Income, Income and Educational Inequality and Mortality in Urban Regions of Brazil*

Neir Antunes Paes

Professor (PhD), Department of Statistics, Federal University of Paraíba (UFPB) antunes@de.ufpb.br

Mardone Cavalcante França

Professor, Department of Statistics, Federal University of Rio Grande do Norte (UFRN)

Doctoral student in Health Sciences, UFRN

mardonefranca@globo.com

ABSTRACT:

The first goal of this study was to perform an empirical verification of the absolute income and the income inequality hypotheses for 16 metropolitan regions of Brazil (MRBs), based on data from the Demographic Census of 2000 and vital statistics from 1999-2001. The second goal was to model the relation between the standard mortality rates by cardiovascular, cancer diseases, and some socioeconomic indicators as: income, income inequality for the MRBs, and income inequality and educational inequality for the 27 Brazilian capital cities in 2000. Multiple regression models were adjusted. The significance of the models was tested by Analysis of Variance and the regression coefficients correspondent to each of the explanatory variables by student's t-Test. The results suggest that mean income was the determinant health factor for the population residing in MRBs and not income inequality. The educational inequality has more important role over the health status of the adult population in the capital cities in Brazil than the income inequality.

Keywords: Urban health, Adult mortality, Income inequality, Educational inequality, Mortality.

* Paper presented at the XXVI IUSSP International Population Conference, 27 September - 2 October 2009, Marrakech, Morocco.

1. INTRODUCTION

The relation between socioeconomic status and health has long been controversial, with studies producing discordant results (Lynch and Davey 2002, Wildman 2001, Wolfson et al 1999, Wilkinson 1994). 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 (Kaplan et al 1996, Kennedy et al 1996, Wilkinson 1992a). One of the foci of this debate has been the role of income in determining the individual or collective health of the population. (Deaton 2003, Lynch et al 2001, Rodgers 1979, Preston 1975).

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. 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 and Kulkarni 2004, Blakely et al 2003, Braveman and Tarimo 2002, Rossi et al 2000, Wilkinson 1992b, Rodgers, 1979).

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 (De Vogli et al 2005, Deaton and Lubotsky 2003). Wilkinson found a correlation of -0.81 between income inequality and life expectancy at birth for 11 industrialized countries (Wilkinson, 1992a). 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 1990s (Drumond and Barros, 1999).

On the other hand, some studies demonstrated that educational inequality is more malicious for health because it has impact on the adoption of a wealthy lifestyle that minimize the effects of the risk factors from chronic and degenerative diseases - cancer and cardiovascular diseases (Antunes et al 2008, Bassanesi 2008, Boakari 2008, Menviele et al 2008, Albano et al 2007, Muney-Lleras 2004, Messias 2003, Steenland et al 2002, Wünsch-Filho and Moncau 2002, Bloom 2000, Faggiano et al 1995, Ross and Wu Chia-Ling 1995).

Groot and Van der Brink (2004) concluded that education has an important role in the determination of the standard of health population. They found that people with better educational level are those who smoke less, drink less and has a tendency to have a wealthy life, which has a more favorable impact even on the individual as in the collective health.

In this same line of interest, Menvielle et al. (2008) using longitudinal data, investigated the effects of the educational inequality on the total mortality rates for cancer of both men and women in twelve European populations, and they found a great variation in different levels of education.

In a recent work elaborated by Albano et al. (2007) for the United States, considering deaths of individuals from 25 to 64 years old, race, and educational level as independent variables, they concluded that the mortality rate for the main types of cancer was greater among those with less than 12 years of education in relation to those having more than 12 years, for all groups investigated.

The study of adult mortality is crucial because it considers the active age group (10 to 64 years old) which has the chance to generate necessary wealth to maintain the balance between the demands of society for basic services, and the capacity of the economy to supply it in adequate quantity and quality. The cardiovascular and cancer diseases are the main causes of death for adults in many countries as well as Brazil, particularly for the metropolitan and capital cities.

In Brazil, this subject has also called the attention to the scholars, mainly since the end of the 1990s, when the system of mortality improved the quality of the vital statistics and the socioeconomic indicators were more available (Boakari 2008, Bassanesi 2008, França and Paes 2007, de Godoy 2007, Messias 2003).

