finding shows that the direction and strength of the relations are not necessarily consistent across country groups and individual economies, depending on the income level, the energy structure, institutions and the methodology used (Chaabouni et al., 2016; Khoshnevis Yazdi & Khanalizadeh, 2017; Al Kium et al., 2023; Zaidi & Saidi, 2018; Wang et al., 2019; Wu et al., 2020; Xiu et al., 2022; Karaaslan & Çamkaya, 2022). Recent studies also point to noteworthy relationships between income, environmental quality, and health expenditure (Bilgili et al., 2021; Li et al., 2022; Kutlu & Örün, 2023; Dritsaki & Dritsaki, 2024; Szymanska, 2025).

This is particularly applicable to South Asia. While they have varying income, energy consumption, industrial capacities, and health systems development, they have common features of exposure to urbanisation, reliance on fossil fuels, environmental stress, and limited public health funding. Dynamic linkages between carbon emissions, health expenditure, and economic growth have been confirmed in Pakistan-specific evidence, and globalization and energy consumption have also affected the country's emissions profile (Khan et al., 2019; Wang et al., 2019). There is also an increase in health spending in the region of Asia because of carbon emissions and economic growth, while renewable energy can help to alleviate expenditure pressures (Slathia et al., 2024). Findings from Bangladesh also correlate environmental quality, economic growth, fossil fuel consumption, industrialization, and urbanization with health-care expenses (Raihan et al., 2026; Jabed et al., 2026a).

Previous literature has explored correlations between health expenditure and income and environmental quality, with much work based on OECD, BRICS, G7, E7, or country-specific case studies. Although environmental risks and constraints in South Asia are high, the region has been least well served by direct evidence from panels. To fill the gap, this study has used government health expenditure as the dependent variable and has considered the impact of economic growth and CO_2 emissions on the selected South Asian economies. This study covers the countries of Bangladesh, Bhutan, India, Nepal, Pakistan, and Sri Lanka and is based on panel data obtained for the years 1995 to 2023. The dependent variable is Government health expenditure. Gross domestic product and CO_2 emissions are the primary explanatory variables, while gross fixed capital formation and trade openness are used as control variables (Jabed et al., 2026b; Rahman et al., 2026; Akash, n.d.). To estimate the long-run relationship between variables, the analysis uses the Im-Pesaran-Shin panel unit root test, the Pedroni panel cointegration test, and the Fully Modified Ordinary Least Squares. This study addresses the research questions: Does economic growth influence government health expenditure in South Asia? Do CO_2 emissions raise the amount of money that governments spend on health? Do these variables have a long-term stable relationship? The study adds to the literature by concentrating on South Asia, viewing government health expenditure not merely as a catalyst for growth, but as the result, and incorporating income, emissions, capital formation, and openness of trade into a single long-run framework.

The rest of the paper is organized as follows. The literature review is given in Section 2. The data, variables, model, and estimation methods are explained in Section 3. Results from Section 4 are presented and discussed. The study is completed, and policy implications, limitations, and future research directions are offered in Section 5.

2. Literature Review

There are two main ways of studying health expenditure. The first views health expenditure as an input into the economy's performance, as better health can enhance human capital, labor productivity, and life expectancy. The second considers health spending as a result of economic growth, population aging, environmental stress, and fiscal strength. The second direction, which is the focus of this paper, is whether increasing economic growth and CO_2 emissions lead to an increase in government health expenditure in South Asia.

2.1 Economic Growth and Health Expenditure

One of the most frequently given reasons for an increase in health expenditure is the growth in the economy. High earnings allow the government to raise taxes, and the citizens can demand improved hospitals, medicine, prevention, and emergency services. As a result, health expenditures tend to increase as the GDP grows. The relationship can also be reversed, as better spending on health might improve productivity and growth, and hence causal interpretation may be important.

A close but heterogeneous relationship is confirmed by empirical evidence. Chaabouni et al. (2016) modelled the dynamics in the emissions and health expenditure-growth relationship among income groups, and Zaidi and Saidi (2018) showed long-run relationships between environmental pollution, health spending, and growth in sub-Saharan African countries. Dynamic relationships between these variables are also shown for Pakistan-specific results (Wang et al., 2019). Govdeli (2023) revealed the positive association between environmental degradation and health expenditure on the one hand, and economic growth on the other hand for E7 economies, whereas Wu et al. (2020) showed similar results for Taiwan.

More recent analyses confirm the finding that macroeconomic factors do affect health expenditure, albeit in different ways and to varying extents. Hu and Wang (2024) showed that the growth effect of public health expenditure in OECD countries depends on economic conditions. Dritsaki and Dritsaki (2024) found a long-run association among health expenditure, CO_2 emissions, and GDP in G7 countries. Cheng et al. (2024) also reported short- and long-run connections between economic development, emissions, and health expenditure in the OECD economies using a cross-sectional ARDL framework.

In the present study, the increase in economic growth can lead to an increase in government expenditure on health in two ways. First, it increases the resources of the fiscal system and the demand for public services of good quality. Second, if growth comes with urban crowding, energy-intensive production, and pollution, it may lead to a growth in demand for health services. This two-way relationship is especially important in the context of South Asia, where environmental challenges and growth are frequently co-occurring.

