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AN EMPIRICAL ANALYSIS OF THE IMPACT OF RENEWABLE RESOURCE USE ON PUBLIC HEALTH IN INDIA

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ABSTRACT

This study investigates the relationship between renewable energy consumption, fossil fuel use, and public health outcomes in India, using annual data from 1990 to 2019. Employing Ordinary Least Squares (OLS) regression models, the study explores the effects of renewable energy, CO2 emissions, fossil fuel consumption, and other socio-economic variables such as Human Development Index (HDI) and urbanization on life expectancy, mortality rates, and death rates. The findings reveal that renewable energy consumption positively impacts life expectancy and reduces mortality, while fossil fuel use is associated with increased mortality and adverse health effects. Urbanization plays a crucial role in enhancing life expectancy and reducing mortality due to improved healthcare infrastructure and services. However, the reliance on fossil fuels remains a significant challenge for public health. These results highlight the importance of transitioning to renewable energy sources and implementing environmental regulations to improve public health outcomes in developing economies like India.

Keywords: Life expectancy, Infant mortality, Renewable energy consumption, fossil fuel consumption

1. INTRODUCTION

Energy plays a critical role in the economic and social advancement and the enhancement of life quality worldwide. However, the current methods of energy production and consumption are unsustainable if technological advancements halt and if there's a significant increase in demand (Kaygusuz, 2007). It's widely acknowledged that the combustion of fossil fuels, which emit more carbon than any other energy source, is a key factor driving global climate change and deteriorating air quality across various regions. Despite the consensus on the detrimental impacts of fossil fuels, developing countries have escalated the burning of fossil fuels like oil, coal, and gas in industries, and solid fuels in homes, to boost production and satisfy growing domestic energy needs. This reliance on fossil fuels does contribute to per capita income growth, but it also leads to the emission of greenhouse gases, adversely affecting human health. This includes a higher mortality rate and a surge in respiratory diseases, among other health issues, stemming from the decline in environmental quality. (Hanif, 2018; Ibrahim et al., 2022; ul-Haq et al., 2023).

In 2019, a staggering 99% of the global population lived in areas not meeting the World Health Organization's air quality guidelines, according to WHO reports. The future looks bleak with predictions of massive increases in carbon dioxide and other greenhouse gas emissions potentially ravaging the natural environment. This environmental decline is expected to heighten health risks worldwide, especially in developing countries, leading to an increase in lung cancer, cardiovascular diseases, and respiratory illnesses (Apergis et al., 2018; Cohen et al., 2017; Kelly & Fussell, 2015; Koengkan et al., 2021). Alarmingly, air pollution is linked to approximately 6.7 million deaths annually due to environmental damage, with a shocking 89% occurring in developing nations (WHO, 2019). Consequently, emissions in these regions are causing not just a rise in health problems but also a surge in healthcare costs and a shortage of medications. Air pollution is a major global issue, primarily responsible for respiratory diseases. In 2019, the WHO documented 3.23 million deaths from chronic obstructive pulmonary disease, 262 million asthma cases, and 17.9 million cardiovascular disease deaths, with these numbers rapidly increasing (WHO, 2019).

Despite their role in meeting energy demands, the use of fossil and solid fuels is linked to significant health issues, including respiratory conditions, lung cancer, and other pulmonary diseases (Beatty and Shimshack 2014; Brunekreef and Holgate 2002). These fuels remain the most economical energy sources, extensively used at both domestic and larger scales (Barnes 2014; Chafe et al. 2014). Their affordability makes them particularly appealing to developing economies dependent on non-renewable sources for manufacturing. Addressing the challenge of global climate change requires measures that not only encourage voluntary action but also align with the economic interests of these countries, such as investing in a diverse range of energy sources and shifting towards renewables energy (Kaygusuz, 2007b; Khan, 2019; Liu, 2017). Transitioning to renewable energy sources, like solar, wind, and geothermal power, could significantly reduce air pollution and improve human health in the short term, while mitigating global warming in the long run, yielding numerous positive outcomes (Koengkan et al., 2021; Mujtaba & Ashfaq, 2022; Rodriguez-Alvarez, 2021; Ullah et al., 2020).

