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Trends in infant mortality inequalities in the Americas: 1955–1995

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Study objectives: To describe overall and income related trends in infant mortality inequalities in the Region of the Americas from 1955 to 1995.

Design: Infant mortality rates (IMRs) were computed and their trends assessed by ordinary least squares. Overall trends in IMR inequalities among countries were analysed by comparing 10 year period IMRs, Gini coefficients, and Lorenz curves. Income related trends in IMR inequalities were assessed using 10 year period IMR ratios between the highest and the lowest quintiles of the per capita gross national product (GNP) distributions (adjusted for purchasing power).

Setting: Aggregated country data were used for all countries with over 200 thousand inhabitants (33 geopolitical units). The 10 year period midpoint IMR estimates used for the 1955–1995 time series were those published by the United Nations in 1997.

Main results: IMRs decreased from 90.34 to 31.31 per 1000 live births between 1955 and 1995 at an average of 15.3 every 10 years. In contrast, Lorenz curves and Gini coefficients were similar for the five 10 year periods. After grouping by adjusted GNP distribution, a similar decreasing trend of IMR was observed in all groups. The rate ratio between the group at the lowest quintile and that at the highest quintile ranged from 4 to 5. The analysis of variance for repeated observations showed that there is a significant reduction in the IMR (F=130.18; $p<0.01$), that trends did not differ significantly among groups (F=1.16; $p=0.32$), and that they were approximately linear (F=155.83; $p<0.01$).

Conclusions: Despite a sizable reduction in the infant mortality, whether or not income related, levels of IMR inequality among countries have remained almost constant between 1955 and 1995 in the Region of the Americas. Further analysis and focused interventions are needed to tackle the challenges of reducing these persistent mortality inequalities.

The infant mortality rate (IMR) has traditionally been used as an indicator of the health conditions of the population. It is related to a variety of factors, such as socioeconomic status, maternal health, quality and access to health services, and public health practices. The IMR is one of the indicators that has experienced a sharp decline in recent decades in the Region of the Americas.[1] Had the rates at the beginning of the 1950s not changed, the number of annual infant deaths in Latin America and the Caribbean would have reached almost a million and a half in the 1990s, that is, around one million more than those actually registered between 1990 and 1994.[2]

The reduction in infant mortality is a priority for the Pan American Health Organisation (PAHO) and for many government programmes in the Region of the Americas.[3] Furthermore, in the Declaration of Alma Ata, countries committed themselves to reducing the IMRs up to 30 deaths per 1000 live births by the year 2000.[4]

In the 1990s this indicator has been subjected to several analyses using socioeconomic groupings to examine inequalities in the Region of the Americas, but most of them have been cross sectional. It has been shown that in the 1990–1994 period, the IMR in Latin America was around six times greater than that of Canada, which had the lowest rate in the Region at that time.[1] Another study shows the existence of an important inequality in the IMRs between the group with the greatest per capita gross national product (GNP) (7.9 per 1000 live births) and that with the lowest (63 per 1000 live births) for the 1991–1996 period.[5] In 1997, 35% of the deaths in children under 1 concentrated on 20% of the live births, which corresponded to the groups with worse socioeconomic situation.[6]

All the studies showed a reduction in the IMRs, while at the same time, showing major differences among the countries. This study has the purpose of responding to the following basic question: How has the inequality in infant mortality evolved in the Region of the Americas between 1955 and 1995?

In today's global economy, inequalities continue to increase. In 1960, the income gap between the richest fifth of the world's population and the poorest fifth was 30 to 1; in 1997 it was 74 to 1.[7] Achieving equity in health is of special importance in Latin America and the Caribbean, as these areas also show the greatest levels of inequity in income distribution in the world.[8]

There is evidence that people at a socioeconomic disadvantage suffer a heavier burden of illness and have higher mortality rates than their better off counterparts.[9] For this reason this perspective was incorporated into the analysis of the second part of the study. Although determining the causes of IMR inequity in the Region of the Americas is an important question and one that merits due reflection and debate, it lies beyond the scope of this article.

For PAHO, most inequalities in health are avoidable events. Measuring and documenting these inequalities is the first step for the development of public policies geared toward reducing and ultimately eliminating them.

