

BMJ Open Environmental factors and cardiovascular diseases: the association of income inequality and green spaces in elderly residents of São Paulo, Brazil

Kaio Henrique Correa Massa,¹ Roman Pabayo,² Maria Lúcia Lebrão,¹ Alexandre Dias Porto Chiavegatto Filho¹

To cite: Massa KHC, Pabayo R, Lebrão ML, *et al.* Environmental factors and cardiovascular diseases: the association of income inequality and green spaces in elderly residents of São Paulo, Brazil. *BMJ Open* 2016;**6**:e011850. doi:10.1136/bmjopen-2016-011850

► Prepublication history for this paper is available online. To view these files please visit the journal online (<http://dx.doi.org/10.1136/bmjopen-2016-011850>).

Received 12 March 2016
Revised 7 June 2016
Accepted 1 August 2016

ABSTRACT

Objective: We aimed to analyse the individual and contextual determinants associated with cardiovascular diseases (CVDs) morbidity among the elderly.

Methods: The sample consisted of 1333 individuals aged 60 or older residing in the city of São Paulo, from the Health, Welfare and Aging (SABE) study survey performed in 2010. The association between CVD with both income inequality and green spaces was analysed using Bayesian multilevel models, controlling for individual and contextual factors.

Results: We found a significant association between income inequality and green spaces, and risk of CVD. In comparison to elderly residents in areas with low-income inequality, there was an increased risk for CVD among those residing in the medium–low (OR=1.35, 95% CI 1.15 to 1.59), medium–high (OR=2.71, 95% CI 2.18 to 3.36) and high (OR=1.43, 95% CI 1.14 to 1.79) quartiles of income inequality. Those living in medium–low (OR=0.44, 95% CI 0.39 to 0.49), medium–high (OR=0.56, 95% CI 0.48 to 0.65) and high (OR=0.48, 95% CI 0.43 to 0.55) green spaces levels had lower risk of CVD.

Conclusions: These findings highlight the importance of area-level characteristics on CVD risk and the need to develop healthcare policies focused on the effect of individual and contextual characteristics.

Strengths and limitations of this study

- To best of our knowledge, the results of our analysis are the first to highlight the importance of area-level income inequality and green areas for cardiovascular diseases morbidity in a large and highly unequal city of Latin America.
- This study indicates the importance of contextual characteristics of the neighbourhood of residence for cardiovascular diseases in the elderly, an age group that will require ever more attention in the near future.
- Individual data are amenable to recall bias, especially given the age structure of the sample.
- The sample was not representative for the residential areas, so one should not draw conclusions specific for each of the administrative areas.

In Latin America and the Caribbean, CVD was responsible for the highest proportion of preventable mortality in 2011: 42% in men and 50% in women.⁴

In Brazil, mortality rates attributed to CVD have recently decreased, but CVD still remains the main cause of death, especially in older residents.⁵ In 2013, CVDs were responsible for 28.1% of all deaths in the country, and if one excludes deaths from violence and other external causes, it is responsible for 32.1% of total mortality.⁶

Morbidity from CVD is also a growing concern in public health. Total years lived with a chronic illness among older adults has increased over time, especially due to the advances in treatments of infectious diseases and the longer survival of individuals with chronic diseases. CVD is now responsible for the highest number of years spent with a disability among the elderly.⁷

Contextual characteristics of the residential area are important determinants of health outcomes, especially in developing countries.^{8 9}

INTRODUCTION

Population ageing is a global phenomenon that has led to important social and healthcare changes.¹ According to the WHO,² life expectancy has steadily increased worldwide, although it is still much higher in developed countries compared with middle-income and low-income countries.

