Income, income inequality and mortality in metropolitan regions of Brazil: an exploratory approach

Mardone Cavalcante França and Neir Antunes Paes

Universidade Federal do Rio Grande do Norte/
Universidade Federal da Paraiba

Abstract

The goal of this study is to perform an empirical verification of the hypotheses of absolute income and income inequality for 16 metropolitan regions of Brazil (MRB), based on data from the Demographic Census of 2000 and vital statistics from 1999-2001 (deaths by age, sex and causes of death). To test the hypotheses, multiple regression models were adjusted for each independent variable and the statistical significance of regression coefficients corresponding to each hypothesis was verified. The results suggest that mean income is the determinant health factor for the population residing in MRB and not income inequality.

Key words: urban health, adult mortality, income inequality, metropolitan regions, Brazil.

Resumen

Ingresos, desigualdad de ingresos y mortalidad en regiones metropolitanas de Brasil: un acercamiento exploratorio

El objetivo de este estudio es realizar una verificación de las hipótesis de los ingresos absolutos y de la desigualdad de ingresos para 16 regiones metropolitanas de Brasil (RMB), basada en los datos del Censo Demográfico del 2000 y de las estadísticas vitales del trienio 1999-2001 (muertes por edad, sexo y causas de muerte). Para probar las hipótesis se ajustaron modelos de regresión múltiple para cada variable independiente y verificada e significado estadístico de los correspondientes coeficientes de regresión para cada hipótesis probada. Los resultados sugieren que el ingreso medio es un factor determinante de la salud de la población que reside en las RMB y no la desigualdad del ingreso.

Palabras clave: salud urbana, mortalidad adulta, desigualdad de ingresos, regiones metropolitanas, brasil.

Introduction

The relation between socioeconomic status and health has long been controversial, with studies producing discordant results (Wolfson *et al*., 1999; Wildman, 2001; Wilkinson, 1994; Lynch y Davey, 2002). Socioeconomic status is generally measured by indicators of income, education, occupation, and living conditions, among others, while health is measured by morbidity, mortality and self-declared health status (Wilkinson, 1992; Kaplan *et al*., 1996; Kennedy *et al*., 1996). One of the foci of this debate has been the role of income in determining the individual or collective health of the population. The controversy that feeds the interest and scientific production centers around the following questions: Does health generate income? Or does income generate health? The former is usually supported by sociologists and the latter by economists (Lynch *et al*., 2001; Rodgers, 2002; Preston, 1975; Deaton, 2003).

The wealth of scientific production found in the literature is focused on the negation or corroboration of the hypotheses of absolute income and income inequality. This problem was investigated by Wilkinson in a series of articles with income as a predictive variable of health conditions. He demonstrated that absolute income (mean income) and not income inequality is important in determining the health status of individuals in poor countries (Wilkinson, 1992; Braveman, 2002; Blakely *et al*., 2003). During the 1990s and the first years of this decade, various studies were published in different parts of the world, correlating income level and income inequality with mortality. The results, for the most part, corroborate the hypothesis of absolute income for poor countries and the hypothesis of income inequality for rich countries (Ghosh y Kulkarni, 2004; Rossi *et al*., 2000).

Studies on the relation between health and income that focus on metropolitan areas have been performed, mainly in the United States and other high-income countries such as Canada, England and Australia, and demonstrate that the significance of the association between income inequality and mortality cannot be generalized for all countries (Deaton y Lubotsky, 2003; De Vogli *et al*., 2005). Wilkinson found a correlation of -0.81 between income inequality and life expectancy at birth for 11 industrialized countries (Wilkinson, 1992). In another study in metropolitan areas of the United States with an adult population aged between 15 and 64 years, Lynch (Lynch *et al*., 1998) found a strong association between indicators of income inequality and mortality, concluding that areas with high income inequality and low mean income showed excess mortality when compared to areas of low inequality and high mean income. In Latin America, studies on the relation between mortality and socioeconomic indicators are scarce, mainly those dealing with adult mortality, despite increased interest in this topic since the 1990 (Drumond y Barros, 1999). A variation in the spatial mortality pattern was verified in the Brazilian state capitals, by comparing proportional mortality for the principal causes of death (Sichieri *et al*., 1992).

