The time-trend of economic inequality in infant mortality Portugal 1971-1991

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«By the year 2000, the actual differences in health status between countries and between groups within countries should be reduced by at least 25%, by improving the level of health of disadvantaged nations and groups.»

Target 1 of the common health policy adopted by WHO European Region member countries in 1980.

1. Introduction

Measurement of inequality in health is at its most useful when the prevailing time-trend can be established. Single year estimates can signal the need for policy intervention (by virtue of the degree of inequality being judged undesirable); but they provide no way of knowing whether past or present measures are in any way successful. In contrast, a time series of inequality measures can inform the policy-maker if the country is moving in the desired direction, or not. It may also suggest the type of health and social phenomena that underly changes in the distribution, thereby indicating possible corrective measures.

In Portugal, as in most other countries, the only means currently available for examining the time-trend of inequalities in health is through data on mortality. The use of such data is not without its drawbacks. On the one hand, information on deaths does not indicate health among the living (in particular, for diseases where the case-fatality ratio is low, the mortality rate will be a gross underestimate of the incidence of the condition in the community); and on the other, the scope and accuracy of socio-economic information collected at the time of death are somewhat limited. With the increasing availability of large scale micro-data bases, which include information on morbidity that may easily be crosstabulated with demographic and economic variables, there has naturally been a trend away from using mortality data. However, information on deaths does have some advantages. First of all, it provides detail on a particular (and important) dimension of the social concern for health, that of the length of life. Mortality statistics are, therefore, complementary to the morbidity indicators, which may be interpreted as measuring the «healthfulness» of life (Jazairi, 1976). Secondly, unlike morbidity data they do not raise the problem of cultural variability in the rates reported by (or on behalf) of

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different socio-economic groups (d'Houtaud and Field, 1984). The actual occurrence is accurately and completely documented in developed countries, although some variability remains in the accuracy of cause-of-death and demographic background of the deceased. Finally, it is also the case that specific types of mortality are highly correlated with increased risks of ill-health in survivors, when both are disaggregated by individuals' socio-economic characteristics. According to Tooley (1966, p. 18) and Blaxter (1981, pp. 34-35), this is especially true of mortality among infants. Therefore, examining inequities in death may, in some circumstances, be an informative means of establishing inequities in health.

This article concentrates precisely on the time-trend of income related inequality in infant deaths. Children under 1 year long been recognized as highly vulnerable to the adverse living conditions that go hand in hand with poverty. Numerous epidemiological studies, both at the aggregate and micro levels, have added support to this view (e. g., Blaxter, 1981; Paneth et al., 1982; Nersesian, 1988; Stockwell et al., 1988). In Portugal, the issue has attracted a good deal of attention from researchers and policy-makers. The rapid decline in infant mortality rates witnessed throughout the 1970's and 80's is often put forward as an example of improved levels of general well-being, not least by government sources. Doubts have been raised, however, as to whether the decline was accompanied by improvements in the socio-economic and spatial distribution of those rates. All research results to date point to the equity gains having been negligible (e. g., Kannisto; 1986; Leitão, 1988). These studies, however, have some important drawbacks. They cover limited time-spans; do not distinguish between the different types of infant mortality; make limited use of statistical techniques available for summarizing distributions; or simply fail to address the issue of socio-economic differences.

The present paper aims to answer questions raised in the Portuguese debate but has features which may be useful to research in other contexts. The analysis makes use of the concentration index methodology introduced to health economics by Wagstaff et al. (1989, 1991). The methodology is extended by using indices that take due account of alternative social judgements on the degree of equality preference. This seems to be a crucial element missing from previous analyses of health domain inequity, where researchers habe typically used standard measures that entail (possibly) unappealing assumptions about the weight attached to inequity at different levels of the income distribution. Such measures also implicitly presume a degree of agreement about equity judgements, which is rarely found in practice. By contrast, the «generalized» measures here introduced can yield numerical estimates of the degree of inequality that are conditional on the choice of a single parameter which reflects different distributional points of view. The empirical analysis is based on geographical observations *ranked* by economic position. The approach is particularly useful for countries with an insufficiently developed information base.

The rest of the paper is organized as follows. Section 2 sets out the methodology, describing first the tools of measurement and estimation procedures and then the empirical approach, data and variables used in the analysis. Section 3 presents the results. Finally, section 4 discusses the main implications of the findings. An extended version of the analysis may be found in Pereira (1995).

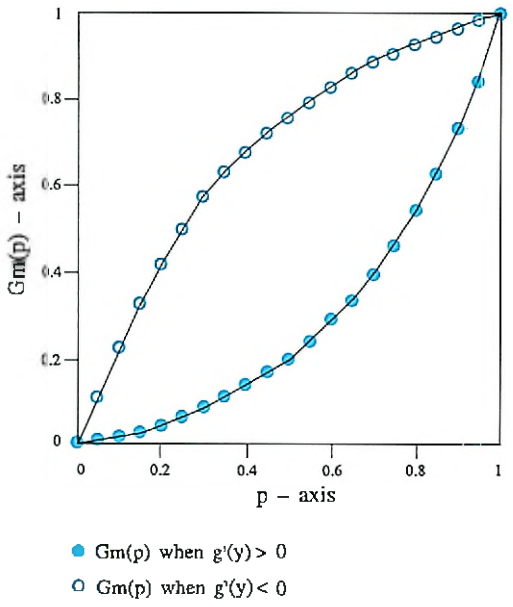
2. Methodology

2.1. Concentration indices

Allow that income Y is a continuous random variable with p. d. f. $f(Y)$, distribution function $F(Y)$, and c. d. f. $F(y)$. Assume further that mortality in a given period, M, is also a random variable, related to Y by means of a continuous invertible function $M = g(Y)$, so that its first derivative and $E[g(Y)] = \mu_m$ (the mean level of mortality) exist, and $g(Y) \geq 0$ for all $Y \geq 0$. The relationship between $p = F(y)$ and $G_m(p) = F_1[g(y)]$, interpreted as the proportional share of total mortality accounted for by persons having an income less than or equal to y, yields the *mortality concentration curve*. The curve is represented in a unit square *(Figure 1)*.

The actual shape of the mortality concentration curve depends on the sign of $g'(y)$, the first derivative of mortality with respect to income. If $g'(y) > 0$ for all $y \geq 0$, the curve is convex to the $p = F(y)$ – axis, implying that $F_1[g'(y)] < F(y)$ for all y. In this case, the concentration curve falls below the diagonal, signifying that higher income groups experience a greater than proportional share of mortality. If $g'(y) < 0$ for all $y \geq 0$, the concentration curve is concave to the $F(y)$ – axis and lies above the diagonal, with $F_1[g'(y)] > F(y)$. In this case, the poor unambiguously account for a higher share of total deaths. Obviously, when $g'(y) = 0$ at all levels of income, the curve coincides with the diagonal, signifying that mortality is distributed in exact proportion to income. It is of course quite possible that the mortality concentration curve crosses the diagonal

Figure 1
Mortality concentration curves



[*eg.* if $g'(y)$ is positive at low levels of income but negative at higher levels], in which case no unambiguous conclusions can be made regarding the association of income and mortality.