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% of all deaths occurring in Brazilian state capitals were caused by infectious/parasitic diseases, while only 12% were related to diseases of the circulatory system. In 1995, this picture was completely altered, with 7% of deaths caused by infectious/parasitic diseases and 33% by circulatory system disorders. In recent decades the metropolitan regions of Brazil (MRBs) 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 for the Brazilian urban populations. In the attempt to give contribution to this subject, two goals of this study needed to be performed: first, by means of an ecologic study, an empirical and exploratory verification of the hypotheses of absolute income, and income inequality in MRBs for the adult population; second, to model the relation between the standard mortality rates by cardiovascular, cancer diseases, and some socioeconomic indicators as: income, income inequality for the 16 MRBs, and income inequality and educational inequality for the 27 Brazilian capital cities in 2000.

2. 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 Brazil Gross Domestic Product GDP/PIB per capita values 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 MRBs.

For the 27 state capitals, were obtained three indicators: GDP per capita, the income from the 10% richest and the 40% poorest, and also the proportion of people over 25 years old with less than four, and more than 12 years of education. .

The quality of the death-related data used to calculate adult mortality can be considered satisfactory, given that the MRBs and the capital cities are highly urbanized. Reporting in these areas is almost total and the proportion of deaths classified as "of undetermined cause" is at acceptable levels (mean 6%) for the MRBs, but for some capital cities these proportions were high, which demanded special attention.

Furthermore, two additional indicators were constructed. First, the ratio of educational inequality (REI) measured by the ratio between the proportion of people over 25 years old with less than four years of education and those with more than 12 years of education. Second, the ratio of income inequality (RII), measured by the ratio between income of the 10% richest and the 40% poorest. The higher the values of these ratios the more unfavorable educational and income conditions of the population.

The REI indicator was constructed only for the capital cities as a proxy of the Gini´s educational index, similar to Gini´s index used to express the income inequality since the first indicator is not available. The RII indicator was also constructed for the capital cities in order to keep a conceptual compatibility with the REI indicator, both based on extreme educational and income distributions.

The year 2000 was chosen for this study because the availability of data from demographic census about population characteristics and from socioeconomic indicators for metropolitan regions and capital cities.

3. METHODS

It proceeded an evaluation of the quality of death data. Since the metropolitan and capital cities are well urbanized areas, with good vital registrations systems, it was assumed that the coverage of deaths was satisfactory. Therefore, there was no need to make registration correction.

Nevertheless, due to the elevated proportion of ill defined causes of death for a few capital cities from North and Northeast, it is recommended that some type of correction be done in order to avoid unbiased estimators of the mortality rates. Therefore, the Ledermann procedure (Vallin 1987), proposes to distribute ill defined causes of deaths in defined causes of death. This way, the mortality rates by cardiovascular and cancer diseases were adjusted by Ledermann´s factor corresponding to each cause of death.

The following hypothesis were tested for metropolitan regions of Brazil: 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 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 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, GDP per capita, 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, GDP per capita, 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. For the study of the diagnosis of the models, the techniques of residual analysis were used, which showed that the basic suppositions were satisfied.

For the capital cities a similar statistical analysis procedure was adopted. Pearson's bivariate correlation test was used between indicators of mortality and income, income and educational inequality ratios. Two multiple regression models were adjusted. The dependent variables were the age-standard mortality rates for cancer (SAMC) and age-standard mortality rates for cardiovascular illnesses (SAMCI). As independent variables GDP per capita, REI and RII were considered.

4. RESULTS

4.1 Descriptive Statistics

In Appendix 1 is shown the results for the 27 capital cities. The following discussion related to the descriptive statistics refers only to the 16 metropolitan regions of Brazil. In 2000, there were 170.8 thousands deaths in the MRBs, of which 97.6 thousands were in the correspondent capital cities. The leading causes of death in the MRBs showed external causes (27.1%) followed by cardiovascular illnesses (23.4%) and cancer (15.1%). The MRBs 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% of the total population and 42.6% of the urban population, accounting for 28.2% 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 1,211,7% and 38.5%, respectively. Life expectancy at birth and Gini's index appear as the lowest coefficients of variability, with 2.8% and 9.2%, respectively.