This context raises intriguing questions about the link between renewable energy use, environmental pollution, and public health in developing countries, highlighting its crucial role in promoting economic growth and minimizing public health losses. Despite significant economic advancements and improved living standards in these regions, they face pressing ecological challenges, including excessive energy consumption, severe environmental pollution, and declining health levels. There is a notable gap in the literature regarding the dynamic relationship between renewable energy, various pollutants, and public health. Thus, this paper aims to: (1) explore the dynamic connections between renewable energy use and public health through dynamic econometric models; (2) analyze the impact of renewable energy on environmental pollution and health; and (3) provide insights for scholars and policymakers on integrating energy usage, environmental pollution, and public health into a cohesive system. This could significantly influence policy decisions aimed at enhancing public health levels impacted by pollution from fossil fuel consumption.

The paper is structured as follows: a literature review, a discussion on research design and methodology, an analysis of the relationship between renewable energy, environmental pollution, and public health, followed by conclusions and policy recommendations.

2. LITERATURE REVIEW

2.1 *Nexus between renewable energy use and public health*

This section delves into the relationship between the utilization of renewable energy and public health outcomes. Research conducted by Koengkan et al. (2021) indicated that in the Latin America and Caribbean region, there is an inverse correlation between the consumption of renewable energy and deaths attributed to outdoor air pollution. Similarly, Wang et al. (2023) explored how renewable energy impacts life expectancy and economic growth from 1960 to 2015, finding a beneficial link between the use of renewable energy and increased life expectancy. Majeed et al. (2021) analyzed the connection between renewable energy usage and human health across 155 countries using various panel data techniques, such as

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pooled ordinary least squares, random effects, fixed effects, two-stage least squares, and generalized method of moments, covering the years 1990 to 2018. Their findings suggest that renewable energy contributes to higher life expectancy and lower mortality rates, with economic growth, trade, and urbanization also leading to improved health conditions. Furthermore, Stefko et al. (2021) investigated the impact of renewable energy use in specific sectors (including transport, electricity, heating, and cooling) on the occurrence of certain disease groups within the European Union from 2010 to 2019, employing panel regression models like the pooling model, fixed effects model, and random effects model. Their research confirmed significant positive effects of renewable energy use on disease prevalence.

2.2 *Nexus between renewable energy use and environmental pollution*

Ocak et al. (2004) identified renewable energy sources as key to sustainable energy development and reducing environmental pollution in Turkey. Using the augmented mean group estimator and panel bootstrap causality method, Destek & Aslan (2020) found that the consumption of hydroelectricity, biomass, and wind energy lowers carbon emissions in G-7 countries, though solar energy's effect was not statistically significant. Karasoy & Akçay (2019) observed that renewable energy use decreases carbon emissions over both short and long terms, confirming the neutrality hypothesis between renewable energy consumption and income in both durations. Conversely, for non-renewable energy, the neutrality hypothesis is applicable only in the short term, with the conservation hypothesis relevant in the long term. Assi et al. (2021) demonstrated a negative association between environmental pollution, economic freedom, and renewable energy use, but a positive link between innovation, real GDP, and renewable energy in ASEAN +3 economies from 1998 to 2018. Lanre Ibrahim et al. (2022) discovered that structural change indicators significantly lower carbon emissions, just as environmental technology and renewable energy do, whereas reliance on natural resources greatly increases carbon emissions in five leading African carbon emitters—Algeria, Egypt, Morocco, Nigeria, and South Africa—from 1990 to 2019. Abbasi & Abbasi (2012) discussed the potential negative impacts comparable to those of fossil fuels when deploying renewable energy technologies on both large centralized systems and small, distributed scales. Alharthi et al. (2022) explored the impact of renewable energy and environmental pollution on health and household income in Middle Eastern and North African (MENA) countries from 2000 to 2019 using Pooled Mean Group (PMG) regression. They concluded that renewable energy significantly benefits individual health and reduces environmental pollution, whereas non-renewable energy consumption adversely affects health but increases per capita income in the MENA region.

