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Income and heart disease mortality trends in Sao Paulo, Brazil, 1996 to 2010

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ABSTRACT

Background: Reductions in heart disease mortality rates are variable according to socioeconomic status.
Methods: We performed a time trend analysis of all heart diseases (all circulatory diseases, except rheumatic, cerebrovascular, and aortic diseases) comparing three different household income levels (high, middle, and low) in the city of Sao Paulo from 1996 to 2010.
Results: A total of 197,770 deaths were attributed to heart diseases; 62% of them were due to coronary diseases. The rate of death due to heart diseases declined for the city as a whole. The annual percent change (APC) and 95% confidence intervals for men living in the high, middle and low income areas were −4.1 (−4.5 to −3.8), −3.0 (−3.5 to −2.6), and −2.5 (−2.8 to −2.1), respectively. The decline in death rate was greatest among men in the wealthiest area. The trend rates of women living in the high-income area had one joinpoint; APC was −4.4 (−4.8 to −3.9) from 1996–2005 and −2.6 (−3.8 to −1.4) from 2005–2010. Middle and low income areas had an APC of −3.6 (−4.1 to −3.1) and −3.0 (−3.2 to −2.7) from 1996–2010, respectively. During the last 5 years of observation, there was a gradient of the decline of the risk of death, faster for people living in the wealthiest area and slower for people living in the more deprived neighborhoods.
Conclusion: Reduction in deaths due to heart diseases is greatest for men and women living in the wealthiest neighborhoods.

1. Introduction

Coronary heart disease (CHD) mortality rates started declining in 1968 in the United States, followed by Western European countries, Australia, Japan, and Latin America countries; however, CHD mortality rates continue to rise in the Russian Federation and some Eastern European countries [1–3]. The decline of CHD mortality rates is heterogeneous in countries with higher CHD rates such as Finland, Ireland, and the United Kingdom [4]. CHD mortality rates vary according to social deprivation in Scotland [5], by migration status in England and Wales [6], and by neighborhood score regardless of gender and race in the US [7]. Additionally, an international comparison of six cohorts revealed that the decline in cardiovascular mortality differed according to socioeconomic status [8].

CHD trends are variable throughout the world due to epidemiological and nosological factors [3,9]. One important reason for the geographic and temporal variability is differences in the way physicians complete the death certification. Frank Epstein recognized the most common notification error occurring with the shift from a CHD code to other heart diseases or vice versa, and this problem is certainly associated with the quality of medical care [10]. To avoid this bias, we adopted his recommendation to analyze a broader category of "all heart diseases" (all circulatory diseases, except rheumatic disease, stroke, and aortic diseases) as a surrogate for CHD deaths. Declining heart mortality is reported in most developing countries. In Brazil, the decline has been observed since 1983, first in the largest state of Sao Paulo, and later for the whole country [11]. However, there are scarce data to verify if the decline of heart mortality is reducing or widening the social gap in these countries.

We evaluated heart mortality trends in the largest city of South America, Sao Paulo, Brazil, from 1996 to 2010, to test two hypotheses. The first hypothesis is that the decline of CHD mortality rates is differential according to socioeconomic status, with a slower reduction in death rates for people living in the poorest areas. Second, as a consequence of the increased prevalence of obesity and diabetes in Brazil [11], a putative flattening tendency may occur for the last 5 years of observation (2006–2010) mainly among the youngest age strata, as observed in Scotland [5].

2. Methods

2.1. Data collection

In the city of São Paulo, mortality data are centralized at the Health Statistics Department, which monitors the quality of information and ensures a low number of

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ill-defined deaths (<1%) with a continuous adjudication of fatal events and classification by a selected team of nosologists. Data on mortality due to heart diseases were collected from 1996 to 2010 because this is when Brazil adopted the 10th revision of the International Classification of Disease (ICD-10). We analyzed "all heart diseases" defined as deaths whose underlying cause was classified as I-10-15, I-20-25, or I-26-52 in individuals over 35 years old. Further, we separately analyzed "coronary heart disease" (ICD-10: I20-25), however the results did not change materially. Mortality data were plotted as 2-year moving average trend.

The city of São Paulo is organized into 96 districts that are categorized in this study into three areas according to household income as high, middle, and low. We classified districts according to the proportion of households in each district with a family income equal or lower than five minimum wages. The population estimate for each year is based on the National Census Data (1991, 2000, and 2010). We present data in five age strata: 35 to 44, 45 to 54, 55 to 64, 65 to 74, and ≥75 years old. Mortality rates were adjusted according to the population of the city of São Paulo in the year of 2000.

We did not require institutional review board approval because all data on mortality and hospitalization are of public domain and are available without personal identifiers, such as residence, or any type of identification number of the index event.

2.2. Statistical analyses

We described the mortality trends by calculating the average percent change (APC) using Joint Regression Program 3.5.1 [12]. This is a log-linear model using Poisson regression that performs a simulation to verify the peak and trends to identify points where the trend line changes significantly in magnitude or direction. We analyzed separately the average annual percent change (AAPC) for the last 5 years of observation, i.e., from 2006 to 2010. Linear trends in the AAPC (i.e., changes in the slope) over levels of income within each sex/age-stratum and for age-adjusted rates were tested using Poisson regression by treating the lowest to highest income area. The simultaneous equality of annual changes (β coefficients) in the three income areas were tested using the Wald test [13]. We report data as estimation points and 95% confidence interval and statistically significant change implies a 95% confidence interval (95% CI) that does not cross zero. For AAPC calculation, we used the R-statistics software.

