Health, economic growth, and Gini index in North America using a panel model

Salud, crecimiento económico, e índice Gini en Norteamérica usando un modelo panel

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Abstract

Objective: The objective of this paper is assessed the nexus among health status, economic growth, and the Gini index in North America and its countries using a panel model.

Materials and Method: The materials consist of annual data regarding life expectancy, government health expenditure as percentage of the gross domestic product, Gini index, and gross domestic product at constant 2015 US$ for the period 2000-2019. The method applies a panel model for North America and its three countries: Canada, Mexico and The United States. North America diversity treatment among countries is dealt with fixed and random effects.

Results: North America inhabitants health status are negatively influenced by an increasing income inequality, and a reduction on economic growth. The country that expends more in health care is The United States, follow by Canada and Mexico. The biggest reduction on life expectancy from an increase in income inequality is in The United States, followed by Canada and Mexico. Life expectancy increases when Canada and The United States experience economic growth. The countries with inarticulate health policy responses to an increase in income inequality are first Mexico followed by The United States.

Conclusions: In North America and its countries an increasing income inequality reduces life expectancy, and government health expenditure. Economic growth benefits life expectancy and government health expenditure. Health status seems to improve with a reduction in income inequality and a greater public health expenditure. Therefore, policies that increases income inequality and reduces public health expenditure seems to be advocates of a reduction: in health status, population welfare and economic growth.

Keywords: Health expenditure; Economic growth; Life expectancy; Gini index; North America.

Resumen

Objetivo: Un análisis cuantitativo de las relaciones entre salud, crecimiento económico e índice de Gini en América del Norte y sus países se realiza mediante un modelo de panel. El estado de salud está representado por la esperanza de vida y los sistemas de salud pública por el gasto público en salud. El crecimiento económico es el cambio porcentual del producto interno bruto. La desigualdad de ingresos se representa con el índice de Gini.

Materiales y método: Los materiales consisten en datos anuales de esperanza de vida, gasto público en salud como porcentaje del producto interno bruto, índice de Gini y producto interno bruto en dólares estadounidenses constantes de 2015 para el período 2000-2019. El método consiste en aplicar un modelo de panel para América del Norte y sus tres países: Canadá, México y Estados Unidos. El tratamiento de la diversidad entre los países de América del Norte es abordada con efectos fijos y aleatorios.

Resultados: El estado de salud de los habitantes de América del Norte se ve influenciado negativamente por la creciente desigualdad de ingresos y la reducción del crecimiento económico. El país que más gasta en salud es los Estados Unidos, seguido de Canadá y México. La mayor reducción en la esperanza de vida debido a un aumento en la desigualdad de ingresos se encuentra en los Estados Unidos, seguido de Canadá y México. La esperanza de vida aumenta cuando Canadá y Estados Unidos experimentan crecimiento económico. Los países con respuestas de política de salud desarticuladas ante un aumento en la desigualdad de ingresos son primero México seguido de Estados Unidos.

Conclusiones: Las políticas que aumentan la desigualdad de ingresos y reducen el gasto público en salud parecen ser promotoras de una reducción: en el estado de salud, el bienestar de la población, y el crecimiento económico.

Palabras clave: Gasto de salud; Crecimiento económico; Esperanza de vida; Índice de Gini; Norteamérica.

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Introduction

The last decades have seen an increase on income inequality. With the actual income distribution, the richest top 1% of the population accumulates more of the 50% of global income, with a corresponding Gini index of 0.85.[1] Where the Gini index values are inside the range of cero to one. A Gini index equal to zero implies that everyone has the same income. A Gini index equal to one implies that only one person on the world holds all income. During this time, health systems in North America have experienced an increasing income inequality, alongside with increasing private health expenditures. Most of the private health expenditures are conformed by out of pocket expenses. These conditions hinder health access for income and health vulnerable groups. In what follows Tables 1 and 2 display some of these dynamics for the period under study.

Table 1. Health expenditure in North America and its countries. Averages, 2000-2019

Region and countries	*hgdp per-capita*	% *hgdp* total	% *hgdp* government	% *hgdp* private
North America	4,121	10.31	5.71	4.60
Canada	4,133	9.92	7.03	2.89
Mexico	502	5.55	2.65	2.90
The United States	7,730	15.45	7.45	8.00

Notes: is gross domestic product health expenditure, the units for per-capita are current United States dollars, % total is current health expenditure as percentage of, % government is domestic general government health expenditure as percentage of, % private is the difference between % total and % government[2,3,4]. Source: Own elaboration based on data from the World Bank and Stata 17 MP.

Table 1 shows that health expenditure *per-capita* in The United States is 1.87 times larger than in Canada, and 15.39 times larger than in Mexico. The government and private health expenditure decomposition exhibits that private health expenditure is larger in The United States and Mexico, than the government health expenditure. In Canada government expenditure is larger than the private health expenditure. The country that expends the most in health is the United States with 15.45 of its total gross domestic product, it is followed by Canada with 9.92% and Mexico with 5.55%. The health expenditure *per-capita* in decreasing order are The United States (7,730 US$), Canada (4,133 US$), and Mexico (502 US$).

