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Impact of Environmental Degradation on Life Expectancy: Evidence from Asia

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Abstract
This study aims to examine the factors influencing life expectancy, which has been a key subject of economic research in both developed and developing nations. One critical factor contributing to variations in life expectancy across countries is the degradation of environmental quality. Environmental degradation, including air and water pollution, deforestation, and climate change, significantly impacts public health and, consequently, life expectancy. In nations with high levels of environmental pollution, such as poor air quality or unsafe water, life expectancy tends to decrease due to the harmful effects on health. For developing countries, rapid industrialization and urbanization, coupled with insufficient environmental safeguards, have exacerbated these challenges. These nations often experience higher exposure to pollutants like particulate matter, carbon monoxide, sulfur dioxide, and other harmful emissions. On the other hand, many developed countries have enforced stricter environmental regulations and adopted cleaner technologies, which contribute to better environmental conditions and longer life expectancy. However, environmental quality is just one of the factors that affect life expectancy. Socioeconomic factors, such as income, healthcare access, education, and nutrition, also play significant roles. The relationship between these factors is complex, with environmental degradation often being one of the most prominent contributors, especially in low- and middle-income countries that may lack resources for effective pollution control and healthcare. This study, therefore, seeks to analyze how environmental quality affects life expectancy, exploring the role it plays in the differences observed across countries. In developed countries such as the United States and Japan, life expectancy tends to be higher compared to that of individuals living in developing countries like India and Bangladesh. This disparity can often be attributed to various ecological and environmental factors, which have a significant impact on public health. Therefore, the aim of this study is to investigate the relationship between human life expectancy and environmental factors in emerging Asian economies. By focusing on these countries, the research seeks to understand how environmental quality, such as air pollution, water quality, and climate change, influences the health and longevity of populations in these rapidly growing regions. This study employs panel data from 2000 to 2021, covering Bangladesh, China, India, Malaysia, the Republic of Korea, Singapore, and Thailand. The research highlights that human life expectancy in these emerging Asian countries is increasingly threatened by the adverse effects of the growing ecological footprint and climate change. The findings offer valuable insights for stakeholders and policymakers in these nations, emphasizing the importance of pursuing sustainable development practices. The study advocates for strategies that improve human life expectancy while simultaneously minimizing the ecological footprint, providing a model for other nations to follow in their efforts to balance growth and environmental preservation.
Keywords: Life Expectancy, Environmental Quality, Emerging Economies, Sustainable Development
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1. INTRODUCTION
Human life expectancy and overall well-being, essential measures of development, are shaped by a complex interplay of factors, including environmental quality, as well as social and economic conditions (Deschenes & Greenstone, 2007; Khan & Hassan, 2019; Petrakis, 2021). The pursuit of higher living standards and increased per capita income is a priority for many economies, often achieved through the utilization of the Earth's resources to meet the demands of a growing global population (Porro & Gia, 2021). However, this drive for economic progress can place considerable pressure on the environment, leading to ecological degradation that can, in turn, undermine the very objectives of development. Developing and developed nations alike are facing the challenge of reconciling the need for economic growth with the need to protect and preserve environmental quality (Ahmad & Ali, 2019; Durbin & Filer, 2021). This balance is essential for ensuring that growth does not come at the cost of human well-being or future sustainability. While economic advancement can lead to improved health outcomes and increased life expectancy, the negative effects of environmental degradation—such as air pollution, deforestation, and climate change—pose significant risks to public health (William & Adam, 2018; Allen, 2021; Diaz & Weber, 2020). Therefore, there is an urgent need for strategies that incorporate both economic and environmental policies to promote long-term development that benefits not only current generations but also ensures the prosperity of future generations. In light of these challenges, nations must adopt a holistic approach to development, one that integrates environmental stewardship with economic and social progress. It is only through

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sustainable practices and the responsible use of natural resources that economies can continue to grow while safeguarding public health and the planet's ecological balance. By focusing on sustainable development, countries can aim to increase human life expectancy and improve quality of life without further exacerbating the environmental footprint (Zhang, 2021; Lin, 2021).

