

Is it possible to reduce AIDS deaths without reinforcing socioeconomic inequalities in health?

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Background The wide use of highly active antiretroviral therapy has led to an impressive improvement in AIDS survival after the mid-1990s in cities and countries with a high access to these medications. Notwithstanding its beneficial overall effect, antiretroviral therapy was also reported as a factor for the increase in socioeconomic inequalities in health, because AIDS patients have unequal access and adherence to these medications.

Methods We assessed trends AIDS mortality in districts of São Paulo, Brazil, from 1995 to 2002, in order to test their association with area-level socioeconomic indices in a city with a large-scale and cost-free distribution of highly active antiretroviral therapy. We gathered information on yearly death rates due to AIDS, adjusted for gender, age group, income, instruction, living standards, and the human development index. Trend estimation used the autoregression procedure of exact maximum-likelihood estimation for time-series analysis. Regression analysis was used to study the association between the annual percentage decrease in AIDS deaths and socioeconomic indices.

Results AIDS mortality decreased in São Paulo from 32.1 deaths (per 100 000 inhabitants) in 1995 to 11.2 deaths (per 100 000 inhabitants) in 2002. District-level figures of social development did not show an association with the annual percentage decrease in AIDS mortality, with all correlation coefficients corresponding to *P*-values >0.27.

Conclusions This observation indicates that the perspective of public policies addressed to the entire population contribute to reducing inequalities in health, while attaining an overall reduction in AIDS deaths, may have been feasible in the Brazilian context.

Keywords AIDS, HAART, mortality, socioeconomic factors, São Paulo, Brazil

While studying different datasets on child health, Victora *et al.*¹ proposed the 'inverse equity hypothesis' to explain the increase in inequalities in health over time, which happens when overall health outcomes improve due to public-health interventions. According to this hypothesis, early increases in the gap between population segments occur when new health programmes

are implemented, as they initially reach those of higher socioeconomic status (SES) and only later affect the poor. Inequalities in health would diminish only after the rich have achieved new minimum achievable levels of morbidity and mortality and the poor have greater access to health interventions.

Recent studies on AIDS mortality and survival appraised the effectiveness of highly active antiretroviral therapy (HAART), and acknowledged the decline in AIDS mortality and opportunistic infections as attributable to the use of more intensive antiretroviral therapies.^{2,3} The wide use of HAART has led to an impressive improvement in AIDS survival after the mid-1990s in affluent cities and countries with a high access to these medications. Notwithstanding its beneficial overall effect, HAART was also reported as a factor for the increase of

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socioeconomic inequalities in health, because AIDS patients have unequal access and adherence to this medication.^{4–6}

From the onset in the earlier 1980s, AIDS indices increased till 1995 in the city of São Paulo, Brazil, reflecting a complex process, in which the burden of disease progressively shifted to the poorest and most marginalized segments of the global population. During the 1980s, reported AIDS cases in the city of São Paulo corresponded to 31.1% of the incidence in Brazil. This proportion subsequently reduced to 12.8% in 2000, as the disease spread from metropolitan areas to the interior of the country.⁷

Fonseca *et al.*⁸ studied AIDS incidence in Brazil based on educational levels, and verified that the epidemic began among people with higher educational attainment, and progressed steadily to the less-educated social strata, especially among women. From 1980 to 1986, the highest incidence of the disease was observed among men who have sex with men, a group with relatively high levels of education. From 1987 to 1991, AIDS incidence showed a marked increase in the number of intravenous drug users and individuals with low SES.⁹ After 1992, the increase in AIDS cases in heterosexuals led to a significant number of women being affected by the epidemic.¹⁰

The present study aimed at testing the ‘inverse equity hypothesis’ in relation to the recent reduction in AIDS deaths in our midst. According to this hypothesis, we could expect a greater reduction in more affluent areas of the city, while poorer peripheral districts would have experienced a worse evolution for this outcome. After appraisal of this hypothesis a strategy was developed to document the recent evolution of AIDS deaths in a major Brazilian city, while evaluating the possibility of reducing AIDS deaths without reinforcing health inequalities in the context of large-scale and cost-free distribution of anti-retroviral medicines. The objective of the present study was to describe trends of AIDS mortality in São Paulo from 1995 to 2002. In particular, we aimed at assessing the association between the annual percentage decrease in AIDS mortality and SES indices of the city’s districts.

