TRENDS IN SOCIOECONOMIC INEQUALITIES IN MORTALITY IN DEVELOPING COUNTRIES: THE CASE OF CHILD SURVIVAL IN SÃO PAULO, BRAZIL*

NARAYAN SASTRY

I examined trends in socioeconomic inequalities in under-five mortality for the state of São Paulo, Brazil, over a 21-year period from 1970 to 1991, during which much of the mortality transition unfolded. During this time, there was a decline in inequality in under-five mortality by household wealth but a substantial increase by mother's education. Improvements in infrastructure and economic development were associated with lower levels of socioeconomic inequality in under-five mortality. Mother's education emerged as the key factor underlying socioeconomic inequalities in under-five mortality even as levels of education for women increased and inequality in schooling fell.

In the past few years, there has been growing policy and research interest in socioeconomic inequalities in health and the health of the poor in less-developed countries (Gwatkin 2000).[1] Reducing health inequalities by socioeconomic status and improving the health of the disadvantaged have become central goals of the World Bank, the World Health Organization, other international organizations, and major donors of development assistance (Wagstaff 2000). Yet progress toward achieving these goals may have been stymied by an important gap in documenting and understanding *trends* in socioeconomic inequalities in infant and child mortality in less-developed countries.[2] Few studies have described trends in these measures, and even fewer have sought to explain them. Little is known about how socioeconomic inequalities in health have changed over time as the development processes unfolded and levels of urbanization rose, women's educational attainment improved, infrastructure spread, and income and wealth increased.[3] Braveman

*Narayan Sastry, RAND Corporation, 1700 Main Street, P.O. Box 2138, Santa Monica, CA 90407-2138; E-mail: sastry@rand.org. I gratefully acknowledge the research assistance of Gabriela Lopez and Stephanie Williamson and financial support from the National Institutes of Health through Grants HD36695 and HD38556.

1. Socioeconomic inequalities in health refer to the extent to which differences in health status are systematically related to differences in socioeconomic status.

2. Numerous studies have examined the effects of socioeconomic status on health or mortality using cross-sectional data. However, few of them have extended their findings to characterize levels of *inequality*, using either rate ratios or, especially, more sophisticated measures of inequality (described later). Additional complications of extracting information on trends in socioeconomic inequalities in health from cross-sectional studies are that the specific measures of socioeconomic status often differ across studies, as do the number and type of other variables that are held constant.

3. Cleland, Bicego, and Fegan (1992) found that disparities in child survival by socioeconomic status and maternal education did not narrow from the 1970s to the 1980s in a dozen developing countries. Wagstaff's (2002a) reanalysis of the results from a number of studies showed that inequality in under-five mortality increased in Bolivia from 1994 to 1998, in Vietnam from 1993 to 1998 (Nguyen and Wagstaff 2002), and in Uganda from 1988 to 1995 (Stecklov, Bommier, and Boerma 1999). In addition, Victora et al. (2000) reported no changes in inequality in children's health and infant mortality in two areas of Brazil from the late 1980s to the early 1990s. Several studies have shed some light on this issue by examining differences in covariate effects over time. For example, DaVanzo and Habicht (1986) found that the effects of mother's education on child survival increased over time in Malaysia, and Merrick (1985) found that the effects on children's survival of mothers' education decreased but those of fathers' education increased in urban Brazil between 1970 and 1976.

and Tarimo (2002:1622) noted that "relatively little information is routinely available on health status or health care disparities between better- and worse-off groups *within* most countries, and particularly on how within-country social disparities may change over time." In contrast, much research has documented trends in poverty and income inequality over time and has analyzed the factors underlying these trends—both in Brazil and in other parts of the developing world (see, e.g., Lam and Levison 1991; Psacharopoulos et al. 1995).

Research on socioeconomic inequalities in health in less-developed countries has, until recently, focused on disparities based on categorical indicators of status, such as region, rural-urban place of residence, mother's education, sex, and race or ethnicity. In Brazil, attention has focused primarily on rural-urban and regional differences in mortality, particularly between the poor and underdeveloped Northeast region and the rest of the country, and secondarily on differences by income and education (Sastry 1996).[4] The tremendous geographic diversity in the level and pace of social and economic development in Brazil has been the principal reason for this focus; differences by socioeconomic status have tended to mirror the regional differences and hence have received less attention. Another reason is that many past studies used basic indirect estimation techniques. Because stratification of the sample was necessary for estimating mortality differences, these studies were restricted to examining the effects of one or two covariates at most.

Less attention has been paid to examining the effects of broader social and economic trends on declines in infant and child mortality and on changes in disparities in mortality. One exception is a study by Victora et al. (2000), which examined trends in the inequality of children's health by economic status in Brazil. These researchers found that in Ceará state in Northeast Brazil, disparities in children's health and infant mortality between the rich and the poor remained largely unchanged between 1987 and 1994. For the city of Pelotas in southern Brazil, the situation was largely the same from 1982 to 1992. However, when the analysis of inequality in infant mortality for Pelotas was stratified by low birth-weight status (there were no other controls), Victora et al. found that inequality declined among normal birth-weight births but widened substantially among low birth-weight births. (They argued that the narrowing of inequality in infant mortality for normal birth-weight births occurred because affluent families reached the minimum achievable level of infant mortality.)

A growing number of studies have examined inequalities in health and survival by household economic status in less-developed countries.[5] Virtually all of them have focused on infants and children, for whom the best data are available. These studies have drawn on data sets with measures of household economic status, such as the World Bank's Living Standards Measurement Study (Wagstaff 2000; Wagstaff and Watanabe 2000), or data sets with measures of household asset ownership and housing characteristics, such as the Demographic and Health Surveys, together with techniques proposed by Filmer and Pritchett (1999, 2001) for converting these measures into a wealth index (Bonilla-Chacin and Hammer 1999; Gwatkin et al. 2000). These new studies have presented concentration curves and concentration indices—more-sophisticated measures of inequality

4. See, for example, Barros and Sawyer (1991), Carvalho (1974), Carvalho and Wood (1978), Castilla (1996), Daly (1985), Monteiro (1996), Monteiro et al. (1992), Sawyer, Fernández-Castilla, and Monte-Mor (1987), Schmertmann and Sawyer (1996), Simões and Monteiro (1995), Simões and Oliveira (1997), Szwarcwald and Castilho (1995), and Wood and Carvalho (1988).

5. The concept of "pure" inequalities in health—variation in health status across individuals in a population according to their health status itself—has recently been promoted for use by policy makers and researchers (see, e.g., Gakidou, Murray, and Frenk 2000; World Health Organization 2000). However, there have been a number of forceful critiques of this approach (see, e.g., Braveman, Starfield, and Geiger 2001; Szwarcwald 2002). In this article, my primary interest is in *socioeconomic* inequalities in health, which corresponds closely with that of the vast majority of previous studies.

that have some important advantages over the rate ratios across groups that are typically used—to characterize levels of inequality in health by economic status. Few of these studies have examined trends. They have, however, uncovered substantial cross-country differences in inequality in children's health and survival by household economic status. Of considerable interest is that of the 9 countries examined by Wagstaff (2000) and the 44 countries examined by Gwatkin et al. (2000), inequalities in under-five mortality by household economic status were the highest for Brazil. Wagstaff (2000) found that the concentration curve for Brazil lay the farthest from the 45-degree line and did not intersect with any other country's concentration curve, indicating that inequality in under-five mortality by household economic status in Brazil was *unambiguously* the worst.

In this article, I examine the effects of social and economic development on socioeconomic inequalities in under-five mortality for the state of São Paulo, Brazil, over a 21-year period during which much of the transition in infant and child mortality unfolded. I investigated whether the improvements in infant and child survival were accompanied by declining inequalities by socioeconomic status or whether the most-advantaged segments of society benefited more from these improvements. Focusing on inequality in under-five mortality by household wealth and mother's education, I drew on microdata from Brazilian censuses conducted in 1970, 1980, and 1991. The major strengths of these data include the availability of detailed individual- and household-level covariates and extremely large samples.

I begin by providing some background on trends and differences in infant and child mortality in São Paulo over the past 30–40 years. In the subsequent section, I describe the data and methods. I then present the results and end the article with some conclusions.

