Firdous, Rehana; Chatrath, Sarvjeet Kaur; Jadoon, Atif Khan et al.

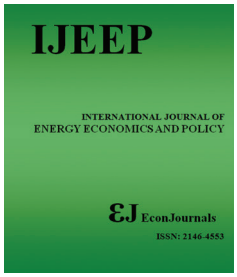
Article

Exploring dynamic nexus between economic growth, environmental degradation, and public health in Pakistan : a moderated mediation approach

International Journal of Energy Economics and Policy

Provided in Cooperation with:
International Journal of Energy Economics and Policy (IJEEP)

Reference: Firdous, Rehana/Chatrath, Sarvjeet Kaur et. al. (2023). Exploring dynamic nexus between economic growth, environmental degradation, and public health in Pakistan : a moderated mediation approach. In: International Journal of Energy Economics and Policy 13 (1), S. 241 - 249. https://econjournals.com/index.php/ijeep/article/download/13866/7132/32081. doi:10.32479/ijeep.13866.



International Journal of Energy Economics and Policy

ISSN: 2146-4553

available at http: www.econjournals.com

International Journal of Energy Economics and Policy, 2023, 13(1), 241-249.

Exploring Dynamic Nexus between Economic Growth, Environmental Degradation, and Public Health in Pakistan: A Moderated Mediation Approach

Rehana Firdous[1], Sarvjeet Kaur Chatrath[2], Atif Khan Jadoon[1]*, Munawar Iqbal[3], Syeda Azra Batool[4], Zameer Ul Hassan[5]

[1]Department of Economics, School of Economics, University of the Punjab, Pakistan, [2]Canberra Business School, University of Canberra, Australia, [3]College of Statistical and Actuarial Sciences, University of the Punjab, Pakistan, [4]School of Economics, Bahauddin Zakariya University, Pakistan, [5]Pak-AIMS, Institute of Management Sciences Lahore, Pakistan.
*Email: atifkhan.eco@pu.edu.pk

Received: 16 October 2022 **Accepted:** 05 January 2023 **DOI:** https://doi.org/10.32479/ijeep.13866

ABSTRACT

Since the start of this century, much attention has been given to economic growth and environmental changes and their effects on human beings. The present study has developed a comprehensive model to discuss the nexus between economic growth, environmental degradation, and public health. Furthermore, renewable energy consumption and public health spending are used as moderators to make the model more inclusive. The time series data from 1972 to 2020 has been used, and a regression path modeling tool SPPS-PROCESS Model 29, has been applied to carry out the results. The results showed a positive and significant effect of economic growth on environmental degradation, while renewable energy consumption reduces environmental degradation. Furthermore, environmental degradation is negatively affecting the health status in Pakistan. The results of the total effects showed that economic growth positively contributes to public health with a low coefficient. The indirect conditional impact of economic growth on human health through the mediating role of environmental degradation becomes positive from negative in the long run due to renewable energy and public spending on health. Based on the result, some policies are suggested in the last section of this study.

Keywords: Economic Growth, Environmental Degradation, Health Status, Public Health Spending, Renewable Energy
JEL Classifications: O44, E62, Q20

1. INTRODUCTION

Developing countries have experienced rapid economic growth since the second half of the last century. Industrialization in developing countries and technology from the developed world has enabled developing countries to grow rapidly. The increased economic activities brought many positives for the developing countries in the form of a reduction in poverty, improved education and health facilities, infrastructural development, technological advancement, etc. On the other side, higher growth rates have somehow posed some adverse effects on the countries in the form of depletion of natural resources, environmental degradation, income inequalities, and health degradation. The present study attempts to investigate the effect of growth rate on the health status of individuals in Pakistan directly and indirectly through the mediating role of environmental degradation. Moreover, to assess the accurate picture of the direct and indirect impact of growth rate on the health status of humans, two moderators, renewable energy consumption and public health expenditure, are also incorporated.

The higher economic growth rates enable a country to generate resources that can be used for the betterment of the masses through

improved health facilities. Many researchers have empirically tested the relationship between economic growth and public health (Eggoh et al., 2015; Lange and Vollmer, 2017; Niu et al., 2021; Thoa et al., 2013; Wu et al., 2021). The high growth rates result in the form of increased per capita income. Higher per capita income increases calorie intake and other micronutrients, which are essential for better health outcomes, especially in developing countries where a large portion of the population does not have basic health facilities. In this way, an increase in economic growth rate will result in improvements in human health like an increase in life expectancy at birth, improved food and water safety, and maternity death ratio (Catalano et al., 2011; Falagas et al., 2009; Kunze, 2014). Moreover, the high growth rates also increase public expenditure, causing improved public health. Many researchers have established a positive relationship between economic growth and public health (Bezruchka et al., 2008). Higher per capita income may negatively affect public health in developing countries due to diseases of affluence (alcohol and smoking consumption), sedentary lifestyles, and adverse eating habits (Lange and Vollmer, 2017; Lu et al., 2017).

Significant literature is variable on the relationship between economic growth and air quality. Grossman and Krueger (1995) presented the concept of the Environmental Kuznets Curve (EKC) while analyzing the relationship between national income and pollution. The results showed an inverted U-shape relationship between national income and pollution (Carbon Dioxide (CO_2)). Later, many researchers found the various shape of the relationship between national income and pollution, i.e., linear upward sloping (Ardakani and Seyedaliakbar, 2019; Azomahou et al., 2006), inverted U-Shaped (Jadoon et al., 2021; Jadoon et al., 2022; Mahmood et al., 2019; Shahbaz et al., 2017), U-Shaped (Eyup and Roula, 2020), and N-Shaped (Lorente and Alvarez-Herranz, 2016). In another theory of growth environment relationship, namely the Porter Hypothesis (PH), Michel Porter (1991) postulates that strict environmental regulation can increase efficiency and innovation, increasing commercial competitiveness and improving the environment. Many researchers have validated the PH (Ciabuschi et al., 2012; Zhang and Vigne, 2021). Some researchers have shown severe concerns and concluded that the results of PH could not be generalized (Lanoie et al., 2008; Palmer et al., 1995; Popp, 2006; Zhang and Du, 2020). Some other empirical studies showed mixed results on PH (He et al., 2020). From these two theories and related studies, it is extracted that economic growth is affecting the environment. The usage of renewable energy in advanced countries has increased, reducing environmental degradation growth (Mbarek et al., 2018).

