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Health Expenditure and Environmental Pollution in Latin American and Caribbean's

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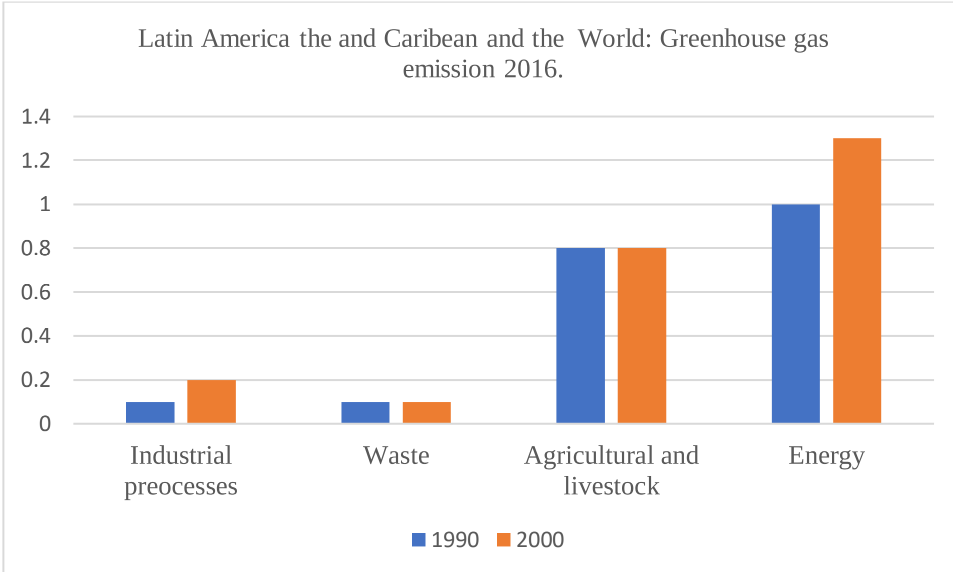
Abstract

This analysis explores the connections between economic growth (GDP), environmental degradation (CO2), population growth (PG), and health spending (HE) using a pooled mean group calculation (ARDL-PMG) autoregressive distributed lag model and employing Granger causality checks to Latin American and Caribbean States for the period from 1996 to 2017. Short-term causalities from CO2 to HE is unidirectional and permanent. Over the short term, the causal path between CO2 and GDP is unobservable. Furthermore, unidirectional short-run causality from GDP to HE was suggested in the article analysis. There are short-run bidirectional causalities between GDP, CO2, and HE when measured per two or more independent variables. If we apply CO2 to the GDP and PG factors, the causality of HE is measurable, and the GDP and PG pair's causality to health spending is neutral. Similarly, if we apply population growth to the health expenditures and gross domestic product of the variable, there is causality. Long-run bidirectional causalities occur between GDP, CO2, and HE. For the research outcomes, the causality from HE to GDP is not strong. The clear causality of health spending and CO2 to economic development is neutral if we measure each pair of variables. The long-term PMG projections indicate that environmental pollution is increased by population growth and health spending, while economic growth lowers environmental pollution.

Keywords: *Health expenditure, economic growth, population growth, environmental degradation, ARDL-PMG approach, granger causality.*