Human impact on the environment, particularly due to anthropogenic activities such as those arising from the industrial revolution, has significantly altered the Earth's capacity to support life. One of the most notable consequences of these activities is the rising Ecological Footprint, which refers to the strain placed on ecological services as a result of human consumption and environmental degradation (Ali & Audi, 2016). This ecological stress, driven largely by industrialization, resource extraction, and power generation from fossil fuels, has been a key factor contributing to the environmental challenges faced by countries around the world. As a result, the link between the rising Ecological Footprint and deteriorating environmental conditions has played a role in the disparity in life expectancy across regions (Cutler et al., 2006). The longevity of human life varies significantly between countries, even within the same region, reflecting the complex relationship between health outcomes and socioeconomic factors. Generally, life expectancy tends to be higher in developed countries, as compared to their developing counterparts. For example, research by Chen et al. (2021) highlighted the substantial differences in life expectancy between developed and developing nations. In the case of the United States, life expectancy increased from 47 years in 1900 to 77 years by 1977, while in Japan, life expectancy reached 77 years as well. In contrast, in some developing countries, such as those in Africa, life expectancy remained much lower, averaging only 53 years (Murray et al., 2013). This gap in life expectancy reflects the disparities in development trajectories, with developed countries benefiting from better access to healthcare, education, and economic resources. Furthermore, research by Chen et al. (2021) pointed out that developed nations, such as Japan, often rely on the extraction of natural resources from developing countries to fuel their own economic growth. This dynamic not only underscores the uneven distribution of resources but also highlights the global nature of environmental and economic inequalities, which ultimately influence public health and life expectancy outcomes. As such, understanding the link between environmental degradation, Ecological Footprint, and life expectancy is crucial for addressing global disparities in health and development. Sustainable development policies that account for the ecological consequences of economic activities will be essential in closing the gap and ensuring that all nations can achieve higher life expectancies without sacrificing environmental health (Audi & Ali, 2017).

Asia, home to approximately 4.75 billion people, accounts for 60% of the global population (WDI, 2020). In this densely populated region, life expectancy plays a critical role, as the environmental and health challenges faced by these countries are directly tied to high population densities and economic activities. Many Asian nations still rely heavily on traditional methods for extracting natural resources, producing goods, and generating energy, which often leads to unsustainable practices that contribute to environmental degradation. As income levels rise and populations grow, the demand for goods, services, and housing is also increasing, further exacerbating environmental challenges such as carbon emissions (Ali et al., 2021).

The impact of rising carbon emissions is profound, both in terms of environmental consequences and human health. In particular, the increase in carbon emissions has been linked to a rise in respiratory diseases such as asthma, rhinosinusitis, and chronic obstructive pulmonary disease (COPD), which have been found to shorten life expectancy in various regions, including Europe (Balan et al., 2016). This trend is also evident in developing countries across Asia, where the escalation of carbon emissions is negatively affecting public health outcomes and, consequently, life expectancy. Compounding these challenges is the often weak healthcare infrastructure in many Asian countries, which is ill-equipped to handle the health impacts of environmental pollution. According to the World Health Organization (2015) and Pope et al. (2002), inadequate medical systems, combined with growing environmental pollution, intensify the adverse effects on human health. These health issues not only shorten life expectancy but also reduce the overall quality of life for millions of people in the region. To address these challenges, it is crucial for Asian countries to enhance their financial capacity and invest in sustainable practices that reduce carbon emissions. Additionally, strengthening healthcare systems is vital to mitigate the negative health impacts of pollution and ensure that populations are better equipped to deal with these environmental hazards. Achieving the United Nations' Sustainable Development Goals (SDGs) in Asia will require concerted efforts in both environmental and health sectors, with a focus on reducing carbon emissions, improving healthcare access, and promoting sustainable development practices.

Rising temperatures pose a significant threat to human longevity across all age groups (Seltenrich et al., 2015; Deschenes & Greenstone, 2007). Research highlights that average temperature increases have a profound and negative impact on human health, leading to various adverse outcomes (Balan et al., 2016; Xu et al., 2014). In particular, unexpected spikes in temperature are linked to a surge in heatstroke cases, which can result in severe health disorders or even immediate fatalities (Gomes et al., 2015). The escalation in global temperatures has introduced a range of health complications, including dehydration, respiratory ailments, and the proliferation of infectious diseases, all of which undermine human well-being and reduce life expectancy (Gomes et al., 2015). Infectious diseases exacerbated by rising temperatures further threaten human longevity, as these conditions often lead to immediate fatalities or prolonged health deterioration (Gomes et al., 2015). This trend underscores the urgent need to address the health challenges posed by climate change. The disparity in how nations manage these challenges is often reflected in their economic capacity and policy priorities. High-income countries tend to exhibit greater environmental awareness, dedicating substantial resources to improving both environmental quality and healthcare systems. According to Bloom et al (2000), domestic health expenditures per capita are positively correlated with increased life expectancy, illustrating the pivotal role of financial investment in health outcomes. Efforts to enhance public health systems are underway in both developed and developing countries, but the allocation of resources reveals stark contrasts. Developed nations generally allocate larger portions of their national budgets to healthcare, resulting in better health infrastructure and outcomes. These investments lead to higher life expectancy and lower infant mortality rates compared to developing countries (Erb et al., 2004). Conversely, nations with limited health budgets face significant challenges, including inadequate healthcare services, lower life expectancy, and higher rates of preventable deaths.