Environmental degradation is one of the significant factors causing health issues. Germ Theory, based on the cause-and-effect approach given by John Snow in the 19th century, can illustrate environmental health. A triangle of the Agent-Host-Environment approach explains the relationship between environment and health. In this approach, agent refers to any virus and bacteria which become the cause of disease. Host refers to a human being by whom the infectious disease is received. Environment refers to external factors (climate, biological, and socio-economic factors such as crowding, sanitation, and health facilities) affecting agents and providing them an opportunity for exposure. Germ theory states that agents in the presence of socio-economic factors (overpopulation, insufficient sanitation facilities, and unavailability of sufficient health facilities) cause dangerous diseases to agents (human beings). There is consensus among researchers that environmental degradation due to greenhouse gas emissions adversely affects people's health (Naz et al., 2019).

The economic growth rate, directly and indirectly, affects the individuals' health status through the mediating role of environmental degradation. The direct effect of high economic growth is discussed above, but the indirect effect is discussed in only one study (to the best of the researcher's knowledge). In the recent past, Urhie et al. (2020) tested the direct and indirect impact of economic growth on health performance through the mediating role of air pollution in Nigeria. The authors have incorporated government health expenditure as a moderator between air pollution and health performance. The results were obtained by SPSS-PROCESS developed by Hayes (2017) using time series data from 1980 to 2015. The model outcome showed that economic growth is increasing air pollution. The results also indicated that health status has negative and insignificant relation to air pollution.

In contrast, Government spending on health positively and significantly contributes to the health status of the people in Nigeria. The interaction of CO_2 and health expenditure also stipulates a negative impact on health. In literature, several studies have shown a positive and significant effect of state expenditure in the health sector on human health status (Boachie and Ramu, 2016; Farag et al., 2013; Onofrei et al., 2021; Shuaibu and Timothy, 2016).

Regarding Pakistan, some studies have concluded that the economic growth rate is positively contributing to public health in Pakistan as a high growth rate increase the public expenditure on health (Akram et al., 2008; Mujtaba and Shahzad, 2021; Rahman et al., 2018). According to Shahbaz et al. (2016), life expectancy in Pakistan has increased from 42.86 years in 1960 to 65.7 years in 2013. However, when a developing country's process of economic growth moves on, it results in many shortfalls, e.g., inequality, environmental degradation, reduction in natural resources, etc. However, environmental degradation is the most dangerous to humans and nature, to which researchers and economists are paying particular attention. For Pakistan as well, many studies have concluded that a higher growth rate is polluting the environment (Baloch et al., 2018; Murshed and Dao, 2020). Similarly, many researchers have also established that air pollution negatively affects human health (Arafat et al., 2022; Majid et al., 2012). Some of the studies have also established the economic growth-environmental degradation-health channel by stating that economic growth increases environmental degradation that is negatively contributing to public health in Pakistan (Haseeb et al., 2019; Yazdi and Khanalizadeh, 2017; Majeed et al., 2021; Mujtaba and Shahzad, 2021).

It is evident from the literature that there exists nexus between economic growth, environmental degradation, and health. To the

best of the researcher's knowledge, only one study has checked the relationship among three variables in a single study. Urhie et al. (2020) conducted an empirical study to check the direct and direct impact of economic growth, through the mediating role of air quality, on the health status of Nigerian people. Moreover, government expenditure on health was taken as a moderator between air quality and health status. However, this study left out a significant moderator (renewable energy) to check the mediating role of the environment while studying the relationship between economic growth and health. Furthermore, this study also did not validate the existence of moderation moderation mediation of the developed model. The present study has extended the model by incorporating renewable energy consumption as a moderator between economic growth and environmental degradation for Pakistan economy. The proposed model for the present study is given In Figure 1:

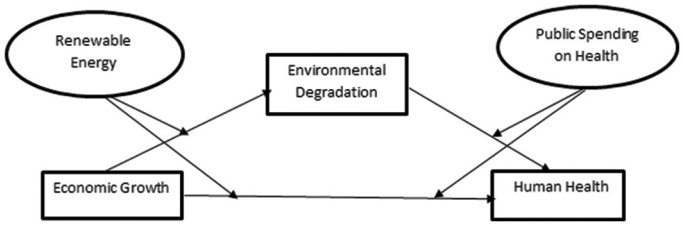
Figure 1 shows economic growth's direct and indirect effects on human health. Environmental degradation is taken as mediating variable between economic growth (independent variable) and human health (dependent variable). Renewable energy and public health spending are taken as two moderators in the model. It is assumed in Figure 1 that economic growth affects human health through different channels. The first channel is the total effect that economic growth has on human health. The second channel is the direct conditional effect of economic growth on human health in the presence of two moderators, renewable energy and public health. The third channel is the indirect effect, in which economic growth affects environmental degradation (renewable energy moderates this relationship), and environmental degradation affects human health (public health spending moderates this relationship).

