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Abstract

Data from 4 Latin-American countries are used to test the impact of socio-economic status (SES) on infant mortality across countries. Bolivia, Dominican Republic and Perú belong to a cluster of late beginners of the modern demographic regime, which are catching up with Colombia, initially the closest to the more modern Latin American countries such as Chile or Costa Rica. Using a pooled sample of Demographic and Health Survey data between 1985 and 2010, the study confirms that an increment up in income or education have an independent and reducing effect on the relationship between SES and infant mortality, controlling for other social determinants such as health care and place of residence. Policies that increase parental income and maternal education favor infant health in every country, regardless of initial conditions of any sort. Yet only education provides a similar gain in terms of survival across countries, controlling for income. Therefore the combination of income and education as SES measures does indeed influence the magnitude of the effect across countries, and policies that reduce the price of health may be able to compensate for the lower income in some countries. Otherwise the SES gradient would continue overshadowing the advances in reducing mortality.

Keywords: infant mortality, SES, education, income, Latin America, MDG.

Introduction

Social inequality is one of the causes for the persistence of health inequalities within and across countries (Preston, 1975; Marmot, 1991; Wilkinson, 1996). In this line, national and international policy goals committed to flatten out health inequalities by socio-economic status (SES) have become commonplace in the development agenda (WHO, 2000; Unicef, 2005; UN-MDG). Yet the so called SES/health gradient appears to be inevitable in developed and developing countries alike, and some argue that social inequality relates to the slow rate of improvement in health outcomes in the last decades. Indeed, the global rate of improvement in health outcomes measured by infant and child mortality has slowed down from 2.2 per cent between 1970 and 1985 to around 1.3 per cent by the beginning of the 21st century (Murray, Laakso et al, 2007).

Latin America has experienced an improvement rate in child health over 4 per cent in the last 35 years, which is associated mainly with the decline in preventable causes of death such as diahrrea, malaria, or under-nutrition (Black et al, 2003; Murray, Laakso et al, 2007). However only five countries in the region will fulfill its commitment to the Millenium Development Goals (MGD 4) of slashing child mortality by 2/3 between 1990 and 2015 (UN-ECLAC, United Nations- Economic Commission for Latin America and the Caribbean report, 2010). Furthermore, infant and child mortality appear to have stagnated in some countries in the region, and one of the main explanation relates to the relationship between socio-economic status and mortality at the national and subnational level (Jasper et al, 2011; WHO, 2008; Unicef, 2004).

Latin America, the most unequal region in the world, provides an ideal setting to study why mortality by SES is greater in some countries than in others. The hypothesis in this paper is that infant and child mortality relate to the persistent stratification in the access to the "social" determinants of health such as income, education, clean water, and health care, among others. In other words, how each country has dealt with the provision and access to these social goods causes the differences in mortality by SES across countries. The social determinants of health relate to poverty, but does not imply that even in countries, where the poor have access to all these goods, health inequalities by SES will disappear. Distal socio-economic factors such as income or political inequality, culture or government policies are sometimes difficult to avoid and depend deeply on the social and economic structure of the society and thus create and protect health inequality over time.

In simple terms, I test two hypothesis: (1) an increase up in income or education reduces the risk of child mortality in any country, but (2) the magnitude of the reduction depends on the inequalities in the SES distribution within countries, making the effect larger in some countries than others. The paper uses a DHS sample of 151.020 children born between 1985

and 2010, which provides the basis for a cross-national comparison and data on the mechanisms attenuating the relationship between SES and mortality in four countries with apparently increasing SES/mortality inequality: Bolivia, Colombia, the Dominican Republic and Perú (Jasper et al, 2011; UNESCO, xxx; Minujin and Demonica, 2004, WHO reports, 2000). The contribution of this paper is twofold: first, to offer a comparative perspective on the SES/ infant and child mortality relationship in Latin America. Indeed, individual and comparative studies assessing health inequalities over time for Latin America, are scant (xxx). Second, an updated discussion of why some of these countries in the region will not commit to the MDG-4 in the near future.

