TI 2007-035/3
Tinbergen Institute Discussion Paper

Are Urban Children really healthier?

Ellen Van de Poel[1]
Owen O'Donnell[2]
Eddy van Doorslaer[1,3]

[1] *Erasmus Universiteit Rotterdam;*
[2] *University of Macedonia, Thessaloniki, Greece;*
[3] *Tinbergen Institute.*

Tinbergen Institute
The Tinbergen Institute is the institute for economic research of the Erasmus Universiteit Rotterdam, Universiteit van Amsterdam, and Vrije Universiteit Amsterdam.

Tinbergen Institute Amsterdam
Roetersstraat 31
1018 WB Amsterdam
The Netherlands
Tel.: +31(0)20 551 3500
Fax: +31(0)20 551 3555

Tinbergen Institute Rotterdam
Burg. Oudlaan 50
3062 PA Rotterdam
The Netherlands
Tel.: +31(0)10 408 8900
Fax: +31(0)10 408 9031

Are urban children really healthier?

Evidence from 47 developing countries

Ellen Van de Poel[a*], Owen O'Donnell[ab] and Eddy Van Doorslaer[ac]

[a] *Erasmus School of Economics, Erasmus University Rotterdam, The Netherlands*
[b] *University of Macedonia, Greece*
[c] *Tinbergen Institute, The Netherlands*

ABSTRACT

On average, child health outcomes are better in urban than in rural areas of developing countries. Understanding the nature and the causes of this rural-urban disparity is essential in contemplating the health consequences of the rapid urbanization taking place throughout the developing world and in targeting resources appropriately to raise population health. We use micro data on child health taken from the most recent *Demographic and Health Surveys* for 47 developing countries. The purpose of this paper is threefold. First, we document the magnitude of rural-urban disparities in child nutritional status and under-five mortality across all 47 developing countries. Second, we adjust these disparities for differences in population characteristics across urban and rural settings. Third, we examine rural-urban differences in the degree of socioeconomic inequality in these health outcomes. The results demonstrate that there are considerable rural-urban differences in mean child health outcomes in the entire developing world. The rural-urban gap in stunting does not entirely mirror the gap in under-five mortality. The most striking difference between the two is in the Latin American and Caribbean region, where the gap in stunting is more than 1.5 times higher than that in mortality. On average, the rural-urban risk ratios of stunting and under-five mortality fall by respectively 53% and 59% after controlling for household wealth. Controlling thereafter for socio-demographic factors reduces the risk ratios by another 22% and 25%. We confirm earlier findings of higher socioeconomic inequality in stunting in urban areas and demonstrate that this also holds for under-five mortality. In a considerable number of countries, the urban poor actually have *higher* rates of stunting and mortality than their rural counterparts. The findings imply that there is a need for programs that target the urban poor, and that this is becoming more necessary as the size of the urban population grows.

* Correspondence to:
Ellen Van de Poel, Department of Applied Economics
Erasmus University Rotterdam
Burg. Oudlaan 50/P.O. Box 1738
3000 DR Rotterdam,The Netherlands
Tel: +31 10 408 1502, Fax: +31 10 408 91 41
e-mail: **vandepoel@few.eur.nl**

INTRODUCTION

On average, child health outcomes are better in urban than in rural areas of developing countries. Understanding the nature and the causes of this rural-urban disparity is essential in contemplating the health consequences of the rapid urbanization taking place throughout the developing world and in targeting resources appropriately to raise population health. Comparison of mean levels of health is not sufficient for these purposes. It ignores variation in health with population characteristics, such as income, that are not necessarily invariant to urbanization and can potentially be used to target resources more effectively than is possible with a simple rural-urban distinction. One objective of this paper is not only to document the magnitude of rural-urban disparities in child nutritional status and mortality across 47 developing countries but also to determine the extent to which these disparities are explained by differences in population characteristics across urban and rural settings. Even if population characteristics were to explain all of the rural-urban difference in child health, targeting health resources on the basis of rural-urban location would still be efficient if there were homogeneity in these characteristics within rural and urban sectors. But the greater is within sector population heterogeneity, the stronger is the argument for allocating resources in relation to characteristics besides rural-urban location. Living standards, for example, obviously do vary within urban settings. In fact, income inequality is typically greater in urban areas than it is in rural areas (Deaton & Drèze, 2002; Kuznets, 1965). Health programs that target the rural population overlook the urban poor who may enjoy little or no health advantage over their rural counterparts. The second objective of the paper is to compare health outcomes for poor urban and rural children and to examine rural-urban differences in the degree of socioeconomic inequality in these outcomes. This will contribute to appraisal of the case for paying greater attention to poor urban populations in the prioritization of health programs.

