Income inequality and elderly self-rated health in São Paulo, Brazil

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Purpose: To test the association between income inequality and elderly self-rated health and to propose a pathway to explain the relationship.

Methods: We analyzed a sample of 2143 older individuals (60 years of age and over) from 49 distritos of the Municipality of São Paulo, Brazil. Bayesian multilevel logistic models were performed with poor self-rated health as the outcome variable.

Results: Income inequality (measured by the Gini coefficient) was found to be associated with poor self-rated health after controlling for age, sex, income and education (odds ratio, 1.19; 95% credible interval, 1.01–1.38). When the practice of physical exercise and homicide rate were added to the model, the Gini coefficient lost its statistical significance (P > .05). We fitted a structural equation model in which income inequality affects elderly health by a pathway mediated by violence and practice of physical exercise.

Conclusions: The health of older individuals may be highly susceptible to the socioeconomic environment of residence, specifically to the local distribution of income. We propose that this association may be mediated by fear of violence and lack of physical activity.

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Introduction

The relationship between income inequality and population health has been the subject of a number of studies. A recent meta-analysis of 23 multilevel studies found that a 0.05-unit increase in the Gini coefficient of income inequality was associated with a 7.8% excess risk of mortality (95% confidence interval, 5.9%–9.8%) [1]. A follow-up analysis from the same authors concluded that the authors of country-level studies found a stronger association between income inequality and health than those in which authors analyzed smaller geographic aggregates (such as neighborhoods) [2]. A similar result was found by Wilkinson and Pickett [3]. In another review, Subramanian and Kawachi [4] concluded that the null results found for smaller areas may stem from the fact that most of these studies were from areas with low income inequality, mostly outside the United States. Lynch et al [5] have stretched this argument further by suggesting that the association between income inequality and health found in the literature could be the result of “American exceptionalism,” more specifically in relation to state-level differences in education and race relations.

The objective of the present study was to test the association between area-level income inequality and individual health by analyzing a sample of Brazilian older adults. Our choice of population advances the literature in two ways. First, our sample comes from a highly unequal area situated outside the United States (for which the results have been mixed). Second, our sample focuses on an age group for which literature has been hitherto mostly unsupportive of the income inequality theory. In an analysis of U.S. and Canadian metropolitan areas, Ross et al [6] found an association between overall mortality and income inequality for all age groups except for the elderly (65 years and older). A similar result was found by Backlund et al [7], leading them to conclude that “income inequality is not a major driver of mortality trends in the United States because most deaths occur at ages 65 and over.”

A focus on older segments of the population is of particular interest because of their greater susceptibility to features of their social environment. Young adults may also be highly influenced by their surroundings, but their capability to adapt quicker to adverse conditions might mitigate the influence of environmental forces. In a review, Yen et al [8] concluded that elderly health is influenced by a range of area-level characteristics such as socioeconomic status, demographics, racial composition, perceived environmental resources, and accessibility to physical activity.

The association between income inequality and violence is among the strongest and most established in the literature [9,10]. An increase in local violence can also lead to a disproportional
increase in fear of crime, particularly for elderly persons because they feel they are not able to protect themselves [11]. Perceived safety has been found to influence the mobility status of the elderly [12], which could have an important effect in their overall health [13].

We propose here that for the relative income theory to hold as an epidemiologic fact there is no satisfying reason for it not work for elderly persons. In fact, its effects should be larger in more vulnerable populations. Our aim in this work was to first test the theory for the sample. Given the results, and taking into consideration previous studies regarding elderly health, we then aimed to propose a causal pathway by which income inequality could affect elderly health.

Methods

The study used a sample of elderly (60 years of age and older) residents of the Municipality of São Paulo, from the Health, Well-Being and Aging study, implemented by the Department of Epidemiology of the University of São Paulo and coordinated by the Pan-American Health Organization and the World Health Organization [14]. Subjects were selected by clustered sampling. An initial sample of 72 census tracts from the Municipality of São Paulo was chosen by the probability proportional to size approach. Within each census tract, 90 households were randomly selected to account for an expected number of 1500 individuals older than 60 years of age. Using the same census tracts, we selected a secondary sampling unit of individuals ages 75 years of age or older to account for the greater mortality for the age group, as the study was originally developed as a cohort. This totaled 2143 (1568 + 573, for each sampling group) older adults included in the study (with a response rate of 88.4%). Each participant was visited in residence by a trained health professional, which applied an individual extensive questionnaire, followed by anthropometric analysis. The period of the visits ranged from January 2000 to March 2001.