This increased longevity means a longer exposure period to risk factors of non-communicable diseases. Cardiovascular disease (CVD) is now considered the most important cause of death worldwide.³



CrossMark

¹Department of Epidemiology, School of Public Health, University of São Paulo, São Paulo, Brazil

²Department of Community Health Sciences, University of Nevada, Reno, Nevada, USA

Correspondence to

Kaio Henrique Correa Massa; kaiomassa@usp.br

Recent studies have found that socioeconomic characteristics of the neighbourhoods (such as income inequality, violence and median income) are associated with risk of mortality in developing countries.^{10 11} Contextual characteristics have also been found to be associated with other health outcomes, such as the association of income inequality with exposure to chronic diseases risk factors¹² and risk for depression.¹³ However, studies that analysed the association of characteristics of the neighbourhood and risk for CVD are still scarce in Brazil, a country with a wide range of socioeconomic and environmental factors that could significantly impact health. The present study aimed to analyse the effect of individual and contextual determinants of CVD morbidity among elderly residents of the largest city in Latin America.

METHODS

Data

This study is part of the Health, Welfare and Aging Study (SABE), a representative multiple-stage probabilistic sample of individuals aged 60 years and older residing in the city of São Paulo.¹⁴ Data were obtained from a household questionnaire administered in 2010, which comprised of 11 thematic blocks covering information on sociodemographic factors, cognitive evaluation, health conditions, functional status, mobility test, drugs use, access to services, family network, social support, work history and housing characteristics. This study is coordinated by the Department of Epidemiology of the School of Public Health of the University of São Paulo.¹⁴

Study design

A cross-sectional study was conducted to analyse the association between the individual and environmental characteristics with CVD morbidity in elderly residents of São Paulo, Brazil.

Variables

The dependent variable is the self-reported presence of a CVD confirmed by a medical diagnosis. At the individual level, the demographic and socioeconomic variables of interest are gender, age (categorised into 60–64, 65–69, 70–74, 75–79, 80–84 and 85 or more years), race (white, mixed, black and others), educational attainment (categorised according of the total number of years of formal education), income (categorised in terms of minimum wages of the year of data collection) and marital status (with or without a partner).

The models also included behavioural factors such as alcohol consumption, risk of alcoholism, smoking and body mass index (BMI) to control for individual confounding. Data for alcohol consumption was obtained by a self-referred 3-month consumption question (yes or no). Risk of alcoholism was assessed according to the Short Michigan Alcoholism Screening Test-Geriatric (SMAST-G).¹⁵ Smoking history was divided into three categories: never smoked, used to smoke and currently

smoking. The BMI of each respondent was calculated by using the individual's weight and height (kg/m^2). Respondents were then subsequently categorised into underweight ($<22 \text{ kg}/\text{m}^2$), normal weight (≥ 22 and $<27 \text{ kg}/\text{m}^2$) and overweight ($\geq 27 \text{ kg}/\text{m}^2$) as recommended by the Technical Standard of Food and Nutrition Surveillance for reference values of the elderly.¹⁶ We also included the two most prevalent chronic diseases (diabetes and hypertension) to test their independent associations with CVD morbidity.

Socioeconomic and environmental characteristics of area of residence were calculated using data from the 2010 Census for each of the 32 administrative areas of the municipality of São Paulo, known as *subprefeituras*. The contextual characteristics of interest were income inequality (measured by the Gini Index), green spaces per inhabitant (total green area per square metre) and average per capita income of the administrative area. The contextual variables were categorised in quartiles and classified using a qualitative terminology (low, medium–low, medium–high and high, respectively).

Statistical analysis

Multilevel logistic regression was conducted to analyse the association between contextual characteristics and risk of CVD in order to account for the clustering within the neighbourhood, assuming the non-independence of observations. The first level of the model referred to individual-level characteristics and the second level to the area-level (contextual) characteristics. We applied Bayesian multilevel models, a recommended approach to decrease bias in multilevel analysis with dichotomous-dependent variables. The approach also allows the comparison of model fit by comparing the Bayesian Information Criterion (BIC) of each model, where decreasing values indicate better fit.¹⁷

The analyses were performed with Stata V.13.1 (Stata Corporation, College Station, Texas, USA, 2013). For the descriptive statistics of demographic, socioeconomic, behavioural variables and for the bivariate analysis according to CVDs presence, we included the survey mode procedure, which considers the complex sample design regarding sampling weight and individual clustering (secondary sampling units) within census tracts (primary sampling units). Multilevel analyses were performed using the *gllamm* command, including the corresponding weighting to take into account the complex sampling design.