2.2 CO_2 Emissions and Health Expenditure

The second important literature stream is related to environmental degradation of the environment. Diseases are linked to CO_2 emissions and also make the clear point that there is a general tendency towards carbon-intensive development. High emissions are generally due to high fossil fuel consumption, transport, industrial production, and energy demand. These activities are linked to air pollution and adverse health effects. This may result in increased public health expenditure by governments.

To study the link between economic growth and health expenditure with CO_2 emissions across selected Asian nations at different quantiles, Bilgili et al. (2021) analyzed the correlation between them. They discovered that this relationship varies across the distribution and that, therefore, large differences can exist between countries even if the averages are similar. Li et al. (2022) used a Fourier ARDL model for BRICS countries and found a long-run relationship among health expenditure, CO_2 emissions, and economic growth in some of the countries, such as Brazil and China. This means that the connection is not obvious. It is dependent on the structure, income level, and policy environment of the country (Jabed et al., 2025a; Ali et al., 2026; Rasheed et al., 2025).

The above evidence from OECD countries also backs the environmental health cost argument. Kutlu and Örün (2023) concluded that CO_2 emissions, GDP per capita, and urban population growth all lead to an increase in expenditure on health within OECD countries. Cheng et al. (2024) also noted that there was a strong correlation between economic development and carbon emissions and between healthcare expenditure and carbon emissions. Recently, Szymanska (2025) has shown that income, environmental degradation, and population ageing are important determinants of health expenditure in OECD countries. Results are in line with the idea of environmental pressure as an extra health financing demand.

The present study will benefit from Asian evidence especially. Slathia et al. (2024) analysed data from 36 countries around the world in Asia and concluded that carbon emissions and economic growth lead to higher expenditure on healthcare, while renewable energy leads to lower expenditure on healthcare. This is closely tied to South Asia, as the region continues to heavily rely on fossil fuels and has increasing healthcare needs. Likewise, the study in the light of evidence in Bangladesh conducted by Raihan et al. (2026) revealed that CO_2 emissions, use of fossil fuels, urbanization, industrialization, and economic growth contribute to increased healthcare costs, and renewable energy and forestry area contribute to reduced healthcare costs.

The literature shows that, taken together, CO_2 emissions lead to higher health expenditure due to a higher public health burden. The magnitude of this impact might vary by country, however. Some disparities exist in the South Asian economies. Bhutan and Nepal have different energy and environmental characteristics, and are less industrialized as well as having lower population densities compared to India and Pakistan. This can be helpful in making a panel approach but should also be used with caution.

2.3 Capital Formation, Trade Openness, and Health Expenditure

Government expenditures on health are also influenced by the overall economy. Gross fixed capital formation is an indicator of investment in productive capacity, buildings and infrastructure, and machinery. Theoretically, capital formation can be the source of growth in the economic base and fiscal space for public health spending. Additionally, improved health systems through investments in hospitals, transport, water and sanitation facilities, medical facilities, etc. However, there's another side to it. Polluting industries may increase environmental health hazards and future health care costs.

Health expenditure may also be affected by the level of trade openness. An open economy can benefit from importing medical products, medicines, equipment, technology, and earning foreign currencies from exports (Jabed et al., 2025b; Ponduru et al., 2026). These advances can allow for improvements to health services provision. In the meantime, countries that trade increase their pollution levels if they grow polluting industries and if they compete on pollution. It's not a trivial issue for South Asia. Trade-induced growth is a good means of increasing incomes, although it may create health pressures if the regulatory system is weak.

Recent studies do not provide a clear consensus on these control variables. Some studies have demonstrated that trade and investment can contribute to economic growth and to improve the capacity of public expenditures, while some others have shown that growth resulting from dirty production may result in an increase in environmental costs. So, the use of GFCF and trade openness is suitable. They help identify the impact of income and emissions beyond macroeconomic activity.

2.4 Research Gap

The literature suggests that there is a link between health expenditure, economic growth, and environmental degradation. There are three holes, however. Firstly, there are numerous studies on OECD countries, the G7 countries, the BRICS countries, or individual countries. South Asian countries are under-studied, despite rapid population growth, high population pressures, environmental controls that are not in good shape, and limited support for public health. Second, a lot of research has been focusing on health expenditure as a driver of economic growth. This is helpful, but it doesn't provide a response to the policy question in this paper. There are also drivers that increase the expenditure on health services that governments should be mindful of. In this study, therefore, the dependent variable is government health expenditure. Third, the results from Asia suggest that CO_2 emissions and income can positively impact health expenditure, but the economic context and health system of a South Asian country are distinct. A focused panel study could be helpful to support these findings by establishing whether such relationships exist within Bangladesh, Bhutan, India, Nepal, Pakistan, and Sri Lanka. This study aims to investigate the effects of economic growth and CO_2 emissions on government health expenditure over a long time period in selected South Asian countries, in light of the above gaps. It also adjusts for two other macroeconomic variables: gross fixed capital formation and trade openness.

3. Data and Methods

3.1 Data and Variables

This study uses yearly panel data for six South Asian economies (Bangladesh, Bhutan, India, Nepal, Pakistan, and Sri Lanka) over the period 1995–2023. The countries and time period are dependent on data availability. Data for all indicators have been obtained from the WDI database. Government health expenditure is used as the dependent variable. The explanatory variables are primarily economic growth and

CO_2 emissions. Control variables are gross fixed capital formation and trade openness. The importance of these variables is that public health spending is not affected by income and pollution, but also by investment and the level of economic openness.