Using survival models, the findings indicate that in all four countries income and education have a direct and independent effect on mortality by SES. Increases up in the income ladder reduce the risk of infant and child mortality in every country, but Bolivia: its middle income group does not enjoy the greater benefits of survival as in the other countries, and only the richest quintile ensures their survival. Children born in Perú experience the greater benefits of a rising middle class among the four countries. As with income, an increase up in the educational ladder reduces the risk of infant and child mortality in every country, too. Yet the effect is stronger in Perú and Bolivia rather than in Colombia or in the Dominican Republic. Urban residence appears as the protective factor that makes the difference between Perú and Bolivia and the island country, which shares borders with Haiti, and Colombia. Colombia as the country with the lowest rates in infant and child mortality names the degenerative and chronic diseases as the main health concern in comparison to the other countries. Finally, policies that increase parental income and maternal education favor infant health in every country, regardless of initial conditions of any sort. Yet only education provides a similar gain in terms of survival across countries, controlling for income. Therefore the combination of

income and education as SES measures does indeed influence the magnitude of the effect across countries, and policies that reduce the price of health may be able to compensate for the loss of income in some countries.

The paper is structured as follows: the first section reviews the literature of SES/health inequalities, with a focus on infant and child mortality in Latin America. The second section turns into the theoretical framework of Mosley and Chen to link infant mortality to SES. The third section goes into the data and the statistical methods. The fourth section presents the results. The final section contains the discussion about how to monitor equity improvements in health/mortality in developing settings.

Previous literature

In his review of the role of social medicine in health outcomes in Latin America, Waitzkin et al (2001) traces back to the mid-19th century the activists and scholars denouncing the negative effects of social structure on disease, malnutrition, and premature mortality. Later, in 1939, the minister of health of Chile and future president, Salvador Allende, wrote about the need for socio-economic reforms such as income redistribution, state regulation of food and a national housing program to address maternal and infant mortality, and other communicable and occupational diseases. In the 50´s Ernesto "Che" Guevara, based on his travelling across Latin America, promoted the need for a revolution as a pre-condition to improve population health.

Yet in the second half of the 20th century the infant mortality fell by more than a factor of six while the total fertility rate was more than halved to 2.4 children in 2005, making the population healthier and raising population growth in every country in Latin America, regardless of political and economic conditions (ECLAC, 2008; 2010a). The demographic transition is therefore cited as one of the sources for health inequality: the lag between

mortality and fertility combined with the age structure (Charckiel, 2004) and the level of income and education would favor differences in morbidity and mortality risk within and across countries. Furthermore, the countries with major migration flows from Europe such as Argentina, Uruguay, Cuba and Chile began this transition at the onset of the century while the rest of the countries, such as Brazil, Mexico, Colombia, Bolivia, Perú or Ecuador, among others, experienced it 30 or 40 years later.

Antonovsky (1967) claims that health inequality rises with the onset of the demographic transition but falls in the advanced stages. No country in the region has reached the most advanced stages of the demographic transition (ECLAC, 2010a). This fact poses the question whether the differences in mortality across countries is just a temporary state bound to disappear with development. The fact that the worst performers in income growth, such as Bolivia, Perú, Nicaragua, Honduras and Guatemala did raise average life expectancy above 18 years has kept the question open.

Soares (2009) argues that health improvements in Latin America had been unrelated to income change. Indeed, public health measures such as vaccinations, public health, antibiotics and contraceptive methods, all social policy choices, appear as the explanations for the achievement. In addition, another argument is that the socio-economic effects of health are not poverty driven (Deaton, 2003). The health inequality is observed across all levels of SES in rich and developed countries, regardless of the indicators (Marmot, 1991; Singh-Manoux et al, 2005).

Health inequalities appear to be inevitable, and research has shown that some national populations display a steeper gradient than others with similar or even lower levels of economic development (Gravelle, 1998; Mackenback et al, 2009). Preston (1975) provides an explanation by arguing that if the income – health relationship is curvilinear, countries with

greater income inequality are likely to experience higher mortality rates. In other words, the relative position within the income distribution is a major cause for health inequality (Wilkinson, 1992; 1996). Indeed, Latin American countries are known for persistent high poverty and income inequality (PNUD, 2010). In the last decade, some countries of the region has seen the poverty head count ratio and the Gini coefficient fall by 12 per cent to 33 per cent and xxx per cent to xxx per cent between 1990 and 2009 (Grynspan and Lopez Calva, 2011). For instance in income inequality, Brazil experienced a fall from 0,62 in 2003 to 0,57 in 2009, followed by Perú with a fall from 0,50 to 0,46 (ECLAC, 2010a). Yet the levels remain strikingly high and disparate across countries, perhaps insufficient to attenuate mortality risks and reduce health inequalities across social groups in countries, where the average income per head has not surpassed the 8.000 U$ dollar per person threshold (Daniels, 2011). Furthermore, Bolivia, Colombia and Haiti are the most unequal countries in the region while Uruguay, the more egalitarian, still surpasses the Gini coefficient of the United States of America by almost 10 per cent.