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Abbreviations: IMR, infant mortality rate; GNP, gross national product; PPP, purchasing power parity

METHODS

Study population and data sources

All the countries in the Region of the Americas with a population above 200 000 inhabitants, that is 33 geopolitical units, were included in the study. Smaller countries were excluded to avoid unstable IMR estimates. The 10 year period midpoint IMR estimates used for the 1955–1995 time series were those published by the United Nations in 1997.[10]

Analysis

The study was divided into two parts, the first of which was devoted to the analysis of trends of infant mortality inequalities among the countries of the Region in the historical series. In this part, the infant mortality trend by 10 year periods, the percentage of countries that achieved the goal of IMR levels of 30 per 1000 live births or lower as well as the degree of inequality of the indicator among the countries were analysed.

Inequalities were measured with Lorenz curves and Gini coefficients in each period.[11]

The Lorenz curve is a cumulative frequency curve that compares the distribution of a specific variable with the uniform distribution that represents equality. This equality distribution is represented by a diagonal line, and the greater the deviation of the Lorenz curve from this line, the greater the inequality. The Gini coefficient is twice the area between the Lorenz curve and the diagonal, and takes values between 0 and 1, a value close to 1 indicating complete inequality. For its application in health, the "x" axis represents the cumulative population and the "y" axis the cumulative distribution of the health variable studied (for example, deaths). In the Gini index, people/groups or geographical units are ordered by the health variable under study, from the worst to the best situation. In this study, Gini coefficients were calculated using Brown's approximation.[12]

In the second part, the socioeconomic dimension was incorporated in the study by assessing the changes in the inequality between five groups of countries. These groups corresponded to quintiles of the GNP per capita adjusted by purchasing power parity (PPP)[13] at the midpoint of the period analysed (1975). As this information was not available for all the countries, the number of countries in the analysis dropped to 25, so the groups were constituted as follows: Group 1: The United States, Canada, Venezuela, Argentina, and Barbados; group 2: Mexico, Uruguay, Bahamas, Panama, and Costa Rica; group 3: Trinidad and Tobago, Brazil, Chile, Peru, and Colombia; group 4: Jamaica, Ecuador, Nicaragua, Guatemala, and the Dominican Republic; and group 5: Guyana, Paraguay, Belize, Honduras, and Haiti. The trend was analysed in the five groups of countries and the rate ratio was calculated between the group of countries in the lowest and highest quintiles.[9]

In both parts of the study trends analyses of the time series were complemented with simple linear regression, including the calculation of the slope of the straight line (β) and its standard error.

A repeated observations one way analysis of variance was performed with the purpose of evaluating the change in time of IMRs and the parallelism of the temporal trajectories among the groups defined in accordance with the corrected GNP. A test for linearity of trends was also carried out.

RESULTS

Part I : Trend of the inequality in infant mortality among countries of the Region

The IMR in the Region of the Americas declined from 90.34 per 1000 live births in 1955 to 31.31 in 1995, that is, a reduction of 65% (fig 1). Not all of the countries of the Region presented the same reduction. Four countries (Paraguay, Guyana, Bolivia, and Haiti) showed a decrease of 41 to 60%, while most of the countries (19 within the 33 countries included in the study) presented a reduction between 61 and 80% of the IMR.
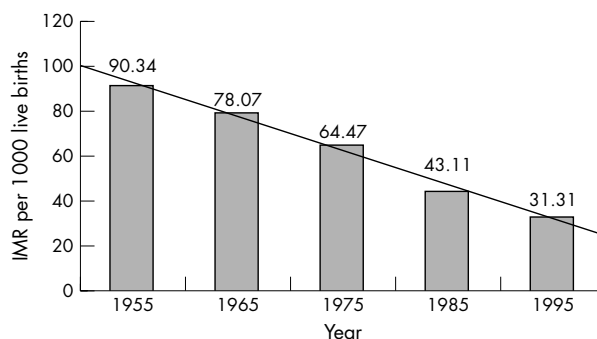