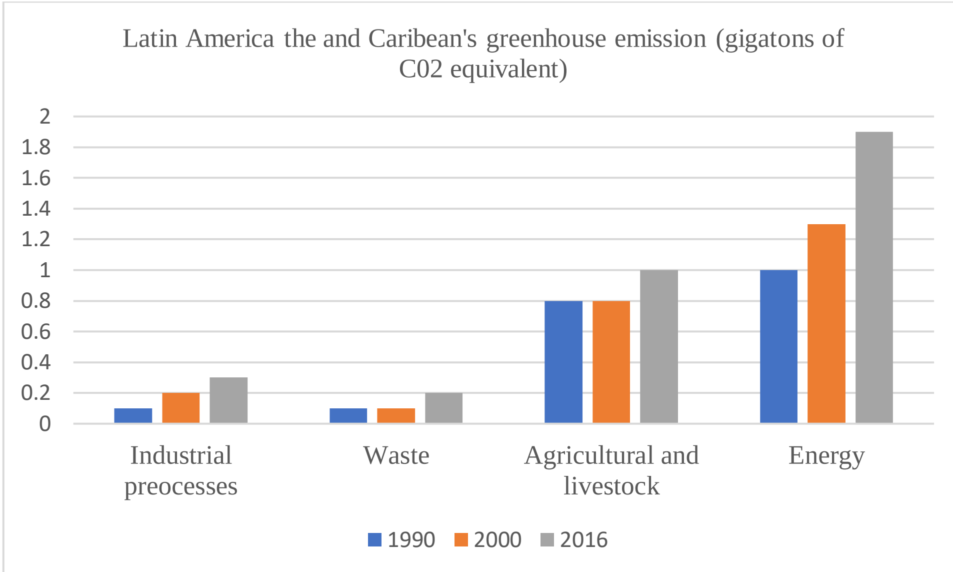
1. Introduction

The global financial crisis has driven many nations to significantly increase spending, with health care being a common priority. However, to enhance the welfare of a population, the availability of health care is important, which in turn would have an impact on greater productivity, increased economic development and fiscal resources. Nevertheless, economic growth could be higher if success achieved by further spending on health? The established literature's observations concerning the effects of health spending on health for economic development are unclear (Khoshnevis Yazdi & Khanalizadeh, 2017; Mohsin et al., 2019; Zaidi, Saidi, & society, 2018). Increased economic expansion, urbanization, and industrialization in both industrialized and developing countries, as a means of the release of a number of various air contaminants into the atmosphere, have contributed to a major degradation in air quality (Hoffmann et al., 2020). The aim of the present research is to explore the causal connections of Latin America and Caribbean nations between health spending, population growth GDP, and environmental pollution. To analyze the short- and long-run correlations between the variables, we use the ARDL-PMG method and report the course of causality between them. This article is the first to employ the pairing connection test of variables to examine health and pollutant issue that involves nations in Latin America. This method uses a detailed econometric approach that allows for connections to causality.



Sustainable development agenda 2030 report (2016)

In low-income countries, half of the planet's population rely on open fires, including firewood and other traditional biomass, to meet the energy demand for necessities such as cooking and heating. There is no decline in the overall use of biomass for energy usage, and it is currently rising in the poorest households (Ajide & Alimi, 2020; Hossain, Majumder, & Akter, 2019). Health spending and economic development have been examined around the globe using multiple lenses. For countries where income is low, the challenges remain. The evidence from investigations and policies to have a successful implementation of such affiliations have been low. (Lu et al., 2020) employing the Kuznets curve to investigation the nexus between economic growth and ecological pollution in China. The study indicated that there exists a one-way casual affiliation between carbon emission and economic growth. The findings of this article confirm the investigations of (Wang, Asghar, Zaidi, Wang, & Research, 2019) in Pakistan for period 1195-2017. The study findings indicated that the nations had a favorable bi-directional nexus between health spending, carbon dioxide emission, and economic growth. Similarly, with the findings conducted in the investigations of (DİNÇER, YUKSEL, & Policies, 2019; Lago-Peñas, Cantarero-Prieto, & Blázquez-Fernández, 2013). A comparative investigation of China and India's health expenditure, environmental pollution, and GDP casualty for the period 1960-2019 employing the GMM regression analysis were estimated by (Atuahene, Yusheng, & Bentum-Micah, 2020). The empirical data suggests that CO2 emissions have a substantial favorable influence on health spending, economic development had an adverse influence on health spending in nations over the time of review. The population growth had an implication on India's health cost, while its influence on China's health spending indicated a positive affiliation. The study backed by the current inquiry (Mehrara, Sharzei, & Mohaghegh, 2012) argued that there was a near correlation among well-being spending and ecological efficiency. In order to explore the long-term balance and short-term effects by employing panel co-integration examinations, error corrections technique, and Ordinary Least Square (OLS). In both the short-run and the long-run, the article found evidence of strong correlation between environmental quality and health spending. Though there is heated argument on health spending, environmental pollution, economic growth, population growth, investigation in the Latin America and Caribbean’s are rarely scared even though the nation's emission in the past thirty years continues to increase.



Sustainable development agenda 2030 report (2016)

The purpose of this investigation is to explore the health expenditure by nations within the Latin America and the Caribbean's. The data from World bank report 2020 indicated that between the years 2000 – 2019, health expenditure percentage of GDP have grown from 6.53 - 7.96. Similarly, government internal spending for such period increases from 133$ to 336$. This reason been that their nations accounted for year in year increase in emission of environmental pollutants. Other aims of this article are to throw more light on the effects of pollution on the cost of government expenditure. This investigation unlike other research that explore the bi-directional casualty will analysis the pair by pair of variables to understand the affiliation that exits between them.