The authors of this manuscript have certified that they comply with the Principles of Ethical Publishing in the International Journal of Cardiology.

3. Results

From 1996 to 2010, we evaluated 197,770 deaths due to "all heart diseases"; 62% of these were due to CHD. During the 15 years studied, the risk reduction for heart diseases in the city of Sao Paulo was differential according to socioeconomic status. The differences among these three areas are disclosed at Table 1. It shows that from the wealthiest to the poorest of areas, there is an increment of the proportion of inhabitant that is young, non-white, and with few years of formal education. Additionally, the proportion of premature deaths is higher in the low-middle areas compared to the high income one.

Fig. 1 shows that a downward trend for age-adjusted heart diseases death rates for men for men and women was consistent during the entire study period for the city as a whole. This tendency was more pronounced for men living in the wealthiest area compared to those living in other areas. Among female, this pattern was not so evident, because for women living in the high income area, a slower pace was observed after 2005.

Table 2 shows that during the last 5 years of observation for both sexes. The decline of the age-adjusted death rates was observed for in all areas of the city with a significant gradient from wealthiest to poorest area. The pace of reduction was faster for people living in the high income area. For men, this pattern was present, except for the age strata 35–44 years. In contrast, for women the pattern was different according to age-strata. For women aged 35 to 64 years-old, the reduction of heart deaths was more pronounced for whom were living in the poorest area, however for age over 65 years-old, there is an inversion of this gradient according to area of living with a greater decline for women residing in high income areas compared to women living in the middle and low income areas.

4. Discussion

We found that the decline in deaths due to heart diseases is not equal among different household incomes, used as an index of socioeconomic status. During the last 5 years of observation, the decline persisted for men and women without a plateau.

The cause of the declining mortality is most likely due to differences in case-fatality or incidence rates. Unfortunately, there are scarce studies about case-fatality of heart diseases according to socioeconomic status in Brazil because lethality is socially determined. [14] One exception is the paper from Lopes et al., which evaluated the two-year survival of patients with a medically confirmed diagnosis of heart failure. They found that patients receiving treatment in a public facility had three times higher risk of death compared to patients who could pay for private care [15]. We do not have a population-based registry of acute coronary syndrome to verify temporal trends.

There are few surveys addressing prevalence of cardiovascular risk factors according to income in Sao Paulo. Compared to previous data in Sao Paulo obtained in 1987 [16,17], the prevalence of smoking declined from 44.6% to 25.4% in men and from 31.9% to 19.9% in women. Regarding uncontrolled blood pressure, there was no change among men and a small change among women (from 18.2% to 14.4%) from 1987 to 2002. Recent data obtained by telephone survey in the city of São Paulo showed that the prevalence of tobacco use, low fruit and vegetable intake, and insufficient leisure physical activity decreased in men with higher education levels while the rates of overweight and sedentary lifestyle increased with high educational level; obesity and alcohol abuse were not influenced by education. For women, tobacco use, overweight, obesity, low fruit and vegetable intake, and insufficient leisure physical activity decreased according to educational level [18]. It is clear that the profile of risk factors is

Table 1
Demographic characteristics of the three areas of the City of Sao Paulo according to household income.

Areas	High	Middle	Low
(Number of inhabitants)	(2,298,732)	(3,025,526)	(5,102,126)
Characteristics , median (interquartile range)			
% Households<5 minimum wage	17.3 (12.1 to 22.4)	33.8 (30.8 to 36.6)	53.5 (45.8 to 58.8)
Illiteracy over age 15	1.7 (1.2 to 2.4)	3.9 (3.2 to 4.4)	6.1 (5.2 to 7.0)
People over age 60	16.6 (14.7 to 18.1)	10.8 (4.6 to 13.3)	5.4 (4.5 to 6.7)
Self-reported race as White	80.9 (75.6 to 88.1)	72.9 (64.1 to 77.4)	63.9 (56.5 to 68.3)
Mortality data (2006 to 2010)			
Main causes (%)			
Cardiovascular	33 (32.3 to 34.0)	33.9 (32.3 to 34.8)	32.9 (31.7 to 33.6)
Cancer	23.2 (231.6 to 24.4)	20.2 (19.5 to 21.4)	17.4 (16.2 to 18.4)
Respiratory	13.9 (13.1 to 14.3)	12.4 (11.4 to 12.8)	11.3 (10.7 to 11.8)
External	5.1 (4.3 to 6.0)	7.6 (6.5 to 8.2)	10.2 (9.6 to 12.8)
Chronic diseases under age 50	12.5 (9.3 to 16.7)	21 (16.2 to 24.0)	34.5 (29.7 to 37.7)
Medical autopsy (%)	19.9 (16.0 to 24.2)	26.5 (24.4 to 29.3)	31.9 (27.9 to 35.7)
CHD among heart diseases (%)	62.8 (60.8 to 65.3)	61.5 (58.5 to 66.1)	65.1 (62.2 to 66.1)