In Brazil, alterations in epidemiologic profile are also associated to the aging population and rapid urbanization.

In the 1980s and 1990s the effects of the epidemiologic transition were already being seen, with the increase in diseases associated to the lifestyle of modern metropolises, while deaths from infectious and parasitic diseases declined. In 1930, around 46 per cent of all deaths occurring in Brazilian state capitals were caused by infectious/parasitic diseases, while only 12 per cent were related to diseases of the circulatory system. In 1995, this picture was completely altered, with seven per cent of deaths caused by infectious/parasitic diseases and 33 per cent by circulatory system disorders. In recent decades the metropolitan regions of Brazil (MRB) have been the preferred destination of population migrations from small cities and rural areas, triggering a chaotic growth in the large metropolises and consequently, promoting a process of spatial and residential segregation that has caused peripheral areas to expand vertiginously, giving rise to large numbers of slums and an increase in urban violence (Szwarcwald *et al*., 1999). Despite the number of studies that have used life expectancy at birth, infant mortality and general mortality as well as specific causes of death among different countries or within a country itself, no definite conclusion has been arrived at to put an end to the controversy over the socioeconomic determinants of health in individuals or communities.

In spite of the importance, there are few studies on the relation between socioeconomic status and health in Brazilian metropolitan populations. The goal of this study was to perform, by means of an ecologic study, an empirical and exploratory verification of the hypotheses of absolute income and income inequality in 16 MRB, in 2000.

Data and sources

The data used in this article come from four basic sources: a) The Information System on Mortality (SIM) of the Ministry of Health, from where information was obtained on deaths by sex, age, area of residence and causes of death (ICD-10), considering mean number of deaths occurring from 1999 to 2001 to calculate adult mortality rates; b) The Brazilian Institute of Geography and Statistics (IBGE), using the Demographic Census of 2000 to obtain the population data necessary to calculate the adult mortality rates of individuals aged 10 to 64 years; c) Regional Accounts of Brazil for per capita GDP values of metropolitan regions and d) The Human Development Atlas of Brazil (ADHB)-2000, elaborated by the United Nations Development Program (UNDP), in partnership with the Institute of Applied Economic Research (IPEA) and IBGE. From ADHB were obtained indicators of life expectancy at birth (both sexes), infant mortality rate (per 1000 live births), per capita family income (in Reais - $R) and Gini's index, all aggregated for the 16 MRB. The quality of the death-related data used to calculate adult mortality can be considered satisfactory, given that the MRBs are highly urbanized areas encompassing state capitals and neighboring municipalities. Reporting in these areas is almost total and the proportion of deaths classified as «of undetermined cause» is at acceptable levels (mean six per cent).

Methods

The following hypotheses were tested: a) the hypothesis of absolute income: «the health status (measured by life expectancy at birth, infant mortality and adult mortality from specific causes) of the population of metropolitan regions of Brazil is associated to absolute income (measured by GDP per capita, per capita family income);» b) the hypothesis of inequality of income: «the health status (measured by life expectancy at birth, infant mortality and adult mortality from specific causes) of the population of metropolitan regions is not associated to unequal income distribution (measured by Gini's index).» Two statistical analysis strategies were used to verify the two hypotheses: first, Pearson's bivariate correlation test was used between indicators of mortality and income. Therefore, correlations were calculated between life expectancy at birth, infant mortality and adult mortality (10 to 64 years) standardized by sex and age for cancer and cardiovascular diseases and the indicators of income, per capita GDP, per capita family income and Gini's index. Second, the adjustment of multiple regression models with life expectancy at birth, the coefficient of infant mortality and adult mortality rates standardized by sex and age for cardiovascular diseases and cancer included in the models as dependent variables and verifiers of the health status of the population. On the other hand, per capita GDP, per capita family income and Gini's index are included as independent variables.

Four multiple regression models were adjusted, one for each dependent variable. The significance of the models was tested by Analysis of Variance (ANOVA) and the regression coefficients correspondent to each of the explanatory variables by student's t-Test.