2. Literature review

The essential viewpoint of environmental degradation, which has been thoroughly studied in all previous studies in terms of determinants, implications, and various aspects, deals with its significant impacts on public health. Latest studies on organic and inorganic contamination of the atmosphere in developed countries and its effects on human wellbeing. (Vaccari et al., 2019) believed that chemicals were spread through Waste Electrical and Electronic Equipment (WEEE) informal disposal facilities and may have a harmful effect on public health by exposure or transport processes. According to their study, health issues are adversely affected as air emissions rises in a region due to which many health problems occur that need to be regulated. It is also clear that rising environmental emissions often contribute to higher spending on health. This research was unable to acquire information on the determinants of rising conservational emissions in health spending. (Mehrara et al., 2012) argued that a clear link existed between health and environmental quality investment. Through employing co-integration checks, error correction models, and Ordinary Least Square (OLS) to analyze the long-term equilibrium as well as short-term results, the article indicated evidence of a causal nexus between ecological quality and health spending in the short and long run. The complex nexus between economic growth and emissions of carbon dioxide (CO_2) for 181 nations using the cross-correlation research approach is discussed by (Narayan & Sharma, 2015). The research paper indicates that a favorable cross-correlation between the current level of revenue and the previous level of CO_2 emissions and a negative cross-correlation between the current level of revenue and the potential level of CO_2 emissions would lead to a decrease in CO_2 emissions as revenue grows over time, in agreement with the theory of the environmental Kuznets curve (EKC). Two major classes of environmental emissions in China; foreign direct investment and human capital were proposed (Lan, Kakinaka, Huang, & Economics, 2012). According to them, FDI has a major effect on China's environmental emissions, but this impact depends heavily on the human resources. But the effects or prospects of environmental emissions affecting government health budgets have not been discussed. There are a variety of recent reports that address climate change determinants (Afolayan, Okodua, Oaikhenan, Matthew, & Policy, 2020), (Berrang-Ford et al., 2019). These articles, however, didn't concentrate on the effect of environmental emissions on health expenditure. In Taiwan, (Wu et al., 2020) examine the co-movement and nexus between air emissions and health care spending, employing wavelet modeling for Taiwan for the period 1995 Q1-2016 Q4. economic growth was employed as a control variable. The findings indicated that co-movement occurs, and causality varying at frequencies and periods between air emissions and healthcare spending. (Kjellstrom & McMichael, 2013) a similar investigation in Iran concluded that environmental quality is affiliated with health expenditure utilizing the ARDL model. However, in a study by (Zaidi et al., 2018) in Sub Sahara African on the variables of environmental pollutants, health spending and economic growth for the year 1990-2015. The panel ARDL model estimation indicated a two-pathway nexus between CO2 and Nitric Oxide. Past investigation on the affiliation between environmental pollution, health expenditure, population growth, and carbon emission have produced mixed results.

Review of Literatures on health expenditure, economic growth, environmental pollution, and population growth

Author	Variables	Methodology	Location	Duration	Findings
(Rana, Alam, Gow, & Management, 2020)	Health spending, gross domestic product	Panel data, Unit root, co-integration, and causality estimations	161 countries	1995–2014	No long-term co-integration exit. Income across various level differs for health expenditure
(Apergis, Bhattacharya, Hadhri, & Research, 2020)	Health expenditure, national income, carbon dioxide emission	Cross-sectional dependence, temporal persistence	178 countries	1995-2017	1% rise in national income leads to 7.2% increase in health expenditure. 1% increase in C02 emission leads to a 2.5% rise in health spending.
(Hashmi & Alam, 2019)	Environmental directive, innovation, CO2 emission, population, and real GDP.	Panel fixed effect, random effect, and GMM	OECD countries	1999-2014	One percent improve in eco-friendly patent decrease 0.017 percent in environmental pollution. 1 percent increase in tax returns leads to 0.03 percent reduction in CO2.
(Haseeb, Zandi, Hartani, Pahi, & Nadeem, 2019)	Population growth, supply chain performance, and economic growth	Smart Partial Least Square model	Indonesia		Population growth influence economic growth positively
(Mohsin et al., 2019)	Energy consumption, population, CO2 emission, and environmental pollution.	Error correction model, Platykurtic distribution, co-integration	Pakistan transport sector	1975 to 2015	rise in economic growth, urbanization, and energy consumption increased transport-based environmental degradation urbanization.
(Atuahene et al., 2020)	Health Expenditure, CO2 Emissions, and real GDP	panel data, Generalized Method of Moments (GMM)	China and India	1960-2019	Significant positive impact between carbon emission and health expenditure, negative effect between GDP and health spending.
(Atilgan, Kilic, & Ertugrul, 2017)	Health expenditure, economic growth	Bound test approach, ARDL model and Kalman filter modeling	Turkey	1975-2013	The investigations indicate that a 1 percent rise in per-capita health spending will lead to a 0.434 percent rise in per-capita gross domestic product.
(Piabuo & Tieguhong, 2017)	Health expenditure and economic growth	OLS, FMOLS, DOLS	Six CEMAC and five SSA nations	1995-2015	The findings show a favorable and significant affiliation between the sample nations' health expenditure and economic growth.