The evidence does not support the relative income hypothesis neither in developed nor in developing countries (Wagstaff, 2000; Deaton, 2003; Larrea et al, 2004; Subramanian et al, 2004). The relative income hypothesis has attracted more attention recently because of the importance given to psychosocial mechanisms related to it such as stress, lack of self-respect or empowerment, social or racial exclusion, which are key determinants of health as mainly studies of the developed world has shown. In this line, the long standing history of income inequality fits the story of social stratification associated with all types of discrimination. Studies are scant on this area, at least for Latin America (Urrea, xxx), but studies on the US has confirmed the residual effect of race and gender in creating health inequalities (Deaton and Paxson, 2002).

Lustig (2011) relates the fall poverty and income inequality with the fall in the dependancy ratio through the demographic transition, the increasing share of educated people and the cash transfer programmes attached to health and educational outcomes. In this line, the fact that Cuba, the best performer in health and educational outcomes in Latin America, appears as the forerunner is a reason for concern. Perhaps, social policy is at the core of the expansion of the Cuban educational system, which has raised the relative performance of all students and their children, improving the average and attenuating health inequality (xxx).

In contrast, many argue that the differences in health across countries reflects differences in the degree of subsidized medical care (Wagstaff, 2000). Yet the series of health reforms, with Colombia pioneered with Chile in the 90´s, have been run with mixed results in infant, child and maternal mortality outcomes across social groups (Homedes and Ugalde, 2001; Panorama Social, 2005).

Recently, there is a strand of research focusing on the role urbanization to explain health inequality in the developing world (xxx). The starting point is that rural mortality has been higher than urban mortality, at least since the 1960´s. With increasing rural-urban migration in the developing world, the new picture entails an improvement in average health because access to medical care and water supplies are concentrated in cities. Yet rapid urbanization without access to drinking water, electricity and sanitation, may create health inequality. Furthermore, as the opportunities to create jobs are overwhelmed by urban population growth, larger shares of the population live in poverty, bolstering health inequalities.

In sum, there are competing causes, which confound each other. Thus there is no consensus around the mechanisms through which health inequalities by SES be reduced. Out of 32 countries in Latin America only five will achieve the Millenium Development Goals target in

infant and child health for 2015: Nicaragua (already in 2009), Cuba, Ecuador, Grenada and Perú (ECLAC/CELADE, 2010a). These countries are not the richest, but a range of social policy choices rather than the level of economic development appears to have favored the least advantaged socio-economic groups and therefore the income national gradient appears to be associated with lower rates of infant, child and even maternal mortality.

2. Theoretical framework for infant and child mortality

The Mosley and Chen framework connects the effect of socio-economic factors on morbidity/mortality through a set of mechanisms or proximate determinants such as maternal factors (child´s sex, mother´s age, parity and birth order), environment (rural-urban, water source, toilet and sanitation), nutrition (breastfeeding and food), injury (accidents or violence), and personal illness care (health habits and services), among others. Distal socio-economic factors such as the impact of government policies and proximate factors have improved in almost every country in Latin America, even Haiti until 2005, but the magnitude of their effects varies within and across countries. The analysis here is based on income and education as measures of SES and their impact on mortality.

Income

It influences whether the family has enough material resources to ensure the child survival. Income enable access to medical care at delivery and later, to provide the adequate nutrition such as breastfeeding, compensate the risks associated with truncated breastfeeding or improve the dietary intake ((Townsend et al, 1982; Rustein, 2000). Therefore children of low income families are more likely to develop serious chronic health problems (Case and Paxson,

2002). In this line, a strand of research has promoted the idea that either insurance expansion, employment policies or public education is the most reasonable way of reducing health inequalities (xxx). Some argue that equalizing income would have a marginal impact in reducing health inequalities by SES (Rosenzweig and Wolpin, 1991). In addition, others indicate that subsidized insurance expansions may not improve outcomes unless the unhealthy habits of the low income families change (Case and Paxson, 2002).