Results

Descriptive statistics

The 16 MRB considered in this study are composed of 263 municipalities distributed by the five main geographic regions in the country-North, Northeast, Midwest, Southeast and South. Each MRB has the capital of its corresponding state as a nucleus and the remaining municipalities are confined to the contiguous geographic area that makes up its periphery. Figure 1 and Table 1 show respectively, the map of Brazil with the spatial administration of MRBs and the corresponding descriptive statistics. The 16 MRBs, used as analysis units, represent 23.4 per cent of the total population and 42.6 per cent of the urban population, accounting for 28.2 per cent of the country's GDP. There was an average of 170 thousand deaths in individuals aged 10 to 64 years between 1999 and 2001. The total population of MRBs varied from 17.9 million for the São Paulo MR to 709 thousand inhabitants for the Florianópolis MR. Life expectancy at birth ranged from 74.6 years for Florianópolis to 65.2 for the Maceió MR, while infant mortality rate extended from 11.9 to 43.0/1000 live births.

Income inequality, measured by Gini's index, lay between 0.56 and 0.68, while the coefficient of variation in table 1 revealed that population and per capita GDP showed the greatest relative variability with 1 211, seven and 38.5 per cent, respectively. Life expectancy at birth and Gini's index appear as the lowest coefficients of variability, with 2.8 and 9.2 per cent, respectively.

Bivariate correlation

The results of bivariate correlation between the variables, shown on the correlation matrix in table 2, reveals that life expectancy at birth has a positive association $r = 0.64$, ($p = 0.008$) with per capita family income, while infant mortality rate correlates inversely with this variable $r = -0.84$, ($p = 0.00$). A significant positive correlation was also observed between adult mortality rates for cancer, cardiovascular diseases and log(per capita GDP) and the respective values for correlation coefficient ($r = 0.53$, $p = 0.035$ and $r = 0.64$, $p=0.008$). No significant correlation was detected with Gini's index for any of the mortality measures used in this study. These results point to a significant correlation between health status and mean income (absolute) of the population with no direct association between health status and income inequality.

