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Abstract

Data from 4 Latin-American countries are used to test the impact of socio-economic status (SES) on infant and child 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 child mortality is socially stratified by SES in every country, controlling for other social determinants such as health care and place of residence. SES measured as income and education have direct and independent effects on mortality, with the exception of Bolivia. In Bolivia there is a combined effect of income and education. The educational inequality in mortality is lower in Colombia than in the other countries, but not the income inequality in mortality. Similarly, there is some evidence that the inequalities are decreasing in Colombia and Perú,and rather stable in Bolivia and the Dominican Republic. Finally, the unobserved heterogeneity at the family level is still more important than any SES estimate, making the case for more detailed micro data on causes of deaths, health habits, and ethnicity, specially in Perú and Bolivia.

Keywords: inequalities in infant and child mortality, SES, Latin America.

Introduction

Health inequalities appear to be a common trait of societies in the developed and less developed world. Some claim that the inequalities are persistent -if not increasing- and hypothesize that they relate to social and economic policies outside the health sector (Behm, 1979; Link and Phelan, 1995; Deaton, 2003; Mackenback et al, 2009). True, attempts to reduce poverty and expanding public health insurance for the poor have improved the survival rates of their children, but the differences in health between social groups remain (Cutler and Lleras-Muney, 2011).

In one of my previous papers I show that inequalities in infant mortality are socially stratified in Colombia and are indeed decreasing, but omit to study whether the pattern in generalizable to other countries with a similar level of development. In this paper, Latin America, the most unequal region in the world in terms of income, provides an ideal setting to explore to what

extent inequalities in mortality vary across countries, and if so, whether these mortality inequalities are increasing over time? The main reason for this interest is that Latin America is above the world average in health/mortality outcomes, but still far away from developed country standards. A cross-national comparison among its countries in terms of their standing in health inequality with respect to others reveals clues about how their institutions influence population health. I focus on infants and children below the age of five from Bolivia, Colombia, the Dominican Republic and Perú because previous studies indicate that the four countries have experienced large reductions in child mortality, but apparently increasing inequality in its mortality during the last three decades (Wagstaff, 2002/3; Minujin and Demonica, 2004; Jaspers_Faijer et al, 2011). The aim of the paper is then to compare the four countries in terms of their inequalities in infant and child mortality during the period 1990-2010.

The paper is structured as follows: the first section reviews the literature about causes for health inequalities. The second section turns into the theoretical framework of Mosley and Chen to link infant and child mortality to socio-economic status (SES) and present a summary of the similarities and differences of the four countries in terms of SES and demographic factors. The third section goes into the data and the statistical methods. I use Demographic and Health Survey (DHS) micro data samples because of their comparability across countries in terms of health and socio-economic variables and time coverage. The pooled sample accounts for 151.158 children and 6.442 deaths for children between 0-60 months. The fourth section presents the results. The final section contains the discussion and the conclusions**.** As in previous studies, I confirm that a high SES person has a lower mortality risk than a low SES person in every country during the period of study. Income and education have direct and independent effects on infant and child mortality, with the exception of Bolivia, where there may exist different thresholds for income and education to influence mortality. Within

countries, Colombia, the more advantaged country in the study, appears to have the highest mortality inequality by SES whereas the Dominican Republic the lowest mortality inequality. Yet the educational differences in mortality inequality between countries favor Colombia over the other countries, with Bolivia at the bottom. Furthermore, inequalities in mortality appear to have declined over time in the Colombia and Perú, but rather stable in Bolivia and the Dominican Republic. The unobserved heterogeneity at the family level is still more important than any SES estimate, specially in Perú and Bolivia.

The contribution of this paper is threefold: first, little is known about the differences in infant and child mortality between countries of the region. Few studies assess changes in inequality in infant and child mortality by SES for Latin American countries. Second, the temporal trend of inequalities in infant and child mortality is quantified using detailed and comparable DHS data at the individual level by country for the period between 1985 and 2010. Third, the paper quantifies the unstudied importance of unobserved heterogeneity with respect to observed variables in models of infant and child mortality.

1. Previous literature

The literature indicates that the decline in infant and child mortality relates to changes in the socio-economic structure of the society such as income growth, educational expansion and advances in the health sector (Adler et al, 1994). However, in spite of the progress in overall development, inequalities in health/ mortality remain in less developed countries and elsewhere (Lynch and Phelan, 1995). A reason is that the effect of socio-economic determinants of child health can be confounded by other structural changes such as the demographic transition (Antonovsky, 1964; Oechsli and Kirk, 1975), urbanization (Behm, 1979), life styles (Marmot et al, 1991), access and use of health care services (Townsend et al, 1982) and the overall social environment (Preston, 1975; Wilkinson, 1996), among others.

