CAN WE REDUCE THE LEVEL OF BOTH AVERAGE RATE AND INEQUITY IN INFANT MORTALITY? THE CASE OF COLOMBIA

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Abstract

Previous studies for Colombia show important infant mortality inequalities by socioeconomic status. This paper advances in that direction. First, it measures socioeconomic inequalities in infant mortality. Second, it estimates the socioeconomic and demographic determinants for infant mortality using a Cox hazard model with time-varying variables. Finally, it simulates the impact of particular public policy interventions on the level of both infant mortality rates and its inequity. I use secondary data from the 1995 and 2000 Demographic and Health Surveys. I constructed an asset index as socioeconomic status indicator and as key inequality indicator I used the extreme groups and the concentration indexes. The results indicate that the development of appropriate aqueduct and sanitary installations, the promotion of education, and the promotion of the use of health services during pregnancy would lead directly to a reduction in both the level of infant mortality and its inequities. Among those public policies, the use of health services during pregnancy is the one with the highest impact on both average level and inequities in infant mortality in Colombia.

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Introduction

Previous studies for Colombia and other developing countries show important infant mortality inequalities by socioeconomic status. In the case of Colombia, health differentials by socio-economic status have been identified in a number of studies since the 1970's (Ministry of Health and Ascofame, 1972, Vivas J et al. 1988; Pabon A, Rodriguez E. and Rico J, 1984; Pabon 1991; Oróstegui M, 1990). These studies analyze health status, access and use of health services and distribution of health resources. They all point the existence of a constant positive relationship between health indicators and income, health and level of urbanization, and urban/rural health differences. A considerable number of studies have also analyzed the determinant factors in health but few have related them to inequalities or inequities in health (CIE, Universidad de Antioquia 2001; Florez and Nupia, 2001; Ministry of Health and Econometria, 2001). In assessing the status of health, measured in terms of infant mortality and chronic malnutrition among children, Florez and Nupia (2001) find for 1995 that the educational level of the mother and the use of health services for childcare are factors that contribute to inequities. There are also important effects derived from contextual factors, such as the socioeconomic inequities of a region, poverty, and geographical isolation (CIE, 2001). The positive effect of socioeconomic level on health status is the greatest in regions with the highest inequality, whether measure in terms of poverty levels, income distribution or educational level.

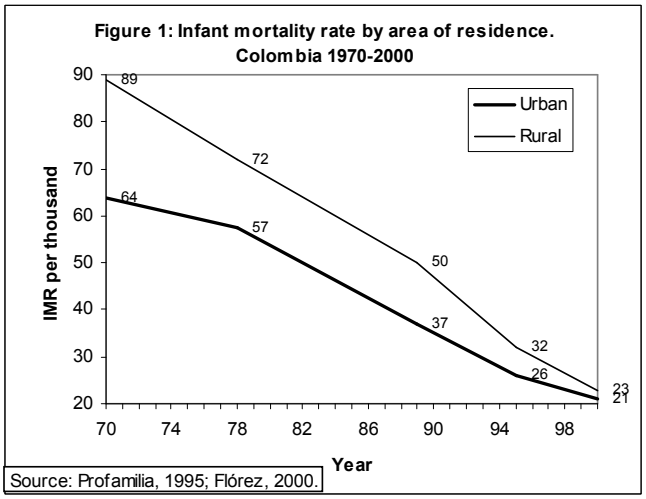
Despite the enormous contribution of existing studies to understand the relationship between infant mortality and its determinants, more research needs to be done on the contribution of these elements to the inequities observed in infant mortality. This paper explores several challenges in that direction. First, it identifies levels and inequalities in infant mortality in Colombia in 1995 and 2000. Second, it analyses, for year 2000, the relationships between macro and micro determinants of infant mortality and the inequities at the national level. Third, it proposes different policy interventions on how to address those health inequities.

Trends in infant mortality in Colombia

During the second half of the 20th century, several structural and demographic changes took place in Colombia. Advances in medicine, transfer of biomedical technology, public investments in health and education, improvements in economic conditions, and the urbanization process among others were factors that positively affected living conditions and led to a decrease in mortality and fertility rates. The infant mortality rate declined from 186 per thousand in the 1930s to 135 in 1950, to 57 in 1980, and to 21 per thousand in 2000. The most important changes occurred between 1950 and 1970. By the end of the century, when infant mortality reaches relatively low levels, the rate of decline slowed down and the major causes of infant deaths shifted from exogenous to endogenous factors (Flórez, 2000).

