Author's response to reviews

Title: Suicide rates and income in Sao Paulo and Brazil: a temporal and spatial epidemiologic analysis from 1996 to 2008.

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Author's response to reviews: see over
Reply Letter

**Reviewer: Gianluca Serafini**

**Major Compulsory Revisions**

This is in summary an interesting exploratory spatial analysis aimed to investigate mortality data and geographical patterns as well as their social, economic, and cultural correlates in the city of São Paulo from 1996 to 2005. Although interesting and well conducted, the manuscript needs some major revisions to the actual version. First, within the abstract, the aim is not adequately specified; also, the classical framework put forward by Durkheim has not been adequately presented in the introduction, therefore it results difficult for the reader to follow the conclusion section based on this poor initial background. Moreover, the specific age range of suicide deaths which are analyzed in this exploratory analysis should be specified.

(1) Page 5, the first statement is too generic; many other risk factors for suicide may be mentioned.

**Answer:** We thank the reviewer for these nice comments and suggestions. The age range will be mentioned in the methods. Other modifications will be shown here. We rephrased the sentences to:

**Abstract.**

**Background:** In a classical study, Durkheim noted a direct relation between suicide rates and wealth in the XIX century in France. Since that time, several studies have verified this relationship. It is known that suicide rates are associated with income, although the direction of this association varies worldwide. Brazil presents a heterogeneous distribution of income and suicide across its territory. We aimed to evaluate the relationship between suicide rates and income in Brazil, State of São Paulo (SP), and City of SP, considering geographical area and temporal trends.

**Main text**

Suicide rates vary widely between and within countries, since it is a complex phenomenon, related to several singularities. Some general demographic risk factors are known as sex (men), age-strata (young, elderly) and ethnicity (European). Other factors contribute to suicide and include: genetic loading, personality characteristics (impulsivity, aggression), psychiatric and physical disorders (pain, incapacity), life events (loss, trauma), social isolation, availability of means, substance abuse, and economic condition (WHO 2002; Hawton and van Heeringen 2009). The highest suicide rates are in Eastern Europe (former USSR countries) and the lowest rates, in some Latin American countries (Baudelot and Establet 2008; Hawton and van Heeringen 2009). Disparate geographic distribution of suicide has been recognized for the past two centuries, with the first seminal observations of Morselli (1882) and Durkheim (1951), who acknowledged an endemic pattern of suicide in the late XIX century in Europe. Morselli noted a higher suicide rate in Denmark and central Germany, while Durkheim observed the same in northern France, a finding confirmed recently by Baller & Richardson (2002) in an analysis using the same data.

The first population-based suicide studies date from the early nineteenth century in Europe, highlighted through the work of Jean-Pierre Falret, Esquirol disciple.
Later, many other studies emerged as led by Morselli, Masaryk, Guerry, Tarde, Winslow, Wagner (Masaryk 1881/1970; Morselli 1882; Durkheim 1951; Giddens 1970). Methodologically, the most consistent work belonged to Emile Durkheim, which combined the available empirical data with a well-defined sociological theory (Durkheim 1951). "The suicide", Durkheim's masterpiece, inaugurated the modern sociology and was one of the first ecological studies, a major influence in epidemiology. Durkheim's theory is based on two concepts: social integration and social regulation. Suicidal behavior is common in societies where there is a low degree of social integration, culminating in the egoistic suicide. The individual is protected from egoism by religions with strong group ties (e.g. Catholic Church) and family ties. Suicidal behavior is also common in societies where there is a low degree of social regulation, culminating in the anomic suicide. Social regulation can be understood as external regulatory forces on the individual. Economic cycles (depression or prosperity) and income level are examples of factors that could modulate anomic suicide. Durkheim is commonly criticized for not providing a specific explicit definition of these social variables. Some derivations, extensions and reinterpretations of his theory were attempts to overcome such omission (Henry and Short 1954; Gibbs and Martin 1964; Douglas 1970; Lester 1989). Despite the criticism, he remains one of the most well-known names of suicidology (Shneidman 2001). Sociologists, psychologists, epidemiologists, psychiatrists have used the same basic methodology established by Durkheim (Baudelot and Establet 2008). In the late XIX century, France history was marked by great economic development, which was accompanied by one of the highest suicide rates ever observed. When Durkheim claimed that "poverty protects against suicide," he based his observation on two area-based comparisons. He noted higher suicide rates in France compared to poorer countries, and also that suicide rates were higher in regions of France with greater wealth concentration. This finding raised the hypothesis that economic development could be related to individualism and, ergo, to social isolation and suicide. We aimed to evaluate the same relationship in Brazil and São Paulo regions using Geographic Information System (GIS) and statistical techniques. However, the relationship between wealth and suicide is not straightforward; on the contrary, it is complex and changes throughout time and space. In Europe, for instance, different patterns were observed at the beginning of the twentieth century (Halbwachs 1930/1978).