Methods

Design of the study, population characteristics and sources of information

This is an ecological study, assessing the recent evolution of AIDS mortality in 96 districts of the city, and the association between the annual percentage decrease in AIDS deaths and SES characteristics of these areas. The study population comprised the residents of São Paulo during the years 1995–2002.

With nearly 10 millions inhabitants, São Paulo is one of the largest cities in Latin America, and the capital of the most populous and industrialized Brazilian state. The city has the highest scores for several indices of social development in the country. Nonetheless, wealth has not been distributed in a homogeneous way, and affluent and deprived areas coexist in the city, displaying patterns of severe inequalities at the country level. Sposati¹¹ described geographic patterns of deprivation in the city, and identified progressively poorer SES in its encircling peripheral areas, in contrast to the more affluent central portion. Figures for the human development index (HDI) calculated for each of the city’s districts ranged from 0.245 to

0.884, indicating the intense socioeconomic gradient in São Paulo. From the 96 districts of the city, 38 presented HDI lower than 0.5, 52 had figures between 0.5 and 0.8, and 6 ranked HDI higher than 0.8.

Mortality data stratified by gender, age, and area of residence were gathered from the official information system for deaths in the state of São Paulo, which was reported as a reliable set of information during recent years.^{12–14} ‘AIDS’, as the underlying cause of death, refers to codes B20–B24 of the International Classification of Diseases, 10th revision. The dataset does not allow for the classification of AIDS deaths according to transmission category, which could improve the study of association between deprivation and AIDS mortality.¹⁵

General censuses taken in 1991, 1996, and 2000 supplied population information for the estimation of death rates. The characterization of the city’s districts used data provided by the census taken in 2000, which is the most recent source of population information.

Socioeconomic variables

Income was measured in US dollars, and refers to the household per-capita average for each area. The Gini coefficient¹⁶ gauged inequality of income distribution at the area level. Literacy rate refers to people >14 years. Years of study (averages) and high-school graduate individuals (proportions) refer to the head of the household in each area. Population crowding is the number of dwellers per room in households. We also assessed the proportion of slum households (shantytowns) and household ownership, taking account of standard of living in each area. The HDI is a composite measurement assembling information on income, instructional levels, and longevity. The local health authority estimated this index for the city’s districts, according to methodological criteria set forth by the United Nations Development Programme.¹⁷

Data analysis

Death rates were calculated for each year and district of the city after adjusting for age group and gender distribution by the direct method.¹⁸ The estimation of trends and levels of death rates used the autoregression procedure of exact maximum-likelihood estimation for time-series analysis.¹⁹ Prior and current levels of AIDS deaths in each area refer to ex post forecasts for 1995 and 2002, respectively, rather than the observed values, in order to reduce random variation of estimates. The calculation of the annual percentage decrease in AIDS deaths in each area used Poisson regression analysis, according to methodological indications supplied by Antunes and Waldman.²⁰

As death certificates are poor indicators of the SES characteristics of the deceased, spatial data analysis was the strategy to assess covariates for reduction in AIDS deaths. We used space as an organizing frame to explore variations in the annual percentage decrease in AIDS deaths, by expressing single general relationships between this outcome and SES indices.

The assessment of association between figures of the annual percentage decrease in AIDS deaths and SES indices used ordinary least squares (OLS) regression analysis.¹⁸ The random distribution of residuals is a necessary assumption for the

application of OLS regression analysis. However, this condition cannot always be met by social indices, which usually present spatial autocorrelation of figures. In order to prevent this effect from affecting parameters of regression analysis, we also appraised the correlation between trends of AIDS deaths and SES indices using two schemes of generalized least squares regression analysis, which take account of spatial autocorrelation of measures: simultaneous autoregressive (SAR) and conditional autoregressive (CAR).²¹ The SPSS 8.0 1997 software was used for statistical analyses.

Grouping of areas through cluster analysis

The present geographical division of the city into 96 districts was established in 1991 by official institutions for administrative purposes, with the main objective of delimiting regions with homogeneous socioeconomic characteristics. The population of these areas ranged from 8404 to 333 436 inhabitants in the census taken in 2000, with an average of 108 690 inhabitants per district.