There is a considerable body of literature documenting the rural-urban disparity in child health outcomes in the developing world. Most of the literature focuses on discrepancies in measures of child nutritional status. This clearly demonstrates that, on average, urban children are better nourished; they are less likely to suffer chronic malnourishment (stunting) and to be severely underweight (von Braun, McComb, Fred-Mensah & Pandya-Lorch, 1993; Ruel, Garrett, Morris, Maxwell, Oshaug, Engle et al,1998; Menon, Ruel & Morris, 2000; Sahn & Stiffel, 2003; Smith, Ruel & Ndiaye, 2005; Fotso, 2006; Fotso, 2007). In the recent literature, less attention has been given to rural-urban differences in child mortality but that which exists shows that urban children face a lower risk of dying before their first, or fifth, birthday (Cleland, Bicego & Fegan, 1992; Brockerhoff, 1995; Sastry, 1997; Gould, 1998; Wang, 2003; Cai & Chongsuvivatwong, 2006). Table 1 provides a summary of the recent cross-country evidence on the rural-urban gap in child health outcomes in the developing world.

Rural-urban differences in mean outcomes do not reveal the considerable variation in health experiences of children *within* rural and urban settings. Sahn & Stiffel (2003) find that the contribution of the rural-urban gap to total variation in child nutritional status is quite small in 14 Sub-Saharan African countries. Total inequality in children's height-for-age in Sub-Saharan Africa appears to be mainly a matter of inequality within urban and rural areas. So, although the rural-urban disparity is large, it is not the primary source of variation in child health. Clearly, populations are not homogenous within rural-urban sectors and one has to take care not just to compare their means.

A difference in mean outcomes certainly does not imply that an urban child can expect to enjoy better health than her otherwise identical counterpart in a rural setting. The disparity may largely derive from differences in population characteristics, such as levels of income and education. The literature suggests that population and community characteristics are important in explaining the rural-urban disparity in child health outcomes (Fotso, 2007; Sastry, 1997). Smith et al (2005) report significant rural-urban differences in the levels of household proximal and socioeconomic determinants of child nutritional status using Demographic and Household Survey (DHS) data from 36 developing countries. They find very few significant differences across urban and rural settings in the effects of determinants on child nutrition. From this it is concluded that the urban advantage is due to the superior conditions, including behavioral factors such as nurturing practices, rather than differences in the effects of conditions on nutrition. But the authors do not quantify the share of the rural-urban disparity that is explained by differences in conditions.

Despite better average health outcomes in urban areas, there is some evidence of little or no differences in health between rural and urban poor children (Cameron, Kgamphe, Leschner & Farrant, 1992; WHO, 1993; WRI, UNEP, UNDP & WB, 1996). The higher mean in urban areas may be simply due to a lower proportion of poor children but it might also be that there is a higher socioeconomic gradient in child health in urban areas (Bitran, Giedion, Valenzuela & Monkkonen, 2005). Menon et al (2000) have shown that the socioeconomic gradient in childhood stunting is indeed higher in urban areas of

10 developing countries and Fotso (2005) finds the same for Sub-Saharan African countries. Ruel, Haddad & Garrett (1999) present a similar finding regarding prevalence of diarrhea in Latin-America. The last column of Table 1 provides a summary of evidence comparing socioeconomic inequality in child health indicators across urban and rural areas.

From the existing evidence it is clear that there is a rural-urban gap in mean child nutritional outcomes but a few studies suggest that this is at least partly explained by differences in levels of proximal and socioeconomic determinants of nutrition. There is also some evidence that while mean child nutritional status is higher in urban areas, socioeconomic inequality is also higher.