RESULTS

Sample characteristics

The sample consisted of 1333 individuals aged 60 or older residing in the city of São Paulo in 2010. Descriptive analysis indicates that most of the individuals were females (59.9%), 58.6% reported being white and around 35% being black or brown (29.3% brown and 6.7% black, respectively). Most of the elderly had low

educational attainment, with more than 70% having only 7 years of formal education or less. In relation to income, most of the elderly earned three minimum wages or less, and 46.3% had income between 1 and 2 minimum wage per capita (table 1).

Of the sample, 70% reported not having ingested alcohol in the past 3 months. Among those reporting having ingested alcohol, most of the elderly were not at risk of alcoholism (88.1%), according to SMAST-G. Less than half the elderly never smoked (about 37% reported being a former smoker and a smaller proportion, 11.9%, reported being current smoker). Most of the elderly were categorised as being overweight (55.1%). A medical diagnosis of diabetes was reported by 25.2% of the elderly population. Prevalence estimates for hypertension and CVD were 66.7% and 22.8%, respectively (table 1).

Bivariate associations with CVD

The prevalence of CVD did not differ across sociodemographic groups, such as gender, race, education, income and marital status. Higher prevalence of CVD was observed in higher age groups (table 2).

We found a statistically significant association of alcohol consumption and smoking with risk for CVD. Presence of CVDs was less frequent for individuals who reported alcohol ingestion during the past 3 months (19.1%). Current smokers had the lowest presence of CVD (13.2%), followed by individuals who never smoked (22.6%) and former smokers (26.3%; table 2).

Statistically significant differences in the prevalence of CVDs were also observed for individuals with diabetes and hypertension. Among individuals who reported being diagnosed with diabetes, ~35% also had been diagnosed with a CVD, while among those reporting having hypertension the proportion was 28% (table 2).

Multilevel regression models

Results from the adjusted models indicated a statistically significant association between some of the individual characteristics and CVD. Older individuals had statistically higher odds of CVD. Completing 8 years or more of formal education was also independently associated with greater risk for CVD. Those living without a partner were significantly less likely to report CVD in comparison with those living with a partner (OR=0.57, 95% CI 0.40 to 0.81). We did not find any significant association between race, gender and individual income with CVD risk (table 3). The analysis of behavioural characteristics indicated that alcohol consumption was significantly associated with lower odds of having a CVD (OR=0.74, 95% CI 0.56 to 0.99). We found no significant association between smoking and BMI with CVD risk (table 3). On the other hand, both diabetes (OR=2.04, 95% CI 1.39 to 2.98) and hypertension (OR=2.33, 95% CI 1.37 to 3.95) were associated with CVD risk (table 3).

Table 1 Distribution of demographic, socioeconomic and behavioural characteristics, presence of diabetes, hypertension and CVD of the elderly, 2010, São Paulo, Brazil

Demographic and socioeconomic characteristics	n*	Per cent†
Gender		
Male	477	40.06
Female	856	59.94
Total	1333	100
Age categories, years		
60–64	355	31.62
65–69	231	22.59
70–74	218	17.73
75–79	166	12.78
80 years or older	363	15.28
Total	1333	100
Race		
White	775	58.67
Brown	383	29.30
Black	94	6.73
Other	68	5.30
Total	1320	100
Education, years of formal study completed		
0–3	527	35.34
4–7	494	37.25
8+	311	27.41
Total	1332	100
Income, minimum wage		
<1	38	3.18
1–2	579	46.65
2–3	238	18.98
3–4	124	11.24
4+	189	19.95
Total	1168	100
Marital status		
With partner	659	54.97
Without partner	658	45.03
Total	1317	100
Alcohol ingestion		
No	951	68.20
Yes	381	31.80
Total	1332	100
Risk of alcoholism		
No	341	88.41
Yes	37	11.59
Total	378	100
Smoking		
Never smoked	702	51.03
Former smoker	488	37.02
Current smoker	142	11.96
Total	1332	100
BMI		
Underweight	169	11.2
Normal weight	425	33.7
Overweight	650	55.1
Total	1244	100

Continued

Table 1 Continued

Demographic and socioeconomic characteristics	n*	Per cent†
Diabetes		
No	998	74.83
Yes	333	25.17
Total	1331	100
Hypertension		
No	432	33.24
Yes	900	66.76
Total	1332	100
Cardiovascular diseases		
No	1009	77.13
Yes	322	22.87
Total	1331	100

Source: SABE study, 2010.