The *mortality concentration index* is defined as:

$$C_m = 1 - 2\int_0^1 F_y[g(y)]dF(y) = 1 - 2\int_0^1 G_m(p)dp \qquad (1)$$

where $p = F(y)$, and $G_m(p)$ is the mortality concentration curve. This index, first suggested by Wagstaff et al. (1991), provides a measure of the extent of health inequalities that are systematically associated with income position. C_m varies from – 1.0, when only the poorest person dies in the period under consideration (in which case $G_m(p)$ is $\lceil$ – shaped), and + 1.0, when only the richest person dies (with $G_m(p)$ being $\rfloor$ – shaped). It takes a value of zero when there is no systematic association between mortality and the individual's rank in the income distribution[1].

As with any inequality measure, C_m embodies a particular weighting scheme, which in turn has normative implications for inequality measurement. Given the widespread use of standard concentration measures in economics, these implications are well known (cf. Atkinson, 1970). Greater weight is attached to health inequities occurring around the mode of the income distribution rather than at the sparser lower and upper tails. Furthermore, the measure is not sensitive to income differences as such, but instead to relative rankings of persons given their income positions. There seems to be no particularly compelling reason to believe that such a weighting scheme is desirable. For this reason, it seems useful to also consider a parametric variant of the standard concentration index that explicitly reflects alternative normative viewpoints — the so-called «generalized» or «extended» concentration index.

Making use of the fact that the Lorenz curve for income can be interpreted as a special case of the concentration curve for the function $g(y) = y$, and drawing on Kakwani's (1980, p. 444) and Yitzhaki's (1983, p. 620) formulations of the extended Gini, it follows that a family of *generalized mortality concentration indices* can be expressed as a weighted integration of the area below the mortality concentration curve:

$$C_m(\delta) = 1 - \delta\,(\delta - 1)\int_0^1 (1 - p)^{\delta - 2}\, G_m(p)dp \qquad (2)$$

This equation defines various coefficients, one for each value of the distributional judgement parameter $\delta > 1$. As $\delta \to 1$, $C_m(\delta)$ approaches zero for all distributions, implying indifference to income related health inequalities. At $\delta = 2$, $C_m(\delta)$ is equivalent to the standard concentration index, C_m. In the limiting case $\delta \to \infty$, the implicit ethics of $C_m(\delta)$ approximate the maximin rule (defined over incomes)[2]. Each of the $C_m(\delta)$ measures has the same sign properties as C_m, varying from – 1.0, with negative values signigying pro-rich mortality inequality and positive values, pro-poor mortality inequality.

The effect of varying δ can be seen from *Figure 2*, which shows the relationship between the weighting scheme [$w = \delta(\delta - 1)(1 - p)^{\delta - 2}$] in equation (2) and rank in the income distribution. At values of $1 < \delta < 2$, the weights increase with income rank, signifying that $C_m(\delta)$ attaches greater weight to mortality incquities at the top of the income distribution [*Figure 2 (a)*]. At $\delta = 2$ (the standard concentration index), weights and rank are independent. Subse-

[1] Given that $G_m(p)$ can cross the diagonal, C_m might register a value of zero even if mortality shares do not correspond to income shares. This would happen if, for example, the area between $G_m(p)$ and the diagonal lying to the right of the intersection were equal to the corresponding area to its left.

[2] It should be noted that δ has a similar effect on measured inequality to Atkinson's (1970) inequality aversion parameter. The behaviour of $C_m(\delta)$ at the extremes $\delta \to 1$ and $\delta \to \infty$ resembles that of $A(\in)$ at the extremes $\in \to 0$ and $\in \to \infty$ of inequality aversion.

quent increases in δ leads the weights to decrease with income rank [*Figure 2 (b)*]. Therefore, higher values of δ mean that greater weight is attached to health inequities at the lower end of the income distribution and lesser to those ocurring at the upper end. Thus, the generalized index puts at the disposal of the analyst a parameter which reflects different judgements about how the concentration curve values are aggregated.

The indices presented above can be calculated by a variety of methods. In the present paper the standard indices were estimated on the assumption that the concentration curve is piecewise linear. The formula used is as follows (Morgan, 1962)[3].

$$C_m = \sum_{j=1}^{J} (p_j m_{j-1} - p_{j-1} m_j) \qquad (3)$$

where p_j is the cumulative proportion of income ranked units up to the jth class and m_j is the cumulative proportion of total mortality experienced by the same units. The generalized indices were calculated using a covariance formula suggested by Lerman and Yitzhaki (1984, 1989) for the Gini coefficient:

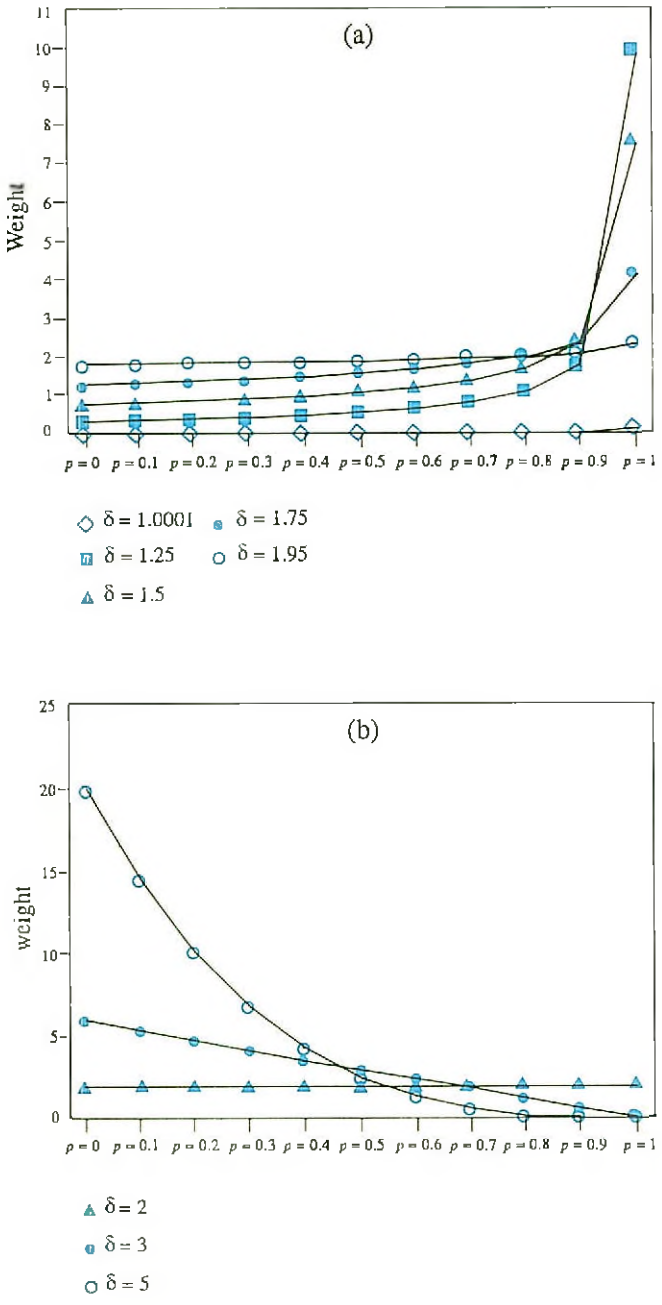
$$C_m(\delta) = \frac{-\delta \, cov\,[m, [1 - F(y)]^{\delta - 1}]}{\mu_m} \qquad (4)$$