This paper presents a comprehensive and consistent analysis of the magnitude and explanation of rural-urban disparities in child health throughout the developing world. It adds to the existing literature by using the most recent data from 47 countries to estimate the size of rural-urban relative risks for both child stunting and mortality and to determine the extent to which these disparities can be accounted for by rural-urban differences in socioeconomic and demographic factors. By also comparing the degree of socioeconomic inequality in child health across rural and urban settings, the paper develops a cohesive argument concerning the nature and the implications of rural-urban differences in the distribution of child health. More specifically, this paper extends the existing literature in five respects. First, it looks at the rural-urban gap in *both* childhood mortality and stunting. While there is considerable evidence that malnutrition is an informative health indicator in developing countries and a good predictor of mortality (Pelletier, Frongillo & Habicht, 1993; Pelletier, Frongillo, Schroeder & Habicht, 1995; Schroeder & Brown, 1994), the magnitude and the explanation of the rural-urban disparities in the two indicators may differ. Harttgen & Misselhorn (2006) show that access to health care has a greater impact on child mortality than on malnutrition. Since rural areas are usually more deprived of health care facilities, this could cause rural-urban mortality differentials to be greater than those in malnutrition. In fact, from a cross-country analysis, Fay, Leipziger, Wodon & Yepes (2005) find that, after controlling for socioeconomic factors, stunting is negatively associated with the urbanization rate whereas the opposite is true of infant and child mortality. Besides environmental hazards and pollution, a possible explanation could be the higher prevalence of HIV/AIDS in urban, densely populated areas (Dyson, 2003). Differences between urban and rural areas in food supply, including its diversity and security, should reflect more strongly in nutritional indicators than in mortality. Further, urban areas are characterized by a greater dependence on cash income, weaker informal safety nets and greater labor force participation of women (Ruel et al, 1999), which may all impact differently on child malnutrition than mortality.

Second, this paper paints a broad picture of rural-urban disparities in child malnutrition and mortality by using data on 47 developing countries. Malnutrition is measured using the new growth standards that were released by the World Health Organization in April 2006 (WHO, 2006). The new standards adopt a fundamentally prescriptive approach designed to describe how all children should grow rather than merely describing how children grew in a single reference population at a specified time (Garza & de Onis, 2004). For example, the new reference population includes only children from study sites where at least 20% of women are willing to follow breastfeeding recommendations. Use of this new reference population could affect estimates of rural-urban disparities since some of the factors used in predicting potential growth, such as breastfeeding, differ in prevalence between urban and rural locations. This is one of the first studies presenting estimates of nutritional status based upon these new standards.

The third contribution of this paper is to quantify the extent to which the rural-urban gaps in child malnutrition and mortality are explained by differences in population characteristics. Fourth, the paper extends the evidence on socioeconomic inequality within urban and rural areas to a broader set of countries and health indicators and employs concentration indices to summarize inequality across the entire distribution rather than simply comparing extremes as in ratio measures. Finally, this paper pays attention to both relative and absolute rural-urban inequality. As recently demonstrated by Lynch, Smith, Harper & Bainbridge (2006), relative and absolute inequality are not necessarily explained by the same factors. Whereas most economic and epidemiological research has focused on relative inequalities, policy makers may be most interested in absolute inequality.

DATA AND METHODS

Data are from the most recent Demographic Health Surveys (DHS) of all 47 countries for which anthropometric data are available. Table 2 lists all the countries, years of survey and sample sizes.

Nutritional status is measured by a binary indicator of chronic malnourishment, or stunting. A child is considered stunted if its height falls two standard deviations below the median height of children of the same age and gender in a ‘healthy’ reference population. The new Multicentre Growth Reference Study (MGRS) population which includes children from Brazil, Ghana, India, Norway, Oman and the USA is used as the reference group (WHO, 2006). To our knowledge, this is the first study on a large set of developing countries using this new reference population. To check sensitivity of the results to this change in reference group, the analysis is also done by using the US National Center for Health Statistics (NCHS) reference population (WHO, 1995). DHS contain anthropometric data for children aged 0-5 years at the time of survey. However, for 6 of the countries (Central African Republic, Comoros, Niger, Togo, Kyrgyzstan Republic and India) data were only available for children aged 0-3 years.[1]

Under-five mortality is measured by an indicator of whether the child died before or at 60 months that is constructed from a full fertility history of each woman in the survey. For the purpose of this analysis, under-five mortality is preferred to infant mortality since it covers the same age range as the stunting measure and allows for longer exposure to environmental conditions that are likely to be important determinants of rural-urban disparities. Children were included in the sample if they were born between 15 and 5 years before the survey. This long time span provides sufficient observations on under-five mortality, but admittedly has the disadvantage that living conditions at time of survey do not necessarily reflect circumstances during the first 5 years of life.[2] Using under-five mortality also implies that there is no distinction between deaths of newborn babies and deaths of older children despite the fact that they may have quite different causes. To check robustness of the results, we also conducted the entire analysis using infant instead of under-five mortality, for which we only used data on children that were born up to and including 60 months before the survey. The results were qualitatively similar to those for under-five mortality and are therefore not discussed in detail.

