The spatial segregation of poverty is associated with higher mortality in Porto Alegre, Brazil

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Abstract

Background: The link between poverty and poor health outcomes is well known; more recently there is some evidence that suggests an independent effect of income inequality on health. However this association of income inequality with health appears to be weaker at smaller spatial levels. The paper examines the question whether socioeconomic segregation at the neighbourhood level, which is the spatial manifestation of income inequality, is associated with higher mortality rates.

Methods: Data on mortality rates, income, income inequality (gini coefficient) and income segregation were analysed for all 73 districts within the city of Porto Alegre, Brazil. The outcomes in this study are district level standardized mortality rates for total mortality, premature cardiovascular mortality and infectious disease causes mortality. Census data were used to calculate the proportion of income groups at census tract level (n = 2,157) and to calculate global segregation scores for the city and local segregation scores for localities within the city.

Results: The results demonstrate the existence of income inequality and income segregation within the city and a relationship, at district level, between these measures and health outcomes. There is some evidence to suggest that income segregation is associated with population health over and above the effects of income and income inequality. If poor people are completely isolated in the neighbourhoods where they live, those districts have around 14 deaths per 1000 population more than districts where poor people are not isolated in their neighbourhoods.

Conclusion: The residential segregation of poor people within cities may need to be addressed, along with income inequality, if health inequalities are to be reduced. Urban and economic development that results in increasing the spatial segregation of poor people may result in widening health inequalities.

Keywords: Urban segregation; income segregation, income inequality, health inequalities

Introduction.

Income inequality and health

The relationship between income, poverty and increased risk of disease and mortality is well established. More recently, studies have shown that in addition to the health risks associated with low household income, the level of inequality within an area, or the gap between rich and poor, can affect population health (Wilkinson 1997, Kawachi et al 1999, Lynch et al 1998, Babones 2009). Kondo et al (2009) carried out a meta-analysis of 27 multi-level studies looking at the effects of income inequality on mortality rates and concluded that a 0.05 unit increase in the Gini coefficient of income inequality was associated with a 7.8% excess mortality risk. Some studies, within Brazil, have reported an association between levels of inequality and health outcomes at state level (Messias 2003) and within cities (Filho et al 2012).

A review of studies on the association of income inequality with population health by Wilkinson and Pickett (2006) showed that the association of income inequality with health is stronger when income inequality is measured at the country level, and this association gets progressively weaker when inequality is measured at smaller area levels. This pattern is also supported by other studies (eg. Subramanian & Kawachi, 2004). Wilkinson and Pickett (2006) argue that the health of people in deprived neighbourhoods is poorer not because of the inequality within their neighbourhoods, but because they are deprived in relation to the wider society. The wider social (and national) levels are the relevant spatial units for the mechanisms generating the negative health outcomes, whether they are psychosocial social comparison effects, or social structural processes generating social inequalities. Wilkinson (1997) also argues that residential segregation which measures income inequality in small areas is not the relevant spatial unit when considering the association of income inequality with health.

The authors argue that the country level is the relevant level in relation to income inequality as the structural processes that result in negative health outcomes are primarily generated at the wider social level, rather than at local levels. However, it can also be argued that the relevant meaure of income inequality at the local neighbourhood level is not an apsatial measure of inequality like the gini coefficient but a spatial measure of inequality like spatial socioeconomic segregation, which is the residential manifestation of income inequality. It is possible that higher levels of spatial segregation at the local level are associated with poorer health outcomes, mirroring the association between income inequality and poor health at the country level. This hypothesis has rarely been tested in the literature so far.

Income segregation and health

Income inequality and income segregation are two linked, but distinct, concepts. Income inequality is a necessary condition for income segregation to exist but not sufficient to cause income segregation (Watson 2009, Reardon and Bischoff 2011). Income segregation arises when there are processes of spatial constraint, affecting those with the least resources (Castells 2004). Income segregation can be understood as the enforced separation of disadvantaged social groups (Marcuse 2005).

Income segregation may act to reinforce any negative effects of inequality (Massey and Denton 1993). Urban environments tend to be stratified, geographically, along multiple socio-economic factors (Torres et al 2003) and there is a long tradition of concern within Sociology with the way in which urban spatial divisions reinforce social inequality (Park et al 1925). More recently Wilson (1987) revived academic interest in neighbourhood effects, premised on the concept that there is an effect of living in a poor area, over and above the effect of individual levels of poverty. Van Ham et al (2012) has recently reviewed the literature on neighburhood effects. Other reviews of neighbourhood effects on health include Pickett and Pearl (2001), Kawachi and Berkman (2003) and Tampubolon (2011). Ross et al (2001) examined the relationship between income inequality and mortality rates in urban areas of the US, UK, Canada, Australia and Sweden and found a relationship between income segregation and working age mortality, after income is controlled for. They bring together the study of health and income equality with the emerging literature on neighbourhood effects and argue that income segregation leads to a ‘triple health jeopardy’. That, in addition to the effects of individual poverty and income inequality, there are independent negative health effects that result from income segregation.