(2) Page 6, why the authors did not consider to investigate also suicide attempts and/or deliberate self harms (DSHs) together with suicide rates? Are information about suicide attempts and/or DSHs also available in the SEADE registry?

Answer: The information about suicide attempts is not available in Brazilian statistic health official registries.

(3) What is exactly the period in which the search was conducted?

Answer: The study was conducted in 2011 using data from 1996 to 2008.

(4) How many researchers conducted the search in the SEADE? Additionally, why the authors decided to choose the period from 1996 to 2008 for their investigation?

Answer: Daniel H. Bando and Andre R. Brunoni conducted the search in the SEADE. We chose 1996 because it was the year in which ICD 10 was implemented in Brazil.
(5) Which kind of classification (e.g., ICD–9, ICD–10)? And which codes were used to identify death by suicide? Are all data about the variables which are investigated available?

**Answer:** All the study used the Tenth Revision of the ICG that has been implemented in Brazil since 1996. We used all codes that correspond to “intentional selfharm”, X60 to X84 according to the International Classification of Diseases and Deaths (ICD-10). All variables used in the study are available at http://www.datasus.gov.br (Ministry of Health National Unified System Department of Information Technology - 2009); http://www.ibge.gov.br (Brazilian Institute of Geography and Statistics - 2010); http://www.prefeitura.sp.gov.br (Death Records Improvement Program - 2010); and http://www.seade.gov.br/ (SEADE Foundation).

We rephrased this sentence to:

**Data extraction**

We collected data from Brazilian and São Paulo State Death registry databases for the period 1996 to 2008. All the analyses were conducted on people aged 15 years and over separately for men and women (Vichi, Masocco et al. 2010; Pompili, Innamorati et al. 2011). The age-adjusted rates for suicide were calculated using the WHO standard population as a reference (Ahmad, Boschi-Pinto et al. 2001). Rates are per 100,000 individuals per year. Deaths considered as suicides were those that used codes corresponding to “intentional selfharm”, codes X60 to X84 according to the Tenth Revision of the International Classification of Diseases and Deaths (ICD-10). We chose the data from 1996 onwards because it was the year in which ICD-10 was implemented in Brazil. The databases assessed were those of the Ministry of Health (DATASUS 2009). For the city of São Paulo, these data were adjudicated by the Health Department, and both mean the same events, but is the same base (PRO-AIM 2010).

The total number of inhabitants and average income per capita were based on the National Census (www.ibge.gov.br – IBGE 2000). Population projections in São Paulo was based on SEADE Foundation (SEADE 2010). Average income is strongly correlated with Human Development Index (HDI), Gini index and education (For nation-wide approach the Pearson Correlation was: +0.92, -0.66, +0.87, respectively; p-value<0.01). So, we decided to use the average income, because it is one of the most common socioeconomic indicators used in ecological studies?? (Rehkopf and Buka 2006). It is a simple measurement that allows comparisons with other studies (Vijayakumar, Nagaraj et al. 2005) and is a reliable information extracted from the National Census. All data are free-accessed.