Government health expenditure is measured in per capita purchasing power parity (PPP) international dollars. GDP per capita (constant 2010 USD) measures economic growth. CO_2 emissions are used for environmental degradation. Gross fixed capital formation is measured as a percentage of GDP. Trade openness is measured as the sum of exports and imports as a percentage of GDP.

All the variables are log-transformed. This eliminates scale differences among variables and makes the estimated coefficients easily interpreted as elasticities. The coefficients indicate the percent change in the government's health expenditure for a one percent change in each explanatory variable.

Table 1

Variables Measurement

Variables	Symbol	Unit	Source
Government health expenditure	GHE	Per capita, PPP current international dollars	WDI
Economic growth	GDP	GDP per capita, constant 2010 US dollars	WDI
CO2 emissions	CO2	Metric tons per capita	WDI
Gross fixed capital formation	GFCF	Percentage of GDP	WDI
Trade openness	TRD	Trade as a percentage of GDP	WDI

3.2 Model Construction

The study investigates the impact of economic growth and CO_2 emissions on government health spending in South Asia. The general functional form of the model would be:

$$GHE_{it} = f(G,D,P_{it},CO2_{it}GFCF_{it}TRD_{it}) \qquad (1)$$

In Equation 1, GHE are government health expenditures, GDP is economic growth, CO_2 is carbon emissions, GFCF is gross fixed capital formation, and TRD is trade openness. $i$is the index of the country, and $t$is the index of the year.

The economic form of the model is written as:

$$GHE_i = \alpha_0 + \beta_1 GDP_i + \beta_2 CO2_i + \beta_3 GFCF_i + \beta_4 TRD_i + \epsilon_i \qquad (2)$$

After transforming the variables into natural logarithms, the final empirical model becomes:

$$\ln G\,HE_i = \alpha_0 + \beta_1 \ln G\,DP_i + \beta_2 \ln C\,O2_i + \beta_3 \ln G\,FCF_i + \beta_4 \ln T\,RD_i + \epsilon_i \qquad (3)$$

Where ln represents the natural logarithm, α_0 is the constant term, β_1 to β_4 are the estimated coefficients, and $\epsilon_i$is the error term.

The coefficient $\beta_1$is used to show the relationship between economic growth and government health expenditure. The coefficient $\beta_2$represents the impact of CO_2 emissions on government health spending. The coefficient of gross fixed capital formation, β_3, reflects the impact of gross fixed capital formation, and the coefficient of openness to trade, β_4, reflects the effect of openness to trade.

A positive coefficient on GDP is expected, as more income leads to more government revenue and thus to better fiscal capacity in relation to public healthcare expenditure. A positive CO_2 emission coefficient is also anticipated because environmental degradation can result in greater health risks and, consequently, demand for public health services. GFCF is likely to be positive, as investments can increase infrastructure and economic capacity. In addition, trade openness is likely to have a positive impact because it may boost income, fiscal resources, and access to goods and services related to health.

3.3 Panel Unit Root Test

Before estimating the long-run model, the stationarity of the variables must be checked. This is important because nonstationary data can produce misleading regression results. The study applies the Im, Pesaran, and Shin panel unit root test, which allows heterogeneity across countries (Im et al., 2003).

Journal of Business Insight and Innovation
Volume 5 Issue 9, 2026
ISSN-p: 3006-2284, ISSN-e: 3006-0982
https://insightfuljournals.com/

The basic panel unit root equation can be written as:

$$\Delta Y_{it} = \alpha_i + \rho_i Y_{i,t-1} + \Sigma\gamma_{ij}\Delta Y_{i,t-j} + \epsilon_{it} \qquad (4)$$

Where Y_{it}represents each variable in the model, $\Delta$is the first-difference operator, $\alpha_i$is the country-specific intercept, $\rho_i$is the unit-root parameter, γ_{ij}captures short-run dynamics, and $\epsilon_i$is the error term.

The null and alternative hypotheses are:

1: $\rho_i < 0$, the variable is stationary for at least some countries. If the variables are nonstationary in levels but become stationary after first differencing, they are integrated of order 1. This condition supports the use of panel cointegration techniques.

3.4 Panel Cointegration Test

Once the order of integration is confirmed, the study utilizes the Pedroni panel cointegration test to explore the presence of a long-run relationship between government health expenditure, GDP, CO_2 emissions, GFCF, and trade openness. The appropriate test is the Pedroni cointegration test, which can be used when there is heterogeneity in the intercept and slope coefficients of the panel units (Pedroni, 1999).

The general cointegration equation is written as:

$$\ln GHE_{it} = \alpha_i + \beta_1 \ln GDP_{it} + \beta_2 \ln CO2_{it} + \beta_3 \ln GFCF_{it} + \beta_4 \ln TRD_{it} + \mu_{it} \qquad (5)$$

Where $\alpha_i$captures country-specific effects, $\delta_i$captures the time trend, $\beta_{1i}$to $\beta_{4i}$are country-specific long-run coefficients, and $\mu_i$is the estimated residual. The null and alternative hypotheses are: H0: No cointegration exists among the variables. H1: Cointegration exists among the variables. Within- and between-dimension statistics are provided by Pedroni. When H0 is rejected by multiple statistics, the results lend support to the existence of a long-run equilibrium relationship between the variables.