FIGURE 1
MAP INDICATING METROPOLITAN REGIONS BY GEOGRAPHIC REGIONS OF BRAZIL, 2000

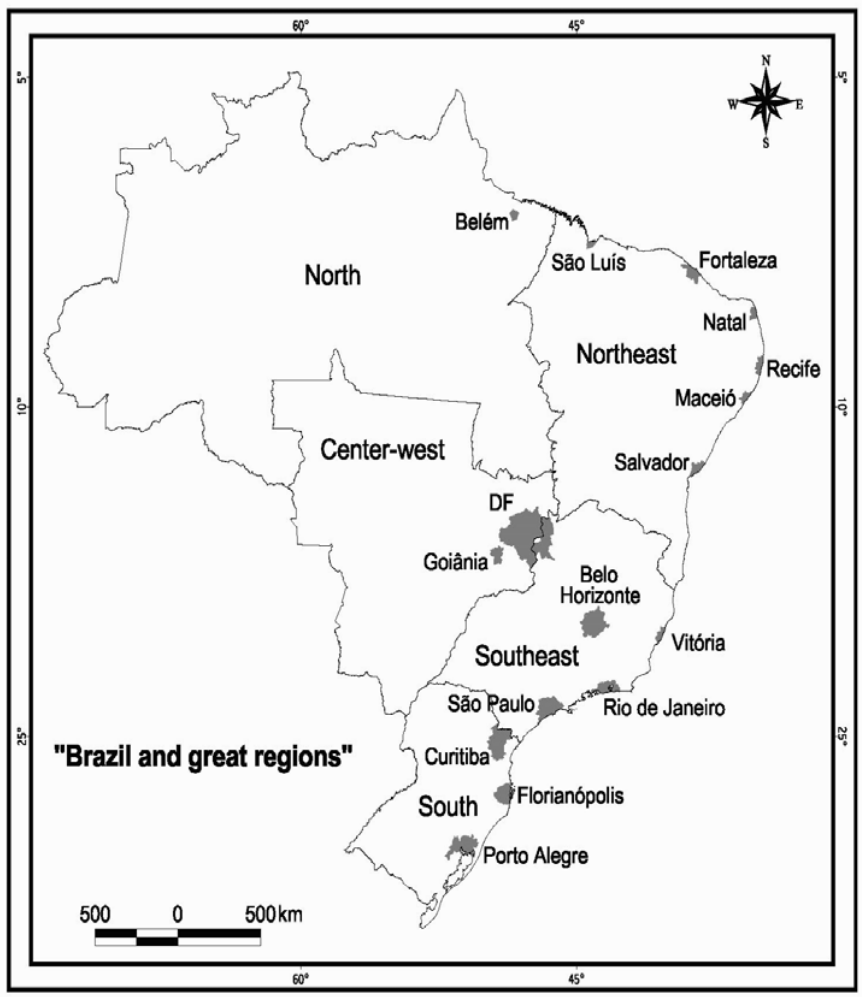


TABLE 1
POPULATION, HEALTH STATUS, INCOME INDICATORS AND DESCRIPTIVE STATISTICS FOR METROPOLITAN REGIONS OF BRAZIL RMB), 2000

Metropolitan regions	Population (in 1000) (1)	Life expectancy at birth (2)	Infant mortality (1000 live births) (2)	Adult mortality rate (per 100 000) cardiovascular disease (3)	cancer (3)	Per capita GDP (R$) (4)	Per capita family income (R$) (2)	Gini's Index (2)
BH - Belo Horizonte	4 357.94	70.43	27.53	70.46	28.88	8 397	394,34	0.57
BL - Belém	1 795.54	70.55	26.48	48.28	33.30	3 689	273.59	0.56
CT - Curitiba	2 768.39	70.88	20.22	65.98	38.30	8 723	457.44	0.54
DF - Federal District	2 958.20	70.07	22.87	55.19	29.68	10 815	483.26	0.62
FL - Florianópolis	709.41	74.58	11.90	51.51	33.56	6 715	521.3	0.65
FT - Fortaleza	2 984.69	69.59	34.73	34.31	26.82	4 339	252.7	0.61
GN - Goiânia	1 639.52	70.13	21.17	59.00	29.80	4 779	403.32	0.61
MC - Maceió	989.18	65.23	43.00	63.84	21.36	3 744	247.83	0.61
NT - Natal	1 097.27	68.39	37.87	44.25	23.66	4 126	277.12	0.68
PA - Porto Alegre	3 718.78	72.03	16.16	62.90	44.29	9 929	456.35	0.50
RF - Recife	3 337.57	70.61	30.00	76.94	30.89	5 496	280.82	0.50
RJ – Rio de Janeiro	10 898.16	69.51	21.60	66.11	35.84	8 169	452.61	0.59
SD - Salvador	3 021.57	69.13	36.32	64.60	30.04	8 296	311.24	0.67
SL – São Luís	1 070.69	68.62	29.53	48.93	28.80	3 696	229.26	0.66
SP – São Paulo	17 878.70	70.43	20.24	72.07	37.05	11 094	507.93	0.62
VT - Vitória	1 438.60	68.68	28.34	57.79	33.01	9 127	368.36	0.61
Mean	3 724.66	69.93	26.75	58.88	31.58	6 946	369.84	0.60
Minimum	709.41	65.23	11.90	34.31	21.36	3 689	229.26	0.50
Maximum	17 878.70	74.58	43.00	76.94	44.29	11 094	521.3	0.68
Standard deviation	45 131.59	1.950	8.386	11.28	5.65	2 676.26	102.04	0.05
Coefficient variation%	1 211.70	2.79	31.35	19.17	17.89	38.53	27.59	9.17

Sources: (1) IBGE Demographic Census of 2000; (2) UNDP- Human Development Atlas of Brazil, 2000; (3) Authors' estimates; (4) IBGE Regional Accounts of Brazil, 2000.