Infant mortality has always been higher in rural than in urban areas (Figure 1). This inequality by area of residence reflects the poor socioeconomic, health and educational conditions prevalent in rural areas. However, the rural-urban differential follow the expected pattern (CEPAL, 1995). When infant mortality is high, it is high in both urban and

rural areas. Since infant mortality declines first in urban areas, the rural-urban differential increases. Later, rural infant mortality declines and rural and urban rates tend to converge (Figure 1). By 2000, rural and urban infant mortality are very similar. There is no doubt that the factors that played an important role in infant mortality decline in both urban and rural areas were the implementation of strategies based on the principles of primary health services, the public investment in maternal health, the national and international programs towards universal coverage in vaccination schemes, and the public investment in improving sanitary and environmental conditions (Florez, 2000).



The Data

I use data from Demographic and Health Surveys (DHS) carried out in 1995 and 2000 in Colombia. DHS are part of the Macro International worldwide surveys. They are designed mainly to collect information on family planning, maternal and infant health, infant survival, and other aspects of reproductive health. Both surveys were nationwide with a multistage and probabilistic sample design of households. It is representative of regional and sub regional areas including the major urban centers in the country.

The DHS questionnaire includes sections on household characteristics (housing conditions, general demographic characteristics of their members), women in reproductive age (marriage, fertility, family planning, maternal health, etc.) and their children (complete birth histories, prenatal care, breastfeeding, diseases, nutrition, etc.). The sample for the analysis is limited to children ever born (CEB) during the five years previous to the survey from the women interviewed. These account 5,050 children in DHS- 2000. Deaths were highly concentrated in the first month of life, and very few deaths were reported after 24 months of age.

Methods

Measurement of SES

None of the DHS include a section on household consumption and earnings. However, all have questions on the housing conditions (access to basic services–water and sewerage–

flooring material, overcrowding) and on family assets–car, motorcycle, TV, blender, fridge, radio, tractor (rural) etc.–that provide an idea of the economic condition of the household. I use the methodology developed by researchers at the World Bank and Macro International that uses an analysis of principal components to measure household wealth by an index of physical assets. It uses variables on housing conditions and physical assets. In this case, socioeconomic status of the household is defined in terms of fixed assets or wealth, and not in terms of earnings or consumption. The asset index is defined for the household, and each individual receives the index value for his/her household.

Analytical Framework

Inequities

Inequality indicates relevant and systematic differences between individuals and groups in a given society or community. I adopt here the approach in which inequalities in health that are unnecessary, avoidable and unfair are defined to be inequitable (Whitehead, 1992; Braveman, 1998). Only inequalities from biology differences (e.g. sex or age) or those that arise from freely adopted harmful behavior are not inequitable. Therefore, one can observe inequalities by geographical area, socioeconomic status, gender or race. However, those by socioeconomic status are the ones considered in this paper.

There are some available indicators for the measurement of health inequities by socioeconomic status (SES) (Wagstaff, Kakwani and VanDoorslaer, 1997; Mackenbach and Kunst, 1997; Dachs, 2001). Two of those available forms of measurement were used here: extreme groups (relationship between low/high SES) and the concentration index (Gini-type coefficient). Wagstaff has applied the concentration index in several countries and I follow his methodology (Wagstaff, 1999).[1] The sign of the concentration index (CI) indicates progressiveness or regressiveness in the health variable distribution according to the attribute of the variable under analysis. Since mortality is a negative attribute, a negative concentration index indicates survival conditions favoring the higher socioeconomic groups.

General conceptual framework

Based on available literature, I start from the assumption that the positive relationship between health and socioeconomic status (the social gradient) is brought about by complex causal relationships by which several causes act on health. The general conceptual framework used here is based on the extensive literature on the subject (Mosley Chen 1984, cited by Casterline, Cooksey and Fattah, 1989-; Evans et al. 2001; Goldman 2001; Wagstaff, 2002; Palloni and Tienda, 1986; Pebley and Stupp, 1987).