where cov [•] denotes covariance, $m = g(y)$ is the level of mortality of an income group with average income y, μ_m is the mean level of mortality and δ is the distributional judgement parameter. The covariance component is given by:

$$cov\,[\,\bullet\,] = \sum_{k=1}^{n} w_k (m_k - \mu_m)\,[(1 - E_k)^{\delta - 1} - \sum_{k=1}^{n} w_k (1 - E_k)^{\delta - 1}] \qquad (5)$$

where w_k is the proportion of the population in income group k, m_k the mean level of mortality in group k, and E_k a mid-interval estimator of $F(y)$, *ie*, $E_k = w_{k-1} + w_k / 2$.

Figure 2 (*a* – *b*)
Weights and income rank using the generalized concentration index



2.2. Empirical approach, data and variables

The empirical approach is based on the use of geographical observations *ranked* by economic positions. The infant population is first disaggregated by mother's place of residence, and then ranked by an

[3] The results arrived at by this procedure are identical to those obtained when covariance methods are applied to grouped data (see, e. g., Wagstaff et al., 1991).

index of average income levels in the spatial units. The cumulative percentiles of these observation together with the respective infant death percentiles serve as inputs to the construction of concentration curves. The ranking element assures that we are measuring socio-economic differences, albeit at a high level of aggregation, and not merely geographical inequalities.

The procedure is justified by the incompleteness and inaccuracy of more direct alternatives. For example, the obvious approach to the problem would be to rank the infant population by some proxy of families' economic circumstances, such as the father's profession or mother's level of educational achievement, both of which are recorded on Portuguese death certificates. This method is adopted by Wagstaff et al. (1991), who use data grouped by occupational class, to compute standard concentration coefficients for *adult* mortality in England and Wales, Finland and Sweden. However, in Portugal the quality of socio-economic information on death certificates is known to be particularly poor. The National Statistical Institute (INE) only began publishing crosstabulations of deaths by occupational class in 1987, and then only for adults of working age. Furthermore, even if the necessary data were readily available, it would then have to be linked with data on births, decomposed by the same categories. These statistics are also generally not available. Even if they were, it is by no means certain that this would provide a satisfactory basis for examining inequity. The linking of occupational class data from two sources (recorded in quite different circumstances) is, after all, one of the main reasons commonly advanced for doubting the value of mortality-based inequity analyses (Power et al., 1991, p. 17).

The present approach has no such drawbacks. Information on mother's place of residence is generally reliable and complete on both death and birth certificates. The economic ranking of geographical units is an area that is relatively well researched. It needs to be stressed, nevertheless, that the relationship between mortality and income levels is being measured at a high level of aggregation. Persons living within the geographical units will obviously have unequal command over resources, to which may be associated further inequalities in mortality. If this is true, then the computed indices are likely to be biased, showing *lesser* inequity than is in fact the case. Yet this is a problem that is shared by studies that measure socio-economic status directly. Virtually all work on mortality has used grouped data, usually by occupational class. Within those classes there will also be inequalities. Therefore, given the underdeveloped information base and the limitations of alternative methods, there seems to be good reason for pursuing the current approach.

The empirical analysis considers four conventionally used components of infant deaths:

i) *Perinatal mortality*. Stillbirths occurring at 28 weeks or more of gestation and deaths of live born infants occurring in the first week of life;
ii) *Neonatal mortality*. Deaths occurring in the first four weeks of life;
iii) *Post-neonatal mortality*. Deaths occurring from the fifth week of life up to one year;
iv) *Infant mortality*. Deaths occurring in the first year of life (*ie*. the sum of neonatal and post-neonatal mortality).

It is common to express the perinatal mortality *rate* per thousand live births and stillbirths at 28 or more weeks of gestation, and the *rates* for the other three components per thousand live births. The main reason for considering the components separately is that they are differentially affected by specific causal factors (WHO, 1970; Jazairi, 1976; Blaxter, 1981; Edouard, 1985). In particular, neonatal and perinatal deaths are more sensitive to hereditary factors, the natural environment and the impact of ante-natal and obstretric and perinatal care. Post-neonatal deaths, on the other hand, mainly reflect poor conditions in dwellings, bad nutrition and lack of sanitation and hygiene — in short, the type of situations that are associated with poverty.

The unit of observation is the *district* ($n = 18$), which is the main geographical entity used for administrative and statistical purposes in Portugal. The period of analysis is comprised by the years 1971 to 1991 for the infant mortality indicator and 1976 to 1991 for the other three components[4]. As *Table 1* shows, there are considerable differences in death rates between the districts, both at the beginning and end of the period. For example, in 1971 the infant mortality rate varied between 25.9 and 65.7 deaths per 1000 live births. By 1991, there had been

[4] The different periods of analysis are due to inconsistencies in the published data. For some years in the period 1971-75, the published statistics for the neonatal, post-neonatal and perinatal components refer to the *de facto* district of death/birth. I use only data broken down by the mother's place of residence. The data sources are: INE, *Estatísticas Demográficas* and INE, *Estatísticas de Saúde*, for the period 1971-86; and Ministério da Saúde (DGCSP), *Natalidade, Mortalidade Infantil e Mortalidade Perinatal 1987/91*, for the remaining years.

Table 1
Mortality rates at the endpoints of period of analysis

	Infant	Neonatal	Post-neonat	Perinatal
1971-1976*:				
National rate	48.3	19.8	13.1	29.1
Maximum	65.7	30.4	30.5	39.3
Minimum	25.9	8.0	8.7	15.7
1991:				
National rate	10.7	6.9	3.8	12.0
Maximum	20.5	10.6	9.9	14.5
Minimum	7.4	3.3	2.1	6.9

* The infant mortality rate refers to 1971 and the neonatal, post-neonatal and perinatal rates to 1976.

a marked decline in rates throughout the country, but the highest recorded value (20.5) was still almost three times greater than the lowest (7.4). The ratios between extreme values are greater for the neonatal and postneonatal components and smaller for perinatal mortality.