Next to simple rural-urban disparities in the two health indicators, we also present the disparities that remain after controlling for differences in household wealth, parents' education, availability of (any) toilet and safe drinking water, maternal age at birth, sex of child, short birth interval, and birth order.[3] All of these variables have well documented relevance in explaining children's health status (see e.g. Sastry, 1997; Smith et al, 2005).[4] Rural areas are characterized by lower educational achievement, poorer living standards and lower awareness of healthy behavior (Smith et al, 2005, Table 6) and these differences could be confounding raw rural-urban disparities. Birth order and maternal age at birth are included in quadratic form to allow for non-linear effects. The educational level of each parent is captured by a binary variable indicating whether the mother/father had no education.[5] To control for a short birth interval, a dummy variable is used for births that are closer than 24 months to the preceding birth (Sastry, 1997). Drinking water is considered safe when coming from a tap, covered well, (hand) pump, covered borehole, tanker truck or vendor and bottles (Victora, Fenn, Bryce & Kirkwood, 2005).
As is quite common practice with DHS data, a wealth variable is derived using principal component analysis (Filmer & Pritchett, 2001). This wealth index is constructed from information on housing conditions (electricity supply, the number of persons per room, the type of floor, wall and roof material), possession of assets (car, motor, bicycle, radio, television, and fridge) and age and sex of the household head. [6] Since the quality of sanitation and drinking water can be expected to have a direct impact on child health, we decided not to include these in the principal component analysis. Except in the regression analysis of the pooled (urban and rural) data, the wealth indices used are

estimated separately for the urban and rural samples within each country. This allows the proxy variables to have different relationships with wealth in urban and rural settings.[7]

Rural-urban relative risk ratios are estimated using Poisson regression, which facilitates control for confounding factors (Zou, 2006; Barrington, Griffiths, Tate & Dezateux, 2006; Kaye, Mirembe, Bantebya, Johansson & Ekstrom, 2006). Absolute inequality is measured by the rural-urban difference in the probability of a child being stunted/dying. This is estimated by the partial effect of a rural dummy in a probit regression of stunting/mortality evaluated at the sample means of the other independent variables.

Socioeconomic inequality in stunting and under-five-mortality is measured using the concentration index, which indicates the degree to which stunting/mortality is disproportionately concentrated among the poor (Wagstaff, Paci & van Doorslaer, 1991). Applied to binary indicators, such as stunting and mortality, the bounds of the concentration index depend upon the mean of the indicator (Wagstaff, 2005). This would impede rural-urban comparison due to substantial differences in means across locations. To avoid this problem, we use an alternative but related concentration index that was recently introduced by Erreygers (2006) and does not suffer from mean dependence.

All estimation takes account of sample weights (provided with the DHS data) and standard errors are corrected for clustering at the community level.

RESULTS

RURAL-URBAN DISPARITY

The proportion of children that are stunted and that died before the age of five in rural and urban areas as well as the rural-urban ratios in these proportions are given in Table 3. Figure 1 illustrates the rural-urban relative risks of stunting and under-five mortality for all 47 developing countries grouped by region. There are significant differences in the rural-urban stunting rates in all but 4 countries (Comoros, Madagascar, Namibia and Uzbekistan).[8] The median rural-urban ratio in stunting is 1.4. It is largest in Latin America and the Caribbean (LAC), where the median is 1.92 and smallest in South and South-East Asia (SSEA), where the median is 1.24. It is well known that malnutrition rates relative to child mortality are higher in South Asia than in Sub-Saharan Africa (SSA) (Harttgen & Misselhorn, 2006). But it appears that the rural-urban disparities in malnutrition are more marked in Sub-Saharan Africa.

