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Environmental performance indicators and quality of life: New insight from emerging countries

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ABSTRACT

The aim of the study is to look into the nexus involving environmental performance and quality of life in the Next-11 countries using data from the period 2000–2020. This study employed a novel panel technique called cross-sectionally augmented autoregressive distributive lag (CS-ARDL), which addresses slope heterogeneity, cross-sectional dependence, and a combination of I (0) and I (1) variables. The finding demonstrates that rising industrialization leads to higher per capita incomes over the next 11 countries. This study offers new insights into achieving environmental sustainability alongside economic growth and quality life.

1. Introduction

The Next-11 countries known as emerging countries are used in this study which is a group of countries identified by Goldman Sachs Investment Bank as having great potential to become the biggest economies in the world in the twenty-first century. Bangladesh, Egypt, Indonesia, Iran, Mexico, Nigeria, Pakistan, the Philippines, South Korea, Turkey, and Vietnam are among the countries involved. Environmental performance can be expressed as the behaviour of the environment due to the uses of various natural resources and emissions of various harmful substances. It relates to the quantity of energy used, the greenhouse gas emissions caused by energy use, the amount of water consumed, the creation and disposal of waste, as well as some additional environmental consequences brought on by the use or execution of the structure or the premises. Quality of life (QoL) is a multifaceted notion essential for the intended health outcome. Physical, psychological, economic, and social factors have long been considered parts of the quality of life for health; however, in recent years, it has been widely understood that the environment is the most vital component of the quality of life [1,2]. Environmental degradation may have significant consequences for human health and well-being, as well as the health and well-being of other species and the ecosystem as a whole. Greenhouse gas emissions and other forms of pollution can contribute to climate change, which can lead to more catastrophic weather conditions, higher ocean levels, warmer temperatures owing to changes in rainfall patterns, and other consequences. It can cause major health problems such as respiratory disorders, cancer, heatstroke, heat exhaustion, malaria, dengue fever, Lyme disease, asthma, and other ailments. As a result, this will increase infant, neonatal, and maternal mortality and reduce life expectancy and earning capacity. A decent environment may improve people's quality of life by providing clean air to breathe, access to clean water, and attractive natural spaces to enjoy. Hitam and Borhan [3] show that environmental pollution is a significant concern in the world respect to economic development process. The degradation of the environment begins to have a direct impact on human life quality and may even pose a threat to humanity's survival. Amuka et al. [4] define that, in the previous four decades, significant quantities of greenhouse gas (CO_2) emissions in addition to methane gas emissions were caused by people with environmental operations, which is reflected in the rising levels of carbon dioxide in the surrounding environment. As a result, the earth is getting warmer due to the consequences of climate change. Along with human health and living standards, the average life expectancy may be in danger due to the negative effects of climate change.

Moreover, infant mortality rates are often higher in emerging nations than in developed countries. The world's greatest infant mortality is in Sub-Saharan Africa, with 27 per 1000 deliveries, which is responsible for 43% of all newborn deaths globally. Central and Southern Asia is second (23 deaths per 1000 live births), which is responsible for 36% of all newborn deaths globally (WHO, 2022). Infant mortality in SADC nations is more influenced by access to better water supplies, sanitary

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infrastructure, and CO_2 emissions than by factors related to socioeconomic status [5,6]. Wang et al. [7] examine the influence of air pollution on child mortality in China using a dataset from 2004 to 2015 at the prefecture-city level. Using the ventilation coefficient to measure urban air pollution, a 10 μg/m^3 increase in annual PM2.5 levels causes 163 extra infant deaths per 100,000 live births in a city. Particulate matter pollution is thought to be directly responsible for 738 deaths annually [8]. This study considers per capita income and infant mortality as proxies of quality of life at a glance, which has never been done before. Several studies show that a nation with an excessive amount of environmental deterioration has higher infant mortality and causes illnesses related to both physical and mental health [5,9–11]. To implement effective policies to prevent excess child mortality, it is crucial to understand the relative risk of increased deaths among children under 5 due to long-term exposure to ambient PM2.5 pollution [12]. In contrast, studies on economic growth are somewhat controversial. Despite an exhaustive examination of the evidence demonstrating a negative association between environmental quality and economic development, environmental performance improves economic growth. On the basis of Omri and Kahouli [13], CO_2 emissions and economic growth are positively correlated, with the link extending to GDP per capita. Because fossil fuels contribute significantly to greenhouse gas emissions, which trap heat and cause climate change, energy consumption and CO_2 emissions are highly comparable. Sial et al. [14] examines how the energy consumption from fossil fuels affects the infant mortality rate in 15 Asian economies between 1996 and 2019, using the infant mortality rate as a measure of living standards. The results show a U-shaped association between infant mortality and fossil fuel energy consumption, suggesting that high fossil fuel consumption lowers living standards in these Asian countries because of poor air quality. Besides that, burning biomass outside increases air pollution globally, especially in low- and middle-income nations. The research indicates that for every square kilometer that is burned, there is a corresponding nearly 2% rise in infant mortality in the downwind areas [15]. Numerous studies examine the connection between energy use and GDP [16–20]. Coccia [21] and Coccia and Bontempi, [22] identify key technologies for the ecological transition to address the issue of fossil fuel pollution. These technologies include offshore wind turbines, carbon capture, storage, and utilisation (electrochemical and bioconversion of CO_2), sustainable ammonia production with energy-saving innovations, and cellular agriculture, which produces environmentally friendly alternatives to animal-based foods and materials. Many emerging countries, like the next 11 countries, have major effects on people's health and the natural environment. The majority of these such as [23–26] cities have significant levels of air pollution as a result of a combination of factors such as motor vehicle exhaust, industrial activity, and the consumption of fossil fuels. Many of these countries are likewise concerned about water contamination. Aside from environmental concerns, many developing nations suffer additional issues relating to the quality of life, such as insufficient access to healthcare, education, control of infant and child mortality, and other essential services. Enhancing the availability and quality of these services is essential for improving the population's overall well-being. As these countries struggle to fulfil their citizen's basic needs, ensuring a proper environment is a far cry. Coccia and Bellitto [27] highlights a contradiction in the economic growth-progress equation, showing that human progress often harms the environment, society, and health, including an increase in cancer cases in developed nations.

Based on the developed model, the key question is whether environmental performance influences the quality of life in the Next-11 countries. What policy recommendations can be derived for these nations? This research aims to look into the association between environmental performance and quality of life as well as offer some recommendations for improving a country's health sector and environmental quality. Most of the research based on this study was concentrated on individual countries with small frameworks. This study incorporates the existing body of previous research by concentrating on a group of emerging countries (Next-11), to the best of the author's knowledge. The Next-11 nations are closely linked through commerce, international cooperation, and mutually beneficial relationships; the data exhibit cross-sectional dependency issues as well as slope heterogeneity issues. This paper used cross-sectional autoregressive distributive lag (CS-ARDL) for newly created cross-sectional autoregressive distributive lag tests and second-generation unit root tests to address those issues. Much of the study overlooks the issue of environmental performance and quality of life coexistence. This study also aimed to provide unique results by addressing these two variables at the same time and employing advanced econometric techniques, resulting in policy implications for the Next-11 nations. Therefore, an obscure relationship between environmental performance and quality of life, which tend to exhibit quite different patterns in emerging nations, is worth considering as a study for the Next-11 countries. To increase the quality of life by reducing environmental factors' negative impact and enhancing the positive influences of these factors in Next-11 countries, the fundamental aim is to seek the association between environmental performance and quality of life in countries among the Next-11. The study has been organized around some specific objectives, including examining the associations between environmental performance and per capita income in Next-11 countries, estimating the associations between environmental performance and infant mortality in Next-11 countries, and lastly, suggesting some policy recommendations as per the findings and results from estimations.

2. Frameworks and literature review

According to the Pollution Heaven Hypothesis (PHH), stringent environmental laws in developed nations force polluting industries to relocate to developing nations, increasing pollution in those areas [28, 29]. However, empirical research demonstrates that the effects of environmental laws vary depending on the viewpoint. With few government-imposed clean-up or abatement regulations, trade patterns which are heavily impacted by comparative advantage cause emerging nations to specialize in heavy industry, while others concentrate on light manufacturing and services [30,31]. According to Low and Yeats (1992), one of the first studies on trade in polluting industries, the stricter environmental regulations in industrialised countries have led to a rise in net imports of 11 chemicals. They also noted that when it came to items with high pollution, developing nations enjoyed a comparative edge.