There are only a few empirical studies that have examined the relationship between income segregation and health. Waitzman and Smith (1998) used individual data from an US national survey and aggregated data from the 30 largest metropolitan areas in US, and concluded that, after controlling for individual-level income, the concentration of poverty was significantly associated with elevated risk of mortality and that the concentration of affluence was associated with a significantly reduced mortality risk. Lobmayer and Wilkinson (2002) also found significant positive association between urban segregation and several mortality indicators. This relationship was independent from the effect of mean income and income inequalities. Szwarcwald et al (2002) in a study of infant mortality in the city of Rio de Janeiro, Brazil, found that the negative effects of poverty are amplified when that poverty is spatially concentrated.

There may be a number of reasons for the relationship between poor health and income segregation. It is known that poor nutrition, sub standard housing conditions and overcrowding increase susceptibility and exposure to infectious diseases like tuberculosis (Acevedo-Garcia, 2000; Acevedo-Garcia, 2001). Poor segregated areas, in spite of their greatest needs, often have inadequate services and restricted access to primary care services (Lobmayer & Wilkinson, 2002; Ross et al., 2001, Hastings 2009). Poor neighbourhoods are more likely to be exposed to environmental pollutants (Anderton et al 1994, Ellen et al 2001, Cohen et al 2003, Ash and Fetter 2004, Hassing et al 2009). So income segregation may enable the affluent access to the greatest resources and reinforce the social exclusion of the disadvantaged (Massey 1996, Massey and Denton 1988, Jargowsky 1996). While people who live in close proximity to the more affluent may benefit from the better quality public services in those areas (what Hou and Myles 2005 call the 'spill-over' effect), the overall effect of income segregation is to reinforce, rather than just reflect, social inequality (Dwyer 2010).

Brazil has long been an unequal country, with differing levels of access to basic services. In addition, between 1950 and 2000 the urban population of Brazil increased dramatically, and it is predicted that by 2050 over 90% of the population will live in an urban environment (United Nations 2012). In many Brazilian cities the increased population has resulted in overcrowding in poor quality housing in areas lacking in basic infrastructure (Szwarcwald et al 2002), Da Mata et al 2005).

Despite the reductions in the gini index of income inequality in Brazil in recent years (Lopez-Calva and Rocha 2012), Brazilian housing policies still largely recreate socioeconomic segregation by creating large social housing settlements for the poor that are located on cheap land in the outskirts of the city. Such housing policies displace poor families to isolated areas, distant from the supply of resources, services, employment and opportunities, which very often turn into distressed neighbourhoods (Sabatini 2006).

The research question

Is spatial socioeconomic segregation within districts of a Brazilian city (Porto Alegre) associated with higher mortality? Does this association remain even after adjusting for district income levels and income inequality? This study makes a contribution to the emerging empirical study of the effects of income segregation and makes use of recently developed spatial measures of segregation. These measures are discussed in the methods section below.

Data and Methods

This is an ecological, cross-sectional study examining the association between district level population mortality rates and district level measures of income segregation, within the city Porto Alegre, Brazil. The city has a total population of 1,358,384 inhabitants. For this analysis there are 73 districts that are further subdivided into 2,157 census tracts.

The outcome variables are total mortality rates, and specific mortality rates for premature cardiovascular disease and infectious disesease causes. Geo-referenced mortality data was obtained for the period 2000 to 2004, a total of 51,562 deaths, from the National Mortality Information System (SIM). Rates per 1,000 population (for total mortality) and per 100,000 of the population (for premature cardiovascular disease and infectious disease mortality), were calculated at district level and standardised by age and sex, with the total city as the standard population.

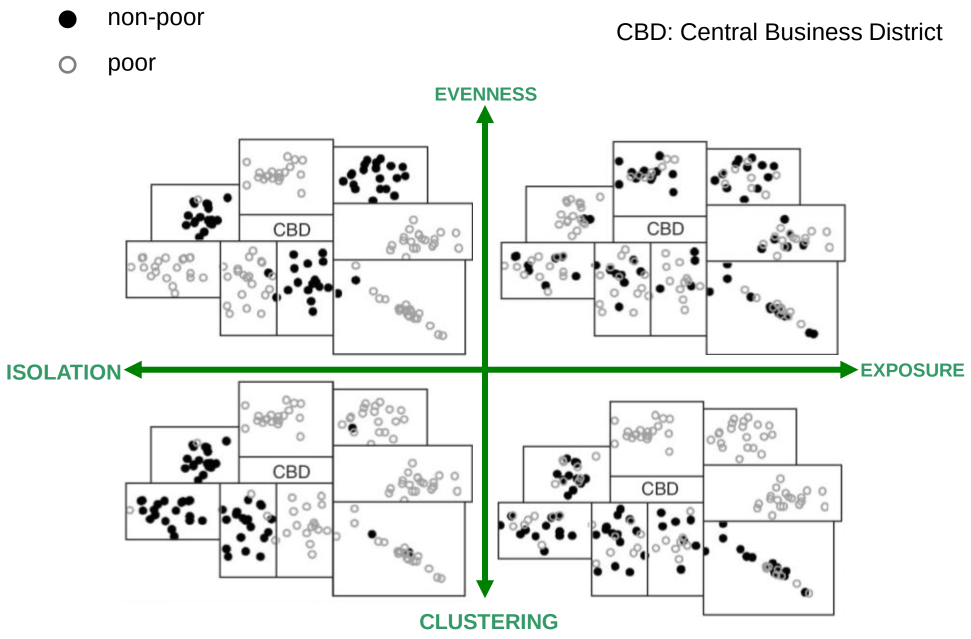
District level mean head of household income was derived from the 2000 Census. Census income data are banded in multiples of the official minimum salary in Brazil. In 2000, the minimum salary in Brazil was R$151. The Inter-Union Department of Statistics and Socio-Economic Studies (DIEESE) calculated that in 2000 the minimum salary was R$151 would cover only 15% of a family's basic needs (DIEESE 2012). The gini coefficient of income inequality was calculated from the income distribution within districts. The global and local spatial measures of income segregation are derived from the income distributions at census tract level. The analysis presents a description of the outcomes and indices. In order to determine whether income segregation has an independent effect on the health outcomes, over and above the effect of mean income and income inequality (gini coefficient), these variables are considered separately and together in multiple regression models.