Population stunting rates based upon the older NCHS reference population are consistently lower than those based upon new MGRS reference.[9] de Onis, Onyango, Borghi, Garza & Yang (2006) find the same for Bangladesh, Dominican Republic and a pooled sample of North American and European children. Estimates of rural-urban disparities tend to be slightly larger using the old NCHS reference, with the median rural-urban ratio being 1.55 rather than 1.4 with the new reference. Rural-urban relative risks in under-five mortality are also presented in Figure 1. In most cases the rural-urban differences are again significantly different from 1 but there are 15 countries in which this is not the case. In relative terms, urban-rural disparities in the two indicators are generally similar, with the striking exception of LAC. The median rural-urban relative risk of under-five mortality across all countries is 1.36, compared with 1.40 for stunting. The mortality relative risk is largest in Near East (NE) (1.46), although there are 6 countries in SSA where the ratio is 1.5 or more, and smallest in LAC (1.24). Results are similar for infant mortality. The median rural-urban relative risk ratio is 1.43 and the differences are significantly different in all but 12 countries.

Table 3 also shows absolute rural-urban inequality in stunting and under-five mortality. That is, the difference in the probability of being stunted/dying between rural and urban. We immediately see that absolute inequality in mortality is much smaller than that in stunting, which follows from the lower prevalence. Regional patterns in absolute inequality are not exactly the same as those for relative inequality. The absolute rural-urban gap in stunting is highest in LAC and smallest in the NE, whereas relative inequality was highest in the latter region. Absolute inequality in mortality is highest in SSA, and similar across all other regions.

There is little or no correlation in the ranking of countries by rural-urban relative disparities in stunting and in child mortality. The Spearman correlation coefficient is small (0.14) and insignificant (p-value=0.35).[10] But this is largely due to the remarkably higher rural-urban relative risks of stunting in LAC compared both with other regions and with mortality disparities in LAC. After leaving out the LAC countries, the Spearman correlation coefficient equals 0.31 and is significant (p-value=0.06). The correlation between rankings of countries by rural-urban absolute inequality in stunting and in mortality is larger than for relative inequality (Spearman coefficient is 0.32 (p-value=0.029) and 0.45 (p-value=0.004) without LAC).

The very large rural-urban disparities in stunting in LAC have been found in other studies (Smith et al, 2005; Ruel, 2000) but there does not appear to have been any research into the causes of this interesting phenomenon, neither as to why the disparity is not so large in under-five mortality. At this stage, one can only speculate on possible explanations, which may include the high economic inequality typical of LAC countries. For example, obesity is increasingly recognized as a substantial problem in Latin America's developed cities (Uauy, Albala & Kain, 2001; Filozof, Gonzalez, Sereday, Mazza & Braguinsky, 2001) while under nutrition continues to prevail in the underdeveloped rural hinterland. Another factor may be the high altitude at which rural populations in some LAC countries live (e.g. Andean populations in Peru and Bolivia). Living at high altitude can cause oxygen shortages (hypoxia), which in turn can lead to growth retardation in children (de Meer, Bergman, Kusner & Voorhoeve, 1993; Greksa, 1986; Toselli, Tarazona-Santos & Pettener, 2001). Further, high altitude environments can be characterized by food production (and consumption) constraints that might affect nutritional status of these populations (Berti & Leonard, 1998).

WHAT IS LEFT OF THE GAP AFTER CONTROLLING FOR WEALTH AND OTHER FACTORS?

Figure 2 shows the rural-urban risk ratios for childhood stunting before and after controlling for differences in household wealth and other characteristics. The adjusted risk ratios are calculated from country specific Poisson regressions of a binary indicator of stunting on a rural dummy and the household characteristics.[11] For each country, the first bar represents the uncontrolled relative risk (which is exactly the same as in Figure 1) and the second gives the risk-ratio after controlling for household wealth only, which is represented by dummy variables indicating the wealth quintile in which the household falls. For each country, a wealth index is calculated from the full sample and so urban and rural households in the same wealth quintile are comparable. The third bar represents the risk ratio after controlling for not only wealth but also the household, mother and child covariates described in the data and methods section: parents' education, availability of a toilet and safe drinking water, maternal age at birth, sex of child, short birth interval, and birth order.