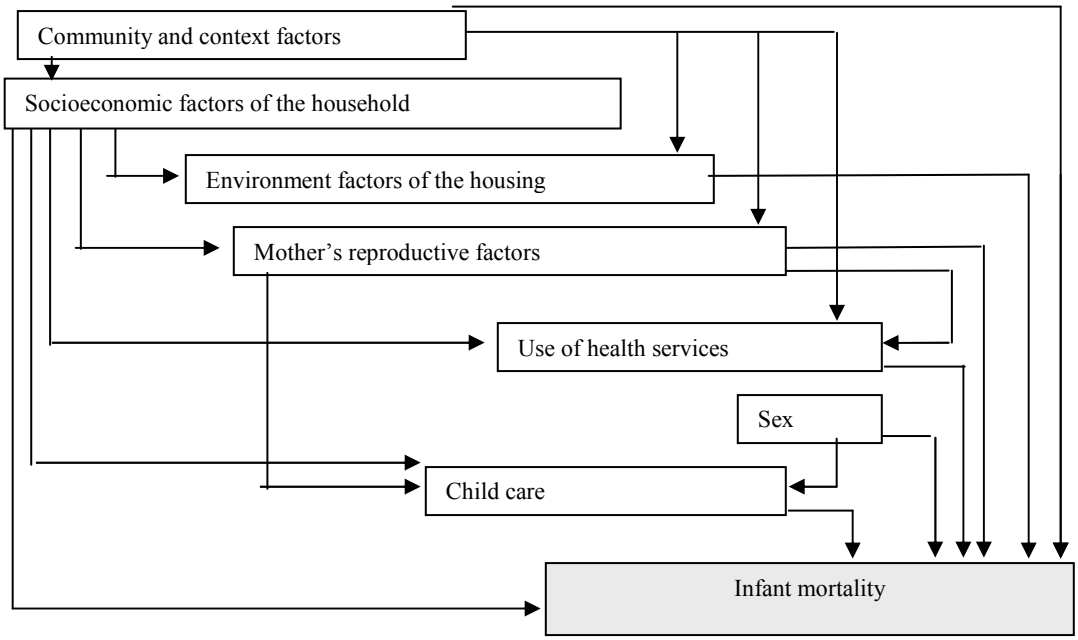
The conceptual framework starts with government policy for health and related sectors in which the supply and financing of health services and other sectors services affect health. The supply of health services–in terms of availability, accessibility, price and quality–affects its use and then affects health status (nutrition, morbidity, mortality, etc.). The supply of other services (infrastructure, access to water supplies and sewerage) affect health practices, and hence, health status. Therefore, government policy and action indirectly affect health status through factors that influence health practices and hygiene in the household, and those factors are usually classified as socioeconomic determinants of health.

In the household, there are a number of risk factors and actions that have a direct influence on health status ("proximal factors"). These include the use of preventive and curative health services, nutrition, hygiene, lifestyle, biological considerations, demography and reproductive habits, among others.

The infant mortality model

Following the conceptual framework explained above, a conceptual hierarchical model for analysis was constructed with risks factors potentially associated with infant mortality. The basic idea of a hierarchical model is that factors higher in the hierarchy (partially) determine the ones below them, as a linked chain (Victora et al., 1997). Factors most proximal to the outcome are the ones that are most directly associated. According to this framework, socioeconomic variables, including socioeconomic status, must affect child survival directly or by the different sets of proximate determinants (environmental factors, mother's reproductive factors, use of health services, and child care variables). Each set of proximate determinants, in turn, affect child survival directly or through the set of variables in a lower hierarchy. The factors and its hierarchical structure are shown in Figure 2.

Figure 2: Risk factor hierarchy for infant mortality model



The model includes community and context factors such as years of education of adult women in the municipality, region and area of residence (Level 1). Household socioeconomic factors (Level 2) include asset index, and mother's education. Household environment and hygiene factors, such as the source of drinking water, access to sewerage, flooring material, and crowding conditions are added at Level 3 jointly with household characteristics such as female household head and proportion of children previously dead in

the household. Mother's reproductive factors (age at childbirth, birth order, preceding birth interval and survival of the previous child) are part of Level 4. Sex of the child and use of health services (adequate prenatal care and delivery by physician) are added in Level 5; and finally a variable related to the care of the child (breastfeeding as a varying variable) is included in Level 6.

Since complete fertility histories are available, a duration analysis is used and a probability model for survival during the first year of life was constructed. The dependent variable is the risk of dying at each age between birth and one year, and time duration is measured in months. We use a Cox proportional risk semi-parametric model with covariates (Lelievre and Bringe, 1998; Rodriguez, 2001).

Socioeconomic inequities in infant mortality

Table 1 shows the level and the extent of socioeconomic inequalities in infant mortality by sex and area of residence. Infant mortality rate by socioeconomic groups, extreme group ratios and concentration indexes clearly evidence inequities, favoring the higher socioeconomic groups[2]. There is a large gap between the bottom and the upper quintile, and the mortality rate declines monotonically as assets distribution increases. This suggests that survival conditions are worse for poor children than for better off children and that those conditions improve as SES increases. Infant mortality in the poorest group is more than twice that of the richest group.

Results indicate that during the last five years, reduction in infant mortality has been very modest, and inequities have increased. Infant mortality was 27 per thousand in 1995 and 21 per thousand in 2000. The decreasing trend occurred in both urban and rural areas, but it was more significant in rural areas. In 1995, the rural mortality rate was 1.3 times the urban rate, but in 2000 it dropped to 1.2 times (Table 1). In contrast to higher infant mortality in rural areas, average inequities are smaller. In other words, there is higher infant mortality in rural areas but fewer differences between socioeconomic groups (lower CI in rural than in urban areas, Table 1).