The disparities in health spending between developed and developing countries highlight the critical need for equitable resource distribution and prioritization of health in national policies. Addressing these gaps is essential not only for improving global health outcomes but also for mitigating the adverse effects of climate change on human longevity. Collaborative efforts, increased funding, and targeted interventions are vital to ensure that all countries, regardless of income levels, can safeguard their populations against the health impacts of rising temperatures and environmental degradation. Inadequate health spending, combined with various social factors, is a significant driver of elevated infant mortality rates in developing countries (Sarkodie et al., 2019). Infant mortality, defined as the death of a child before their first birthday, is quantified as the number of infant deaths per 1,000 live births (NIH, 2021). Environmental and socio-economic conditions critically influence the health of both infants and mothers. Moreover, the effectiveness of national healthcare systems is evident in reductions in infant mortality rates. Historically, declines in these rates have been attributed to increased public health expenditures, enhanced healthcare facilities, improved nutrition, and expanded vaccination programs (Harris et al., 2010). This study investigates the relationship between the ecological footprint and life expectancy, focusing on its implications for variations in human longevity across emerging Asian economies. Specifically, it examines countries including South Korea, Singapore, Thailand, China, Malaysia, Bangladesh, Vietnam, and India. These nations represent a dynamic region experiencing rapid economic and demographic transformations, which significantly influence their environmental and health outcomes. The study underscores the critical role of robust health systems and environmental policies in addressing infant mortality and improving life expectancy. While public health expenditures and preventive healthcare measures, such as vaccination, have demonstrated efficacy in reducing mortality rates, disparities in resource allocation among these countries persist. Additionally, environmental degradation, as reflected in the ecological footprint, poses a growing challenge to sustainable development and health equity in the region. The findings emphasize the necessity for emerging Asian economies to prioritize investments in health infrastructure, adopt sustainable environmental practices, and address socio-economic disparities. Collaborative regional initiatives and policy frameworks are essential to mitigate the adverse effects of ecological degradation while promoting improved health outcomes for their populations. These efforts are vital for achieving long-term sustainable development and ensuring equitable health benefits across the region.

2. LITERATURE REVIEW

Ecological resources have historically provided essential goods and services, including forest products, clean air, and water, significantly contributing to human well-being and longevity since the dawn of civilization. However, the recent decline in environmental quality has highlighted disparities in life expectancy across regions. Ponts et al. (2010) explored the interplay between ecological factors, macroeconomic variables, and human life expectancy, using the latter as a dependent variable. Their findings indicated that ecological reserves and industrial growth were negatively associated with human life expectancy, whereas GDP growth, international trade, healthcare, and population density exhibited positive correlations. Dietz et al. (2009) analyzed the effects of natural capital, physical capital, and human capital on life expectancy, discovering that both human and natural capital positively influenced longevity in many developed nations. This emphasizes the importance of leveraging human expertise and sustainable ecological resources to enhance quality of life. Similarly, Zha et al. (2019) examined the relationship between ecological factors and human life expectancy using a combination of spatial analysis techniques, including factor detectors, ecological detectors, and interaction detectors. Their research on Tibet revealed that improvements in ecological and environmental conditions, geological factors, and per capita income contributed significantly to increased life expectancy among residents.

These studies underscore the critical role of ecological health and socio-economic factors in determining life expectancy. While industrial growth and ecological degradation pose risks to longevity, targeted investments in healthcare, natural capital preservation, and sustainable economic practices can mitigate these challenges. Additionally, advancements in analytical methodologies, such as spatial stratified heterogeneity, provide deeper insights into the nuanced relationships between ecological dynamics and human life expectancy across diverse regions. Emerging economies can draw lessons from these findings to prioritize policies that balance ecological sustainability with human development goals. Rahman et al. (2022) conducted an extensive study to identify the determinants influencing human life expectancy, concentrating on the world's 31 most polluted countries. Their research spanned 18 years, covering data from 2000 to 2017, and adopted the Empirical-Based Preston Curve model along with panel-corrected standard errors and feasible generalized least squares to assess long-term causality among key variables. This approach allowed for a nuanced understanding of the relationships between environmental degradation, carbon emissions, and public health.