Education

It influences the informational resources available to keep the children healthy. Meara (2001) makes the argument that education enables to compare and choose the health investment with higher pay offs in a shorter period of time. Therefore educated mothers use information more efficiently, and as the share of educated mothers increases, the risk of mortality should decline (Caldwell, 1982). In this line, educated mothers may have preferences for lower family size, but are likely to favor shorter birth intervals because they tend to get pregnant later in life, or at least when the stock of education is enough to ensure a minimum level of physical resources (xxx). Finally, education relates to healthy lifestyles. Therefore educated mothers are more likely to understand and avoid the hazards related to the source of drinking water, sanitation, diet or smoking, among others, during pregnancy and later on in life.

Hypotheses

The hypothesis are two : (1) an increase up in income or education reduces the risk of child mortality in any country, but (2) the magnitude of the reduction depends on the inequalities in the SES distribution within countries, making the effect larger in some countries than others.

3. Data and methods

The paper uses DHS survey data from four (4) Latin-American countries: Bolivia (1994/1998/2004/2008), Colombia (1990/1995/2000/2005/2010), Dominican Republic (1991/1996/1999/2002/2007) and Perú (1992/1996/2000/2005/2008). According to previous studies of infant and child mortality, these countries are experiencing rising mortality inequality as average mortality falls. They share with other Latin American countries such as Ecuador, El Salvador, Guatemala, Honduras and Nicaragua that the most serious health problem in their population relates to mother and child mortality and chronic and degenerative diseases (ECLAC, 2005). Similarly, the four countries have very relatively high income inequality and poverty according to World Bank estimates: inequality measured by Gini in 2009 is for Colombia (0.55), Bolivia (0.51), Dominican Republic (0.48) and Perú (0.46). Poverty measured by head count ratio is led by Bolivia (54%), Colombia (45%), Dominican Republic (41%) and Perú (35%). On the other hand, the history of social and racial discrimination is common and deep in the four countries (xxx). Finally, the fact that these four countries have the longest series within Demographic and Health Surveys (DHS) in Latin America reveals the importance in the agenda to improve health outcomes.

Table 1: descriptive data

The countries have at least four (4) waves of DHS[1], which enables to estimate infant (0-1) and child (1-5) mortality outcomes and rates from complete birth histories between 1985 and 2010. The collection of DHS data is widely known and comparable across countries and over time. The analysis is limited to the national level; the surveys collect also rural and urban population. To avoid problems with censored data, the analysis is based on a Cox proportional hazard model with frailty. To avoid recall bias, only births occurring in the last five years are included in the analysis.

Based on the previous section, the theoretical model of survival may contain the following variables:

$$\text{Infant mortality } (1/0) = \text{f}(\text{Household Income}_{i}, \text{Mother´s Education}_{i,} \text{Controls})$$

The equation captures the effect of SES measured by income and education on mortality. The wealth index is a proxy for permanent income/resources based on housing conditions, key durable assets and public infrastructure, which correlates with socio-economic status and hence with child mortality (Bollen et al, 2007). Using factor analysis, I create an asset quartile, which rests on the assumption that the poor of Colombia have the same level of physical resources as in Bolivia, for instance. Note later than the non poor category includes the rich and the middle income class.

I merged the 6 initial categories of education into four: (1) no education plus some primary education (2) complete primary education (3) incomplete secondary education as the reference category (4) complete secondary education plus higher education. Note later than

[1] Other countries with less than 5 DHS surveys: Nicaragua, Guatemala, Brazil, Honduras, Haiti …

post primary education includes incomplete secondary and complete secondary and higher education.

I estimate Cox hazard models for infant (0-12 months) and child (12-59 months) mortality risks for the pooled sample and each country. I began with a model to estimate roughly the change in the mortality risk between 1990 and 2010. The idea was to capture the decline in the level of mortality over time. Then I run a basic model of infant and child mortality on SES (income and education) and survey time, using the pooled sample; the aim is to capture trends that otherwise would be neglected in the country by country analysis. Then I add the control variables to run the full model and compare the robustness of the SES estimates on mortality.

The control variables follow the Mosley and Chen framework and include:

- Mother´s age: the child of a woman older than 20 faces a lower risk of mortality. 20 is the average year of first birth in these countries (DHS final reports), and by this age these women might have received at least some secondary education.
- Parity: the number of children alive by the time of birth. Research indicates that above 3 increases the risk of mortality for the higher parity birth (Trusell and Peebly, 1984).
- Firstborn: the risk of mortality is higher than for the other births (Muhuri and Preston, 1991). Twins and multiple births were dropped from the sample.
- Child´s sex: male infants have a higher risk of mortality than female infants, but preferences may distort the trend (Muhuri and Preston, 1991)
- Breastfeeding duration: the WHO recommends at least 6 months of exclusive breastfeeding to ensure survival (Rustein, 2000).
- Delivery at a public or private hospital rather than at home: it raises the likelihood of survival because the birth is attended by trained personnel. Furthermore, this variable monitors policy efforts (Bryce at al, 2006).