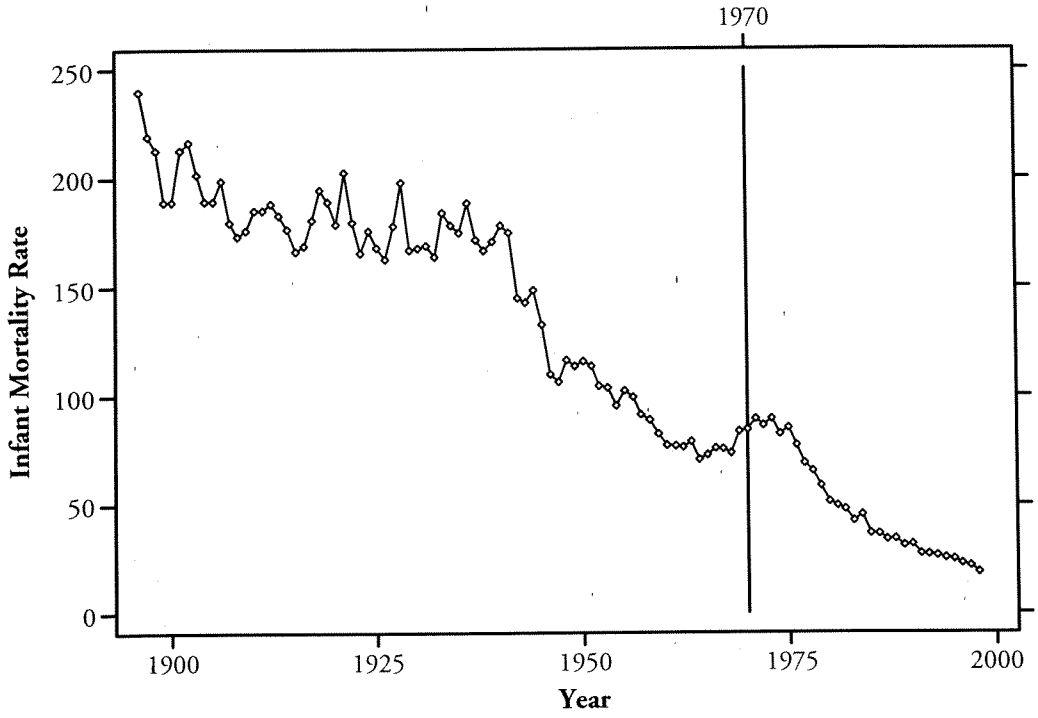
BACKGROUND

São Paulo is Brazil's largest state, with one fifth of the country's total population. The state, which is located in southeastern Brazil, had a population of 31.5 million in 1991 (Fundação SEADE 1993). The city of São Paulo and its surrounding metropolitan area is the most industrialized region in Latin America. This region, located in the southeastern part of the state, forms Brazil's urban-industrial heartland and dominates the country economically. For instance, the greater São Paulo region generates one third of Brazil's income, although it contains only one tenth of the country's population (Abranches 1995). During the past 30 years, the city and state have led Brazil and Latin America in many important demographic and socioeconomic trends. For example, the state has the highest level of urbanization in the country, with 93% of the state's population living in urban areas in the mid-1990s.

The decline in infant mortality in São Paulo state began in the early 1940s (see Figure 1). It was interrupted by an increase in mortality between the mid-1960s and the early 1970s. From 1964 to 1971, the infant mortality rate in São Paulo state rose by 26%, from 71 per 1,000 to 89 per 1,000. However, it then declined rapidly, so that by 1980, it had returned to its long-term trend line. During the study period, the infant mortality rate declined from 84 per 1,000 in 1970 to 27 per 1,000 in 1991.

A number of studies have investigated why infant mortality rates increased in São Paulo between 1964 and 1971. One set of studies has argued that the economic policies of the military government that took power in 1964 were the main cause of the upturn in infant mortality (Sawyer 1981; Wood 1982; Yunes 1981). Although there was rapid economic growth of over 10% per year beginning in 1964, there was a sharp concurrent drop in real wages, with the legal minimum wage falling by approximately 60% between 1964 and 1973. Other factors that may have contributed to the rise in infant mortality rates include insufficient investment in water supply and sanitation (Monteiro and Benicio 1989) and in health services (Leser 1974) to keep pace with rapid rates of population growth.

Figure 1. Infant Mortality Rate for São Paulo State: 1894–1998



Beginning in 1973, infant mortality rates began to decline in the state. Most researchers have attributed the fall to improvements in infrastructure (Costa and Duarte 1989). In the 1970s, Brazil embarked on an intensive effort to expand the water-supply and sanitation systems (Merrick 1985), which raised the proportion of households in São Paulo with running water from 71.3% in 1973 to 98.6% in 1984 (Sawyer et al. 1987). Other important changes that contributed to lower mortality rates were longer durations of breast-feeding, the greater use of oral rehydration therapy, higher immunization rates, and an increase in the number of health centers (Monteiro et al. 1989; Victora et al. 1996; Zúñiga and Monteiro 1995).

DATA AND METHODS

This study was based on data from the survey component of the Brazilian population censuses that were conducted in 1970, 1980, and 1991. One quarter of the households were selected for the survey component in 1970 and 1980; in 1991, 10% of the households were selected in municipalities with a population of 15,000 or higher and 20% were selected in the rest. Information was collected on the housing conditions and demographic, social, and economic characteristics of each resident. Most of the core questionnaire had few, if any, changes from census to census, which allowed me to create identical measures for each year. The high sampling percentages resulted in exceptionally large samples. Although my analysis was based only on parous women aged 20–34, the sample sizes were 297,729 for 1970, 527,927 for 1980, and 406,976 for 1991—a total of 1,232,632 observations.

I restricted the analysis to child mortality among women aged 20–34 because a mother's age was used to control for the duration of her children's exposure to the risk of death. (The duration since the mother's first marriage is a commonly used alternative to

mother's age as a control for children's exposure; however, information on age at first marriage is not available from the Brazilian censuses.) As a result, deaths to children of older women correspond to births occurring in the more distant past. Since the covariates reflect conditions at the time of the interview, the inclusion of older women—and hence children who were born in the more distant past—may have yielded misleading results, given the rapid changes in living conditions over the study period. Also, underreporting the number of children born is more likely among older women. I excluded women aged 15–19 because children of teenage mothers face higher mortality that is due, in part, to their mothers' age. (Although mother's age was measured and is included in the analysis, it is confounded with children's exposure.)

The core questionnaire collected information from women on the number of children born and the number of these children who were alive at the time of the interviews. I used this information to construct an index of child mortality for each mother using the techniques proposed by Trussell and Preston (1982). The index was used to estimate under-five mortality probabilities indirectly. Because the indirect estimates were based on individual-level index values, I was able to construct comparable indirect estimates of mortality that controlled for individual- and household-level demographic, social, and economic characteristics using regression analysis. Next I describe the construction of the child mortality index (CMI), the regression analysis, and the measures of socioeconomic inequality in under-five mortality.

Index of Child Mortality

The CMI is based on the ratio of observed to expected deaths among all births to each woman in the sample aged 20–34 years. It assumes that a child's risk of death is proportional to a standard mortality schedule, $q^s(a)$, and hence to the risk faced by other children. The probability of a child born to the jth mother in the ith group dying by exact age a, $q_{ij}(a)$, is given by

$$q_{ij}(a) = \beta_{ij} q^s(a), \tag{1}$$

where β_{ij} is the mother's proportionality factor. A model life table was chosen as the standard mortality schedule. The most important assumptions underlying the indirect estimation of child mortality are that the levels of fertility and childhood mortality have been constant in the recent past. Restricting the analysis to women aged 20–34 minimized the impact of violations of these assumptions.[6]

I examined deaths of children separately for subgroups of women on the basis of five-year age categories and levels of education because women of higher socioeconomic status generally bear children at a later age. Hence, among mothers of the same age, those of higher socioeconomic status will have younger children. These children are less likely to have died because they were younger and because of their higher socioeconomic status. If I ignored the fact that children of higher socioeconomic status are younger (holding mother's age constant), the estimated mortality rates for these children would be understated. Consequently, it was important to control for fertility differences—and hence for children's exposure to the risk of death—by mothers' socioeconomic status when I calculated the CMI. I did so by stratifying mothers according to whether they had completed elementary school, an outcome that occurred well before the start of childbearing. This

6. The mean births to women aged 30–34 decreased from 3.1 in 1970 to 2.1 in 1991. The decline in fertility was larger among less-educated women—with childbearing at younger ages falling especially fast among these women. For women aged 30–34 who had not completed elementary school, the mean parity fell by one third, from 4.0 births in 1970 to 2.7 in 1991; for women with at least an elementary school education, fertility fell by 20%, from 2.5 births in 1970 to 2.0 in 1991.

procedure simply yields more-accurate estimates of the CMI and reduces any bias in the estimated relationship between socioeconomic status and under-five mortality.

The expected number of dead children for the jth woman in age group d and education group i, E_{ij}, was given by

$$E_{ij} = B_{ij} \times PD_i^s(d), \tag{2}$$

where B_{ij} is the number of children born to this woman and $PD_i^s(d)$ is the expected proportion of children who died among women in five-year age group d and education group i under the standard mortality schedule. I estimated $PD_i^s(d)$ by inverting the conventional procedure for estimating child mortality from summary information from mothers on the number of children ever born and the number of children who died.

The final step was to calculate the value of the CMI for each woman. For the jth woman in the ith education group, this index is the ratio of observed deaths (O_{ij}) to expected deaths (E_{ij}) of children:

$$\begin{aligned} CMI_{ij} &= O_{ij} / E_{ij} \\ &= O_{ij} / [B_{ij} \times PD_i^s(d)]. \end{aligned} \tag{3}$$

On the basis of Eq. (1), the observed number of dead children can be written as $\beta_{ij}E_{ij}$. Thus, the ratio of observed to expected dead children—the CMI—is simply β_{ij}, the proportionality factor described earlier.