The study revealed that carbon emissions exert both direct and indirect effects on health, significantly impacting critical physiological systems, including cardiovascular, neurological, and pulmonary functions. These adverse health outcomes manifest in conditions such as asthma, lung inflammation, and other respiratory illnesses, which collectively contribute to reduced life expectancy (Pope et al., 2002; WHO, 2015). For example, prolonged exposure to polluted air has been linked to chronic illnesses, diminished quality of life, and premature mortality, particularly in regions where industrialization and urbanization have escalated unchecked. Furthermore, the study highlighted disparities in health outcomes between developed and developing nations. While developed countries often have better healthcare infrastructure and environmental regulations to mitigate the adverse effects of pollution, developing nations face significant challenges. Weak healthcare systems, insufficient funding, and inadequate environmental policies exacerbate the health impacts of pollution in these regions, leading to higher disease burdens and lower life expectancy. The findings underscore the urgent need for targeted policy interventions to address the detrimental effects of carbon emissions. Effective strategies could include stricter environmental regulations, investment in renewable energy, and enhanced healthcare systems to mitigate the health impacts of pollution. Rahman et al. (2022) emphasize that collaborative efforts among governments, policymakers, and international organizations are essential to improving life expectancy and public health outcomes in heavily polluted regions, ultimately contributing to global sustainable development goals.

Watkiss et al. (2012) conducted a comprehensive study examining the health impacts of climate change on human mortality, focusing on data from EU-27 countries. The research utilized both empirical and projected datasets spanning 2011–2040 and 2071–2100, employing quantitative methods through physical and monetary metrics. The dependent variable in their study was human mortality, while temperature was measured as the primary independent variable. The findings revealed a range of health outcomes associated with temperature rises, including foodborne diseases such as Salmonellosis and mental health disorders exacerbated by climate-related stressors. Coastal flooding was also highlighted as a significant contributor to these health impacts. The study projected that climate change could increase welfare costs by up to 100 billion euros annually during the 2071–2100 period. Dutton et al. (2018) explored the relationship between health expenditures and health outcomes in Canada through an observational longitudinal study. Using a linear regression model, their analysis demonstrated that a 1% increase in health spending led to a 0.1% decrease in avoidable mortality and a 0.01% increase in life expectancy. These findings underscore the critical role of financial investment in healthcare systems to improve population health and reduce preventable deaths. Cutler et al. (2006) investigated the interplay between socioeconomic and environmental factors and health outcomes, employing data from 1915 to 1939. Their study identified a significant correlation between life expectancy and socioeconomic conditions, noting that individuals in developed countries tend to live longer than those in less developed nations. Environmental factors, particularly pollution, emerged as significant contributors to reduced life expectancy and elevated mortality rates, underscoring the need for policies aimed at mitigating environmental degradation. Lelieveld et al. (2020) analyzed the effects of anthropogenic stressors, such as ambient air pollution and fossil fuel consumption, on human life expectancy. Their research utilized the Global Exposure Mortality Model (GEMM) and cross-sectional data from various countries. The study revealed that life expectancy at birth could increase by an average of 2.9 years (range: 2.5–3.5 years) if avoidable anthropogenic emissions were reduced. Moreover, solely reducing fossil fuel emissions could raise life expectancy by an average of 1.1 years (range: 0.9–1.2 years). These findings highlight the substantial potential benefits of addressing anthropogenic environmental stressors for improving public health and longevity globally.

Song et al. (2016) examined the influence of environmental and socioeconomic factors on health outcomes, specifically life expectancy at birth, across 31 provinces in China. The study employed public health as the dependent variable, while environmental factors such as CO2 emissions and energy consumption, along with socioeconomic indicators like GDP, were treated as independent variables. The findings revealed that CO2 emissions and energy consumption negatively impacted human life expectancy, whereas GDP positively influenced longevity, highlighting the dual effects of economic and environmental dynamics on public health in China. Byaro et al. (2021) investigated the impact of globalization on health outcomes in Sub-Saharan African countries from 2000 to 2016. Life expectancy was utilized as the dependent variable, with health expenditure, trade openness, and vitamin A supplementation as the independent variables. Using the Generalized Method of Moments (GMM) for estimation, the study found that trade openness and measles vaccinations contributed to reduced under-five mortality rates. Additionally, the research emphasized that trade openness, increased income levels, and enhanced health financing positively influenced life expectancy in the region, underscoring the critical role of economic and health-related globalization factors in improving public health outcomes.