4.2 Metropolitan regions of Brazil

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 illnesses and log(GDP per capita) and the respective values for correlation coefficient (r

Figure 1. Map of the localization of the Metropolitan Regions of Brazil – 2000

= 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 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(GDP per capita).

Table 1. Population, health status, income indicators and descriptive statistics for Metropolitan Regions of Brazil, 2000.

Metropolitan Regions	Population (per 1000) (1)	Life expectancy at birth (2)	Infant Mortality (1000 live births)(2)	Adult mortality rate (per 100.000)		Per capita GDP (R$) (4)	Per capita familiy income (R$) (2)	Gini´s Index (2)
				Cardiovascular diseases (3)	Cancer (3)			
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 – Distrito Federal	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 (%)	1211,70	2.79	31.35	19.17	17.89	38,53	27,59	9.17

Sources:
(1) IBGE – Demographic Census of 2000; (2) PNUD-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, 2000.

Variables	LEB	IM	LogGDP	PCFI	GINI	SAMC	SAMCI
LEB	1,0000						
IM	-0,8453* (0,0000)	1,0000					
LogGDP	0,3918 (0,1330)	-0,5398* (0,0310)	1,0000				
PCFI	0,6390* (0,0080)	-0,8442* (0,0000)	0,8012* (0,0000)	1,0000			
GINI	-0,2250 (0,4020)	0,2234 (0,4050)	-0,1224 (0,6520)	-0,0417 (0,8780)	1,0000		
SAMC	0,0391 (0,8860)	-0,1912 (0,4780)	0,5281* (0,0350)	0,3620 (0,1680)	-0,4093 (0,1150)	1,0000	
SAMCI	0,6459* (0,0070)	-0,7954* (0,0000)	0,6369* (0,0080)	0,6562* (0,0060)	-0,4096 (0,1150)	0,3477 (0,1870)	1,0000

(p-value) * $p < .05$

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

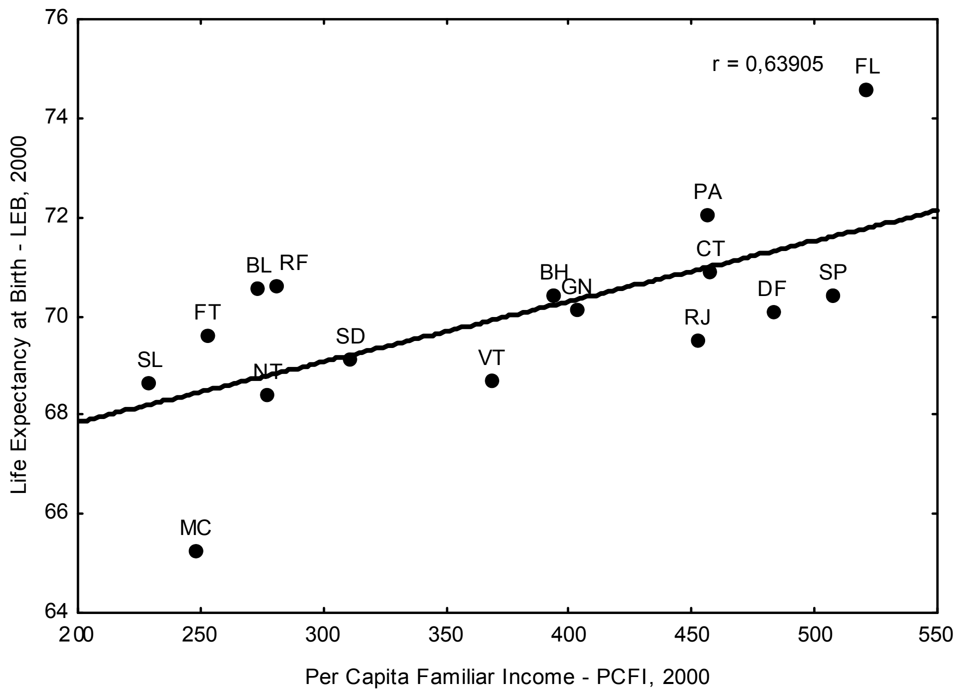

Figure 2. Correlation between life expectancy at birth and per capita family income (in reais) in Metropolitan Regions of Brazil, 2000.