The demographic transition relates to the time lag between fertility and mortality and therefore favors differences in morbidity (diarrhea, malaria and so forth) and mortality risk within groups and between areas (Charckiel, 2004). In other words, the stage the country is in, defines the type of diseases their children might be fighting against. Furthermore, the age structure of the population determines the dependency ratio of the families, which is associated with the health conditions of their members, being the children the most vulnerable. Urbanization is another confounder of the health impact of socioeconomic determinants because in less developed countries it´s been happening fast and thus without access to drinking water, sanitation and electricity (Vlahov et al, 2007; UN-Habitat, 2003). The result is though the widening share of the urban poor and increases in the risk of mortality for their children. However, some argue that the differences in health reveal differences in the degree of subsidized medical care. The evidence suggests otherwise: inequality in health remains in developed and less developed areas or countries, regardless of the health care policy (Deaton, 2003). The focus shifts therefore to looking into socio-economic factors such as inequality in income, education, political participation, or culture and ethnicity instead of fixing inequalities through access to medical care alone. Indeed, the social environment is part of the explanations for health inequalities. The literature indicates that countries with low income and great income inequality are likely to experience higher mortality rates through several mechanisms ranging from material deprivation to stress-related diseases (Preston, 1975; Wilkinson, 1996; Adler et al, 1994). Hence absolute and relative income appear to have a combined effect on the health outcomes of poor countries, but the evidence is not conclusive (Mayer and Sarin, 2005). Yet the fact that among the less developed countries some had lower life expectancy than others with lower or similar economic development supports the expectation that social and economic policy does have a role in improving survival.

Another source of health inequality is racial discrimination, such that the individual characteristics of a woman entail that her children have a higher or lower probability of death. Racial and ethnic differences in health are common, but the causes vary a lot from country to country. In the US, there is ample evidence of infants of African American parents being more likely to die in the first year of life than infants of white parents (Luke and Brown, 2006). Furthermore, white infants born in the poorest counties have a higher likelihood of survival than non-white infants born in the wealthiest counties (Krieger et al, 2008). These differences are partially offset by controlling for education, income or age. Flórez, Medina and Urrea (2003) present evidence of racial and ethnic discrimination for most countries of Latin America, including Colombia, with clear negative effects on human capital, and note whitening as a consequence of self-identification in recent censuses. If borne out by empirical evidence, racial discrimination in health calls for both equity and efficiency arguments for correction through public policies such as affirmative action policies, compensation and correctional policies. Studies are scant however on this area, at least for Latin American countries, being Brazil the exception, and comparisons by ethnic lines across countries are difficult to pursue because most countries still don´t have racial categories in their household surveys and censuses. A reason is perhaps that racial inequality emerged in 2001 in the international public agenda with the UN Conference on Racism (Telles, 2006).

Papers calling for cross-national comparisons of infant and child mortality for less developed countries present a picture of improvements in absolute health, but not in their relative inequalities. Cleland et al (1992) studies social determinants of child health for the period between 1965 and 1985 in 12 less developed countries, including the Dominican Republic, Perú and Colombia. Using World Fertility Survey and Demographic Health Surveys, they conclude that maternal education and father´s occupation have a modest impact – less than 10

and 8 per cent on average - in reducing infant and child mortality, and show that relative inequalities within countries have widened. Perú is however an exception to the norm because more than 30 per cent of the decline can be explained by the expansion of maternal education and its relative inequality fell marginally from 1.43 to 1.37. Using Living Standard Measurement Surveys (LSMS) data from nine less developed countries, Wagstaff (2000) presents a snapshot of the inequalities in child mortality by quintile of consumption in each country, and the differences between countries were not statistically significant. Larrea and Freire (2002) study the association between child malnutrition and socioeconomic status using DHS data for Colombia, Perú, and Bolivia, and LSMS data for Ecuador. They find out a pattern of differences in malnutrition by socioeconomic status in the four countries and indicate a better standing for Colombia with respect to the other countries, given that Colombia had at the time a 24 per cent higher income per head than Perú and almost two times the income per head of Bolivia and Ecuador. Minujin and Demonica (2004) run a more comprehensive study using a sample of 24 less developed countries with comparable DHS data. Their study estimates the relative gap of mortality using a family wealth index as measures of socioeconomic status in the absence of expenditures and concludes that the reduction in child mortality was mostly concentrated on the middle and top groups; they estimate temporal trends in socio-economic inequalities by country for the period 1985 - 2000 and found out that Bolivia, Colombia, Perú and the Dominican Republic were experiencing higher inequality while lowering the level of child mortality. Jaspers_Faijer et al (2011) show that child mortality by wealth has indeed fallen in every country of the region, but the rate of improvement has slowed down. Using DHS data from 41 less developed countries, Fuchs et al (2010) note that mother´s education matters more for child survival than household wealth and indicate that further controls are necessary to assess whether other mechanisms influence the relationship between education, income and mortality.