I converted the CMI to an estimated under-five mortality probability, $q(5)$, by multiplying the $q(5)$ value for the chosen standard life table by the weighted average of the index—with the number of live births to each woman serving as the weight ($q(5) \times 1{,}000$ is henceforth referred to as the *under-five mortality rate* or simply *under-five mortality*). I chose the Coale-Demeny West regional model life-table level 18.5 as the mortality standard for this study on the basis of a preliminary analysis (results not shown) that used indirect estimation techniques described in *Manual X* (United Nations 1983). Preston and Haines (1991) recommended using the $q(5)$ life-table parameter to summarize results because it is likely to be the least sensitive to time trends or an error in the choice of a model life table. The weighting procedure provided a useful way to combine information on child mortality across women of a wide age range (20–34 years) who had a corresponding large variation in the number of children born (and thus exposed to the risk of death). Values for the weighted average of $q(5)$ are close to the corresponding unweighted estimates that are based only on the mortality of children to women aged 30–34, which is the standard approach to estimating the $q(5)$ parameter using indirect estimation techniques (United Nations 1983).

Regression Analysis

I conducted a regression analysis of the CMI, which allowed me to estimate under-five mortality rates after controlling for demographic, social, and economic characteristics. The regressions were run using weighted least squares with the child mortality index as the dependent variable and the number of live births to the mother as the weight. This approach to regression analysis of the child mortality index was proposed by Trussell and Preston (1982) and has been applied elsewhere (e.g., Preston and Haines 1991); the results were not sensitive to the choice of weighted least squares over an alternative, such as Poisson regression.

I used the regression models to produce adjusted estimates of under-five mortality by calculating predicted values of the child mortality index while holding all variables constant at their samplewide means *except* the single independent variable of interest (wealth

and, separately, mother's education), which retained its actual values. The covariates included in the analysis were the household possessions-based wealth index (see the next section); household water supply; household sanitation; and mother's education, current age, and interstate migration status.

Measures of Inequality

Finally, I used the under-five mortality estimates to calculate concentration curves and concentration indices that describe and summarize socioeconomic inequalities in under-five mortality according to household economic status or mother's years of education. To measure the family's economic status, I used an index of household wealth that was based on a principal-components analysis of the characteristics of housing and ownership of consumer durables (see Filmer and Pritchett 2001). The household-wealth index was the score of the first principal component and was based on the presence of electricity in the household; ownership of a radio, refrigerator, television, and automobile; and the number of bedrooms and bathrooms in the dwelling. I also calculated measures of socioeconomic inequality in under-five mortality according to the mothers' years of education that reflected the mothers' highest level of educational attainment (rather than the number of years of schooling, which is affected by the repetition of grades).

The concentration curve plots the cumulative proportion of mothers who were ranked in ascending order by household economic status or years of education (on the x-axis) against the cumulative proportion of under-five mortality (on the y-axis). If there were perfect equality in children's deaths according to household economic status and mothers' years of education, then the concentration curves would lie along the diagonal. The farther the concentration curves lie above the diagonal, the more that inequalities in under-five mortality favor mothers from households of higher economic status or with more education.[7]

When one compares two concentration curves that do not cross, the one farther from the diagonal represents an unambiguously less-egalitarian distribution based on *any* measure of inequality that respects the principle of transfers (Atkinson 1970). When concentration curves cross, there are two ways to resolve the inherent ambiguity and to rank them. The first is to transform them into generalized concentration curves (Shorrocks 1983) by scaling them according to the *level* of mortality in each population. Generalized concentration curves permit an absolute comparison of well-being and are much less likely to cross than are relative concentration curves and hence are less likely to lead to ambiguous rankings. The second way to rank (relative) concentration curves that cross is to construct the corresponding concentration index for each curve (discussed next) and compare the two values. The concentration index is one of only two measures of socioeconomic inequality in health to meet what Wagstaff, Paci, and van Doorslaer (1991) argued are the minimal requirements for such a measure (the other is the slope index of inequality, which is closely related to the concentration index).[8] The standard concentration index reflects a particular characterization of inequality aversion—specifically, one that is sensitive to changes in the middle of the distribution. This assumption is reflected in a set of weights that are assigned to the concentration of ill health in different parts of the socioeconomic-status distribution.[9]

7. The concentration curves and indexes did *not* weight each mother-level observation by the number of her children ever born because the inequality measures should not reflect differential fertility, which would have been the case if I had used weighted values.

8. The requirements that Wagstaff et al. (1991) identified are (1) that the measure reflect the socioeconomic dimension of inequalities in health, (2) that it reflect the experiences of the entire population, and (3) that it is sensitive to changes in the distribution of the population across socioeconomic groups.

9. Wagstaff (2002b) developed an extended concentration index that can incorporate alternative patterns of inequality aversion.

The concentration index is defined as twice the area between the concentration curve and the diagonal and is negative when the concentration curve lies above the diagonal.[10] The index is calculated as follows (see Kakwani, Wagstaff, and van Doorslaer 1997):

$$C = \frac{2}{n\bar{x}} \sum_{i=1}^{n} x_i R_i - 1,$$

where x_i is the under-five mortality index for the ith mother, $R_i = (2i - 1) / 2n$ is the relative rank for the ith mother, and $\bar{x}$ is the mean of the under-five mortality index. The variance for the concentration index (which takes into account serial correlation in the data) is calculated as

$$\hat{Var}(C) = \frac{1}{n}\left[\frac{1}{n}\sum_{t=1}^{n} a_t^2 - \left(1 + C\right)^2\right],$$

where

$$a_t = \frac{x_t}{\bar{x}}\left(2R_t - 1 - C\right) + 2 - q_t - q_{t-1}$$

and

$$q_t = \sum_{j=1}^{t} x_j \Big/ \sum_{j=1}^{n} x_j .$$

The standard concentration curve and index are well-suited for assessing changes over time in *relative* socioeconomic inequalities in under-five mortality, since these measures are independent of the absolute level of mortality. Over the study period, however, there were large secular declines in under-five mortality rates. Generalized concentration curves (described earlier), which are scaled to the mean level of under-five mortality, provide a useful way to assess changes in socioeconomic inequalities in health that reflect these improvements in survival.

RESULTS

I present my results in two subsections. I begin by describing trends in levels of under-five mortality and trends in inequality in under-five mortality by household wealth and mother's education. Next, I present adjusted measures of socioeconomic inequality in mortality that control for the effects of a variety of demographic, social, and economic characteristics.

Under-Five Mortality: Levels and Inequality

The under-five mortality rates for São Paulo state were 117.0 for 1970, 96.0 for 1980, and 45.7 for 1991 (see Table 1). Under-five mortality dropped by 61% over the entire 21-year period. It fell by 18% between 1970 and 1980 and by 52% between 1980 and 1991.

The estimated levels of under-five mortality are consistent with infant mortality rates based on vital statistics from Fundação SEADE, the São Paulo state statistical agency. The under-five mortality estimates based on data for women aged 20–34 refer, on average, to approximately four years before the date of each census (see United Nations 1983 for details on calculating the reference period for indirect estimates of child mortality). The infant mortality rates for 1966 (75.9 per 1,000), 1976 (77.2 per 1,000), and 1987 (33.9 per 1,000) were all 76%–80% of the corresponding under-five mortality rate. My

10. The concentration curve is the bivariate analog of the Lorenz curve, whereas the concentration index is the bivariate analog of the Gini index. For the Lorenz curve and Gini index, the same variable appears on both the x-axis and the y-axis.

Table 1. Levels and Inequality of Under-Five Mortality, by Area, for São Paulo State: 1970, 1980, and 1991 (standard errors in parentheses)

Area	Under-Five Mortality		Concentration Index		Sample Size (Mothers)
1970					
Total	117.0	(0.36)	–0.216	(0.0023)	297,729
Urban	114.4	(0.41)	–0.238	(0.0027)	233,252
Rural	124.7	(0.78)	–0.120	(0.0047)	64,477
1980					
Total	96.0	(0.31)	–0.163	(0.0023)	527,927
Urban	95.8	(0.33)	–0.176	(0.0025)	465,877
Rural	97.5	(0.89)	–0.098	(0.0064)	62,050
1991					
Total	45.7	(0.21)	–0.175	(0.0036)	406,976
Urban	45.2	(0.22)	–0.163	(0.0038)	371,020
Rural	49.8	(0.72)	–0.174	(0.0110)	35,956