Table 2 baseline is the % total for North America. Therefore, all entries are equal to 100. The government percentage on total health expenditure are above the 50% for North America region, for the five years under observation. A similar pattern is shared by Mexico and The United States. In contrast, Canada exhibits a government health expenditures percentage of about 70%. Thus, the figures for Mexico and The United States are inferior to Canada.

Table 2. Total health expenditure decomposition in government and private percentages for North America and its countries. 2000-2019

Region and countries	2000	2005	2010	2015	2019
% total North America	100	100	100	100	100
% government North America	56	52	55	56	57
Canada	75	73	68	69	69
Mexico	50	42	48	50	54
The United States	46	44	49	50	50
% private North America	44	48	45	44	43
Canada	25	27	32	31	31
Mexico	50	58	52	50	46
The United States	54	56	51	50	50

Notes: *hgdp* is gross domestic product health expenditure, % *hgdp* total North America is current health expenditure as 100%, % *hgdp* government for North America and its countries is domestic general government expenditure as percentage of *gdp* total health expenditures, % *hgdp* private for North America and its countries is the difference between % *hgdp* total and % *hgdp* government[5,6,7,8].
Source: Own elaboration based on data from the World Bank and Stata 17 MP.

It is important to mention that Canada in the two decades under analysis, the government health expenditure has been reduced from 75% to 69%. Perhaps this trend speaks of a reduction in the participation of the Canadian public health expenditure, and at the same time it has been replace with an increasing participation from the private sector in this type of expense. In contrast, Mexico and the United States has been increasing the government health expenditure in the two undergoing decades. The smallest private percentage on total health expenditure is for Canada with figures close to 30%, although increasing from 25% in 2000 to 31% in 2019. Mexico and the United States exhibits figures around the 50% levels for the five years under consideration, albeit a decreasing participation of private percentage in total health expenditure.

There are not data for the pandemic years to date (April, 2023) in the World Development Indicators, World Bank data base. Perhaps new dynamics would be established with the massive government financial interventions in health sectors, as well as in research and development of vaccines, treatments, and cash stimulus. According with some references the pandemic outbreak caused by the SARS-CoV-2 has placed a setback on the health systems[9]. SARS-CoV-2 has declined global life expectancy and had placed setbacks in areas including childhood immunizations and infectious diseases treatments such as malaria and tuberculosis[10]. This author mentions some mitigating measures from The United States to palliate SARS-CoV-2 effects: The United States global health funding has increased since the onset of the pandemic. Through regular appropriations, but mostly through emergency supplemental funding. Most of this funding has been specifically used to support global access to the SARS-CoV-2 vaccines, testing, and therapeutics. Continuing with this author, central to this funding strategy is the goal of

strengthening health systems to achieve multiple objectives across global health programs. He says that such a system requires a robust primary care infrastructure buttressed with a *cadre* of community health workers and supported by universal health coverage: crosscutting activities such as surveillance, diagnostic laboratory capacity, and access to clean water, sanitation, and hygiene, particularly in health care facilities. Optimal health access depends on addressing the prevention and treatment of a wide spectrum of illnesses[2]. This view is wider than the previous ones, as it considers health as a holistic process.

One of the immediate impacts of the SARS-CoV-2 is that global life expectancy has been declined by around two years[11]. Other impact of the SARS-CoV-2 is the reduction of breast diagnostic services and breast cancer treatments, which would undoubtedly increase woman mortality rate[12]. Life expectancy in The United States declined nearly a year from 2020 to 2021, the lowest level since 1996[10]. Also, identified substantial geographical and socioeconomic inequalities in cervical cancer globally, with a clear gradient of increasing rates for countries with lower levels of human development[13]. The council on foreign relations released a seminal study on the emerging crisis of noncommunicable diseases, and recommended The United States leadership in several areas, including primary and secondary prevention of cardiovascular disease, tobacco control, human papillomavirus vaccination, and cervical cancer screening[10]. Other priority areas include nutrition, physical activity, obesity, and integration of mental health into primary care[10]. Even though some of these areas are addressed in current United States programmatic efforts, non-communicable diseases fail to obtain the level of attention that they deserve to support health gains in low-income countries.

It is also important to consider that health access depends on organization and financial support from the health system. Therefore, government health expenditure is key to provide universal access. In this way those that cannot afford health services with out of pocket expenditures can gain access to the health system and improve their health status.

Is worth mentioning that health is a multidimensional phenomenon. It is affected for environmental and economic factors. However, not all these factors have a proper record. Thus, several studies that analyze health status simplify its factors list to only economic factors[14,15,16]. Other studies have suggested a relationship between an increasing income inequality with health indicators poor performance, like a low life expectancy and an increasing child mortality rate[17].

It is important to mention that health markets exhibit failures like asymmetric information and externalities. These markets are characterized by natural monopolies (public goods), and intellectual property rights monopolies (patents). With market failures out of pocket health expenditures provides health access for those with sufficient income to pay monopoly prices. If health access is left to market incentives, income and health vulnerable groups would not have a proper medical attention. This could imply social inequalities in individual development. To avoid this type of social inequalities, government intervention is necessary to correct health market failures and provide universal health access.