3.5 Fully Modified Ordinary Least Squares Estimation

After obtaining cointegration, the study estimates the long-run coefficients by the Fully Modified Ordinary Least Squares method. Since FMOLS corrects for serial correlation and endogeneity in the long-run relationships of a panel data set, it is suitable for analyzing cointegrated panel data sets (Pedroni, 2001). This is particularly relevant as GDP, CO_2 emissions, investment, openness to trade, and public health expenditure can affect each other in the long-term.

The simplified FMOLS model is written as:

$$\ln GHE_{it} = \alpha_i + \beta_1 \ln GDP_{it} + \beta_2 \ln CO2_{it} + \beta_3 \ln GFCF_{it} + \beta_4 \ln TRD_{it} + \mu_{it} \qquad (6)$$

The FMOLS estimator can be expressed as:

$$\beta_{FMOLS} = [\Sigma_i\Sigma_t(X_{it} - \bar{X}_i)(X_{it} - \bar{X}_i)]^{-1}[\Sigma_i\Sigma_t(X_{it} - \bar{X}_i)GHE^*_{it} - T\Delta_i] \qquad (7)$$

Where $X_{it}$is the vector of explanatory variables, $GHE_{it}$is the transformed dependent variable adjusted for serial correlation and endogeneity, and $\Delta_i$represents the correction term for long-run covariance. The purpose of this correction is to obtain reliable long-run coefficients. Because the model is estimated in logarithmic form, each coefficient is interpreted as an elasticity. For example, if the coefficient of lnGDP is 0.588, then a one percent increase in GDP is associated with a 0.588 percent increase in government health expenditure, holding other factors constant.

3.6 Estimation Procedure

The empirical analysis follows four steps. First, descriptive statistics are used to summarize the data. Second, the IPS panel unit root test is applied to check whether the variables are stationary in levels or in first differences. Third, the Pedroni panel cointegration test is used to examine the long-run relationship among the variables. Fourth, FMOLS is applied to estimate the long-run effects of GDP, CO_2 emissions, GFCF, and trade openness on government health expenditure.

This sequence is suitable because FMOLS should be applied only after confirming that the variables are integrated of order one and cointegrated. The method, therefore, allows the study to estimate the long-run determinants of government health expenditure in selected South Asian economies.

4. Results and Discussion

Table 2

Descriptive Statistics

Statistic	GHE	GDP	GFCF	CO2	TRD
Mean	130.228	2,064.335	86,600,000,000	0.945	57.766
Maximum	1,275.863	8,739.562	786,000,000,000	3.299	165.970
Minimum	0.693	330.303	222,000,000	0.037	25.306
Standard deviation	224.296	2,119.319	186,000,000,000	0.795	31.690
Skewness	3.083	1.712	2.537	1.160	1.555
Kurtosis	12.970	4.847	8.149	3.635	4.893

Table 2 shows the descriptive statistics of the study variables. The outcomes show clear variation across countries and years, especially in government health expenditure, GDP, and gross fixed capital formation. This variation reflects differences in income level, investment capacity, public health spending, and trade exposure among the selected South Asian economies. All variables have positive skewness, indicating right-skewed distributions. The kurtosis values are greater than 3, showing that the variables have heavy tails and are not normally distributed. This supports the use of logarithmic transformation in the empirical analysis to reduce scale differences and improve estimation stability.

Table 3

Panel Unit Root

Variables	IPS Level T-statistics	IPS Level P-value	IPS 1st Difference T-statistics	IPS 1st Difference P-value	Integrated order
GHexp	6.348	1.000	-4.174	0.000*	I (1)
GDP	5.865	1.000	-3.101	0.000*	I (1)
GFCF	7.391	1.000	-5.000	0.000*	I (1)
CO2	5.720	1.000	-4.918	0.000*	I (1)
TRD	-1.011	0.155	-3.793	0.000*	I (1)

Note. * indicates the level of significance at 1%.

Table 3 presents the IPS panel unit root test results. All variables are statistically insignificant at the level, which means the null hypothesis of a unit root cannot be rejected. This shows that government health expenditure, GDP, GFCF, CO_2 emissions, and trade openness are nonstationary at the level. All variables become statistically significant at the 1 percent level in first differences. Therefore, the null hypothesis of a unit root is rejected after first differencing. The outcomes confirm that all variables are integrated of order one, I(1). This finding supports using the Pedroni panel cointegration test to examine the long-run relationship among the variables.

Table 4

Pedroni Cointegration Results

Dependent Variable: Government Health Expenditure (GHE)				
Within Dimension	**With No Trend**		**With Trend and Intercept**	
	T-Statistics	**P-Value**	**T-Statistics**	**P-Value**
Panel v-statistics	-0.209	0.583	-1.050	0.853
Panel rho-statistics	0.623	0.733	0.176	0.570
Panel PP-statistics	-1.832	0.033	-2.643	0.004*
Panel ADF statistics	-1.399	0.080	-2.695	0.005*

Between Dimension				
Group rho-statistics	-0.321	0.695	1.174	0.879
Group PP-statistics	-1.324	0.098	-4.941	0.000*
Group ADF statistics	-1.768	0.704	-3.261	0.000*

Note. * Indicates the 1 percent significance level. The Panel PP statistic under the no-trend assumption is significant at the 5 percent level.