TABLE 2
BIVARIATE CORRELATION MATRIX OF THE HEALTH STATUS
AND INCOME INDICATORS IN METROPOLITAN REGIONS
OF BRAZIL (MRB), 2000

Variables	LEB	IM	LogGDP	PCFI	GINI	SAMC	SAMCI
LEB	1.0000						
	-0.8453*						
IM	(0.0000)	1.0000					
	0.3918	-0.5398*					
LogGDP	(0.1330)	(0.0310)	1.0000				
	0.6390*	-0.8442*	0.8012*				
PCFI	(0.0080)	(0.0000)	(0.0000)	1.0000			
	-0.2250	0.2234	-0.1224	-0.0417			
GINI	(0.4020)	(0.4050)	(0.6520)	(0.8780)	1.0000		
	0.0391	-0.1912	0.5281*	0.3620	-0.4093		
SAMC	(0.8860)	(0.4780)	(0.0350)	(0.1680)	(0.1150)	1.0000	
	0.6459*	-0.7954*	0.6369*	0.6562*	-0.4096	0.3477	1.0000
SAMCI	(0.0070)	(0.0000)	(0.0080)	(0.0060)	(0.1150)	(0.1870)	

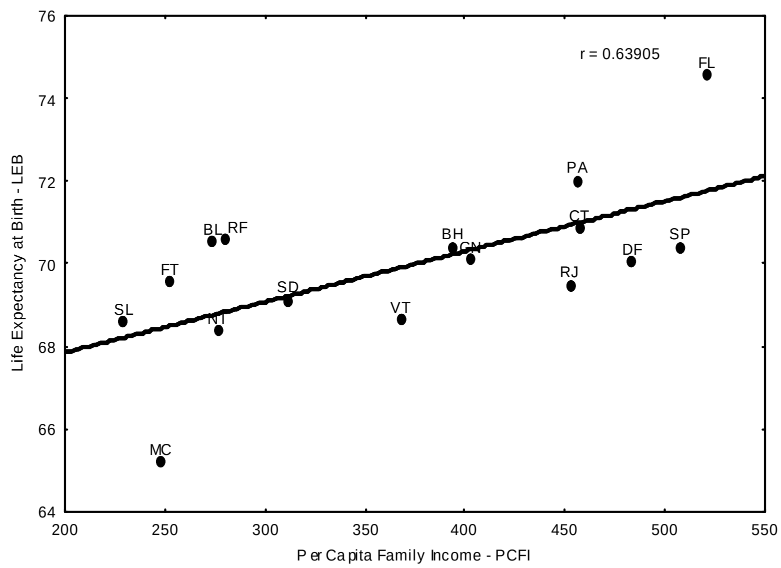
(p-value) * p < .05. LEB = Life expectancy at birth; IM = Infant Mortality; LogGDP = logarithms of per capita GDP; PCFI = Per capita family income; Gini = Gini's Index; SAMC = age-standardized adult mortality for cancer; SAMCI = age-standardized adult mortality for cardiovascular illnesses.

Figure 2 shows the dispersion diagram and trend line for the correlation between life expectancy at birth and per capita family income, while Figure 3 depicts the trend lines for the association between adult mortality from cancer and cardiovascular diseases and log(per capita GDP).

Regression models

The results of adjusting regression models 1 and 2 for life expectancy at birth and infant mortality are presented in table 3, with R^2 values of 0.45 and 0.75, respectively, showing that only the coefficients of per capita income were significant ($p < 0.01$) in explaining the variation in life expectancy at birth and infant mortality rate. On the other hand, no statistic significance was found for the regression coefficients associated to Gini's index for the same variables. With respect to models three and four in table 3, which show adult mortality rates for cancer and cardiovascular diseases as dependent variables and log(per capita GDP) and Gini's index as explanatory variables, the coefficient associated to per capita GDP was significant ($p < 0.01$) for cancer but not for cardiovascular diseases. The regression coefficients associated to Gini's index were not significant ($p > 0.05$).