2. MATERIAL AND METHODS

2.1. Model Specification and Data

The primary objective of this study is to check the total, conditional direct, and conditional indirect effects of economic growth on human health in Pakistan. The conditional direct effect of economic growth on public health is moderated by renewable energy consumption and public spending on health. The conditional indirect effect of economic growth on human health is moderated by renewable energy consumption and government expenditure on health and is mediated by environmental degradation. For this purpose, this study has used per capita economic growth rate, an explanatory variable of the model, as a proxy of economic growth. Human health, the model's dependent variable, is measured by life expectancy at birth (years). Environmental degradation, performing the role of mediation, is measured by CO_2 emissions (metric tons per capita). For this study, data on renewable energy and government expenditures on health have been taken from the Statistical Review of World Energy and the State Bank of Pakistan (SBP), respectively. Data on per capita economic growth rate, CO_2 emissions, and life expectancy at birth have been taken from WDI. The range of data is from 1972-2020. The following equations are formulated to test the relationship among variables mentioned in Figure 1:

Figure 1: The proposed moderated moderated mediation model



$$CO_2EMT = \beta_0 + \beta_1 GDPpcg + \beta_2 RE + \beta_3 GDPpcg * RE + e$$

$$LEAB = \alpha_0 + \alpha_1 GDPpcg + \alpha_2 CO_2EMT + \alpha_3 GEOH + \alpha_4 RE + \alpha_5 GDPpcg * RE + \alpha_6 GDPpcg * EXOH + \alpha_7 CO_2EMT * GEOH + \mu$$

Where: LEaB = life expectancy at birth, GDPpcg = GDP per capita growth rate, CO_2EMT = CO_2 (metric tons per capita), EEOH = government expenditure on health (% of GDP), RE = renewable energy consumption (% of total energy consumption), GDPpcg * RE, GDPpcg * GEOH and CO_2EMT * GEOH are representing the interaction between economic growth and renewable energy consumption, economic growth and government expenditure on health and environmental degradation and government expenditures on health respectively.

2.2. Methodology

The formulated model in Figure 1 is estimated through Hayes PROCESS-MACRO for SPSS software developed by Hayes (2013). Most researchers use PROCESS-MACRO to estimate independent variables' direct and indirect impacts on dependent variables through different paths or channels. In addition to estimating the coefficient of observed variables, PROCESS estimates direct and indirect impacts in single and multiple mediators' models, two and three-way interaction in moderation models, along with simple slopes and regions of significance for probing interactions. There are different types of PROCESS-MACRO models, which researchers can apply according to their observed variables and formulated models.

The present study has developed a model with one mediating variable (environmental degradation) and two moderators (renewable energy and public health spending). Both moderators are moderating the direct conditional impacts of economic growth on human health. In estimating the indirect conditional effects of the independent variable on the dependent variable, the first moderator moderates the relationship between the independent variable and the mediator, and the second moderator moderates the relation between the mediator and the dependent variable. An appropriate PROCESS model for this estimation is PROCESS model 29. So, the present study applies the SPSS-PROCESS model 29 to estimate the independent variable's total, direct conditional, and indirect conditional impacts on the dependent variable.

2.2.1. Percentile boot strap confidence interval

We use moderated moderated mediation index to check whether moderated moderated mediation exists in our formulated model. This index is calculated by multiplying the regression weight of the interaction of part A with the regressional weight of the

interaction of part B. So it is a product of two numbers. It should be different from zero. PROCESS uses Boot Strapping to see whether this index is significant or not. We have to look at the borders of two bootstrap confidence intervals. If zero does not lie inside this interval, it is significant. Zero is not part of this interval; we have significant moderated moderated mediation and vice versa. Suppose the values of the low-level confidence interval and upper-level confidence interval do not lie inside the value of the low-level bootstrap confidence interval and upper-level bootstrap confidence interval. In that case, the indirect conditional effects of the independent variable on the dependent variable are significant.

2.2.2. Johnson Neyman output

Model 29 of PROCESS-MACRO uses Johnson Neyman output for the interaction of moderators. When moderators are continuous variables, Johnson Neyman's (1939) approach is better than estimating significance at fixed values. Johnson Neyman's technique provides two values of the moderator at which the slope of the independent variable converts from non-significance to significant. The slope of the independent variable is only significant outside of the range provided by the function.

2.2.3. Standard deviation

For the conditioning values, PROCESS-MACRO model 29 selects -1 standard deviation, mean, + 1 standard deviation. So here limit of standard deviation from its mean value is -1 and +1.

2.2.4. Diagnostic test

A robust standard error (HC4) diagnostic test has been performed in order to deal with the problem of heteroscedasticity.

3. EMPIRICAL RESULTS

PROCESS-MACRO model 29 has been applied for estimation, and the results are presented below:

3.1. Total Effects

PROCESS MACRO model 29 has estimated the total effects of the formulated model through Ordinary Least Square (OLS).

The results in Table 1 show that economic growth positively and significantly affects environmental degradation. It means that if there is a 1% increase in the per capita economic growth rate, environmental degradation will be increased by 0.210 metric tons per capita in Pakistan. Many studies have found economic growth's positive and significant effect on environmental degradation (Mujtaba and Shahzad, 2021; Pajooyan and Moradhasel, 2008; Urhie et al., 2020). Like this study, Cowan et al. (2014) also established a positive relationship between gross domestic product and CO_2 emissions in BRICS countries, and Shahbaz et al. (2021) for India. However, the results of this study reject Porter's Hypothesis (1991), which lays down that economic growth will generate competition and, consequently, the presence of air quality regulations will improve the environment.

