Does Income Distribution Matter? A Multilevel Analysis of Income inequality and Self-Rated Status in Brazil

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Introduction

The relationship between socioeconomic status (at the individual or population-level) and health is well established. The general pattern is one by which persons or populations of higher socioeconomic status generally have better health.[1] However, it has been suggested that health is affected not only by the absolute level of income, but also by degree to which income is equitably distributed within a population.[2-11]

In his seminal work, Preston[12] provided evidence of a concave relationship between country per capita income and life expectancy: life expectancy increases with income but at a decreasing rate. Preston noted that this concave relationship could be due to a possible detrimental effect of income distribution on health. This hypothesis was tested by Rodgers[2] four years later using data from 56 developed and developing countries. Despite the strong association between income inequality and life expectancy observed by Rodgers[2], income inequality is not viewed as having an impact on health per se; rather the association is perceived as an artefact caused mainly by the concavity effect. [2],[13, 14]

Nevertheless, subsequent work by Wilkinson[3] posited that income distribution itself had an effect on health, by which living in a society with unequal income distribution was detrimental to health regardless of absolute income levels. This hypothesis led to a surge of new studies seeking to understand this complex relationship. Studies shifted from the ecological designs, in which the lack of individual-level information particularly individual-level the socioeconomic characteristics drew a great deal of criticism., to analyses that included individual and contextual features simultaneously,[15-17] particularly through multilevel models, regarded as the most appropriate methodology to approach this issue. [9,10,11,18]

The mixed and controversial nature of the evidence on the effects of income inequality on health has been reflected in several recent reviews. [9,19,20] Although a recent study carried out in Norway showed a strong association between income inequality and health, in general the income inequality hypothesis has been difficult to confirm in more egalitarian countries.[16,21,22] In contrast, the strongest evidence comes from the United States or countries with higher levels of income inequality. [9,11,23-26] There has also been substantial discussion on the geographic area or more generally higher-level group for which income inequality should be measured in studies of the effect of income inequality on health. The definition of the relevant geographic area should be linked to the processes through which it is believed that inequality is operating. Wilkinson and Pickett[20] emphasize the importance of measuring income inequality for broad geographical areas such as US states, as they argue that poor health in deprived areas is not a consequence of the inequality within their neighbourhood, but rather a result of social stratification which is amplified when measured in relation to the wider society.

Brazil constitutes an ideal case in which to examine the income inequality hypothesis. It is one of the most unequal countries in the world and is divided into large geographical units that vary substantially in income inequality . Moreover, only few studies have addressed this issue based on Brazilian data, all of them ecological[27-29], which poses the need for a more comprehensive approach.

In the present study we use nationally representative survey data from Brazil and multilevel modelling to estimate the contextual effect of income inequality (measured at the state and metropolitan areas) on health.

Material and methods

Individual data were taken from the PNAD- Pesquisa Nacional de Amostra por Domicílios- a large survey carried out in Brazil in 2003. In addition to the usual socioeconomic and demographic information, the survey includes a supplement with information on different dimensions of health status[30]. The sample has a complex design with multiple stages (municipality, cluster and household) which produces representative information for the whole country (except the rural areas of the North region), its five macro regions, and the 27 units of the federation (26 states and one federal district, Brasilia, the capital of Brazil) which are referred in this study as states. It also provides representative samples of 10 Metropolitan Areas. These areas are composed of the Federal District and the nine traditional metropolitan areas, each one formed by a capital of state and surrounding municipalities. The final sample is composed of 194,936 and 76,125 individuals aged 25 years or more for Brazil and the metropolitan area respectively.

Two contextual variables (at the state and metropolitan area-level) were included in the analyses: the Gini coefficient, which is the measure of income inequality used in this study and the per capita gross domestic product (GDP) which has been consistently used as a confounding variable as wealth is an important predictor of individual and population health status. Gini and GDP values for the 27 states were obtained from IPEA

– an economic research institute linked to the Brazil's Planning Ministry. The GINI coefficient for each of the 10 metropolitan areas was calculated by the Brazil United Nations Development Programme (UNPD) in partnership with IPEA, whereas the GDP was calculated using data from the Brazilian Bureau of Statistics, IBGE. All the contextual variables refer to the year 2000.

The outcome variable is self-rated health status which was obtained from individuals' responses to the following question: "in general how do you consider you state of health?". Five possible answers were offered (very good, good, fair, poor and very poor). The five categories were collapsed into two categories, with the value 1 representing the poor state of health (very poor and poor) and zero otherwise (very good, good and fair). In an extensive review, Idler and Benyamini[31] showed that self-rated health status has been consistently associated with mortality. There is also evidence that self-rated health is a strong predictor of morbidity.[32] Table 1 summarises individual and contextual characteristics in the Brazilian and metropolitan area context.