In short, studies show that each country for which data is available there is a pattern of higher mortality in groups with lower SES, regardless of the measures. It is also acknowledged the multiple mechanisms through which SES measures may work. However little is known about the differences between countries. Furthermore, there is a concern that the temporal trend of socioeconomic inequalities in child health may be widening despite the overall improvement of survival and development in the last decades.

2. Theoretical framework for infant and child mortality

Several studies have confirmed that the effect of income and education on infant mortality is significant across less developed countries (Adler et al, 1993). Yet the mechanisms through which measures of SES work are still an open question because their distribution among the population varies by country and over time. Furthermore they work at different levels (individual, family or community). Thus I use the Mosley and Chen framework to connect the effect of socio-economic factors such as income and education on morbidity/mortality through maternal factors (child´s sex, mother´s age, fertility and birth order), environment (rural-urban, water source, toilet and sanitation), nutrition (breastfeeding and food), injury (accidents or violence), and personal illness care (health care services), among others. Whether measured at the individual or country level, all these variables associated to infant and child mortality are important to capture the differences and similarities in socio-economic and demographic factors among the countries in the paper.

Income and Assets

Income and assets influence whether the family has enough material resources to ensure the child survival. Income enables 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 (Rutstein, 2000). Yet the health impact of income

and assets depends also on their distribution, and the distribution varies by country. Preston (1975) argues that countries with greater income inequality are likely to experience higher mortality rates. He cites as evidence the lower life expectancies of Venezuela, Mexico and Colombia in terms of their national income, the countries with income inequalities around 50 percent of the sample back then. Today, the picture has not changed very much even though income inequality has fallen around one per cent per year in the last 10 years for the 17 Latin American countries with comparable data, including the four countries of our study (Lopez Calva et al, 2010). In this line, Wilkinson (1996) notes that the relative deprivation within the countries rather than the absolute deprivation explains health inequalities between them. However, the evidence is still a contentious topic (Mayer and Sarin, 2005). In terms of the four countries in the paper, Bolivia has the worst social and economic indicators in the region, and Colombia some of the best because of a long history of stable growth and political stability. The Dominican Republic and Perú lie just in between (see table 1).

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). An implication is that income is less important as long as the mother understands and avoids the hazards related to the source of drinking water, sanitation, diet or smoking, among others, during pregnancy and later on in life. Furthermore, educated mothers have preferences for lower family size, and are more 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. According to the 2005/10 DHS report, 59 per cent of women have completed secondary education in the Dominican

Republic, but even few do in Bolivia (54 per cent); educational attainment is higher in Colombia (76 per cent) and in Perú (72 per cent).

Proximate determinants (data taken from final DHS reports)

Bolivia has a higher overall ***fertility*** than any of the other countries. Fertility in Bolivia has declined from 5 children per woman in 1989 to 3.5 in 2008. Fertility rates in Colombia, Perú and the Dominican Republic fell to 2.4 children per woman by 2005/7. In contrast, the median ***age*** at first marriage, an important indicator of lifetime fertility, is around 20 years and very similar across countries. For ***nutrition***, the median duration of breastfeeding is around 15 days in the Dominican Republic whereas in Bolivia and Perú it is 4 months and 4.4 months, and Colombia falls in between within 2.6 months. Yet under-nutrition measured by stunting (2 standard deviations) accounts for 27 per cent of their children in Perú and Bolivia while only 10 and 13 per cent of children in the Dominican Republic and Colombia. ***Urbanization*** in is another salient feature among these four countries, which are below the regional average of 83 per cent. With 66 per cent of urbanized population, Bolivia lags behind the Dominican Republic (70 per cent), Perú (71 per cent) and Colombia (75 per cent). Furthermore, access to drinking ***water*** varies also within and between these countries according to place of residence. For instance, on average Perú has the highest proportion of people without access to water (13 per cent urban and 50 per cent rural), followed by Bolivia, where only 7 per cent of urban residents and 56 per cent of rural residents have no access to water. Even Colombia, with less than 2 per cent of urban residents without water, has 27 per cent of rural people without access. In terms of ***personal illness care***, the percentage of births delivered at the hospital, the Dominican Republic and Colombia have almost universal coverage while in Perú (79 per cent) and Bolivia (72 per cent) there is still room for improvement. Yet Bolivia shows the highest proportion of immunized children among the countries (78 per cent) while Colombia,

Peru and the Dominican Republic ranges between 56 and 67 per cent. Contraceptive knowledge is above 70 per cent in Colombia, the Dominican Republic and Perú, but not in Bolivia, where the use of modern methods is 34 per cent. Finally, it is worth mentioning that all four countries are populated with considerable ethnic diversity, and have a long history of racial discrimination since colonial times. Given that infant and child mortality varies with ethnicity (Jaspers_Faijer et al, 2011), many aspects of unobserved behavior can be unrelated to SES, and however have a direct influence on infant and child health. In Bolivia and Perú, around 30 per cent of the population is indigenous and Quechua and Aymara are widely spoken. In contrast, Colombia has an indigenous population of around 4 per cent, and almost 10 per cent of afro-descendants. The Dominican Republic has no indigenous population, but 73 per cent of the population consider themselves multiracial (African and European descent), 11 per cent black and 16 per cent white.