FIGURE 2
CORRELATION BETWEEN LIFE EXPECTANCY AT BIRTH AND PER CAPITA FAMILY INCOME(IN REAIS) IN METROPOLITAN REGIONS OF BRAZIL (MRB), 2000



Discussion

Brazil is a country of continental dimensions and great social, economic and demographic diversity that has high indices of poverty in its metropolitan areas.

The evidence that this study reveals regarding the absolute income hypothesis confirms the previously known results that in poor countries the income that individuals possess to supply their basic needs is the most important factor in determining the health status of the population and not income inequality, although it is an aggravating factor to be considered (Wilkinson, 1992; Fiscella y Franks, 1997).

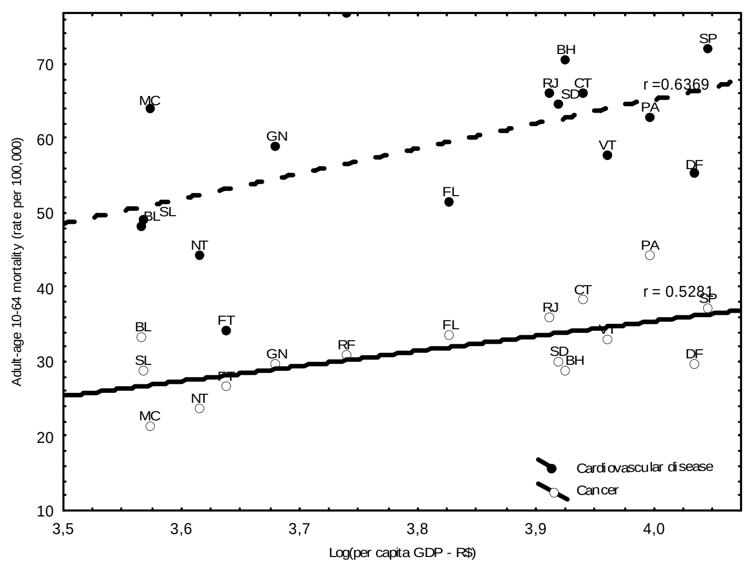
The international life expectancy curve versus per capita GDP elaborated by Preston in 1975 and revised by Deaton (Preston, 1975; Deaton, 2003) with data from the year 2000 for more than 100 countries in different stages of development, both in terms of income and epidemiologic transition shows a non-linear relation between these two variables. For the MRBs, however, this relation suggests a linear tendency, as shown in figure 2. In this sense, Brazil's position on the curve stands out, lying exactly on the intermediate part between the almost-vertical segment of poor countries and the beginning of the plateau, where the more developed countries are situated. This finding is consistent with the historical development process of Brazil, which, from the economic point of view, has alternated between periods of high growth and periods of stagnation.

This process has elevated the prevalence of chronic and degenerative diseases concomitantly with the accelerated aging of the population, mainly in metropolitan areas. The wealth of the country is concentrated in these regions, where a large part of the population enjoys a lifestyle that incorporates routine habits that predispose to cancer and cardiovascular diseases, among others, while another part live in poverty and social degradation, subjecting these individuals to infectious/parasitic diseases and all forms of urban violence. It is in this setting, mixed with opulence and poverty, that environmental, microbiological, physical and chemical factors increase the risk of contracting diseases, for both rich and poor (Braveman, 2002; McMichael, 2000).

Since the beginning of the 1990s the Brazilian government has been implementing public income transfer policies for families whose per capita monthly income is less than ¼ of the minimum wage (USD33). In 2004, according to the National Research per Sample of Domiciles (PNAD/2004), government social programs reached 50.3 per cent of households belonging to this income stratum.

In this sense, the corroboration of the absolute income hypothesis, that is, that mean income is an important factor in determining the health status of the population in MRBs, points towards public income transfer policies for the poorest strata of the population that result in an increase of mean family income and consequent improvement in health status.

FIGURE 3
CORRELATION BETWEEN ADULT MORTALITY FROM CARDIOVASCULAR DISEASE, CANCER AND LOG (PER CAPITA GDP) IN METROPOLITAN REGIONS OF BRAZIL (MRB), 2000



Although the logic of income transfer policies in Brazil is correct, since they benefit a large number of extremely needy individuals, they leave something to be desired because the values transferred are generally insufficient to be used for health care. In fact, the resources transferred contribute, above all, to meeting basic food needs that ensure survival.