(Halıcı-Tülüce, Doğan, Dumrul, & management, 2016)	Health expenditure, Economic growth	Panel data analysis	twenty-five high-income and nineteen low-income economies	1995–2012 and 1997–2009	The findings indicated that individual health spending was favorably affiliated to real GDP.
(Lago-Peñas et al., 2013)	Health expenditure, income		31 OECD nations		Health investment is more vulnerable to cyclical income fluctuations than to cycles. Nations with a higher private share of overall spending on health are adapting more rapidly.
(Khoshnevis Yazdi & Khanalizadeh, 2017)	health expenditure, income, CO2 and PM10 emissions	ARDL method	MENA region	1995 – 2014	The analysis indicates that health spending, earnings, emissions of CO2, and PM10 are co-integrated. Although long-run elasticity suggests that earnings and emissions of CO2 and PM10 have a statistically favorable effect on health spending,
(Liu, Xia, & Hou, 2019)	Health expenditure, dynamic health efficacy	Super-slack-based measure (SBM) model and Malmquist productivity index (MPI)	China	2007 - 2016	Government spends more on economic development in rural areas compare with health expenditure.

3. Empirical analysis

This work was a comparative analysis aimed at testing the long and short-run nexus between the emission of carbon dioxide and health expenditure, economic development, and population growth. The World Bank database (www.databank.worldbank.org) has compiled the data for these variables. The period of research is from 1996 to 2017. The selected metrics are based on the Targets for Sustainable Development (UN, 2015). The paper collected data from nations in Latin America and the Caribbean.

Pool Mean Group Estimation

The goal of the paper is to explore the short-term and long-term association using the ARDL-PMG methodology between government spending, environmental emissions, population, and economic growth, as employed by (Pesaran, Shin, & Smith, 1999). The ARDL technique can assist in the creation of short-term and long-term relations and can be grouped as a model for error detection and affiliation. The technique is essential since, regardless of the integration order of the constructs, it can evaluate hypothetical long-term relationships, whether I(1) or jointly integrated I(0) and I(1), except that the explanatory indicators are restricted to I(1). The approach can't, however, be used when the order 2 series (I (2)) is integrated. Furthermore, this approach offers reliable and accurate estimators since the endogenous and exogenous variables lag time —the phase of ARDL, including the long-term affiliation of variables.

$$\Delta \mathrm{HE} = \alpha i + \sum_{j=1}^{m-1}(\beta ij\Delta \mathrm{HE}) + \sum_{i=0}^{N-1}(\varphi il\Delta \mathrm{GDP}) + \sum_{r=0}^{p-1}(\Upsilon ir\Delta \mathrm{CO2}) + \sum_{u=0}^{s-1}(\theta iu\Delta \mathrm{PG}) + \delta HE\ . + \delta \mathrm{GDP} + \delta\ \mathrm{CO2} + \delta\ P\mathrm{G} + \varepsilon_{it} \ldots\ldots 1$$

Where HE is the dependent variable and GDP, CO2 and PG is the exogenous variable, εit is the error term, and Δ is 1st difference estimator. When health expenditure was used as the endogenous variable to developed the long-term nexus of the ADRL technique. A lagged variable's option is centered on the Schwarz Bayesian Criterion and Akaike data Criterion. Application of standard co-integration experiments in the existence of variables I (0) and I (1) as conducted (Pedroni, 2004) to assess the nature of potential long-term nexus among variables. In comparison, according to the following alternative hypotheses, the ARDL boundary test has the opportunity to test the presence of a potential long-term association: The null hypothesis of no co-integration in Eq. (1) provides Ho: $\delta = \delta = \delta = \delta = 0$ Ho: $\delta \neq \delta \neq \delta \neq \delta = 0$. The second condition for the ADRL model states that the long-term nexus between the variables can be determined when the null hypothesis of co-integration is acknowledged.

For the econometric model of equation 1, the article then defined the long-term affiliation. The testing technique for bounds is center on the Fisher statistics. For a given statistical significance (Pesaran, Shin, & Smith, 2001) considered two bounds of critical values. The first implies that I (0) are all variables used in the ARDL model, while the other assumes I (1) variables. If the measured F-statistic approaches the value of the upper critical limits, H0 is refused. The co-integration test remains inconclusive if the F-statistic falls beyond the boundaries. When the Fisher statistic is smaller than the lower bound value, so it is not feasible to dismiss the null hypothesis. In the second stage, the long-term equation can be calculated when the co-integration relationships are formed. By calculating an error correction model (ECM), we obtain the short-term dynamic relationship in the third step. An ECM is deployed as follows;

$$\mathrm{HE} = \alpha i + \sum_{j=1}^{m-1}(\beta 1j\mathrm{HE}) + \sum_{I=1}^{n-1}(\varphi 2j\mathrm{GDP}) + \sum_{j=1}^{p-1}(\Upsilon 3j\mathrm{C02}) + \sum_{j=1}^{s-1}(\theta 4j\mathrm{PG}) + b\mathrm{ECM}_{t-1} + + e_{2it} \ldots\ldots 2$$

Where ECM $_{t-1}$ is the error correction model for the long-run equilibrium connection between the indicators. a and b are the adjustment speed to the equilibrium point. Similarly, e_{2it} represents the residual.