2.3 *Nexus between fossil fuel energy consumption, total natural resources, urbanization, human development and renewable resources*

This section delves into the interconnections among fossil fuel consumption, total natural resources, urbanization, human development, and the use of renewable resources. Spelta & De Giuli (2023) explored the market dynamics between the renewable and fossil fuel energy sectors in Europe from 2003 to 2022 through wavelet analysis, identifying significant co-movements at intervals ranging from two months to two years until 2011. Ediger & Kentel (1999) noted a critical and inevitable transition from fossil fuels to renewable energy sources in Turkey. The role of natural resources in a country's economic prosperity has historically been seen as either a curse or a blessing, depending on the management of these resources. Han et al. (2023) observed a positive link between natural resources and the uptake of renewable energy. Nonetheless, Ahmadov & Van Der Borg (2019) indicated that while

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general natural resource wealth might support renewable energy production, specific resources like petroleum could hinder it in the EU.

Concerning urbanization and its impact on renewable resources, Yang et al. (2016) concluded that urbanization in China has driven overall energy consumption more than it has renewable energy consumption growth (RECG). Bao & Xu (2019), however, found no causal relationship between renewable energy consumption and urbanization in China. The influence of human development on the adoption of renewable resources yields mixed findings. Sasmaz et al. (2021) identified a bidirectional causality between renewable energy use and human development across 28 OECD countries from 1990 to 2017, employing the Westerlund and Edgerton panel cointegration test with structural breaks and the Dumitrescu and Hurlin causality test. Conversely, Amer (2020) investigated the energy-human development nexus across 103 countries from 1990 to 2015, discovering that renewable energy consumption's impact on the Human Development Index (HDI) was negligible in all income groups except for lower middle-income countries.

3. **Theoretical framework, data and methodology**

3.1 *Theoretical Framework*

This study employed Grossman's (1972) health demand model, which posits that "health is a capital good." According to this model, individuals are born with an initial stock of health that depreciates over time, but this health capital can be enhanced through the consumption of medical care (Grossman, 2017) and improvements in environmental quality (Wang et al., 2023). A decline in an individual's health stock ultimately leads to mortality. The health production function can be expressed as follows:

$$H = f(X)$$

Where, H represents the measure of health, used as a proxy for health outcomes, while X denotes a set of factors influencing health, including variables such as income, education, healthcare costs, and environmental conditions. For the purpose of macro-level analysis, the factors within X can be categorized into three subsections: economic, social, and environmental determinants (Stefko et al., 2021).

$$H = f(Y, S, V)$$

In this study, Y is a vector of energy variables (renewable energy consumption, fossil fuel consumption), S is a vector of social variable (urbanization, HDI) and V is a vector of environmental factors (CO_2 emission).

3.2 *Empirical Methodology*

The relationship between renewable energy consumption and human health has garnered significant attention. This study empirically investigates the impact of renewable energy on human health, utilizing life expectancy at birth and infant mortality rate as proxies for human health due to their comprehensive representation at the individual level (Qu et al., 2017; Barua et al., 2022; Gasimli et al., 2022). These proxies are widely supported in the literature as valid measures of health (Shobande, 2020; Saleem et al., 2022). To assess the influence of clean energy on health outcomes, renewable energy consumption(Koengkan et al., 2021) is used as a key explanatory variable, alongside other factors such as gross domestic product (GDP) per capita(Anser et al., 2020), and urbanization(Hanif, 2018), which are known to affect health.

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The current study investigates impact of renewable energy on health outcomes. So, the first part explores the relationship between life expectancy, a positive indicator of health outcomes and renewable energy, and the second part explores the relationship between mortality rate (infant) which a negative indicator of health outcomes, and renewable energy for India. The study uses the annual data for 29 years from 1990 to 2019. Table 1 highlights the names of variables, symbols, units of measurement and data source used in the study.