The decline in infant mortality between 1995 and 2000 has been accompanied by an increase in inequity, greater in cities than in rural areas. The concentration index in cities went from –0.057 to –0.132, and in rural areas from –0.052 to –0.078 (Table 1).[3] It seems that the highest socioeconomic groups, especially in urban areas, benefited more by the improvement in health than the poorest groups. These Colombian results confirm the findings of Wagstaff (2001) in other developing countries, where improvements in the average health status have been accompanied by greater inequities. Reducing infant mortality in India, for example, have occurred parallel to an increase in inequities.

What underlines these inequalities in infant mortality? One can assume that there is an association between income inequality and infant mortality inequality. However, there might be other characteristics associated with SES that cause those inequities.

Table 1: Infant mortality rate and socio-economic inequities by sex and area of residence. 1995 and 2000

Infant mortality rate (per thous)	1995	2000
Total	27,3	20,6
Sex: Male	32,3	25,9
Female	22,0	15,0
Male / Female	1,5	1,7
Area: Urban	24,7	19,3
Rural	31,8	23,4
Rural / Urban	1,3	1,2
Socioeconomic inequities (CI)	**1995**	**2000**
Total	-0,110	-0,091
Sex: Male	-0,088	-0,127
Female	-0,147	-0,050
Area: Urban	-0,057	-0,132
Rural	-0,052	-0,078
N	5.141	4.670

Infant mortality models estimation

The variables and their inequalities

The first three columns of Table 2 show the mean, the concentration index and the extreme ratios of the covariates used in the estimation of the Cox model. The variables to be included were selected according to the conceptual hierarchical model defined above.

Unsurprisingly, better socioeconomic and household characteristics are more common on rich people. The better-off groups have higher educational level; tend to live in more developed and urbanized areas while the poor are more likely to have less education and to live in rural and less developed areas. Rich people are also more likely to have piped drinking water while the poor tend to rely on wells and on surface water. The poor are more likely to have a latrine or pit or not have any formal sewerage connection at all, while the rich families are more likely to have a restroom inside the dwelling. The poor tend to have raw floors (earth or sand) while the rich are more likely to have finished floors made from fine material (polished woods, ceramic, carpet, etc). The poor are more likely to live in crowding conditions (3 or more persons per bedroom) while the rich are more likely to live in large spaces. Female household heads are more likely to be present among the rich. The poor are more likely to have higher proportions of children dead than the rich.

Mother's education, a well known determinant of child survival, indicates that better-off women are better educated than poor women (Table 2). Mother's reproductive characteristics (age at childbirth, child's birth order[4], and length of previous interval) indicate that the start, the level and the timing of reproductive patterns are skewed towards worse-off women. Two indicators were included to capture the use of health services: adequate prenatal care[5] and delivery by physician / delivery at health institution. Women in high socioeconomic groups are more likely to have adequate prenatal care while poor women have much less prenatal visits during pregnancy. Similarly, better-off women tend to deliver their child at a health institution or be attended by a physician while poor women are more likely to deliver at home and be attended by a midwife.

Breastfeeding was included as a childcare variable and it was included as a time-varying variable. Available literature indicates that duration of breastfeeding has a direct positive effect on child survival, especially in poor sanitary conditions. Duration of breastfeeding has a skewed SES distribution towards the poor, which means that better-off children have (if any) shorter breastfeeding periods than poor children.

Estimated Cox model coefficients

Table 2 also reports the log-odds coefficient estimates indicating Gross and Net effects. According to the hierarchical approach, the full (gross) effect of a factor is estimated without the factors in lower levels of the model. [6] The net effect of a factor is estimated including all defined levels in the model. Elasticities based on gross effects are estimated at the sample mean.[7]

Among the community and context factors, only the place of residence showed significant effects. Children living in a small city or in rural areas have a relative risk of dying almost twice times as much as those children living in capital cities. Surprisingly, educational level of adult women did not show any significant gross effect.

Mother's education–included in the second hierarchy as proxy of socioeconomic characteristics–shows significant and positive gross effects on children's survival prospects. Thus, the risk of dying among children decreases as mother's education increases. However, the quadratic term indicates a decreasing effect.[8] The effect of mother's education is not longer significant, after introducing the variables in lower hierarchies, and in particular after adjusting for mother's reproductive characteristics and childcare variables. Asset index, the SES variable, did not show any significant gross effect.