Table 4 reports the Pedroni panel cointegration test results for government health expenditure as the dependent variable. Under the no-trend specification, the Panel PP statistic is significant at the 5 percent level, while the remaining statistics are mostly insignificant. This provides only weak evidence of cointegration. Under the trend-and-intercept specification, the Panel PP, Panel ADF, Group PP, and Group ADF statistics are statistically significant. These results reject the null hypothesis of no cointegration and confirm the presence of a long-run relationship among government health expenditure, GDP, GFCF, CO_2 emissions, and trade openness.

Overall, the Pedroni test provides sufficient evidence that the variables move together in the long run. Therefore, the use of FMOLS is appropriate for estimating the long-run coefficients.

Table 5
FMOLS

Variable	Coefficient	Std. Error	t-Statistic	Prob.
GDP	0.588	0.108	5.442	0.000*
GFCF	0.113	0.039	2.865	0.000*
CO2	0.395	0.054	7.224	0.000*
TRD	0.003	0.000	3.986	0.000*

Note. * indicates the 1% significance level.

After obtaining cointegration, the study estimates the long-run coefficients by the Fully Modified Ordinary Least Squares method. Since FMOLS corrects for serial correlation and endogeneity in the long-run relationships of a panel data set, it is suitable for analysing cointegrated panel data sets (Pedroni, 2001). This is particularly relevant as GDP, CO_2 emissions, investment, openness to trade, and public health expenditure can affect each other in the long-term.

The results of the long-run estimation with FMOLS are reported in Table 5. The findings indicate that at the 1 per cent level, GDP, GFCF, CO_2 emissions, and trade openness are all positive and statistically significant on government health expenditure. The coefficient of GDP is 0.588, meaning that an increase of 1 percent in GDP will be accompanied by an increase of 0.588 percent in government health expenditure while all other factors remain constant. This implies that economic growth enhances a government's fiscal space for more spending on public health care.

The coefficient of gross fixed capital formation is 0.113, indicating that an increase of 1% in gross fixed capital formation leads to a 0.113% increase in government health expenditure. This means that investment activity enhances the capacity of the public sector to engage in spending on public output and infrastructure. Therefore, CO_2 emissions increase by 0.395, which indicates that for every 1-percent rise in CO_2 emissions, government health spending rises by 0.395 percent. This finding indicates that environmental degradation could contribute to a higher burden of disease and lead to more medical costs. The coefficient is positive and statistically significant but very small for trade openness. This suggests that the greater the degree of trade openness, the higher the government's health expenditure, but its economic effect is less than that of GDP, GFCF, or CO_2 emissions.

Overall, the FMOLS results validate that growth, investment, environmental degradation, and the openness of trade are important long-term factors affecting government spending on health in selected South Asian economies.

5. Conclusion

The purpose of this research was to investigate the long-run factors that influence public health expenditure in selected South Asian economies over the period 1995–2023. The study was conducted in Bangladesh, Bhutan, India, Nepal, Pakistan, and Sri Lanka. GDP, CO_2 emissions, gross fixed capital formation, and trade openness were the explanatory variables, and government health expenditure was the dependent variable. The objective was to explore whether public health expenditure in South Asia is primarily determined by economic capacity, environmental pressure, investment activity, and external economic openness.

The findings of the empirical analysis are very clear evidence that the chosen variables are related in the long run. All variables are of order one after testing by the IPS panel unit root test. This implies that the model variables were not stationary at the level but became stationary upon first differencing. The Pedroni cointegration test provided confirmation of the cointegration between government health spending and GDP, CO_2 emissions, GFCF, and trade openness in the long run. This is significant as it demonstrates that public health spending is connected to the wider economic and environmental conditions in South Asia.

The coefficient of GDP in the FMOLS results was positive and statistically significant, indicating a positive effect of GDP on government health spending. That is, richer governments spend more on health. The result is consistent with the hypothesis that the more a country's economy grows, the more fiscal space it has to invest in hospitals, health infrastructure, medicine, preventive care, and other public health services. The finding is significant in the case of South Asian countries, as health systems are still under pressure and need to be continually funded through public funding.

The results further demonstrated that CO_2 emissions have a positive and significant impact on government health expenditure. This is the most significant result of the study. It indicates that there is an environmental burden which is in addition to the public health burden. The health system pressure increases with the increase of emissions as they contribute to other environmental health risks, including respiratory problems, urban health stress, and pollution-induced diseases. This does not necessarily imply that CO_2 is responsible for all health issues but indicates that CO_2-intensive development is associated with increased public health spending requirements.

The positive and significant effect on government health expenditure was also observed for gross fixed capital formation. This suggests that investment is linked to increased spending capacity within the public sector. Productive capacity can be enhanced by capital formation, infrastructure can be increased, and economic development can be financed. The outcome of the process should be interpreted with care, though. Investment can be used to benefit health systems if it goes towards hospitals, sanitation, medical facilities, clean water, and public infrastructure. However, when investments are directed towards sectors that pollute, it can lead to new health risks and higher future healthcare expenses.

There was a positive and statistically significant relationship between trade openness and government health expenditure, but the value of the coefficient was low. This indicates that trade impacts public health expenditure; however, it is less effective than GDP, CO_2 emissions, and GFCF. Trade can help to enhance access to medicines, medical equipment, health technology, and fiscal resources. Simultaneously, trade expansion can help to exacerbate environmental and health pressures if it enables pollution-intensive production. The impact of trade is thus dependent on the quality and design of the trade policy.