(6) Finally, the authors should be more detailed when describing the limitations of their study. Importantly, misclassification could affect the suicide registration. There is evidence that official suicide rates may be underestimated because of suicide misclassification. Also, whether they have data regarding exclusively the period from 1996 to 2005 in their SEADE registry, this must be reported.

**Answer:** We included this limitation.

We only used the SEADE population projections, as mentioned earlier. We rephrased the sentences to:

**Methods**

**Study design**
We designed an epidemiological study considering suicide mortality data in three different regions (Fig. 1): (1) a nation-wide comparison of the 27 States in Brazil and also its 558 micro-regions; (2) a within-state comparison, including the 645 municipalities in the State of São Paulo (SP); (3) a city-wide comparison, among the 96 neighborhoods that compose the city of São Paulo.

Figure 1

To explore our hypothesis that suicide, income, and socioeconomic disadvantage are related, we chose regions with distinct socioeconomic patterns. Regions were characterized by the Gini index, the HDI, and the GDP per capita. The Gini coefficient is a measure of income inequality, ranging from 0 (total equality) to 1 (total inequality). The HDI is based on life expectancy, education, and GDP per capita, also ranging from 0 (minimum development) to 1 (maximum development). Remarkably, these regions present distinct indexes of Gini, HDI, and GDP per capita (Table 1). We chose the city and State of São Paulo for analysis because considering economy and population aspects, they are the most relevant regions of Brazil.

Data extraction

We collected data from Brazilian and São Paulo State Death registry databases for the period 1996 to 2008. All the analyses were conducted on people aged 15 years and over separately for men and women (Vichi, Masocco et al. 2010; Pompili, Innamorati et al. 2011). The age-adjusted rates for suicide were calculated using the WHO standard population as a reference (Ahmad, Boschi-Pinto et al. 2001). Rates are per 100,000 individuals per year. Deaths considered suicide were those that used codes corresponding to “intentional self-harm”, codes X60 to X84 according to the International Classification of Diseases and Deaths (ICD-10). We chose the data from 1996 onwards as to avoid bias, since during this period the ICD-10 was implemented. The databases assessed were those of the Ministry of Health National Unified System Department of Information Technology (DATASUS 2009). For the city of São Paulo, these data are reviewed by the Death Records Improvement Program, but is the same base (PRO-AIM 2010). All data are from official health statistics sources used in Brazilian ecological studies.

The total number of inhabitants in São Paulo and Brazil and average income per capita were based on the National Census (www.ibge.gov.br (IBGE 2010)). Population projections was based on SEADE Foundation (SEADE 2010). Average income is strongly correlated with Human Development Index (HDI), Gini index and education (For nation-wide approach the Pearson Correlation was: +0.92, -0.66, +0.87, respectively; p-value<0.01). So, we decided to use the average income, because it is one of the most common socioeconomic indicators used in this study design (Rehkopf and Buka 2006). It is a simple measurement that allows comparisons with other studies (Vijayakumar, Nagaraj et al. 2005) and is a reliable information extracted from the National Census. All data of the investigated variables are of free access.

Data synthesis

For each region, income was categorized in tertiles according to its distribution in three areas, from the wealthiest (area 1) to the poorest (area 3) (Moniruzzaman and Andersson 2008).
(...)

Discussion

The present study has some limitations. Different procedures and cultural and social practices and values probably have various effects on death records and lead to misclassification of suicide (WHO 2002; Hawton and van Heeringen 2009).

(6) Minor Essential Revisions. Page 4, as authors reported suicide rates (occurring more frequently in poor areas) in many developed and wealth countries (e.g. United States, Great Britain, Japan, France), I suggest to also include some recent papers reporting suicides rates in Italy to provide more completed data to the reader.