Segregation Indices

This study will use newly developed global and spatial indices of exposure and isolation as described by Feitosa et al (2007). Segregation measures have a long history. Jahn et al (1947) first presented a series of four measures, each capturing a different aspect of residential segregation and reported observed correlations between city level ethnic segregation and mortality outcomes. In recent decades a plethora of segregation measures have been developed, each capturing different aspects of the phenomena. In an important development Massey and Denton (1988) reviewed the range of segregation measures and identified five distinct dimensions of segregation, evenness, exposure, concentration, clustering and centralisation. More recently Reardon and O`Sullivan (2004) proposed that Massey's five dimensions of residential segregation could be reduced to two dimensions, isolation-exposure and evenness-clustering.

The isolation-exposure dimension is the extent to which a member of a particular group would encounter members of their own group or members of other groups. The evenness-clustering dimension is the extent to which groups are distributed within a given geographical area (see Figure 1). Such an approach overcomes the 'checkerboard problem' of previous measures of segregation that could not detect the spatial patterns within geographical areas. Figure 1 demonstrates that despite having the same proportions of poor people in each quadrant (or city) and hence the same degree of income inequality (as measured by the Gini coefficient), the four quadrants represent different levels of spatial socio-economic segregation with the bottom-left quadrant (isolated and clustered) representing the most spatially segregated city. This study examines the isolation-exposure dimension of spatial segregation.

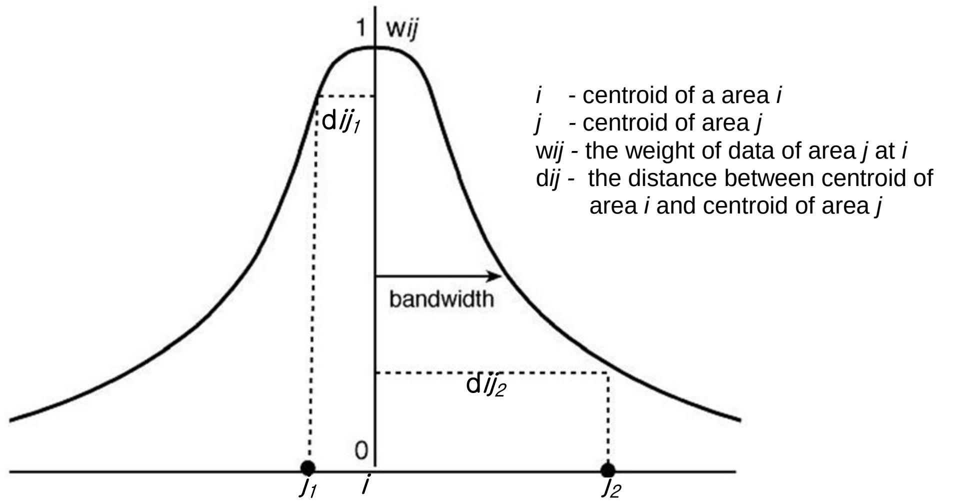
Figure 1: Dimensions of spatial segregation (Adapted from Bell, 2006 and from Reardon & O'Sullivan, 2004)



The segregation measures that are used here are spatial. The defining aspect of spatial measures of segregation is that they employ composite population counts, which model the interaction across boundaries using a weighted population average. Rather than using only the segregation of the population within a given area unit a spatial measure also takes into account the nature of the surrounding population. In order to calculate the local population intensity the estimator is placed on the centroid of each areal unit and a geographically weighted population average is calculated, taking into account the distance between groups. So, all areal units contribute to the population intensity of any specific areal unit, but observations nearer to this specific areal unit are given greater weight than observations further away.

Feitosa et al (2007) argue that such an approach fits well with segregation studies as urban areas have different localities where people interact and the intensity of this interaction can be assumed to be related to the distance between any two given areas. This approach also addresses one of the problems associated with spatial analysis, part of the modifiable areal unit problem MAUP (Openshaw 1984). Administrative boundaries can be arbitrary, and depending on how boundaries are constructed, boundary lines can result in very different aggregated measures. By applying spatial measures of segregation and calculating population intensities for localities in this study, the problems associated with different sized census tracts may be mitigated somewhat. For this study we employ a Gaussian kernel function, see (Figure 2).

Figure 2. Gaussian kernel decay function and bandwidth used in this study



Adapted from Fotheringham et al, in http://www.geocomputation.org/2001/talks/keynote.ppt#356,13,Slide 13 Captured 17 December 2009.