All analyses (trend estimation, study of correlation) were performed at district level, thus examining the 96 regions together. Area-level figures for the annual percentage decrease in AIDS deaths were subsequently classified into four clusters exclusively for descriptive purposes, i.e. production of maps and presenting synthetic indications of socioeconomic indices and indicators of wider regions. Cluster analysis aggregated small areas of the city into four broader sets, according to the magnitude of the observed decrease in AIDS deaths. The first cluster (stationary trend) refers to areas in which the annual percentage decrease in AIDS deaths was not significantly different from zero. The allocation of the remaining areas of the city into three additional clusters (low, medium, and high decrease) used the K-means method of cluster analysis²² for the outcome variable of the study, i.e. the annual percentage decrease in AIDS deaths.

Results

AIDS mortality decreased in São Paulo from 32.1 deaths (per 100 000 inhabitants) in 1995 to 11.2 deaths (per 100 000 inhabitants) in 2002. The overall reduction of 65.0% in the period corresponded to an annual percentage decrease of 16.9% (95% confidence interval 11.6–22.3%). The assessment of death rates at the small-area level also indicated an overall decreasing trend. The box plot of these rates (Figure 1) indicates the median, quartiles, and upper and lower values for the districts in each year, and allows the perception of the drop in AIDS mortality concurrent with a shrinking variation of rates among areas of the city.

The declining trend was not homogeneous in the city, and different areas displayed discrepant patterns of decrease in AIDS mortality (Figure 2). The cluster classification of areas allowed the identification of four levels of decrease, according to the magnitude of the annual percentage decrease in death rates: stationary trend (i.e. areas in which the annual percentage decrease in rates was not significantly different from zero), low (average annual decrease of 13.0%), medium (18.5%) and high decrease (23.8%). Table 1 presents information on the yearly death rate of each cluster: cluster 1 aggregated 15 areas with a total of 1 034 033 inhabitants; cluster 2 comprised 31 areas with

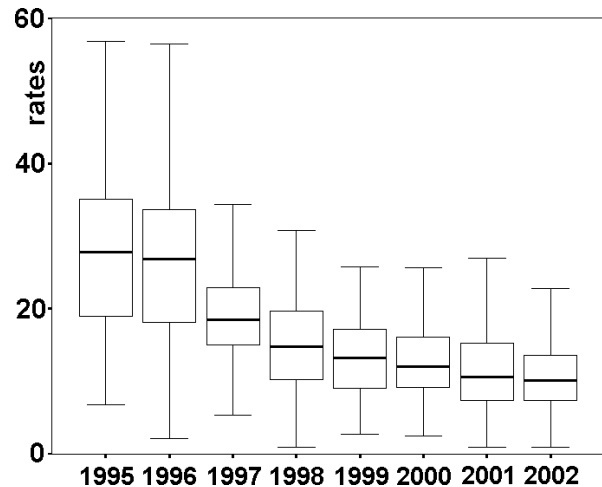


Figure 1 Box plots (median, quartiles, and extreme figures) for the area-level age-adjusted and gender-adjusted rates of AIDS mortality (per 100 000 inhabitants) in 96 districts of the city of São Paulo, Brazil, 1995–2002

4 042 263 inhabitants; cluster 3 had 37 areas with 4 073 185 inhabitants; cluster 4 included 13 areas with 1 284 471 inhabitants.

Table 2 presents summary information of prior (1995) and current (2002) levels of AIDS death rates and SES indices for the four clusters of small areas. The comparison of these figures indicates that the decrease in AIDS deaths was greater in areas with higher prior levels of mortality. The decrease throughout the period resulted in lower current levels of mortality for the clusters with greater decrease. As areas with higher prior levels of AIDS deaths tended to present a steeper decline, these areas had lower current level of mortality.

As to the SES indices, average figures presented in Table 2 for each cluster indicate their lack of association with the annual percentage decrease in AIDS deaths. This observation was confirmed by the assessment of correlation coefficients measured by regression analysis at the small-area level (Table 3). Despite being not homogeneous in the city, the annual percentage decrease in AIDS deaths did not correlate with SES indices in the OLS, SAR, and CAR procedures of regression analysis.

The observation of maps in Figure 2 reinforces the lack of association between SES indices and the annual percentage decrease in AIDS mortality. While figures of social development indicated progressively worse profiles for encircling peripheral areas of the city, the four clusters classifying different patterns of decreasing trends had their districts similarly distributed both in the more affluent central portion of the city, and in its poorer peripheral areas.