- Urban residence: it captures living conditions, but is associated with the exposure to public health measures and access to general infrastructure such as electricity and roads (Hobcraft, Mc Donald and Rutstein, 1984; Bryce at al, 2006).
- Water source: this control captures whether the water is contaminated through its provision, which is associated with a higher risk of mortality (Rustein, 2000; Bryce at al, 2006)

Time and country dummies were added, too. Results are expressed as relative risks, considering family based frailty to correct for unobserved heterogeneity and to account for multiple death events for children within the same family. Next I run full models by country to test whether there´s a common pattern in the factors influencing the risk of mortality. Based on these results, I run interactions of SES by country to capture any differences across countries.

4. Results

The descriptive statistics present a summary of the means of the mortality outcomes and covariates by country. Colombia shows the lowest infant mortality rate of the four with 16 per 1000 while Bolivia with 45 per 1000 is the highest. Results for U5 mortality are … Every country experienced a rise in the share of non- poor income households and women with post-primary education. The Dominican Republic has the highest increase of its non- poor, with 168 per cent while Perú and Bolivia show impressive rates above 30 per cent. Colombia lags behind with an increase of 8 per cent between 1990 and 2010. Similarly, the change in the share of women with post-primary education ranges from 24 per cent in the Dominican Republic, 27 per cent in Colombia to more than 40 per cent in Perú and Bolivia.

Table 1: descriptive statistics – infant mortality rates by survey year and country

Table 1a: descriptive statistics – U5 mortality rates by survey year and country

The demographic variables such firstborn and female show no important differences across countries. Parity indicates the demographic transition by showing negative changes between the initial and the final period for each country. The urban population remains rather stable, with a negative change, which is more related to sample size fluctuations rather than trends (DHS final reports). Among the remaining control variables such as breastfeeding duration, birth delivery at the hospital, and access to water, marginal differences across countries confirm that the public policies have been in place. The Dominican Republic is the country with the lowest breastfeeding duration of 13 months between 1991 and 2007. Birth at the hospital has risen in all countries, particularly in Bolivia with a 57% increase between 1994 and 2008. Indeed, 72 per cent of the births have occurred in a hospital facility. In contrast, Perú has the lowest share of hospital delivery with 65 per cent , but a change of 51 per cent between 1992 and 2008. Urbanization varies marginally by country, but remains within the range that at least 65 per cent of the population lives in the cities, as in Colombia *(I am still checking the report to understand the negative change in urbanization and water_piped)*.

Table 1b: descriptive statistics – country sample

I begin by confirming the decline in infant and U5 mortality risk for the four countries between 1990 and 2005. By looking at the hazard ratio in table 2, the four countries show improvements in survival rates for infants, being Perú the forerunner with a 46 per cent decrease between 2008 and 1992. For children between 12 and 59 months, the survival rate is basically the same for all.

Table 2: Change in mortality hazard by age in two points in time

Using the pooled sample, the basic bivariate models of infant mortality in table 3 confirms the mortality inequality by SES: income and education present significant and large estimates. Model 3 shows that infants of income-poor parents have a 35 per cent higher risk of mortality than the middle income group; infants of the lowest educated mothers have a 45 per cent higher risk. Adding controls, model 4 confirms the pattern: the relative risks remain statistically significant, but rose to 45 per cent higher risk in income-poorest and fell to 29 per cent in less than primary education. In short, income and education have an independent effect on infant mortality, regardless of controls. Yet income has a stronger effect than education. All the controls have the right signs and were statistically significant, but urbanization and water source. The estimates for child mortality are more and less the same, but the effect of income and education is stronger. Hence policies that increase parental income and maternal education favor infant health in every country, regardless of initial conditions of any sort.