The WHO African Region had the highest chance of a child dying before they turned one (52 out of every 1000 deliveries), which exceeded the childbirth rate for the WHO European Zone by over seven times (7 out of every 1000 live births). In 2018, there were 29 infant deaths per 1000 live births, down from an expected incidence of 65 fatalities per 1000 live births in 1990. From 8.7 million in 1990 to 4.0 million in 2018, there have been fewer baby deaths each year (WHO). Abdullah et al. [9] found the GDP, CO_2 emissions, and fertility rate to be the key factors that influence infant mortality in Malaysia. The study discovers an ongoing association between the factors under consideration, as well as a direct correlation between the death rate and CO_2 and an inverse correlation between the infant mortality rate and GDP. Tanaka [32] reveals that the newborn period saw the biggest decrease in mortality, revealing an essential pathophysiologic mechanism. This decrease was most pronounced among children born to mothers with low levels of education. Since 1987, India has examined its laws governing both air and water pollution. They believe these restrictions will help mitigate air pollution, but these mitigations of air pollution only had a small impact on infant mortality, which is statistically negligible [33]. According to Currie and Neidell [34], nearly 1,000 baby lives were saved in California throughout the 1990s due to reductions in carbon monoxide (CO) and particulates (PM10). They also found that CO_2 has a significant impact on infant mortality at relatively low levels.

2.1. Literature review

The study under consideration examines the relationship between environmental performance and quality of life for the Next-11 nations. The Quality of life can be represented by physical, economic, social, emotional, and personal well-being domains [35]. Most of the studies used life expectancy, infant mortality, neonatal mortality, maternal mortality, education, income, happiness, satisfaction with life, and overall well-being as indicators of the quality of life [36–38]. Environmental performance includes the use of natural resources such as water use, energy use, material use, and environmental emissions and wastes such as greenhouse gas emissions, waste generation, and air pollution. In many studies, CO_2 emission, PM 2.5 emission, methane emission, water, and sanitation are used as proxies of environmental performance. Chang et al. [36] investigate that environmental factors related to environmental quality, the proportion of green outer space, and contentment with open space are intermediates for quality of life in China. By using multiple linear regressions, the outcomes reveal the relevance of people's anxiety and sleep in moderating the association across their environment and the consequences for their quality of life. Living within 500 meters of a green space area, in particular, improved physical QoL and physical activity but did not affect psychological QoL. Because of the regulating effects of high stress and lack of sleep, low environmental quality has a detrimental impact on all aspects of QoL. Chowdhury and Islam [39] applied descriptive statistics to BRICS countries from 2002 to 2016 on GDP growth rates. According to the findings, there is an adverse relationship between the GDP growth rate and the environmental performance index. Except for Russia, the study found a strong link between EPI and GDP growth rates. Between the years 1980 and 2015, Majeed and Mumtaz [37] investigated the effects of environmental degradation on happiness in 99 countries of the world, and the outcome showed that happiness is heavily influenced by CO_2 emissions, whereas species preservation and marine protected areas promote happiness. This study also implies that income does not drive happiness. Majeed and Ozturk [11] employed Two-stage least squares (2SLS) and the System Generalized Method of Moments (SGMM) to look at the association between environmental deterioration and population health outcomes. Environmental deterioration has a detrimental impact on population health. It indicates that countries with substantial amounts of environmental damage have lower life expectancy and higher newborn mortality rates. Using the Method of Moment Quantile Regression (MMQR) and Two Stage Least Squares (2SLS) in West Africa from 2006–2018, Musibau et al. [40] found that environmental performance boosts economic growth, despite an extensive review of the literature revealing a negative link between air quality and economic growth. A study in West Africa revealed an adverse link between biodiversity, habitat, and economic expansion. Zhao and Sun [41] assessed the impact of environmental performance on happiness in China by using multiple linear regression analysis, where the influence of environmental performance on happiness showed that people's pleasure will significantly rise if they are satisfied with environmental performance. Additionally, the GDP variable might lessen the impact on people in areas with high GDP on their expectations of happiness. Using the random effects and fixed effects approach for 12 SADC countries, Mutizwa and Makochekanwa [5] found that in SADC nations, the release of carbon dioxide (CO_2) has an effect on health. On the other hand, it has been discovered that factors other than socioeconomic status have a bigger influence on child mortality than sanitation facilities and access to better water sources. Abdullah et al. [9] analyzed the effects of CO_2 emissions and fertility rates on infant mortality using the ARDL model. The analysis finds a long-term correlation between the studied variables, as well as a direct association between CO_2 and mortality rate and an inverse relationship between GDP and mortality rate. Between 1990 and 2016, Oyelade et al. [42] used panel quantile regression to investigate the association between CO_2 emissions, health expenditure, fertility rate, mortality rate, and quality of life. The findings revealed that in Anglophone West African nations, the quality of life is affected by CO_2 emissions, which are generated from gaseous fuel use, as are liquid fuel consumption and biomass burning. Nadimi et al. [43] employed the impact of CO_2 emission, poverty, GDP, GNI, and energy utilization over the quality of life using the timeframe 2005–2013. By utilizing multivariate statistical analysis, the study discovered that clean energy benefits society, whereas CO_2 emissions do the opposite in terms of quality of life.

Some specific hypotheses are developed Base on literature reviewed and this hypothesis is considered null hypothesis, those are mentioned below:

H_1: There is an adverse relationship between environmental performance and per capita income

GDP per capita persists as the foremost measure of the quality of life. Per capita income is affected by environmental performance. In this null hypothesis, environmental performance is adversely correlated with per capita income. The main concern of the study is to reject this null hypothesis. Several studies reveal an association between GDP per capita and CO_2 emission, especially in developing countries and developed countries [20], Algeria (Bouznit and Pablo-Romero, 2016), OECD countries [17], Next-11 countries (Chen and Huang, 2013), high, middle & low-income countries [13,44,45].

H_2: There is an adverse association between environmental performance with infant mortality

Infant mortality increases with environmental performance. The null hypothesis states, a negative relationship between infant mortality and environmental performance. Several studies conducted by researchers argued against this null hypothesis [5,9,11].

However, previous research has largely focused on common environmental indicators such as CO_2 emissions, nitrous oxide, PM 2.5, and others. But this study focuses on four proxies of the independent variable (environmental performance), namely carbon dioxide emission, methane emission, people with basic drinking water, and industrialization, and two proxies of the dependent variable (quality of life), namely per capita income and infant mortality. The majority of the research based on this study was focused on specific nations with limited frameworks. This study adds to the body of knowledge by concentrating on a collection of developing nations in the Next 11 countries where environmental degradation should be its main concern at this moment. In contrast to the majority of studies, this one covered cross-sectional dependence, slope homogeneity, serial correlation, and various integrating attributes of the variables, making use of a cross-sectional autoregressive distributive lag (CS-ARDL) model for several newly established tests.

2.2. Conceptual framework

Fig. 1 presents the cyclical demonstration of industrialization, environmental pollution, GDP growth, and quality of life. The industrialization of a country contributes not only to rising per capita income but also to increasing waste production with the development of the sector. Although in a newly industrialized country, the only things that matter are production and profit, however, with increased manufacturing, a substantial volume of contaminants are generated. Environmental quality significantly deteriorates if these contaminants remain unchecked and exceed the threshold limit. The economic growth of a country is fostered by industrialization, where employment rises with the opening up of more lucrative industries. Increased income of individuals brings the desire to raise their living standards which promotes rural-to-urban migration. Moreover, these migrant workers require more industries to find employment which ultimately contributes to the GDP growth of the nation. Interestingly, in addition to fueling industrial growth and boosting employment, an increased GDP also

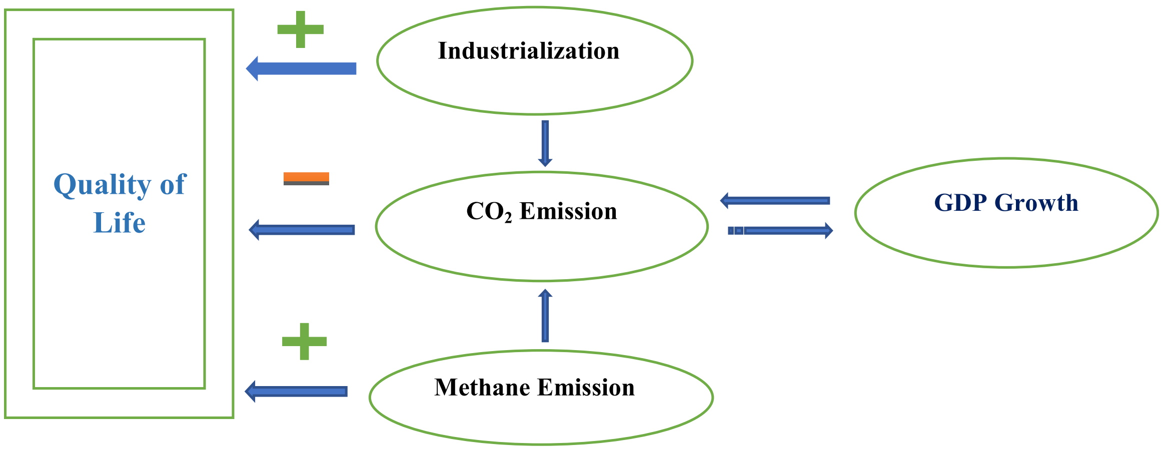

Fig. 1. Cyclical demonstration of industrialization, environmental pollution, GDP growth, and quality of life.
Source: Developed by Authors

generates a huge amount of CO_2 as a byproduct, which is detrimental to the environment.