Among the variables included in the environmental factors of the household hierarchy, the main source of drinking water, the flooring material and the crowding conditions have significant gross effects. Piped water inside the household, finished floor and non-crowding conditions reduce infant mortality risks.

Children living in households where water comes from piped network or from a well inside the plot have a risk 30% lower than that of children living in households with other source of drinking water (Table 2). Results on sanitation indicate that access to sewerage does not have significant gross effects but it does have a significant net effect after introducing mother's reproductive factors. Type of floor material has a significant gross impact on child

survival: children living in households with unfinished floors (earth or sand) have a risk of mortality 60% greater than that of children living in households with finished floors. Children living in large spaces have a relative risk of dying of 30% lower than that of children living in crowding conditions. Female as household head and the proportion of previous children dead in the household did not show significant gross effects.

Table 2: Estimated Cox survival model for children under one year of age. COLOMBIA 2000

	Variable	Variable definition			Resuls from the model		
		Mean or % in the category	Concentration Index	$5^{th}Q$ / $1^{st}Q$	Gross effect	Gross Elasticity	Net effect
Level 1	*Community and context factors*						
	Mean years of education adult women	5,1	0,063	1,33	0,932	-0,361	0,892
	Region of residence: Atlantica	27,8	-0,211	0,38	0,779	-0,069	1,228
	Oriental	17,0	-0,046	0,89	0,662	-0,070	0,796
	Central	25,6	0,064	1,43	0,541	-0,157	0,649
	Pacífica	16,3	-0,126	0,71	0,962	-0,006	1,308
	Bogota (ref)	13,2	0,424	-	1,000		1,000
	Place of residence: Capital city (ref)	29,1	0,383	17,69	1,000		1,000
	Small city	23,5	0,230	6,11	1,944 *	0,154 *	1,441
	Town	14,7	0,054	1,23	1,705	0,079	1,398
	Rural area	32,7	-0,568	0,03	1,935 +	0,216 +	1,280
Level 2	*Socioeconomic factors of household:*						
	Asset index	-0,6	-2,512	(2,1; -3,7)	0,986	0,008	1,077
	Years of mother's education	7,0	0,183	2,70	0,952 +	-0,342 +	0,988
	Square years of mother's education				0,990 +	-0,154 +	0,986 **
Level 3	*Environment factors of the housing*						
	Source of drinking water: Aqueduct	81,1	0,150	2,44	0,702 +	-0,287 +	0,744
	Type of toilete facility: Any	87,8	0,100	1,69	0,753	-0,249	0,546 **
	Main floor material: Unfinished	18,3	-0,637	0,02	1,604 +	0,086 +	1,287
	Crowding conditions: 3+ persons/room	37,0	-0,294	0,00	0,695 *	-0,135 *	0,586 **
	Female head of household	21,1	0,082	1,56	1,017	0,004	0,987
	Proportion of children dead in hhold	6,8	-0,290	0,27	1,180	0,012	0,749
Level 4	*Mother's reproductive factors:*						
	Mother's age at child birth	25,8	0,011	1,07	0,963 *	-0,983 *	0,966 **
	Square years of mother's age childbirth				1,007 ***	0,291 ***	1,007 ***
	Birth order	2,4	-0,112	0,54	1,428 *	0,855 *	1,282
	Square of birth order				0,875 ***	-0,387 ***	0,887 ***
	Length of previous interval: 1 st birth	37,5	0,107	1,87	1,000		1,000
	<15 months	3,6	-0,152	0,29	1,701	0,019	1,634
	15-23 months	12,9	-0,169	0,28	0,883	-0,016	1,644
	24-35 months	14,0	-0,183	0,32	0,682	-0,054	1,319
	> 35 months	32,0	0,040	1,13	0,560	-0,185	1,098
	Surviving of previous child	1,8	-0,212	0,75	0,583	-0,011	0,726
Level 5	*Use of health services:*						
	Adequate prenatal care	61,7	0,130	1,98	0,352 ***	-0,640 ***	0,518 ***
	Delivery by physician	85,9	0,080	1,45	0,754	-0,242	0,742
	Sex of the child: Male	51,0	0,005	1,03	1,727 ***	0,277 ***	1,543 **
Level 6	*Child care:*						
	Breastfeading (months)	10,4	-0,037	0,77	0,020 ***	-2,043 ***	0,020 ***
Log-Likelihood							-668,79 ***
d.f.							30

(-) The value of the variable for the 1^{st} Quintile is zero.

+ Significant at 15%, * Significant at 10%; ** significant at 5%; *** significant at 1%

The variables included in the hierarchy of mother's reproductive factors such as age at childbirth, parity, and previous birth interval, greatly contribute to improve infant survival. Higher parity, teenage mother and short birth intervals were all strongly associated with a statistically significant higher risk of mortality. In all model specifications, the effect and statistical significance of this set of variables did not change after including variables in lower hierarchies.