Furthermore, the results also show that environmental degradation is negatively related to renewable energy consumption in Pakistan. If there is a 1% increase in renewable energy consumption, there will be 0.036 metric tons per capita reduction in CO_2 emissions in Pakistan. The same results are obtained by Koengkan et al. (2021) for Latin America and Caribbean Region. Economic growth and renewable energy consumption have a negative and significant relationship with environmental degradation in Pakistan. Summary statistics of the model reveal that R-square is 68% which shows a good fit of the model. F-statics is 7.758, which shows the overall model is highly significant.

The results of the total impact of environmental degradation and economic growth on human health in Pakistan are presented in Table 2. The coefficient of the economic growth rate indicates that economic growth has a positive and significant effect on human health in Pakistan. If per capita economic growth rate increases by 1%, then life expectancy at birth will increase by 0.204 years in the country. The low impact of economic growth on health is due to income inequality in Pakistan. According to Haider (2021), Pakistan is divided between the richest and poorest groups. The wealthiest group has access to quality education and health care services, while the poorest do not have even a minimum of these. The poorest group holds only 0.17% of the national income, while the wealthiest group has 37% of the national income (Pasha, 2018). This situation has widened income inequality and unequal access to services such as health care and education, so the overall impact of economic growth on human health is small, and in some studies, it is negative due to the problems mentioned above.

The effect of environmental degradation on human health in Pakistan is negative and significant. If per capita CO_2 emissions are increased by one metric ton, life expectancy will be reduced by 2.934 years on average. Similar results are obtained by Ilyas et al. (2010), Khwaja et al. (2012), and Asghar et al. (2020) for Pakistan. The results also reveal that renewable energy consumption has a positive and insignificant impact on health status. Furthermore, renewable energy consumption indirectly impacts human health due to the interaction term,

Table 1: Relationship between economic growth and environmental degradation (CO_2EPC is outcomes variable)

	Coeff	Se(HC4)	t-values	p-values	LLCI	ULCI
Constant	0.011	0.033	0.346	0.731	–0.055	0.077
GDPpcg	0.210	0.019	2.550	0.035	–0.048	0.027
RE	–0.036	0.012	–2.930	0.005	–0.60	–0.011
GDPpcg*RE	–0.011	0.011	–1.940	0.004	–0.033	0.010
R-square		MSE	F(HC4)	Df1	Df2	p-value
0.688		0.025	7.758	3.000	45.000	0.000

Table 2: Total impact of growth on human health (LEAB is outcomes variable)

	Coeff	Se(HC4)	t-values	P-values	LLCI	ULCI
GDPpcg	0.204	0.111	1.837	0.044	–0.020	0.428
CO_2Epc	–2.934	1.305	–6.043	0.000	–1.298	2.569
RE	0.057	0.120	0.472	0.640	–0.299	0.186
GDPpcg*RE	0.035	0.057	2.626	0.035	–0.150	0.079
GSOH	0.758	1.558	2.487	0.029	–2.388	3.905
GDPpcg*GSOH	0.125	0.752	2.167	0.068	–1.644	1.393
CO_2Epc*GSOH	–2.094	2.503	1.877	0.058	–2.2267	1.078
Constant	61.202	0.149	410.918	0.000	60.901	61.502
R-square		MSE	F(HC4)	DF1	DF2	P-values
0.981		0.737	93.193	7.000	41.000	0.000

but there is no direct relationship between both variables. Similar results were obtained by Azam (2019), Caruso et al. (2020) and Shah et al. (2022). The combined effects of per capita economic growth and renewable energy consumption on human health are positive and significant in the case of Pakistan. If the government increases health spending, life expectancy will also increase in Pakistan. It means that if government expenditures on health are increased by 1% of GDP, life expectancy will be increased by 0.758 years on average. These results are similar to the finding of Saleem et al. (2021) and Siddiqui et al. (1995).

The interaction term, composed of economic growth and public spending on health, has a positive and significant impact on public health. Whereas interaction term, consisting of economic growth and environmental degradation, is significantly and negatively contributing to public health in the country. Summary statics of the model reveals P-value is.000 and the F-statics is 93.193, which means the overall model is highly significant.

The formulated model's outcome variable indicates that economic growth positively correlates with environmental degradation and human health. Environmental degradation's contribution to human health is negative. Health expenditures are also improving the health status of the masses. Renewable energy has no significant direct impact on human health.

3.2. Conditional Effects

To check the conditional effects of economic growth on human status, PROCESS MACRO MODEL 29 has been applied. In this model, economic growth is the independent variable, and human health is the dependent variable. Environmental degradation plays the role of mediator. There are two moderators; renewable energy is moderator 1, and public spending on health is moderator 2. In conditional effects, the independent variable (economic growth) affects the mediator (environmental degradation), and the mediator (environmental degradation) is consequently affecting the dependent variable (human health). Moderator 1 (renewable energy) is strengthening the relationship between the independent variable (economic growth) and mediator (environmental degradation). Moderator 2 (public spending on health) is strengthening the relationship between the mediator (environmental degradation) and dependent variable (human health).

Conditional effects of economic growth on human health are classified into:

- Conditional indirect effects
- Conditional direct effects.

3.2.1. Conditional indirect effects of economic growth on human health

The conditional indirect impact of economic growth on health, mediated by environmental degradation and moderated by renewable energy and public spending on health, can be assessed with the help of the index of moderated moderated mediation. The index indicates whether there exists moderated moderated mediation or not. The value of the index with upper and lower bound is given in Table 3:

This index is calculated by multiplying the regressional weight for the interaction of part A with the regressional weight for the interaction of part B. this index test whether we have an indirect effect moderated by two moderators. The process used Boot Strep Confidence Interval (BSCI) instead of a P-value to check the significance of the model. The significance of the conditional indirect effects can be tested by looking at two borders. If zero does not lie inside these intervals, an index is significant. In this case, the low-level confidence interval is negative, and the upper-level confidence interval is positive; it means zero is not part of the confidence interval, so we have significant moderated moderated mediation.