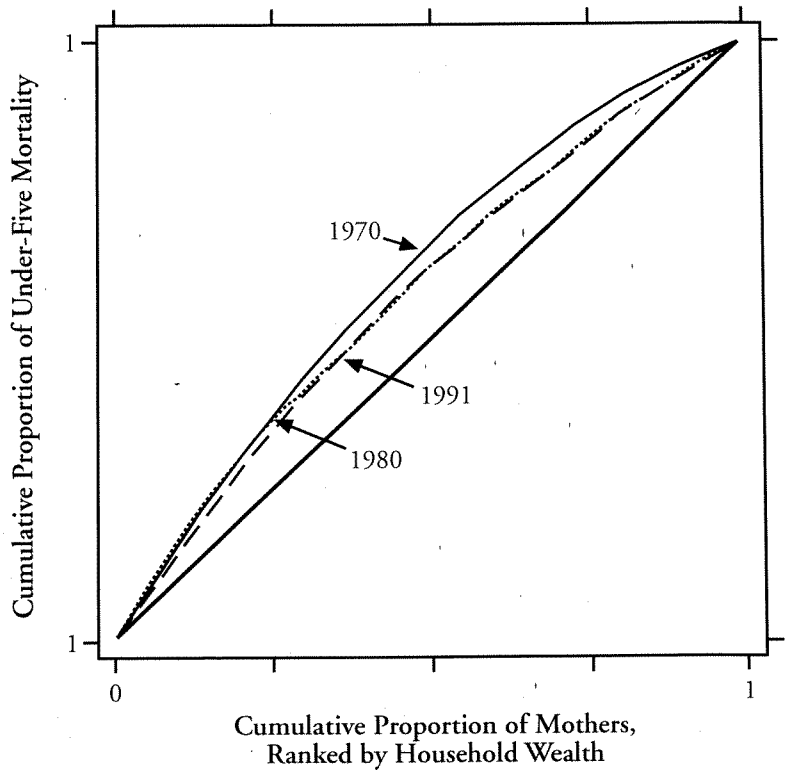
Source: Author's calculations based on microdata for São Paulo state from the 1970, 1980, and 1991 Brazilian censuses.

estimates and those based on vital statistics (see Figure 1) both suggest that it was not until the mid-1970s that sharp and sustained declines in infant and child mortality occurred in São Paulo.

The concentration curves for 1970, 1980, and 1991 indicate that inequality in under-five mortality by household economic status declined over the study period. Figure 2 shows the concentration curves for 1970, 1980, and 1991, and Figure 3 shows the corresponding deviations of the concentration curves from the diagonal (which implies perfect equality). The two sets of curves are useful for examining inequality over the entire range of the economic-status measure, with the deviations curve providing the necessary detail to compare carefully the concentration curves for different years. I highlight two important findings. First, the 1980 curve dominates the curve for 1970; that is, the 1980 curve is below the 1970 curve over the entire distribution of wealth. This finding indicates that there was unambiguously less inequality in under-five mortality by household wealth in 1980 than in 1970. Second, the 1980 and 1991 curves overlap over much of the upper two thirds of the household-wealth distribution, but the 1991 curve lies above the 1980 curve in the bottom third of the distribution. This finding indicates that there was a relative increase between 1980 and 1991 in under-five mortality for women in the least-wealthy third of households. In fact, for the bottom fifth of households, there was a relative increase in under-five mortality compared with 1970. In contrast, there was little relative change between 1980 and 1991 in under-five mortality for women in other parts of the household-wealth distribution.

The fact that the 1991 curve crosses both the 1970 and 1980 curves means that definitive and unambiguous rankings of inequality in under-five mortality by household wealth cannot be made for comparisons involving 1991. To address this issue, I examined generalized concentration curves and the concentration index. The generalized concentration curves for 1970, 1980, and 1991 (presented in Figure 4) reflect the large decline in under-five mortality that occurred between 1980 and 1991. In doing so, they provide a way to resolve the ambiguity of the comparisons that are based on the relative concentration curves (see Figures 2 and 3). The results indicate that although there was no clear

Figure 2. Concentration Curves for Under-Five Mortality, by Household Wealth for São Paulo State: 1970, 1980, and 1991



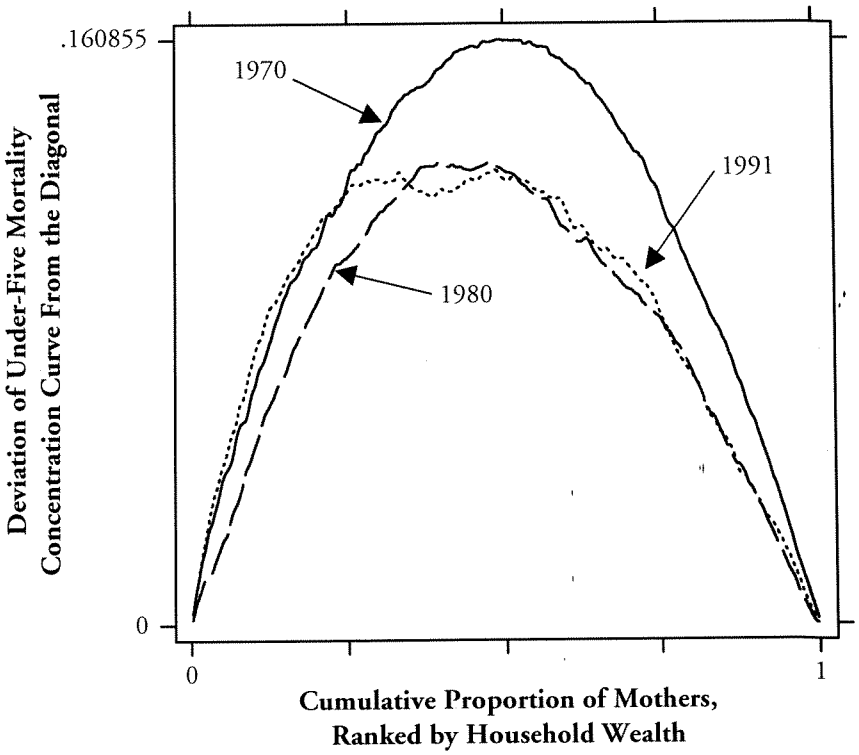
difference in relative inequality between 1980 and 1991, the large decline in under-five mortality rates means that throughout the entire wealth distribution, under-five mortality was substantially lower in 1991 and hence that higher levels of well-being prevailed.

Finally, in Table 1, I present estimates of the concentration index for 1970, 1980, and 1991 for the entire state of São Paulo and separately for rural and urban areas. The concentration index for the state rose substantially between 1970 and 1980, from –0.216 to –0.163, indicating that there were lower levels of inequality in under-five mortality by household wealth in the latter period. Subsequently, there was a small but statistically significant decrease in the concentration index (indicating higher levels of inequality in under-five mortality by household wealth), with the concentration index reaching –0.175 in 1991.

The results presented in Table 1 suggest that the rise in inequality in under-five mortality by household wealth between 1980 and 1991 for the state was due to a sharp increase in the index for rural areas (since there were declines in the index for urban areas). Between 1980 and 1991, inequality in under-five mortality by household wealth increased dramatically in rural areas, to levels well above those found in 1970 (Sastry 2004). Because of these diverging trends for rural and urban areas, the subsequent analysis focuses exclusively on socioeconomic inequalities in under-five mortality for the urban areas of São Paulo state.

The concentration curves for urban areas of São Paulo state (not shown) revealed that inequality in under-five mortality by household wealth was unambiguously lower in

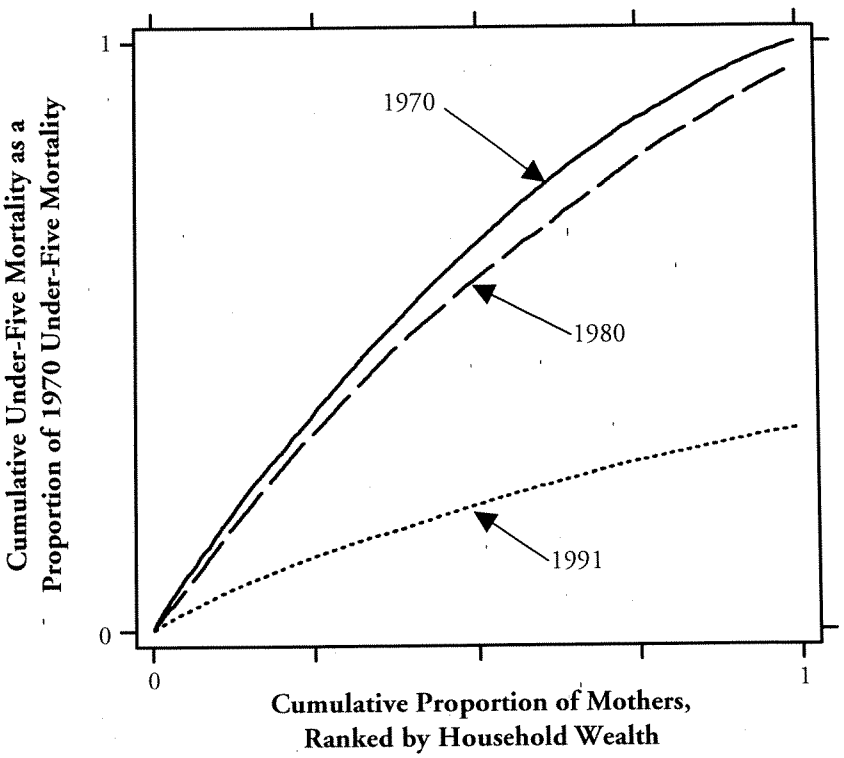
Figure 3. Concentration Curve Deviations for Under-Five Mortality, by Household Wealth for São Paulo State: 1970, 1980, and 1991



both 1980 and 1991 than in 1970; however, the 1980 and 1991 curves intersect and hence cannot be ranked definitively. The generalized concentration curve for 1991 dominates (i.e., is everywhere lower than) the 1980 curve, indicating that although relative inequality was similar for these two years, absolute levels of under-five mortality were far lower in 1991 and hence that everyone was better off.