*Absolute numbers on the unweighted sample.

†Weighted sample proportion.

BMI, body mass index; CVD, cardiovascular disease; SABE, Health, Welfare and Aging.

At the contextual level, we observed significant associations between income inequality, green spaces, average income and CVD risk. In comparison to those living in areas with low-income inequality, those living in area of medium–high income inequality (OR=2.38, 95% CI 2.03 to 2.78) were at greater odds of having a CVD (table 3). In comparison to those living with the low green space, those in the medium–low, medium–high and high green space level (OR=0.44, 95% CI 0.39 to 0.49; OR=0.56, 95% CI 0.48 to 0.65 and OR=0.48, 95% CI 0.43 to 0.55, respectively) were significantly less likely to report having a CVD (table 3).

When adjusting for average household income within administrative areas of the São Paulo, in comparison with the residents in areas with lowest income inequality, those living in the medium–low (OR=1.35, 95% CI 1.15 to 1.59, medium–high (OR=2.71, 95% CI 2.18 to 3.36) and high-income inequality level (OR=1.43, 95% CI 1.14 to 1.79), had higher odds of CVD (table 4). In comparison to the spaces with the lowest amount of green space, those in the medium–low (OR=0.37, 95% CI 0.34 to 0.41), medium–high (OR=0.48, 95% CI 0.41 to 0.58) and high (OR=0.48, 95% CI 0.42 to 0.54) green space level had significantly lower risk for CVD (table 4).

DISCUSSION

The study highlights the association between sociodemographic, economic, behavioural and environmental factors and CVD risk among elderly residents of São Paulo. At the individual level, being older, having lower educational attainment, living with a partner, not consuming alcohol and having diabetes or hypertension were consistently associated with higher odds of CVDs. At the contextual level, area-level characteristics such as income inequality, green spaces and average income were also statistically associated with CVDs.

Table 2 Demographic and socioeconomic characteristics according to CVDs presence, 2010, São Paulo, Brazil

	CVDs presence			p Value*
	No (%)	Yes (%)	Total (%)	
Gender				0.489
Male	78.07	21.93	100	
Female	76.50	23.50	100	
Age categories				0.000
60–64	84.94	15.06	100	
65–79	77.33	22.67	100	
70–74	74.60	25.40	100	
75–79	74.26	25.74	100	
80 years or older	66.01	33.99	100	
Race				0.449
White	76.58	23.42	100	
Brown	79.36	20.64	100	
Black	70.27	29.73	100	
Other	76.77	23.23	100	
Education, years of formal study completed				0.057
0–3	73.81	26.19	100	
4–7	76.51	23.49	100	
8+	82.13	17.87	100	
Income, minimum wage				0.215
<1	84.59	15.41	100	
1–2	74.97	25.03	100	
2–3	75.68	24.32	100	
3–4	83.78	16.22	100	
4+	79.63	20.37	100	
Marital status				0.301
With partner	75.75	24.25	100	
Without partner	78.18	21.82	100	
Alcohol ingestion				0.044
No	75.35	24.65	100	
Yes	80.93	19.07	100	
Risk of alcoholism				0.480
No	81.38	18.62	100	
Yes	76.51	23.49	100	
Smoking				0.005
Never smoked	77.33	22.67	100	
Former smoker	73.68	26.32	100	
Current smoker	86.76	13.22	100	
BMI				0.313
Underweight	80.31	19.69	100	
Normal weight	78.08	21.92	100	
Overweight	75.29	24.71	100	
Diabetes				0.000
No	81.15	18.85	100	
Yes	65.03	34.97	100	
Hypertension				0.000
No	88.35	11.65	100	
Yes	71.59	28.41	100	

* χ^2 test.