One way in which government can intervene in health markets is through public health expenditure. Public health expenditure has been growing in the last decades given two new dynamics. One, an increase in life expectancy that overwhelms pension systems. Two, new technologies, drugs and treatments increasing costs[3,18]. During the pandemic SARS-CoV-2 years the cost of financing research and vaccinates has been vast. Research and development from the 15 largest pharmaceutical companies record about $138 billion of US dollars in 2022. This last figure represents a 43% increase with respect to 2017[19].

Several studies have pointed out that universal health access is desirable for vulnerable groups for reasons of income or specific health conditions[5]. When out of pocket expenses are not enough to secure a good standard in health status for the vulnerable groups, public health expenditures should be ideally a complement to them. This public policy view made necessary an assessment of the public health expenditures and health status related with efficiency and income inequality regarding health market failures alleviation.

The objective of this paper is assessed the nexus of health status, economic growth and the Gini index in North America and its countries using a panel model. Health status is gauged by life expectancy and public health system by government health expenditure. Economic growth is gross domestic product percentage change. Income inequality is represented by the Gini Index. The gross domestic product percentage change would allow the obtention of an economic growth measure. The Gini index is a measure of income inequality. The North America region is composed by three countries: Canada, Mexico and The United States. A panel model is implemented to distinguished individual fixed effects and individual random effects in this region. The period under analysis is 2000-2019 with annual data. Recent years are not available in the Work Development Indicators data base (Retrieving date April, 2023) to show what had happened in health systems regarding the SARS-COVID-19 outbreak. It is important to know how the health status relates with key economic indicators to help assessing the effectiveness of the health system and try to direct resources thorough a suitable policy where they are needed the most.

Materials and method

The summary statistics of each variable used in the panel model are reported on Table 3. These variables are life expectancy at birth total (years), domestic general government health expenditure (% of *gdp),* Gini index, gross domestic product (*gdp* constant 2015 US$), for each country that conforms the North America geographical area: Canada, Mexico and The United States. The statistics reported are the mean, standard deviation, coefficient of variation and kurtosis.

The mean life expectancy at birth for males and females (total) measured in years is larger in Canada with 80.90, than in Mexico (74.28) and The United States (78.06). The coefficient of variation (the ratio between standard deviation and the mean) for life expectancy is bigger for Canada and The United States (0.01, respectively), than in Mexico 0.00. These figures implies that there is more data variability around the mean for Canada and The United States, than for Mexico. The kurtosis of 3.34 indicates that the data have more outliers in Mexico. The United States and Canada kurtosis are 1.95 and 1.70, respectively. Thus, the country with less data outliers is Canada. So, Canada is the country with the biggest life expectancy, less outliers, and greater variation of the data around the mean in North America.

The domestic general government health expenditure as percentage of the gross domestic product is larger in The United States with 7.45%. It is followed by Canada (7.03%) and Mexico (2.65%). The largest data variability around the mean is also for The United States, with a coefficient of variation of 0.13, follow by Mexico (0.12) and Canada (0.08). Mexico exhibits a kurtosis of 2.39 meaning it has the biggest outliers, it is followed by The United States (1.88) and Canada (1.59). So, The United States is the country with the largest health expenditure as percentage of the gross domestic product and coefficient of variation.

The average of the Gini index is bigger in Mexico (49.06), than in The United States (40.86) and Canada (33.49) for the period 2000-2019. The biggest dispersion of the data measured by the standard deviation is for Mexico (1.67) followed by The United States (0.44) and Canada (0.29). The largest dispersion of the data around the mean is for Mexico (0.03) followed by The United States (0.01) and Canada (0.01). The largest outliers in the data are for Canada (3.70) followed by Mexico (2.95) and The United States (2.25).

The largest gross domestic product at constant 2015 United States trillions of dollars on average for the entire period of 2000-2019 is for The United States (16.59), followed by Canada (1.42), and Mexico (1.04). Similar pattern is followed by the standard deviation, the biggest one is for The United States (1.82), next Canada (0.16) and last Mexico (0.13). The coefficient of variation indicates that Mexico has the biggest dispersion of the data around the mean (0.13) followed by The United States and Canada, both with a value of 0.11. Regarding the kurtosis, the biggest outliers are in The United States (2.12), followed by Canada (2.01), and finally Mexico with (1.79).

During the period under analysis there are 19 years of data where The United States have a higher health care expenditure. Life expectancy in The United States is lower than in Canada, who in turn spends less in health care. In 2019 life expectancy in Canada is 82 years on average for women and men, while for the same year life expectancy in The United States is 79 years total. The lowest life expectancy is exhibited for Mexico with an average of 74 years for 2019.

The highest health expenditure is exhibited by The United States for the period 2005-2019. In 2019 health expenditure is 8.5% of The United States *gdp*. Canada has a health expenditure on 2019 of 7.5% of its *gdp*. The country that expends less in health is Mexico with a 2.8% of its *gdp* for the 2019 year.