Table 3: Survival models of infant mortality using the pooled sample

In table 4 the independent effect of income and education by country is confirmed for infant and child mortality. As in the pooled sample, data here covers all the survey years available, and the SES categories are simplified into those having non-poor income and post-primary education. For infant mortality, the largest decline in relative risk for non-poor income groups compared to the poor groups is in Colombia (100-56=44 per cent), followed by Perú (38 per cent), Dominican Republic (19 per cent) and Bolivia (3 per cent, but not significant). Post primary education in all countries display a reduction in the relative risk of around 20 in Colombia and the Dominican Republic and around 30 per cent in Perú and Bolivia by comparison with to those with primary and less education. In contrast, the child mortality estimates group together Colombia, Bolivia and Perú with a relative risk around 40% to 50%

while the Dominican Republic reaches nearly a 60 per cent less risk for the post primary educated mothers. The controls follow the pattern in the pooled sample, but urbanization appears as an important determinant of infant mortality in Perú and Bolivia. In sum, income and education are always protective factors in every country, but only education provides a similar gain in terms of survival across countries.

Table 4: Survival models of child mortality by country

Given that income and education appear to reduce the relative risk of mortality, I run models with interactions to capture whether the effect of income on mortality changes with education or not. In the pooled sample, the interaction term between income and education is statistically significant only for the secondary and higher educated mothers. This finding is confirmed by restricting the observation by countries and by asset quartiles (results not shown here). In other words, the interaction reveals an income gradient only within the richest groups. The relative risk of mortality of a child with rich, but low educated mother is (100-94) = 6 per cent less than the any non- poor income children. Yet with education the relative risk is 3 per cent higher than the non – poor income children.

When looking this trend across countries, we make the categories smaller so that the effect did not get lost because of sample size issues. Using Colombia as the reference country, our findings indicate that the interaction term between income and each country confirms the stronger effect of income for Perú and Bolivia. The interaction for the Dominican Republic is not significant. With education, the effect of the interaction between education and country is stronger for Perú and Bolivia. In short, income appears to matter more in Perú and Bolivia than in Colombia or in the Dominican Republic. The result sounds reasonable given that Colombia has the lowest infant and child mortality rate across these countries, and chronic and degenerative diseases are mentioned as the primary health problem for infant mortality

(ECLAC, 2005). An important difference between the Dominican Republic and Perú and Bolivia appears to be that the place of residence does matter in the latter ones as a factor reducing mortality. It might be that an island country sharing borders with Haiti, the poorest and unhealthiest country in the hemisphere, might exercise some sort of unobserved influence. On the other hand, the same estimates for child mortality follows the trend of the infant mortality models.

5. Conclusions (need to add the MDG discussion)

Using survival models, the findings indicate that in all four countries income and education have a direct and independent effect on mortality by SES. Increases up in the income ladder reduce the risk of infant and child mortality in every country, but Bolivia: its middle income group does not enjoy the greater benefits of survival as in the other countries, and only the richest quintile ensures their survival. Children born in Perú experience the greater benefits of a rising middle class among the four countries. As with income, an increase up in the educational ladder reduces the risk of infant and child mortality in every country, too. Yet the effect is stronger in Perú and Bolivia rather than in Colombia or in the Dominican Republic. Urban residence appears as the protective factor that makes the difference between Perú and Bolivia and the island country, which shares borders with Haiti, and Colombia. Colombia as the country with the lowest rates in infant and child mortality names the degenerative and chronic diseases as the main health concern in comparison to the other countries.

Policies that increase parental income and maternal education favor infant health in every country, regardless of initial conditions of any sort. Yet only education provides a similar gain in terms of survival across countries, controlling for income. Therefore the combination of income and education as SES measures does indeed influence the magnitude of the effect across countries, and policies that reduce the price of health may be able to compensate for the loss of income in some countries.

Appendix

Table 1: descriptive statistics – country sample estimating infant mortality rates using DHS data