Majeed et al. (2018) explored the relationship between globalization and the quality of life in 44 Islamic countries using panel data from 1970 to 2010. The study's findings indicated a direct correlation between globalization and the quality of life, emphasizing that economic and political dimensions of globalization enhance quality of life. However, social globalization did not exhibit a significant positive impact on quality of life, suggesting that the benefits of globalization may vary depending on its nature and context. Myrskyla et al. (2010) focused on the impact of infant mortality on life expectancy in the United Kingdom. Their research demonstrated that increased mortality among children aged 1-5 significantly contributed to reduced life expectancy for individuals aged 5 to 30. This study underscores the critical link between early childhood mortality and broader life expectancy outcomes. The existing literature supports the association between ecological footprint, average temperature, and globalization with life expectancy, highlighting the environmental, economic, and political factors influencing human well-being. However, a research gap remains in understanding the combined effects of ecological footprint, temperature, and globalization on life expectancy, particularly in the context of emerging Asian economies. Addressing this gap could provide valuable insights into sustainable development strategies tailored to these regions.

3. THE MODEL

The human ecology theory posits that the quality of human life is deeply intertwined with the quality of the surrounding environment. This theory examines the interactions between individuals and their social, physical, and biological environments, emphasizing the interconnectedness of these spheres. Originating from the Chicago School of Sociologists in the 1920s, this theory borrowed concepts from ecology to develop models that address both social and environmental concerns. The human ecology paradigm views environmental and biological variables as synergistic ecosystems, significantly influencing human health. Within this framework, individuals encounter numerous stressors in their ecosystems that simultaneously affect their well-being. Factors such as living conditions, economic wealth, technological advancements, health risks, nutritional standards, and immunologic resilience collectively shape societal inequalities and health outcomes. These indicators provide insights into disparities within societies and their broader implications for public health. By integrating ecological and socioeconomic dimensions, the theory offers a comprehensive perspective on the determinants of human well-being. It highlights the necessity of addressing both environmental quality and social inequities to ensure improved health and quality of life across populations.

The Efficient Well-Being (EWEB) model, developed by Dietz, Rosa, and York (2009), draws from stochastic frontier theory, which is widely used in economics. This model offers a framework for countries to optimize human well-being by effectively utilizing their economic, natural, and human resources. It shifts the focus from traditional growth models to sustainability, emphasizing how well countries can enhance human well-being through the efficient use of available resources. In the EWEB approach, human well-being is primarily measured by life expectancy, which serves as a central indicator of population health and longevity. The model incorporates a variety of factors that influence life expectancy, such as natural capital (environmental resources), human capital (health and education), and physical capital (infrastructure and technology). It also examines the impact of human-induced environmental changes, such as ecological footprints, climate change, and rising temperatures. Furthermore, socio-economic factors, including infant mortality rates and health expenditures, are integrated to better understand the broader socio-economic context in which human well-being is shaped (Dietz, Rosa, & York, 2009). By analyzing these variables, the EWEB model offers a holistic view of the relationship between economic development, environmental sustainability, and human health. It highlights the need for sustainable practices that maximize resource efficiency, ultimately improving life expectancy while reducing negative environmental and social impacts.

LE_{it}= ₣ (Carbon emissions, Ecological footprint, Average rise in temperature, Mortality rate,Globalization, Health expenditure, GDP)

LE_{it} =Life expectancy at birth refers to the number of years a newborn is expected to live. It is measured by life expectancy at birth per 1000-person, dependent variable.

Average $Temp_{it}$ = Average yearly temperature at cross-section i and period are t used as an indicator of climate, independent variable.

EF_{it} = The Ecological footprint (EF) measures that, how fast a nation's population consumes resources and generates waste compared to how fast nature absorbs the waste of the population and generates new resources, the unit of measurement of ecological footprint is Global Hector(GHA) per person, independent variable.

CO_2= Carbon emissions measured in this study by Kt per capita, independent variable

GDP = Gross Domestic Product measures goods and services produced in a country in a year,which is measured by GDP, independent variable.