As stated previously, the ARDL technique estimators, and all parameters are found employing the PMG method. This assessment technique is considered the most consistent based on the maximum likelihood approach because it accounts for the human traits and offers a superior long-term nexus assessment. The PMG estimators obtained are thus presented asymptotically and typically. Although the proposed PMG method (Pesaran et al., 1999) suggests that the coefficients are heterogeneous, the change parameter errors and fluctuations are short-run and long-term, the PMG technique undertakes that the short-run coefficients are heterogeneous, while the long-run coefficients are believed to be similar and homogeneous for all items throughout the panel. In particular, the option of such a technique is acceptable because there is cause to assume that homogeneity can be linked over the long term to the impact of numerous influences, such as macroeconomic policies, developments in technological digital technology and complex technological, which have been present in the group in both Latin American and Caribbean countries. We must therefore integrate the hypothesis executed by the PMG approach, affirming that coefficients for long-term relationships are the same for each region ($\gamma_{l\,ij} = \gamma_{l\,j}$ (Eq1) and $\beta_{1i\,j} = \beta_{1j}$ (Eq2), $\forall l = 1 \ldots 3$). Furthermore, this hypothesis was factored into the condition of the bond tests.

Granger causality

Through Granger causality tests (Engle & Granger, 1987), causality connections can be found. The causality affiliation is placed into three groups for analysis in this study: short-run, long-run, and strong causality. Next, using the coefficient of ECT, long-term causality is checked. The null hypothesis is H_0: $\delta_l = 0$, whiles the alternative hypothesis is H1: $\delta l \neq 0$ for the l models; l = (1, 2, 3, 4).
In Eq2, for example, if we test the variables one by one, the causality from HE to GDP is evaluated using H0: $\beta 2i = 0$, while H_1: $\beta_{2i} \neq 0$ is the alternative. If we measure per pair in Eq2, H0: $\beta 2i = \beta 3i = 0$ is used to test the causality from HE and CO2 to PG, while the alternative is H1: $\beta_{2i} \neq \beta_{3i} \neq 0$.
For all factors, the short-term, linked paths of causality were modified identically. Finally, using the coefficient of indicators in the first variance and the ECT coefficient, strong causality is checked. In Eq2, the article measures the indicators one-by-one by checking H_0: $\beta_{2i} = \mu_1 = 0$ the causality from HE to GDP is obtained against the alternative H_1: $\beta_{2i} \neq \mu_1 \neq 0$. If we measure per pair in Eq2, H_0: $\beta_{2i} = \beta_{3i} = \mu_1 = 0$ is used to test the causality from HE and C02 to PG against the alternate H_1: $\beta_{2i} \neq \beta_{3i} \neq \mu_1 \neq 0$. For both models, causality checks are performed in the same way as in Eq2.

Test of unit roots

The investigation employed the E-views software was used to conduct the unit root test. Augmented Dickey-Fuller to establish if the variables included in the study are stationary. All variables were integrated according to order I (1). Except for the GDP growth rate that was stagnant at levels, the I (0) order stochastic process is integrated.

Table 1. Unit root test

	At Level		At first difference	
	T-statis	Probability	T-statis	Probability
HE	-1.990668	0.2881	-5.883871	0.0001
CO2	-2.347557	0.1680	-3.810992	0.0104
GDP	-3.140695	0.0424	-4.333198	0.0050
PG	-0.023111	0.9455	-3.840885	0.0098

Cointegration bounds test

We extend the boundary test method to the three models bestowing to the findings of the unit-root assessment to analyze the long-term affiliation between indicators. The article put the sequence of lags for the three indicators employing Akaike Knowledge and a Schwartz Bayesian criterion, after measuring Eq1.To research the probability of a long-term nexus between dependent and explanatory factors, the common F-statistic is employed for the models. The two critical values are 2.56 and 3.49 at the 5 percent and at 10 percent 2.20 and 3.09 according to (Pesaran et al., 2001) table. The two are 2.20 and 3.09 at the 10 percent mark. The measured F-statistic is greater than at 5 and 10 percent value. The outcome confirms the evidence of a long-term nexus between all indicators.