Country	Year	No. children	IMR estimates from life tables	std error per 1000	CI higher	CI lower	rel std error
Bolivia	1989	5567	78,6	3,7	86	71,2	4,7%
	1994	3414	71	4,9	80,8	61,2	6,9%
	1998	6990	65,5	3,1	71,7	59,3	4,7%
	2003	9866	53,9	2,3	58,5	49,3	4,3%
	2008	8064	45,3	2,4	50,1	40,5	5,3%
Colombia	1986	2537	30,1	3,5	37,1	23,1	11,6%
	1990	3542	21,8	2,5	26,8	16,8	11,5%
	1995	4740	29,6	2,5	34,6	24,6	8,4%
	2000	4194	22,8	2,4	27,6	18	10,5%
	2005	13010	21,6	1,3	24,2	19	6,0%
	2010	15972	16,5	1	18,5	14,5	6,1%
Dominican Republic	1986	4736	66,1	3,8	73,7	58,5	5,7%
	1991	4087	45	3,4	51,8	38,2	7,6%
	1996	4506	48,1	3,3	54,7	41,5	6,9%
	1999	503	25,1	7,2	39,5	10,7	28,7%
	2002	11126	29,5	1,7	32,9	26,1	5,8%
	2007	10841	30,2	1,4	33	27,4	4,6%
Perú	1986	3036	78,6	5,1	88,8	68,4	6,5%
	1991-1992	8937	60	2,6	65,2	54,8	4,3%
	1996	16678	48,5	1,7	51,9	45,1	3,5%
	2000	12771	36,2	1,7	39,6	32,8	4,7%
	2005	4868	27	2,4	31,8	22,2	8,9%
	2007	5149	22,7	2,1	26,9	18,5	9,3%
	2008	6177	23	2	27	19	8,7%

Table 1a: descriptive statistics – country sample estimating U5 mortality rates using DHS data

xxx

Table 1b: descriptive statistics – country sample estimating the variation between the first and last survey available

Variables by country	Colombia		Peru		Dom. Republic		Bolivia	
Survey Year	2010	var	2008	var	2007	var	2008	var
Non poor (middle + rich income)	0,45	8%	0,52	33%	0,59	168%	0,57	39%
Post primary education	0,66	27%	0,73	46%	0,73	24%	0,56	40%
Firstbirth older than 20	0,34	-24%	0,4	8%	0,31	-11%	0,36	0%
Parity	2,5	-7%	3	-12%	2,7	-7%	3	-12%
Firstborn	0,34	0%	0,29	21%	0,32	3%	0,26	30%
Female	0,48	-2%	0,49	2%	0,47	0%	0,48	2%
Breastfeeding duration	18	38%	23	21%	13	30%	23	-8%
Birth delivered at hospital	0,89	7%	0,65	51%	0,76	-8%	0,72	57%
Urban	0,64	-22%	0,58	-3%	0,56	-5%	0,52	-4%
Water_piped	0,65	-26%	0,68	21%	0,77	13%	0,77	35%

Table 2: Change in mortality hazard by age in two points in time

Variables	Col	Peru	Dom R	Bol
0-12 months	0,73***	0,54***	0,83***	0,69***
failures	763	2396	1047	1708
observations	51173	63137	44671	32468
12-60 months	0,30***	0,25***	0,31***	0,25***
failures	49	165	76	87
observations	16973	12168	13546	8508
survey time	1990/2010	1992/2008	1991/2007	1994/2008

Table reports the hazard rate between the initial and the last available survey data using Cox proportional hazard models.

Table 3: Pooled sample - Cox hazard models of infant mortality, 0-12 months

Variables	1	2	3	4
Rich	0,67***		0,70***	0,67***
Middle class	1		1	1
Poor	1,27***		1,16***	1,13***
Poorest	1,78***		1,35***	1,45***
Higher and secondary		0,61***	0,76***	0,71***
Some secondary edu		1	1	1
Primary edu		1,25***	1,15***	1,14***
Less than primary edu		1,55***	1,45***	1,29***
survey time	x	x	x	x
controls				x
failures	5914	5914	5914	5914
subjects	151020	151020	151020	151020
observation	191449	191449	191449	191449
Log L	-68477	-68463	-68371	-64445

Cox hazard models with frailty. Controls for age, parity and firstborn, breastfeeding duration child´s sex, urban, and trained assistance at delivery.

Table 3a: Pooled sample Cox hazard models of child mortality, 12-60 months

Variables	1	2	3	4
Rich	0,38***		0,77	0,76*
Middle class	1		1	1
Poor	1,46***		1,44***	1,43***
Poorest	2,36***		1,84***	1,89***
Higher and secondary		0,58***	0,47***	0,50***
Some secondary edu		1	1	1
Primary edu		1,75***	1,32**	1,26**
Less than primary edu		2,76***	1,94***	1,80***
survey time	x	x	x	x
controls				x
failures	943	943	943	943
subjects	118474	118474	118474	118474
observation	126855	126855	126855	126855
Log L	-10503	-10541	-10475	-64445

Cox hazard models with frailty. Controls for age, parity and firstborn, breastfeeding duration child´s sex, urban, and trained assistance at delivery.