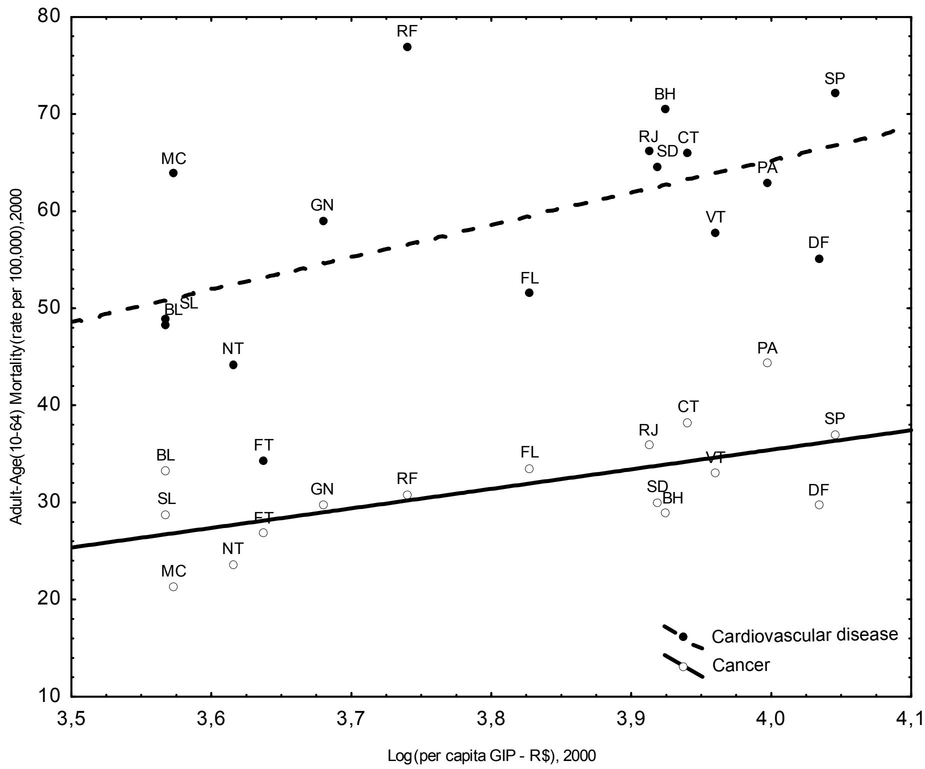

Figure 3. Correlation between adult mortality for cardiovascular disease, cancer and log(per capita GDP) in Metropolitan Regions of Brazil, 2000.

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 3 and 4 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 ($p > 0.05$).

Table 3. Summary of the results of the adjusted regression models for Metropolitan Regions of Brazil, 2000.

Model	Coefficient	t-test		ANOVA F-test	
		t	p-value	F	p-value
Model 1: LEB = β_0+ PCFI β_1+ GINI β_2+e -	**R^2=0,4478.**			**5,2711**	**0,0210**
Intercept (β_0)	69,9011	14,2758	0,0000		
Per capita familiar 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 familiar 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 familiar 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 familiar income; Gini = Gini´s Index; logGDP= logarithms of GDP per capita.

4.3 Capital Cities

Table 4 shows the results of adjusting regression models 1 and 2 respectively for adult standardized mortality rates for cardiovascular illnesses (SAMCI) and cancer (SAMC) as dependent variables. Both models were regressed with the following explanatory variables: ratio of income inequality (RII), ratio of educational inequality (REI) and GDP per capita. The results showed that the regression coefficient of REI for cardiovascular diseases was highly significant (p=0.0070). For cancer, it was also significant, although with an inferior level (p=0.078). For the log(GDP) the significance was accepted even with a level of 0.10, since this is a macroeconomic indicator, which final value is an estimate with some grade of uncertainty very difficult to measure. The F test for both models were significant (p=0.035). On the other hand, the RII was not statistically significant (p=0.339) for neither the cardiovascular diseases nor cancer in this study.