The top panel of Table 2 presents summary information on differences and inequality in under-five mortality by household wealth in urban areas of São Paulo state. Three measures of inequality are shown in Table 2: the ratio of under-five mortality in the lowest wealth quintile to that in the highest quintile, the difference in under-five mortality between the lowest and highest wealth quintiles, and the concentration index. All three measures reveal a consistent decrease in inequality in under-five mortality by household wealth between 1970 and 1991. The ratio of under-five mortality for the lowest to highest quintile of household wealth fell from 3.08 in 1970, to 2.72 in 1980, to 2.22 in 1991. Over this period, the difference in under-five mortality between the first and fifth wealth quintiles shrank relative to the overall level of mortality. In 1970, the difference between the lowest and highest wealth quintiles was 116.4, while the overall under-five mortality rate for urban areas was 114.4—indicating that the difference was slightly greater than the overall mortality rate. By 1980, the difference of 91.4 was smaller than the overall under-five mortality rate of 95.8, and by 1991, the difference of 36.5 was only 80% of the overall mortality rate of 45.2. Finally, the concentration index rose from –0.238 in 1970, to –0.176 in 1980, to –0.163 in 1991. On the basis of the

Figure 4. **Generalized Concentration Curves for Under-Five Mortality, by Household Wealth for São Paulo State: 1970, 1980, and 1991**



concentration index, inequality in under-five mortality by household wealth fell by one third over the study period.

An examination of under-five mortality rates by wealth quintile reveals that the decline in inequality in under-five mortality by household wealth was the result of a much larger relative drop in under-five mortality for lower quintiles than for higher quintiles. Specifically, there was a 61% decline in under-five mortality for the lowest quintile between 1970 and 1991, which is one third larger than the 46% decline for the highest quintile over this period. Overall, and for each group, the magnitude of the declines in mortality was much smaller for 1970–1980 than for 1980–1991. For the lowest wealth quintile, under-five mortality rates fell by 16% between 1970 and 1980 but by 54% between 1980 and 1991. For the highest quintile, under-five mortality fell by only 5% during the earlier period but by 44% during the later period.

Turning to inequality in under-five mortality by mother's education, two main findings emerged from an examination of the concentration curves (not shown). First, in 1991, there was an unambiguously higher level of inequality in under-five mortality by mother's years of education than in 1970 or 1980, since the 1991 concentration curve lay above the 1970 and 1980 curves everywhere. At the same time, the generalized concentration curve for 1991 dominated the corresponding curves for 1970 and 1980, indicating that the decline in mortality meant that all mothers were better off in 1991 based on improvements in children's survival. Second, the 1970 and 1980 concentration curves intersected, although except for two small portions toward the bottom and top of the education distribution, the 1980 curve is everywhere below the 1970 curve. However, because the decline

Table 2. Levels and Inequality of Under-Five Mortality, by Wealth and Mother's Level of Education for Urban Areas of São Paulo State: 1970, 1980, and 1991 (standard errors in parentheses)

Variables	1970			1980			1991		
	Under-Five Mortality		Percentage in Category	Under-Five Mortality		Percentage in Category	Under-Five Mortality		Percentage in Category
Quintile of Wealth									
1 (lowest)	172.4	(1.04)	20.3	144.5	(0.84)	20.0	66.5	(0.58)	20.0
2	131.3	(0.96)	19.8	106.8	(0.73)	22.3	47.8	(0.51)	20.2
3	102.7	(0.87)	20.1	83.0	(0.71)	19.4	42.3	(0.47)	20.0
4	75.2	(0.79)	20.5	68.8	(0.66)	20.2	35.3	(0.44)	19.9
5 (highest)	56.0	(0.70)	19.3	53.1	(0.65)	18.1	30.0	(0.42)	19.8
Total	114.4	(0.41)	100.0	95.8	(0.33)	100.0	45.2	(0.22)	100.0
Ratio: lowest to highest	3.08		1.05	2.72		1.10	2.22		1.01
Lowest – highest	116.4			91.4			36.5		
Concentration index	–0.238	(0.0027)		–0.176	(0.0025)		–0.163	(0.0038)	
Mother's Education									
Elementary or less									
Illiterate	176.6	(1.18)	15.3	155.6	(1.20)	9.1	98.3	(1.35)	4.8
Literate	104.0	(0.48)	69.7	98.5	(0.45)	55.9	55.6	(0.39)	36.7
Middle	68.4	(1.22)	9.0	72.9	(0.70)	19.9	36.5	(0.35)	33.1
Secondary	43.7	(1.35)	5.2	49.3	(0.89)	10.0	22.0	(0.39)	17.8
Higher	29.7	(2.88)	0.8	36.9	(1.10)	5.1	14.9	(0.49)	7.6
Total	114.4	(0.41)	100.0	95.8	(0.33)	100.0	45.2	(0.22)	100.0
Ratio: lowest to highest	5.95		19.13	4.22		1.78	6.60		0.63
Lowest – highest	146.9			118.7			83.4		
Concentration index	–0.208	(0.0028)		–0.157	(0.0025)		–0.274	(0.0037)	

Note: The concentration index for mother's education is based on mother's years of education.

Source: Author's calculations based on microdata for São Paulo state from the 1970, 1980, and 1991 Brazilian censuses.

in under-five mortality between 1970 and 1980 was relatively modest, even when it is factored in (using the generalized concentration curves), the curves for 1970 and 1980 cross. Thus no definitive ordering can be made regarding levels of inequality in under-five mortality by mother's education in 1970 and 1980.

The bottom panel of Table 2 presents summary information on differences and inequality in under-five mortality by mother's level of education. I examined three summary measures of inequality in under-five mortality: the ratio of under-five mortality in the lowest group (mothers with an elementary or lower level of education and who are illiterate) compared to the highest group (mothers with higher education); the difference in under-five mortality between the lowest and highest educational groups; and the concentration index (based on the mothers' years of education). Although parallel to the measures used for examining inequality in under-five mortality by household wealth, they are different in one important aspect: the rate ratios and absolute differences are based on fixed—rather than relative—categories.

All three summary measures indicate that inequality in under-five mortality by mother's education fell between 1970 and 1980 but then increased in 1991 to a level above that in 1970. For example, the ratio of under-five mortality for illiterate mothers compared to mothers with higher education was 5.95 in 1970, 4.22 in 1980, and 6.60 in 1991. There was a large improvement in average educational levels over this period, as reflected in the distribution of mothers in the sample across educational categories. In 1970, 15.3% of the mothers were illiterate, and only 0.8% had a higher education; by 1991, however, fewer than 5% of the mothers were illiterate, and 7.6% had a higher education. This absolute improvement in education could affect the assessment of changes in inequality in under-five mortality by mother's education, especially when these results are compared to those based on inequality in wealth. In particular, increases in the ratio of mortality among the least-educated group to the most-educated group may be less important because the number of women in the former group declined while the number in the latter group increased. However, the results for the concentration index, which is based on mothers' single years of education, suggests that this was not the case because exactly the same findings are apparent when this measure is examined. The concentration index increased from –0.208 in 1970 to –0.157 in 1980, but then dropped to –0.274 in 1991. Over the full study period, the level of inequality in under-five mortality by mother's education, based on the concentration index, increased by one third.

One interesting result with regard to under-five mortality by mother's level of education is that mortality *increased* between 1970 and 1980 for women with middle, secondary, or higher education. Only for women with elementary or less education was there a decrease in under-five mortality over this period. It is unclear what accounted for this result, although it may have been caused, in part, by the large increases in educational attainment between 1970 and 1980 that shifted women from disadvantaged backgrounds up the educational distribution. Between 1980 and 1991, however, all groups experienced substantial declines in under-five mortality. For the lowest group (illiterate women), there was a 37% decline in under-five mortality; for the highest group (women with higher education), there was a 60% decline.

Adjusted Levels of Socioeconomic Inequality in Under-Five Mortality

The results presented so far have shown raw differences and inequalities in under-five mortality rates by socioeconomic status. Of considerable interest is the extent to which underlying differences in demographic, social, and economic characteristics shaped these results. For instance, low levels of under-five mortality among the most-educated women may reflect, in part, the survival advantages conferred by higher household wealth. By controlling for the set of covariates identified earlier, I was able to examine inequality in under-five mortality by mother's level of education net of other key factors.