However, all industries demand energy, either in renewable or non-renewable form, which, upon utilization, releases CO_2. Non-renewable energy (e.g., natural gas, coal, petroleum, and wood) contains different forms of carbon, which create carbon dioxide by reacting with oxygen. Additionally, with the expansion of industries, living standards have increased. That also demands more household energy, ultimately generating more CO_2. Therefore, it is clearly seen that industrialization is the key factor in raising CO_2 emissions, which are consistently rising in developing countries. Developed countries, on the other hand, could focus more on controlling CO_2 emissions by using green energy and so on; however, they might have already reached the maximum pollution level affecting public health. This indicates that the pattern of emitted CO_2 and GDP growth depends on a nation's economy, technologies, environmental policies, population, and many more factors. In a nutshell, although industries are necessary for a country to expand its economy and ensure the quality of life of its citizens, CO_2 emissions are crucial for industrializing a country. This concept fits with the Environmental Kuznets Curve Hypothesis, which posits a relationship between CO_2 emissions and GDP growth [46]. It says that the growth of industry and polluting extractive activities during a nation's early economic development causes CO_2 emissions to rise as output rises. When economic growth reaches a particular point in the second phase, new, less polluting technology can be adopted. Additionally, this phase sees an increase in the proportion of the purportedly less polluting services sector. However, some service operations, such as transportation, are extremely polluting or depend on inputs from such activities, making them indirectly accountable for the emissions produced by such activities. Therefore, it cannot be said with certainty that an economy's tartarisation entails industries with a lesser environmental impact and ones that rely heavily on information [47]. However, all these circulations of CO_2 and methane emission from industrialization are directly connected to the quality of life.

3. Materials and methods

3.1. Sample and data

This study's sample was drawn from the Next-11 countries, which are thought to be the fastest developing in the twenty-first century. These include Bangladesh, Egypt, Indonesia, Iran, Mexico, Nigeria, Pakistan, the Philippines, South Korea, Turkey, and Vietnam. The study used data from secondary data sources. World Development Indicators (WDI), Our World in Data (OWD) and Environmental Performance Index (EPI) are the core primary data sources. Under this research, balanced panel data on environmental performance and quality of life from 2000-2020 for Next-11 Countries are considered. The panel data technique also assesses the reduction in endogeneity brought on by country-specific effects, the causality of factors that were neglected, and the assessment of errors. Data are analyzed by using Stata 16 and Eviews 10 statistical software.

3.2. Measures of variables

Table 1 demonstrates the way the variables have been measured with labels. Quality of life is presented by the proxies of infant mortality and per capita income which is the dependent variable. On the other side, independent variables include environmental performance presented by carbon dioxide emission, methane emission, people with basic drinking water, and industrialization. As shown in Table 1, every variable has been converted to its natural logarithmic form.

3.2.1. Per capita income

The average purchasing power is represented by GDP per capita. In order to quantify the quality of life as a stand in for economic measures of well-being in the N-11 nations, GDP per capita (constant 2015 US dollars) is utilized [48–50].

Table 1
Specification of the variables.

Types of variable		Variable Details	Indicated By	Sources
Dependent Variable	Quality of Life (QOL)	Gross Domestic Product (GDP) per capita (constant 2015 US$)	LPCI	WDI (2023)
		Infant Mortality (per 1,000 live birth)	LIM	WDI (2023)
Independent Variable	Environmental Performance (EP)	Carbon dioxide emission (metric tons per capita)	LCO_2	OWD (2023)
		Methane Emission (Gg)	LCHA	EPI (2023)
		People using at least basic drinking water services (% of population)	LPBW	WDI (2023)
		Industry (including construction), value added (% of GDP)	LIND	WDI (2023)

3.2.2. Infant mortality

Since infant mortality seems closely related to many factors that enhance society's well-being, it is frequently applied as an indicator of citizen's overall quality of life. High infant mortality rates are frequently symptomatic of a country's shortcomings, this perhaps has an unfavorable effect on one's quality of life as a whole. Several studies used infant mortality as a proxy Variable [5,9,51].

3.2.3. Carbon dioxide (CO_2) emission

Because carbon dioxide is a greenhouse gas that causes climate change, it is frequently used as an indicator of a nation's environmental performance. When compared to nations with lower CO_2 emissions, those with higher CO_2 emissions often have greater carbon footprints and are seen to perform worse environmentally. Hossain et al., [52], Assadzade et al. [53], Oyelade et al. [42], and Mohammed et al. [54] used carbon dioxide as an environmental variable.

3.2.4. Methane emission

Methane is a potent greenhouse gas that accumulates significantly more heat in the troposphere of the Earth compared to carbon dioxide. Agriculture, landfills, the exploitation and burning of fossil fuels, and other activities are only a few of the causes of methane emissions. Methane involved in several studies (Adeel-Farooq et al., 2020; [55, 56]).

3.2.5. Basic drinking water

Water security and cleanliness are essential for human health, which is a significant aspect of environmental performance. Several factors may have an impact on the drinking water systems including the source of the water, the treatment technique used to purify it, and the infrastructure required to deliver it. Mutizwa and Makochekanwa [5], Rahman et al. [2], and Kamal [57] also used this variable in their studies.

3.2.6. Industrialization

The environmental impact of industrialization has been enormous. The construction of factories and other major industrial facilities has frequently resulted in environmental pollution, as well as the loss of natural ecosystems. Mining, deforestation, and the use of pesticides and fertilizers are all examples of industrial operations that can have a harmful influence on the environment. Numerous studies used industrialization as an economic indicator [58–61].

3.3. Models and data analysis procedure

In order to model the relationship between environmental performances along the quality of life in the Next-11 countries, this study incorporates a panel data method. A suitable methodology for time series and cross-section analysis is panel data. To investigate the association two models are simplified based on the two proxies of quality of life. Thus, this research has applied the econometric models to investigate the association among the variables and the models have followed the linearity of the variables and parameters.

3.3.1. Model 1: nexus between per capita income and environmental performance

Per capita income = f (environmental performance)

The functional form of this model:

$$PCI = f\,(CO_2, CHA, PBW, IND) \tag{1}$$

Where the quality of life is measured with Per capita income (PCI) and environmental performance is represented by CO_2 emission (CO_2), methane emission (CHA), People using at least basic drinking water services (PBW) and Industrialization (IND).

Econometric form of this model:

$$PCI_{it} = \beta_1 + \beta_2 CO_{2it} + \beta_3 CHA_{it} + \beta_4 PBW_{it} + \beta_5 IND_{it} + \mu_{it} \tag{2}$$

Taking the log in both sides in the econometric model:

$$(PCI_{it}) = \beta_1 + \beta_2(CO_{2it}) + \beta_3(CHA_{it}) + \beta_4 L(PBW_{it}) + \beta_5 L(IND_{it}) + \mu_{it} \tag{3}$$

3.3.2. Model 2: nexus between infant mortality and environmental performance

Infant mortality = f (environmental performance)

The functional form of the model:

$$IM = f\,(CO_2, CHA, PBW, IND) \tag{4}$$

Where the quality of life is measured with infant mortality (IM), environmental performance is represented by CO_2 emission (CO_2), methane emission (CHA), People using at least basic drinking water services (PBW) and Industrialization (IND).

Econometric form of the model:

$$IM_{it} = \beta_1 + \beta_2 CO_{2it} + \beta_3 CHA_{it} + \beta_4 PBW_{it} + \beta_5 IND_{it} + \mu_{it} \tag{5}$$

Taking the log in both sides in the econometric model:

$$(IM_{it}) = \beta_1 + \beta_2(CO_{2it}) + \beta_3 L(CHA_{it}) + \beta_4 L(PBW_{it}) + \beta_5 L(IND_{it}) + \mu_{it} \tag{6}$$

The marginal change of the independent factors that influence per capita income and infant mortality rate is represented by the coefficient value of the variables.