Table 4. Summary of the results of the adjusted regression models for cardiovascular diseases and cancer for capital cities of Brazil, 2000

Model	Coefficient	t-test		ANOVA F-test	
		T	p-value	F	p-value
Model 1: SAMCI = β_0 + RII β_1 + REI β_2 + Log(GDP)β_3				**3.381**	**0.035**
Intercept - β_0	-39.350	-0.602	0.552	na	na
RII – β_1	0.173	0.975	0.339	na	na
REI - β_2	0.644	2.934	0.007	na	na
Log(GDP) - β_3	0.371	1.689	0.100	na	na
Model 2: SAMC = β_0 + RII β_1 + REI β_2 + Log(GDP)β_3				**3.445**	**0.033**
Intercept - β_0	5.960	-1.559	0.132	na	na
RII - β_1	0.141	0.799	0.432	na	na
REI - β_2	0.402	1.841	0.078	na	na
Log(GDP) - β_3	0.696	3.175	0.004	na	na

na = not applicable

SAMCI = age-standardized adult mortality for cardiovascular illnesses; SAMC = age-standardized adult mortality for cancer; RII =ratio of income inequality; REI = ratio of educational inequality; GDP = Gross Domestic Product per capita.

5. DISCUSSION

Brazil is a country of continental dimensions and great social, economic and demographic diversity that has high indices of poverty in its urban areas particularly in the metropolitan ones. Due to the process of the epidemiological transition in which Brazil is experiencing associated with the huge increase of the urban gathering and the ageing process, the country has an elevated prevalence of the number of chronic and degenerative diseases.

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 1992b, Fiscella and 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. 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 (USD33.00). In 2004, according to the National Research per Sample of Domiciles (PNAD/2004), government social programs reached 50.3% 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.

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% of domiciles benefiting from income transfer programs have proper sewage removal; 69% have indoor plumbing and 66% 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.

Another aspect experienced by Brazil during the 1990´s, was an important increase in the rates of enrollment in basic education, reaching an average proportion of 95% of children attending school.

To evaluate the educational inequality only considering the amount of years of education may not reveal the most relevant aspect, in the case, the quality of the teaching offered by the Brazilian schools. Nevertheless, to measure the inequality under the average years of education can be useful and contribute to reveal the effects of the educational disparities over health, income, and others important elements of life. In this way, the results found here for the capital cities suggest that the REI was a reasonable variable for explaining the variation in the rates of mortality observed for cardiovascular diseases and cancer of the adult population. This result nevertheless was not verified for the variable RII.

Muller (2002) using a similar method for 50 American states concluded that lack of high education was the most powerful determinant for explaining the variation on the mortality rates for several causes of death when compared with the income inequality. Other authors (Glied and Muney Lleras 2006, Ross and Wu Chia-Ling 1995, Groot and Van der Brink 2004, Muney-Lleras 2004) also concluded for the United States that the more years of education a person has the higher the capacity of the individual to adopt a life style that is favorable to a better health condition and to access the advanced medical technology.

Even considering that the literature doesn´t show works that deals directly with the question about the effects of the educational inequality over the health in opposition to the income inequality as proposed in this study, the results found in the literature points out the same direction as researched here: the benefits of education over health.

Although the studies done in Brazil which relates the mortality for cardiovascular diseases and cancer with factors linked to education don´t do it by the point of view of the educational inequality, there is agreement with the results found here which stress the role of education as determinant of mortality by these kinds of diseases for capital cities (Boakari 2008, Bassanesi 2008, Oliveira et al 2006, Antunes 2008, de Godoy et al. 2007, Wünsch-Filho and Moncau 2002).

6. 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 and 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 (Teixeira 2004), in addition to showing agreement with many experiments that found similar outcomes (Blakely et al 2003, Ghosh et al, 2004, Braveman et al 2002, Van Doorslaer et al 1997).