Hypotheses. From previous sections the following hypotheses are proposed:

1) An offspring of a high SES mother has a lower risk of mortality than an offspring of a low SES mother in every country, but the differences in inequalities between countries are expected to favor those (e.g. Colombia and Perú) with a higher proportion of mothers with education and income because access to informational resources is more widespread among their populations.
2) The inequality in infant mortality in each country is expected to be lower than the inequality in child mortality because the conditions of delivery have improved during the period of study while the inequality in child mortality is expected to increase in Bolivia and Perú because the pattern of malnutrition remains and doubles the levels of Colombia and the Dominican Republic.

3) The temporal pattern of inequality in mortality in each country is expected to remain stable because the negative effect of rapid urbanization is compensated by the positive effect of health care services.
4) The level of unobserved heterogeneity is expected to be larger than any SES estimates, particularly in Perú and Bolivia, because the unobserved behavior not related to SES is higher in countries with a higher proportion of indigenous population, and their settlement pattern are marked by historical traits of disadvantage in terms of public goods.

3. Data and methods

This paper uses Demographic and DHS[1] cross-sectional survey data from four Latin-American countries: Bolivia (1993/1994/1998/2004/2008), Colombia (1990/1995/2000/2005/2010), Dominican Republic (1991/1996/1999/2002/2007) and Perú (1992/1996/2000/2005/2008). The collection of DHS data is widely known and comparable across countries and over time. The pooled sample accounts for more than 151.158 children, 6.442 deaths and the broad information about micro-level determinants of child mortality, including urban and rural differences. The analysis is limited to the national level. The data enables to estimate infant (0-1) and child (1-5) mortality outcomes and rates from complete retrospective birth histories between 1985 and 2010. Data on causes of death are not available, and only births occurring in the last five years are included in the analysis.

Based on the previous section, the theoretical model of mortality contains the following variables:

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

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

The equation captures the effect of SES measured by income and education on infant and child mortality. Given that measures of income are not reliable in less developed and poor countries (Deaton, 2003) and its omission from DHS surveys, I create an asset index following the methodology proposed by Filmer and Pritchett (2001). I use principal component analysis on a set of available variables by country and sort each survey sample into quartiles according to sampling weights to ensure representativity at the national level. Yet I transform it into a dummy that captures the non- poor (rich and the middle income) and poor (poorest and poor) to enable the statistical strength of the interactions in the cross-national comparisons. After doing sensitivity analysis, I merged the six available categories of education into a dummy for the post primary education (incomplete secondary and complete secondary and higher education) and primary education (primary, incomplete primary and none). Time and country dummies were added, too.

The control variables follow from the theoretical section and include: 1) 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 more than primary education. 2) Fertility: the number of children alive by the time of birth. Research indicates that above three children increases the risk of mortality for the higher parity birth (Trusell and Peebly, 1984) 3) Firstborn: the risk of mortality is higher than for the other births (Muhuri and Preston, 1991). Twins and multiple births account for less than 2 per cent of the sample and were dropped without consequences in the estimates. 4) Child´s sex: frailty among male infants is common, but they can outgrow it (Madise et al, 2003; Handa et al, 2008). 4) Breastfeeding duration: the WHO recommends at least 6 months of exclusive breastfeeding to ensure survival (Rutstein, 2000). 5) 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 (Bryce at al, 2006). 6) 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 (Bryce at al, 2006). 7) 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)

Vaccination is omitted because of little variation, in other words, the average vaccination rate is above 90 per cent in the four countries; models including vaccination did not affect the overall results. Race and ethnicity is omitted because it´s available for the latest two waves only in Perú and Bolivia, but only for the last wave in Colombia and the Dominican Republic. Including smoking or alcohol consumption would exclude more than 75 per cent of the sample data.

Estimation strategy. To deal with censored data, the analysis is based on survival models; the chosen specification is a piecewise constant exponential hazard model with frailty to capture the unobserved level of family heterogeneity and to account for multiple death events for children within the same family. 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 obtain the full model as the basis for the cross-national comparison. Next I run full models by country to test whether there´s a common pattern in the SES factors influencing the relative risk of mortality. Based on these results, I test differences in SES between countries and over time. Across all models, attention is given to the comparison between the unobserved family heterogeneity and the observed variables such as SES, gender, place of delivery or residence, among others, through the estimation of the median hazard ratio, MHR. Following Merlo and Larsson (2005), the MHR is the median difference in risk between individuals from high-risk families and low-risk families.