The economic ranking of the observations was established via a 3-year moving average of an index of wages in the construction industry, derived from a continuous employment survey carried out by the INE[5]. This is the *only* indicator of living standards in the districts that is available for all years under consideration. Although the nature of the index might raise doubts as to its ability to proxy the underlying variable of interest, concordance tests with other possible indicators for the years when these are available revealed fairly strong positive associations. Values of the Spearman correlation coefficient, Kendall's Tau-b and Goodman and Kruskal's Gamma in the range {0.65, 0.84} were computed for associations between the rank of the chosen index and those of 3 standard of living indices (census — regional product — and market research-based) in selected years when these were available. This suggests that the analysis is robust in terms of choice of available income proxies[6].

The concentration curves and indices were estimated by using data on the numerators (number of deaths) and denominators (live births and still-births) of the four mortality indicators. For example, the infant, neonatal and post-neonatal mortality curves were constructed by measuring, on the horizontal axis, the cumulative percentage of live births with the districts ranked from poorest to richest; and on the vertical axis, the cumulative percentage of deaths occuring to infants of mothers residing in the income-ranked districts. A visual representation is available in *Figure 4*, which presents the observed concentration curves in the years 1976 and 1991. For the case of perinatal mortality, one obviously has to add still births to live births and deaths in order to calculate the percentiles. The standard concentration indices (C_p) were computed using the linear approximation formula given in equation (3), with p_i representing the cumulative proportion of live births (plus still births in the case of perinatal mortality) and m_i representing the cumulative proportion of respective deaths (plus still births for perinatal mortality).

3. Results

Table 2 presents the series of standard concentration indices calculated for the four infant death components. All the indices have negative signs, suggesting that lower levels of average income are associated with higher mortality rates. The burden of infant deaths is, therefore, generally unfavourable to the poorer districts. There is also a clear pattern in the relative values of the four indicators. Apart from a short period in the late 1980's — which detailed inspection of the data suggests is not an artefact effected by the ranking variable — inequity is always greatest for post-neonatal mortality and least for the perinatal and neonatal components. Thus, the closer one gets to birth the smaller the degree of inequity. It is, however, worth noting that a larger number of deaths are associated with these smaller income differentials (see *Table 1*).

The most salient finding is, nevertheless, the significant decline in the degree of inequity over the two decades. For example, the concentration index for infant mortality, which stood at – 0.117 in 1971, had by the end of the period risen to – 0.030. Between 1976 and 1991, the absolute values of all component indices are at least halved, suggesting that the WHO precept cited earlier has already been surpassed. The average annual rates of change (reported in the lower part of *Table 2*), suggest that the greatest relative «equity gains» were achieved for the neonatal and perinatal components. Indeed, by 1991 there is virtually no income related inequity in the distribution of these deaths. It is also clear that in the late 1970's, the overall decline in inequity

[5] The source is INE, *Anuário Estatístico* (various years).

[6] Nevertheless, actual inequality estimates based on a more general measure of living standards are provided in section 4. It needs to be stressed that the construction industry wage variable is used because there are no other indicators available for all years under analysis.

Table 2
Standard concentration coefficients. Infant mortality and components, 1971-1991

Year	Infant	Neonatal	Post-neonatal	Perinatal
1971	– 0.117	na.	na.	na.
1972	– 0.102	na.	na.	na.
1973	– 0.119	na.	na.	na.
1974	– 0.103	na.	na.	na.
1975	– 0.109	na.	na.	na.
1976	– 0.080	– 0.028	– 0.158	– 0.046
1977	– 0.098	– 0.068	– 0.148	– 0.062
1978	– 0.097	– 0.063	– 0.149	– 0.066
1979	– 0.080	– 0.034	– 0.153	– 0.031
1980	– 0.068	– 0.054	– 0.092	– 0.073
1981	– 0.091	– 0.075	– 0.124	– 0.071
1982	– 0.078	– 0.056	– 0.129	– 0.052
1983	– 0.065	– 0.043	– 0.109	– 0.034
1984	– 0.036	– 0.030	– 0.047	– 0.038
1985	– 0.034	– 0.023	– 0.058	– 0.006
1986	– 0.055	– 0.061	– 0.043	– 0.041
1987	– 0.058	– 0.044	– 0.087	– 0.012
1988	– 0.048	– 0.050	– 0.045	– 0.055
1989	– 0.063	– 0.070	– 0.048	– 0.033
1990	– 0.050	– 0.032	– 0.082	– 0.008
1991	– 0.030	– 0.007	– 0.072	– 0.001
Average rate of annual change				
1976-1991	3.9%	4.7%	3.4%	6.1%
1971-1975	1.3%	na.	na.	na.
1976-1980	3.0%	– 18.4%	8.3%	– 11.9%
1981-1985	12.6%	14.0%	10.6%	18.3%
1986-1991	7.6%	14.7%	– 11.2%	16.2%

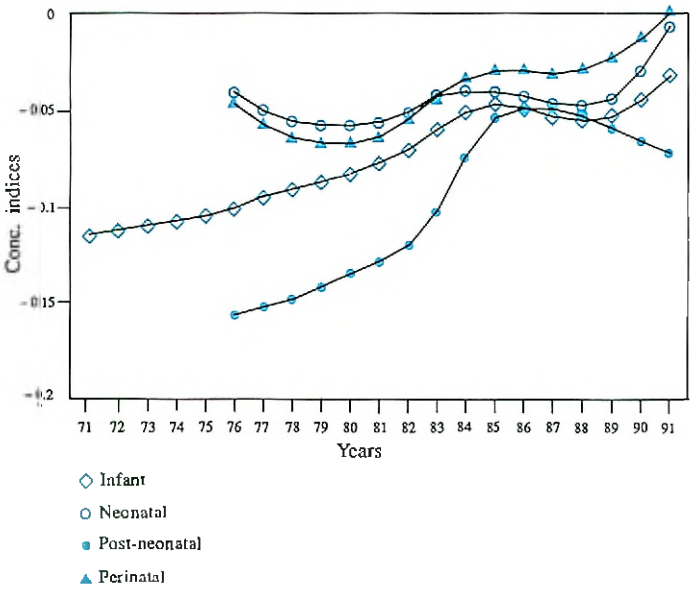
na. = not available

levels is primarily attributable to improvements in the post-neonatal distribution, but that in the 1980's this role is taken over by the close-to-birth components[7].