For its turn, the results found here suggest that the educational inequality has more of an important role over the health status of the adult population in the capital cities in Brazil than the income inequality. It must be considered that Brazil is on the top list as one of the countries with the higher income inequality of the world. The models revealed that the educational inequality and log(GDP per capita) were significant but not income inequality. The fact that GDP was significant, may imply that higher financial availability to the people will provide more, and better health, health care facilities, individual health plans, and better access to treatment of illnesses and chronic degenerative diseases.

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.

REFERENCES

ALBANO JD, Ward E, Jemal A, Anderson R et al., 2007, Cancer Mortality in the United States by educational level and race. J Natl Cancer Inst.,;99:1384-94.

ANTUNES JLF, Borrel C, Pérez G, Boing AF and Wünsch-Filho V, 2008, Inequalities in mortality of men by oral and pharyngeal cancer in Barcelona, Spain and São Paulo, Brazil, 1995-2003. International Journal for Equity in Health. 2008;7:14. Available at: http://equityhealthj.com/content/7/1/14. Accessed dez 5, 2008.

BASSENESI SL, Azambuja MI, Achutti A, 2008, Mortalidade precoce por doenças cardiovasculares e desigualdades sociais em Porto Alegre: da evidencia à ação. Arq Bras Cardiol, 90(6):403-412.

BLAKELY T, Atkinson J and O`Dea D, 2003, "No association of income inequality with adult mortality within New Zeland: a multi-nivel study of 1.4 million 25-64 year olds", in *J Epidemiol Community Health, 57: 279-284.*

BLOOM G, 2000, Equitity in health in unequal societies: towards health equities during rapid social changes. IDS Working paper 112.

BOAKARI FM, 2008, Poverty and education: Brazils's search for viable solutions? Advances in education in diverse communities: Research, policy and praxis 2006; 4:253-294. Available at: http://www.sciencedirect.com/science. Accessed jan 30, 2008.

BRAVEMAN, P. and Tarimo E, 2002, "Social inequalities in health within countries: not only an issue for affluent nations", in *Soc Sci Med, 11: 1621-1635.*

DE GODOY MF, de Lucena JM, Miquelin AR et al., 2007, Mortalidade por doenças cardiovasculares e níveis socioeconômicos na população de São José do Rio Preto, Estado de São Paulo, Brasil. Arq Bras Cardiol, 88(2):200-206.

DE VOGLI, R, Mistry R, Gnesotto and Cornia G.A, 2005, "Has the relation between income inequality and expectancy disappeared? Evidence from Italy and top industrialized countries", *in J Epidemiol Community Health, 59 : 158-197.*

DEATON, A. and Lubotsky D, 2003, "Mortality, inequality and race in American cities and States", in *Soc Sci Med, 56(6) : 1139-1153.*

DEATON, A, 2003, "Health, inequality and economic development", in *Journal of Economic Literature, vol XLI :113-158.*

DRUMOND, Jr. M. and Barros M.B.A, 1999, "Desigualdades socioespaciais na mortalidade do adulto no município de São Paulo", in *Rev Bras Epidemiol, 2(1-2), 34-49.*

FAGGIANO F, Lemma P, Costa G, Gnavi R and Pagnarelli F, 1995, Cancer mortality by educational level in Italy. Cancer Causes Control, 6:311-320.

FRANÇA MC, Paes NA, 2007, Income, income inequality and mortality in metropolitan regions of Brazil: an exploratory approach. Papeles de Población. Julio-septiembre, 53: 225-239.

FISCELLA, K. and Franks P, 1997, "Poverty or income inequality as predictor of mortality: longitudinal cohort study", in *BMJ, 314:1724-1727*

GHOSH, S. and Kulkarni P.M, 2004, "Does the pattern of causes of death vary across socioeconomic classes within a population? An exploratory analysis for India", in *Genus, LX, No.2 : 55-81.*

GLIED S, Muney-Lleras, 2006, A. Health inequality, education and medical inovation. Working Paper no. 9738, NBER Working paper Series. National Bureau of Economic Research. Available at: http://www.nber.org/papers/w9738. Accessed dez 12, 2006.

GRAVELLE, H, Wildman J. and Sutton M, 2002, "Income, income inequality and health: what can we from aggregate data?", in *Soc Sci Med, 4 : 577-589.*

GROOT W, Van der Brink HM, 2004, The health effects of education: survey and meta-analysis. Journal Educational Literature. 2004**;** I1, I2.