4. Results

Figure 1 shows that Colombia has the lowest hazard rate among the four countries in infant and child mortality. Table 2 presents a summary of the variation of covariates by country between the initial and the last survey available. A crude comparison indicates a lot of variation between countries. Every country has experienced a rise in the share of non- poor income households and women with post-primary education. While the proportion of non-poor in Perú, Bolivia and Perú show impressive rates around 50 per cent, Colombia shows an increase of 2 per cent during the period. The change in the proportion of women with post-primary education ranges from 11 per cent in Perú to 56 per cent in Colombia. Looking at the latest survey by country, breastfeeding duration exceeds the two year maximum that the WHO recommends for children. Colombia and the Dominican Republic enjoy levels of hospital delivery above 90 per cent while Bolivia and Perú are at around 70 per cent. The coverage of water pipelines is rising with the exception of the Dominican Republic.

Table 2: summary descriptive of covariates by country

Using the pooled sample, the basic bivariate models of infant mortality in table 4 and 5 shows that SES influences infant and child mortality. The relative risk is the difference in mortality risk between poor and non-poor, in other words, the inequality disfavors the children of poor or uneducated parents. Model 1 estimates the inequality in infant mortality by 34 per cent for poor people and 24 per cent for uneducated people. Adding controls in model 2, the inequality in mortality decreases to 28 per cent in income and 13 per cent in education. The inequality, or the gap, is about the same for child mortality.

Table 3: survival models of infant mortality, 0-12 months

Full and separate models by country show that child mortality is stratified by SES, but not in infant mortality. With the exception of Colombia, the relationship between infant mortality

and SES is weak everywhere. The inequality in mortality for Colombia is about 49 per cent in income and 20 per cent in infant mortality in education. And interactions between income and education were significant only in Bolivia. The unobserved heterogeneity measured by the median hazard ratio is above 2 in every country and stronger than any other effect. Yet the frailty effect is too large in the Dominican Republic (REVISE DATA) and not significant in Perú.

Table 4: survival models of child mortality, 12-59 months

Using Colombia as the baseline, I compare the differences in mortality between countries through interacting SES (education and income) and country. For infant mortality, the education/country interaction is around 46 per cent higher in Perú, 68 in the Dominican Republic, and 66 in Bolivia. In contrast, the income/country interaction indicates a statistical difference only in the Dominican Republic of almost 62 per cent by comparison with Colombia. For child mortality, the income/country interaction is on the borderline of the 10 per cent statistical significance for the three countries. In other words, income inequality in mortality is higher in Colombia than in the remaining countries. On the other hand, the education/ country interaction for child mortality indicates that the differences across countries are specially marked between Bolivia and the rest. In short, the educational inequality in mortality for Bolivia is larger than for the other countries.

Table 5: Interaction SES/countries, using Colombia as the reference

Table 6 presents a mixed picture of the evolution of relative inequalities by country. In Colombia, there is some evidence of a decrease in the inequality of infant mortality based on income during the period 1990-2010, but not on education. For child mortality, no changes are reported. In Perú, a long term pattern of increase in relative inequality based on income

for infant mortality and a short term pattern of decrease based on education for child mortality. No statistical evidence of any change for the Dominican Republic for both measures of SES. And an encouraging pattern in Bolivia, where the relative inequality in infant and child mortality based on income appears to be decreasing whereas increasing according to education.

Table 6: Interaction SES/time to estimate the temporal trend of relative inequality by country

5. Discussion and Conclusions

As in previous studies, we find that infant and child mortality is socially stratified in the four countries. On average, the inequality in mortality by SES is around 30 per cent after controlling for other health determinants such as place of delivery and urban residence. Looking into the individual countries, social inequalities in child mortality are strong and robust in the four countries, but not in infant mortality, with the exception of Colombia. I presume two things: either that being infant mortality a rare event the lack of enough cases must have influenced the results or that the income works indirectly through the place of delivery. True, DHS final reports show that all social groups have benefitted from delivering at the hospital rather than home (DHS final reports).

Income and education have an independent effect in all countries, but not in Bolivia. The interaction term in Bolivia shows a combined effect, which indicates an effect of income and education varying by social groups or perhaps by place. There is some historical evidence about how the settlement pattern between different ethnic groups still influence health nowadays (Larre and Freire, 2005), in particular for certain indigenous groups up in the Andean mountains, where the supply and demand of health coverage are low for cultural reasons. Hence some unobserved behavior not related to income and education may be causing this potentially damaging effect. Yet the lack of data on causes of mortality in the DHS data impedes us to link the contribution of these unobserved proximate determinants to the diseases that touch infants and children.