BMI, body mass index; CVD, cardiovascular disease.

Older age has been consistently associated with increased exposure to risk factors and, consequently, to health disorders. In this context, the prevalence of chronic diseases has been increasingly associated with

Table 3 Multilevel logistic models of CVD prevalence according to demographic, socioeconomic, behavioural and environmental characteristics in the elderly, 2010, São Paulo, Brazil

	Empty model (n=1257)		Model 1 (n=1005)		Model 2 (n=1005)		Model 3 (n=1005)	
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
<i>1° Level</i>								
Intercept	0.22**	0.21 to 0.23	0.07**	0.02 to 0.18	0.06**	0.02 to 0.17	0.08**	0.03 to 0.24
Gender								
Female			1.04	0.79 to 1.38	1.04	0.79 to 1.38	1.05	0.79 to 1.38
Age categories								
65–69			1.89*	1.17 to 3.04	1.84*	1.12 to 3.03	1.92*	1.16 to 3.19
70–74			2.07*	1.21 to 3.55	2.05*	1.19 to 3.56	2.15*	1.24 to 3.74
75–79			1.82*	1.15 to 2.88	1.82*	1.13 to 2.92	1.88*	1.17 to 3.01
80–84			3.44**	2.19 to 5.39	3.45**	2.18 to 5.47	3.56**	2.26 to 5.59
Race								
Brown			1.01	0.77 to 1.32	0.99	0.76 to 1.30	0.98	0.75 to 1.29
Black			1.33	0.76 to 2.34	1.33	0.76 to 2.34	1.31	0.75 to 2.28
Other			0.95	0.48 to 1.86	0.95	0.48 to 1.87	0.97	0.49 to 1.91
Education (years)								
4–7			0.92	0.64 to 1.31	0.92	0.64 to 1.32	0.92	0.64 to 1.33
8+			0.62*	0.39 to 0.97	0.62*	0.39 to 0.99	0.62*	0.39 to 0.98
Income, minimum wages								
1–2			1.46	0.76 to 2.82	1.51	0.78 to 2.89	1.48	0.77 to 2.84
2–3			1.53	0.80 to 2.92	1.59	0.83 to 3.04	1.57	0.83 to 2.97
3–4			1.10	0.44 to 2.71	1.15	0.46 to 2.82	1.13	0.46 to 2.79
4+			1.81	0.79 to 4.12	1.89	0.83 to 4.34	1.83	0.80 to 4.16
Marital status								
Without partner			0.56*	0.39 to 0.81	0.57*	0.40 to 0.81	0.57*	0.40 to 0.81
Alcohol ingestion								
Yes			0.74*	0.56 to 0.98	0.74*	0.56 to 0.99	0.74*	0.56 to 0.99
Smoking								
Former smoker			1.51	0.94 to 2.42	1.53	0.95 to 2.46	1.51	0.94 to 2.44
Current smoker			0.77	0.43 to 1.36	0.77	0.44 to 1.36	0.76	0.43 to 1.36
BMI								
Normal weight			1.18	0.72 to 1.94	1.21	0.73 to 2.00	1.19	0.72 to 1.97
Overweight			1.38	0.87 to 2.19	1.41	0.89 to 2.24	1.39	0.87 to 2.21
Diabetes								
Yes			2.01**	1.37 to 2.95	2.04**	1.39 to 2.98	2.02**	1.37 to 2.97
Hypertension								
Yes			2.32*	1.37 to 3.94	2.33**	1.37 to 3.95	2.35*	1.38 to 4.01
<i>2° Level: neighbourhood</i>								
Income inequality, quartile								
2					1.17	0.99 to 1.39		
3					2.38**	2.03 to 2.78		
4					0.90	0.77 to 1.05		
Green space m ² /inhabitant, quartile								
2							0.44**	0.39 to 0.49
3							0.56**	0.48 to 0.65
4							0.48**	0.43 to 0.55
BIC (ICC)	1 313 315	(0.017)	969 023	(0.018)	970 132	(0.053)	968 930	(0.03)

*p<0.05.