Table 4 indicates we have a different combination of two moderators. Indirect effects can be checked by looking at confidence intervals, whether these are significant or not. The value of moderator 1 (renewable energy) is –2.659, one standard deviation, and moderator2 (govt. spending on health) is –0.221, one standard deviation. It is a combination of the low value of moderator one and moderator two, and the effect is –0.166. By looking at the confidence interval, it is clear that zero is not part of the confidence interval, so the impact is significant and negative. So at a low value of the first and second moderator, we have a significant negative indirect effect from the independent variable (economic growth) to the mediator (air pollution) and from the mediator (air pollution) to the dependent variable (health). At a medium value of moderator1 (renewable energy) and moderator2 (govt. spending on health), which is 0.000 (at mean value), we

have a significant negative indirect effect from the independent variable to a mediator and from the mediator to a dependent variable. At an upper value of moderator1 (renewable energy), which is 2.659, and moderator2 (govt. spending on health), which is 0.221, a conditional indirect effect from the independent variable (economic growth) to mediator (air pollution) and from mediator (air pollution) to dependent variable (health) is positive and significant. When there is an increase in national income, public and private spending on health will be increased. The government will invest more in renewable energy consumption and formulate air quality policies to reduce air pollution, which will convert the indirect effect of economic growth on health from negative to positive.

So, in the long run, the indirect effects of economic growth on human health will be converted to positive from negative. These results are in line with the finding of some researchers, such as Rivera and Currais (2004), Mayer (2001), and Narayan et al. (2010). According to them, economic growth will tackle the problem of air pollution in the long run and positively contribute to human health. However, a finding of Granados and Ionides (2008) is opposed to this study. According to them, economic growth and human health positively in Sweden in the 19th century. However, over time, it began to weaken, and in the second half of the 20th century, it converted to negative from positive.

Table 3: Index of moderated moderated mediation

Index value	Boot SE	Boot LLCI	Boot ULCI
0.068	0.070	–0.082	0.201

Table 4: Conditional indirect impact of economic growth on health GDPpcg → CO_2Epc → LEaB)

RE	GSOH	Effect	BootSE	BootLLCI	BootULCI
–2.659	–0.221	–0.434	0.485	–0.562	1.368
–2.659	0.000	–0.407	0.466	–0.560	1.293
–2.659	0.221	–0.381	0.449	–0.552	1.243
0.000	–0.221	–0.229	0.298	–0.759	0.404
0.000	0.000	–0.215	0.292	–0.744	0.401
0.000	0.221	–0.201	0.287	–0.744	0.405
2.659	–0.221	0.892	0.429	–1.414	0.192
2.659	0.000	0.838	0.409	–1.343	0.190
2.659	0.221	0.784	0.395	–1.312	0.193

3.2.2. Conditional direct effects of economic growth on health

The next step is to check how economic growth directly affects human health in Pakistan. Condition direct effects will assess how economic growth impacts human health in the presence of different moderators, such as renewable energy and public spending on health. The results are presented in Table 5.

Table 4 indicates that there are different combinations of these two moderators. Moderator 1 is one standard deviation below the mean, and moderator 2 is one below the mean, with a P-value is 0.000. P-value indicates the marginal significance of direct effects. At a lower value of moderator1 (renewable energy), which is –2.744, and moderatore2 (govt. spending on health), which is –0.216, effects and P-values are 0.240 and 0.054, respectively. It means a positive and significant conditional direct impact of both moderators moderating economic growth on health. At a medium value of moderator1 (renewable energy) and moderator2 (govt. spending on health), which is 0.000, effects and P-values are 0.121 and 0.007, respectively. It shows that, at medium values of both moderators, conditional direct effects of economic growth, moderated by both moderators on human health, are positive and significant. At an upper value of moderator1 (renewable energy), 2.744, and moderator2 (govt. spending on health), which is 0.216, the effect and p-values are 0.003 and 0.059, respectively. It means the impact of economic growth moderated by two moderators on human health is positive and significant. It means that if renewable energy is consumed during the growth process and the government is spending more on health, the impact of economic growth on health will be positive. These results are in line with the finding of Nawab et al. (2021) and Omri and Belaïd (2021). However, these are opposed to the finding of Pata (2021). According to him, economic growth is degrading the air quality, and the use of renewable energy and health expenditure in the USA and Japan cannot compensate for the impact of this degradation on human health.

Above mentioned finding shows that in Pakistan, economic growth positively contributes to health (total effects). Economic growth is also degrading the air quality, and this environmental degradation is adversely affecting human health (conditional indirect effects). In the presence of renewable energy and public spending on health, economic growth has a positive impact on human health (conditional indirect effects).

Table 5: Conditional direct effect of economic growth on health

RE	GSOH	Effect	Se(HC4)	t-vaules	p-values	LLCI	ULCI
–2.659	–0.221	0.362	0.246	2.325	0.033	–0.171	0.823
–2.659	0.000	0.298	0.220	2.354	0.023	–0.147	0.743
–2.659	0.221	0.270	0.303	0.892	0.377	–0.342	0.883
0.000	–0.221	0.232	0.195	1.885	0.04	–0.163	0.626
0.000	0.000	0.204	0.111	1.837	0.054	–0.020	0.428
0.000	0.221	0.176	0.205	1.861	0.024	–0.237	0.589
2.659	–0.221	0.137	0.247	2.555	0.052	–0.362	0.637
2.659	0.000	0.110	0.147	2.747	0.059	–0.187	0.406
2.659	0.221	0.082	0.193	2.424	0.024	–0.308	0.471

4. CONCLUSION

The high growth rates in developing countries are affecting the health of humans through different direct and indirect channels. In literature, most of the studies have tried to establish various channels through which economic growth relates to human health. To the best of the researcher's knowledge, one study has tried to check the effect of the economic growth rate on the health status of individuals with the help of mediating variable "air quality." The study missed one important moderating variable, i.e., renewable energy consumption that may affect the relationship between economic growth and public health. This study attempts to fill this gap in the literature by estimating the total, direct conditional and indirect conditional impact of economic growth on human health in Pakistan. A regression Path analysis tool, SPSS-PROCESS model 29, has been applied for the empirical estimations. Environmental degradation is taken as mediating variable along with two moderators, i.e., renewable energy consumption and public spending on health.