The bandwidth needs to be specified, to allow for the degree of distance-decay. If the bandwidth is too small the kernel estimator will be under-smoothed and the spatiality of the phenomenon may not be taken into account and if it is too big it may become over-smoothed and so hide most of the structure of the data. In this paper, based upon the size of the census tracts, local expertise and after exploring surfaces generated by different bandwidth estimates, a bandwidth of 400 metres was chosen. The authors found that this would be a meaningful scale to detect segregation effects in a city like Porto Alegre. The indices used are developed by Feitosa et al (2007), based on the work of Reardon and O'Sullivan (2004), and Wong (2002, 2003, 2005).

The local population intensity is calculated as shown in equation 1.

$$\breve{L}_j = \sum_{j=1}^{J} k(N_j) \qquad (1)$$

The kernel estimator *k* estimates the spatial influence of each areal unit in the city on the locality *j* (or census tracts in our study). As discussed in Figure 2, for this study a Gaussian kernel decay function was used to estimate this spatial influence. *Nj* is the total population in areal unit *j, J* is the total number of areal units (or census tracts) in the city. Equation 2 calculates the local population intensity of a particular group *m* in the locality *j* (denoted by *jm*, which refers to the population of group *m* in the locality *j*.

$$\breve{L}_{jm} = \sum_{j=1}^{J} k(N_{jm}). \qquad (2)$$

Feitosa et al (2007) use these intensities to develop spatial versions of the isolation index developed by Bell (1954). The spatial isolation index, as shown in equation 3, expresses the exposure of group *m* to itself. It is the average proportion of group *m* in the local environments of each member of group *m*.

$$\breve{Q}_m = \sum_{j=1}^{J} \frac{N_{jm}}{N_m} \left(\frac{\breve{L}_{jm}}{\breve{L}_j} \right) \qquad (3)$$

N_{jm} population of group *m* in census tract *j*

N_m population of group *m* in the city

$\breve{L}_{jm}$ population intensity of group *m* in census tract *j*

$\breve{L}_j$ population intensity of census tract *j*

As the indices above are global spatial measures they summarise the extent of the segregation at the city level. It is possible to decompose these measures for each locality (Feitosa et al 2007), these local scores measure the amount that each locality contributes to the global segregation score of the city. Equation (4) is thus a decomposition of equation (3) and estimates the local spatial isolation index.

$$\breve{q}_{jm} = \frac{N_{jm}}{N_m}\left(\frac{\breve{L}_{jm}}{\breve{L}_j}\right) \qquad (4)$$

The census tract scores are aggregated to the district level in order to model the effects on district level health outcomes. ArcView 3.1 was used to calculate local population intensities and the exposure and isolation indices. Excel software was used to organize the database; SPSS 14.0 for Windows for non-spatial analyses, GeoDa 0.9.5-i (Beta) and SigEpi1.4 for spatial analyses and TabWin 3.5 for thematic maps.