In the above equation: i= 1, …, N represent studied countries t= 1, …, T represents studied time period

β_1 to β_5= All are the coefficients to be estimated

μ_{it} = Combined time series and cross-section error term where, $\mu_{it} \sim N(0,\sigma^2)$

The slope homogeneity test is a way to determine whether the association between two or more variables is consistent across different groups. Considering the method offered by Pesaran and Yamagata [62], initial slope heterogeneity is examined. This test is based on the distribution of the weighted slope across all nations. The testing has yielded the following equation:

$$\breve{\Delta} = \sqrt{N}\left(\frac{N^{-1}S\% - k}{\sqrt{2k}}\right) and \breve{\Delta}_{adj} = \sqrt{N}\left(\frac{N^{-1}S\% - k}{\sqrt{\frac{2k\,(T-k-1)}{T+1}}}\right) \tag{7}$$

To examine the possibility of cross-sectional dependence, we employ the test created by Pesaran [63]. Given the regular shocks' frequent occurrence, the disturbances' dependence on geography, and their unidentified causes in the error term, the panel data model is expected to show significant cross-sectional dependency in the errors [64–66]. The standard equation used in the CSD test is summarized in the equation that follows.

$$CSD = \sqrt{\frac{2T}{N(N-1)N}\sum_{i=1}^{N-1}\sum_{K=i+1}^{N}\widehat{Corr}_{i,t}} \tag{8}$$

Here, N represents the sample size, T for the time period, where $\widehat{Corr}_{it}$ is the sample estimate of the pairwise correlation of the residuals of the country. The assumed null hypothesis of the test is no cross-sectional dependence and the alternative hypothesis is Cross-sectional dependence. However, the unit root test can be employed to determine the stationarity of a series. In panel data modelling, after confirming slope variability and even cross-sectional dependency, the well-known first-generation stationarity test such as Augmented Dickey-Fuller (ADF), Philips Perron, Breitung, and Hadri will not work. The stationarity of the variables was therefore investigated using a cross-sectional augmented Im, Pesaran and Shin (CIPS) and the covariate augmented Dickey-Fuller (CADF) second-generation unit root test which is developed by Pesaran (2007) in spite of the CSD and slope heterogeneity. These tests enable us to compare the alternative hypothesis, which indicates the missing unit roots in the panels, where the opposite takes place in a null hypothesis. The cross-sectional mean computation required for a CIPS calculation is demonstrated by the following equation.

$$CIPS = \frac{1}{N}\sum_{i=1}^{N} t_i \quad (N, T) \tag{9}$$

Multiple evaluations systems of panel cointegration tests such as Kao et al. [67] and Pedroni [68] were not taking cross-sectional dependence into consideration. The second-generation panel cointegration methodology created by Westerlund (2007) takes into consideration variations in the slope, coefficient of determination, and correlated errors. By taking these issues into account, this method accurately predicts cointegration properties. The current analysis has been used the newly created method named the cross-sectionally augmented autoregressive distributed lags model after proving the presence of a long-run association using Westerlund's [69] Panel Cointegration test (CS-ARDL). This study uses the test developed by Chudik et al. [70] for both short-run and long-run assessments. This approach addresses the problems of mixed-order integration, slope heterogeneity, CSD, and unnoticed common elements. The equation shown below can be applied as a representation of the CS-ARDL for two dependent variables.

The following is the formula for the model-1:

$$LPCI = \propto_{it} + \sum_{j=1}^{P}\beta_{it}LPCI_{i,t-j} + \sum_{j=0}^{P}\gamma_{it}X_{t-j} + \sum_{j=0}^{3}\delta\overline{Y}_{t-j} + \varepsilon_{it} \tag{10}$$

Where $\overline{Y}_t = \left(\Delta L\overline{PCI}_t,\ \overline{X}_t\right)'$ and

$X_{it} = (LCO_{2it},\ LCHA_{it}, LPBW_{it}, LIND_{it}$

Where the quality of life is measured with per capita income (PCI) and environmental performance is represented by CO_2 emission (CO_2), methane emission (CHA), People using at least basic drinking water services (PBW) and Industrialization (IND).

The following is the formula for the model-2:

$$LIM = \propto_{it} + \sum_{j=1}^{P}\beta_{it}LIM_{i,t-j} + \sum_{j=0}^{P}\gamma_{it}X_{t-j} + \sum_{j=0}^{3}\delta\overline{Y}_{t-j} + \varepsilon_{it} \tag{11}$$

Where $\overline{Y}_t = \left(\Delta L\overline{IM}_t,\ \overline{X}_t\right)'$ and

$X_{it} = (LCO_{2it},\ LCHA_{it}, LPBW_{it}, LIND_{it}$

4. Results

The findings of Pesaran and Yamagata's [62] slope homogeneity test are shown in Table 2. The results demonstrate the slope and non-uniformity of the model's coefficients. In the null hypothesis, all slope coefficients are supposed to be identical. To verify these test data, p values were calculated. Tested null proposition was rejected at that point since the calculated p-value was significant at a 1% level. The variable has a heterogeneity problem throughout the unit, according to the tested hypothesis. Every econometric analysis of panel data ought to begin with a cross-sectional dependency test. Ignoring this relationship could lead to incorrect estimates of the parameters and inaccurate estimates of the standard deviation. Table 3 displays the outcomes of Pesaran's [63] CSD test which emphasizes the impact of cross-sectional dependence on panel data. In other words, LGDP, LIM, LCO_2, LCHA, LPBW, and LIND all share a cross-sectional dependency resulting from comparable economic, social, and political circumstances.

The second-generation panel unit root test known as CIPS is indicated by the presence of slope heterogeneity and cross-sectional dependency. The CIPS test for unit roots in heterogeneous panels, created by Pesaran (2007) is one of the well-known tests utilized in this study, runs the t-test while considering the problems of heterogeneity and cross-sectional dependence. These tests enable us to compare the alternative hypothesis, which suggests that the variables are stationary, to the null hypothesis, which states that there are unit roots in the panels. The test's outcomes are displayed in the Table 4 which shows methane emissions, per capita income, and the numbers of people consuming basic drinking water are all stationary at level. Contrarily, the first difference is constant for infant mortality (LIM), carbon dioxide (LCO_2), and industrialization (LIND). Consequently, our findings supported the mixture concept for integration orders I (0) and I (1). One of the conditions for adopting a panel CS-ARDL model is to validate that the variables adopted in this study may have a long-term association, in particular the cointegration. However, throughout this research phase, we were also required to take the heterogeneity and cross-sectional dependency of the cointegrating factors into account. The cointegration tests created through Westerlund (2007) are applied, and the results appear in Table 5 for all panels. The outcome demonstrates that all panels' variables exhibit considerable long-run correlation as well as cointegration.

The Panel CS-ARDL model is deemed to be the most suitable one to use in our study since it considers the heterogeneity slope, cross-sectional dependency, and long-run cointegration among the variables as well as different integration of I (0) and I (1). For the whole data set of N-11 countries, the following Table 6 presents the long-run elasticities of per capita income and infant mortality with respect to carbon dioxide emission, methane emission, the number of people utilizing at least basic drinking water, and industrialization estimates. Therefore, the CS-ARDL model is explored in this analysis, which includes the foundation models for both periods. Table 6 reveals the CS-ARDL analysis's results. Examining the long-term results of model 1 will be the first subject of discussion. The expected long-run coefficient of CO_2 emission affects per capita income (LPCI) in a mostly positive way [71]. That indicates that a 1% increase in CO_2 emission in N-11 countries would result in 0.067% rise in LPCI, which is significant. Mendoza et al. [72] found that in Japan and Korea, carbon dioxide emissions positively influence per capita income whereas China does it negatively. However, the coefficient value of methane emission is positively influenced the per capita income. That demonstrates that 1% higher in methane emission, LPCI increases by 0.042 percent. People using basic drinking water doesn't significantly affect LPCI in the both long and short run. Industrialization shows a significant contribution to per capita income in the long run in N-11 countries. This demonstrates how emerging countries make contributions to their country's per capita income that helps to expand trade and the living standard of their country's citizen. The finding of

Table 2
Results of slope homogeneity test.

	Slope Homogeneity Tests	Δ Statistics	P value
Model-1	$\tilde{\Delta}$ test	5.963	0.001
	$\tilde{\Delta}_{adj}$ test	7.396	0.001
Model-2	$\tilde{\Delta}$ test	7.543	0.001
	$\tilde{\Delta}_{adj}$ test	9.356	0.001

Source: Author's Self Estimation

Table 3
Results of cross-sectional dependency test.

Variable	Test Statistics	P-value
LGDP	30.537	0.001
LIM	33.523	0.001
LCO_2	13.183	0.001
LCHA	2.63	0.009
LPBW	33.656	0.001
LIND	1.973	0.049

Source: Author's Self Estimation

Table 4
Results CIPS unit root test.

Variables	CIPS Test	
	At Level	1st Difference
LGDP	-2.191**	-2.053
LIM	-1.035	-2.998***
LCO_2	-1.644	-3.861***
LCHA	-2.328**	-3.827
LPBW	-2.854***	-3.177
LIND	-1.766	-4.496***

Note: ***,** and * are symbolized at 1%, 5% and 10% level of significance.

Table 5
Results of Westerlund test for cointegration.

Model	Statistics	P value
Model-1	1.2826	0.099
Model-2	4.3034	0.001

Source: Author's Self Estimation

Table 6
Results of CS-ARDL model.