The comparison between countries indicates that Colombia has the lowest educational inequalities in mortality among the four countries. This is not rather surprising given that Colombia has had the higher proportion of educated people, which is associated with their lower fertility, and their demand for health care, among other things. Yet the same does not

hold for income. Although the estimates are on the statistical borderline, the income inequality in mortality is higher in Colombia than in the remaining countries. Very unexpected, given that the four countries have a similar level of income inequality despite the recent changes mentioned by Lopez Calva et al (2010). It might be that the response to these changes are quicker in Perú, Bolivia and the Dominican Republic because the social distance between the richest and the poorest is more felt in countries with lower GDP per head. Furthermore, unlike the others, Colombia has little room to make improvements in the reducing the dependency ratio and perhaps faces the challenge to reduce income inequality through changes in the tax system.

McGillvray et al (2009) reminds us that globally inequality in child mortality has increased faster than the steady growth of income. Even though the picture is mixed, on the overall, our results show no statistical evidence for an increasing trend of relative inequality in mortality during the period of study. It is either decreasing or stable. A limitation in our estimates may be that the retrospective nature of household survey data is populated with SES measures not representing the mortality risk during the period of study. For instance, education, albeit recognized as more stable for being fixed in time, does not always capture social and economic change as income does (Shaw et al, 2005, p.642), and our measure of assets is a composite index, which has been announced to be superior to income or expenditure self-reported data (Filmer and Pritchett, 2001), but based on cross-sectional data alone. In spite of the potential measurement bias, the paper shows that each country for which data is available there is a pattern of higher mortality in groups with lower income, wealth, education and class.

The study also shows consistently that access to medical care is important to reduce mortality inequalities, particularly infant mortality. It makes the case that hospital rather than home as

the place of delivery reduces the risk of mortality, albeit still unequally because the demand for health preventive care is still low among the more disadvantaged groups.

How a country deals with inequalities across social groups makes the difference. If the goal is to satisfy health care needs fairly, a general implication so far is then that policies related to infant and child mortality must consider the independence of income and education as policies for both work through different instruments (Deaton, 2002). Furthermore, in line with the Mosley and Chen framework we may need to consider contextual or country-level variables to know whether the individual effects are overestimated and propose policies that reduce health inequality within and foster fairness in meeting health needs for those on the bottom of the distribution.

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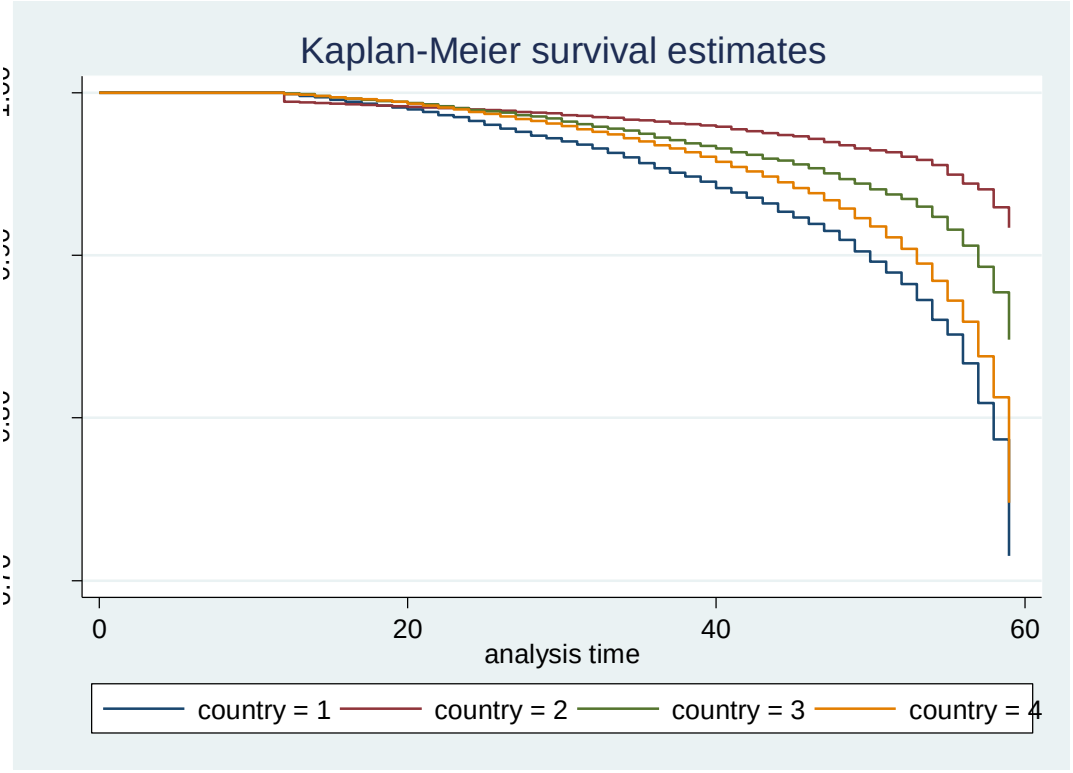
Appendix

Figure 1.