Figure 1 Trend of the infant mortality rates (deaths before 12 months of age per 1000 live births) in the Region of the Americas (33 countries), 1955–1995
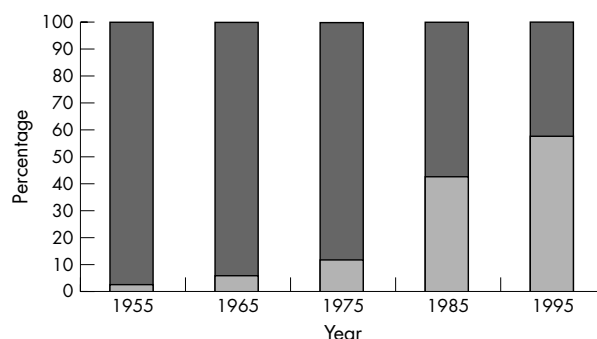

Figure 2 Percentage of countries of the Region of the Americas (33 countries) with infant mortality rates (deaths before 12 months of age per 1000 live births) equal or less than 30 per 1000 live births (goal of Health for All 2000), 1955–1995.

Ten countries or territories showed a decrease of more than 80% (Netherlands Antilles, Puerto Rico, Canada, Jamaica, Martinique, Guadeloupe, Cuba, Chile, Barbados). The countries that presented the highest percentage of reduction were Cuba (87.65%), Chile (88.33%), and Barbados (93.18%).

There was a sharper decline between 1970 and 1980 (rate difference of 21.36 per 1000 live births) as compared with the other periods (around 12 per 1000 live births). The slope (β) of the adjusted regression was −15.3 (SE=2.8), which amounts to an average reduction of 15.3 infant deaths per 1000 live births in every 10 year period. An important increase in the percentage of countries with an IMR below 30 per 1000 live births was also observed between 1975 and 1985 (12% to 39%, respectively) (fig 2). In 1995, 58% of the countries had achieved the goal set in Health for All by the Year 2000.

The Gini coefficients for mid-period years were: 0.32 in 1955; 0.28 in 1965; 0.29 in 1975; 0.34 in 1985, and 0.33 in 1995. The Lorenz curves for the same periods were also very similar (fig 3). They suggest that 50% of the deaths of the children under one year of age were concentrated in 30% of the population of live births.

Part II: Changes in inequality according to groups of GNP

Figure 4 shows decreasing trends of IMR in all five groups of countries classified by adjusted GNP. The trend is lower (β=−6.46; SE=1.79) in group 1, in which infant mortality presents lower values. For the remaining groups the regressions slopes were higher and very similar: group 2 (β=−20.98; SE=5.63); group 3 (β=−23.19; SE=2.92); group 4 (β=−23.44; SE=1.35); and group 5 (β=−26.68; SE=6.86), and represent a reduction of around 25 deaths per 1000 live births in every 10 years period. The regression lines of groups 3 and 4 are superposed in figure 4. The estimated rate ratios between extreme
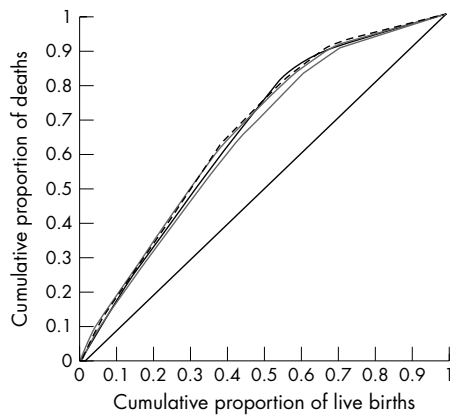
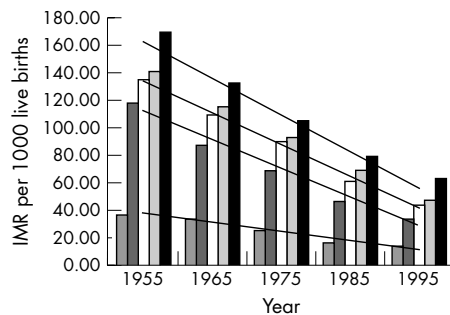**Figure 3** Lorenz curves for infant mortality rates. Region of the Americas (33 countries), 1955–1995.