**p≤0.001.

BMI, body mass index; BIC, Bayesian Information Criterion; CVD, cardiovascular disease; ICC, intraclass correlation coefficient.



Table 4 Multilevel logistic models of CVD prevalence adjusted by individual characteristics, according to area-level average income, income inequality and green spaces, 2010, São Paulo, Brazil

	Full model Income inequality (n=1005)		Full model Green spaces (n=1005)	
	OR	95% CI	OR	95% CI
<i>1° Level</i>				
Intercept	0.06**	0.02 to 0.17	0.12**	0.04 to 0.33
<i>2° Level: neighbourhood</i>				
Average income, quartile				
2	1.14	0.97 to 1.33	0.97	0.85 to 1.11
3	0.76*	0.63 to 0.92	0.98	0.86 to 1.11
4	0.49**	0.39 to 0.63	1.41**	1.24 to 1.60
Income inequality, quartile				
2	1.35**	1.15 to 1.59		
3	2.71**	2.18 to 3.36		
4	1.43*	1.14 to 1.79		
Green space m ² /inhabitant, quartile				
2			0.37**	0.34 to 0.41
3			0.48**	0.41 to 0.58
4			0.48**	0.42 to 0.54
BIC (ICC)	969 991	(0.062)	969 017	(0.071)

*p<0.05.

**p≤0.001.

BIC, Bayesian Information Criterion; CVD, cardiovascular disease.

ageing.⁷ The significant association found here between CVDs and older age, reinforces the importance of specific strategies and healthcare in older individuals, especially given the fact that the presence of CVD occurs often concurrently with other chronic diseases.

Our analysis also found that individuals with higher education had overall lower odds of CVDs. Studies in Brazil¹⁸ and other countries¹⁹ have historically found a higher proportion of chronic diseases for the most socially vulnerable individuals. The lower odds of CVDs among the elderly with higher education found for the present analysis emphasises the close relationship between social inequality and poor health.

Regarding marital status and CVDs, the current literature indicates an inverse association between living with a partner and health.^{20–21} Gomes *et al.*²² in a study with elderly residents of São Paulo, described the association between living without a partner and higher risk of death. However, we found a significant association between living without a partner and lower risk for CVDs. This finding can be explained by the fact that older individuals living with a partner may have higher survival rates after being diagnosed with a disease, and that persons who lived without a partner may have died earlier than those with a companion, increasing the proportion of healthy elderly in the sample. Moreover, marital status may change over time and the results of the cross-sectional approach can be influenced by cohort effects.

Alcohol use, more specifically alcohol abuse, is frequently mentioned as a risk factor for several chronic diseases.²³ However, evidence of a beneficial effect of moderate alcohol consumption for CVDs has been described in the literature.²⁴ We found that individuals who reported

alcohol consumption had a lower risk for CVD. It can be the case that alcohol consumption for this cohort is mostly moderate, since a small proportion of the elderly showed risk of alcoholism, according to SMAST-G results.

The improvement of health habits, such as healthy diet, not smoking, moderate alcohol consumption and regular practice of physical activity has been shown to have an important impact in reducing the risk of developing chronic diseases.¹ Therefore, the intervention on modifiable risk factors and lifestyle should be encouraged in the elderly to control chronic diseases, especially when the disease has high comorbidity, such as CVDs with diabetes and hypertension, as was the case for the present study.

We found a consistently significant association between CVDs and the characteristics of the area of residence analysed by the study, that is, income inequality and green spaces. Higher income inequality was consistently associated with higher presence of CVD for the elderly. On a previous study of cardiovascular mortality in São Paulo, Farias²⁵ found that residents living in regions with lower socioeconomic status had higher odds of CVD mortality. Similarly, the evidence found in this study indicates increased odds of having a CVD among those who live in very unequal areas, even after controlling for the average income of the residence area.

Access to green spaces has been previously associated with better health conditions, such as stress reduction.^{26–27} We found an inverse association between presence of green spaces and risk for CVD, indicating that residing in a region with more green spaces was protective against CVD, independently of socioeconomic factors and average income of the administrative area. This finding contributes to the discussion about the importance of green

spaces for health promotion, and needs to be taken into consideration in decisions about urban planning.