Variables	Model-1		Model-2	
	Dependent Variable (LPCI)		Dependent Variable (LIM)	
	Coefficients	Standard Errors	Coefficients	Standard Errors
LCO_2	0.067*	0.041	0.045**	0.021
LCHA	0.042	0.097	0.027	0.025
LPBW	8.246	26.503	-0.062	1.485
LIND	0.187***	0.060	-0.048	0.035
Adjusted Term (ECT)	-1.382***	0.094	-1.094***	0.165
Short-run Dynamics				
LCO_2	0.099*	0.053	0.060*	0.036
LCHA	0.060	0.122	0.017	0.014
LPBW	16.078	36.055	0.183	2.163
LIND	0.247***	0.083	-0.074	0.054

Source: Author's Self Estimation
Note: ***,** and * are symbolized at 1%, 5% and 10% level of significance.

industrialization shows that LPCI rises by 0.187% if industrialization rises by 1 percent over time. Many studies show industrialization is linked to higher average incomes and higher standards of living [73–76]. In model 1, the error correction term (ECT) has the required sign, which is negative, and the ECT value is -1.382 %. This suggests that the rate of progress toward equilibrium is -1.382 percent. Similar outcomes are shown in short-run dynamics, where industrialization and CO_2 emissions exhibit a significant impact on LPCI in the studied countries. This reveals that growing 1 % CO_2 emissions and industrialization would result in 0.099% and 0.247% increase in per capita income respectively in N-11 countries. However, people with basic drinking water and methane emission do not have considered the influence on LPCI. So, in the case of model-1 (LPCI), it can be concluded that CO_2 emissions and industrialization are both highly significant and favorable but methane emissions, which is the second most important factor for the reason of global warming, also a positive influence per capita income not significantly. Results of second model state that, infant mortality (LIM) is the dependent variable. CO_2 emission significantly influences infant mortality over the longer period [77–79]. That indicates that 1% higher in CO_2 emission rises 0.045% in LIM. This result is not unexpected given that developing nations like N-11 prioritize expansion during their initial stages of economic development, which results in increased carbon dioxide emissions and a decline in environmental quality. Mutizwa and Makochekanwa [5], Abdullah et al. [9], Currie and Neidell [34] have showed carbon dioxide has significant impact on infant mortality. On the other hand, methane emission is also positively connected with infant mortality. In particular, a 1% increase in methane emission raises infant mortality by 0.027% in N-11 countries, which is also not negligible. It implies that in addition to carbon dioxide emissions, methane emissions are equally harmful to newborns and should be considered in N-11 countries. Drabo [80] also shows methane emission is key to rises in infant mortality. Evidence from high- and middle-income nations demonstrates that mitigating greenhouse gas emissions, which reduce nitrogen dioxide and PM2.5 air pollution levels, has a beneficial effect on children's and adolescents' respiratory health [81]. However, People using basic drinking water and industrialization both are negative effects on infant mortality which is not significant. It demonstrates that with a 1% rise in using basic drinking water and industrialization, LIM falls by -0.062% and -0.048% respectively. The error correction term (ECT) in model 2 has the necessary sign, which is a negative value of -1.094%. This indicates that the equilibrium advancement rate is -1.094 percent. In the short term, Carbon dioxide emission positively and significantly influences infant mortality by 0.060%. In addition, it can be shown that infant mortality is increasing as a result of both methane emissions and people using basic drinking water. Infant mortality increased by 0.017% and 0.183% for every 1% increase in methane emission and using basic drinking water respectively. Nevertheless, Industrialization has an adverse impact on infant mortality in N-11 countries which is not statistically significant involves a 1% increase in industrialization reduces infant mortality by -0.074%. However, results for robustness are in Table 7 shown by the common correlated mean group (CCEMG) and the augmented mean group (AMG) as AMG and CCEMG offer very high levels of reliability. AMG estimator supports both cross-sectional dependencies along with slope heterogeneity when long- term components of heterogeneous panel data are estimated. It is notable that the AMG estimator maintains its effectiveness and objectivity in panel data independent of the cross-section and temporal dimensions [82].

The outcomes of model-1′s estimation demonstrate that over a long period, CO_2 emission positively influences per capita income (LPCI) significantly in both AMG and CCEMG tests. The per capita income increased by 0.127% in N-11 countries for a 1 % increase in Carbon dioxide, where both test findings are similar. On the other hand, methane emission negatively affects the LPCI in both tests. Per capita income decreased by .03% in AMG and .04% in CCEMG for a 1% rise in methane emission significantly. Both people with using basic drinking water and industrialization stimulate LPCI by 0.667% and 0.118% respectively per 1% rise over time. But basic drinking water has negative influence on LPCI for the case of CCEMG model. However, summary of the model 1 finding that Carbon dioxide and industrialization both have significant impact on rising per capita income in Next-11 countries.

The finding of model 2 estimation in both model AMG and CCEMG demonstrate that carbon dioxide emission promotes infant mortality in the long term in N-11 countries. Next-11 countries face rising infant mortality by 0.006% and 0.008% in both AMG and CCEMG test respectively as 1% rise carbon dioxide emission. However, methane emission has significant negative influence on infant mortality. Infant mortality decreases by 0.011% for 1% increase in methane emission.

Table 7
Results of AMG and CCEMG model.

Variables	Model-1		Model-2	
	AMG	CCEMG	AMG	CCEMG
LCO_2	0.127**	0.114**	0.006	0.008
LCHA	-0.030	-0.042*	-0.011*	-0.004
LPBW	0.677	-1.066	-0.783	-1.575
LIND	0.118	0.221***	-0.028	-0.011
Constant	6.853	18.871	7.567	6.447

Source: Author's Self Estimation, Stata 16
Note: ***,** and * are symbolized at 1%, 5%,and 10% level of significance.

People using basic water and industrialization both are negatively affect infant mortality in both models. That indicates that both water and industrialization decreases infant mortality.

The study make use of the Dumitrescu and Hurlin [83] Granger causality test to properly examine the causation across variables in the context of cross-sectional dependency and slope heterogeneity. The outcomes are shown in the Appendix 1. Table displays the results of panel Dumitrescu Harlin Causality Test for the whole sample of Next 11 nations. Results indicate a bidirectional causal linkage is present between PCI and IM at 1% level of significance. That means, for Next-11 countries, PCI causes IM and IM also causes PCI which validates the conservation hypothesis. Bidirectional causal association is also found between PBW and CHA at 1 % significance level and CHA and CO_2 at 5% significance level. In this study variable, there are observed many unidirectional causal relationships which is also significant. PCI, CHA, and PBW have a significant unidirectional causal linkage at 1%, while IND has a significant unidirectional causal linkage at 10%. Additionally, IM, CHA, CO_2 and IND have a unidirectional causal relationship at a 1% significance level, meaning that CO_2 emission, methane emission and industrialization play an important role in infant mortality. CO_2 and IND show unidirectional causal association at 1% level. No causal linkage found between CO_2 and PCI, meaning that carbon dioxide emissions have minor role to influence per capita income in Next-11 countries. PBW and IM, on the other hand, do not have a causal relationship. No causal relationship also demonstrates in PBW and CO_2.Result of IND and CHA also do not confirm any causal association in case of N-11 countries.

5. Discussion

Since the Panel CS-ARDL model considers all of these issues, it is the ideal model to utilize in our investigation. Tables 6 and 7 show the results of CS-ARDL model and AMG, CCEMG models respectively for Next-11 countries by considering environmental performance and quality of life. The three models are comparable in terms of sign, dimensions, and predictive value. The expected long and short run coefficient of CO_2 emissions and methane emission affects per capita income in a mostly positive way. Accordingly, if CO_2 emissions increase by 1% in N-11 countries would lead to a 0.067% long-term gain in per capita income and a 0.099% short-term increase. Also shows that for every 1% rise in methane emissions, there is a 0.042% gain in per capita income. According to both the AMG and CCEMG tests, CO_2 emissions and income per capita are positively correlated over time, but methane emissions is inversely correlated. In contrast to China, Mendoza et al. [72] discovered that CO_2 emissions had a favorable impact on per capita GDP in Japan and Korea. In the long run, industrialization significantly raises per capita income in N-11 nations. This illustrates how rising nations boost their GDP, which raises commerce and raises the standard of life for their population. Numerous studies demonstrate the connection between industrialization and increasing average earnings and living standards living [73–76]. Results of Model 2 state that, carbon dioxide emission and methane emission has a considerable and favorable impact on infant mortality over time. According to this, a 1% increase in CO_2 emissions causes a 0.045% rise infant mortality. Models AMG and CCEMG show that, whereas methane emissions have a detrimental effect on infant mortality over the long term in N-11 nations, carbon dioxide emissions do inversely. Carbon dioxide has a large influence on infant mortality, according to research by Mutizwa and Makochekanwa [5], Abdullah et al. [9], and Currie and Neidell [34]. Where Drabo [80] also demonstrate that rising of newborn mortality is mostly a result of methane emission. However, infant mortality in N-11 nations is negatively impacted by industrialization and individuals using basic drinking water throughout the long and short terms which is also relevant to AMG and CCEMG. However, Industrialization promotes a country's economic progress by increasing employment as more attractive industries spring up. With the expansion of the industry, a country's industrialization contributes not just to rising per capita income but also to increased waste output. Although Next-11 countries are newly industrialized countries, the only things that matter are productivity and profit, increasing manufacturing generates a significant amount of toxins. It has the potential to cause serious health issues such as respiratory illnesses, cancer, heat exhaustion, heat exhaustion, dengue infection, malaria, chronic Lyme disease, asthma, and other maladies. As a result, newborn mortality, neonatal mortality, and maternal mortality rise, while life expectancy and earning capacities fall in these countries that reduce quality of life of the citizens of Next-11 countries. Moreover, this study demonstrates a significant connection between environmental performance and quality of life in these developing nations. However, Table 8 shows the summary of findings.