KAPLAN, G.A, Pamuk E.R, Lynch J.W, Cohen R.D, and Balfour J.L, 1996, "Inequality in income and mortality in the United States: analysis of mortality and potential pathways", in *BMJ, 312(7037) : 999-1003.*

KENNEDY, B.P, Kawachi I and Pothrow-Stih D, 1996, "Income distribution and mortality: cross sectional ecological study of the Robin Hood index in the United States", in *BMJ, 312 : 1004-1007.*

LYNCH, J.W and Davey S.G, 2002, "Commentary: income inequality and health: the end of the story?", in *Int J Epidemiol, 31(3) : 549-551.*

LYNCH, J.W, Kaplan G.A, Pamuk E.R et al, 1998, "Income inequality and mortality in metropolitan areas of the United States", in *Am J Public Health, 88(7) : 1074-1080.*

McMICHAEL, A.J, 2000, "La salud y el entorno urbano en um mundo cada vez más globalizado: problemas para los países em desarrollo", *[Artículo publicado en inglés en el Bulletin of World Health Organization, 78(9) : 1117-1126].*

MENVIELE G, Kunst AE, Stirbu I, Strand GH, Borrell C, Regidor E, et al., 2008, Educational differences in cancer mortality among women and men: a gender pattern that differs across Europe. British Journal of Cancer, 98:1012-1019.

MESSIAS E, 2003, Income inequality, Illiteracy rate and life expectancy in Brazil. American Journal of Public Health, 93 (8):1294-1296.

MULLER A, 2002, Education, income inequality, and mortality: a multiple regression analysis. BMJ. 2002; 324:1-4, Available at: http://www.bmj.com/cgi/content/full/324/7328/23. Accessed jan 23, 2007.

MUNEY-LLERAS A, 2004, The relationship between education and mortality in the United States. Review of Economic Studies, 72 (1):189-221.

OLIVEIRA GMM, Klein CH e Silva NAS, 2006, Mortalidade por doenças cardiovasculares em três estados do Brasil de 1980 a 2002. Rev Panam Salud Publica, 19(2):85-93.

PRESTON, S.H, 1975, "The changing relation between mortality and of economic development", in *Popul Stud, 29 : 231-248.*

RODGERS, G.B, 1979, "Income and inequality as determinants of mortality: an international cross-section analysis", in *Popul Stud, 33 : 343-351. Reprinted in: Int J Epidemiol, 2002, 31 : 549-551.*

ROSS, N.A, Wolfson M.C, Dunn J.R, Berthelot J.M, Kaplan G.A and Lynch J.W, 2000, "Income inequality and mortality in Canada and the United States: a cross-sectional assessment using census data and vital statistics" in *BMJ, 320 : 898-902.*

ROSS C, Wu Chia-Ling, 1995, The links between education and health. American Sociological Review, 60 (5):719-745.

STEENLAND K, Henley J, Thun M, 2002, All-causes and cause-specific death rates by educational status for two million people in two American Center Society cohorts, 1959-1996. Am J Epidemiol, 156;11-21.

SZWARCWALD, C.L, Bastos F.I and Andrade C.L, 1999, "Income inequality and homicide rates in Rio de Janeiro, Brazil", in *American Journal of Health, 89(6) : 845-850.*

TEIXEIRA, C.F, 2004, "Epidemiological transition, health care model, and social security in Brazil: an analysis of trends and policy options", *in Ciênc saúde coletiva, 9: No.4:.Available at: http://www.scielo.br/scielo.php?script=sci_arttext&pid. Accessed june 26, 2005*

VALLIN J, 1987, Seminário sobre causas de muerte: aplicación al caso de Francia. Instituto Nacional de Estudos Demográficos e CELADE, Série E, No. 31, Santiago-Chile.