The results of model 1 show that economic growth positively impacts environmental degradation in Pakistan. One primary reason is that a significant portion of the energy that the industrial sector consumes in Pakistan comes from fossil fuels. The increased consumption of these fossil fuels is causing more CO_2 emissions in the air. Renewable energy is negatively associated with environmental degradation in Pakistan. The total effects of economic growth on human health are positive, which is in line with the findings of Arora (2001), which indicates that economic growth will improve human health in the long run. The value of the coefficient showing the impact of economic growth on public health is low in the present study. The reason for the minor impact of economic growth on human health is that in Pakistan, the fruits of economic growth are enjoyed by only a small portion of the population (20% of the total population). The remaining (more than 80% of the population) do not have access to essential health services (Pasha, 2018). Environmental degradation is negatively affecting the health status in Pakistan. Similar results were obtained for India and Pakistan by Yamamoto et al. (2014), who state that environmental degradation is the primary cause of cardiovascular diseases in Pakistan and India. Moreover, the study's results also indicated that Pakistan's public spending and renewable energy consumption positively contribute to human health.

The result of the indirect conditional impact of economic growth on human health through the mediating role of environmental degradation and with two moderators, as stated above, varies over time. Initially, the effect was negative, but over time, it became positive when renewable energy consumption and public spending on health increased. Furthermore, the results also show that the direct conditional effect of economic growth on human health, moderated by renewable energy and public spending on health, is positive. Based on the results, it is suggested that environmental degradation should be controlled most effectively to minimize its adverse effects on the health status of the masses. Pakistan needs to invest more in renewable energy to achieve sustainable growth. It will also positively affect the health status of the masses, as indicated by the present research. So measures should be taken to enhance renewable energy consumption in the industrial sector and for electricity production. There is a dire need to increase effective health spending that is very low in Pakistan.

REFERENCES

Akram, N., Padda, I.U.H., Khan, M. (2008), The long term impact of health on economic growth in Pakistan. The Pakistan Development Review, 47(4), 487-500.

Arafat, W.M.G.M., Haq, I.u., Mehmed, B., Abbas, A., Gamage, S.K.N., Gasimli, O. (2022), The causal nexus among energy consumption, environmental degradation, financial development and health outcome: Empirical study for Pakistan. Energies, 15(5), 1859.

Ardakani, M.K., Seyedaliakbar, S.M. (2019), Impact of energy consumption and economic growth on CO_2 emission using multivariate regression. Energy Strategy Reviews, 26, 100428.

Arora, S. (2001), Health, human productivity, and long-term economic growth. The Journal of Economic History, 61(3), 699-749.

Asghar, M.M., Wang, Z., Wang, B., Zaidi, S.A.H. (2020), Nonrenewable energy-environmental and health effects on human capital: Empirical evidence from Pakistan. Environmental Science and Pollution Research, 27(3), 2630-2646.

Azam, M. (2019), Relationship between energy, investment, human capital, environment, and economic growth in four BRICS countries. Environmental Science and Pollution Research, 26(33), 34388-34400.

Azomahou, T., Laisney, F., Van, P.N. (2006), Economic development and CO_2 emissions: A nonparametric panel approach. Journal of Public Economics, 90(6-7), 1347-1363.

Baloch, A., Shah, S.Z., Noor, Z.M., Magsi, H.B. (2018), The nexus between income inequality, economic growth and environmental degradation in Pakistan. GeoJournal, 83(2), 207-222.

Bezruchka, S., Namekata, T., Sistrom, M.G. (2008), Interplay of politics and law to promote health: Improving economic equality and health: The case of postwar Japan. American Journal of Public Health, 98(4), 589-594.

Boachie, M.K., Ramu, K. (2016), Effect of public health expenditure on health status in Ghana. International Journal of Health, 4(1), 6-11.

Caruso, G., Colantonio, E., Gattone, S.A. (2020), Relationships between renewable energy consumption, social factors, and health: A panel vector auto regression analysis of a cluster of 12 EU countries. Sustainability, 12(7), 2915.

Catalano, R., Goldman-Mellor, S., Saxton, K., Margerison-Zilko, C., Subbaraman, M., LeWinn, K., Anderson, E. (2011), The health effects of economic decline. Annual Review of Public Health, 32, 431-450.

Ciabuschi, F., Dellestrand, H., Kappen, P. (2012), The good, the bad, and the ugly: Technology transfer competence, rent-seeking, and bargaining power. Journal of World Business, 47(4), 664-674.

Cowan, W.N., Chang, T., Inglesi-Lotz, R., Gupta, R. (2014), The nexus of electricity consumption, economic growth and CO_2 emissions in the BRICS countries. Energy Policy, 66, 359-368.

Eggoh, J., Houeninvo, H., Sossou, G.A. (2015), Education, health and economic growth in African countries. Journal of Economic Development, 40(1), 93.