I begin with adjusted inequalities in under-five mortality by household wealth across all urban areas. The results suggest that after I controlled for demographic, social, and economic factors, there continued to be a decline in inequality in under-five mortality by household wealth between 1970 and 1980, but little change in inequality between 1980 and 1991. The concentration curves (not shown) could be ordered clearly, with the 1980 curve dominating the 1970 curve and the 1991 curve lying entirely between the curves for 1970 and 1980. The concentration index had the same trend (see the top panel of Table 3), rising from –0.138 to –0.070 between 1970 and 1980 and falling to –0.078 in 1991. The change in the concentration index between 1980 and 1991 was not statistically significant and, indeed, the concentration curves for these two years lie close to each other. The results based on the rate ratio and the absolute difference between the lowest and highest wealth quintiles were consistent with those based on the concentration curve and index for the change between 1970 and 1980, but they were discrepant for the change between 1980 and 1991 (which was, however, small and unimportant). The results based

Table 3. Levels and Inequality of Adjusted Under-Five Mortality, by Wealth and Mother's Level of Education for Urban Areas of São Paulo State: 1970, 1980, and 1991 (standard errors in parentheses)

Variables	1970			1980			1991		
	Under-Five Mortality		Percentage in Category	Under-Five Mortality		Percentage in Category	Under-Five Mortality		Percentage in Category
Quintile of Wealth									
1 (lowest)	136.1	(0.80)	20.3	111.4	(0.67)	20.0	49.5	(0.39)	20.0
2	119.9	(0.52)	19.8	97.1	(0.38)	22.3	44.3	(0.25)	20.2
3	106.6	(0.42)	20.1	89.9	(0.34)	19.4	41.0	(0.22)	20.0
4	90.9	(0.54)	20.5	82.8	(0.42)	20.2	37.7	(0.26)	19.9
5 (highest)	70.5	(0.90)	19.3	71.7	(0.66)	18.1	32.7	(0.40)	19.8
Total	114.4	(0.41)	100.0	95.8	(0.33)	100.0	45.2	(0.22)	100.0
Ratio: lowest to highest	1.93		1.05	1.55		1.10	1.51		1.01
Lowest – highest	65.6			39.7			16.8		
Concentration index	–0.138	(0.0026)		–0.070	(0.0025)		–0.078	(0.0037)	
Mother's Education									
Elementary or less									
Illiterate	141.2	(0.99)	15.3	131.5	(1.00)	9.1	86.1	(0.87)	4.8
Literate	100.1	(0.50)	69.7	95.5	(0.45)	55.9	50.9	(0.35)	36.7
Middle	93.9	(1.58)	9.0	77.4	(0.81)	19.9	36.9	(0.39)	33.1
Secondary	87.2	(2.22)	5.2	69.2	(1.23)	10.0	25.4	(0.57)	17.8
Higher	79.0	(5.56)	0.8	67.5	(1.74)	5.1	19.8	(0.91)	7.6
Total	114.4	(0.41)	100.0	95.8	(0.33)	100.0	45.2	(0.22)	100.0
Ratio: lowest to highest	1.79		19.13	1.95		1.78	4.35		0.63
Lowest – highest	62.2			64.0			66.3		
Concentration index	–0.068	(0.0028)		–0.086	(0.0024)		–0.194	(0.0036)	

Notes: Adjusted estimates control for covariates and set each covariate to its mean across all urban areas. The concentration index for mother's education is based on mother's years of education.

Source: Author's calculations based on microdata for São Paulo state from the 1970, 1980, and 1991 Brazilian censuses.

on the wealth quintiles, presented in Table 3, suggested that there was a consistent decline in inequality in under-five mortality by household wealth. The ratio of under-five mortality for the lowest quintile to the highest decreased from 1.93 in 1970, to 1.55 in 1980, to 1.51 in 1991. The absolute difference between the lowest and highest quintiles narrowed over this period, from 65.6 in 1970 (57% of the overall level), to 39.7 in 1980 (41% of the overall level), and to 16.8 in 1991 (37% of the overall level).

For each year, there was substantially less inequality in under-five mortality by household wealth based on adjusted under-five mortality than on observed under-five mortality. For example, the adjusted concentration index was 42% lower than the unadjusted index in 1970, 60% lower in 1980, and 52% lower in 1991. The independent relationship between household wealth and under-five mortality thus accounted for roughly half the observed inequality in under-five mortality by household wealth, while the other covariates included

in the models accounted for the remainder. That is, the difference between the adjusted and unadjusted levels of inequality in under-five mortality by household wealth was the result of other covariates—including household water supply and sanitation and mother's education—that were positively correlated with household wealth and negatively related to the risk of under-five mortality.

Over the full study period, there was a more marked drop in inequality in under-five mortality by household wealth after other demographic, social, and economic characteristics were controlled (–43% for the concentration index) than before (–32% for the concentration index). Thus, changes between 1970 and 1991 in the levels and effects of covariates that were used to calculate adjusted mortality levels together served to *reduce* the observed decline in inequality in under-five mortality by household wealth. In other words, the observed decline in inequality in under-five mortality by household wealth between 1970 and 1991 was smaller than it otherwise would have been because the model covariates together operated in the opposite direction to widen these inequalities. In particular, mother's education—which was positively associated with household wealth—had covariate effects that grew larger and stronger over the study period, although inequality in mother's education itself actually declined. This change in the effect of mother's education reduced the observed decline in inequality in under-five mortality by household wealth even as other covariates, such as household sanitation and water supply, had a compensating effect by accounting for part of the mortality advantage that wealthier households enjoyed in earlier years. From a policy perspective, these results highlight the importance of considering the equity effects of other policies, programs, and secular changes when the goal is to reduce economic inequality in health. Some factors, such as improvements in infrastructure, provide alternative pathways through which to reduce economic inequalities in health instead of simply reducing household-wealth disparities themselves. However, the effect of mother's education in this case worked in the opposite direction to increase inequality in under-five mortality by household wealth.

By adjusting for covariates, I found that a clearer picture emerged of trends in under-five mortality inequality by mother's level of education. A comparison of the adjusted concentration curves indicated that there was unambiguously higher—and substantially more—inequality in under-five mortality by mother's education in 1991 than in the two earlier periods. On the other hand, the 1970 and 1980 concentration curves crossed when I considered both the relative and the generalized curves. The summary measures, presented in the bottom panel of Table 3, also showed that adjusted inequality in under-five mortality by mother's level of education increased dramatically over the entire study period. The ratio of under-five mortality for the least-educated group to that for the most-educated group rose from 1.79 in 1970, to 1.95 in 1980, to 4.35 in 1991. Between 1970 and 1991, the absolute gap in under-five mortality between the least-educated and the most-educated groups increased slightly (by 7%), even though the overall level of under-five mortality declined substantially (by 60%). Finally, the concentration index, which was based on mother's years of education, declined greatly over time, from –0.068 in 1970, to –0.086 in 1980, to –0.194 in 1991, indicating a large increase in inequality in under-five mortality by mother's education.

The covariates in the models accounted for a substantial proportion of the inequality in under-five mortality by mother's education in 1970 but a considerably smaller proportion in 1980 and 1991. In particular, the covariates accounted for 67% of the unadjusted concentration index in 1970, 45% in 1980, and 29% in 1991. This finding suggests that demographic factors, living conditions, and household wealth played a significantly less important role over time in accounting for the observed inequality in under-five mortality by mother's education. Instead, the independent effects of maternal education emerged over time as by far the most powerful factor behind the observed inequality in under-five mortality by mother's education. That is, observed differences in under-five mortality by

mother's education were increasingly due to mother's education itself, rather than to other characteristics—such as household wealth—that were correlated with mother's education.

The adjusted decline in under-five mortality was small for women at the bottom of the educational distribution and large for women at the top. Adjusted under-five mortality declined only 40% for illiterate women but 75% for women with higher education. The decline for women with higher education was nearly twice as large as the decline for illiterate women and 50% higher than the unadjusted decline for these same women. Not only were women's higher levels of education more beneficial for their children's survival, but there was also a substantial redistribution of women up the education distribution.

There was an almost twofold increase between 1970 and 1991 in the adjusted concentration index for under-five mortality by mother's education, compared with a 32% increase in the unadjusted concentration index. Hence, the total effect of the covariates that were controlled for in the model was to hold the observed increase in inequality in under-five mortality by mother's education to a much smaller magnitude than it otherwise might have been. In other words, the total effect of all other covariates—including, for instance, household wealth—was to reduce inequalities in under-five mortality by mother's education. This finding has some important policy implications. In particular, on the basis of past trends, a reduction in inequality in under-five mortality by mother's education is unlikely to be achieved by further increasing average educational levels or by reducing inequality in education. To lower the level of inequality in under-five mortality by mother's education, there is a particular need to reduce mortality among the children of mothers with the lowest levels of schooling. Policies and programs to achieve this goal should focus on either directly targeting child-survival interventions toward the least-educated mothers or improving other key factors, such as household wealth or the water supply and sanitation, that appeared to have particularly large benefits for the chances of survival of children in disadvantaged households.