Statistical analysis

Two sets of two-level multilevel logistic regression models were fitted with states and metropolitan areas as the second level. Parameters were estimated using Second-order Predictive Quasi-likelihood (PQL), which considered the best estimation procedure available in the statistical software MLwiN.[33] We initially estimated the effect of the GINI index on self-rated health status adjusting only for age and sex. We then added GDP and the individual-level variables to the model, one at a time, which allowed us to observe not only changes in the GINI coefficient, but also the interrelationship among the variables. Education was the last variable included in the models because educational attainment may be strongly influenced by the way resources are distributed across society and as such, would be a consequence of income inequality, rather than a genuine confounder.[34] Therefore, the model with individual-level education would provide a more conservative estimate of the effect of the Gini coefficient. The basic model fitted was a random intercept model but we also tested for the presence of random coefficients as well as cross-level interactions between the GINI index and individual socioeconomic characteristics.

Table 1 Descriptive statistics of individual-level and contextual characteristics

Variables	Brazil sample	Metropolitan Area sample
	%	%
Response variable	**(n=194,936)**	**(n=76,125)**
Self-rated		
Poor	5.7	4.5
Not poor	94.3	95.5
Individual-level variables	**(n=194,936)**	**(n=76,125)**
Age		
25-29	15.9	15.8
30-34	14.6	14.9
35-39	13.8	13.9
40-44	12.6	12.8
45-49	10.6	11.0
50-59	8.7	9.0
60-64	6.7	6.4
65+	17.3	16.2
Sex		
Male	47.1	45.5
Female	52.9	54.5
Area of residence		
Rural	13.5	2.9
Urban	86.5	97.1
Skin color/Race		
White	50.7	53.0
Pardo	42.3	37.8
Black	7.0	9.3
Per capita household income		
1st Quintile	19.9	15.6
2nd Quintile	21.6	19.1
3rd Quintile	19.7	18.6
4th Quintile	19.4	20.8
5th Quintile	19.5	25.9
Health insurance coverage		
Yes	26.8	34.8
No	73.2	65.2
Education		
< 1	16.1	9.3
1-4	27.9	22.2
5-8	23.6	27.1
9-11	21.8	27.1
12+	10.6	14.4
Area Level variables (median, Range)	**(N=27)**	**(N=10)**
Gini	0.64 (0.56 -0.69)	0.63 (0.59-0.67)
GDP	4.02 (1.62-14.22)	8.34 (3.68-14.22)

Results

Table 2 shows odds ratios of poor health associated with contextual state characteristics and individual-level variables for the country as whole. Model 1 shows that greater state-level income inequality was significantly associated with poor health after adjusting for age and sex.; a 5% increase in the GINI index increased the odds of reporting a poor state of health by 22% (OR =1.22, 95% CI = 1.01-1.46). However, the effect disappears when GDP is included in the model. As expected, GDP showed a significant inverse relationship with the odds of reporting poor health, but this association became non-significant after the inclusion of area of residence, race and individual income. After adjustment for age, sex, Gini, GDP and area of residence, the odds of reporting poor health status were substantially greater in blacks and pardos compared to whites (OR = 1.43, 95% CI = 1.33-1.55 and 1.29, 1.23-1.35 for blacks and pardos respectively). However, the association disappeared after additional adjustment for individual income, presence of health insurance and education. All in all, inequality plays an important role in Brazil as a whole, but through individual-level socioeconomic characteristics. Income and education were strongly associated with self-rated status; the higher the level of income and education the lower the odds of reporting poor health. The interaction shown in model 8 reveals that having health insurance in the urban settings lowers the chance of reporting poor health status (OR:0.82, 95% CI: 0.77-0.89).

Table 3 reports odds ratio of poor health associated with metropolitan area-level and individual-level characteristic in the metropolitan sample. In general the results observed in these models are similar to those observed for the full country sample. However metropolitan area-level inequality was more strongly and consistently associated with health than state-level inequality. A 5% percent increase in the Gini coefficient resulted in a 48% greater odds of reporting poor health (OR = 1.48, 95% CI = 1.24-1.76) This effect was reduced but remained significant after adjustment for all confounding factors considered in the present study (OR = 1.29, 95% CI = 1.04-1.60). As expected Education, household income and presence of health insurance showed a strong inverse association with the odds of reporting poor health.