Among the variables included in the hierarchy related to the use of health services, adequate prenatal care was significantly associated with a lower risk of infant mortality. Thus, children with adequate prenatal care have a 65% lower mortality risk than children who had inadequate prenatal care (Table 2). Sex of the child was included in the models as a control variable. As expected, males have higher risk of mortality than females, and both gross and net effects are highly statistically significant.

With regards to the child care variables, only breastfeeding was included, since vaccination schemes, morbidity indicators, and food habits were collected only for surviving children[9]. Breastfeeding was included as a time-varying variable since it is affected by age of the child.[10] A breastfed child clearly has better survival prospects than a non-breastfed child– the effect is large and highly statistically significant (Table 2).

In summary, the results of the models indicate that education of the mother, access to water and sanitation (flooring material), mother age at childbirth, birth order, adequate prenatal care, and breastfeeding are the most significant determinants. With the exception of breastfeeding, all these significant determinants contribute to inequities in infant mortality since all of them are skewed towards groups with lower SES index.

The effects of public policy interventions

The contribution of a factor to the inequities observed in infant mortality not only depends on its effect on mortality, but also on its inequity in itself. For example, a variable that has a large and statistically significant effect on the risk of dying but it has an equitable distribution between socioeconomic groups would have an impact on the level of infant mortality but not so on its inequity. Based on the results from the Cox model and the observed inequities in each included covariate–presented above–, this section tries to simulate the effect of improving socioeconomic and demographic conditions on both the average rate and inequity in infant mortality. Four simulations were done using variables that showed to be significant in the models and have unequal SES distributions against the poor groups. First, mother's education was improved to at least secondary education. Second, aqueduct as source of drinking water was assumed for all households. Third, giving access to sewerage to all household was simulated. Fourth, access to adequate prenatal care was assumed for all births. Table 3 reports the simulated results in terms of infant mortality rate–total and by socioeconomic groups, extreme ratios and concentration index[11]. All public policy simulations produce a reduction in both the level of IMR and its inequity. However, there are differences in the magnitude of the impact of each public policy.

Table 3: Simulations of public policy interventions on the average rate and inequity of infant mortality, Colombia 2000

	Indicator	Variable used in the simulation			
		Mother´s education (secondary)	Drinking water from Aqueduct	Toilete facility	Prenatal Care
ORIGINAL	Total IMR (per thous)	21,1	21,1	21,1	21,1
	Concentration Index	-0,125	-0,109	-0,109	-0,108
	IMR (per thous) by SES Quintile:				
	1st Quintile	26,9	27,6	27,6	27,5
	2nd Quintile	23,0	20,6	20,6	20,8
	3th Quintile	19,4	18,8	18,8	18,1
	4th Quintile	15,9	17,9	17,9	18,9
	5th Quintile	13,4	15,7	15,7	15,0
	1st Quintile / 5th Quintile	2,0	1,8	1,8	1,8
AFTER	Total IMR (per thous)	20,4	19,5	20,3	12,6
	Concentration Index	-0,111	-0,058	-0,080	-0,024
	IMR (per thous) by SES Quintile:				
	1st Quintile	25,1	22,1	24,4	13,6
	2nd Quintile	22,2	19,8	20,0	12,1
	3th Quintile	19,2	18,8	18,8	12,0
	4th Quintile	15,8	17,9	17,9	12,5
	5th Quintile	13,3	15,7	15,7	11,7
	1st Quintile / 5th Quintile	1,9	1,4	1,6	1,2

Note: The original IMR are the estimated rates from the model up to the included variable category.

The estimated infant mortality rate (from the model up to the second hierarchy) is 21 per thousand with extreme ratio of 2 and concentration index of -0,125. Improving mother's education would reduce the rate of mortality to 20,4 and would improve equity by reducing infant mortality in the two poorest socioeconomic groups while infant mortality would remain the same in the middle and upper groups of the SES distribution. The extreme ratio would decrease to 1,9 and CI would decrease to -0,111. This result suggest that a social public policy on education should be considered along with the package of basic health services in order to obtain substantial improvements in both child survival prospects and its equity.

Improving sanitary conditions (access to aqueduct or to sewerage) would have similar effects on the total infant mortality rate but greater impact on improving equity than mother's education. Total infant mortality would decline to a level around 20 per thousand but it would decline mainly in the first poorest socioeconomic group. The impact is higher in improving access to drinking water than giving access to sewerage. Extreme ratios and CI would decline much more in the first case than in the second one. Programs towards appropriate sanitary installations should be considered along with the package of basic health services to obtain essential reductions in both infant mortality and its inequities.