Discussion

Brazil was the first country to provide unrestricted cost-free access to antiretroviral medicines for AIDS treatment. The first official resolution regulating HAART as the standard of care for treatment of AIDS patients in the country dates back to March 1995, and a large-scale distribution of antiretroviral

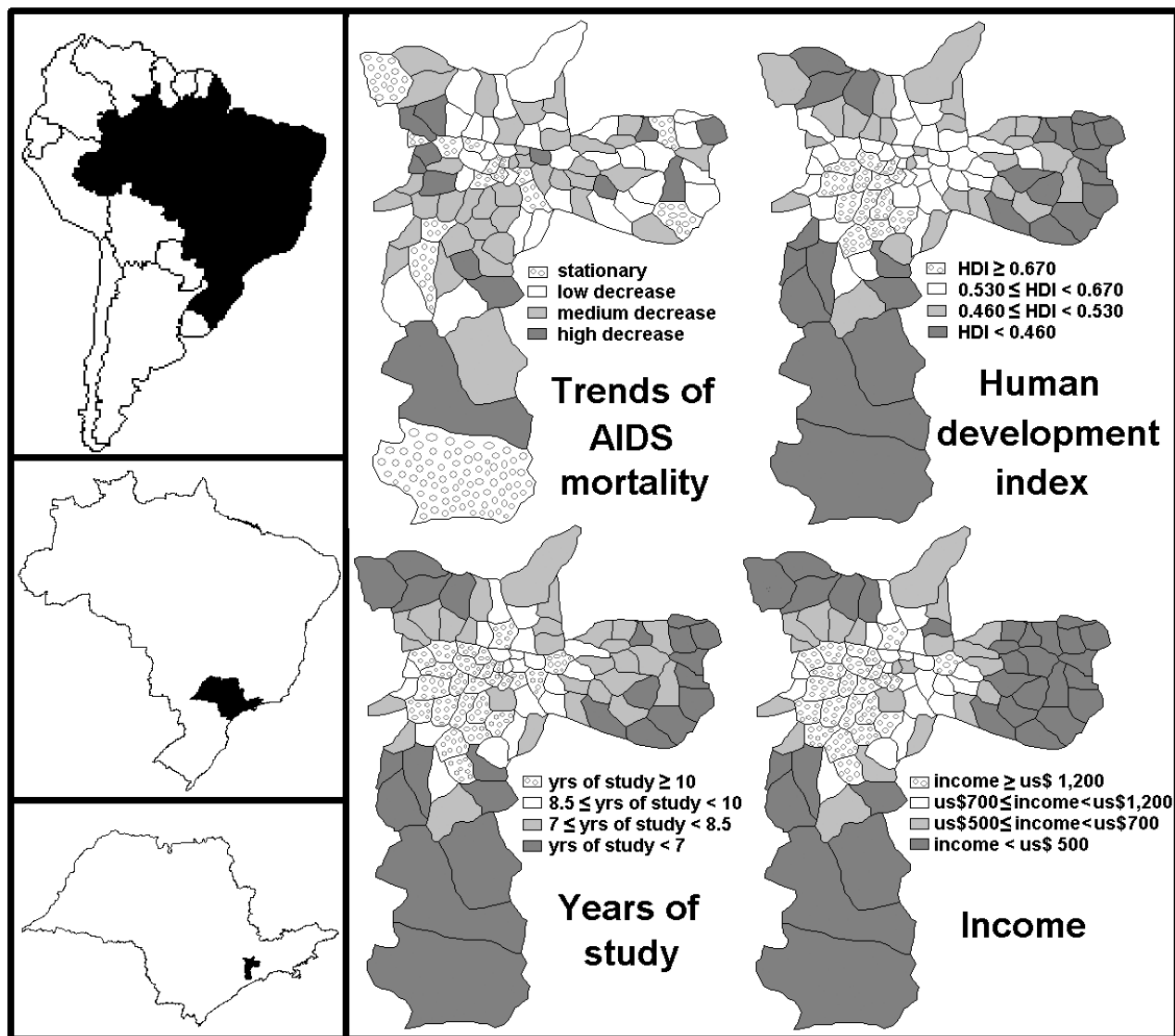


Figure 2 Map of the cluster analysis for the annual percentage decrease in AIDS mortality and SES indices in São Paulo, 1995–2002 (inset of the city in the state of São Paulo, Brazil, and South America)

Table 1 Age-adjusted and gender-adjusted rates of AIDS mortality (per 100 000 inhabitants) and annual percentage decrease in clusters of districts, city of São Paulo, Brazil, 1995–2002