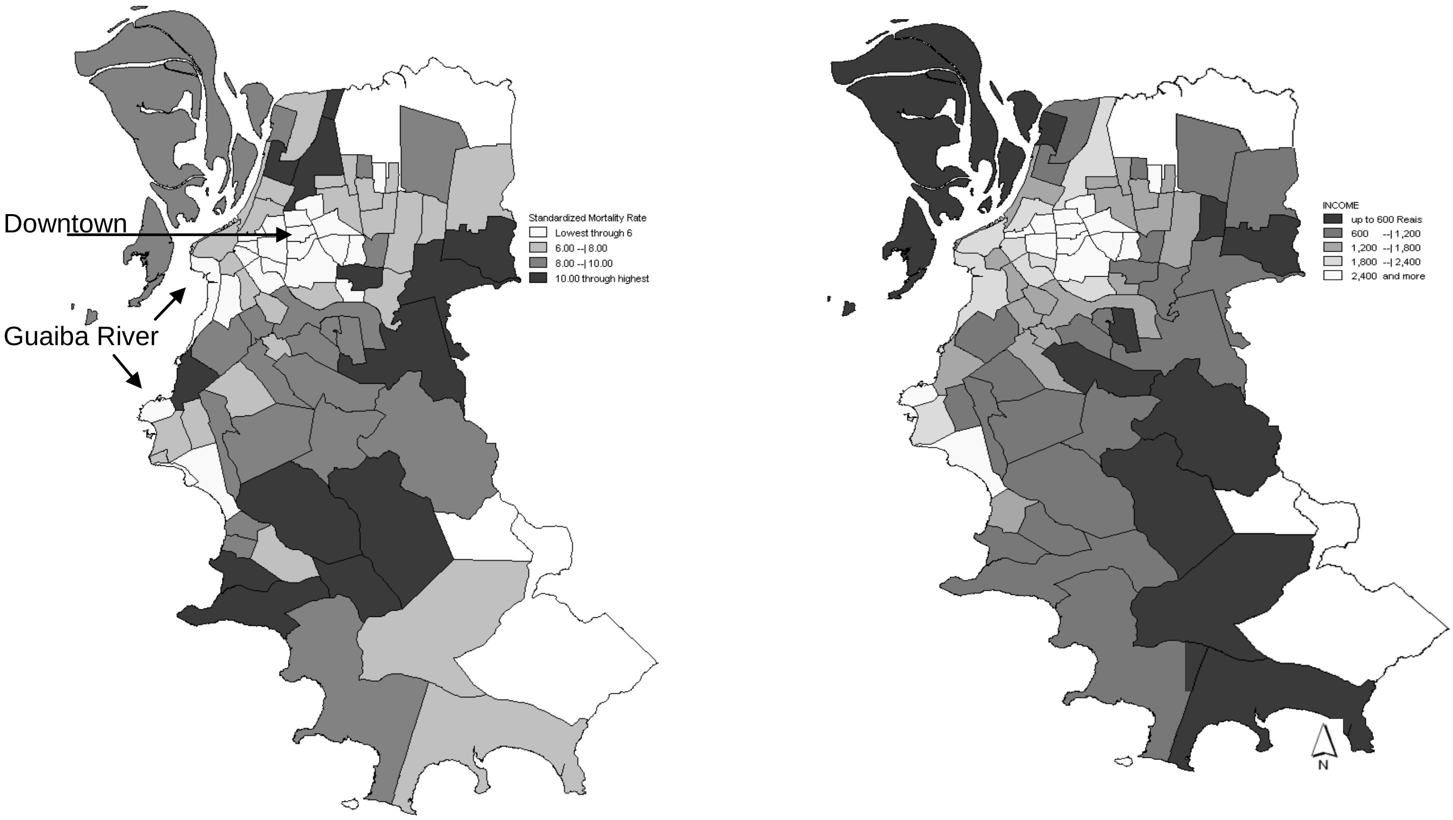
Results

The distributions of total mortality and mean income of districts in Porto Alegre (POA) are mapped in figure 3. The map for the total mortality rate (3a) shows that the central downtown area of POA has the lowest mortality rate (less than 6 deaths per 1,000 population), while some of the outlying areas in the South and East have the highest mortality rates. The map for mean income (3b) shows that central downtown area has the highest mean income, while the poorest districts are on the outskirts of the city. Districts with the lowest mortality rates are also districts with the highest mean incomes, such as the central downtown area. Figure 3b, below shows that 16% of head of households in the city have an income of less than 2 minimum salaries a month.

Figure 3: Distribution of Total Mortality Rate (3a) and Mean Income (3b) in 73 Porto Alegre districts

3a: Total Mortality Rate

3b: Mean Income



Global spatial isolation index.

The global spatial isolation index for the five income groups are shown in Table 1 below, along with the percentage of the city population by income group.

Table 1. Percentage of city population and global spatial isolation index, $\breve{Q}_m$,by income group of head of household.

Income Group	Percentage of city population	$\breve{Q}_m$
20 or + ms	6.0%	0.23
10 to <20 ms	24.1%	0.20
5 to <10 ms	29.1%	0.24
2 to <5 ms	24.4%	0.29
>0 to <2 ms	16.3%	0.31

Feitosa et al (2007) make the point that the global spatial isolation index scores need to be interpreted in the context of the population distribution. As outlined above, the scores can be interpreted as the average proportion of an income group in the locality of members of that income group, in other words, the spatial exposure of an income group to itself.

It can be seen that the highest and lowest income groups are the most isolated. The isolation index score for the highest income group shows that the average member of that income group lives in an area where 23% of others in the locality are from the same high income group. If each locality of the city had a population distribution identical to that in the city as a whole this figure would be 6%. So the highest income group is around four times as likely to live in the same locality as others in the highest income group than would be the case if the income inequality that exists in the city was distributed equally in all localities. The highest income group is the most isolated, but those in the lowest income groups are also isolated, being twice as likely to live in areas with others in the lowest income group. The middle income groups are less isolated being close to what would be expected if the city population were distributed equally amongst localities.