The United States spent 17.8% of its gross domestic product on health care in 2016[14]. The data analyzed here points out that for 2016 the corresponding figure for government health expenditure (private health expenditure is excluded) is 8.5%. The United States total health expenditure as percentage of the gross domestic product is 15.45% on average for the period 2000-2019. The figure provided probably considers the total health expenditure as the sum of private and public health expenditures. Prices of health care labor and goods, including pharmaceutical and administrative costs, appeared to be the major drivers of the difference in overall spending between The United States and other high-income countries[14,21].

"… The United States spends more on health care than any of other OECD countries spend, without providing more services than the other countries do"[3]. The United States provides health insurance from 20 million to an additional 25 million people[20]. This increase on the number of people with health insurance might imply that health care in The United States is becoming more equitable.

The biggest income inequality is experienced by Mexico, with an average of 49.06 of the Gini index for the whole period under analysis. There is a tendency to diminish income inequality in this country: in 2000 it has a value of 53 (in a scale of 0 to 100) and in 2019 it was 47. So, it has decreased by about five percentage points. The next North America country that exhibits a higher Gini index is The United States, although its variation (0.01 coefficient of variation) during the two decades under analysis is nil. The country with less

Table 3. Summary statistics. North America and its countries, 2000-2019, annual data

	mean (standard deviation)	coefficient of variation (kurtosis)
Life expectancy at birth total, years ()		
Canada	80.90	0.01
	(1.00)	(1.70)
Mexico	74.28	0.00
	(0.29)	(3.34)
The United States	78.06	0.01
	(0.75)	(1.95)
Domestic general government health expenditure as percentage of gdp ()		
Canada	7.03	0.08
	(0.54)	(1.59)
Mexico	2.65	0.12
	(0.31)	(2.39)
United States	7.45	0.13
	(0.96)	(1.88)
Gini index ()		
Canada	33.49	0.01
	(0.29)	(3.70)
Mexico	49.06	0.03
	(1.67)	(2.95)
The United States	40.86	0.01
	(0.44)	(2.25)
Gross domestic product, constant 2015 United States trillions of dollars ()		
Canada	1.42	0.11
	(0.16)	(2.01)
Mexico	1.04	0.13
	(0.13)	(1.79)
The United States	16.59	0.11
	(1.82)	(2.12)

Note: The coefficient of variation does not have units. In The United States one trillion of dollars equals 1 followed by 12 zeros, *i.e*., 1,000,000,000,000. Source: Own elaboration based on data from the World Bank and Stata 17 MP.

income inequality is Canada with an average of 33.09 for all the 2000-2019 period, also exhibiting small variation during these nineteen years (0.01 coefficient of variation). The United States *gdp* is the highest in the region (16.59 trillions of dollars). On average for the period under analysis is 12 times bigger than Canada *gdp* (1.42 trillions of dollars), and 16 times bigger than Mexico *gdp* (1.04 trillions of dollars).

A panel model is proposed to assess the nexus between health, economic growth, and the Gini index in North America. Canada, Mexico and The United States conform this geographical area and the corresponding panel model. The analyzed period is 2000 to 2019 with annual data. This period is chosen given the most recent available data in North America. The panel model advantages consist of studying individual fixed effects and individual random effects for each country as well as for the entire North America region. At the same time, statistics are obtained for individuals and the overall regression, conveying more information. The individual fixed effects are country dummies for the intercept, and the individual random effects are country dummies for the slopes. It is important to mention, that the econometric results of this panel model allow making statistic inference, and therefore provides a sound ground for policy making.

In what follows the panel model is represented by the following two equations:

$$logle_{it}=\beta_{0it}+\beta_{1it}\, loggdp_{it}+\beta_{2it}loggini_{it}+u_{1it} \quad (1)$$

$$loghe_{it}=\beta_{0it}+\beta_{1it}\, loggdp_{it}+\beta_{2it}loggini_{it}+u_{2it} \quad (2)$$

where le_{it} represents life expectancy at birth total in years, gdp_{it} stands for the gross domestic product in constant 2015 United States dollars, stands for the Gini index, *heit* is the domestic general government health expenditure as percentage of the gross domestic product, where represents individual countries (i=1 for Canada, i=2 for Mexico, i=3 for United States), at time t (t=2000,…,2019), β_{0it} is the intercept estimator for individual i and time t, β_0 is the intercept for North America, β_{1it} is the slope estimator for individual i and time t with respect to gdp_{it}, β_1 is the slope for North America with respect to gdp, β_{2it} is the slope estimator for individual i and time t with respect to $gini_{it}$, β_2 is the slope for North America with respect to $gini$, u_{1it} is the error term for individual i and time t of equation (1), u_{2it} is the error term for individual i and time t of equation (2), *log* expresses the logarithm operator. The error terms are assumed to be *niid* (normally independent and identically distributed) ~N(0,I1).