**Answer:** We rephrased this sentence to:

*Other recent ecological studies performed in the United States (Tondo, Albert et al. 2006), Japan (Fukuda, Nakamura et al. 2005), Taiwan (Sharma, Gupta et al. 2007), Australia (Taylor, Page et al. 2005), England (Rezaeian, Dunn et al. 2006), Finland (Maki and Martikainen 2007; Maki and Martikainen 2009) and Tuscany (Italy) (Martiello and Giacchi 2012) also demonstrated an inverse relationship. Moreover, an ecological study that grouped data from the G7 countries in 2007 observed an inverse relation between income and male suicides (Ying and Chang 2009). However, other ecological studies found different results. One worldwide, cross-sectional study performed in the late 1990s included data from 52 countries and identified a direct association between per capita GDP and male suicide rates in all regions except former USSR countries, which had abnormally high suicide rates (Baudelot and Establet 2008). In Italy, a study suggested a direct association between high economic status and suicide (Pompili, Innamorati et al. 2011). Another study using World Health Organization (WHO) data focused on countries with a medium Human Development Index (HDI) and found that education and telephone density was directly related to suicide while a high Gini index was inversely related to suicide (Vijayakumar, Nagaraj et al. 2005). Finally, in northern India, from 1996-2005, income was directly related to suicide (Sharma, Gupta et al. 2007).*
Reviewer: Ying-Yeh Chen

Major compulsory revisions

(1) One of the main concerns is the change in data quality across time and places. For the whole Brazil analysis, the upward trend in suicide over the study period was an artifact due to improvement in data quality, as the authors indicated. In figure 3C low suicide rates in some northeast regions (MA, BA and PE) may be also an artifact, as these low suicide rate regions showed clear boundaries corresponding to the boundaries of macro-regions. It's very intriguing that findings were in opposite directions in different analyses in different regions. This may also in part due to poor data quality (poor data, low suicide rate, poor areas). Analyses may be better based on more recent, more reliable data, e.g. 2003 onwards. The alternative approach is to conduct sensitivity analyses using combined data of certified suicides and possible suicides (e.g. undetermined deaths).

Answer: We thank the reviewer for raising this interesting observation. We reviewed the data and accepted this suggestion.

We rephrased the sentences to:

The present study has some limitations. Different procedures and cultural and social practices and values probably have various effects on death records and lead to misclassification of mortality (Hawton 2009; WHO 2002). Another aspect is related with data quality. It is possible that the quality of the information have influenced suicide trends in Brazil. A study based on vital information provided by the Ministry of Health Brazilian system identified more deficient information in the poorest macro-regions (Szwarcwald, Leal Mdo et al. 2002), although this issue has improved in recent years. So, it is possible that the significant suicide increase in area 3 in Brazil could be an artifact. For the nation-wide comparison, we did a sensitivity analysis, based on two periods: 1996-2002 and 2003 onwards. We focused on area 3 because it was the poorest and presented the highest variation on suicide rates. We also analyzed the age-adjusted death rates by “Ill-defined and unknown causes of mortality” (code R99 of ICD-10). For the first period (1996-2002) suicide remained stable and death by “R99” showed a significant increase (APC = +12.2). For the second period (2003-2008) suicide increased significantly (APC = +3.7) and death by “R99” decreased significantly (APC = -15.2). There was an improvement in data quality from 2003 onwards, and also a slightly and significant increase on suicide rates. Thus, partially, we can assume that the significant suicide increase in area 3 in Brazil was due to an artifact, but suicide is a rare event, the APC was lower. Further research must be conducted to clarify these patterns.
Regional suicide rates did not seem to be sex and age-adjusted. Population structure may vary substantially across area and lead to bias in ecological analysis - poor areas, older population, higher rates.

**Answer:** We calculate age-adjusted rates according to the WHO standard population. All details were mentioned in the methods.