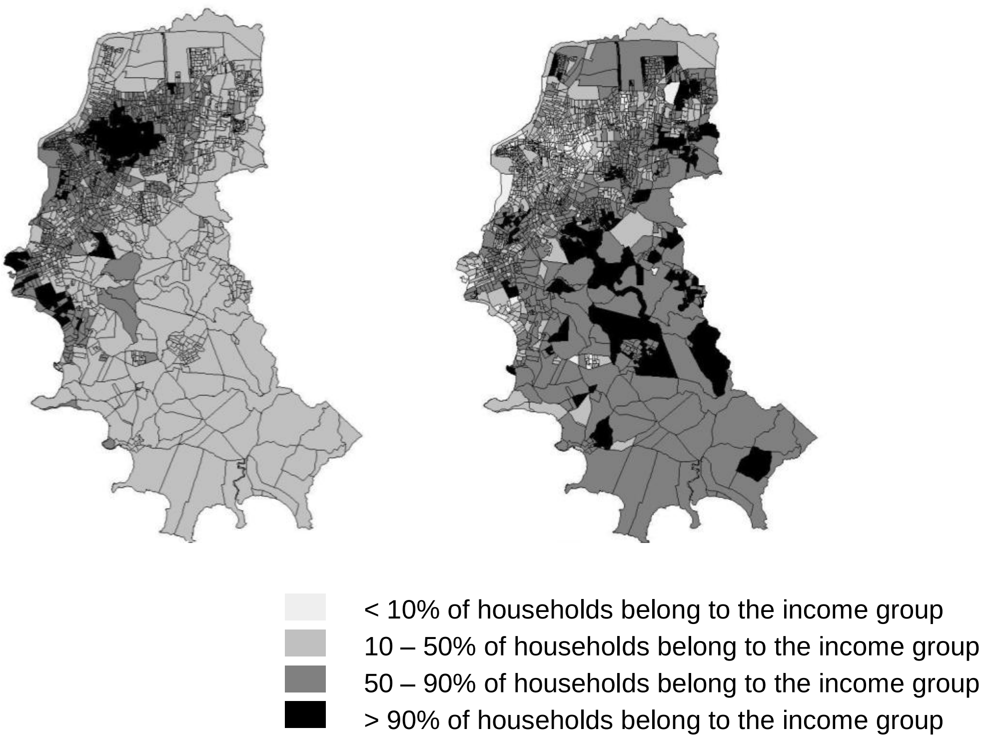
Local Segregatrion indices

It can be seen from the global indices that the poorest and richest income groups are spatially segregated within the city, these income groups tend to live in areas where they have a high level of exposure to their own income group by low exposure to each other. As previously discussed, these global scores can be decomposed and district level scores are calculated. These scores reflect the extent to which that district contributes towards the global spatial segregation score for the city. It is these scores that are used in the regression models examining variation in district level health outcomes. As the middle income groups are not isolated and are not less exposed to other income groups the local scores for these measures are not used in the regression models. The objective is to test whether income segregation has an effect on health, independent of income, and therefore local scores for global indices that are themselves not substantively significant do not actually capture any aspect of segregatation. Figure 4, below, shows the spatial distribution of the local scores for two extreme income groups- the richest and poorest groups. The localities where there is lowest spatial isolation of the poorest groups are in the central downtown area, which are also the localities where there is the highest spatial isolation of the richest groups.

Figure 4 Census tracts of Porto Alegre according to percentiles of local Spatial Isolation Indexes of richest and poorest income groups.

4a: Local Spatial Isolation Index of the richest (10+ minimum salaries)

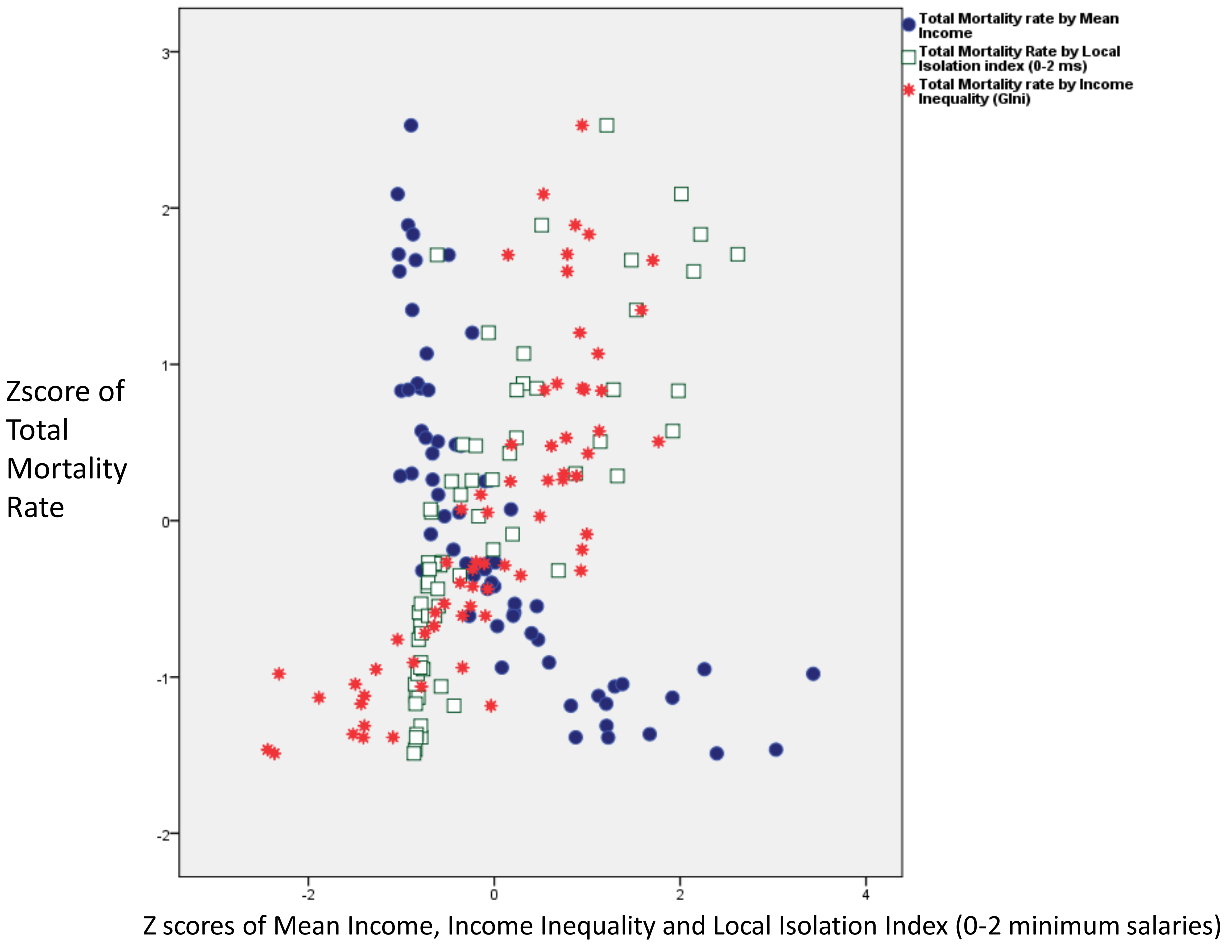
4b: Local Spatial Isolation Index of the poorest (0-2 minimum salaries)