The burden of CVDs is a growing public health challenge, especially in middle-income and low-income countries, where it represents the majority of mortality causes.²⁸ Our analysis indicate the importance of contextual characteristics of the neighbourhood of residence for CVDs in the elderly, an age group that will require ever more attention in the near future, especially considering the rapid demographic transition occurring in Brazil.

The study has some limitations to be considered. First, individual data are amenable to recall bias, especially given the age structure of the sample. Second, the sample was not representative for the residential areas, so one should not draw specific conclusions for each of the administrative areas. Third, validated physical activity scores were not available from the study, which could influence the association between contextual characteristics and CVDs. Fourth, we used cross-sectional data, so a temporal association could not be established.

CONCLUSION

The study highlights the importance of contextual and individual factors associated with the risk for CVDs. The results found here for the largest Latin America city can reflect the future situation of the elderly in the region and indicate the need to develop healthcare policies focused on the effect of individual and contextual characteristics.

Contributors All authors have contributed sufficiently to the project to be included as authors. Specifically, KHCM developed the research question and concept of the manuscript, conducted the main analyses, interpretation of data and draft of the manuscript. RP worked on interpretation of data, draft and revision of the manuscript. MLL was the principal investigator of the Health, Well-Being and Aging survey, and worked on the revision of the manuscript. ADPCF worked on the concept of the manuscript, interpretation of data, draft and revision of the manuscript.

Funding The present study was funded by Fundação de Amparo à Pesquisa do Estado de São Paulo (FAPESP), grant number 2014/12716-3.

Competing interests None declared.

Patient consent Obtained.

Ethics approval The study received approval from the Human Research Ethics Committee of the School of Public Health, University of São Paulo (Case No. 67/1999) and the National Committee for Ethics in Research (CONEP).

Provenance and peer review Not commissioned; externally peer reviewed.

Data sharing statement No additional data are available.

Open Access This is an Open Access article distributed in accordance with the Creative Commons Attribution Non Commercial (CC BY-NC 4.0) license, which permits others to distribute, remix, adapt, build upon this work non-commercially, and license their derivative works on different terms, provided the original work is properly cited and the use is non-commercial. See: <http://creativecommons.org/licenses/by-nc/4.0/>