CONCLUSIONS

In this article, I presented trends in socioeconomic inequality in under-five mortality for São Paulo state from 1970 to 1991. During this period, there were major declines in under-five mortality for the state that were associated with substantial improvements in living conditions, increases in educational attainment, and other demographic and socioeconomic changes. Inequality in under-five mortality by household wealth clearly declined over this period, with the drop concentrated in the 1970–1980 period. Inequality in under-five mortality by mother's education first declined and then increased, with a net rise over the study period. When I controlled for background demographic, social, and economic characteristics, inequality in under-five mortality by household wealth fell even more than did observed inequality between 1970 and 1980 (but remained constant thereafter). On the other hand, adjusted inequality in under-five mortality by mother's education increased substantially, both between 1970 and 1980 and between 1980 and 1991, but especially during the latter period.

The results suggest that, on the one hand, changes in the relationship between mother's education and the risks of under-five mortality increased socioeconomic inequalities in under-five mortality by both household wealth and mother's education in São Paulo between 1970 and 1991. On the other hand, changes in the effects of household wealth on under-five mortality reduced these inequalities. Improvements in household water supply and sanitation and changes in migration patterns had similar effects on socioeconomic inequalities in under-five mortality to those of household wealth. It appears that the poorest households benefited the most from these improvements. Thus, social and economic development (other than improvements in mother's education) were associated with lower levels of socioeconomic inequality in mortality, suggesting that the disadvantaged did indeed benefit from progress over this period. In addition, these changes

kept the increase in inequality in under-five mortality by mother's education between 1970 and 1991 smaller than it otherwise might have been.

The preceding discussion focused on *relative* socioeconomic inequality in under-five mortality—that is, inequality independent of the level of mortality. Over the study period, under-five mortality declined substantially—in large part, because of improvements in mother's education—so that although relative inequality increased, all socioeconomic groups enjoyed lower under-five mortality rates at the end of the study period than at the beginning. Nevertheless, relative socioeconomic inequalities in health are important from many different perspectives. For example, these inequalities are generally perceived as unjust and unfair by policy makers and the public and are the target of programs and policies to reduce them.

Comparing the adjusted and unadjusted concentration indexes for under-five mortality based on mother's education with the corresponding indices based on household wealth suggests that in 1991, mother's education was roughly twice as important in accounting for socioeconomic inequality in under-five mortality. Thus, mother's education appears to have emerged as probably the key factor underlying socioeconomic inequalities in under-five mortality—either through selection effects or through causal effects, whereby schooling provides women with the knowledge, means, and ability to raise healthy children (Caldwell 1979). There were enormous improvements in women's education over the study period. The average number of years of education for women in the sample increased from 3.1 in 1970 to 5.1 in 1980 to 6.4 in 1991. This increase was associated with a large decline in the number of women with the lowest levels of education, but was also remarkably associated with steady declines in inequality in schooling (Lam and Duryea 1999). The Gini index for years of schooling among women in urban areas of São Paulo fell from 0.417 in 1970 to 0.391 in 1980 to 0.329 in 1991, with inequality in women's schooling being unambiguously lower in 1991 than in 1970 or 1980, according to both the standard and generalized concentration curves. Note that there has been little indication that inequalities in pure income or wealth have been declining in Brazil. For example, a recent study found that income inequality remained roughly constant for urban areas of the country between the 1970s and 1990s (Ferreira and Paes de Barros 1999).

A topic of current research and policy interest is the relationship between economic growth and inequalities in health by economic status. Contoyannis and Forster (1999) showed that no predictions could be made about the effects of income growth on health inequality by economic status. Wagstaff (2002a) suggested, however, that evidence—from both cross-sectional and trend analyses—is consistent with the association of higher average incomes with higher levels of inequality in health by economic status. Victora et al. (2000) contended that technological change—which generally accompanies income growth—contributes to widening health inequalities by economic status because the more advantaged tend to benefit sooner from new medical knowledge and treatments. Finally, Szreter (1997), drawing on historical evidence from Britain, argued that rapid economic growth results in worse population health, such as increasing inequalities in health, because economic growth is associated with widespread and pervasive disruption. Unless this disruption is mediated by effective social and political responses, disease and death will result.[11]

However, my results, which provide precise estimates of trends in inequality in health by economic status over a far longer period than did those presented in Wagstaff (2002a) or Victora et al. (2000), do not support these conclusions—at least for São

11. Szreter's (1997) characterization may certainly help explain São Paulo's period of rising infant and child mortality between the mid-1960s and the mid-1970s.

Paulo. In particular, the average annual growth rate in the per capita gross domestic product for Brazil was 8.5% between 1970 and 1980 and 2.2% between 1980 and 1991 (Easterly and Sewadeh 2002). Growth was steady over the first period, but there were several years with negative growth over the second period. However, observed inequality in under-five mortality by household wealth for São Paulo declined both between 1970 and 1980 and between 1980 and 1991. In fact, the largest decrease in inequality in under-five mortality by household wealth occurred between 1970 and 1980. (In contrast, the largest decrease in under-five mortality levels occurred between 1980 and 1991.) Thus, rather than being closely tied to economic growth, as suggested by the previous literature, the trends in inequality in under-five mortality by household wealth in São Paulo were influenced in more complex ways by improvements in sanitation and the water supply, rising levels of education for women, and a "catching-up" effect following the increase in mortality in the late 1960s and early 1970s. Finally, my results suggest that higher levels of women's education were associated with higher levels of socioeconomic inequality in health.

All cross-country studies of inequality in under-five mortality that were reviewed earlier have drawn on survey data, which have a number of important strengths—for example, the samples and survey measures tend to be highly comparable across countries, and the surveys collect information on children's health status in addition to measures of child mortality. However, they have some important weaknesses compared with census data. In particular, using census data and indirect estimation techniques provides an alternative source of information on under-five mortality that has the advantage of substantially larger sample sizes that allow considerably more statistical precision in tracking changes over time. As I have shown, census data also allow researchers to uncover historical trends in socioeconomic inequalities in mortality.

REFERENCES

Abranches, S. 1995. *Crise e Mudança* [Crisis and change]. Geneva: International Labor Office.

Atkinson, A.B. 1970. "On the Measurement of Inequality." *Journal of Economic Theory* 2:244–63.

Barros, R.P. and D.O. Sawyer. 1991. "Unequal Opportunities to Survive: Education and Regional Disparities in Brazil." Working paper. Instituto de Pesquisa Econômica Aplicado, Rio de Janeiro.

Bonilla-Chacin, M. and J. Hammer. 1999. "Life and Death Among the Poorest." Working paper. World Bank, Washington, DC.

Braveman, P., B. Starfield, and H.J. Geiger. 2001. "World Health Report 2000: How It Removes Equity From the Agenda for Public Health Monitoring and Policy." *British Medical Journal* 323:678–81.

Braveman, P. and E. Tarimo. 2002. "Social Inequalities in Health Within Countries: Not Only an Issue for Affluent Nations." *Social Science and Medicine* 54:1621–35.

Caldwell, J.C. 1979. "Education as a Factor in Mortality Decline: An Examination of Nigerian Data." *Population Studies* 33:395-413.

Carvalho, J.A.M. 1974. "Regional Trends in Fertility and Mortality in Brazil." *Population Studies* 28:401–21.

Carvalho, J.A.M. and C.H. Wood. 1978. "Mortality, Income Distribution, and Rural-Urban Residence in Brazil." *Population and Development Review* 4:405–20.

Castilla, F.M. 1996. "Uma Análise Regional dos Differenciais Sócio-Econômicos da Mortalidade na Infância no Brasil, 1960–80" [A Regional analysis of socioeconomic differentials in infant mortality in Brazil, 1960–80]. Pp. 2235–52 in *Anais do X Encontro Nacional de Estudos Populacionais*. Belo Horizonte, Brazil: Associação Brasileira de Estudos Populacionais.

Cleland, J., G. Bicego, and G. Fegan. 1992. "Socioeconomic Inequalities in Childhood Mortality: The 1970s to the 1980s." *Health Transition Review* 2:1–18.

Contoyannis, P. and M. Forster. 1999. "The Distribution of Health and Income: A Theoretical Framework." *Journal of Health Economics* 18:605–22.

Costa, N.R. and C.M.R. Duarte. 1989. "Notas Para Avaliação de Políticas Sociais: A Tendência da Mortalidade Infantil nas Últimas Décadas" [Notes for an evaluation of social policies: The trend of infant mortality in the last decades]. *Dados* 32:241–55.

Daly, H.E. 1985. "Marx and Malthus in Northeast Brazil: A Note on the World's Largest Class Difference in Fertility and Its Recent Trends." *Population Studies* 39:329–38.

DaVanzo, J. and J-P. Habicht. 1986. "Infant Mortality Decline in Malaysia, 1946–1975: The Roles of Changes in Variables and Changes in the Structure of Relationships." *Demography* 23:143–60.

Easterly, W. and M. Sewadeh. 2002. *Global Development Network Growth Database.* Washington, DC: World Bank. Available on-line at http://www.worldbank.org/research/growth/GDNdata.htm

Ferriera, F.H.G. and R. Paes de Barros. 1999. "The Slippery Slope: Explaining the Increase in Extreme Poverty in Urban Brazil, 1976–1996." *Brazilian Review of Econometrics* 19:211–96.