Giving access to adequate prenatal care to all births would significantly reduce both infant mortality rate and its inequity. Infant mortality would be reduced in all socioeconomic groups, but especially in those in the bottom of the SES distribution. Total infant mortality would be reduced from 21 to 12 per thousand, extreme ratios would decrease from 1,8 to 1,2 and the concentration index would approach zero (the equity line). Thus, the use of health services during pregnancy should be strengthened in all programs that aim to improving child health.

Conclusions

This paper has analysed the relationship between socioeconomic inequalities and infant mortality in Colombia in which infant mortality has been declining since the middle of 20th century. Results show that socioeconomic inequalities in infant mortality are against the poor reflecting the major social inequalities present in the country. The results also indicate that there are others important factors–such as sanitation, access to health services and demographic factors–associated to infant mortality that considerably contribute to its inequalities.

Analysis of the socioeconomic and demographic determinants affecting infant survival prospects reveals that mother's education, access to water and sewerage, mother age at childbirth, birth order, adequate prenatal care, and breastfeeding are the most significant determinants. With the exception of breastfeeding, all contribute to the inequities in infant mortality since all of them show a regressive effect on the SES distributions by themselves. The importance of factors in child health status not related to the healthcare sector–such as mother's education, access to basic infrastructure and family planning–indicates that improvements in the level and equity in health is not only the result of efforts of the healthcare sector, but also the result of collaboration between several social sectors–at least healthcare, education and infrastructure.

Public policy interventions should not try only to obtain lower infant mortality but to decline the level of both average rate and inequity in infant mortality. Simulations of the effects of different public policy interventions on infant survival prospects point out that the development of basic service networks for aqueduct and sewerage–appropriate sanitary installations–the promotion of education–especially addressed to the lower socioeconomic groups–and the promotion of the use of health services during pregnancy would lead directly to a reduction in both the level of infant mortality and its SES inequities. Among those public policies, the use of health services during pregnancy is the one with the highest impact on both average level and inequities in infant mortality in Colombia.

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References

Braveman, Paula (1998), *Monitoring Equity in Health: A Policy-Oriented Approach in Low-and Middle-Income Countries*, Geneva, WHO (Division of Analysis, Research and Assessment).

Casterline, John; Cooksey, Elizabeth, y Fattah, Abdel (1989), "Household Income and Child Survival in Egypt", in *Demography,* vol. 26, No. 1, February, pp. 15-36.

CEPAL (1995). *América Latina: Mortalidad en la Niñez*. Una base de datos actualizada en 1995. CELADE-UNICEF.

CIE, Universidad de Antioquia. (2001), *Observatorio de la seguridad social*, Medellín, Grupo de Economía de la Salud (GES), December, Year 1, No. 3.

Dachs, Norberto (2001), "Inequidades en salud. Cómo estudiarlas", in Restrepo, Helena y Málaga, Hernán (edits.), *Promoción de la salud. Cómo construir vida saludable*, s. l., Panamericana.

Evans, T. et al. (2001), "Introduction", en Challenging Inequities in Health. From Ethics to Action, s. l., Oxford University Press.

Flórez, C.E. (2000). Las Transformaciones Sociodemográficas en Colombia durante el Siglo XX. Bogota. Tercer Mundo Editores. pp 181.

Flórez, C. E. y Nupia, O. (2001), Inequidades en el acceso a salud. Estado de salud y utilización de los servicios de atención a la salud, Final report to PAHO, Estudio multicéntrico, Bogotá, CEDE, Universidad de Los Andes.

_____ y Nupia, O. (2001), *Tendencias en las inequidades en el acceso a los servicios de salud en la población colombiana. 1990-2000*, Monografía 1, Final report to Fundación Corona, Bogotá, CEDE y Centro de Gestión Hospitalaria.

Goldman, Noreen (2001), "Social Inequalities in Health. Disentangling the Underlying Mechanisms", in *Annals of the New York Academy of Sciencies*, No. 954, pp. 118-139.

Gwatkin, Davidson R. *et al*. (2000), *Socioeconomic Differences in Health Nutrition, and Population in Colombia*, s. l., HNP Poverty Thematic Group of the World Bank.

Lelievre, Eva y Bringé, Arnaud (1998), "Méthodes et Savoirs No. 2", in *Practical Guide to Event History Analysis,* s. l., Institut National D'études démographiques.

Mackenbach, J. y Kunst, A. (1997), "Measuring the Magnitude of Socioeconomic Inequalities in Health. An Overview of Available Measures Illustrated with two Examples from Europe", in *Social Science and Medicine*, vol. 44, No. 6, pp. 757-771.