The respondents were nested within 49 distritos, a proxy for neighborhood and the smaller area for which health and socioeconomic data are available in São Paulo. The homicide rate was used as a proxy for local violence because crime statistics are not available for distritos, and were calculated separately for each distrito for 1998 to 2000 to decrease annual random variability [15]. The Gini coefficient also was calculated separately for the distritos with data provided by the Instituto Brasileiro de Geografia e Estatística, the national public statistics department of Brazil [16].

Our dependent variable of interest is self-rated health, assessed by the question “How would you rate your health: Excellent/very good/good/fair/poor?” The use of an elderly sample provided a very high percentage of individuals declaring their health as fair or poor (55.3%). It has been also reported that the meaning of “fair” has a different interpretation in Portuguese if compared with other languages [17]. We therefore separated the individuals in two categories: excellent/very good/good/fair and poor (n = 200, 9.4%).

Regular physical exercise was assessed by the question: “During the last 12 months, have you been practicing any exercise or rigorous physical activities regularly such as sports, fast walking, dancing or heavy works at least 3 times a week?” Data for individual income was calculated in terms of minimum wages. Education was assessed as the total number of years of formal education. Height and weight values were taken individually by the health professional and a body mass index (BMI) was subsequently calculated. For the present analysis, individuals were categorized into underweight (BMI < 18.5 kg/m²), normal (18.5 to 25), and overweight/obese (>25). The continuous variables (homicide rate, Gini coefficient and income) were standardized to allow the comparison of their relative effects and to facilitate the interpretation of the Gini coefficient (as it may be expressed on a 0–1 or on a 0–100 scale).

We analyzed the data by applying logistic multilevel models with poor health as the dependent variable. Several benefits have been associated with taking into account a multilevel structure, such as allowing the simultaneous examination of the effects of group-level and individual-level predictors, and accounting for the nonindependence of observations within groups [18]. The use of a multilevel approach has also been suggested in order to avoid the concavity effect in income inequality studies [4]. We first tested the distrito-level variance without including any variable (null model). Next, we examined the relationship between self-rated health and the distrito-level Gini coefficient, controlling for individual-level income (model 1). Then, we included controls for individual-level characteristics: sex, age and education (model 2). The next model included BMI, smoking and physical exercise to control for individual-level health risk factors (model 3). The final model added to the previous ones by including distrito-level violence as an explanatory variable (model 4).

We applied Bayesian inference to estimate the parameters by using Markov Chain Monte Carlo. A Bayesian approach was used for two reasons. First, it decreases inherent bias associated with using maximum-likelihood procedures for binary models [19]. Second, it allows the comparison of goodness-of-fit between the models by calculating the deviance information criterion (DIC) coefficient, a by-product of the Markov Chain Monte Carlo procedure. By combining fit to the data and complexity, DIC discourages overfitting [20]. A model with many parameters will provide good fit to the model but will have fewer degrees of freedom. The DIC is a “badness-of-fit” statistics, with greater values indicating lower performance.

We used MLWin 2.25 software for the analysis. We first calculated maximum-likelihood estimates for starting values of the distribution. The first 500 simulations were discarded as “burn-ins,” followed by 15,000 further estimations to get the distribution of interest. To facilitate interpretation, results were presented as odds ratio (OR), along with 95% CIs. Median odds ratios (MORs) were calculated to analyze distrito-level variance [21]. MORs values are always equal of greater than 1. If it is 1, there is no variation between the distritos, so the larger the MORs, the higher the variation.

On the basis of the results, we fitted a structural equation model to propose a pathway by which income inequality could affect elderly health. We used the sem command from Stata 12 to specify the model. The standard errors were clustered to relax the assumption of independence of observations to independence within clusters of observations. We used standardized root mean square residual (SRMR) to test goodness-of-fit. Values for the SRMR range from zero to 1.0, with values under 0.05 considered to be very good fit [22], although some authors considerer any value under 0.08 to be acceptable [23].

Results

The distributions of the individual characteristics for the total sample and according to the dependent variable (poor health) are shown in Table 1. From the 2143 individuals from the sample, 4 had missing values for SRH and were excluded from the analysis (4/2143 = 0.19%). Poor health was reported by 9.4% of the individuals. Reporting poor health was more frequent in women, individuals ages 75 and older, underweight or overweight/obese, smokers and those not practicing regular physical exercise. A higher Gini coefficient of distrito of residence was significantly associated with greater odds of individuals reporting poor health (P < .05) and the homicide rate was close to significant (P = .07).
The results found here indicate that greater income inequality is associated with poor self-rated health in elderly persons, possibly through a pathway mediated by increased violence and lower levels of physical exercise. When analyzed separately, our findings are consistent with previous studies in which authors have confirmed these mechanisms in independent analysis.