The time-trend is best examined through *Figure 3*, where smoothed plots of the index values are presented[8]. Pro-rich inequity in *infant* mortality shows a steady decline up to the mid-eighties; it then stagnates at $C_{in} \approx -0.06$, but there is a renewal of the declining trend after 1989. This general tendency is the result of quite distinct movements in the component indices. The distribution of post-neonatal mortality is initially very unfavourable to the poorer district. However, the degree of inequity falls rapidly up to the mid-eighties, whereupon the tendency is inverted. By contrast, pro-rich inequity in the neonatal component, which starts off at a much lower level, hardly changes up to the late 80's. It is, however, the moving force behind the renewed overall decline at the turn of the decade. Noticeably, this recent inflexion in the neonatal tendency is also apparent in the perinatal distribution, which is not surprising given the degree of overlap in the indicators.

An explanation for these trends clearly requires evidence based on multivariate analyses. However, bearing in mind the differential impact of causal factors referred to earlier, it is quite plausible that the early sharp fall in post-neonatal mortality inequity is the result of improved living conditions, particularly in the poorest regions. Prior to the mid-1970's, the remotest parts of the country lacked basic sanitation and income was very unevenly distributed. With the advent of democracy in 1974, major improvements were rapidly brought about in these areas, and these may have had a decisive impact on the distribution of post-neonatal deaths.

Figure 3
Smoothed time-trend of standard concentration indices. Infant mortality and components, 1971-1991



[7] The relative weight of component mortality does not change greatly throughout the period. Post-neonatal deaths accounted for 40% of all infant deaths in 1976 and 36% in 1991.

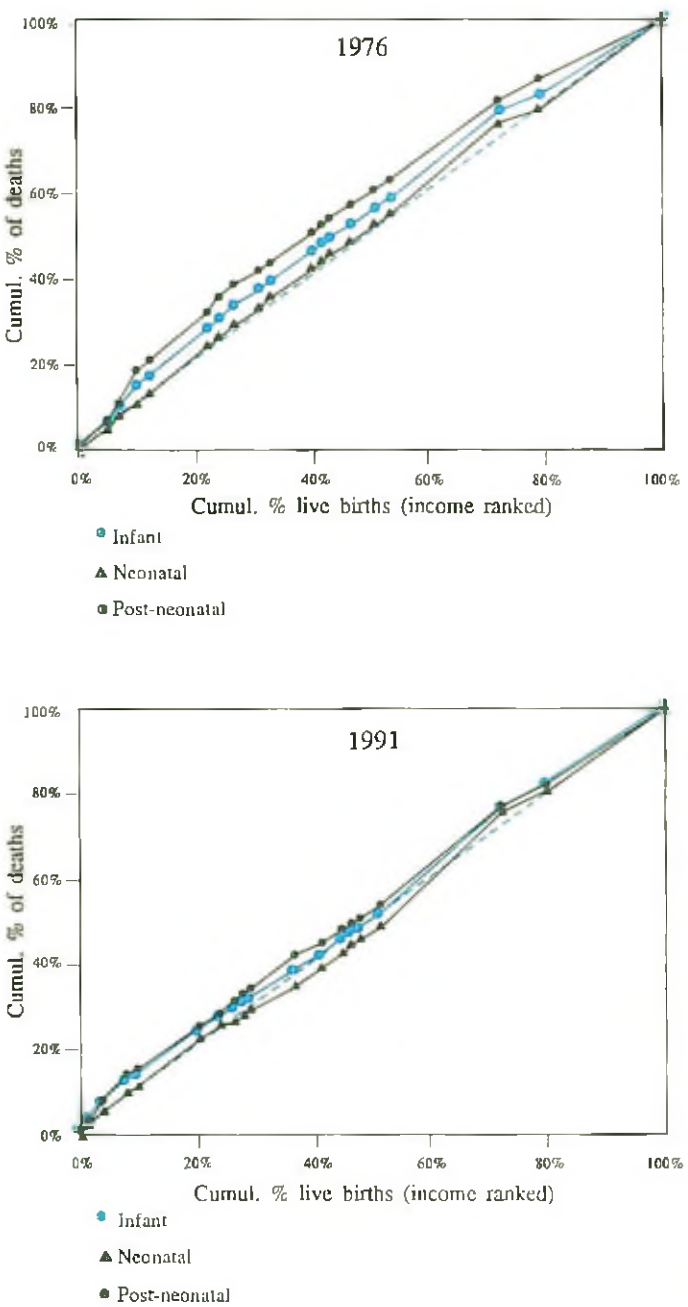
[8] Smoothing of the time series was carried out via a technique sometimes referred to as *T4253H smoothing*. It involves repeated smoothing with running medians of size 4, 2, 5 and 3, followed by hanning (running moving averages). The procedure is available on some statistical packages (e. g., SPSS for Windows).

By the same token, the recent inversion of the tendency may be a result of the increase in poverty in the mid-eighties (Franco, 1990). There is also a plausible explanation for the recent decline in neonatal and perinatal inequity in terms of improved acess to health care. Since the early 80's, a number of new hospitals have opened in previously underserved areas and the spatial distribution of ante-natal care facilities has also improved (Abel-Smith, 1992; Urbano et al., 1993). It may be that these factors provided the necessary stimulus to make the distribution of close-to-birth mortality insensitive to underlying income differences (as reflected by the income-ranked geographical distribution).

The concentration curves at the beginning and end of the period shed further light on the time-trend of the distributions *(Figure 4)*[9]. In 1976, the distribution of infant, neonatal and post-neonatal mortality unambiguously favours the better-off districts. Furthermore, the post-neonatal distribution dominates the infant distribution which in turn dominates that of the neonatal period. In 1991, the dominance relationship is maintained, but there is a conspicuous decline in pro-rich inequity. Indeed, the curves for both infant and neonatal deaths now actually cross the 45° line. It is therefore inadvisable to conclude that, in 1991, there is still a pro-rich bias in these distributions. Even so, the fact that the curves initially cross the diagonal from *above*, means that the very poorest district continue to experience a comparatively high burden of mortality. Therefore, it would seem that the equity gains observed throughout the period are primarily accounted for by districts where average levels of income are highest[10].

In order to check the robustness of the results in terms of alternative distributional judgements, generalized concentration coefficients (with δ set at values between 1.0 and 5.0) were also computed. Given that, in this case, the computational requirements are considerably more demanding, the analysis is restricted to five year intervals. The results are shown in *Figure 5*[11,12].

Figure 4
Concentration curves for infant, neonatal and post-neonatal mortality, 1976 and 1991



[9] This is also true of perinatal mortality. Its concentration curve is not shown for presentational reasons, but it closely follows the configuration of the neonatal curve.