Table 2 cointegration bounds test

Dependent variable	F-statistics	Probability
HE	6.621	0.010**
GDP	7.895	0.006***
CO_2	8.201	0.011**

** 1% significant level and *** 5% significant level.

ARDL Pool Mean Group Analysis

The impact of long-term and short-term elasticity on health expenditure, population growth, greenhouse emissions and economic growth have been demonstrated in Table 3. The notion of error correction is negative and extreme. The article shows a favorable and significant nexus among CO2 pollution, health spending, and population growth in the short- and the long-term. Subsequently, a one percent rise in health spending raises CO2 emissions by 19% and 0.15% percent during the medium- and short-term. Likewise, a population expansion of 1 percent boosts CO2 emissions by 0.32 percent over the long term and 0.45 percent over the short term. However, GDP has an adverse effect on CO2 emissions in both the long and short term. A 1 percent rise in GDP reduces CO2 emissions over the long term by 0.26 percent and over the short term by 0.09 percent. Results are in accordance with studies by study (Khoshnevis Yazdi & Khanalizadeh, 2017) suggested that air population and economic development in MENA countries are favorable. When health spending is a dependent variable, as seen in Table 3, only carbon dioxide has a detrimental and substantial long-term influence on health expenditure. Although population growth and real GDP have a favorable long-term effect on real GDP, A 1 percent increase in real economic growth increases health spending over the long term by 0.38 percent. Similarly, population growth increases of 1 percent increase in health spending by 1.57 percent over the long-term. Such findings are in line with those found in (Hossain et al., 2019; Wu et al., 2020; Zaidi et al., 2018). Setting real GDP as the dependent variable, Table 5 reveals that only CO2 emissions have a long-term adverse and substantial impact on real

GDP, but that the population has a positive and substantial impact on real GDP. In comparison, health spending has little major effect on actual GDP. Other reports (Al-mulali, Lee, Mohammed, Sheau-Ting, & Feedback, 2013) affirm the findings of this study (Chen, Lee, & Chiu, 2014). The result indicates that a 1 percent reduction in CO2 emissions requires a long-term rise in economic output of 0.91 percent. A 1 percent rise in CO2 emissions raises actual GDP over the medium term by 0.3 percent. In comparison, a population growth of 1 percent boosts actual GDP over the long term by 0.098 percent. At 1 percent, the error correction term has an adverse and substantial, indicating an long-term stability at a slow level.

Table 3. Long-run Pool Mean group analysis (C02)

	LONG-RUN			ECM				
	PG	HE	GDP	ECT (-1)	Δ(PG)	Δ(HE)	Δ(GDP)	C
Coefficient	0.3226***	0.1980***	-0.2647***	-0.3345***	0.4590***	0.0159	-0.0924	-0.4553
T statistics	4.254	4.7580	-5.9614	-6.1873	3.3455	0.1797	-0.6752	-6.1281
Prob	0.0000	0.0000	0.0000	0.0000	0.0001	0.8471	0.5894	0.0000

Table 4. Long-run Pool Mean group analysis (HE)

Long-run model estimation

	Coefficient	T. Statistics	Prob
CO2	-0.895241***	-34.369210	0.0011
GDP	0.512001****	6.251420	0.0000
PG	1.633310***	25.148791	0.0000

Error correction model estimation

	Coefficient	t-statistics	Prob
ECT (-1)	-0.102584*	-1.850004	0.0812
ΔHE (-1)	0.089541	0.895420	0.3452
Δ CO2	0.417852	1.658412	0.1101
Δ CO2 (-1)	-0.214588	-1.542698	0.3562
Δ CO2 (-2)	-0.079521	-0.521300	0.7541
Δ GDP	0.289641	0.320109	0.7510
Δ GDP (-1)	0.002840	0.008420	0.9821
Δ GDP (-2)	0.785412	0.796952	0.5428
Δ PG	0.078522	-0.215892	0.6215
Δ PG (-1)	0.269478	0.641000	0.6214
Δ PG (-2)	0.331456	0.879222	0.4330
Cons	-0.354214	-1.485791	0.1852

Table 5. Long-run Pool Mean group analysis (GDP)

	Coefficient	T. Statistics	Prob
CO2	-0.087541***	-33.254110	0.0000
HE	0.000293	2.632541	0.1452
PG	0.076522***	12.521200	0.0000

Error correction model estimation

	Coefficients	T-statistics	Prob
ECT (-1)	-0.560012***	-4.652140	0.0001
ΔGDP(-1)	0.215841	1.156251	0.3012
ΔCO2	0.421581**	2.012010	0.0314

ΔCO2(-1)	-0.085121	-0.145211	0.6851
Δ CO2 (-2)	0.089921	0.542158	0.8752
Δ CO2 (-3)	-0.068744	-0.321548	0.6540
Δ HE	0.114589**	-2.695487	0.0201
Δ HE (-1)	-0.458921**	-1.785215	0.0400
Δ HE (-2)	0.785421	1.462150	0.1874
Δ HE (-3)	-0.584792***	-3.003100	0.0010
Δ PG	-0.511562**	-3.897321	0.0160
Δ PG (-1)	0.085421	0.452637	0.8754
Δ PG (-2)	-0.362147	-1.301248	0.1770
Δ PG (-3)	-0.382410*	-1.214500	0.0800
Cons	2.152001	3.632510	0.0004

Causality tests

To determine the short-run, long-run, and causality nexus between the variables, we used the Wald and F-test.
The long-run causalities for GDP, CO2 and HE are displayed in Table 6. From GDP, PG and CO2 to HE, there is a long-term causality.