Year	Cluster 1 Stationary trend	Cluster 2 Low decrease	Cluster 3 Medium decrease	Cluster 4 High decrease
1995	23.77	27.69	29.55	27.91
1996	16.03	26.05	27.81	33.29
1997	9.95	20.85	18.71	18.83
1998	10.99	16.06	14.82	13.82
1999	11.48	15.45	11.83	11.16
2000	11.75	13.78	12.35	10.43
2001	11.68	13.11	9.96	8.75
2002	11.35	12.21	9.59	7.52
Annual percentage decrease (%)	9.3	13.0	18.5	23.8
95% confidence interval	-0.9 to 20.5%	9.3 to 16.7%	13.1 to 24.2%	17.8 to 30.2%

Table 2 Age-adjusted and gender-adjusted rates in AIDS mortality (per 100 000 inhabitants) and SES indices in clusters of districts, city of São Paulo, Brazil, 1995–2002

	Cluster 1	Cluster 2	Cluster 3	Cluster 4
AIDS death rates				
Prior (1995) level ^a	17.13	25.98	27.33	30.56
Current (2002) level ^a	15.26	11.81	9.28	6.35
Socioeconomic indices				
Human development index	0.561	0.538	0.566	0.527
Per capita income (US\$)	371.34	245.26	308.52	215.69
Gini coefficient	0.563	0.573	0.562	0.592
Literacy rate (≥ 15 y) (%)	96.58	96.64	96.77	96.04
Years of study	9.50	8.68	9.13	8.43
Graduated in high school (%)	43.98	36.62	40.29	34.77
Households in shantytowns (%)	5.90	5.11	5.75	8.45
Household crowding	1.03	1.34	1.31	0.69
Household ownership (%)	65.96	67.78	67.90	71.44
Number of areas	15	31	37	13

^a *Ex post* forecasts.

Table 3 Goodness-of-fit assessment (correlation coefficient and *P* values) of the association between the annual percentage decrease in AIDS mortality and SES indices at the small-area level, city of São Paulo, Brazil, 1995–2002

	OLS	<i>P</i> value	SAR	<i>P</i> value	CAR	<i>P</i> value
AIDS death rates						
Prior (1995) level	0.391	<0.001	0.511	<0.001	0.539	<0.001
Current (2002) level	-0.491	<0.001	-0.490	<0.001	-0.521	<0.001
Socioeconomic indices						
HDI	0.003	0.978	0.016	0.878	0.026	0.802
Per capita income (US\$)	-0.107	0.300	-0.099	0.336	-0.104	0.312
Gini coefficient	0.023	0.825	0.005	0.961	-0.019	0.857
Literacy rate (≥ 15 yrs)	0.016	0.875	-0.034	0.745	-0.049	0.639
Years of study	-0.065	0.526	-0.055	0.598	-0.052	0.616
Graduated in high school	-0.076	0.459	-0.069	0.506	-0.068	0.513
Households in shantytowns	0.087	0.401	0.074	0.473	0.037	0.721
Household crowding	0.002	0.981	0.006	0.955	0.012	0.910
Household ownership	0.114	0.270	0.107	0.299	0.105	0.311

medications by the public healthcare system (including protease inhibitors) for Brazilian AIDS patients has been effective since 1996.²³ The Brazilian policy of offering widespread and cost-free access to antiretroviral drugs was described as a successful example of a developing country's commitment to meet the treatment needs of people living with AIDS.²⁴

The current study documented marked decrease in AIDS mortality in the city of São Paulo during recent years. This reduction (Figure 1, Table 1) has been attributed not exclusively to HAART distribution, but also to programmes of surveillance and prevention.²⁵ This observation is consistent with data suggesting the decline of newly reported cases: AIDS incidence in the city reduced from 43.9 new cases (per 100 000 inhabitants) in 1996 to 29.0 in 2000.⁷ A consistent collaboration between the organized civil society and governmental

agencies was considered one of the key factors for overcoming difficulties associated with a vulnerable social context, and achieving a relative success in the control of the epidemics.²⁶

Conclusions stated at the area-level do not allow for inferences at the individual-level. Notwithstanding the demand for caution in the comparison of studies using different analytical schemes, we find that the current observation of a marked decline in AIDS mortality is consistent with the individual-level appraisal of HAART's contribution to a prolonged survival and increased quality of life of AIDS patients^{27,28} in the Brazilian context.