Without effects hypothesis:

H_0: β_0=0 and β_1=0 and β_2=0
H_1: β_0≠0 and β_1≠0 and β_2≠0

where H_0 is the null hypothesis. H_1 is the alternative hypothesis. The alternative hypothesis assumes that the intercepts and slope are different from zero. The null hypothesis implies that there are no differential effects in the intercept and the two slopes in equations (1) and (2) in North America. The country and time dimensions do not change in this case.

Individual fixed effects hypothesis:

H_0: β_{0i} =0
H_1: β_{0i} ≠0

The null hypothesis assumes that there is no change in the intercept at a country level. Here the individuals are the countries. The alternative hypothesis assumes that the intercept is different for each country. The time dimension does not change between countries, but its variation is considered within each country. Therefore, the subscript does not appear in the null and alternative hypothesis.

Individual random effects hypothesis:

H_0: $\beta_{1i}=0$ and $\beta_{2i}=0$
H_1: $\beta_{1i}\neq 0$ and $\beta_{2i}\neq 0$

The null hypothesis assumes that there is no change in the slopes at a country level. The alternative hypothesis assumes that the slopes for each independent variable (*gdp*, and *gini* respectively) are different for each country. The time dimension does not change in this case, but is variation is considered between each country. Therefore, the subscript does not appear in the null and alternative hypothesis.

Results

The unit root test is important because it assures that the estimated regressions will be not spurious. According with the Levin-Lin-Chu unit root test results in Table 2 all panel variables tested are stationary. This is because the null hypothesis that panels contain unit roots are rejected in three or more options of the Levin-Lin-Chu unit-root test. This means that the autoregressive polynomial of the characteristic function roots of each variable tested stay inside the unit circle. Therefore, these roots do not scape to infinity, which could happen with unstable and volatile panel variables. Unit-roots inside the unit circle assures parsimony in the economic behavior of the analyzed panel variables, and therefore is stationarity, which is a desired property to assure sample estimators convergence with the true population values.

Equation (1) is estimated with three variations in effects in the panel model: without effects, individual fixed effects, and individual random effects. The corresponding estimators are reported next in Table 3. The first column reports without effects, the second column reports individual fixed effects and the third column individual random effects. The estimation method is Ordinary Least Squares (OLS).

From Table 4 the *gini* estimate is negative in the first column reported. This negative sign implies that for one percent that *gini* increases the life expectancy will be reduced in 0.21% of a year for all North America countries. The estimate in column one (-0.21) is decomposed in the within estimator (-0.14) column two, and between estimates (-0.20, 0.12 and -0.31) column three for each individual country. In column three the between estimator for Canada indicates that for one percent that *gini* increases the life expectancy will be reduced by 0.20%. For Mexico for one percent that *gini* increases life expectancy will be increased by 0.12%. The estimator for Mexico exhibits a positive sign perhaps for the time/spatial correlation that this country has with Canada and The United States. Further investigation to separate this correlation can be done with an error component model. However, this investigation escapes from the scope of this study and may be an interesting subject for future research.

For The United States for one percent that *gini* increases the life expectancy would be reduced by 0.31%. Some individuals in The United States get excellent care, but not everyone, and that even though The United States is a great country it tolerates profound disparities in health[20]. Such health disparities seem to be a great social injustice[3]. "… the state if health in the country all the more concerning, at least in relative terms.

Table 4. Results of the estimates of equation (1), 2000-2019, annual observations. Double logarithmic functional form log-log (Student's t)

Independent variable	Dependent variable *Life expectancy at birth total*		
	Without effects	Individual fixed effects	Individual random effects
Gross domestic product *gdp*	0.00 (3.56)***	0.06 (9.55)***	
Canada			0.09 (11.01)***
Mexico			0.04 (6.38)***
United States			0.09 (6.33)***
Gini index *gini*	-0.21 (-26.04)***	-0.14 (-3.53)***	
Canada			-0.20 (-2.40)***
Mexico			0.12 (3.72)***
United States			-0.31 (-2.22)***
Constant	5.04 (112.26)***		2.54 (9.12)***
Canada		1.99 (7.00)***	
Mexico		1.87 (6.36)***	
United States		1.76 (5.75)***	
Akaike information criterion	-378.05	-442.43	-464.64
Schwarz information criterion	-371.76	-431.96	-449.98
Root mean squared error	0.10	0.00	0.00
n	60	60	60

Note: All estimators are significant at 99% (***), n is the number of observations.
Source: Own elaboration based on data from the World Bank and Stata 17 MP.

The U.S.'s life expectancy at birth -77- is close to three years below the OECD average, and is marred by ever-present racial and ethnic disparities"[22].

In column two the constant is investigated for each country with the aid of individual fixed effects. The time dimension does not change between countries, but its variation is considered within each country. For the case of Canada, the initial average value of life expectancy with respect to time is 1.99 for the period 2000-2019, the highest in North America. It is followed by Mexico with a figure of 1.87, and later by The United States with 1.76. These results implies that Canada have better life expectancy even before the period of 2000-2019.