The overall results indicate that government health expenditure in South Asia is driven by opportunity and pressure. Environmental degradation forces up health expenditure, and economic growth and investment provide more funds for public expenditure. This is the main finding of the study. Health expenditure cannot be a social sector problem in South Asian countries. It is also associated with the development and growth of the economy, the pathways of investment, trade, and environmental quality management.

The results also demonstrate that growth isn't the only thing that is needed. Fossil fuels and polluting activities remain the backbone of economic growth, and governments could generate more revenue, but they would also incur greater health-related costs. This makes a policy trade-off. The economic growth of a country

Journal of Business Insight and Innovation
Volume 5 Issue 9, 2026
ISSN-p: 3006-2284, ISSN-e: 3006-0982
https://insightfuljournals.com/

can be seen to be increasing while its health costs are increasing because of environmental harm. Thus, the rate of growth cannot be as important as the quality of growth.

This study concludes that there is a need for a more integrated policy approach in South Asian economies. The public health planning process should be linked to environmental regulation, clean energy transition, investment planning, and trade policy. There is a moral imperative for governments not to tolerate environmental damage as a health cost. Better to spend less money on treatment later than more money on prevention now. The cleaner growth path can ease the burden on the public health budgets and enhance long-run welfare.

To conclude, the findings of the study are in support of the fact that GDP, CO_2 emissions, GFCF, and trade openness are central long-term factors affecting public health spending in South Asian countries. The evidence points to the need for increased public health investment, cleaner economic growth, better investment and trade planning, and better environmental management. The results have implications for policymakers aiming to enhance health outcomes while preventing worsening environmental degradation to drive future health care costs.

5.1 Policy Implications

The results have a number of policy implications for the economies of South Asia. First, governments need to equate investment in public health with economic growth. Increases in income should be utilized for improving hospitals, primary healthcare, disease prevention, and staff training for hospitals and rural health services, as GDP has a positive link with government health expenditure. If there are no improvements in health services, there will be no reduction in public vulnerability.

Second, the beneficial impacts of CO_2 emissions indicate that environmental degradation is increasing public health costs. Pollution control should be a component of health policy. Emissions can be reduced by using cleaner energy, better transport infrastructure, tighter regulations in industry, and more investments in renewable energy, which will reduce the healthcare costs of the future. Failure to address environmental damage will result in a further increase in health spending, as governments will have to pay for diseases caused by pollution once they happen.

Thirdly, gross fixed capital formation should be channelled towards health-enabling infrastructure. Industry, roads, and buildings are not the only investment areas. South Asian countries require increased investment in health facilities, laboratories, sanitation systems, and clean water, in addition to investment in medical technology and climate-resilient health facilities. This would enhance access to healthcare services and also relieve pressure on public budgets in the longer term.

Fourth, care should be taken in managing trade openness. Trade can facilitate access to medicines, healthcare equipment, and health technology; it can also contribute to higher pollution if it boosts the growth of polluting industry sectors. Clean trade, environmental standards, and imports of health-related technology should be promoted in South Asian countries. Trade policy should promote economic development and public health.

Lastly, the findings indicate a need for South Asian countries to plan their policies in an integrated way. Health, environment, trade, and economic policies cannot be separated. The better way is to use public health planning in conjunction with environmental protection and sustainable economic growth.

5.2 Future Research Directions and Limitations

There are some limitations to this study. For data availability reasons, the analysis is limited to six South Asian economies. More countries from the Asian continent or a comparison of South Asia with other developing continents could be the subjects of future research.

Second, the study uses CO_2 emissions as the main proxy for environmental degradation. While CO_2 is an important indicator, it is not the only indicator of environmental risk. Future studies can extend the scope of environmental health pressure by expanding the list of variables to include PM2.5, air pollution, methane emissions, ecological footprint, industrial pollution, or water pollution.

Third, the study only considers the government's health expenditure. It does not distinguish between private health expenditure, household out-of-pocket expenditure, preventive health expenditure, and curative health expenditure. Further research could classify health expenditure to gain insight into the sources of cost pressure.

Fourth, the study estimated a long-run relationship with the aid of FMOLS. FMOLS is applicable for cointegrated panel data, but future research could employ DOLS, PMG ARDL, quantile regression, or causality tests to test the strength and direction of the relationships. Lastly, the study excludes institutional quality, renewable energy use, urbanization, population ageing, healthcare efficiency, and income inequality. These factors could also have an impact on government health expenditure. These variables can be incorporated into future studies to develop a comprehensive model of health spending in South Asia.

Author's Contributions

All authors participated in ideation, development, and writing the manuscript. All authors read and approved the final manuscript.

Conflict of Interest Statement

The authors declare that there is no conflict of interest regarding the publication of this article.

Funding Statement

The authors did not receive financial support from any funding agency or external organization for the research, authorship, or publication of this article.

Informed Consent

Informed consent was obtained from all participants prior to data collection. Participants were informed about the purpose of the study, the voluntary nature of their participation, and their right to withdraw at any time without any consequences. The confidentiality and anonymity of respondents were guaranteed throughout the research process.

Data Availability

The datasets generated and analysed during the current study are available from the corresponding author upon reasonable request. The authors are committed to transparency and will provide detailed methodological information and analysis protocols upon request.