REFERENCES

- World Health Organization (WHO). *Good health adds life to years: global brief for World Health Day 2012*. Geneva, Switzerland: World Health Organization, 2012.
- World Health Organization (WHO). *WHO methods for life expectancy and healthy life expectancy*. Geneva, Switzerland: World Health Organization, 2014.
- Naghavi M, Wang H, Lozano R, *et al*. Global, regional, and national age-sex specific all-cause and cause-specific mortality for 240 causes of death, 1990–2013: a systematic analysis for the Global Burden of Disease Study 2013. *Lancet* 2015;385:117–71.
- Mathers CD, Stevens GA, Boerma T, *et al*. Causes of international increases in older age life expectancy. *Lancet* 2015;385:540–8.
- Mansur AP, Favarato D. Mortalidade por Doenças Cardiovasculares no Brasil e na Região Metropolitana de São Paulo: Atualização 2011. *Arq Bras Cardiol* 2012;99:755–61.
- Ministério da Saúde (BR). Informações de Saúde. Estatísticas Vitais. <http://www.datasus.gov.br> (accessed 21 Aug 2015).
- Prince MJ, Wu F, Guo Y, *et al*. The burden of disease in older people and implications for health policy and practice. *Lancet* 2015;385:549–62.
- Kondo N, van Dam RM, Sembajwe G, *et al*. Income inequality and health: the role of population size, inequality threshold, period effects and lag effects. *J Epidemiol Community Health* 2012;66:e11.
- Chiavegatto Filho ADP, Lebrão ML, Kawachi I. Income inequality and elderly self-rated health in São Paulo. *Ann Epidemiol* 2012;22:863–7.
- Pabayo R, Chiavegatto Filho AD, Lebrão ML, *et al*. Income inequality and mortality: results from a longitudinal study of older residents of São Paulo, Brazil. *Am J Public Health* 2013;103:e43–9.
- Meijer M, Röhl J, Bloomfield K, *et al*. Do neighborhoods affect individual mortality? A systematic review and meta-analysis of multilevel studies. *Soc Sci Med* 2012;74:1204–12.
- Malta DC, Bernal RIT, Almeida MCM, *et al*. Desigualdades intraurbanas na distribuição dos fatores de risco para doenças crônicas não transmissíveis, Belo Horizonte, 2010. *Rev Bras Epidemiol* 2014;17:629–41.
- Pabayo R, Kawachi I, Gilman SE. Income inequality among American states and the incidence of major depression. *J Epidemiol Community Health* 2014;68:110–15.
- Lebrão ML, Laurenti R. Saúde, bem-estar e envelhecimento: o estudo SABE no município de São Paulo. *Rev Bras Epidemiol* 2005;8:127–41.
- Blow FC, Gillespie BW, Barry KL, *et al*. Brief screening for alcohol problems in elderly population using the Short Michigan Alcoholism Screening Test-Geriatric Version (SMAST-G). *Alcoholism Clin Exp Res* 1998;22:131A.
- Ministério da Saúde (BR). Secretaria da Atenção à Saúde. Protocolos do Sistema de Vigilância Alimentar e Nutricional—SISVAN. 2008. http://189.28.128.100/dab/docs/portaldab/publicacoes/protocolo_sisvan.pdf (accessed 12 Jun 2015).
- Rodriguez G, Goldman N. An assessment of estimation procedures for multilevel models with binary responses. *J R Stat Soc Series A Stat Soc* 1995;158:73–89.
- Barros MBA, Francisco PMSB, Zanchetta LM, *et al*. Tendências das desigualdades sociais e demográficas na prevalência de doenças crônicas no Brasil, PNAD: 2003–2008. *Cien Saude Colet* 2011;16:3755–68.
- Barnett K, Mercer SW, Norbury M, *et al*. Epidemiology of multimorbidity and implications for health care, research, and medical education: a cross-sectional study. *Lancet* 2012;380:37–43.
- Manzoli L, Villari P, Pirone GM, *et al*. Marital status and mortality in the elderly: a systematic review and meta-analysis. *Soc Sci Med* 2007;64:77–94.
- Shor E, Roelfs DJ, Bugyi P, *et al*. Meta-analysis of marital dissolution and mortality: reevaluating the intersection of gender and age. *Soc Sci Med* 2012;75:46–59.
- Gomes MMF, Turra CM, Fígoli MGB, *et al*. Associação entre mortalidade e estado marital: uma análise para idosos residentes no Município de São Paulo, Brasil, Estudo SABE, 2000 e 2006. *Cad Saude Publica* 2013;29:566–78.
- Costa JSD, Silveira MF, Gazalle FK, *et al*. Consumo abusivo de álcool e fatores associados: estudo de base populacional. *Rev Saude Publica* 2004;38:284–91.
- Ronksley PE, Brien SE, Turner BJ, *et al*. Association of alcohol consumption with selected cardiovascular disease outcomes: a systematic review and meta-analysis. *BMJ* 2011;342:d671.
- Farias NSO. Mortalidade cardiovascular e desigualdades sociais no município de São Paulo, Brasil, 1996–1998 e 2008–2010. *Epidemiol Serv Saude* 2014;23:57–66.
- Van Dillen SM, de Vries S, Groenewegen PP, *et al*. Greenspace in urban neighbourhoods and residents' health: adding quality to quantity. *J Epidemiol Community Health* 2012;66:e8.
- Thompson CW, Roe J, Aspinall P, *et al*. More green space is linked to less stress in deprived communities: evidence from salivary cortisol patterns. *Landsc Urban Plan* 2012;105:221–9.
- Prevention of Cardiovascular Disease. *Guidelines for assessment and management of cardiovascular risk*. Geneva, Switzerland: World Health Organization, 2007.