We rephrased the sentences to:

*Data extraction*

We collected data from Brazilian and São Paulo State Death registry databases for the period 1996 to 2008. All the analyses were conducted on people aged 15 years and over separately for men and women (Vichi, Masocco et al. 2010; Pompili, Innamorati et al. 2011). The age-adjusted rates for suicide were calculated using the WHO standard population as a reference (Ahmad, Boschi-Pinto et al. 2001). Rates are per 100,000 individuals per year. Deaths considered suicide were those that used codes corresponding to “intentional selfharm”, codes X60 to X84 according to the International Classification of Diseases and Deaths (ICD-10). We chose the data from 1996 to avoid bias, as from this period was implemented the ICD-10. The databases assessed were those of the Ministry of Health National Unified System Department of Information Technology (DATASUS 2009). For the city of São Paulo, this data are reviewed by the Death Records Improvement Program, but is the same base (PRO-AIM 2010). All data are the official health statistics sources used in Brazilian ecological studies.

(3) Why did the authors restrict their analyses to compare suicide rates between three categories of areas, as they have income data for each area (figures 3B, 4B, 5C - confusing here, 5C but not 5B!)? They can carry out ecological analyses based on area-specific data, which would show higher variability than the three categories. But these ecological analyses should account for spatial autocorrelation (rates in areas that are closer to each other are more related), using models such as Bayesian hierarchical modeling.

**Answer:** We regret for this mistake and figure 5 was fixed. There are many ecological designs as well as many statistical techniques to evaluate associations. Logistic regression considers the high income variability. We chose satscan because it is a well-accepted and efficient technique to cluster detection. Spatial autocorrelation was considered in this test. For the temporal approach we chose the design of the three income areas used in a previous study (Moniruzzaman and Andersson 2008). We chose a simple and reliable method that could be compared with other studies. We added this reference in the methods.

We rephrased the sentences to:

*Data synthesis*

For each region, income was categorized in tertiles according to its distribution in three areas, from the wealthiest (area 1) to the poorest (area 3) (Moniruzzaman and Andersson 2008).
The authors also had data for Gini and education and why they did not include these in their analyses? Their results suggest interactions between income level and income inequality.

**Answer:** As socioeconomic indexes are highly correlated and we chose one with less variation across the country. The interaction factor did not change materially the results.

We rephrased the sentences to:

The total number of inhabitants in São Paulo and Brazil and average income per capita were based on [www.ibge.gov.br – (IBGE 2010)]. Population projections was based on SEADE Foundation (SEADE 2010). Average income is strongly correlated with HDI, Gini index and education (For nation-wide approach the coefficient of Pearson Correlation were: +0.92, -0.66, +0.87, respectively; p-value<0.01). So, we decided to use the average income, because it is one of the most common socioeconomic indicators used in this study design (Rehkopf and Buka 2006). It is a simple measurement that allows comparisons with other studies, reviews (Vijayakumar, Nagaraj et al. 2005) and is a reliable information extracted from the National Census (IBGE 2010). All data of the investigated variables are free-accessed.

(4) An important limitation of the spatial analysis using SaTScan for area data is the assumption that all suicides 'concentrate' in the centroids of each area unit - this is very unlikely in areas where the distribution of population is substantially unequal. This should be pointed out. In such case I feel SaTScan should be better used in point data (i.e. the exact location of each suicide is known) or 'very small' area data. It's also very strange that areas in the high risk cluster in Figure 4D scattered across a large region with some areas geographically located within this cluster not classified as part of the spatial cluster - this should not happen as the 'circles' of SaTScan should cover all these areas.

**Answer:** We agree that it should be better to use the smallest area for the satscan analysis. But the municipality is the smallest area unit available for analysis, except for the city of Sao Paulo. For the nation-wide approach, we chose the micro-region as the area unit because it is more appropriate, allows visual inspection of the whole and facilitates to interpret the results. Regarding the result of Figure 4D, the cluster is not always a single set of unit areas. A unit area can be detected as a cluster, as we can see in this research that compares satscan with other cluster detection techniques (Jackson, Huang et al. 2009). We added the satscan limitation in the discussion.