Source: Author using STATA 12. Country 1 (Bolivia), 2 (Colombia), 3 (Dominican Republic) and 4 (Perú)

Table 1. General information

Countries (year 2010)	infant mortality rate	gross national income per head (PPP int. $)	total fertility rate	age under 15	age over 60	pop growth
Cuba	4,60	na	1,50	17,00	17,00	0,10
Chile	7,70	14 590,00	1,90	22,00	13,00	1,00
Costa Rica	8,70	11 270,00	1,80	25,00	10,00	1,70
Grenada	9,00	9 890,00	2,20	28,00	10,00	0,30
Uruguay	9,20	13 990,00	2,10	23,00	18,00	0,10
Dominica	11,30	11 990,00	2,10	24,00	10,00	-0,30
Argentina	12,30	15 570,00	2,20	25,00	15,00	0,90
El Salvador	13,90	6 550,00	2,30	32,00	10,00	0,40
Bahamas, The	14,00	na	2,50	23,00	10,00	1,40
Mexico	14,10	14 290,00	2,30	29,00	9,00	1,30
Belize	14,20	6 210,00	2,80	35,00	6,00	2,20
Peru	14,90	8 930,00	2,50	30,00	9,00	1,20
Venezuela, RB	15,70	12 150,00	2,50	29,00	9,00	1,70
Panama	17,20	12 770,00	2,50	29,00	10,00	1,70
Barbados	17,30	na	1,40	17,00	16,00	0,20
Brazil	17,30	11 000,00	1,80	25,00	10,00	1,10
Ecuador	17,60	7 880,00	2,50	30,00	9,00	1,60
Colombia	18,10	9 060,00	2,40	29,00	9,00	1,50
Jamaica	20,20	7 310,00	2,30	29,00	11,00	0,60
Honduras	20,30	3 770,00	3,10	37,00	6,00	2,00
Paraguay	20,80	5 050,00	3,00	34,00	8,00	1,90
Dominican Republic	22,30	9 030,00	2,60	31,00	9,00	1,40
Nicaragua	22,60	2 790,00	2,60	34,00	6,00	1,30
Philippines	23,20	3 980,00	3,10	35,00	6,00	1,90
Trinidad and Tobago	24,00	24 040,00	1,60	21,00	11,00	0,40
Guatemala	24,80	4 650,00	4,00	41,00	6,00	2,50
Guyana	25,30	3 450,00	2,30	34,00	6,00	0,30
Bolivia	41,70	4 640,00	3,30	36,00	7,00	1,80
Haiti	70,40	na	3,30	36,00	7,00	1,40
Canada	5,20	38 310,00	1,70	16,00	20,00	1,00
United States	6,50	47 360,00	2,10	20,00	18,00	0,90

Source: World Health Statistics, 2012

Table 2: summary descriptive of covariates by country – pooled, last survey and variation between initial and last survey

Mean values of variables	Bolivia			Colombia			Dominican Republic			Perú		
Survey Year	1993	2008	var	1990	2010	var	1991	2007	var	1991	2008	var
Non poor	0.37	0.55	49%	0.49	0.5	2%	0.63	0.89	41%	0.38	0.58	53%
Post primary education	0.35	0.4	14%	0.45	0.7	56%	0.37	0.55	49%	0.46	0.51	11%
Firstbirth older than 20	0.37	0.37	0%	0.45	0.38	-16%	0.38	0.34	-11%	0.4	0.37	-8%
Parity	3.9	3.1	-21%	2.5	2.4	-4%	2.8	2.5	-11%	3.5	3.1	-11%
Firstborn	0.18	0.28	56%	0.32	0.36	13%	0.31	0.33	6%	0.25	0.28	12%
Female	0.5	0.51	2%	0.5	0.51	2%	0.52	0.51	-2%	0.5	0.51	2%
Breastfeeding dur (months)	41	32	-22%	23	28	22%	20	23	15%	29	32	10%
Hospital delivery	0.51	0.68	33%	0.81	0.94	16%	0.93	0.98	5%	0.48	0.68	42%
Urban	0.46	0.54	17%	0.67	0.71	6%	0.59	0.67	14%	0.62	0.54	-13%
Water_piped	0.62	0.8	29%	0.83	0.79	-5%	0.68	0.21	-69%	0.61	0.8	31%

Source: Author´s calculation. "Var" is the variation between the latest available and the initial survey for each country