Greater income inequality has been robustly linked with greater levels of violence [25–27]. The Gini coefficient has been shown to consistently outperform most other predictors of homicide rates, including average income and welfare [28]. Greater income inequality also has been linked to lower rates of physical activity by promoting an “obesogenic” environment that combines a wider availability of cheap and energy dense foods with fewer facilities for physical activity [29]. Living in a high-crime area (more specifically, in those with a high homicide rate) has been consistently associated with lower physical activity for children [30], adolescents [31], and possibly elderly persons.

**Discussion**

In light of these results, we propose here that income inequality affects elderly health via the mediating effects of increased area violence and lower physical activity. All the pathways of the structural equation model were statistically significant ($P < 0.05$), except the direct effect of the Gini coefficient on self-rated health (which was marginally significant, $P = 0.07$). The overall goodness-of-fit value for the model was very low ($SRMR = 0.004$), indicating very good fit.

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**Table 2**

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Total</th>
<th>Poor health status</th>
<th>OR 95% CI</th>
<th>OR 95% CI</th>
<th>OR 95% CI</th>
<th>OR 95% CI</th>
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<tbody>
<tr>
<td><strong>Model 1</strong></td>
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<tr>
<td>Gini coefficient</td>
<td>1.21 (1.04–1.41)</td>
<td>1.19 (1.01–1.38)</td>
<td>1.19 (0.99–1.42)</td>
<td>1.19 (0.99–1.44)</td>
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<tr>
<td>Income</td>
<td>0.66 (0.46–0.96)</td>
<td>0.76 (0.54–1.06)</td>
<td>0.78 (0.52–1.16)</td>
<td>0.77 (0.52–1.16)</td>
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<tr>
<td>Sex</td>
<td></td>
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<tr>
<td>Women (vs. men)</td>
<td>0.93 (0.68–1.28)</td>
<td>0.96 (0.66–1.40)</td>
<td>0.95 (0.65–1.40)</td>
<td>0.95 (0.65–1.40)</td>
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<tr>
<td>Age</td>
<td>1.02 (1.00–1.03)</td>
<td>0.99 (0.97–1.01)</td>
<td>0.99 (0.97–1.02)</td>
<td>0.99 (0.97–1.02)</td>
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<tr>
<td>Years of education</td>
<td>0.90 (0.85–0.96)</td>
<td>0.90 (0.84–0.97)</td>
<td>0.90 (0.84–0.97)</td>
<td>0.90 (0.84–0.97)</td>
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<tr>
<td>BMI (vs. normal)</td>
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<tr>
<td>Underweight</td>
<td>1.79 (0.84–3.81)</td>
<td>1.79 (0.85–3.74)</td>
<td>1.79 (0.85–3.74)</td>
<td>1.79 (0.85–3.74)</td>
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<tr>
<td>Overweight and obese</td>
<td>1.12 (0.75–1.69)</td>
<td>1.14 (0.76–1.71)</td>
<td>1.14 (0.76–1.71)</td>
<td>1.14 (0.76–1.71)</td>
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<tr>
<td>Smoking</td>
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<tr>
<td>Yes (vs. no)</td>
<td>1.41 (0.87–2.29)</td>
<td>1.43 (0.88–2.32)</td>
<td>1.43 (0.88–2.32)</td>
<td>1.43 (0.88–2.32)</td>
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<tr>
<td>Exercise</td>
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<tr>
<td>Yes (vs. no)</td>
<td>0.25 (0.13–0.51)</td>
<td>0.25 (0.12–0.52)</td>
<td>0.25 (0.12–0.52)</td>
<td>0.25 (0.12–0.52)</td>
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<tr>
<td>Homicide</td>
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<tr>
<td>Distrito-level variance (SD)</td>
<td>0.03 (0.04)</td>
<td>0.02 (0.02)</td>
<td>0.02 (0.02)</td>
<td>0.03 (0.04)</td>
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<tr>
<td>Mean odds ratio</td>
<td>1.19 (1.03–1.43)</td>
<td>1.12 (1.03–1.30)</td>
<td>1.13 (1.03–1.31)</td>
<td>1.15 (1.03–1.39)</td>
<td></td>
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</tr>
<tr>
<td>DMC</td>
<td>1330.94</td>
<td>1233.29</td>
<td>1218.78</td>
<td>892.07</td>
<td>893.76</td>
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</tr>
</tbody>
</table>

BMI = body mass index; DMC = deviance information criterion.
adults [32], and older adults [33]. The influence of regular physical activity in elderly health has also been reported [13,34,35]. This is the first study, however, to propose a pathway linking these effects to worst elderly health. As mentioned before, studies that analyzed income inequality and elderly health have previously found no association [6,7]. In our crude income model, the Gini coefficient and individual income were both significantly associated with declaring poor health. After the inclusion of individual characteristics, only the Gini coefficient remained statistically significant (OR, 1.19; 95% CI, 1.01–1.38). With the inclusion of risk factors, the Gini coefficient was only marginally significant (OR, 1.19; 95% CI, 0.99–1.42).