Table 1: Definition of Variables

Variables	Description	Measurement	Source
lyf	Life expectancy at birth, total	Years	World Development Indicators of World Bank, 2021
mortality	Mortality rate, infant (per 1,000 live births)	Per 1,000 live births	World Development Indicators of World Bank, 2021
rnew	Renewable energy consumption	% of total final energy consumption	World Development Indicators of World Bank, 2021
Co2	CO_2 emissions	Metric tons per capita	World Development Indicators of World Bank, 2021
fossil	Fossil fuel energy consumption	% of total final energy consumption	World Development Indicators of World Bank, 2021
totnatrent	Total natural resources rents	% of GDP	World Development Indicators of World Bank, 2021
urban	Urban population	% of total population	World Development Indicators of World Bank, 2021
hdi	Human Development Index		UNDP (2021)

In this study, the following equations were used to evaluate the relationship between life expectancy, infant mortality and death due to air pollution with renewable energy, environmental degradation, Fossil fuel consumption, Total natural rent, Urban and HDI as shown in equations (1) and (2).

Model 1:

lyf = f (rnew, co2, fossil, totnatrent, hdi, urban)

Model 2:

mortality = f (rnew, co2, fossil, totnatrent, hdi, urban)

In the subsequent equations, in Model 1, dependent variable is life expectancy (lyf), and Mortality rate, infant (per 1,000 live births) (mortality) in model 2 and their respective independent variables are Renewable energy consumption (% of total final energy

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consumption) (rnew), CO2 emissions (metric tons per capita) (co2), Fossil fuel energy consumption (% of total) (fossil), Total natural resources rents (% of GDP) (totnatrent), Human Development Index (hdi) and Urban population (% of total population) (urban) . To minimize the problem with the distributional features of estimated coefficients and to overcome the problem of heteroscedasticity, multicollinearity, and for a better fit of the model, we transform all the variables to natural log-linear form. The empirical models in log linear form are shown below.

Model 1:

$$lnlyf = \beta_0 + \beta_1 lnrnew + \beta_2 lnco2 + \beta_3 lnfossil + \beta_4 lntotnatrent + \beta_5 lnhdi + \beta_6 lnurban + \mu_t$$

Model 2:

$$lnmortality = \beta_0 + \beta_1 lnrnew + \beta_2 lnco2 + \beta_3 lnfossil + \beta_4 lntotnatrent + \beta_5 lnhdi + \beta_6 lnurban + \mu_t$$

The symbol ln depicts natural logarithm, and in Models 1 and 2, β_0 depicts intercept and β_1 , β_2 , β_3 , β_4 , β_5 and β_6 depict the slope coefficients of rnew, co2, fossil, totnatrent, hdi and urban respectively. Ordinary Least Squares (OLS) is a linear regression technique used to estimate unknown parameters within a linear model. It operates by applying the principle of least squares, minimizing the sum of squared differences between observed values of the dependent variable and those predicted by the model. Specifically, OLS minimizes the squared vertical distances between each observed data point and the corresponding point on the regression line, aiming to improve the model's fit to the data. In the case of simple linear regression, where only one independent variable is used, the OLS estimator can be derived from a straightforward formula. In this study, OLS regression was selected to model the dependent variable in relation to several independent variables. OLS was chosen due to its ability to produce interpretable diagnostic output, including coefficient estimates and model diagnostics, which facilitate a clear understanding of the relationships between variables.

4. RESULTS AND DISCUSSIONS

4.1 *Descriptive statistics and correlation*

The statistical analysis presented in table 2 reveals key insights about the distribution and behaviour of each variable. The variables in the dataset provide a diverse view of socio-economic and environmental metrics. CO2 emissions and fossil fuel consumption show moderate variability, with CO2 being positively skewed, suggesting a concentration of lower emission levels with some higher extremes. GDP displays a broad range, indicating a mix of economic performance across the years, while HDI is negatively skewed with a relatively narrow spread, suggesting that human development has consistently improved over time. Renewable energy usage is negatively skewed, implying increasing but gradual use. Total natural resource rents show considerable variability and positive skewness, pointing to fluctuations in resource dependency. Urbanization and life expectancy are tightly clustered, with minor variability and near-normal distributions, reflecting consistent improvements. Mortality rates have decreased over time, with a strong negative skew, suggesting most observations are concentrated at lower mortality levels, signalling public health advancements.