Figure 4 Trends in the infant mortality rates (deaths before 12 months of age per 1000 live births) in 25 countries grouped by gross national product adjusted by purchasing power parity in 1975; Region of the Americas, 1955–1995. (Group 1: The United States, Canada, Venezuela, Argentina, and Barbados; group 2: Mexico, Uruguay, Bahamas, Panama, and Costa Rica; group 3: Trinidad and Tobago, Brazil, Chile, Peru, and Colombia; group 4: Jamaica, Ecuador, Nicaragua, Guatemala, and the Dominican Republic; and group 5: Guyana, Paraguay, Belize, Honduras, and Haiti).
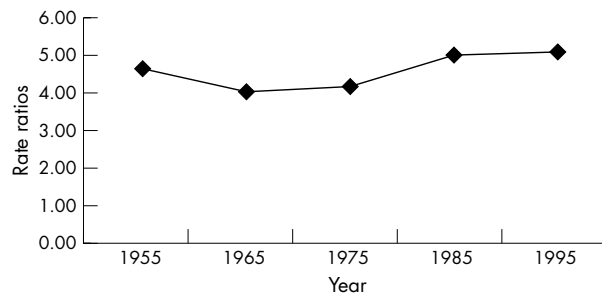

Figure 5 Trend of the rate ratio of infant mortality (deaths before 12 months of age per 1000 live births) between groups of countries (25 countries in this analysis) at the extreme quintiles of gross national product adjusted by purchasing power parity in 1975; Region of the Americas, 1955–1995.

quintiles of the distribution of the GNP were similar in the five periods, ranging between 4 and 5 (fig 5).

The analysis of variance for repeated observations showed that: (a) there is a significant reduction in the IMRs ($F=130.18$, $p<0.01$); (b) the trends do not differ among groups ($F=1.16$; $p=0.316$), and (c) the trends are approximately linear ($F=155.83$; $p< 0.01$).

In 1975 the median of GNP adjusted PPP of the countries under study was US$1940 per capita. This indicator has been increasing in the past decades, and the median for 1995 was

Key points

- IMRs decreased from 90.34 to 31.31 per 1000 live births between 1955 and 1995 in the Region of the Americas.
- In contrast, Lorenz curves and Gini coefficients were similar for the five 10 year periods. After grouping the countries by adjusted GNP distribution, a similar decreasing trend of IMR was observed in all groups. The rate ratio between the group at the lowest quintile and that at the highest quintile ranged from 4 to 5.
- Despite a sizable reduction in the infant mortality, whether or not income related, levels of IMR inequality among countries have remained almost constant in this period.

US$5870 per capita. There were some crossings of countries with respect to the stratification utilised (GNP adjusted PPP), mostly to the next category above and below. Only Chile jumped from group 3 in 1975 to group 1 in 1995.

DISCUSSION

There are few longitudinal studies of the inequality in infant mortality in the Region. Singh and Yu (1995)[14] studied the racial trends of IMR in the United States from 1950 to a projection in 2010, and concluded that even though infant mortality considerably decreased in the country, disparities between the black and white populations increased. Hollstein et al (1998)[15] analysed IMR in Chile in relation to educational differences of the parents of dead children between 1985 and 1995 and reported a decline in the indicator without changes in the relative inequalities.

Despite high levels of underegistration in the Region (between 10% and 50% in some of the countries),[2] IMR is one of the better validated indicators and there are good estimates of its level of underegistration, which make it a reliable instrument for documenting health inequalities.

In the 40 year period between 1955 and 1995 IMRs were reduced to one third of the value at the beginning of the period. However, the results of this study show that the inequalities persist.