Filmer, D. and L. Pritchett. 1999. "The Effect of Household Wealth on Educational Attainment: Evidence From 35 Countries." *Population and Development Review* 25:85–120.

———. 2001. "Estimating Wealth Effects Without Expenditure Data—or Tears: An Application to Educational Enrollments in States of India." *Demography* 38:115–32.

Fundação SEADE. 1993. *O Novo Retrato de São Paulo: Avaliação dos Primeiros Resultados do Censo Demográfico de 1991* [The new picture of São Paulo: Evaluation of the first results of the demographic census of 1991]. 2nd ed. São Paulo: Fundação SEADE.

Gakidou, E.E., C.J.L. Murray, and J. Frenk. 2000. "Defining and Measuring Health Inequality: An Approach Based on the Distribution of Health Expectancy." *Bulletin of the World Health Organization* 78:86–96.

Gwatkin, D.R. 2000. "Health Inequalities and the Health of the Poor: What Do We Know? What Can We Do?" *Bulletin of the World Health Organization* 78:3–17.

Gwatkin, D.R., S. Rutstein, K. Johnson, R.P. Pande, and A. Wagstaff. 2000. "Socioeconomic Differentials in Health, Nutrition, and Population." Working paper. World Bank, Washington, DC.

Kakwani, N., A. Wagstaff, and E. van Doorslaer. 1997. "Socioeconomic Inequalities in Health: Measurement, Computation, and Statistical Inference." *Journal of Econometrics* 77:87–103.

Lam, D. and S. Duryea. 1999. "Effects of Schooling on Fertility, Labor Supply, and Investments in Children, With Evidence From Brazil." *Journal of Human Resources* 34:160–92.

Lam, D. and D. Levison. 1991. "Declining Inequality in Schooling in Brazil and Its Effects on Inequality in Earnings." *Journal of Development Economics* 37:199–225.

Leser, W. 1974. "Crescimento da População e Nível de Saúde na Cidade de São Paulo" [Population growth and the level of health in the city of São Paulo]. *Problemas Brasileiros* 16:17–36.

Merrick, T.W. 1985. "The Effect of Piped Water on Early Childhood Mortality in Urban Brazil, 1970 to 1976." *Demography* 22:1–23.

Monteiro, C.A. 1996. "O Panorama da Nutrição Infantil Nos Anos 90" [The panorama of infant nutrition in the 1990s]. Discussion document No. 1. UNICEF, Brasília, Brazil.

Monteiro, C.A. and M.H.A. Benicio. 1989. "Determinants of Infant Mortality Trends in Developing Countries: Some Evidence From São Paulo City." *Transactions of the Royal Society of Tropical Medicine and Hygiene* 83:5–9.

Monteiro, C.A., M.H.A. Benicio, R. Iunes, N.C. Gouveia, J.A.A.C. Taddei, and M.A.A. Cardoso. 1992. "Nutritional Status of Brazilian Children: Trends From 1975 to 1989." *Bulletin of the World Health Organization* 70:657–66.

Monteiro, C.A., H.P.P. Zuniga, M.H.A. Benicio, and C.G. Victora. 1989. "Better Prospects for Child Survival." *World Health Forum* 10:222–27.

Nguyen, N.N. and A. Wagstaff. 2002. "Poverty and Survival Prospects of Vietnamese Children Under Doi Moi." Policy Research Working Paper No. 2832. World Bank, Washington, DC.

Preston, S.H. and M.R. Haines. 1991. *Fatal Years: Child Mortality in Late Nineteenth-Century America*. Princeton, NJ: Princeton University Press.

Psacharopoulos, G., S. Morley, A. Fishbone, H. Lee, and W.C. Wood. 1995. "Poverty and Income Inequality in Latin America During the 1980s." *Review of Income and Wealth* 41:245–64.

Sastry, N. 1996. "Community Characteristics, Individual and Household Attributes, and Child Survival in Brazil." *Demography* 33:211–29.

———. 2004. "Urbanization, Development, and Under-Five Mortality Differentials by Place of Residence in São Paulo, Brazil, 1970–1991." *Demographic Research* (Special Collection 2, Article 14). Available on-line at http://www.demographic-research.org/special/2/14/s2-14.pdf

Sawyer, D.O. 1981. "Effects of Industrialization and Urbanization on Mortality in Developing Countries: The Case of Brazil." *International Population Conference, Manila 1981.* Liège, Belgium: International Union for the Scientific Study of Population.

Sawyer, D.O., R. Fernández-Castilla, and R.M. Monte-Mor. 1987. "The Impact of Urbanization and Industrialization on Mortality in Brazil." *World Health Statistics Quarterly* 40:84–95.

Schmertmann, C.P. and D.O. Sawyer. 1996. "Migration Bias in Indirect Estimates of Regional Childhood Mortality Levels." *Mathematical Population Studies* 6:69–93.

Shorrocks, A.F. 1983. "Ranking Income Distributions." *Economica* 50:3–17.

Simões, C.C.S. and C.A. Monteiro. 1995. "Tendência Secular e Diferenciais Regionais da Mortalidade Infantile no Brasil" [Secular trends and regional differentials in infant mortality in Brazil]. Pp. 153–56 in *Velhos e Novos Males da Saúde no Brasil,* edited by C.A. Monteiro. São Paulo: Hucitec.

Simões, C.C. and L.A.P. Oliveira. 1997. "A Saúde Infantil no Brasil Nos Anos 90" [Infant health in Brazil in the 1990s]. Working paper. Instituto Brasilero de Geografia e Estatística, Rio de Janeiro.

Stecklov, G., A. Bommier, and T. Boerma. 1999. "Trends in Equity in Child Survival in Developing Countries: An Illustrative Analysis Using Ugandan Data." Working paper. Carolina Population Center, University of North Carolina, Chapel Hill, NC.

Szwarcwald, C.L. 2002. "On the World Health Organization's Measurement of Health Inequalities." *Journal of Epidemiology and Community Health* 56:177–82.

Szwarcwald, C.L. and E.A. Castilho. 1995. "Estimativas da Mortalidade Infantil no Brasil, Década de Oitenta" [Estimates of infant mortality in Brazil in the 1980s]. *Revista de Saúde Pública* 29:451–62.

Szreter, S. 1997. "Economic Growth, Disruption, Deprivation, Disease, and Death: On the Importance of the Politics of Public Health for Development." *Population and Development Review* 23:693–728.

Trussell, J. and S. Preston. 1982. "Estimating the Covariates of Childhood Mortality From Retrospective Reports of Mothers." *Health Policy and Education* 3:1–36.

United Nations. 1983. *Indirect Techniques for Demographic Estimation, Manual X.* New York: United Nations.

Victora, C.G., M.T. Olinto, F.C. Barros, and L.C. Nobre. 1996. "Falling Diarrhoea Mortality in Northeast Brazil: Did ORT Play a Role?" *Health Policy and Planning* 11:132–41.

Victora, C.G., J.P. Vaughan, F.C. Barros, A.C. Silva, and E. Tomasi. 2000. "Explaining Trends in Inequities: Evidence From Brazilian Health Studies." *Lancet* 356:1093–98.

Wagstaff, A. 2000. "Socioeconomic Inequalities in Child Mortality: Comparisons Across Nine Developing Countries." *Bulletin of the World Health Organization* 78:19–29.

———. 2002a. "Inequalities in Health in Developing Countries: Swimming Against the Tide?" Policy Research Working Paper 2795. World Bank, Washington, DC.

———. 2002b. "Inequality Aversion, Health Inequalities, and Health Achievement." *Journal of Health Economics* 21:627–41.

Wagstaff, A., P. Paci, and E. van Doorslaer. 1991. "On the Measurement of Inequalities in Health." *Social Science and Medicine* 33:545–57.

Wagstaff, A. and N. Watanabe. 2000. "Socioeconomic Inequalities in Child Malnutrition in the Developing World." Policy Research Working Paper No. 2434. World Bank, Washington DC.

Wood, C.H. 1982. "The Political Economy of Infant Mortality in São Paulo, Brazil." *International Journal of Health Services* 12:215–29.

Wood, C.H. and J.A.M. Carvalho. 1988. *The Demography of Inequality in Brazil.* New York: Cambridge University Press.

World Health Organization (WHO). 2000. *World Health Report 2000.* Geneva: WHO.

Yunes, J. 1981. "Evolution of Infant Mortality and Proportional Infant Mortality in Brazil." *WHO Statistical Quarterly* 34:200–19.

Zúñiga, H.P.P. and C.A. Monteiro. 1995. "Uma Nova Hipótese Para a Ascensão da Mortalidade Infantil da Cidade de São Paulo Nos Anos 60" [A new hypothesis for the rise in infant mortality for the city of São Paulo in the 1960s]. Pp. 157–72 in *Velhos e Novos Males da Saúde no Brasil,* edited by C.A. Montiero. São Paulo: Hucitec.