[10] The exception to this trend is the ante-penultimate observation (the Oporto district), which has both high living standards and high levels of mortality. Given that it also has the largest number of births, a further crossing of the diagonal is induced. This finding — allied to the fact that widespread social inequalities are known to exist *within* the Oporto district — suggests that the geographical classification may need to be further disaggregated in order to serve as a better proxy of income differences among the Portuguese population.

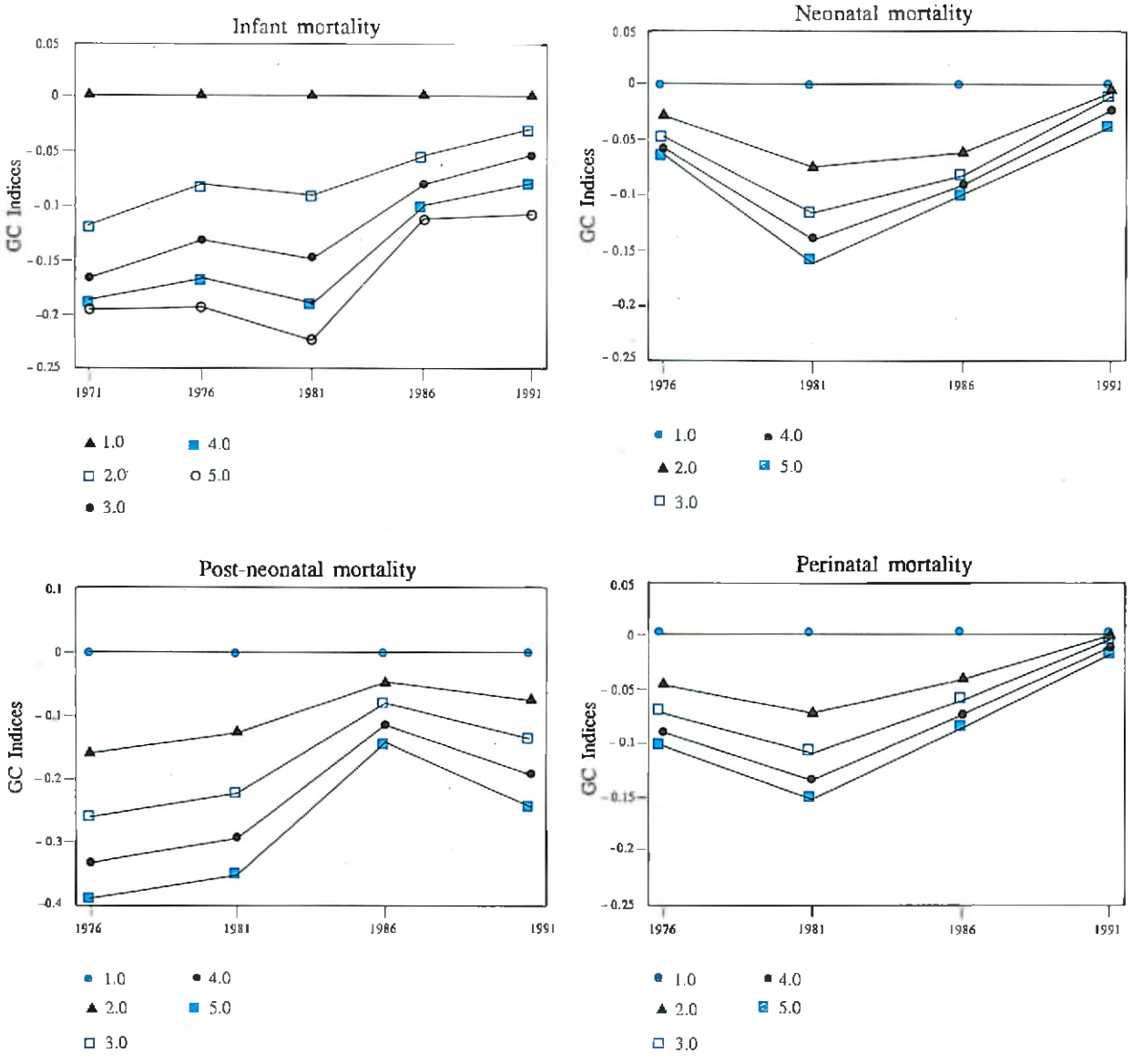
[11] Note that the post-neonatal diagram in *Figure 5* has a different scale.

[12] The indices were computed according to equation (4). Note that μ_n and m_i represent average and district mortality *rates* rather than number of deaths. The w_i and E_i elements represent the same denominators used for calculating the standard concentration indices (*ie*, live births and still births).

As expected, all indices tend to zero when the distributional judgement parameter is set at $\delta \rightarrow 1$ (computed for $\delta = 1.001$). The observer's indifference to economic related inequality leads him to infer that the distribution of mortality favours neither rich nor poor. At $\delta = 2$ the indices are equivalent to the standard coefficients reported in *Table 2*. As the parameter is increased beyond $\delta = 2$ (reflecting greater weight being given to the lower tail of the income distribution), successively greater degrees of pro-rich inequity are shown. For example, the sequence of increases in the 1976 perinatal distribution is: -0.046 at $\delta = 2$; -0.071 at $\delta = 3$; -0.088 at $\delta = 4$; and -0.102 at $\delta = 5$. However, it is noticeable that increased levels of inequality aversion have a differential impact, depending on the type of mortality under consideration.

The degree of measured inequity in the post-neonatal distribution is particularly sensitive to changes in the value of δ. Compare, for example, the sequence of generalized indices for post-neonatal and perinatal mortality in 1986; or for that matter, the sequence of post-neonatal indices in 1991 with the neonatal values in 1981. In both com-

Figure 5
Generalized concentration indices. Infant mortality and components, 1971-1991. Values of $\delta = 1.0$, 2.0, 3.0, 4.0 and 5.0



parisons, the standard concentration coefficients hardly differ, but the effect of increasing inequality aversion is considerably greater for the post-neonatal measurements. This suggests that the poorest districts bear a particularly high burden of post-neonatal deaths, and tends to confirm the view that chances of survival in the 1-12 month age group are highly susceptible to the degree of poverty.

The basic direction of the time-trend for the component indices does not change as greater weight is attached to the tail of the income distribution. Inequities in neonatal and perinatal mortality first increase and then decline. Similarly, post-neonatal inequity shows the reversed tendency identified earlier. Nevertheless, the degree of change in measured inequity is much less at higher levels of inequality aversion. For example, between 1976 and 1991, the rate of annual improvement in the $\delta = 5$ infant mortality indices is 2.8%, which compares unfavourably with the 3.9% change identified in *Table 2*. For the other indicators the differences between annual rates of change at $\delta = 2$ and $\delta = 5$ are: 4.7%-2.4% (neonatal); 3.4%-2.4% (post-neonatal), and 6.1%-5.2% (perinatal).