Table 6 Long-run causality

	Wald	Prob	F-test	Prob
HE	7.15425**	0.0300	7.15425**	0.0300
C02	19.02101***	0.0000	19.02101***	0.0000
GDP	9.92001***	0.0050	9.92001***	0.0050

Short-run causality

The short-run causalities of economic growth, CO2 pollution, health spending, and population growing are illustrated in Table 7. We notice a short-run movement in one direction affiliation from CO2 to HE by checking the variables one-by-one but the reverse path is unobservable. The causal path between CO2 and GDP is not measurable over the short term. Hence, with all variables, the null theory is supported. By comparison, the short-run connection is unidirectional between GDP and HE, which confirms past investigations. The finding is supported by (Chaabouni & Saidi, 2017) whose investigations found a bidirectional causality between health spending GDP of 51 nations employing the GMM analysis technique. Contrarywise, the unidirectional nexus of GDP to HE is identify in evolving nations within many Latin America and Caribbean's nations. Furthermore, causality over the short-term from PG to HE is not measurable. Checking the variables in pairs, we found that GDP, CO2, and HE have short-run bidirectional causalities. The causality of GDP and PG to HE variables is not measurable if we test the variables one by one, but if we apply CO2 to both of these two indicators, the causality of HE is observable and the causality of pairs (GDP and PG) to HE is neutral. AGAIN, the specific short-run causalities of CO2 emissions from HE and GDP are not detected. Similarly, these two factors are inadequate to collectively cause emissions of carbon dioxide. The paired causality is present, however if we apply PG to both the variables (HE, GDP). Third, from HE, CO2, and PG to GDP, the short-run causality (per pair) continues. Lastly, the short-run causality continues for all variables if PG is applied to such variables (GDP, CO2, and HE).

Table 7. Short-run analysis

	Wald	Prob	F-statistic	Prob
CO2→ HE	8.985470**	0.0110	2.148720**	0.0147
GDP →HE	3.197932	0.3621	1.065977	0.3663
PG →HE	6.012361	0.1120	1.7741120	0.1515
CO2, GDP →HE	15.10231**	0.0491	2.218738**	0.0405
CO2, PG → HE	16.36280**	0.0164	2.727134**	0.0131
GDP, PG → HE	10.32140	0.1710	1.566227	0.1556
CO2, GDP, PG → HE	22.05622***	0.0087	2.4550691***	0.0100
HE → CO2	0.105904	0.2556	1.295904	0.2556
GDP →CO2	2.002398	0.5039	0.447398	0.5039
PG → CO2	21.25241***	0.0001	15.16641***	0.0001
HE, GDP → CO2	1.079755	0.4471	0.804877	0.4478
HE, PG → CO2	23.55992***	0.0001	9.279961***	0.0001
GDP, PG → CO2	12.16783***	0.0005	7.583961***	0.0006
HE, GDP, PG → CO2	15.01177***	0.0003	7.583922***	0.0004
HE → GDP	5.998157**	0.0283	4.812257**	0.0288
CO2 → GDP	77.02011***	0.5422	0.371495	0.5425
PG →GDP	12.00094***	0.0000	15.03049***	0.0001
HE, CO2 → GDP	6.091694*	0.0784	2.54847*	0.0795
HE, PG → GDP	22.07680***	0.0000	14.03`340***	0.0000
CO2, PG → GDP	18.02239***	0.0003	8.291197***	0.0004
HE, CO2, PG → GDP	31.70337	0.0000	9.464456***	0.0000

Strong causality

The strong influences of health spending, environmental degradation, population rise and economic growth as seen in Table 8. Second, there are clear bidirectional causalities between economic growth, production of carbon dioxide, rising in pollution and spending on health. It is difficult to detect the clear causality of HE to GDP. The strong causality still remains even though we apply PG to these three variables. Moreover, the causality for all variables is bidirectional if we calculate every pair of variables, except for the strong neutral causation that runs from HE and CO2 to GDP. if we explore the variables one-by-one, bidirectional nexus occurs between HE and CO2, and between CO2 and GDP. For the entire panel, there is no affiliation between HE and GDP. These findings confirm a bidirectional causality (Ben Jebli, Hadhri, & Ecology, 2018) between GDP and CO2. This outcome, on the one hand means that there is an interdependence between Gross national income and spending on health and CO2 emissions.