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Table 2: Descriptive statistics for all variables in data set

Statistical tools	lnlyf	lnmortality	lnrnew	lnfossil	lntotnatrent	lnco2	lnurban	lnhdi
Mean	4.169	4.002	3.737	4.163	1.034	0.058	3.377	-0.634
Standard Deviation	0.059	0.318	0.170	0.083	0.351	0.332	0.092	0.133
Minimum	4.072	3.391	3.481	3.985	0.559	-0.435	3.241	-0.835
Median	4.171	4.056	3.797	4.166	0.919	-0.031	3.370	-0.636
Maximum	4.261	4.436	3.970	4.298	1.961	0.585	3.540	-0.439
Standard Error	0.011	0.058	0.031	0.015	0.064	0.061	0.017	0.024
Kurtosis	-1.225	-1.020	-1.566	-0.302	0.147	-1.400	-1.211	-1.359
Skewness	-0.001	-0.425	-0.271	-0.349	0.736	0.228	0.215	0.057
Sum	125.065	120.058	112.101	124.886	31.011	1.751	101.313	-19.030
Observations	30	30	30	30	30	30	30	30

Source: Author's Computation.

The correlation analysis in table 3 shows that economic growth, urbanization, and human development are tightly linked, as reflected by strong positive correlations between GDP, urbanization, HDI, and life expectancy. As countries develop, their CO_2 emissions rise, suggesting that growth is still driven by carbon-intensive activities. However, higher renewable energy adoption is strongly linked to lower CO_2 emissions, indicating that cleaner energy can mitigate environmental impacts. Mortality rates decrease with improved economic and social conditions, while fossil fuel consumption remains moderately connected to development, though not as strongly as in the past. Overall, development improves quality of life but often comes with environmental trade-offs unless renewable energy is emphasized.

Table 3: Correlation Matrix for all variables in data set

	lnlyf	lnmortality	lnrnew	lnfossil	lntotnatrent	lnco2	lnurban	lnhdi
lnlyf	1							
lnmortality	-0.988	1						
lnrnew	-0.975	0.979	1					
lnfossil	0.759	-0.672	-0.741	1				
lntotnat	0.068	-0.009	-0.103	0.428	1			

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rent								
lnco2	0.988	-0.990	-0.995	0.745	0.076	1		
lnurban	0.996	-0.997	-0.983	0.721	0.060	0.993	1	
lnhdi	0.998	-0.989	-0.983	0.758	0.091	0.992	0.997	1

Source: Author's Computation

4.2 *Empirical results*

The simplified Ordinary Least Squares (OLS) model in table 4 and 5 shows an exceptionally strong fit, with an R-squared value of 0.9994, indicating that almost all of the variation in life expectancy can be explained by the independent variables: renewable energy (rnew), fossil fuel consumption (fossil), natural resource rent (totnatrent), urbanization (urban), and the Human Development Index (HDI). The Adjusted R-squared of 0.9992 further validates the robustness of the model, confirming that the explanatory power remains high even after accounting for the number of predictors included in the analysis.