From 1970 to 1980 there was a clearly sharper decline in IMR as well as an important increase in the proportion of countries that managed to reach the goal of 30 per 1000 live births. These facts can be attributed to several factors: (a) the implementation of the "Expanded Program of Immunization", coordinated internationally by PAHO in the Region of the Americas, which contributed to a 50% reduction in the mortality attributable to several of the main childhood diseases (diphtheria, tetanus, whooping cough, tuberculosis, measles, and poliomyelitis)[16] in children under 1; (b) the reduction of mortality from acute respiratory diseases due to earlier diagnosis and treatment of children at high risk for severe disease; (c) the large scale use of oral rehydration salts [16 17] that produced a dramatic reduction in mortality from acute diarrhoeal diseases, and (d) the emphasis on primary health care, that was one of the principal recommendations of the meeting of Alma Ata, in which the goal of health for all by the year 2000 was established.[4]

In the 1980s, the IMR continued to decrease despite an increase in poverty levels. Several possible reasons can be invoked, among them the influence of the application and/or transfer of technologies.

Some countries such as Paraguay, Guyana, Bolivia, and Haiti call for special attention because they achieved a lower IMR reduction than the Region's average. Paraguay, Guyana, and Haiti were included in group 5 of our study, which represents the lower GNP adjusted PPP. During these past decades, Paraguay gradually increased its GNP, but Guyana and Haiti continue in the lower quintile of GNP adjusted PPP in the American Region.[13] Bolivia was not included in the second

part of our study because of lack of information about GNP adjusted PPP for 1975, but for values referring to 1995, it is also situated in the lower quintile.

Conversely, some countries such as Cuba, Chile, and Barbados presented a very important IMR reduction. After the Cuban revolution in 1959, health and education were two of the most important government priorities. The entire population has free access to the health care system and health is a responsibility of the government.[18] Cuba has the highest proportion (58.2) of physicians for 10 000 inhabitant in the Region of the Americas and 99.9% of the deliveries are attended by trained personnel.[19] Other important factors reported as reasons for this achievement in Cuba were the universal infant immunisation coverage and the successful maternal breast feeding programme.[20]

According to Aguila and Munoz,[21] Chile has experienced great changes in its health conditions, because of economical, social, and demographic phenomena. In an analysis of the reduction of infant mortality rates in Chile between 1960 and 1994, Taucher and Jofre [22] evoked the demographic and socio-economic changes and improvement in health care that occurred during this period. It is suggested that 30% of the reduction in infant mortality between 1972 and 1982 (a period of economic crisis) was attributable to the decreasing proportion of births with high mortality risk, as a consequence of the fertility decline initiated in the mid-1960s. Bahr and Wehrhahn [23] suggest that one of the important factors related to this reduction was the development of primary and secondary health care, especially when applied to rural and marginal urban population. Chile also increased its GNP adjusted PPP considerably, from 2080 in 1975 to 10 860 in 1995.[13]

The country that presented the highest percentage of reduction was Barbados. In this country, the government is pursuing the goal of providing access to health care and a healthy environment to all its citizens.[24] Barbados has a high (51.2) proportion of nurses for 10 000 population, compared with other countries of the Region.[19] This country has been in the higher GNP adjusted PPP quintile of the Region since 1975.

Although the stratified analysis is subject to the effect of possible changes in the composition of groups over time, in the present case there were few crossings of countries with respect to the stratification used. The results are very consistent either taking or without taking into account the classification relative to the adjusted GNP. Countries at the upper quintile of the adjusted GNP distribution kept a constant difference in IMR from countries in the remaining quintiles. Groups 2 to 5 showed similar decreasing trends in IMR. Also the rate ratio between extreme groups were nearly constant, thus showing the persistence of a gap associated with income.

Social inequalities and inequality in health persist in countries of the American Region, perhaps as a consequence of economic policies. In many of the countries of the Region, such as Brazil, Colombia, Ecuador, and Mexico, the income Gini coefficient increased in the last decades.[25] Although government health expenditures in several developing countries are usually more beneficial for those better off than for to the poor, political will combined with effective public policies can move the focus of the expenditures of governments toward the poor. This could lead to reducing the gaps observed in the health sector. PAHO is committed to assisting countries in reducing these gaps and to achieve equity in health. This is considered an indispensable prerequisite for human development. There is still a growing need for identifying, measuring, and reducing the inequalities in living conditions and in the opportunities of access and utilisation of health services.[26]