Table 4: Cox hazard models of infant mortality with frailty, 0-12 months

Variables	Col	Peru	Dom R	Bol
Non poor	0,56***	0,62***	0,81**	0,97
Post primary education	0,80**	0,69***	0,76***	0,69***
Has firstbirth older than 20	0,8***	0,81***	0,76***	0,97
Parity	1,07***	1,01**	1,07***	1,02***
Firstborn	0,81**	0,88**	1,04	0,94
Female	0,81***	0,92**	0,84***	0,92**
Breastfeeding duration	0,75***	0,79***	0,97***	0,90***
Birth delivered at hospital	0,71***	0,67***	0,69***	0,50***
Urban	1,09	0,67***	1,01	0,81***
Water_piped	0,88	1,01	0,99	1,01
survey time	x	x	x	x
failures	763	2396	1047	1708
observations	51173	63137	44671	32468
log likelihood	-7034,4	-22246,6	-10452,9	-16158,9

Table 4a: Cox hazard models of child mortality with frailty, 12-60 months

Variables	Col	Peru	Dom R	Bol
Non poor	0,59*	0,43***	0,56**	0,87
Post primary education	0,60*	0,51***	0,37***	0,59***
Firstbirth older than 20	0,58**	0,77**	0,8	0,9
Parity	1,02	1,05***	1,11***	1,02
Firstborn	0,67	1,15	0,73	0,85
Female	0,58**	0,83*	1,02	0,93
Breastfeeding duration	0,95***	0,93***	0,98	0,98**
Birth delivered at hospital	0,74	0,66***	0,76	0,47***
Urban	1,1	1,04	1,09	0,97
Water_piped	1,19	1,1	1	0,96
survey time	x	x	x	x
failures	91	436	133	283
observations	32992	43970	28081	21812
log likelihood	-882,2	-4356,7	-1262,2	-2697,6

Table 5: Testing interactions between income and education – pooled sample, infant mortality

no control model				full model		
income	i.inc*edu	effect	categories	income	i.inc*edu	effect
0,72	1,42	1,02	poorest	0,64	1,47	0,94
0,72	1,07	0,77	poor	0,64	1,15	0,74
0,72	1,00	0,72	middle	0,64	1,00	0,64
0,72	1,00	0,72	rich	0,64	0,96	0,61

edu	i.inc*edu	effect		edu	i.inc*edu	effect
0,70	1,42	0,99	less than primary	0,70	1,47	1,03
0,70	1,07	0,75	primary	0,70	1,15	0,81
0,70	1,00	0,70	ncomplete secondary	0,70	1,00	0,70
0,70	1,00	0,70	secondary and higher	0,70	0,96	0,67

Table reports relative risks for the richest quartile, and the yellow color shows that the interaction is significant at the 5% level. The full model adds control on for age, parity and firstborn, breastfeeding duration child´s sex, urban, and trained assistance at delivery plus time.

Table 5a: Testing interaction between income and country, infant mortality

no control			
	col-peru	col-dom rep	col-bolivia
non poor	0,57***	0,68***	0,7***
interaction	1,04	1,19*	1,06

full model			
	col-peru	col-dom rep	col-bolivia
non poor	0,47***	0,67***	0,73***
interaction	1,32***	1,03	1,18*
effect	0,62	0,69	0,86

Table reports relative risks for those from the middle up of the income distribution and with pos-primary education. * significant at the 10%, ** at 5% and *** at the 1% level. The full model adds control on for age, parity and firstborn, breastfeeding duration child´s sex, urban, and trained assistance at delivery plus time. Col means Colombia, and Dom Rep Dominican Republic.

Table 5b: Testing interaction between education and country, infant mortality

no control			
	col-peru	col-dom rep	col-bolivia
post primary	0,67***	0,70***	0,70***
interaction	1,00	1,03	0,88

full model			
	col-peru	col-dom rep	col-bolivia
post primary	0,65***	0,77***	0,67***
interaction	1,24***	0,88	1,18*
effect	0,81	0,68	0,79

Table reports relative risks for those from the middle up of the income distribution and with pos-primary education. * significant at the 10%, ** at 5% and *** at the 1% level. The full model adds control on for age, parity and firstborn, breastfeeding duration child´s sex, urban, and trained assistance at delivery plus time. Col means Colombia, and Dom Rep Dominican Republic.

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