Since there were only few metropolitan areas (10) we evaluated the robustness of results by excluding each second-level unit, one at a time, and re-estimating the model (Figure 1). The new parameters were quite robust to exclusion of the metropolitan areas, except for the federal district (53). When the federal district was excluded the odds ratio associated with the Gini coefficient was reduced and became non-significant (OR = 1.14, 95% CI = 0.89-1.48). When the federal district is excluded the correlation between Gini and GDP changes from the non-significant value of -0.46 (p-value = 0.18) to the significant value of -0.72 (p-value = 0.03). Thus, the absence of a Gini effect when the Federal District is excluded may be due to the the fact that the high correlation between GDP and Gini makes it difficult to separate these effects. When GDP is not included, the effect of Gini in the sample without the Federal District is statistically significant at 10% (OR = 1.17, 95% CI = 0.97-1.41). and slightly lower than that observed in the study by Lopez (2004) – (OR = 1.22, 95% CI = 1.08-1.37) for the metropolitan areas of US. Moreover, taking into account that there are only few units at level two and that this may result in higher standard errors for the parameter associated with the Gini coefficients, we might say that income inequality increase the chance of reporting a poor health states among those living in the metropolitan area.

Table 2 Odds ratio and 95% confidence interval of the parameters estimated in the multilevel logistic regression model, Brazil, PNAD 2003.

Variables	**Model 1**	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**	**Model 7**	**Model 8**
Age	1.05 (1.05-1.05)	1.05 (1.05-1.05)	1.05 (1.05-1.05)	1.05 (1.05-1.05)	1.06 (1.05-1.06)	1.06 (1.05-1.06)	1.04 (1.04-1.04)	1.04 (1.04-1.04)
Sex (Ref: Male)								
Female	1.15 (1.10-1.19)	1.15 (1.10-1.20)	1.16 (1.11-1.20)	1.16 (1.12-1.21)	1.16 (1.11-1.20)	1.17 (1.12-1.21)	1.16 (1.12-1.21)	1.16 (1.11-1.21)
Gini	1.22 (1.01-1.46)	1.02 (0.84-1.22)	1.02 (0.84-1.22)	0.97 (0.81-1.15)	0.89 (0.74-1.07)	0.89 (0.74-1.07)	0.92 (0.77-1.10)	0.92 (0.77-1.10)
GDP		0.93 (0.90-0.97)	0.94 (0.90-0.97)	0.94 (0.90-0.98)	0.96 (0.93-1.00)	0.97 (0.93-1.06)	0.98 (0.94-1.02)	0.98 (0.94-1.02)
Area of residence (Ref: Rural)								
Urban			0.81 (0.77-0.85)	0.82 (0.78-0.86)	1.00 (0.95-1.06)	1.03 (0.98-1.09)	1.21 (1.14-1.27)	1.22 (1.16-1.29)
Skin color (Ref: White)								
Pardo				1.29 (1.23-1.35)	1.07 (1.02-1.12)	1.05 (1.01-1.10)	0.98 (0.94-1.03)	0.98 (0.94-1.03)
Black				1.43 (1.33-1.55)	1.14 (1.06-1.23)	1.12 (1.04-1.21)	1.04 (0.96-1.12)	1.04 (0.96-1.12)
Income (Ref: 1st Quintile)								
2nd					0.73 (0.69-0.78)	0.74 (0.70-0.79)	0.82 (0.77-0.86)	0.82 (0.77-0.86)
3rd					0.60 (0.57-0.64)	0.63 (0.59-0.67)	0.73 (0.69-0.78)	0.73 (0.69-0.78)
4th					0.38 (0.35-0.40)	0.42 (0.39-0.44)	0.54 (0.50-0.58)	0.54 (0.50-0.58)
5th					0.19 (0.17-0.20)	0.24 (0.22-0.26)	0.40 (0.36-0.44)	0.40 (0.36-0.44)
Health Insurance (Ref: No)								
Yes						0.68 (0.64-0.73)	0.84 (0.79-0.89)	1.05 (0.85-1.31)
Education (Ref: 5-8)								
< 1							2.20 (2.05-2.34)	2.20 (2.05-2.35)
1-4							1.43 (1.35-1.52)	1.43 (1.35-1.52)
9-11							0.57 (0.52-0.63)	0.57 (0.52-0.63)
12+							0.44 (0.37-0.51)	0.44 (0.38-0.51)
Interaction								
Urban*Health insurance								0.78 (0.63-0.98)

Table 3 Odds ratio and 95% confidence interval of the parameters estimated in the multilevel logistic regression model, Metropolitan area, PNAD 2003.