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REFERENCES
1 **Pan American Health Organisation**. *Health in the Americas, 1998 Edition,* vol 1. Washington, DC: PAHO, 1998. (Scientific Publication no 569).
2 **Pan American Health Organisation**. *Health statistics from the Americas, 1998*. Washington, DC: PAHO, 1999. (Scientific Publication no 567).
3 **Pan American Health Organisation**. *Strategic and programmatic orientations, 1999–2002*. Washington, DC: PAHO, 1999. (Official Document no 291).
4 **World Health Organisation**. *Primary health care: Report of the International Conference on Primary Health Care*. Alma Ata, USSR, 6–12 of September 1978. Geneva: WHO, 1978.
5 **Pan American Health Organisation**. Director, Health people healthy spaces. *Annual Report of the Director PASB, 1996*. Washington, DC: PAHO, 1997. (Official Document no 283).
6 **Pan American Health Organisation**. Health situation in the Region of the Americas. *Annual Report of the Director, PASB, 1998*. Washington, DC: PAHO, 1999. (Official Document no 293).
7 **UNICEF**. *The state of the world's children 2000*. New York: UNICEF, 2000.
8 **Deininger K**, Squire L. A new data set measuring income inequality. *The World Bank Economic Review* 1996;**10**:565–91.
9 **Mackenbach JP**, Kunst A. Measuring the magnitude of socio-economic inequalities in health: an overview of available measures illustrated with two examples from Europe. *Soc Sci Med* 1997;**44**:757–71.
10 **United Nations**. *Demographic Indicators 1950–2050: 1996 Review*. New York: The United Nations, 1997.
11 **Wagstaff A**, Paci P, Van Doorslaer, E. On the measurement of inequality in health. *Soc Sci Med* 1991;**33**:545–57.
12 **Brown M**. Using Gini-style indexes to evaluate the spatial patterns of health practitioners: theoretical considerations and an application based on Alberta dates. *Soc Sci Med* 1994;**38**:1243–56.
13 **The World Bank**. *World Development Indicators, 1999 CD-ROM Database*. Washington, DC: The World Bank, 1999.
14 **Singh GK**, Yu S. Infant mortality in the United States: trends, differentials, and projections, 1950 through 2010. *Am J Public Health* 1995;**85**:957–64.
15 **Hollstein D**, Vega J, Carvajal Y. Desigualdades sociales y salud. Nivel socioeconómico y mortalidad infantil en Chile, 1985–1995. *Rev Med Chile* 1998;**126**:333–40.
16 **Pan American Health Organisation**. *The health conditions in the Americas, 1977–1980*. Washington, DC: PAHO, 1982. (Scientific publication no 427).
17 **Pan American Health Organisation**. Disease prevention and control. *Annual Report of the Director, PASB, 1980*. Washington, DC: PAHO, 1981. (Official Document no 177).
18 **Newell K**. *La salud por el pueblo*. Ginebra: Organización Mundial de la Salud, 1975.
19 **Pan American Health Organisation**. Special Program for Health Analysis, Pan American Health Organization. *Health situation in the Americas: basic indicators 2000*. Washington, DC: PAHO, 1992.
20 **Cuba**, Programa Nacional de Accion. *Cumbre Mundial en Favor de la Infancia: Tercer informe de segmento y evaluación*. La Habana: 1995.
21 **Aguila A**, Munoz H. Trends in birth rates, general, infantile and neonatal mortality in Chile from 1850 to date. *Rev Med Chile* 1997;**125**:1236–45.
22 **Taucher E**, Jofre I. Infant mortality in Chile: the great descent. *Rev Med Chile* 1997;**125**:1225–35.
23 **Bahr J**, Wehrhahn R. Life expectancy and infant mortality in Latin America. *Soc Sci Med* 1993;**36**:373–82.
24 **Pan American Health Organisation**. *Health in the Americas, 1998 Edition, vol II*. Washington, DC: PAHO, 1998. (Scientific Publication no 569).
25 **United Nations Development Programme**. *World Income Inequality Database*. New York: UNDP, 2000. [CD]
26 **Alleyne GAO**. *The health in the framework of reduction in the poverty*. The Meeting of the Permanent Forum for the Application of the Strategy of Cooperation to Development (DAC-OECD); Lima, Peru, 1998. Peru: PAHO, 1999. (PAHO/PER/99.03)