We rephrased the sentences to:

Spatial analysis using satscan has a limitation. For each area unit, the software considers the respective centroid and its radius, according to the suicide rate. This can bias the cluster detection, mostly in large areas with spatial variations in the population density. Despite this limitation in a recent review of software for space-time disease surveillance (include ClusterSeer, SaTScan, GeoSurveillance, Surveillance package for R), satscan was highlighted as the most developed and robust software for cluster detection (Jackson, 2009).
In fact it's difficult to conclude on any spatial patterning of suicide based on figures 3C, 4C and 5B - estimates of suicide rates in small areas/populations are likely to be very unstable and some 'smoothing' approaches should be considered in small-area analyses. It is also crucial to report the mean/median population and suicide numbers (and perhaps their ranges) for the area units used in analyses.

**Answer:** The smoothing process changes the value of the original rates, and therefore we decided not to use this process. Recognition of the spatial pattern of a variable only by visual inspection is always difficult, even using colored thematic maps and Geographic Information System (GIS) techniques. In the State of São Paulo, as described in the results, the spatial pattern of suicide was unclear. However, Satscan, a robust software, detected two significant clusters.

(6) page 12, paragraph 2, line 2, -- seem to mixed up Taiwan and China, the per capita GDP for Taiwan is quite high (around US20,000), categorize it as a developing country is not correct.

**Answer:** We rephrased this sentence to:

> The lack of studies in developing countries still persists; in China (Shandong) an inverse relationship between suicide and income was identified (Zhang, Ma et al. 2010).

(7) One minor issue - the year of census was not indicated.

**Answer:** Sorry for this mistake that was corrected.
Reviewers report:

(1) Bando and colleagues investigated the influence of income on suicide rate of Brazil, State of Sao Paulo and City of Sao Paulo with the use of temporospatial analyses. They detected there has been a direct association between income and risk of suicide, but the two factors were inversely associated at the state level. As suggested by Erwin Shneidman, suicide is a multifaceted event and that biological, cultural, sociological, interpersonal, intrapsychic, logical conscious and unconscious, and philosophical elements are present. I am not agreed with the use of income, as the sole indicator, to explain the variation of suicidal risk throughout the whole country. That would oversimplify the nature of suicide and, more importantly, present a wrong message to the stakeholders of suicide prevention. If the risk of suicide is always positively associated with income, does it imply the Brazilian government should take all possible measures in lowering economic development to keep every member in poverty as a universal approach for suicide prevention? And for selective approach, the government should devote more effort in providing social, medical and family services among the high income group in lowering their suicidal risk. In contrast, they can draw less attention on the poor, as their risk of suicide is always lower?! In principle, all of these are politically unsound that would further widen the social inequality. The authors should rethink whether a higher income would heighten the risk of suicide or the increased suicidal risk was contributed by an increasing income disparity within the territory. Unless living in a Marxist regime, we can’t expect every resident in a higher income district is rich person. For a poor person living in a higher income district, his or her psychological distress for suicidal behavior should be much greater than another person living in a low income region. So, there is a need for the authors to re-clarify their research question in the manuscript. Making more money itself should never be considered as a risk factor of suicide, before the authors can provide more evidence in substantiating their argument.

Answer: We thank the reviewer for these nice comments and suggestions. We do not claim that income is the only risk factor and that there is a causal relation between income and suicide. In fact, our cross-sectional study could not suggest causal relationship – we are pointing out, however, to a significant correlation of income and suicide, which was direct in Brazil and the city of Sao Paulo, but inverse at the State level. Therefore, we are not proposing to use income as a method of suicide prevention. However, household income is a good surrogate for socioeconomic status. Recognizing its association with suicide helps to understand the phenomenon and generates new hypotheses. We clarified these issues in the article. We rephrased the last paragraph:

In conclusion, we performed a descriptive, temporal, and spatial analysis regarding income level and suicide in different regions of Brazil. Results showed that the direction of association varied, albeit resembling similar patterns observed worldwide, with a direct and inverse association in less and more unequal areas, respectively. Taken together, these findings suggest that income and suicide in Brazil are related, although socioeconomic regional characteristics might act as a moderator variable. Future studies comparing suicide rates in other Brazilian States and developing countries should take into account these results by performing separate analyses by region. Also, these results highlight that the association between suicide and income in Brazil varies importantly according to
the considered region. The result of the present study is not conclusive. It helps to understand the phenomenon of suicide, generates new hypotheses for other study designs and can be useful for prevention strategies.