Regarding the *gdp* estimate, it is almost nil in the first column reported (0.00). This estimate implies that *gdp* changes does not influence life expectancy in North America. However, to investigate further the effects of *gdp* per country, the estimate in column one (0.00) is decomposed in the within estimator (0.06) column two, and between estimators (0.09, 0.04 and 0.09) column three. In column three the between estimate for Canada indicates that for one percent that *gdp* increases the life expectancy will be increased by 0.09%. For Mexico for one percent that increases life expectancy will be increased by 0.04%. For The United States for one percent that *gdp* increases the life expectancy will be increased by 0.09%. So, the countries with have a better advantage from an economic growth in increasing life expectancy are Canada and The United States. Without a panel model, the impact of the gross domestic product over life expectancy would be nil. However, the panel model investigates the effects in each country, which makes a richer analysis and allows an idiosyncrasy study for each North America country.

From Table 5 it can be read that the *gini* estimator are negative in the first column reported (-2.37). This negative sign implies that for one percent that *gini* increases the domestic general government health expenditure will be reduced in -2.37% on average per year in North America. The estimate in column one (-2.37) is decomposed in the within estimate (0.01) column two, and between estimates (0.78, -0.07 and -5.61) column three. In column three the between estimate for Canada indicates that for one percent that *gini* increases the domestic general government health expenditure will be increased by 0.78%. This estimator perhaps is contaminated with a spatial correlation with the other two countries, where an error component model could dilucidated this. In the case of Mexico for one percent that *gini* increases the domestic general government health expenditure will be reduced by 0.07%. For The United States for one percent that *gini* increases the domestic general government health expenditure will be reduced by 5.61%. Perhaps, the greatest elasticity of The United States of *gini* with respect to health expenditure

Table 5. Results of the estimates of equation (2), 2000-2019, annual observations. Double logarithmic functional form log-log (Student's t)

Independent variable	Dependent variable *Domestic general government health expenditure*		
	Without effects	Individual fixed effects	Individual random effects
Gross domestic product *gdp*	0.21 (22.10)***	0.76 (8.72)***	
Canada			0.63 (5.41)***
Mexico			0.71 (6.93)***
United States			1.36 (6.20)***
Gini index *gini*	-2.37 (-30.27)***	0.01 (0.02)	
Canada			0.78 (0.66)
Mexico			-0.07 (-0.15)***
United States			-5.61 (-2.78)***
Constant	4.14 (9.81)***		-18.61 (-4.71)***
Canada		1.94 (76.35)***	
Mexico		0.96 (37.90)***	
United States		1.99 (78.40)***	
Akaike information criterion	-109.18	-141.48	-464.64
Schwarz information criterion	-102.89	-131.01	-449.98
Root mean squared error	0.09	0.07	0.00
n	60	60	60

Note: All estimators are significant at 99% (***), n is the number of observations. Source: Own elaboration based on data from the World Bank and Stata 17 MP. All columns are computed using Ordinary Least Squares.

responds to an inarticulate response from health policy makers to an increase in income inequality. "However, despite its higher spending, The United States performs poorly in areas such as health care coverage and health outcomes"[14,18,23,24]. A proposal is made by these authors to revert these health outcomes: "Efforts targeting utilization alone are unlikely to reduce the growth in health care spending in The United States; a more concerted effort to reduce prices and administrative costs is likely needed"[14].

In column two the constant is investigated for each country with the aid of individual fixed effects. The time dimension does not change between countries, but its variation is considered within each country. For the case of Canada, the initial average value

with respect to time is 1.94 of the domestic general government health expenditure. It is followed by Mexico with a figure of 0.96, and later is The United States with 1.99, the highest in North America. These results implies that The United States have the highest domestic general government health expenditure even before the period of 2000-2019 has started.

Regarding the *gini* estimate it has a coefficient of 0.21 in column one. For each one percent that *gini* increases, the domestic general government health expenditure would increase in 0.21% for North America on average for the period under study. However, to investigate further the effects of *gini* per country the estimate in column one (0.21) is decomposed in the within estimate (0.76) column two, and between estimates (0.63, 0.71 and 1.36) column three. In column three the between estimate for Canada indicates that for one percent that *gini* increases the domestic general government health expenditure will be increased by 0.63%. For Mexico for one percent that increases the domestic general government health expenditure would be increased by 0.71%. For The United States for one percent that *gini* increases the domestic general government health expenditure would be increased by 1.36%. So, the country with the biggest elasticity towards public health expenditure is The United States. The biggest expenditure in the world among the richest countries is made by The United States[3,20]. These authors explanations rely on The United States health market structure and income levels. In descending order, it is followed by Mexico (0.71) and Canada (0.63).

Discussion

Given the descriptive statistics and the panel model econometric results, health status is negatively influenced by an increase in income inequality in North America. The results suggest that an increase in economic growth (gross domestic product percentage change) would ameliorate life expectancy and government health expenditure. Therefore, health status is negatively influenced by an increase in income inequality and a reduction on economic growth. Other empirical analysis using time series and cross-section data had found similar results as in this document about the dynamics of health and economic indicators[25,26,27,28,29]. A panel analysis finds that financial inclusion significantly reduces income inequality in developing countries[30]. Also, in an empirical panel analysis it is found that poverty levels are reduced through economic growth in the emerging world, and it recommends policies working in improving the distribution of income where governments could improve the health of the income and health vulnerable groups with the increase of economic growth, and thereby increasing life expectancy[31].