VAN DOORSLAER, E, Wagstaff A, Bleichrodt H et al, 1997, "Income related inequalities in health: some international comparisons", in *J Health Econ, 16 : 92-112.*

WILDMAN, L, 2001, “The impact of income inequality on individual and societal health: absolute income, relative income and statistical artefacts”, *in Health Econ, 10(4): 357-361.*

WILKINSON, R.G, 1994, “Divided we fall. The poor pay the price of increased social inequality with their health”, in *BMJ, 308 : 1113-1114.*

WILKINSON, R G, 1992a, “Income distribution and life expectancy”, in *BMJ, 304 : 165-168.*

WILKINSON, RG, 1992b, “National mortality rates: the impact of inequality?”, in *Am J Public Health, 82 : 1082-1084.*

WOLFSON, M, Kaplan G, Lynch J, Ross N.A and Backlund E, 1999, “Relation between income inequality and mortality: empirical demonstration”, in *BMJ, 319 : 953-957.*

WÜNSCH-FILHO V, Moncau JE, 2002, Mortalidade por câncer no Brasil 1980-1995: padrões regionais e tendências temporais. Rev Assoc Med Bras, 48:250-257.

Appendix 1. Population, health status, income per capita, income and educational indicators for the capitals of Brazil, 2000

Capital city	Population[a] (p/1,000)	Adult mortality rate (p/100,000)[b]		GDP per capita[c] (R$)	Rate of income inequality (RII)[d]	Rate of educational inequality REI[d]
		Cardiovascular illnesses SAMCI	Cancer SAMC			
Aracajú (SE)	461	68.72	58.10	5,221	32.67	1.49
Belém (PA)	1281	70,50	66.54	4,290	31.34	1.58
Belo Horizonte (MG)	2238	70.52	51.16	7,130	27.22	0.79
Boa Vista (RR)	201	103.31	49.35	3,829	21.05	2.79
Brasília (DF)	2051	81.80	56.00	14,224	32.75	0.87
Campo Grande (MS)	664	92.20	55.17	5,385	24.62	1.42
Cuiabá (MT)	483	106.95	59.75	6,678	30.04	1.14
Curitiba (PR)	1587	79.44	60.61	8,087	22.60	0.67
Florianópolis (SC)	342	59.59	56.54	8,049	19.87	0.43
Fortaleza (CE)	2141	75.91	58.24	4,515	33.02	2.24
Goiânia (GO)	1093	83.17	51.18	5,392	24.15	1.12
João Pessoa (PB)	598	85.53	52.03	4,075	27.96	1.38
Macapá (AP)	283	88.35	57.88	4,662	27.93	3.31
Maceió (AL)	798	110.18	57.07	3,895	39.39	2.51
Manaus (AM)	1406	93.01	82.86	11,037	30.81	2.43
Natal (RN)	712	74.81	48.08	4,321	30.51	1.81
Palmas (TO)	137	72.,03	44.26	3,053	30.84	1.55
Porto Alegre (RS)	1361	73.51	72.60	8,764	26.30	0.46
Porto Velho (RO)	335	120.38	64.38	4,078	26.97	2.77
Recife (PE)	1423	102.46	61.53	6,585	41.75	1.23
Rio Branco (AC)	253	120.56	65.32	4,401	27.05	3.87
Rio de Janeiro (RJ)	5858	101.13	68.02	9,818	26.85	0.70
Salvador (BH)	2443	94.54	57.73	3,924	35.03	1.56
São Luís (MA)	870	101.11	64.76	4,370	32.17	1.96
São Paulo (SP)	10434	92.89	60.06	12,154	26.67	0.91
Teresina (PI)	715	88.08	50.47	3,356	31.32	3.10
Vitória (ES)	292	104.23	59.93	20,152	28.26	0.55
Mean	1499	91.80	58.87	6,720.2	29.23	1.65
Minimum	137	59.59	44.26	3.053,0	19.87	0.43
Maximum	10434	120.56	82.86	20.152	41.75	3.87
Standard deviation	2127,71	14,.0	8.13	3.936,2	4.97	0.94
Coeff. Variation (%)	141,98	16.01	13.81	58,6	17.00	56.97

Source: [a] IBGE – Demographic Census of 2000; [b] SIM/DATASUS; [c] IBGE – Authors´estimates;

[d] PNUD – Human Development Atlas of Brazil, 2000.