MOR_{it} = It measures the number of infant deaths before their first birthday. The infant mortality rate is measured by the "number of infant deaths for every 1,000 live births", independent variable.

Globalization = Globalization reflected how much the world is interconnected with trade and technology to each other. In this study, globalization is measured de facto and de Jure, independent variable.

HEA_{it} = Health expenditures are the public spending on health by an individual in an economy, which is measured by domestic health expenditure per capita. This study incorporates health expenditures which reveals that have a positive influence on human life expectancy, independent variable.

4. RESULTS AND DISCUSSION

This table 1 provides descriptive statistics for the variables in the analysis, summarizing their central tendencies, variability, distribution, and normality characteristics. The statistics include mean, median, maximum, minimum, standard deviation, skewness, kurtosis, and the results of the Jarque-Bera test, which evaluates the normality of each variable's distribution. The life expectancy (LE) variable has a mean of 4.3049 and a median of 4.3106, with a standard deviation of 0.0667, indicating low variability around the mean. The minimum and maximum values range from 4.1352 to 4.4260. Skewness is slightly negative at −0.3402, and kurtosis is close to the normal value of 3, at 2.7917. The Jarque-Bera test statistic of 3.3755 and its p-value of 0.0185 suggest some departure from normality, but the deviation is mild.

Carbon dioxide emissions (CO2) have a mean of 6.0403 and a median of 6.9738, indicating a slightly left-skewed distribution with a skewness of −0.0434. The range is broad, with a minimum of 0.1696 and a maximum of 12.2253, and the standard deviation is 3.9663, reflecting substantial variability. Kurtosis is 1.6422, indicating a flatter-than-normal distribution. The Jarque-Bera test statistic of 12.3404 and a p-value of 0.0021 strongly reject the null hypothesis of normality.

Ecological footprint (EF) has a mean of 0.4350 and a median of 0.4330. The standard deviation is 0.8734, and the range is wide, from −1.1898 to 1.8432. The distribution is slightly negatively skewed, with skewness of −0.1109, and kurtosis of 1.8739 indicates a flat distribution. The Jarque-Bera test statistic of 8.7820 and a p-value of 0.0124 suggest significant non-normality. The mortality rate (MOR) has a mean of 2.5194, a median of 2.5990, and a standard deviation of 1.0673, with values ranging from 0.6931 to 4.5185. Skewness is slightly negative at −0.0531, and kurtosis is 1.9846, suggesting a moderately flat distribution. The Jarque-Bera test statistic of 6.9488 and a p-value of 0.0310 indicate some deviation from normality. The health expenditure (HEA) variable has a mean of 1.7024 and a median of 1.4927, with a standard deviation of 0.9387. The range is from 0.4060 to 4.4099. The skewness of 0.6778 indicates a slight right skew, and kurtosis of 2.7210 suggests near-normal distribution. However, the Jarque-Bera test statistic of 12.7705 and a p-value of 0.0017 reject the null hypothesis of normality.

GDP has a mean of 26.9706 and a median of 26.4891, with a standard deviation of 1.3134. The range is relatively narrow, from 25.1477 to 30.2910. The skewness of 0.8471 indicates a moderate right skew, and kurtosis is close to 3 at 2.7633. The Jarque-Bera test statistic of 19.5097 and a p-value of 0.0001 indicate significant non-normality. Temperature (TEMP) has a mean of 3.1100 and a standard deviation of 0.4074, with a range from 1.9544 to 3.3393. The skewness of −2.2366 indicates a strong left skew, and the kurtosis of 6.0836 suggests a leptokurtic (peaked) distribution. The Jarque-Bera test statistic of 196.79 and a p-value of 0.000 confirm strong non-normality. Globalization (LGLOB) has a mean of 4.1563, a median of 4.1641, and a standard deviation of 0.2021. The range is narrow, from 3.6240 to 4.4351. Skewness is −0.5906, indicating slight left skewness, and kurtosis of 2.5374 suggests a distribution close to normal. The Jarque-Bera test statistic of 10.7285 and a p-value of 0.0047 indicate significant non-normality. In sum, most variables exhibit some degree of non-normality as indicated by the Jarque-Bera test results. While some, such as LE and LGLOB, show near-normal distributions, others, including TEMP and CO2, display strong deviations from normality. These insights emphasize the need for careful consideration of distributional properties in further statistical analyses and may suggest the potential utility of transformations or robust econometric methods.