Among the independent variables, the Human Development Index (HDI) exhibits the strongest positive association with life expectancy, with a coefficient of 0.350. This result is consistent with the understanding that improvements in human development—measured through indicators such as education, income, and access to healthcare—contribute significantly to increases in life expectancy. Higher HDI scores reflect better socio-economic conditions, which in turn lead to healthier and longer lives. Urbanization also shows a notable positive impact on life expectancy, with a coefficient of 0.248. As countries urbanize, populations tend to benefit from improved healthcare services, infrastructure, economic opportunities, and overall living conditions, all of which contribute to longer life spans. The statistical significance of this variable highlights the importance of urbanization as a key driver of human well-being. Renewable energy (rnew)demonstrates a positive relationship with life expectancy, as reflected by a coefficient of 0.073. This suggests that increased adoption of renewable energy sources, such as solar and wind, is associated with better environmental quality, which in turn contributes to improved health outcomes. The significance of this relationship underscores the role that sustainable energy plays in fostering healthier populations. Interestingly, fossil fuel consumption (fossil) also exhibits a positive coefficient (0.041) in relation to life expectancy. While fossil fuels are often associated with environmental degradation, this finding may reflect the fact that, in the short term, fossil energy drives economic activities that provide access to healthcare, infrastructure, and other essential services. However, this result should be interpreted with caution, as long-term reliance on fossil fuels may pose risks to health and environmental sustainability. Natural resource rent (totnatrent), on the other hand, shows a small negative effect on life expectancy, with a coefficient of -0.005. This finding aligns with the "resource curse" hypothesis, which suggests that countries heavily reliant on natural resource exports may experience slower progress in human development due to economic volatility, governance challenges, and underinvestment in human capital.

The diagnostic tests conducted on the model further support its validity. The Koenker (BP) test indicates that there is no evidence of heteroscedasticity, suggesting that the variance of residuals is constant across all levels of the independent variables. Similarly, the Jarque-Bera test confirms that the resi duals follow a normal distribution, fulfilling a key assumption of OLS regression.

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Table 4: Summary of Ordinary Least Squared regression model statistics

Variable	Coefficient	Standard Error	Robust Probability	VIF
Dependent: life expectancy (lnlyf)				
Intercept	3.1170	0.2315	0.0000	
lnrnew	0.0730	0.0103	0.0000	2.2570
lnfossil	0.0407	0.0081	0.0000	4.7789
lntotnatrent	-0.0048	0.0011	0.0002	1.4778
lnurban	0.2476	0.0531	0.0001	4.6317
lnhdi	0.3496	0.0384	0.0000	4.6806

Table 5: Ordinary Least Squared regression diagnostics

Test	Value
Number of Observations	30
Akaike's Information Criterion (AIC)	-293.635
Multiple R-squared	0.999354
Adjusted R-squared	0.99922
Joint F-Statistic	7426.466
Prob(>F)	1.91E-37
Degrees of Freedom (F-test)	(5.0, 24.0)
Joint Wald Statistic	35647.04
Prob(>chi-squared) (Wald)	0
Koenker (BP) Statistic	0.33902
Prob(>chi-squared) (BP)	0.88416
Jarque-Bera Statistic	1.137209
Prob(>chi-squared) (Jarque-Bera)	0.566315

The simplified Ordinary Least Squares (OLS) model for mortality in table 6 and 7, using fossil fuel consumption, CO_2 emissions, and urbanization as predictors, provides robust insights into the factors influencing mortality rates. The model explains a substantial portion of the variation in mortality, with a Multiple R-squared of 0.9992 and an Adjusted R-squared of 0.9991. These values indicate that nearly 100% of the variation in mortality is captured by the included variables, highlighting the strength of the model's fit. The model's overall significance is further confirmed by the Joint F-statistic of 10,293.19 (p-value: 0.0), underscoring the importance of these variables in predicting mortality outcomes.

In terms of individual predictors, urbanization has the most pronounced effect on reducing mortality, with a coefficient of -2.99 (p-value: 4.63e-16). This suggests that as urbanization increases, mortality rates decline significantly, likely due to better healthcare infrastructure, access to essential services, and improved living conditions commonly found in urban areas.

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Urbanization's strong negative correlation with mortality emphasizes its critical role in public health improvements. Fossil fuel consumption, on the other hand, shows a positive and highly significant relationship with mortality, with a coefficient of 0.43 (p-value: 9.02e-13). This indicates that higher fossil fuel consumption is associated with increased mortality, possibly due to the adverse health effects of pollution, environmental degradation, and the long-term health impacts associated with the reliance on non-renewable energy sources. The strong statistical significance of this variable highlights the need for considering the environmental costs of energy policies when addressing public health concerns. CO2 emissions have a negative effect on mortality, with a coefficient of -0.21 (p-value: 2.26e-04). This result suggests that reducing CO2 emissions is associated with lower mortality rates, which could be tied to improvements in air quality and environmental health. The relationship between CO2 emissions and mortality underscores the importance of environmental regulations aimed at curbing emissions, as they can have direct public health benefits. The diagnostic tests conducted (Koenker-BP for heteroscedasticity and Jarque-Bera for normality) indicate that the model's assumptions hold, though the main focus remains on the OLS results, which reveal clear, statistically significant relationships between the independent variables and mortality.