The country that expends the most in health care is The United States with the biggest elasticity, follow by Canada and Mexico. The country that reduces more life expectancy by one percent of *gini* increase is The United States, followed by Canada and Mexico. These results match some authors insides, since it is known that The United States has the biggest health expenditures in OECD countries and at the same time it has profound health disparities and social injustices[3,20].

Conclusions

All variables that conform the panel model are stationary according with the unit root tests. The estimates reported in Tables 4 and 5 suggest that an increase in income inequality reduces life expectancy measured in years. At the same time, an increase in income inequality reduces government health expenditure measured as percentage of the gross domestic product for the North America region. For its part, an increase in gross domestic product increases health expenditure and life expectancy at birth, for this same region.

The North America region average results (without effects) are described in the previous paragraphs. Country results points out the presence of heterogenous characteristics in their health status. These characteristics are studied with a panel model that allows to decompose the North America estimators at a country level. In general, each country behaves as the North America region but with different elasticities. The country with a higher initial average value in equation (1) and (2) constant is Canada and The United States, respectively. These results imply that Canada has better life expectancy before the period analyzed. Also, they imply that The United States has a bigger general government health expenditure even before the period of 2000-2019.

The countries that have a better advantage from an economic growth for increasing life expectancy are Canada and The United States. It seems that the greatest elasticity of *gini* with respect to health expenditure is in The United States (-5.61). This elasticity probably responds to an inarticulate response from health policy makers (given to an excessive expenditure in transactional costs) to an increase in income inequality.

It seems that the health status improves with a reduction in income inequality and a greater public health expenditure. Therefore, those policies that increases income inequality and reduces public health expenditure seems to be advocates of a reduction in health status, population welfare and economic growth.

Conflict of interest

The authors declared that we do not have any conflict of interest to declare.

Authors' Contributions

Conceptualization and design, R.E.M.S., C.C.D.N.; Methodology, R.E.M.S., C.C.D.N.; Data Acquisition and Software, R.E.M.S., C.C.D.N.; Data analysis and interpretation, R.E.M.S., C.C.D.N.; Principal Investigator, R.E.M.S., C.C.D.N., Research, R.E.M.S., C.C.D.N., Manuscript Writing— Preparation of the original draft, R.E.M.S., C.C.D.N.; Writing, revision and editing of the manuscript, R.E.M.S., C.C.D.N.; Visualization, R.E.M.S., C.C.D.N.; Supervision, R.E.M.S., C.C.D.N.

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References

1. Piketty T. Capital in the Twenty-first Century. Cambridge Massachusetts: The Belknap Press of Harvard University Press;1998.

2. Khan M, Roy P, Matin I, et al. An Adaptive Governance and Health System Response for the COVID-19 Emergency. World Dev. 2021; 137, 105213. Available from: 10.1016/j.worlddev.2020.105213

3. Reinhardt UE, Hussey PS, Anderson GF. U.S. Health Care Spending in an International Context. Health Aff. 2004; 23(3):10-25. Available from: https://doi.org/10.1377/hlthaff.23.3.10

4. Schieber G, Maeda A. Health Care Financing and Delivery in Developing Countries. Health Aff. 1999;18(3), 193-205. Available from: 10.1377/hlthaff.18.3.193

5. Molina, R, Pinto M, Henderson, P, Vieira C. Health Spending and Financing: the Current Situation and Trends. Pan American Journal of Public Health, 2000; 8 (1/2), 71-83. Available from: https://iris.paho.org/handle/10665.2/8795

6. Organización Panamericana de la Salud. La Salud en las Américas 1998. Washington, D.C.: Organización Panamericana de la Salud; 1998.

7. Sen A, Kliksberg B. Primero la Gente. Una Mirada desde la Ética del Desarrollo a los Principales Problemas del Mundo Globalizado. Barcelona, España: Ediciones Deusto Planeta De Agostini Profesional y Formación, S.L; 2007.

8. Suárez R, Henderson P, Barillas E, Vieira, C. Gasto Nacional y Financiamiento de la Salud en América Latina y el Caribe: Desafíos para la Década de los Noventa. Organización Panamericana de la Salud, Organización Mundial de la Salud, Serie Informes Técnicos Número 30; 1994.