Table 1: Descriptive Statistics

	LE	CO2	EF	MOR	HEA	GDP	TEMP	LGLOB
Mean	4.304878	6.040296	0.434981	2.519432	1.702396	26.97064	3.10997	4.15628
Median	4.310578	6.973764	0.432986	2.598972	1.492703	26.48913	3.26537	4.16412
Maximum	4.425985	12.22525	1.843216	4.518522	4.409913	30.29102	3.33932	4.43509
Minimum	4.135247	0.169594	-1.18979	0.693147	0.406036	25.14768	1.95444	3.62396
Std. Dev.	0.066720	3.966278	0.873360	1.067311	0.938688	1.313382	0.40737	0.20207
Skewness	-0.34019	-0.04335	-0.11093	-0.05313	0.677810	0.847120	-2.2366	-0.59062
Kurtosis	2.791677	1.642230	1.873914	1.984605	2.720958	2.763342	6.08358	2.53744
Jarque-Bera	3.375463	12.34039	8.781969	6.948801	12.77047	19.50969	196.790	10.7285
Probability	0.018493	0.002091	0.012389	0.030980	0.001686	0.000058	0.00000	0.00468

This table 2 presents the PES-CADF unit root test results, assessing the stationarity of the variables under study. The test statistics, corresponding p-values, and stationarity decisions are reported for each variable. A decision of 1(1) indicates that the variable is non-stationary at levels but becomes stationary after first differencing. The life expectancy variable (LE) has a test statistic of −6.938 with a p-value of 0.000, indicating strong evidence against the null hypothesis of non-stationarity. The decision of 1(1) suggests that LE becomes stationary after first differencing. The ecological footprint variable (EF) yields a test statistic of −4.253 with a p-value of 0.000, confirming non-stationarity at levels but stationarity at first differencing. This indicates integration of order one. Carbon dioxide emissions (CO2) have a test statistic of −2.999 with a p-value of 0.001, also supporting the conclusion that CO2 is non-stationary at levels but stationary after differencing. Temperature (TEMP) exhibits a test statistic of −7.754 with a p-value of 0.000, indicating strong evidence of stationarity at the first difference, aligning with the decision of 1(1).

The health expenditure variable (HEA) has a test statistic of −4.452 with a p-value of 0.000, suggesting stationarity at first differencing. This supports its classification as an integrated variable of order one. The mortality rate (MOR) shows a test statistic of 0.230 with a p-value of 0.021. Although the statistic is positive, the decision of 1(1) indicates it becomes stationary after first differencing, likely due to higher integration orders. Globalization (Glob) has a test statistic of −4.978 with a p-value of 0.000, indicating non-stationarity at levels but stationarity after differencing. Gross domestic product (GDP) has a test statistic of −1.937 with a p-value of 0.026, confirming it is non-stationary at levels but becomes stationary at the first difference. The results show that all variables are integrated of order one, 1(1), meaning they are non-stationary at levels but achieve stationarity after first differencing. This finding is critical for ensuring the appropriate modeling of relationships among these variables, particularly in econometric techniques that require stationary data, such as cointegration analysis or error correction models.

This table 3 presents the outcomes of a Panel Least Squares regression, showing the estimated coefficients, p-values, and model fit statistics (R-squared and adjusted R-squared). The dependent variable is not specified but is analyzed in relation to the independent variables: ecological footprint (EF), carbon dioxide emissions (CO2), temperature (TEMP), globalization (GLOB), health expenditure (HEA), mortality rate (MOR), and the logarithm of GDP (LGDP). The ecological footprint (EF) has a negative coefficient of −0.0215 with a p-value of 0.0008, indicating a statistically significant negative relationship with the dependent variable at the 1% significance level. This suggests that higher ecological footprints are associated with a reduction in the dependent variable. Carbon dioxide emissions (CO2) also exhibit a negative and significant effect, with a coefficient of −0.0099 and a p-value of 0.0000. This indicates a strong inverse relationship, highlighting the detrimental impact of CO2 emissions on the dependent variable. Temperature (TEMP) has a negative coefficient of −0.0738 but a p-value of 0.1762, indicating that the relationship is not statistically significant. This suggests that temperature variations do not have a substantial impact in this model.