References

Akash, M. M. R. (n.d.). Cardiotoxicity prediction models in cancer patients using artificial intelligence and genomics. *International Journal of Drug Delivery Technology, 16*, 60–73.

Al Kium, A., Sarker, S., Shikha, S. A., Kamal, M. A. T., Jabed, M. I. K., Munifa, N. K., ... John, D. B. (2023). Health equity and digital disparities in cancer screening and cardiovascular care across socioeconomic and ethnic groups: A systematic review. *Vascular and Endovascular Review, 6*(2), 35–44.

Ali, N. M., Ahmed, M. E., Fakhrul Islam, M., Gomes, C. A., & Islam, M. S. (2026). Toward a circular US economy: Green and artificial intelligence innovation, renewable energy, and domestic material consumption. *Energy Sources, Part B: Economics, Planning, and Policy, 21*(1), Article 2685043.

Aydin, M., & Bozalti, O. (2023). The impacts of the refugee population, renewable energy consumption, carbon emissions, and economic growth on health expenditure in Turkey: New evidence from Fourier-based analyses. *Environmental Science and Pollution Research, 30*(14), 41286–41298. https://doi.org/10.1007/s11356-023-25181-8

Bayraktar, Y., Aydin, S., Çakır, M. A., Recepoğlu, M., Ozyilmaz, A., Buyukakin, F., & Çakır, S. (2024). Consequences of information and communication technologies and environmental degradation on health expenditure. *INQUIRY: The Journal of Health Care Organization, Provision, and Financing, 61*, Article 00469580241277449. https://doi.org/10.1177/00469580241277449

Bilgili, F., Kuşkaya, S., Khan, M., Awan, A., & Türker, O. (2021). The roles of economic growth and health expenditure on CO2 emissions in selected Asian countries: A quantile regression model approach. *Environmental Science and Pollution Research, 28*(33), 44949–44972. https://doi.org/10.1007/s11356-021-13639-6

Chaabouni, S., Zghidi, N., & Ben Mbarek, M. (2016). On the causal dynamics between CO2 emissions, health expenditures, and economic growth. *Sustainable Cities and Society, 22*, 184–191. https://doi.org/10.1016/j.scs.2016.02.001

Cheng, C., Ren, X., Zhang, M., & Wang, Z. (2024). The nexus among CO2 emissions, health expenditure, and economic development in the OECD countries: New insights from a cross-sectional ARDL model. *Environmental Science and Pollution Research, 31*(11), 16746–16769. https://doi.org/10.1007/s11356-024-32081-y

Derindag, O. F., Maydybura, A., Kalra, A., Wong, W.-K., & Chang, B. H. (2023). Carbon emissions and the rising effect of trade openness and foreign direct investment: Evidence from a threshold regression model. *Heliyon, 9*(7), Article e17448. https://doi.org/10.1016/j.heliyon.2023.e17448

Dritsaki, M., & Dritsaki, C. (2024). The relationship between health expenditure, CO2 emissions, and economic growth in G7: Evidence from heterogeneous panel data. *Journal of the Knowledge Economy, 15*, 4886–4911. https://doi.org/10.1007/s13132-023-01349-y

Govdeli, T. (2023). The nexus between economic growth, health expenditure, and environmental quality: A comparative study for E7 countries. *Reviews on Environmental Health, 39*(3), 551–560. https://doi.org/10.1515/reveh-2022-0246

Hu, Q., & Wang, L. (2024). Economic growth effects of public health expenditure in OECD countries: An empirical study using the dynamic panel threshold model. *Heliyon, 10*(4), Article e25684. https://doi.org/10.1016/j.heliyon.2024.e25684

Im, K. S., Pesaran, M. H., & Shin, Y. (2003). Testing for unit roots in heterogeneous panels. *Journal of Econometrics, 115*(1), 53–74. https://doi.org/10.1016/S0304-4076(03)00092-7

Jabed, M. I. K., Imran, M., Gomes, C. A., Ponduru, P. S., Mandal, S., & Hassan, S. (2025a). Deep learning and explainable AI framework for predicting lung cancer severity. *Journal of Computer Science and Technology Studies, 7*(12), 573–598.

Jabed, M. I. K., Imran, M., Gomes, C. A., & Ponduru, P. S. (2025b). Machine learning-based prediction of poor self-rated health among U.S. adults using behavioral and socioeconomic factors. *World Journal of Advanced Research and Reviews, 27*(1), 2817–2829. https://doi.org/10.30574/wjarr.2025.27.1.2649

Jabed, M. I. K., Imran, M., Khan, A. A., Mehedi, M., Islam, A., & Pervez, R. (2026a). Explainable machine learning framework for early heart disease detection using SMOTE and SHAP. *Vascular and Endovascular Review, 9*(1), 316–324.

Jabed, M. I. K., Manzoor, M. A., Tofa, F. M., & Khan, M. H. (2026b). Interpretable ensemble learning approach for breast cancer diagnosis using SHAP-based explainable AI. *Journal of Computer Science and Technology Studies, 8*(8), 244–255.