The research data for Brazil as a whole reveal that only 42 per cent of domiciles benefiting from income transfer programs have proper sewage removal; 69 per cent have indoor plumbing and 66 per cent receive trash collection service. These numbers suggest that the mere transfer of money without concomitant investment in infrastructure services that improve the quality of health of the population is not the definite solution to the health question in Brazil, mainly in highly-populated urban areas such as the MRBs.

TABLE 3
SUMMARY OF THE RESULTS OF THE ADJUSTED REGRESSION MODELS FOR METROPOLITAN REGIONS OF BRAZIL (MRB), 2000

Model	Coefficient	t-test		ANOVA – F-test	
		t	p-value	F	p-value
Model 1: LEB=β_0+PCFIβ_1+GINIβ_2+e	$R^2 = 0.4478$			5.2711	0.0210
Intercept (β_0)	69.9011	14.2758	0.0000		
Per capita family income(β_1)	0.0121	3.0579	0.0092		
GINI (β_2)	-7.3061	-0.9633	0.3530		
Model 2: IM = β_0+ PCFI β_1+ GINI β_2+e	$R^2 = 0.7482$			19.3097	0.0001
Intercept (β_0)	34.0834	2.3962	0.0323		
Per capita family income (β_1)	-0.0687	-6.0035	0.0000		
GINI (β_2)	29.8282	1.3539	0.1988		
Model 3: SAMC = β_0+ LogPCFI β_1+ GINI β_2+e	$R^2 = 0.5718$			8.6788	0.0040
Intercept (β_0)	-18.9015	-0.7571	0.4625		
Log Per capita family income (β_1)	29.1155	3.5022	0.0039		
GINI (β_2)	-39.2486	-2.0185	0.0646		
Model 4: SAMCI = β_0+LogGDPβ_1+GINIβ_2+e	$R^2 = 0.3619$			3.6865	0.0539
Intercept (β_0)	5.6982	0.0942	0.9264		
LogGDP (β_1)	26.2128	1.9902	0.0680		
GINI (β_2)	-77.2651	-1.6305	0.1270		

LEB = Life expectancy at birth; IM = Infant Mortality; SAMC = age-standardized adult mortality for cancer; SAMCI = age-standardized adult mortality for cardiovascular illnesses; PCFI = Per capita family income; Gini = Gini's Index; logGDP = logarithms of per capita GDP.

Conclusion

The results suggest that income inequality is not directly associated with the health of the population that live in the metropolitan regions of Brazil, corroborating many of the studies that point to mean income and not income inequality as the most important for the health of individuals in developing countries. The age-standardized adult mortality rate for cancer yielded Pearson's correlation coefficient of 0.53 ($p < 0.035$) in table 2 and figure 3, when correlated with the log(per capita GDP), signifying that the higher the per capita GDP, the higher the mortality rates for cancer in the adult population of the MRBs examined in this study. However, no significant correlation was found between adult mortality from cancer and Gini's index. With regard to cardiovascular diseases, table 2 and figure 3 show a correlation coefficient of 0.64 ($p = 0.008$) but no statistical significance with Gini's index. It is important to point out that these results are, to a certain extent, a result of the epidemiologic transition process in Brazil and consistent with international trends.

Notwithstanding the reservations and criticisms of using aggregate data to test these hypotheses (Gravelle, Wildman y Sutton, 2002) the results found in this study continue to be important, since they broaden information on this question in countries at a similar development stage to that of Brazil, in addition to showing agreement with many experiments that found similar outcomes (Van Doorslaer *et al*., 1997; Braveman *et al*., 2002; Blakely *et al*., 2003; Ghosh *et al*., 2004).

It is important to point out, however, the need for widening the scope of this study in future investigations. Therefore, the country should be divided into smaller spatial units, using individual data that allow these relationships to be examined in more detail and with more accuracy in order to minimize problems implicit in ecologic studies when testing this type of hypothesis.

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