9. González-Carrasco, C. Todo es Posible. Del Colapso Sistémico a Soluciones Sistémicas. Perú, Lima: Grupo Ígneo; 2020.

10. Parekh A. Optimizing US Global Health Funding. JAMA. 2023; 329(17):1447-1448. Available from: 10.1001/jama.2023.1736

11. Arias E, Tejada-Vera B, Kochaneck K, Ahmad F. Provisional Life Expectancy Estimates for 2021. Vital Statistics Rapid Release. NVSS. 2022; Report No. 23, 1-16. Available from: https://www.cdc.gov/nchs/data/vsrr/vsrr023.pdf

12. Gathani T, Dodwell D, Horgan K. The Impact of the First 2 years of the COVID-19 Pandemic on Breast Cancer Diagnoses: a Population-Based Study in England. British Journal of Cancer. 2023; (128):481–483. Available from: https://doi.org/10.1038/s41416-022-02054-4

13. Singh D, Vignat J, Lorenzoni V, et al. Global Estimates of Incidence and Mortality of Cervical Cancer in 2020: a Baseline Analysis of the WHO Global Cancer Elimination Initiative. The Lancet. 2023; 11(e197-e206). Available from: https://doi.org/10.1016/S2214-109X(22)00501-0

14. Papanicolas I, Woskie LR, Jha AK. Health Care Spending in The United States and other High-Income Countries. JAMA. 2018; 319(10):1024-1039. Available from: 10.1001/jama.2018.1150

15. World Bank. World Development Indicators. Data Base. Retrieved on March, 2023. Available from: https://databank.worldbank.org/source/world-development-indicators#

16. World Health Organization. World Health Statistics 2022. Retrieved on May, 2023. Available from: https://www.who.int/news/item/20-05-2022-world-health-statistics-2022

17. Amin K. Income Distribution and Health: a Worldwide Analysis. The Park Place Economist. 2001; IX:(45-52). Available from: https://digitalcommons.iwu.edu/parkplace/vol9/iss1/14

18. Olivares-Tirado P, Zanga R. Waste in Health Care Spending: A Scoping Review. Int. J. of Healthc. Manag. 2023; 1-14. Available from: https://doi.org/10.1080/20479700.2023.2185580

19. IQVIA Institute for Human Data Science. Global Trends in R&D 2023: Activity, Productivity, and Enablers. United States, Parsippany, New Jersey: IQVIA; 2023. Available from: https://www.iqvia.com/insights/the-iqvia-institute/reports/global-trends-in-r-and-d-2023

20. Bauchner H, Fontanarosa PB. Health Care Spending in The United States Compared with 10 Other High-Income Countries. What Uwe Reinhardt might Have Said. JAMA. 2018; 319(10):990-992. Available from: 10.1001/jama.2018.1879

21. Anderson GF, Reinhardt UE, Hussey PS, Petrosyan V. It's the Prices, Stupid: why The United States is so Different from other Countries. Health Aff. 2003; 22(3):89-105. Available from: https://doi.org/10.1377/hlthaff.22.3.89

22. Davis E. Study: U.S. Lags behind other Wealthy Countries in Health Outcomes. U.S. News and World Report. [Online publication]. 2023. Available from: https://www.usnews.com/news/best-countries/articles/2023-02-01/u-s-lags-behind-other-wealthy-countries-in-health-outcomes-study-finds

23. National Center for Health Statistics. NCHS: U.S. Life Expectancy Fell from 78.8 Yrs 2019 to 76.1 Yrs 2021 (8.31.22), State Variation 2020 (8.24.22). AEA. 2022. Available from: https://www.aeaweb.org/forum/2994/nchs-life-expectancy-fell-from-2019-2021-state-variation-2020

24. National Center for Health Statistics. Life Expectancy in the U.S. Dropped for the Second Year in a Row in 2021. 2022. Available from: https://www.cdc.gov/nchs/pressroom/nchs_press_releases/2022/20220831.htm

25. Aiyard S, Ebeke C. Inequality of Opportunity, Inequality of Income and Economic Growth. World Development. 2020; 136:(1-10). Available from: https://doi.org/10.1016/j.worlddev.2020.105115

26. Bíró A, Hadju T, Kertesi G, Prinz D. Life Expectancy Inequalities in Hungary over 25 years: The Role of Avoidable Deaths. JPSS. 2021; 75(3):443-455. Available from: https://doi.org/10.1080/00324728.2021.1877332

27. Daly MC, Duncan GJ, Kaplan GA, Lynch JW. Macro–to-micro Links in the Relation between Income Inequality and Mortality. Milbank Q. 1998; 76(3):315-339. Available from: 10.1111/1468-0009.00094

28. Kawachi IBP, Kennedy I, Lockner K. Long Live Community: Social Capital as Public Health. AP. 1997; (35):56-59.

29. Sentürk Ī, Ali A. Socioeconomic Determinants of Gender-Specific Life Expectancy in Turkey: A Time Series Analysis. Sosyoekonomi. 2021; 29(49):85-111. Available from: 10.17233/sosyoekonomi.2021.03.05

30. Omar, MdA, Inaba K. Does Financial Inclusion Reduce Poverty and Income Inequality in Developing Countries? A Panel Data Analysis. J. Econ. Struct. 2020; 9(37):1-25. Available from: https://doi.org/10.1186/s40008-020-00214-4

31. Amar S, Idris I, Pratama, Anis A. Exploring the Link between Income Inequality, Poverty Reduction and Economic Growth: an ASEAN Perspective. Int. J. Innov. Creativity Chang. 2020; 11(2):24-41. Available from: https://www.ijicc.net/index.php/ijicc-editions/202...