A greater concern for the tail of the income distribution, has a conspicuous impact on the course of inequity in total infant deaths. At $\delta = 5$, the 1981 distribution of infant mortality is actually more inequitable than that of ten years earlier. Furthermore, de post-1986 improvement, identified by the standard measurements, now appears insignificant. Finally, note that at $\delta \geq 4$, the inequity ranking of the components in 1986 reverts to that found for other years at all levels of inequality aversion (*ie.* post-neonatal > infant > neonatal > < perinatal). This suggests that the reversal identified by the standard measures for the late 80's is not robust to different distributional perspectives.

All these results are indicative of the very poorest districts supporting a relatively high proportion of infant deaths. They also suggest that the generalized concentration coefficient is particularly sensitive to inequities that are the result of poor socio-economic conditions. If there is a policy concern for the very poorest in society, and not merely for inequality as such, then the generalized concentration indices are clearly a useful measurement tool.

4. Discussion

The problem of inequity in infant deaths has, for some time, captured the attention of researchers and policy-makers in Portugal. Recently, concern has focused on whether socio-economic and regional disparities, first identified in the 1970's, have shown signs of abating. Given that time series data are available, this question lends itself well to the concentration index approach. There is a problem, nevertheless, with regard to the choice of variable(s) used to partition the population. Our interest is in mortality inequalities that are related to economic status. However, information recorded on birth and death certificates that might be used to proxy this variable is generally of poor quality and, in any case, has only been published since 1987. Consequently, the present analysis has drawn on geographical observations of mortality and births ranked by an index of economic position.

Given that economic status is measured in an indirect manner, the validity and reliability of the inequity estimates may well be questioned. Such reservations cannot be fully resolved while a suitable alternative is unavailable. Nevertheless, there is no doubt that the data approach *does* address the question of interest. The economic ranking of the districts provides an ordering of the population in terms of average income levels. Admittedly, there exists a wide variance in commodity choice opportunities within the districts, but this is also true of occupational classifications (*eg.* «skilled manual» may include long-term unemployed bricklayers and high earning electricians). The important point about the data approach is that a high level of aggregation is involved. It is possible that trends in the aggregate-level relationship between the socio-economic status and mortality of populations in the districts is quite different from the individual-level association between the same variables. However, we have no way of knowing since longitudinal individual-level data are not available. In these circumstances, the procedure of using geographical observations ranked by income levels is a valid method for measuring inequities in the health sphere. For countries with an insufficiently developed information base, it may be the only means for shedding light on the important question of time trends.

Table 3
The effect of using an alternative measure of living standards in the districts. Infant mortality

Year	Living standards ranking variable	
	Census-based	Wage index
1971	– 0.089	– 0.117
1981	– 0.082	– 0.091
1991	– 0.021	– 0.030

Doubts may also be raised about the legitimacy of using the construction industry wage index as a measure of living standards in the districts. As I have stressed the choice is due to unavailability of more refined proxies in all years under consideration. *Table 3* reports the results of using an alternative proxy. The new measure is based on population census information collected in 1971, 1981 and 1991. The ranking was established by a simple weighted average of the district orderings for three indicators: the percentage of population living in urban areas; percentage of dwellings with access to electricity, running water and refuse collection; and the adult literacy rate. Though the new measure produces lower inequality estimates, the general trends shown by the main results are clearly visible. Judging by the concordance tests reported earlier, other proxies would also show similar results.

The results obtained in section 3 point to three main conclusions. First, the degree of pro-rich inequity is currently much lower than it was in the 1970's. Irrespective of the indicator under consideration or the level of inequality aversion implied by the measures, the 25% reduction in health inequality prescribed by the WHO has already been surpassed. Secondly, there are important differences in the trends of the four mortality components. Close-to-birth mortality inequities seem to have been largely erradicated. In contrast, inequity in the distribution of deaths to children aged 1-12 months is once again on the increase, after initially showing the greatest fall. The actual rates of these deaths are, however, much smaller than those in the earlier period of life. Finally, although the overall degree of inequity is much reduced, there are signs that the position of the very poorest has not shwn much improvement. This conclusion is suggested by both the configuration of the concentration curves and the trend of the inequality averse measures.

There is an apparent disagreement between these results and those of previous research. The studies by Kannisto (1986), Pereira et al. (1987) and Leitão (1988) all suggest that the degree of inequity in infant deaths has remained more or less stagnant. The reason for this discrepancy is plain to see, but it needs spelling out not least for the important policy implications it holds. Previous studies have simply measured geographic mortality differentials and not whether these are associated with inequality in command over resources. They, therefore, address a quite different question to the one examined in this paper. Nevertheless, geographic inequality results are often assumed to be a straightforward reflection of economic differences in much the same way as the «north-south divide» in British mortality differentials is accepted as clear-cut evidence for inequities related to living standards (e. g., Whitehead, 1987). The actual time-trend of the two types of inequity may, however, be quite different.

Figure 6
Comparison of concentration and Gini indices for infant mortality, 1971-1991

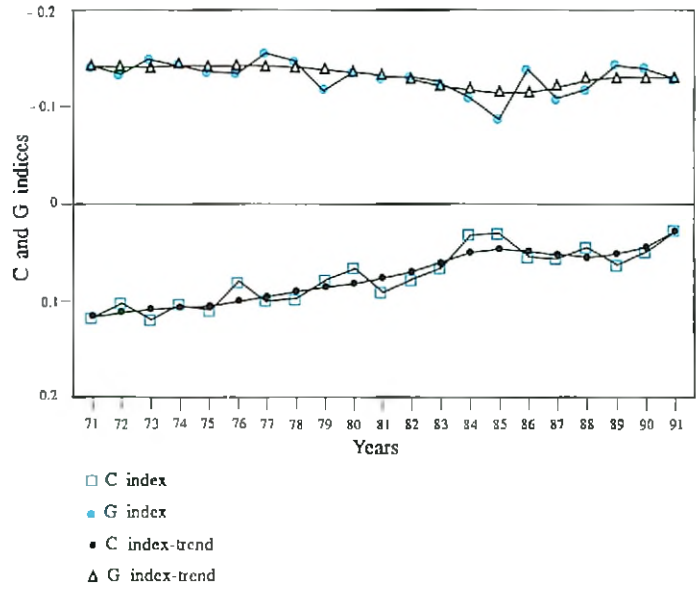


Figure 6 compares the evolution of geographic and income-related inequities in infant mortality between 1971 and 1991. The plots in the negative region reproduce the data presented in *Table 2* and *Figure 3* (*ie.* the observed and smoothed trends of the standard concentration indices). The plots in the positive area represent analogous trends for the Gini coefficient, which is used to summarize geographic inequalities in mortality[13]. Quite clearly, spatial inequalities have not diminished. Throughout the 1970's and 80's the trend of the Gini measures hardly diverges from a value of around 0.13. Furthermore, the Gini is insensitive to changes in income related inequality. In six of the years under analysis (75, 80, 81, 82, 87 and 88) the change in the coefficient (*vis-à-vis* the preceding year) is actually sign-antagonic to the change in the concentration index. The obvious implication of these findings is that geographical inequalities in infant deaths are still pervasive but that they no longer reflect, so decisively, known differences in standards of living. If there is a policy concern for area differences, then it may be useful to target other factors which are known to affect the survival chances of infants (*eg.*

[13] The Gini was calculated by ranking the districts in ascending order of *mortality rate*.

very young mothers, mothers of high parity, the distribution of medical technology and so on).