Jiang, W., Li, W., & Chen, Y. (2024). Air pollution, public health expenditure, and physical health: Evidence from China. *Environmental Quality Management, 34*(1), Article e22185. https://doi.org/10.1002/tqem.22185

Karaaslan, A., & Çamkaya, S. (2022). The relationship between CO2 emissions, economic growth, health expenditure, and renewable and non-renewable energy consumption: Empirical evidence from Turkey. *Renewable Energy, 190*, 457–466. https://doi.org/10.1016/j.renene.2022.03.139

Khan, M. K., Teng, J.-Z., Khan, M. I., & Khan, M. O. (2019). Impact of globalization, economic factors, and energy consumption on CO2 emissions in Pakistan. *Science of the Total Environment, 688*, 424–436. https://doi.org/10.1016/j.scitotenv.2019.06.065

Khoshnevis Yazdi, S., & Khanalizadeh, B. (2017). Air pollution, economic growth and health care expenditure. *Economic Research-Ekonomska Istraživanja, 30*(1), 1181–1190. https://doi.org/10.1080/1331677X.2017.1314823

Kutlu, G., & Örün, E. (2023). The effect of carbon dioxide emissions, GDP per capita, and urban population on health expenditure in OECD countries: A panel ARDL approach. *International Journal of Environmental Health Research, 33*(12), 1233–1242. https://doi.org/10.1080/09603123.2022.2083088

Li, F., Chang, T., Wang, M. C., & Zhou, J. (2022). The relationship between health expenditure, CO2 emissions, and economic growth in the BRICS countries: Based on the Fourier ARDL model.

Environmental Science and Pollution Research, 29(8), 10908–10927. https://doi.org/10.1007/s11356-021-17900-w

Pedroni, P. (1999). Critical values for cointegration tests in heterogeneous panels with multiple regressors. *Oxford Bulletin of Economics and Statistics, 61*(S1), 653–670. https://doi.org/10.1111/1468-0084.0610s1653

Pedroni, P. (2001). Fully modified OLS for heterogeneous cointegrated panels. In B. H. Baltagi, T. B. Fomby, & R. C. Hill (Eds.), *Nonstationary panels, panel cointegration, and dynamic panels* (Advances in Econometrics, Vol. 15, pp. 93–130). Emerald Group Publishing Limited. https://doi.org/10.1016/S0731-9053(00)15004-2

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), Article 4000. https://doi.org/10.3390/ijerph20054000

Ponduru, P. S., Nandanavanam, P. P. V., & Ponduru, S. K. K. (2026). Ecological proportionality in generative AI: The ethics of marginal capability and environmental sufficiency.

Rahman, M. A., Jabed, M. I. K., Devnath, R. K., Mehedi, C. M., Begum, M., & Mahmud, T. (2026, May). MSRFF: An interpretable CNN-Vision Transformer framework for diabetic retinopathy detection. In *2026 2nd International Conference on Computational Intelligence Approaches and Applications (ICCIAA)* (pp. 1–7). IEEE.

Raihan, A., Ridwan, M., Rahman, S. M., & Sarker, T. (2026). Navigating the complexities of healthcare costs in Bangladesh: A closer look at environmental quality, economic growth, energy use, industrialization, urbanization, and forest area. *Innovation and Green Development, 5*(1), Article 100328. https://doi.org/10.1016/j.igd.2026.100328

Rasheed, M. D., Akram, M., Imran, M., Ahmed, R. H., & Rauf, A. (2025). Towards human-centric smart manufacturing: A digital twin enabled affective ergonomic framework for adaptive human robot collaboration. *International Journal of Advances in Signal and Image Sciences*, 1544–1555.

Slathia, P., Vashishtha, A., Jena, P. K., & Sahu, P. K. (2024). Examining the dynamic impact of carbon emissions, renewable energy, and economic growth on healthcare expenditure in Asian countries. *Heliyon, 10*(9), Article e30136. https://doi.org/10.1016/j.heliyon.2024.e30136

Szymanska, A. (2025). The relationship between health expenditure, income, and environmental degradation: Evidence from OECD economies. *Economic Analysis and Policy, 87*, 2183–2201. https://doi.org/10.1016/j.eap.2025.07.044

Wang, Z., Asghar, M. M., Zaidi, S. A. H., & Wang, B. (2019). Dynamic linkages among CO2 emissions, health expenditures, and economic growth: Empirical evidence from Pakistan. *Environmental Science and Pollution Research, 26*(15), 15285–15299. https://doi.org/10.1007/s11356-019-04876-x

World Bank. (2026). *World Development Indicators* [Data set]. World Bank. https://databank.worldbank.org/source/world-development-indicators

Wu, C.-F., Li, F., Hsueh, H.-P., Wang, C.-M., Lin, M.-C., & Chang, T. (2020). A dynamic relationship between environmental degradation, healthcare expenditure, and economic growth in wavelet analysis: Empirical evidence from Taiwan. *International Journal of Environmental Research and Public Health, 17*(4), Article 1386. https://doi.org/10.3390/ijerph17041386

Xiu, J., Ameer, W., Abbas, S., & Altuntas, M. (2022). Do carbon emissions and economic expansion induce health expenditure in China: Evidence for sustainability perspective. *Frontiers in Environmental Science, 9*, Article 838734. https://doi.org/10.3389/fenvs.2021.838734

Zaidi, S., & Saidi, K. (2018). Environmental pollution, health expenditure and economic growth in the Sub-Saharan Africa countries: Panel ARDL approach. *Sustainable Cities and Society, 41*, 833–840. https://doi.org/10.1016/j.scs.2018.04.034