Eyup, D., Roula, I.L. (2020), The impact of economic structure to the environmental Kuznets curve (EKC) hypothesis: Evidence from European countries. Environmental Science and Pollution Research International, 27(11), 12717-12724.

Falagas, M., Vouloumanou, E., Mavros, M.N., Karageorgopoulos, D.E. (2009), Economic crises and mortality: A review of the literature. International Journal of Clinical Practice, 63(8), 1128-1135.

Farag, M., Nandakumar, A., Wallack, S., Hodgkin, D., Gaumer, G., Erbil,

C. (2013), Health expenditures, health outcomes and the role of good governance. International Journal of Health Economics and Management, 13(1), 33-52.

Granados, J.A.T., Ionides, E.L. (2008), The reversal of the relation between economic growth and health progress: Sweden in the 19th and 20th centuries. Journal of Health Economics, 27(3), 544-563.

Grossman, G.M., Krueger, A.B. (1995), Economic growth and the environment. Quarterly Journal of Economics, 110(2), 353-378.

Haider, M. (2021), Human development report 2020: Massive income inequality among rich and poor. The News, Available from: https://www.thenews.com.pk/print/816040-human-development-report-2020-massive-income-inequality-among-rich-and-poor

Haseeb, M., Kot, S., Hussain, H.I., Jermsittiparsert, K. (2019), Impact of economic growth, environmental pollution, and energy consumption on health expenditure and R&D expenditure of Asean countries. Energies, 12(19), 3598.

Hayes, A.F. (2013), The Process Macro for SPSS and SAS (version 2.13) [Software].

Hayes, A. F., and Montoya, A. K. (2017), A tutorial on testing, visualizing, and probing an interaction involving a multicategorical variable in linear regression analysis. Communication Methods and Measures, 11(1), 1-30.

He, W., Tan, L., Liu, Z.J., Zhang, H. (2020), Property rights protection, environmental regulation and corporate financial performance: Revisiting the porter hypothesis. Journal of Cleaner Production, 264, 121615.

Ilyas, S.Z., Khattak, A.I., Nasir, S.M., Qurashi, T., Durrani, R. (2010), Air pollution assessment in urban areas and its impact on human health in the city of Quetta, Pakistan. Clean Technologies and Environmental Policy, 12(3), 291-299.

Jadoon, A.K., Akhtar, S., Sarwar, A., Batool, S.A., Chatrath, S.K., Liaqat, S. (2021), Is economic growth and industrial growth the reason for environmental degradation in saarc countries. International Journal of Energy Economics and Policy, 11(6), 418-426.

Jadoon, A.K., Sarwar, A., Qasim, H.M., Javaid, M.F., Liaqat, S., Ahmed, M. (2022), Some methodological considerations for the relationship between environmental degradation, economic growth and energy consumption for South Asian countries. International Journal of Energy Economics and Policy, 12(1), 365-372.

Khwaja, H.A., Fatmi, Z., Malashock, D., Aminov, Z., Kazi, A., Siddique, A., Carpenter, D.O. (2012), Effect of air pollution on daily morbidity in Karachi, Pakistan. Journal of Local and Global Health Science, 3(1), 2-13.

Koengkan, M., Fuinhas, J.A., Silva, N. (2021), Exploring the capacity of renewable energy consumption to reduce outdoor air pollution death rate in Latin America and the Caribbean region. Environmental Science and Pollution Research, 28(2), 1656-1674.

Kunze, L. (2014), Life expectancy and economic growth. Journal of Macroeconomics, 39, 54-65.

Lange, S., Vollmer, S. (2017), The effect of economic development on population health: A review of the empirical evidence. British Medical Bulletin, 121(1), 47-60.

Lanoie, P., Patry, M., Lajeunesse, R. (2008), Environmental regulation and productivity: Testing the porter hypothesis. Journal of Productivity Analysis, 30(2), 121-128.

Lorente, D., Alvarez-Herranz, A. (2016), An approach to the effect of energy innovation on environmental Kuznets curve: An introduction to inflection point. Bulletin of Energy Economics, 4(3), 224-233.

Lu, Z.N., Chen, H., Hao, Y., Wang, J., Song, X., Mok, T.M. (2017), The dynamic relationship between environmental pollution, economic development and public health: Evidence from China. Journal of Cleaner Production, 166, 134-147.

Mahmood, H., Furqan, M., Alkhateeb, T.T.Y., Fawaz, M.M. (2019), Testing the environmental Kuznets curve in Egypt: Role of foreign investment and trade. International Journal of Energy Economics and Policy, 9(2), 225-228.

Majeed, M.T., Yu, Z., Maqbool, A., Genie, M., Ullah, S., Ahmad, W. (2021), The trade-off between economic growth and environmental quality: Does economic freedom asymmetric matter for Pakistan? Environmental Science and Pollution Research, 28(31), 41912-41921.

Majid, H., Madl, P., Alam, K. (2012), Ambient air quality with emphasis on roadside junctions in metropolitan cities of Pakistan and its potential health effects. Health, 3(3), 79-85.

Mayer, D. (2001), The long-term impact of health on economic growth in Latin America. World Development, 29(6), 1025-1033.

Mbarek, M.B., Saidi, K., Rahman, M.M. (2018), Renewable and non-renewable energy consumption, environmental degradation and economic growth in Tunisia. Quality and Quantity, 52(3), 1105-1119.

Mujtaba, G., Shahzad, S.J.H. (2021), Air pollutants, economic growth and public health: Implications for sustainable development in OECD countries. Environmental Science and Pollution Research, 28(10), 12686-12698.

Murshed, M., Dao, N.T.T. (2020), Revisiting the CO_2 emission-induced EKC hypothesis in South Asia: The role of export quality improvement. GeoJournal, 87, 535-563.