Studies that found no association between income inequality and elderly health have analyzed data from the United States and Canada. Despite being considered to have high income inequality when compared with other developed countries, even the United States is a considerably equal place if compared with the municipality of São Paulo. In the year 2000, the Gini coefficient for São Paulo was 0.51 [36], which is substantially greater than 0.41 for the United States [37], which is noteworthy if we take into consideration the large country-wide differences in costs of living. As the Gini coefficient in the US continues to grow, and Brazil’s to decrease, this situation may become more similar in the future.

The structural equation model was chosen in two phases. In the first, lack of physical activity was selected as the variable most associated with greater odds of declaring poor health. By analyzing physical activity separately, we found that it was strongly correlated with the homicide rate, which in turn was also highly correlated with local income inequality. Because the homicide rate was not significantly associated with poor health, and with knowledge of the extensive literature linking income inequality with increased violence [28], we speculated that the homicide rate could be a mediating factor between income inequality and lower physical activity. Second, we developed a structural equation model to test this pathway by excluding and then by including a direct pathway between income inequality and poor health, finally choosing the latter option, which provided the lower SRMR (0.004 vs. 0.011 for the other), albeit the fact that the direct pathway was only marginally significant (P = .07). We also tested models with the inclusion of education, as it was the only variable (apart from physical exercise) that remained significant in the final model and because previous studies indicate an association between education, physical exercise and elderly health [38]. For all the possibilities tested (education as a mediator between inequality and SRH, as a mediator between physical exercise and SRH and with an independent direct effect on SRH), the SRMR was greater (0.07 in all cases) than our final model, indicating worst fit.

The use of self-rated health has a few limitations, especially regarding the possibility of socioeconomic differences in its prediction of mortality [39,40]. Its strengths come from being a good predictor of overall health [41], and from allowing a more widespread comparison and reproducibility, as it is the most frequently used outcome in income inequality studies [1]. A recent study of older Brazilians found that the predictive power of self-rated health in relation to mortality was comparable to that of a health score based on 10 different parameters [42]. By including poor health as a separate category, we avoided the bias resulting from the translation of “fair health” from Portuguese to English, which can sometimes have a positive meaning.

Our proposed pathway or mechanism by which income inequality could affect elderly health should be taken with considerable caution because it has several limitations, the most important being that it comes from a cross-sectional study. Because of the fact that most of social and health systems are dynamic, a causal interpretation of the data is strengthened if the outcome of interest is allowed to change over time. The use of structural equation models with cross-sectional data, despite being the most frequently found in the literature, is considered less desirable than one with longitudinal data [43]. Also, the strength of the importance of the association between physical exercise and the Gini Coefficient to predict poor self-rated health is still not clear. Despite it being statistically significant, physical exercise only marginally changed the OR for the Gini coefficient and poor self-rated health. The homicide rate was statistically significant in the pathway analysis but not in the final multilevel model, suggesting it may have an effect only as a mediator.

The sample also has limitations. First, it does not aim to be completely representative of the older population of the Municipality of São Paulo, as it was oversampled for individuals 75 years of age and older. Second, there is a possibility of selection bias by non-respondents, as older adults with worst health may be less willingly to take an extensive questionnaire and anthropometric analysis. Third, caution is suggested when applying the results to other countries, as self-rated health assessment has been shown to vary according to cultural differences [41].

### Conclusion

Developed countries have historically first become rich and then become old. The same demographic process of low fertility and high longevity that took more than a century to unfold in France is expected to occur in only two decades in Brazil [44]. Understanding the social determinants of elderly health has become a fast-rising priority for developing countries as they try to cope with this new situation.

Our study suggests that elderly persons may be susceptible to the socioeconomic environment of residence, more specifically to the local distribution of income. Promoting a better environment for the practice of physical exercise by elderly residents is a challenge that goes beyond the physical presence of parks, trails and recreational facilities [45]. A more egalitarian distribution of income could not only decrease fear of crime and increase the practice of physical exercise, but also promote social capital, another important determinant of elderly health [46].

Further studies should focus on the recent decrease in income inequality in Brazil, in order to test if the association is a consequence of areas with an extremely unequal distribution of income or a specific characteristic of Brazil.

### References