Scatterplots

Figure 5 shows the scatterplot of the total mortality rate by Mean Income, Income Inequality and the Local Isolation Index for the poorest income group earning 0-2 minimum salaries per month. All the variables were transformed into z-scores in order to compare them within the same graph. The scatterplot shows similar linear associations between all the three measures describing the socioeconomic composition of POA districts and the total mortality rate. Districts where mean income was lower, income inequality was higher and poor income groups were spatially isolated had higher total mortality rates. The correlation coefficients were -0.77 for mean income, 0.80 for income inequality and 0.79 for the local isolation index of poor income groups. In addition, there were strong correlations between the local isolation index and mean income (-0.65) and with income inequality (0.72). This suggests districts where the poor are spatially isolated tend to be districts where the mean income is lower and income inequality is higher.

Figure 5: Scatterplot of total mortality rate with mean income, income inequality and the local isolation index of the poor in 73 POA districts



Regression models

The results of the regression models with the different mortality rates (total, premature cardiovascular and infectious disease) as dependent variables are shown in Table 2. The top third of the table shows the coefficients (and 95% confidence intervals) of the district socio-economic variables predicting the total mortality rate in POA districts. In Model 1, the constant refers to the average (age and sex adjusted) mortality rate in POA which is 8.5 per 1000 inhabitants. A unit increase in the mean monthly income of POA districts (which corresponds to R1,000) is associated with a decrease of around 1.3 deaths per 1000 inhabitants. In Model 2, income inequality (gini coefficient) is added to the model. The model fit (Rsq) improves and a unit increase in the gini coefficient (which means going from complete equality to complete inequality) is associated with an increase of 13.7 deaths on average. Models 3 to 6 add in the local isolation indices for different income groups. The model with the best fit is the one with the local isolation index for people living on 0 to 2 minimum salaries (or the poorest group). A unit increase in the coefficient for the local isolation index can be interpreted as going from an area where no one else in the locality is from the same (poor) income group to one where 100% of the locality members belong to the same (poor) income group. This unit increase in the local isolation index is associated with an increase in the mortality rate by 48.5 deaths per 1000 inhabitants. In this model, the effect of income inequality reduces and is no longer statistically significant.

The Middle third of Table 2 shows the results of the same models predicting the premature cardiovascular mortality rate (per 100,000 inhabitants). The findings are similar to the models predicting the total mortality rate. The best fitting model is model 3 with income, income inequality and the local isolation index for the poor income group. In this model, the coefficient for income inequality also reduces to non-significance. The bottom third of Table shows the results predicting the infectious disease mortality rate. Here the best fitting model is Model 5 in which a unit increase in the local isolation index of the relatively wealthier income group (who earn 5-10 minimum salaries on average) is associated with a decrease in the infectious disease mortality rate by 1,574 deaths per 100,000 inhabitants. As with the best fitting models for the other dependent variables, the coefficient for income inequality also reduces to non-significance.

Table 2: Multiple regression models predicting total mortality rate, premature cardiovascular disease and infectious disease mortality rates in 73 POA districts

Total Mortality	**Model 1**	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**
Constant	8.55 (8.02, 9.08)	1.17 (-3.41, 5.75)	4.50 (0.26, 8.74)	1.18 (-3.16, 5.51)	8.78 (3.26, 14.31)	1.03 (-3.67, 5.73)
Mean Income	-1.28 (-1.54, -1.02)	-0.39 (-0.99, 0.21)	-0.50 (-1.03, 0.02)	-0.16 (-0.75, 0.43)	-1.16 (-1.81, -0.50)	-0.51 (-1.47, 0.45)
Income inequality (Gini)		13.71 (5.24, 22.17)	4.65 (-3.71, 13.00)	10.47 (2.15, 18.78)	2.22 (-7.20, 11.64)	14.15 (5.22, 23.07)
Local isolation index (0-2 ms)			48.51 (27.53, 69.48)			
Local isolation index (2-5 ms)				83.15 (26.22, 140.07)		
Local isolation index (5-10 ms)					-124.61 (-185.18, -64.04)	
Local isolation index (10+ ms)						7.03 (-35.20, 49.25)
R^2	0.60	0.65	0.74	0.70	0.73	0.66