Several studies in different countries appraised the contribution of HAART to the decline in AIDS mortality as being effective.^{29,30} Despite the growing conviction of its beneficial effect, there is a general concern regarding the inconsistent use

of these medicines and the development of multi-drug resistant strains of HIV. The World Health Organization indicated socioeconomic-related factors affecting the adherence to therapy for HIV/AIDS.³¹ Bamberger *et al.*³ stated that most practitioners fear a low adherence to the treatment cost and schedule, and sometimes are reluctant to prescribe HAART to those who may have difficulties in complying with complicated medication regimens, even in the context of universal distribution of these medicines. Farmer *et al.*^{32,33} took into account the implication of this fear in the context of public health, and proposed a 'HIV equity initiative' in order to deliver antiretroviral therapy to underprivileged AIDS patients. Originally used for the control of tuberculosis, in which treatment adherence and drug resistance are also critical issues, the directly observed therapy (DOT) scheme would promote the judicious use of HAART, if there is an uninterrupted supply of high-quality drugs.

The present study of trends in a city with an intense socioeconomic gradient and a large-scale and free-of-charge distribution of HAART did not foster this concern, because the recent reduction in AIDS deaths in the city was uncorrelated with SES indices (Tables 2 and 3), and poorer trends of mortality were not observed for deprived areas. This observation is in contrast to recent reports for other large cities. Rodríguez-Sanz *et al.*⁴ observed a poorer evolution of AIDS mortality in deprived neighbourhoods of Barcelona, Spain, and patients with low educational attainment, in the context of an overall reduction in AIDS deaths attributed to the use of antiretroviral drugs from 1996 to 2001. McFarland *et al.*⁵ also observed a worse pattern of AIDS mortality for people living in poorer areas, despite the large-scale distribution of HAART in San Francisco, USA. Wood *et al.*⁶ assessed data on HIV-related mortality for a population setting in which antiretroviral drugs were also delivered free of charge (Vancouver, Canada), and reported a strong association between a shorter survival and lower SES of patients.

Although health services provide free HAART treatment in Barcelona, San Francisco, and Vancouver, unequal access and inconsistent use of antiretroviral therapy continued affecting AIDS patients. Persons in the lower socioeconomic strata might

have been less likely to be prescribed the more effective therapeutic schemes even when it is recommended for their clinical characteristics. They also might have faced more difficulties in complying with medication regimes and adverse effects. Further research could assess additional explicative hypotheses for this contrast, relating the concentration of co-morbidities such as mental illness, drug use, and hepatitis C virus, which may have affected AIDS patients in the low SES strata in high income countries to a greater extent than in low/middle income countries.

Contrary to expectations furthered by the 'inverse equity hypothesis',¹ the evidence gathered in the present study indicated that the recent reduction in AIDS deaths in São Paulo was not influenced by major estimates of SES indices of the city's districts (Tables 2 and 3). This observation suggests that the perspective of public policies addressed to the entire population contribute to reducing inequalities in health, while attaining an overall reduction in AIDS deaths is feasible.

The impressive decline in AIDS deaths in São Paulo in recent years was uncorrelated with area-level SES indices. However, the decline in AIDS deaths was not homogeneous in the city, and discrepant patterns of decrease were identified (Figure 2). The observation of higher figures for the annual percentage decrease in districts previously presenting higher levels of AIDS mortality (Tables 2 and 3) is an additional indication that recent programmes of treatment and prevention, besides contributing to the overall decrease in AIDS mortality levels, might have had an additional effect on the reduction of inequalities in health.

In spite of its recent decline, mortality from AIDS-related conditions remains a major problem of public health, the importance of which cannot be overlooked. The World Health Organization³⁴ acknowledges that the AIDS epidemic in Brazil has spread from the major urban centres to smaller municipalities across most of the country, where the distribution, adherence, and monitoring of HAART may be more difficult. Notwithstanding the active and successful programme to treat patients in Brazil, health authorities cannot rest on their laurels, and efforts for health promotion must take account of new challenges posed by the changing pattern of AIDS indices in the country.

KEY MESSAGES

- AIDS mortality in São Paulo underwent an overall reduction of 65% from 1995 to 2002.
- During this period, AIDS patients were provided unrestricted cost-free access to antiretroviral medicines.
- In spite of an intense socioeconomic gradient in the city, the recent reduction of AIDS deaths was not influenced by SES indices at district level.
- The perspective of public policies addressed to the entire population contribute to improving health outcomes without reinforcing inequalities in health may be feasible.

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