OPS (2001), *Hoja Resumen sobre desigualdades en salud,* s. d.

Oróstegui, M. (1990), "Situación de salud", en Yepes, F. (edit.), *La salud en Colombia*. *Estudio Sectorial de Salud*, Bogotá, Ministerio de Salud, Departamento Nacional de Planeación.

Pabón, A. (1991), *Demanda y utilización de servicios de salud*. *Encuesta nacional sobre conocimientos, actitudes y prácticas en salud*, Bogotá, Ministerio de Salud, Instituto Nacional de Salud.

_____; Rodríguez, E., y Rico, J. (1984), *Demanda y utilización de servicios de salud*. *Estudio nacional de salud*, Bogotá, Ministerio de Salud, Instituto Nacional de Salud.

Palloni, Alberto y Tienda, Marta (1986), "The Effects of Breastfeeding and Pace of Childbearing on Mortality at Early Ages", en *Demography*, vol. 23, No. 1, February, pp. 31-52.

Pebley, Anne y Stupp, Paul W. (1987), "Reproductive Patterns and Child Mortality in Guatemala", in *Demography*, vol. 24, No. 1, February, pp. 43-60.

República de Colombia, Ministerio de Salud y Ascofame (1972), *Methods and Results*. *Study of Human Resources for Health and Medical Education in Colombia*, Bogotá.

República de Colombia, Ministerio de Salud y Econometría. (2001). *Evaluación y reestructuración de los procesos, estrategias y organismos públicos y privados encargados de la afiliación, pago y recaudo de aportes al sistema*. Manuscrito.

Rodríguez, Germán (2001), *Generalizer Linear Statistical Models,* Notes, s. l., Princeton University.

Victora, C. G. *et al.* (1997), "The Role of Conceptual Frameworks in Epidemiological Analysis. A Hierarchical Approach", in *Int J Epidemiol*, No. 26, pp. 224-227.

Vivas, J. *et al.* (1998), *El sistema nacional de salud*, Bogotá, Fedesarrollo, Organización Panamericana de la Salud.

Wagstaff, Adam (2002), "Poverty and Health Sector Inequalities", Theme papers, in *Bulletin of the World Health Organization*, No. 80, pp. 97-105.

_____ (2001), *Poverty and Health*, s. l., Comission on Macroeconomic and Health Working Paper Series, Paper No. WG1.

_____ (2000), *Unpacking the Causes of Inequalities in Child Survival. The Case of Cebu, The Philippines*, s. l., The World Bank Working Paper.

_____ (1999), *Inequalities in Child Mortality in the Developing World. How Large are They? How can They be Reduced?,* s. l., Working Paper of the World Bank.

_____; Kakwani, N., y Doorslaer, E. van (1997), "Socioeconomic Inequalities in Health. Measurement, Computation and Statistical Inference", in *Journal of Econometrics*, No. 77.

Wagstaff, Adam; Doorslaer, E. van, y Watanabe, N. (2001), *On Decomposing the Causes of Health Sector Inequalities with an Application to Malnutrition Inequalities in Vietnam*, s. l., The World Bank Working Paper.

Whitehead, M. (1992), "The Concepts and Principles of Equity and Health", in *Int J Health Serv*, No. 22, pp. 430-445.

[1] The concentration index, like Gini coefficient, is the area between the distribution (concentration) curve observed and the diagonal. The concentration index may vary from -1 to 1. It is zero when there is perfect equity. The further away from zero, the greater the inequity.

[2] Socioeconomic inequities were also estimated separately for urban and rural areas controlling by sex. However, only totals are used here.

[3] It must be remembered that the further away from zero, the greater the inequity.

[4] It is defined chronologically and indicates the number of children previously born to the same mother.

[5] Adequate prenatal care was defined as having at least 4 prenatal visits during pregnancy

[6] If, for instance, the effect of a factor is reduced when more proximal factors are added to the model, these mediate part of the effect of the more distal factor (Victora et al., 1997).

[7] In the case of categorical variables, the elasticity indicates the effect of increasing the particular category in a given percentage whereas the other categories are proportionally reduced.

[8] The variable was standardized to reduce correlation problems.

[9] Weight at birth was also excluded due to the high percentage of missing in this variable (about 30% in each country).

[10] Age at date of the survey for surviving children or age at death affects duration of breast-feeding: younger children or children who died earlier in life has shorter breast-feeding durations.

[11] The simulated results are obtained by applying the coefficient vector (crude effects from the hierarchy corresponding to the simulated variable) to the counterfactual distribution of the vector x. Survival distribution and its associated infant mortality rate, total and by SES quintile, are then re-estimated.