Variables	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
Age	1.05 (1.05-1.05)	1.05 (1.05-1.05)	1.05 (1.05-1.05)	1.06 (1.05-1.06)	1.06 (1.05-1.06)	1.06 (1.05-1.06)	1.09 (1.02-1.18)
Sex (Ref: Male)							
Female	1.12 (1.04-1.20)	1.12 (1.04-1.20)	1.12 (1.04-1.20)	1.11 (1.03-1.19)	1.11 (1.03-1.20)	1.12 (1.04-1.20)	1.16 (1.12-1.21)
Gini	1.48 (1.24-1.76)	1.49 (1.21-1.83)	1.51 (1.24-1.83)	1.29 (1.01-1.49)	1.23 (1.01-1.49)	1.24 (1.01-1.52)	1.29 (1.04-1.60)
GDP		1.00 (0.97-1.04)	1.00(0.97-1.04)	1.01 (0.99-1.01)	1.03 (0.99-1.07)	1.03 (0.99-1.06)	1.03 (0.99-1.06)
Area of residence (Ref: Rural)							
Urban			0.67 (0.56-0.81)	0.68 (0.56-0.83)	0.89 (0.73-1.07)	0.92 (0.76-1.12)	1.04 (0.86-1.27)
Skin color (Ref: White)							
Pardo				1.34 (1.24-1.46)	1.07 (0.98-1.16)	1.04 (0.96-1.13)	0.96 (0.88-1.05)
Black				1.56 (1.39-1.76)	1.19 (1.05-1.35)	1.17 (1.03-1.32)	1.07 (0.95-1.21)
Income (Ref: 1st Quintile)							
2nd					0.77 (0.70-0.86)	0.80 (0.72-0.88)	0.86 (0.77-0.95)
3rd					0.59 (0.57-0.66)	0.63 (0.57-0.71)	0.72 (0.64-0.81)
4th					0.39 (0.35-0.44)	0.45 (0.40-0.51)	0.56 (0.49-0.63)
5th					0.22 (0.19-0.25)	0.30 (0.26-0.34)	0.46 (0.40-0.54)
Health Insurance (Ref: No)							
Yes						0.61 (0.55-0.67)	0.74 (0.66-0.81)
Education (Ref: 5-8)							
< 1							1.96 (1.75-2.19)
1-4							1.42 (1.29-2.19)
9-11							0.62 (0.55-0.71)
12+							0.48 (0.39-0.60)

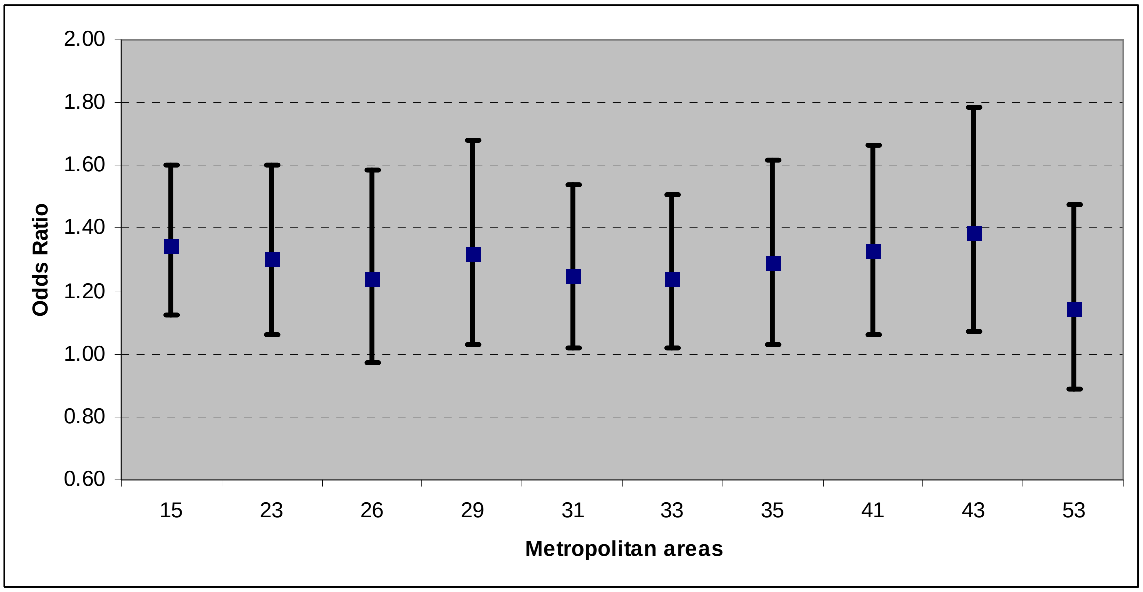

Figure 1 Odds ratio and 95% confidence interval for reporting a poor health status for 5% variation in the Gini coefficient, obtained from excluding each one of the metropolitan area from the model

Conclusion

In this study income inequality affects the individual health status only in the metropolitan context. This suggests that the detrimental effect of inequality may be potentialized in these areas by eroding norms and social bonding. Future works should analyse data from a broader metropolitan context.

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