(2) In page 5, it mentions the HDI is based on life expectancy, education, GDP per capita, and a development index (ranging from 0 to 1). What does it represent for? How to calculate HDI from these 4 factors?

**Answer:** HDI is a socioeconomic indicator derived from the United Nations Development Program (UNDP). It is a global formula to compare countries, and it is useful for intra-country analyses. The information of the National Census is available for all Brazilian municipalities (IBGE, 2010). HDI is correlated with income. We chose to use only average income in the analysis. All survey data are official and free access.

We rephrased the sentences to:

*The total number of inhabitants in São Paulo and Brazil and average income per capita were based on the National Census (www.ibge.gov.br – (IBGE 2010)). Population projections was based on SEADE Foundation (SEADE 2010). Average income is strongly correlated with HDI, Gini index and education (For nation-wide approach the coefficient of Pearson Correlation were: +0.92, -0.66, +0.87, respectively; p-value<0.01). So, we decided to use the average income, because it is one of the most common socioeconomic indicators used in this study design (Rehkopf and Buka 2006). It a simple measurement that allows comparisons with other studies, reviews (Vijayakumar, Nagaraj et al. 2005) and is a reliable information extracted from the National Census (IBGE 2010). All data of the investigated variables are free access (DATASUS 2009; IBGE 2010; PRO-AIM 2010; SEADE 2010).*

(3) The authors should clarify why it is necessary to calculate the risk ratio at the 3 levels: national, state and city. According to the last paragraph in page 5, it mentioned source of suicide data of Sao Paulo state and city were different from the national statistics. Are they comparable in terms of data completeness and reliability? There may be a problem, if the 2 data sources are not comparable with each other.

**Answer:** The National Mortality System in Brazil begins with the data collected by the municipalities that are send to the States, and finally to the Ministry of Health. This processing from local to federal level is mandatory by the Law for all vital events. The difference is that in the city of Sao Paulo, the adjudication of all deaths is performed for all events occurred. We change “more reliable” for “adjudicated” (page 5).

(4) 3. The study classified all geographical district into 3 areas according to the income level. What are the criteria in defining these areas? Are they comparable at the national, state and city level?

**Answer:** Yes, household income applied for the City of Sao Paulo was obtained from the National Census. The criterion was defined in the methodology, we add a reference. For the temporal approach we chose the design of the three income areas used in a previous study (Moniruzzaman and Andersson 2008). We chose a simple and reliable method that could be compared with other studies. The data are comparable, as explained above.

We rephrased the sentences to:
Data synthesis

For each region, income was categorized in tertiles according to its distribution in three areas, from the wealthiest (area 1) to the poorest (area 3) (Moniruzzaman and Andersson 2008).

(5) Following the last question, the authors should also clarify whether there have been any changes in terms of zoning over the whole study period. I assume that, due to economic developing in Sao Paulo city, some districts should get richer or less socially deprived at the end of 12-year period.

Answer: The relative position of the 96 districts according to household income did not change materially during one decade despite of general improvement of income. After the submission of this manuscript, the results of the 2010 National Census were publicized. We compared the classification in 2010 versus 2000 of the 96 districts of the City according to household income tertiles. Only two districts had its position shifted in 2010 compared to 2000. However, both districts have a similar population and number of events.
References:


New York, The free press.


SEADE (2010). "Fundação Sistema Estadual de Análise de Dados - SEADE."