Table 3: Piece-wise constant hazard models of infant mortality, 0-12 months

Variables	1	2: full	Col	Peru	Dom R	Bol
Non poor	0,66***	0,72***	0,51***	0,98	1,1	0,79
Post primary education	0,76***	0,87*	0,80*	0,93	0,88	0,87
Has firstbirth older than 20		0,89	0,83	0,85	0,83	1,01
Parity		1,30***	1,47***	1,33**	1,31	1,18
Firstborn		0,97	0,81	1,22	0,84	1,07
Male		1,25***	1,32***	1,29**	1,21	1,11
Breastfeeding duration		0,08***	0,06***	0,02***	0,11***	0,17***
Birth delivered at hospital		0,63***	0,74**	0,51***	2,98*	0,63***
Urban		1,02	1,40**	0,73**	1,13	0,97
Water_piped		0,93	0,94	0,97	1,19	1,07
survey time		x	x	x	x	x
failures	1239	1239	348	376	186	329
subjects	150158	150158	39019	49213	31915	30011
clusters	105156	105156	31742	35653	22837	21617
log likelihood	-7748	-7219	-1531	-2328,2	-1278	-2025
prob lratio test of theta			0,039	0,118	0	0,059
frailty var			0,53	0,71	10,1	0,96
MHR			2	2,23	20,7	2,55

Table 4: Piece-wise constant hazard models of infant mortality, 12-59 months

Variables	1	2: full	Col	Peru	Dom R	Bol
Non poor	0,68***	0,78***	0,74***	0,78***	0,78**	0,81***
Post primary education	0,66***	0,77***	0,79**	0,73***	0,76***	0,85**
Firstbirth older than 20		0,85***	0,81**	0,87***	0,81**	0,93
Parity		1,14***	1,21*	1,11**	1,21**	1,05
Firstborn		0,92	0,85	0,92	0,96	1,01
Male		1,19***	1,33***	1,17***	1,14*	1,11**
Breastfeeding duration		0,58***	0,09***	0,13***	1,11	1,72***
Birth delivered at hospital		0,74***	0,71***	0,84***	0,66***	0,67***
Urban		0,91**	1,14*	0,83***	0,98	0,88*
Water_piped		0,95	1	0,94	0,9	1,04
survey time	x	x	x	x	x	x
failures	5517	5517	686	2253	992	1586
subjects	120348	120348	31162	39869	25610	23707
clusters	90361	90361	26520	31201	19800	18602
log likelihood	-18573	-18445	-2931	-7053,62	-3612	-4873
prob lratio test of theta			0	0	0	0
frailty var			0,8	0,72	3,2	0,35
MHR			2,35	2,25	5,51	1,76

Table 5: Interaction SES/countries, using Colombia as the reference

	Infant mortality		Child mortality	
Countries	Edu	Inc	Edu	Inc
Colombia	1.00	1.00	1.00	1.00
Perú	1.46***	1.23	1.10	0.84*
Dom Republic	1.68**	1.62**	1.05	0.80*
Bolivia	1.66***	1.10	1.27***	0.82*

Piece-wise constant hazard models. Controls for dummy variables for age at first birth older than 20 months, firstborn, parity, sex, marital status, place of residence, breastfeeding duration, family planning (none, traditional and modern methods) and trained assistance at delivery.

Table 6: Interaction SES/time to estimate the temporal trend of relative inequality by country

	Bolivia					Colombia			
	Infant mortality		Child mortality			Infant mortality		Child mortality	
	Nonpoor	Postprim	Nonpoor	Postprim		Nonpoor	Postprim	Nonpoor	Postprim
1993	1.82	0.45	2.00*	0.89	1990	5.01***	0.94	0.97	0.73
1994	0.90	0.48*	1.17	0.71	1995	3.89**	0.93	0.71	0.77
1998	0.60	0.45**	1.16	1.01	2000	2.90	1.70	1.07	1.17
2003	0.80	0.84	1.30*	1.11	2005	2.76	0.84	0.83	0.84
2008	1.00	1.00	1.00***	1.00	2010	1.00***	1.00	1.00	1.00

	Dominican Republic					Perú			
	Infant mortality		Child mortality			Infant mortality		Child mortality	
	Nonpoor	Postprim	Nonpoor	Postprim		Nonpoor	Postprim	Nonpoor	Postprim
1991	0.80	1.93	1.10	0.71	1991	0.51*	0.47**	0.96	0.69**
1996	1.07	1.16	0.72	0.74	1992	0.36**	0.43**	0.74	0.59**
					1996	0.56*	0.51**	1.08	0.88
2002	0.82	1.27	1.05	1.13	2000	1.00	0.58*	1.34**	1.04
2007	1.00	1.00	1.00	1.00	2008	1.00	1.00*	1.00***	1.00

Piece-wise constant hazard models. Controls for dummy variables for age at first birth older than 20 months, firstborn, parity, sex, marital status, place of residence, breastfeeding duration, family planning (none, traditional and modern methods) and trained assistance at delivery