Narayan, S., Narayan, P.K., Mishra, S. (2010), Investigating the relationship between health and economic growth: Empirical evidence from a panel of 5 Asian countries. Journal of Asian Economics, 21(4), 404-411.

Nawab, T., Bhatti, M.A., Nawaz, M.A. (2021), Does technological innovation advance environmental sustainability in ASEAN countries? Pakistan Journal of Humanities and Social Sciences, 9(3), 425-434.

Naz, S., Sultan, R., Zaman, K., Aldakhil, A.M., Nassani, A.A., Abro, M.M.Q. (2019), Moderating and mediating role of renewable energy consumption, FDI inflows, and economic growth on carbon dioxide emissions: Evidence from robust least square estimator. Environmental Science and Pollution Research, 26(3), 2806-2819.

Niu, X.T., Yang, Y.C., Wang, Y.C. (2021), Does the economic growth improve public health? A cross-regional heterogeneous study in China. Frontiers in Public Health, 9, 704155.

Omri, A., Belaïd, F. (2021), Does renewable energy modulate the negative effect of environmental issues on the socio-economic welfare? Journal of Environmental Management, 278(Pt 2), 111483.

Onofrei, M., Vatamanu, A.F., Vintilă, G., Cigu, E. (2021), Government health expenditure and public health outcomes: A comparative study among EU developing countries. International Journal of Environmental Research and Public Health, 18(20), 10725.

Pajooyan, J., Moradhasel, N. (2008), Assessing the relation between economic growth and air pollution. The Economic Research, 7(4), 141-160.

Palmer, K., Oates, W.E., Portney, P.R. (1995), Tightening environmental standards: the benefit-cost or the no-cost paradigm? Journal of Economic Perspectives, 9(4), 119-132.

Pasha, H.A. (2018), Growth and Inequality in Pakistan. Germany: Friedrich-Naumann-Stiftung für die Freiheit.

Pata, U.K. (2021), Do renewable energy and health expenditures improve load capacity factor in the USA and Japan? A new approach to environmental issues. The European Journal of Health Economics, 22(9), 1427-1439.

Popp, D. (2006), International innovation and diffusion of air pollution control technologies: The effects of NOX and SO2 regulation in the US, Japan, and Germany. Journal of Environmental Economics and Management, 51(1), 46-71.

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), 113.

Rivera, B., Currais, L. (2004), Public health capital and productivity in the Spanish regions: A dynamic panel data model. World Development, 32(5), 871-885.

Saleem, A., Cheema, A.R., Rahman, A., Ali, Z., Parkash, R. (2021), Do health infrastructure and services, aging, and environmental quality influence public health expenditures? Empirical evidence from Pakistan. Social Work in Public Health, 36(6), 688-706.

Shah, M.H., Salem, S., Ahmed, B., Ullah, I., Rehman, A., Zeeshan, M., Fareed, Z. (2022), Nexus between foreign direct investment inflow, renewable energy consumption, ambient air pollution, and human mortality: A public health perspective from non-linear ARDL approach. Front Public Health, 9, 814208.

Shahbaz, M., Loganathan, N., Mujahid, N., Ali, A., Nawaz, A. (2016), Determinants of life expectancy and its prospects under the role of economic misery: A case of Pakistan. Social Indicators Research, 126(3), 1299-1316.

Shahbaz, M., Sharma, R., Sinha, A., Jiao, Z. (2021), Analyzing nonlinear impact of economic growth drivers on CO2 emissions: Designing an SDG framework for India. Energy Policy, 148, 111965.

Shahbaz, M., Solarin, S.A., Hammoudeh, S., Shahzad, S.J.H. (2017), Bounds testing approach to analyzing the environment Kuznets curve hypothesis with structural beaks: The role of biomass energy consumption in the United States. Energy Economics, 68, 548-565.

Shuaibu, M., Timothy, P.O. (2016), Human capital development dynamics in Africa: Evidence from panel cointegration and causality in 33 Countries. Applied Econometrics and International Development, 16(1), 116-131.

Siddiqui, R., Afridi, U., Haq, R., Tirmazi, S.H. (1995), Determinants of expenditure on health in Pakistan [with Comments]. The Pakistan Development Review, 34(4), 959-970.

Thoa, N.T.M., Thanh, N.X., Chuc, N.T.K., Lindholm, L. (2013), The impact of economic growth on health care utilization: A longitudinal study in rural Vietnam. International Journal for Equity in Health, 12, 19.

Urhie, E., Afolabi, A., Afolabi, A., Matthew, O., Osabohien, R., Ewetan, O. (2020), Economic growth, air pollution and health outcomes in Nigeria: A moderated mediation model. Cogent Social Sciences, 6(1), 1719570.

Wu, C.F., Chang, T., Wang, C.M., Wu, T.P., Lin, M.C., Huang, S.C. (2021), Measuring the impact of health on economic growth using pooling data in regions of Asia: Evidence from a quantile-on-quantile analysis. Front Public Health, 9, 689610.

Yamamoto, S.S., Phalkey, R., Malik, A.A. (2014), A systematic review of air pollution as a risk factor for cardiovascular disease in South Asia: Limited evidence from India and Pakistan. International Journal of Hygiene and Environmental Health, 217(2-3), 133-144.

Yazdi, S.K, Khanalizadeh, B. (2017), Air pollution, economic growth and health care expenditure. Economic research-Ekonomska Istraživanja, 30(1), 1181-1190.

Zhang, D., Du, P. (2020), How China "Going green" impacts corporate performance? Journal of Cleaner Production, 258, 120604.

Zhang, D., Vigne, S.A. (2021), How does innovation efficiency contribute to green productivity? A financial constraint perspective. Journal of Cleaner Production, 280, 124000.