6. Conclusion and recommendations

The primary objective of this study was to examine whether environmental performance is related to quality of life in the Next 11 countries, where CO_2 emissions, methane emissions, people using basic drinking water, and industrialization were used as factors of environmental performance. We have considered those factors to evaluate the association with per capita income in the first model and infant mortality in the second model. The Next-11 nations are the focus of this research, which covers the years 2000 through 2020. Panel cointegration and second-generation unit root tests were suggested as a result of the presence of cross-sectional dependency and slope heterogeneity. The second-generation panel unit root test displays a combination of stationary values at I (0) and I (1). The marginal link between environmental factors and proxies for quality of life was evaluated using a CS-ARDL model. CS-ARDL's findings indicate that CO_2 emissions and industrialization are positively associated with per capita income in the long and short term. The model does demonstrate that increased industrialization and CO_2 emissions result in higher per capita incomes in the Next-11 nations. However, methane emissions and people with access to basic drinking water are both positively related to per capita income, which does not completely describe this association in the case of N-11 countries. The study also uses AMG and CCEMG for robustness checks. In addition to carbon dioxide emissions and industrialization, the CCEMG estimation finding reveals methane emissions negatively influence per capita income in the Next-11 countries. The CS-ARDL estimation, on the other hand, shows CO_2 emissions are likewise positively linked to infant mortality. Methane emissions are inversely correlated with infant mortality in the next 11 countries, according to the AMG estimate. Infant mortality in N-11 nations is not severely influenced by people having access to adequate drinking water. As a result, the long-term correlation between the observed variables was valid. Therefore, the report asserts that lowering carbon dioxide and methane emissions is crucial for raising living standards in the Next-11 nations. It will be able to lower carbon dioxide emissions by minimizing deforestation, utilizing cutting-edge technology, conserving land, and using energy efficiently. All of these will contribute to a reduction in the likelihood of the spread of respiratory infections. The current study is the first of its kind; to the best of our knowledge, no in-depth research has been done to examine how environmental performance and quality of life compare across the Next-11 countries. The empirical findings from the study may help legislators and policymakers have a better understanding of the significance of resource efficiency and help them develop energy policies in these nations. Massive economic and industrial development leads to increased CO_2 emissions within considered countries, as well as increased infrastructure spending and energy use that improve GDP but degrade environmental quality. Therefore, industrial and environmental policy may be a crucial and effective tool for promoting rapid economic expansion and development while also improving quality of life. Pollution-induced poor air quality can cause health problems. To maintain excellent health and general wellbeing, one must be able to breathe clean air. Healthier populations and higher

Table 8
Summary of the findings.

Variables	Results	Reasons
Per Capita Income (dependent)		
Carbon dioxide emission	Positive	Industrialization and economic development in these countries are associated with an increase in manufacturing and energy-intensive industries, resulting in higher CO_2 emissions and a rise in GDP per capita.
Methane Emission (Gg)	Mixed	In the "Next 11" countries, methane emissions are higher and per capita income is also higher due to agriculture, energy production, waste management, technology, and innovation. However, following the initial stage of development, nations with a greater GDP are concentrating on reducing methane emissions.
People using at least basic drinking water services	Mixed	A higher per capita income leads to infrastructure development, such as the provision of water services, in the Next 11 nations. Consequently, there is an increase in access to clean water. As these nations expand, however, the water becomes increasingly polluted, leading to generally inconsistent results.
Industrialization	Positive	The industrialization of the Next-11 countries is advancing quickly. Therefore, the per capita income increases as the countries become more industrialized.
Infant Mortality (dependent)		
Carbon dioxide emission	Positive	CO_2 emission is the primary cause of climate change in the Next-11 countries. It increases global temperature, harsh weather and ecosystem disruption. Through their effects on food security and the development of infectious diseases, CO_2 emission has a significant impact on infant mortality.
Methane Emission (Gg)	Mixed	Methane generated in the Next-11 countries concentrates in the atmosphere. It causes the world's temperature to rise, which indirectly affects infant mortality. Despite mixed results for explaining infant mortality in all estimations, the results are almost positive.
People using at least basic drinking water services	Negative	Access to basic drinking water lowers newborn mortality, promotes better nutrition and cleanliness, and protects against waterborne infections. The infant mortality scenario was improved in the Next-11 countries by having access to basic drinking water.
Industrialization	Negative	In the Next-11 countries, industrialization leads to better healthcare facilities, a stronger economy, and urbanization, which all contribute to better child health. In these regards, infant mortality tends to decline with more readily available healthcare.

Source: From empirical findings of this study

standards of living are more common in areas with superior environmental performance, such as lower levels of air pollution and effective air quality laws. A healthy lifestyle depends on having access to clean, safe drinking water. Waterborne infections and poor quality of life can result from pollution and poisoning of water supplies. Water quality is typically greater in areas with strict environmental rules and efficient water management systems, which helps to improve the overall quality of life. A healthy environment with enough resources from the natural world and various ecosystems can improve the quality of life. These services offer chances for leisure, travel, and outdoor activities, fostering both physical and mental health. Additionally, it is crucial to maintain ecosystem balance and provide basic services like clean water, food production, and climate management, which depend on biodiversity and ecosystem health. Environmental performance is essential for reducing the effects of climate change, especially in terms of greenhouse gas emissions and climate change adaptation. Effective climate change policies enable communities to better prepare for and respond to extreme weather conditions like hurricanes, droughts, and heatwaves. In the face of climate-related difficulties, resilience and enhanced quality of life are facilitated by adequate infrastructure, disaster preparedness, and sustainable behaviours. Sustainable practices in fields like energy, transportation, waste management, and urban planning are also included in the definition of environmental performance. Improved public transit, cleaner and more efficient energy sources, decreased trash production, and better urban surroundings can all result from a focus on sustainability.

By lowering pollution, improving accessibility, fostering economic development, and fostering communities, these variables have a favourable impact on quality of life. It is crucial to remember that environmental performance is linked to many facets of quality of life, including societal equality, economic prosperity, and public health. The quality of life for both present and future generations can be improved by a strong commitment to environmental stewardship and sustainable practices. This study also recommends that N-11 nations adopt carbon pricing mechanisms to lower carbon emissions, such as a carbon tax or cap and trade system, which offers cash incentives for businesses and individuals to cut their emissions. This adaptation will enhance public health and productivity. They also should employ ecologically responsible equipment and resources that serve as renewable energy, which ought to be utilized in the manufacturing process. Besides, to reduce infant mortality, healthcare investment in public spending should be increased, and we need to ensure the living standard of every individual by making sure they have access to clean drinking water and basic sanitation facilities. With few substitutes for environmental variables, the current study used per capita income and infant mortality as indicators of quality of life which does not capture the full spectrum of this. Life expectancy, maternal and neonatal mortality, happiness, and life satisfaction would be some other criteria to consider when evaluating the quality of life in future research. This study focused on a specific set of countries such as Next-11 countries. Expanding the study's geographical scope to encompass a broader range of countries with various economic and environmental conditions could help investigators better understand the relationship between environmental elements and quality of life. Future studies should concentrate on how environmental factors affect particular nations in order to gain a deeper knowledge of how they affect people's quality of life.

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Consent to participate

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We have no contradiction to publish and this paper only submitted to this journal only.

Availability of data and materials

World Development Indicators (WDI), Our World in Data (OWD) and Environmental Performance Index (EPI) are the core primary data sources.

CRediT authorship contribution statement

Nisat Akter Suci: Conceptualization, Methodology, Writing – original draft, Writing – review & editing. **Md. Hasanur Rahman:** Conceptualization, Formal analysis, Writing – review & editing. **Shapan Chandra Majumder:** Conceptualization, Formal analysis, Supervision, Writing – review & editing.

Declaration of competing interest

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None.

Appendix 1. Results of Dumitrescu Harlin Causality Test

Null Hypothesis	W-stat.	Zbar-stat.	Conclusion
LPCI → LIM	8.1264	13.0438***	Bidirectional Causality (BC)
LIM → LPCI	2.9527	3.3935***	
LCO_2 → LPCI	0.6970	-0.8138	No Causal Relationship (NC)
LPCI → LCO_2	3.7343	4.8515	
LCHA→LPCI	2.9061	3.3067***	Unidirectional Causality (UC)
LPCI→LCHA	3.8802	5.1236	
LIND→LPCI	2.1108	1.8233*	UC
LPCI→LIND	5.0521	7.3095	
LPBW→LPCI	4.9314	7.0843	UC
LPCI→LPBW	15.9466	27.6303***	
LCO_2→LIM	6.6413	10.2738***	UC
LIM→LCO_2	3.9399	5.2349	
LCHA→LIM	6.7741	10.5215***	UC
LIM→LCHA	3.6329	4.6623	
LIND→LIM	4.4548	6.1954	UC
LIM→LIND	6.3342	9.7010***	
LPBW→LIM	5.4430	8.0386	NC
LIM→LPBW	5.4695	8.0881	
LCHA→LCO_2	2.3458	2.2616**	BC
LCO_2→LCHA	2.3090	2.1930**	
LIND→LCO_2	1.6860	1.0308	UC
LCO_2→LIND	3.1659	3.7912***	
LPBW→LCO_2	4.6921	6.6380	NC
LCO_2→LPBW	3.6103	4.6202	
LIND→LCHA	3.6087	4.6173	NC
LCHA→LIND	1.5830	0.8389	
LPBW→LCHA	3.0145	3.5088***	BC
LCHA→LPBW	6.8272	10.6206***	
LPBW→LIND	5.4568	8.0643	UC
LIND→LPBW	2.8995	3.2944***	

Source: Author's Self Estimation, Eviews 10

Note: ***,** and * are symbolized at 1%, 5% and 10% level of significance

Data availability

Data will be made available on request.