Table 6: Summary of Ordinary Least Squared regression model statistics

Variable	Coefficient	Standard Error	Robust Probability	VIF
Dependent variable: lnmortality				
intercept	15.458	1.252	0.000	
lnfossil	0.360	0.039	0.000	4.092
lnco2	-0.211	0.043	0.000	79.055
lnurban	-3.728	0.304	0.000	3.562
lnhdi	0.554	0.199	0.010	2.571

Table 7: Ordinary Least Squared regression diagnostics

Test	Value
Number of Observations	30
Akaike's Information Criterion (AIC)	-189.098
Multiple R-squared	0.999
Adjusted R-squared	0.999
Joint F-Statistic	10293.192
Prob(>F)	0.000
Degrees of Freedom (F-test)	(3.0, 26.0)
Joint Wald Statistic	89207.660
Prob(>chi-squared) (Wald)	0
Koenker (BP) Statistic	2.9608

Prob(>chi-squared) (BP)	0.0507
Jarque-Bera Statistic	0.0596
Prob(>chi-squared) (Jarque-Bera)	0.9706

5. CONCLUSION AND POLICY IMPLICATIONS

The empirical findings from this study underscore the significant impact of energy consumption patterns on public health outcomes in India. Renewable energy usage emerges as a positive determinant of health, contributing to higher life expectancy and lower mortality rates. This reflects the broader global trend that links renewable energy adoption with improvements in environmental quality and health, particularly by reducing air pollution. The positive relationship between renewable energy and life expectancy suggests that increased adoption of clean energy sources can yield significant public health benefits, potentially mitigating the health risks associated with environmental degradation. Conversely, the results show that fossil fuel consumption is strongly linked to higher mortality rates, highlighting the detrimental health impacts of air pollution and other environmental issues caused by the combustion of non-renewable energy sources. The negative effects of fossil fuel consumption on public health underscore the urgency for policies that prioritize clean energy transitions. While fossil fuel use currently drives economic growth and development, its long-term health costs, particularly in developing economies, cannot be ignored. Urbanization also emerges as a significant factor in improving life expectancy and reducing mortality. The findings demonstrate that urban areas, with better access to healthcare, education, and infrastructure, are associated with improved public health outcomes. As India continues to urbanize, the benefits of well-managed urban growth on public health should be leveraged, ensuring that urbanization contributes to both economic development and better living conditions.

Given these results, several key policy implications emerge. First, there is a need to accelerate the transition toward renewable energy sources to reduce reliance on fossil fuels. Policymakers should prioritize investments in renewable energy infrastructure, such as solar and wind power, to reduce CO2 emissions and promote sustainable development. Environmental regulations aimed at curbing air pollution must be strengthened to mitigate the health risks associated with fossil fuel combustion. Public health initiatives should be aligned with energy policies to maximize the co-benefits of cleaner energy on health. Second, urbanization presents a significant opportunity for improving public health, but it requires careful management. Policymakers should focus on improving urban infrastructure, including healthcare facilities, clean energy access, and efficient public services, to ensure that the health benefits of urbanization are fully realized. Integrating health and environmental policies in urban planning is crucial for sustainable urban development. Lastly, the findings support the need for further research into the dynamic relationship between energy consumption, environmental quality, and public health. Future studies should consider the long-term impacts of energy policies on health outcomes and explore innovative solutions to balance economic growth with public health improvements in developing countries.

In conclusion, transitioning to renewable energy, coupled with better urban planning and stringent environmental regulations, can significantly enhance public health outcomes in India and other developing nations. Policymakers must address the dual challenge of economic development and environmental sustainability to achieve long-term public health improvements.

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