Premature Cardiovascular Mortality						
Constant	252.10 (235.47, 268.72)	71.24 (-76.77, 219.26)	161.66 (17.95, 305.38)	71.40 (-61.60, 204.39)	293.74 (111.05, 476.44)	74.76 (-77.05, 226.57)
Mean Income	-34.59 (-42.72, -26.46)	-12.80 (-32.18, 6.59)	-15.92 (-33.71, 1.87)	-3.25 (-21.29, 14.80)	-35.25 (-56.89, -13.61)	-9.81 (-40.75, 21.13)
Income inequality (Gini)		336.14 (62.65, 609.62)	90.00 (-192.84, 372.84)	198.67 (-56.30, 453.64)	0.35 (-311.01, 311.71)	325.52 (37.02, 614.02)
Local isolation index (0-2 ms)			1317.84 (607.70, 2027.98)			
Local isolation index (2-5 ms)				3529.52 (1783.65, 5275.40)		
Local isolation index (5-10 ms)					-3643.00 (-5646.17, -1639.83)	
Local isolation index (10+ ms)						-169.82 (-1534.09, 1194.46
R^2	0.53	0.57	0.65	0.64	0.63	0.57

Infectious Disease mortality						
Constant	70.62 (60.49, 80.75)	-71.19 (-158.57, 16.19)	-37.35 (-127.55, 52.86)	-71.19 (-159.28, 16.90)	24.98 (-88.00, 137.96)	-76.31 (-165.70, 13.09)
Mean Income	-13.95 (-18.90, -8.99)	3.14 (-8.30, 14.59)	1.97 (-9.19, 13.14)	3.27 (-8.69, 15.22)	-6.56 (-19.95, 6.82)	-1.20 (-19.42, 17.02)
Income inequality (Gini)		263.57 (102.12, 425.02)	171.43 (-6.11, 348.97)	261.75 (92.87, 430.64)	118.43 (-74.11, 310.97)	279.02 (109.13, 448.91)
Local isolation index (0-2 ms)			493.34 (47.59, 939.08)			
Local isolation index (2-5 ms)				46.68 (-1109.76, 1203.12)		
Local isolation index (5-10 ms)					-1574.64 (-2813.38, -335.91)	
Local isolation index (10+ ms)						247.03 (-556.36, 1050.42)
R^2	0.33	0.42	0.47	0.42	0.48	0.43

The residuals of the final regression models were checked for heteroskedasticity and non-normal distributions. Little evidence was found contrary to these assumptions of linear regression. In addition, spatial analysis of the 73 POA districts was conducted by partitioning the variance of district mortality rates into the unique variance of a district and the shared variance of neighbouring districts using cross-classified multilevel models. However, these multilevel regression models did not improve the fit of the simpler multiple regression models and so only the latter results are presented.

Discussion

Porto Alegre is a city where the poorest and richest income groups are spatially segregated which makes it suitable for the study of the effects of income segregation on health outcomes. The main objective of this study was to test whether income segregation had an independent, additional effect on health, in other words, whether income segregation is associated with district level variation in heath outcomes once mean district income levels and income inequality are controlled for. The results of the multiple regression models suggest some evidence in support of the independent effects of income segregation on health. If poor people are completely isolated in the neighbourhoods where they live, those districts have around 14 deaths per 1000 population more than districts where poor people are not isolated in their neighbourhoods. Similar associations were found with mortality rates from premature cardiovascular disease and infectious disease. There is thus some evidence to support the hypothesis of a ‘triple health jeopardy’ arising from the negative health effects from income segregation in addition to the effects of poverty and income inequality (Ross et al. 2001).

These results counter the assertion by Wilkinson (1997) that local residential segregation is not the relevant spatial unit to consider when examining the association of income inequality with health. Instead, the results suggest that it is important to use spatial measures of inequality like spatial socioeconomic segregation, rather than aspatial measures like the gini coefficient when measuring income inequality at small area levels. Rather than merely reflecting the degree of income inequality within a small geographical area, local spatial segregation may actually reinforce the underlying mechanisms of social inequality. Local spatial segregation may be better than the gini coefficient at representing how structural inequalities at the neighbourhood level are reinforced through the clustering and isolation of poor people within a city into neighbourhoods with poor housing conditions, inadequate and restricted access to health, educational, social and transport services, lack of employment opportunities and environmental pollutants, resulting in intergenerational cycles of poverty.

This is a preliminary analysis, of only one city with 73 districts. There are a number of limitations to this study. This is a cross-sectional ecological study showing correlations between two ecological measures. Apart from biases related to the ecological fallacy, there is also the problem of inferring causality from observational evidence. We have not observed whether increasing spatial segregation results in higher mortality. While we have adjusted for mean income levels of districts and income inequality within districts, there may be other unobserved factors that cause the association of spatial segregation with mortality. In addition, we have not estimated any lagged effects of spatial segregation on health. If the association is causal, we don’t know what is the duration of exposure to a spatially segregated neighourhood that will generate higher mortality rates.

However this study does contribute to the growing evidence suggesting that income segregation is an important dimension to consider when understanding the causes of health inequality. As noted, in the last 15 years, Brazil has made some dramatic reductions in poverty and improvements in population health, though there is still some way to go. If income segregation does present an additional risk to health over and above individual income levels then, in order to improve population health and reduce health inequalities, it is not enough to reduce poverty and tackle income inequality. Attention should also be directed to the level and quality of health care and other public services in neighbourhoods where the poor are spatially segregated. This includes action to improve the quality of housing and the environment, public transportation and employment opportunities in those neighbourhoods. Policies to promote mixed income neighbourhoods could also help. Although this is a study of one city in Brazil there are implications for other countries, such as the US and the UK, that have been experiencing shrinking public services, increases in income inequality and income segregation. Urban and economic development that results in increasing the spatial segregation of poor people may result in widening health inequalities.

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