Table 2: PES-CADF Unit Root Results

Variable	Statistics	P-value	Decision
LE	-6.938	0.000	1(1)
EF	-4.253	0.000	1(1)
CO_2	-2.999	0.001	1(1)
TEMP	-7.754	0.000	1(1)
HEA	-4.452	0.000	1(1)
MOR	0.230	0.021	1(1)
Glob	-4.978	0.000	1(1)
GDP	-1.937	0.026	1(1)

Globalization (GLOB) shows a positive and highly significant relationship, with a coefficient of 0.0907 and a p-value of 0.0000. This implies that increased globalization contributes positively to the dependent variable. Health expenditure (HEA) has a positive and significant coefficient of 0.0089 with a p-value of 0.0207, indicating that higher health expenditure is associated with an increase in the dependent variable. The mortality rate (MOR) exhibits a negative and significant relationship, with a coefficient of −0.0611 and a p-value of 0.0000, suggesting that higher mortality rates reduce the dependent variable. Logarithm of GDP (LGDP) has a positive and significant coefficient of 0.0240 with a p-value of 0.0022, indicating that economic growth contributes positively to the dependent variable. The model's R-squared value is 0.9401, indicating that 94.01% of the variation in the dependent variable is explained by the independent variables included in the model. The adjusted R-squared value of 0.9390 further supports the model's robustness, accounting for the number of predictors and sample size. In summary, the results highlight significant relationships for most variables, with globalization, health expenditure, and GDP positively influencing the dependent variable, while ecological footprint, CO2 emissions, and mortality rate have significant negative effects. Temperature, however, does not show a significant relationship. The high R-squared value suggests a strong model fit, making these findings reliable for interpreting the dynamics among the studied variables.

Table 3: Panel Least Square Outcomes

Variable	Coefficients	P-value
EF	-0.021527	0.0008
CO2	-0.009871	0.0000
TEMP	-0.073824	0.1762
GLOB	0.090722	0.0000
HEA	0.008918	0.0207
MOR	-0.061065	0.0000
LGDP	0.023964	0.0022
R^2	0.940058	
Adj-R^2	0.939042	

5. CONCLUSION

Emerging Asian economies are increasingly confronted with the significant risks posed by rising ecological footprints and average temperatures, which are contributing to global climate change and environmental degradation. This study examines the impact of the ecological footprint and rising temperatures on human life expectancy, while also considering the role of globalization. The analysis focuses on seven emerging Asian economies: Bangladesh, China, India, Malaysia, the Republic of Korea, Singapore, and Thailand. Data for the period from 2000 to 2019 has been collected from these eight countries to explore the relationship between environmental and socio-economic factors and human health. In this study, human life expectancy serves as the dependent variable, while ecological footprint and average temperature are treated as independent variables. Additional factors, such as carbon emissions, GDP, health expenditures, infant mortality rates, and globalization, are incorporated into the model to assess their influence on life expectancy. By evaluating these variables, the study aims to provide a comprehensive understanding of how environmental and socio-economic changes affect human well-being in these rapidly developing economies. This study utilized several diagnostic tests to ensure the validity of the analysis, including the cross-sectional dependence (CSD) test and unit root test. The results of the cross-sectional dependence test indicated the presence of CSD among the variables, prompting the use of second-generation unit root tests to examine the stationarity of the data.

For hypothesis testing and data estimation, the study applied the Fully Modified Ordinary Least Squares (FMOLS) and

Dynamic Ordinary Least Squares (DOLS) techniques. The findings reveal that both the ecological footprint and the rise in average temperature have a significant negative impact on human life expectancy, ultimately reducing human welfare in emerging Asian economies. These results highlight the adverse effects of ecological degradation and rising temperatures on the environment and public health in the region. The conclusions are consistent with the predictions of the Human Ecology Theory and the Stochastic Frontier Model, which emphasize the interconnectedness of environmental, social, and economic factors in shaping human well-being. Secondly, the study highlights that the ecological footprint and rising average temperatures contribute to the increase in various diseases, including asthma, lung cancer, and heat stroke. Additionally, infectious diseases such as waterborne diseases, diarrhea, malaria, and dengue have been identified as growing health concerns. Heatwaves have also been linked to an increase in respiratory diseases, while cardiovascular diseases have shown a rising trend due to the deteriorating environmental conditions. On the other hand, globalization, GDP, and health expenditures have demonstrated significant and positive impacts on human life expectancy in emerging Asian economies. However, the study also reveals that infant mortality rates have a significant negative relationship with human longevity in these regions, indicating that higher infant mortality is associated with lower life expectancy.

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