References

[1] C.E. Ferrans, J.J. Zerwic, J.E. Wilbur, J.L. Larson, Conceptual model of health-related quality of life, J. Nurs. Scholarsh. 37 (4) (2005) 336–342.

[2] M.H Rahman, S.C Majumder, M.Z. Rana, The reasons behind the shift of patients from public to private hospitals: Evidence from public hospitals in Cumilla City Corporation, Int. J. Public Policy Adm. Res. 7 (2) (2020) 69–78.

[3] M.B. Hitam, H.B. Borhan, FDI, growth and the environment: impact on quality of life in Malaysia, Procedia Soc. Behav. Sci. 50 (2012) 333–342.

[4] J.I. Amuka, F.O. Asogwa, R.O. Ugwuanyi, A.N. Omeje, T. Onyechi, Climate change and life expectancy in a developing country: Evidence from greenhouse gas (CO2) emission in Nigeria, Int. J. Econ. Financ. Issues 8 (4) (2018) 113.

[5] A. Mutizwa, A. Makochekanwa, Impact of environmental quality on health status: a study of 12 southern African development community (SADC) countries between 2000 and 2008, Botsw. J. Econ. 13 (1) (2015) 87–111.

[6] M.H. Rahman, L.C. Voumik, S. Akter, M. Radulescu, New insights from selected South Asian countries on the determinants of GHG emissions, Energy Environ. (2023), 0958305X231189180.

[7] L. Wang, T. Shi, H. Chen, Air pollution and infant mortality: evidence from China, Econ. Hum. Biol. 49 (2023) 101229.

[8] H.A. Arregocés, R. Rojano, G. Restrepo, Health risk assessment for particulate matter: application of AirQ+ model in the northern Caribbean region of Colombia, Air Qual. Atmos. Health 16 (5) (2023) 897–912.

[9] H. Abdullah, M. Azam, S.K. Zakariya, The impact of environmental quality on public health expenditure in Malaysia, Asia Pac. J. Adv. Bus. Soc. Stud. (APJABSS) 2 (2) (2016) 365–379.

[10] Coccia, M. (2021). Effects of human progress driven by technological: change on physical and mental health. Studi di sociologia: LIX, 2, 2021, 113-132.

[11] M.T. Majeed, I. Ozturk, Environmental degradation and population health outcomes: a global panel data analysis, Environ. Sci. Pollut. Res. 27 (13) (2020) 15901–15911.

[12] W.M. Anita, K. Ueda, A. Uttajug, X.T. Seposo, H. Takano, Association between long-term ambient PM2. 5 exposure and under-5 mortality: a scoping review, Int. J. Environ. Res. Public Health 20 (4) (2023) 3270.

[13] A. Omri, B. Kahouli, Causal relationships between energy consumption, foreign direct investment and economic growth: fresh evidence from dynamic simultaneous-equations models, Energy Policy 67 (2014) 913–922.

[14] M.H. Sial, N. Arshed, M.A. Amjad, Y.A. Khan, Nexus between fossil fuel consumption and infant mortality rate: a non-linear analysis, Environ. Sci. Pollut. Res. 29 (38) (2022) 58378–58387.

[15] H.K. Pullabhotla, M. Zahid, S. Heft-Neal, V. Rathi, M. Burke, Global biomass fires and infant mortality, Proc. Natl. Acad. Sci. 120 (23) (2023) e2218210120.