Table 8 strong causality

	Wald	Prob	F- statistics	Prob
CO_2 → HE	14.63567***	0.0011	8.184789***	0.0021
GDP →HE	7.027561*	0.0709	2.564390*	0.0931
PG → HE	13.21547***	0.0049	2.571369**	0.0375
CO_2, GDP → HE	19.17040***	0.0072	2.738628***	0.0087
CO_2, PG → HE	23.99108***	0.0041	3.142012***	0.0031
GDP, PG → HE	13.81962**	0.0512	1.974231**	0.0573
CO_2, GDP, PG → HE	31.01348***	0.0021	2.709348***	0.0031
HE → CO_2	16.04256***	0.0000	8.021279***	0.0000
GDP →CO_2	17.54710***	0.0000	7.933552***	0.0004
PG → CO_2	22.54865***	0.0000	14.77432***	0.0000
HE, GDP → CO_2	13.12374***	0.0001	5.521247***	0.0010
HE, PG → CO_2	32.01217***	0.0000	10.70406***	0.0000
GDP, PG → CO_2	19.14322***	0.0000	9.854407***	0.0000
HE, GDP, PG → CO_2	28.01294***	0.0000	8.030486***	0.0000
HE → GDP	11.131928	0.1612	1.68556	0.1370
CO_2 → GDP	15.02153*	0.0771	2.065906*	0.0689
PG →GDP	30.24675***	0.0000	6.049350***	0.0000
HE, CO_2 → GDP	11.77434	0.2122	1.308260	0.2306
HE, PG → GDP	32.71377***	0.0001	3.634864***	0.0002
CO_2, PG → GDP	34.57801***	0.0001	3.842001***	0.0001
HE, CO_2, PG → GDP	39.03837***	0.0002	3.002951***	0.0003

4. Conclusion

This research explores the causal connections between health spending, population growth, environmental emissions, and economic growth for the date between 1996 and 2017 for the Latin American and Caribbean nations. To explore the short-and long-term nexus between HE, PG, GDP, and CO_2. The article employed the ARDL-PMG method. Second, the observations of the boundary co-integration and the whole model of error correction show the presence of a long-term affiliation between these factors.

Secondly, the long-term forecast suggests that government spending on health and population growth has a favorable and statistically imperative effect on emissions of the atmosphere. Only the gross domestic product has an effect on CO_2 pollution that is unfavorable and statistically significant. The interdependence between GDP, HE, and PG in a panel of investigated countries indicates that better economic progress lowers environmental effluence and improves health cost. In addition, when the government encourages investment in health spending and decreases environmental emissions, economic growth and social development improves.

Third, there are long-term causalities between economic growth, population growth, degradation of the environment and spending on health. Checking the factors one-by-one, from economic output to health expenditure, there is a short-run unidirectional causality, but the other trend is unobservable. For the short term, all causal paths are invisible between the environmental population and economic development. The short-term causality between GDP and HE, by comparison, is unidirectional and runs from economic growth to expenditure on health. Moreover, we have stated that the short-term causality of health spending derives from economic expansion, production of carbon dioxide, and population change. However, if we add CO_2 to the two causes of economic advance and population rise, the causality of the couple's economic growth and population growth to health expenditure is neutral. In particular, the actual short-run causalities for HE and GDP CO2 emissions are not found. Similarly, when put together the combined impact on carbon emission is less. Therefore, the causality is present if we add population density to any of the two variables, health spending and gross domestic product. In addition, the short-run causality between health spending, CO2 and PG for GDP persists. Finally, if PG is added to the variable's GDP, carbon pollutants, and health cost, the short-run causality applies on all indicators. Fourth, strong bidirectional causalities occur between economic development, carbon dioxide emissions and health spending. However, the robust causality of health costs to GDP is indiscernible. Furthermore, for all variables, the causality is bidirectional if we examination per pair of variables. The strong causality for economic growth in health spending and carbon dioxide emissions is null.

5. Limitations and Further studies

This article has some drawbacks to the sampling size and sources. Data covered only some selected nations that the World Bank database reported for the period of the investigation. Data maybe collected from other sources and the years of analysis increase to cover more areas and variables. Again, the research employed the pooled mean group calculation (ARDL-PMG) autoregressive distributed lag model in the analysis. Further research can adopt different regression analytical methods. Finally, this article only use data on health expenditure, GDP growth, population growth, and carbon emission to establish the affiliation between the variables. Future research can include more variables environmental pollutant indicators. Despite its limitations, this research is significant for corporations and state governments regulatory authorities, as the desire for better environment is the priority of very nation.

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