It is important to stress, however, that the overall decline in income related inequity should not be interpreted as a sign that the issue no longer merits attention. The recent downturn in post-neonatal inequity and the position of the very poorest are two specific questions which the results suggest should be monitored carefully. Altough many of the social and economic circumstances which lead to infant deaths may no longer apply in Portugal, some deaths could probably be avoided. This may best be achieved by targeting social support and health care resources at persons in poverty.

Finally, although the analysis has been useful in identifying past trends in infant health inequity, there is obviously a need for more refined measurement in the future. Essentially, this means access to better data. For example, if small-area observations of both mortality and economic variables were available, then the reliability of inequity estimates would be improved. Such data have indeed become available in the late 1980's and could therefore be used in future analyses. It is also important that the results are compared with those obtained from individual-level data. This will require concerted efforts on the part of researchers and data collecting agencies to guarantee acceptable standards of data quality. If possible, the analysis of individual level data should be based on linked records, in order to avoid the problem of numerator/ denominator bias. Ultimately, however, the results of this paper point to a new situation which requires alternative measures of infant health. The number of deaths ocurring each year are now quite low (at the levels of other EU countries) and the degree of inequity in their distribution is much reduced. If we still wish to monitor the relationship between economic disadvantage and infant health, then more sensitive but equally objective health indicators are required. These might include birth weight or other measures based on clinical examination, many of which could be easily produced as part of routine assessments.

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Résumé

INÉGALITÉ DANS LA DISTRIBUTION DE LA MORTALITÉ INFANTILE. PORTUGAL 1971-1991

Cet article examine l'évolution de l'inégalité socio-économique (iniquité) dans la mortalité infantile au Portugal dans la période 1971-1991. Les enfants âgés de moins d'un an ont été il y a longtemps reconnues comme un groupe particulièrement susceptible aux conditions de vie adverses associées à la pauvreté. Au Portugal, la réduction des taux de mortalité infantile tout au long des années 70 et 80 a été considérée comme un exemple d'une amélioration des niveaux de bien-être général de la population. Cependant, on doute si cette amélioration correspond simultanément à une meilleure distribution économique et geographique de ces taux.

Dans cet article, l'inégalité est mesurée par des courbes et des indices de concentration. Au contraire des travaux antérieurs, des indices paramètriques ont été utilises qui incorporent des jugements de valeur alternatifs quant au degré de préférence par égalité. L'analyse empirique fait recours à des données de routine et considère quatre éléments des décès infantiles: mortalité perinatale, néo-natale, post-natale et infantile. Eu égard à d'importants problèmes dans les travaux qui adoptent des méthodologies directes pour mesurer l'inégalité socio-économique de la mortalité, cet étude adopte une méthode indirecte, ayant pour base des observations d'unités géographiques rangées selon les critères économiques de ces unités. L'abordage est particulièrement utile pour des pays où les systèmes d'information sont peu développés.

Les résultats présentent trois grandes conclusions. Premièrement, le degré d'inégalité en faveur des plus riches est actuellement très inférieur aux niveux détectés au début des années 70. Deuxièmement, il y a des différences importantes dans l'évolution des quatres éléments de la mortalité infantile. L'inégalité en faveur des plus riches dans la mortalité péri-natale et néo-natale parait avoir pratiquement disparu. Cependant, l'inégalité dans la distribution des décès d'enfants âgés entre 1 et 12 mois a augmenté encore, après avoir présenté la diminution la plus significative dans les années 70. Finalement, le degré d'inégalité étant aujourd'hui très inférieur à celui d'il y a vingt ans, il y a des indices qui montrent que la position relative de ceux qui se trouvent dans des conditions d'extrême pauvreté n'est pas significativement meilleure. Des études futurs devraient répliquer l'analyse avec des données plus désagrégées avant que ces conclusions ne soient définitivement acceptées.

Resumo

DESIGUALDADE NA DISTRIBUIÇÃO DA MORTALIDADE INFANTIL. PORTUGAL 1971-1991

Este artigo examina a evolução da desigualdade sócio-económica (iniquidade) na mortalidade infantil em Portugal no período 1971-1991. As crianças com menos de um ano há muito que foram reconhecidas como um grupo particularmente susceptível às condições de vida adversas que se associam à pobreza. Em Portugal, a redução das taxas de mortalidade infantil ao longo das décadas de 70 e 80 tem sido apontada como um exemplo da melhoria dos níveis de bem-estar geral da população. Contudo, levantam-se dúvidas sobre se, simultaneamente, teria havido melhorias na distribuição económica e geográfica dessas taxas.

No artigo mede-se a desigualdade através de curvas e índices de concentração. Em contraste com trabalhos anteriores, utilizam-se índices paramétricos que incorporam juízos de valor alternativos quanto ao grau de preferência pela igualdade. A análise empírica recorre a dados de rotina e considera quatro componentes das mortes infantis: mortalidade perinatal, neonatal, pós-neonatal e infantil. Devido a problemas importantes nos trabalhos que adoptam metodologias directas de medição da desigualdade sócio-económica da mortalidade, o presente estudo adopta um método indirecto, baseando-se em observações de unidades geográficas *ordenadas* pelos padrões económicos dessas unidades. A abordagem é particularmente útil para países onde os sistemas de informação estão pouco desenvolvidos.

Os resultados apontam para três grandes conclusões. Primeiro, o grau de desigualdade a favor dos mais ricos é actualmente bastante inferior aos níveis detectados para o princípio da década de 70. Segundo, existem diferenças importantes na evolução das quatro componentes da mortalidade infantil. A desigualdade a favor dos mais ricos na mortalidade perinatal e neonatal parece ter praticamente desaparecido. Todavia, a desigualdade na distribuição de mortes de crianças com idades compreendidas entre 1 e 12 meses voltou a aumentar, depois de na década de 70 ter revelado o decréscimo mais significativo. Finalmente, muito embora o grau de desigualdade seja hoje bastante inferior ao de vinte anos atrás, há sinais de que a posição relativa dos que se encontram em situações de extrema pobreza não tenha melhorado significativamente. Trabalhos futuros deveriam replicar a análise com dados mais desagregados antes de estas conclusões serem definitivamente aceites.