[16] N. Apergis, J.E. Payne, CO2 emissions, energy usage, and output in Central America, Energy Policy 37 (8) (2009) 3282–3286.
[17] T.H. Chang, C.M. Huang, M.C. Lee, Threshold effect of the economic growth rate on the renewable energy development from a change in energy price: Evidence from OECD countries, Energy Policy 37 (12) (2009) 5796–5802.
[18] H.A. Fakher, Z. Abedi, Relationship between environmental quality and economic growth in developing countries (based on environmental performance index), Environ. Energy Econ. Res. 1 (3) (2017) 299–310.
[19] M.H. Rahman, A. Ruma, R. Nahrin, M.N. Hossain, S.C. Majumder, Examine the empirical relationship between energy consumption and industrialization in Bangladesh: granger causality analysis, Int. J. Energy Econ. Policy 11 (3) (2021) 121–129.
[20] S.S. Sharma, The relationship between energy and economic growth: empirical evidence from 66 countries, Appl. Energy 87 (11) (2010) 3565–3574.
[21] M. Coccia, New directions of technologies pointing the way to a sustainable global society, Sustain. Futures 5 (2023) 100114.
[22] M. Coccia, E. Bontempi, New trajectories of technologies for the removal of pollutants and emerging contaminants in the environment, Environ. Res. 229 (2023) 115938.
[23] S.C. Majumder, M.H. Rahman, Rural - urban migration and its impact on environment and health: evidence from Cumilla City Corporation, Bangladesh, GeoJournal (2022), https://doi.org/10.1007/s10708-022-10816-z.
[24] S.C. Majumder, B.K. Appiah, O.C. Cardorel, Determinants of market to book value and financial performance of Chinese listed firms: implication of MVAIC model, Int. J. Learn. Intellect. Cap. 18 (2) (2021) 131–153.
[25] H. Uddin, S. Ahammed, M.M. Rana, S.C. Majumder, Investigating the relationship between environmental quality and tourism industry in Thailand, Environ. Dev. Sustain. 26 (5) (2024) 12339–12365.
[26] L.C. Voumik, M.H. Rahman, A. Islam, M.A.S Chowdhury, Z. Zimon, The impact of female education, trade openness, per capita GDP, and urbanization on women's employment in South Asian: application of CSARDL model, Systems 11 (2) (2023) 97 (Basel).
[27] M. Coccia, M. Bellitto, Human progress and its socioeconomic effects in society, J. Econ. Soc. Thought 5 (2) (2018) 160–178.
[28] F.L. Gill, K.K. Viswanathan, M.Z.A Karim, The critical review of the pollution haven hypothesis, Int. J. Energy Econ. Policy 8 (1) (2018) 167–174.
[29] G.M. Grossman, A.B. Krueger, Economic growth and the environment, Q. J. Econ. 110 (2) (1995) 353–377.
[30] Grossman, G. M., & Krueger, A. B. (1991). Environmental impacts of a North American free trade agreement.
[31] A. Kearsley, M. Riddel, A further inquiry into the pollution haven hypothesis and the environmental Kuznets curve, Ecol. Econ. 69 (4) (2010) 905–919.
[32] S. Tanaka, Environmental regulations on air pollution in China and their impact on infant mortality, J. Health Econ. 42 (2015) 90–103.
[33] M. Greenstone, R. Hanna, Environmental regulations, air and water pollution, and infant mortality in India, Am. Econ. Rev. 104 (10) (2014) 3038–3072.
[34] J. Currie, M. Neidell, Air pollution and infant health: what can we learn from California's recent experience? Q. J. Econ. 120 (3) (2005) 1003–1030.
[35] R.L. Schalock, M.A. Verdugo, C. Jenaro, M. Wang, M. Wehmeyer, X. Jiancheng, Y. Lachapelle, Cross-cultural study of quality of life indicators, Am. J. Ment. Retard. 110 (4) (2005) 298–311.
[36] K.K.P. Chang, F.K.Y. Wong, K.L. Chan, F. Wong, H.C. Ho, M.S. Wong, L. Yang, The impact of the environment on the quality of life and the mediating effects of sleep and stress, Int. J. Environ. Res. Public Health 17 (22) (2020) 8529.
[37] M.T. Majeed, S. Mumtaz, Happiness and environmental degradation: a global analysis, Pak. J. Commer. Soc. Sci. (PJCSS) 11 (3) (2017) 753–772.
[38] S.A. Sarkodie, V. Strezov, Y. Jiang, T. Evans, Proximate determinants of particulate matter (PM2. 5) emission, mortality and life expectancy in Europe, Central Asia, Australia, Canada and the US, Sci. Total Environ. 683 (2019) 489–497.
[39] T. Chowdhury, S. Islam, Environmental performance index and GDP growth rate: evidence from BRICS countries, Environ. Econ. 8 (4) (2017) 31–36. Iss.
[40] Musibau, H. O., Yanotti, M. B., Vespignani, J. L., & Nepal, R. (2021). Environmental performance in the West African economy: MM-quantile and 2SLS approach.
[41] X. Zhao, Z. Sun, The effect of satisfaction with environmental performance on subjective well-being in China: GDP as a moderating factor, Sustainability 12 (5) (2020) 1745.
[42] A.O. Oyelade, O.E. Maku, O. Oladimeji, The effect of CO2 emissions on quality of life in Anglophone countries in West Africa, Afr. J. Econ. Rev. 10 (1) (2022) 27–41.
[43] R. Nadimi, K. Tokimatsu, K. Yoshikawa, Sustainable energy policy options in the presence of quality of life, poverty, and CO2 emission, Energy Procedia 142 (2017) 2959–2964.
[44] R. Nahrin, M.H. Rahman, S.C Majumder, Economic growth and pollution Nexus in Mexico, Colombia and Venezuela (G-3 Countries): role of renewable energy on carbon dioxide emissions, Energies 16 (2023) 1076 (Basel).
[45] L.C. Voumik, S.M. Nafi, S.C. Majumder, M.A. Islam, The impact of tourism on the women employment in South American and Caribbean countries, Int. J. Contemp. Hosp. Manag. 35 (9) (2023) 3095–3112.
[46] Yandle, B., Bhattarai, M., & Vijayaraghavan, M. (2004). Environmental Kuznets curves: a review of findings, methods, and policy implications.
[47] L.I. Patiño, E. Padilla, V. Alcántara, J.L. Raymond, The relationship of energy and CO2 emissions with GDP per capita in Colombia, Atmosphere 11 (8) (2020) 778 (Basel).
[48] G.S. Becker, T.J. Philipson, R.R. Soares, The quantity and quality of life and the evolution of world inequality, Am. Econ. Rev. 95 (1) (2005) 277–291.
[49] Costanza, R., Hart, M., Talberth, J., & Posner, S. (2009). Beyond GDP: the need for new measures of progress. The pardee papers.
[50] R. Levett, Sustainability indicators—integrating quality of life and environmental protection, J. R. Stat. Soc. Stat. Soc. 161 (3) (1998) 291–302.
[51] T. Rahman, R.C. Mittelhammer, P.R. Wandschneider, Measuring quality of life across countries: a multiple indicators and multiple causes approach, J. Socio Econ. 40 (1) (2011) 43–52.
[52] S. Hossain, M.A. Siddika, I.J. Koly, K. Akter, Exploring the impact of environmental degradation on life expectancy in Bangladesh: An ARDL bounds test approach, Int. J. Sci. Bus. 4 (12) (2020) 69–79.
[53] A. Assadzadeh, F. Bastan, A. Shahverdi, The impact of environmental quality and pollution on health expenditures: a case study of petroleum exporting countries, in: Proceedings of the 29th International Business Research Conference 24, 2014, p. 25.
[54] A. Mohmmed, Z. Li, A.O. Arowolo, H. Su, X. Deng, O. Najmuddin, Y. Zhang, Driving factors of CO2 emissions and nexus with economic growth, development and human health in the Top Ten emitting countries, Resour. Conserv. Recycl. 148 (2019) 157–169.
[55] I. Ari, H. Şentürk, The relationship between GDP and methane emissions from solid waste: a panel data analysis for the G7, Sustain. Prod. Consum. 23 (2020) 282–290.
[56] S. Hanif, M. Lateef, K. Hussain, S. Hyder, B. Usman, K. Zaman, M. Asif, Controlling air pollution by lowering methane emissions, conserving natural resources, and slowing urbanization in a panel of selected Asian economies, PLoS One 17 (8) (2022) e0271387.
[57] S.M. Kamal, Maternal education as a determinant of neonatal mortality in Bangladesh, J. Health Manage 14 (3) (2012) 269–281.
[58] L.C. Voumik, T. Sultana, Impact of urbanization, industrialization, electrification and renewable energy on the environment in BRICS: fresh evidence from novel CS-ARDL model, Heliyon 8 (11) (2022) e11457.
[59] L.C. Voumik, M.H. Rahman, M.M. Rahman, M. Ridwan, S. Akter, A. Raihan, Toward a sustainable future: examining the interconnectedness among Foreign Direct Investment (FDI), urbanization, trade openness, economic growth, and energy usage in Australia, Reg. Sustain. 4 (4) (2023) 405–415.
[60] L.C. Voumik, M.H. Rahman, S.M. Nafi, M.A. Hossain, A.R. Ridzuan, N.Y. Mohamed Yusoff, Modelling sustainable non-renewable and renewable energy based on the EKC hypothesis for Africa's ten most popular tourist destinations, Sustainability 15 (5) (2023) 4029.
[61] R. Patnaik, Impact of industrialization on environment and sustainable solutions–reflections from a south Indian region, in: Proceedings of the IOP Conference Series: Earth and Environmental Science 120, IOP Publishing, 2018 012016.
[62] M.H. Pesaran, T. Yamagata, Testing slope homogeneity in large panels, J. Econom. 142 (1) (2008) 50–93.
[63] M.H. Pesaran, Testing weak cross-sectional dependence in large panels, Econom. Rev. 34 (6-10) (2015) 1089–1117.
[64] R.E. De Hoyos, V. Sarafidis, Testing for cross-sectional dependence in panel-data models, Stata J. 6 (4) (2006) 482–496.
[65] Pesaran, M. H. (2004). General diagnostic tests for cross section dependence in panels (IZA Discussion Paper No. 1240). Institute for the Study of Labor (IZA).
[66] D. Robertson, J. Symons, Factor Residuals in SUR Regressions: Estimating Panels Allowing for Cross Sectional Correlation (No. 473), Centre for Economic Performance, London School of Economics and Political Science, 2000.
[67] C. Kao, M.H. Chiang, B. Chen, International R&D spillovers: an application of estimation and inference in panel cointegration, Oxf. Bull. Econ. Stat. 61 (S1) (1999) 691–709.
[68] P. Pedroni, Panel cointegration: Asymptotic and finite sample properties of pooled time series tests with an application to the PPP hypothesis, Econ. Theory 20 (2004) 597–625.
[69] J. Westerlund, D.L. Edgerton, A simple test for cointegration in dependent panels with structural breaks, Oxf. Bull. Econ. Stat. 70 (5) (2008) 665–704.
[70] A. Chudik, K. Mohaddes, M.H. Pesaran, M. Raissi, Long-run effects in large heterogeneous panel data models with cross-sectionally correlated errors. Essays in Honor of Aman Ullah, Emerald Group Publishing Limited, 2016.
[71] Z.U. Haq, U. Mehmood, S. Tariq, A. Mariam, The impacts of globalization and GDP on CO2 emissions: do technological innovation and renewable energy lower some burden in SAARC countries, J. Knowl. Econ. (2024) 1–24.
[72] A.A. Mendoza, K.D.G.T. Reyes, P.A.D. Soriano, R. Cabauatan, The impact of CO2 emissions on the GDP per capita, employment rate and energy consumption of China, Korea and Japan, Malays. J. Soc. Sci. Humanit. (MJSSH) 6 (11) (2021) 315–333.
[73] K.E. Elfaki, R.D. Handoyo, K.H. Ibrahim, The impact of industrialization, trade openness, financial development, and energy consumption on economic growth in Indonesia, Economies 9 (4) (2021) 174.
[74] C. Ndiaya, K. Lv, Role of industrialization on economic growth: the experience of Senegal (1960-2017), Am. J. Ind. Bus. Manag. 8 (10) (2018) 2072.
[75] E.E.O. Opoku, I.K.M Yan, Industrialization as driver of sustainable economic growth in Africa, J. Int. Trade Econ. Dev. 28 (1) (2019) 30–56.
[76] K.O. Wonyra, Industrialization and economic growth in sub-Saharan Africa: the role of human capital in structural transformation, J. Empir. Stud. 5 (1) (2018) 45–54.
[77] A. Ifa, I. Guetat, Save Infant's live or save economic growth? An analysis by ARDL approach: case of India, Energy Explor. Exploit. 41 (2) (2023) 766–784.
[78] T.J. Luben, A.A. Wilkie, A.K. Krajewski, F. Njie, K. Park, S. Zelasky, K.M. Rappazzo, Short-term exposure to air pollution and infant mortality: a systematic review and meta-analysis, Sci. Total Environ. 898 (2023) 165522.

[79] S. Nazarpour, A.S. Poursani, M. Simbar, R.B. Yarandi, The relationship between air pollution and infant mortality rate, Iran. J. Public Health 52 (6) (2023) 1278.
[80] Drabo, A. (2011). Agricultural primary commodity export and environmental degradation: what consequences for population's health?
[81] R. Picetti, R. Juel, J. Milner, A. Bonell, F. Karakas, A.D. Dangour, R. Hughes, Effects on child and adolescent health of climate change mitigation policies: a systematic review of modelling studies, Environ. Res. (2023) 117102.
[82] S. Bond, M. Eberhardt, Accounting for Unobserved Heterogeneity in Panel Time Series Models, University of Oxford, 2013, pp. 1–11.
[83] E.I. Dumitrescu, C. Hurlin, Testing for Granger non-causality in heterogeneous panels, Econ. Model. 29 (4) (2012) 1450–1460.