Using regression to estimate rural-urban disparities in stunting controlling for confounding factors may be problematic if there is insufficient overlap in the distribution of these factors across urban and rural areas, such that the data do not permit comparison between urban and rural children similar in all observable characteristics. If necessary, sufficient overlap can be imposed on the data by excluding non-comparable observations and the robustness of the results to this exclusion checked. We did this by first running a logistic regression to model the probability of being urban using the same covariates as before. We then used this model to predict the probability of being urban for every child. Thereafter we excluded any urban child for whom this predicted probability was larger than the 90th percentile probability of being urban predicted for any rural child. The fourth bar in Figure 2 shows the same rural-urban risk ratio as the third bar, but calculated on this restricted sample. [12]

In general, rural-urban risk ratios for stunting are larger than 1 and become closer to 1 after controlling for wealth. Adding thereafter other covariates reduces the risk ratios to a smaller extent. In Namibia, the rural-urban disparity is reversed after controlling for wealth. In SSA, controlling for wealth causes the rural-urban disparity to disappear in 6 of the 26 countries (Cote d'Ivoire, Ethiopia, Kenya, Nigeria, Tanzania, and Zimbabwe). In SSEA, controlling for wealth makes the disparity no longer significant in any country, except in Bangladesh where it is actually reversed. For NE, controlling for wealth again reduces the rural-urban disparity substantially but it remains significant in 3 out of the 7 countries. In LAC, the rural-urban disparity remains after controlling for wealth, except in the Dominican Republic and Paraguay, but its magnitude decreases substantially. After controlling for all covariates, the rural-urban disparity in stunting has disappeared in 29 of the 47 countries. While the wealth adjustment has the largest effect, other adjustments are not always small. In SSA in particular, there are 8 countries in which the other household and child characteristics accounted for the rural-urban risk ratio.

Figure 3 shows the same risk ratios for under-five mortality. Controlling for wealth accounts for the rural-urban risk ratio in a further 21 countries. We do see again that wealth is causing the risk ratio to be insignificant in the entire SSEA region. After controlling for wealth, the rural-urban gap in under-five-mortality is reversed in Namibia and Paraguay. Having controlled for wealth, adjusting for the other covariates causes the disparity to disappear in only a further two countries, leaving a significant difference in only 17 of the 47 countries. As compared to stunting, it seems that the other socio-demographic covariates have a smaller effect on the rural-urban disparity in mortality. Harttgen & Misselhorn (2006) also found that household characteristics, such as education and wealth, are more important in explaining malnutrition as compared to mortality, which is more related to health care use. Especially in the LAC region, we see that controlling for wealth causes a large decrease in the magnitude of the rural-urban risk ratio of stunting, but less so for mortality.

The fourth bars in Figure 2 and Figure 3 show the corrected risk ratios that take into account the potential problem of lack of sufficient overlap in the covariates across urban-rural areas. In general these risk ratios are not that different from the uncorrected ones (third bars): the correction reduces the median rural-urban risk ratio from 1.08 to 1.04 for stunting, and from 1.07 to 1.06 for mortality. However, in 9 (10) countries, the rural-urban risk ratio for stunting (mortality) is no longer significant after the correction.

Estimates of the contribution of confounding factors to the explanation of absolute rural-urban differences in mortality and stunting were very similar to those for relative inequality, and so are not presented or discussed in detail.[13] This suggests that there are large rural-urban differences in important determinants of these child health outcomes (Lynch et al, 2006). In sum, controlling for all covariates accounts for the rural-urban risk ratio in stunting and in under-five in 27 and 20 countries respectively. The median risk-ratio is reduced by about 80% (from 1.40 to 1.09 for stunting and from 1.36 to 1.07 for mortality). The correction for wealth differences alone causes a reduction of 53 % and 59% for stunting and mortality respectively.[14]

RURAL-URBAN DIFFERENCES IN SOCIOECONOMIC INEQUALITY IN HEALTH

As seen in the previous section, in many countries the mean rural-urban disparity in child stunting and mortality is not significant after controlling for household wealth. It is possible that the disparity varies with economic status. To test for such an interaction effect, we present in Figure 4 rural-urban risk ratios of stunting and mortality for children in the poorest and the richest wealth quintiles using a common wealth index for both rural and urban populations. It shows that the rural-urban disparity in stunting is in general much larger in the richest wealth quintile, as compared to the poorest. For more than half of the countries (28), there is no significant difference in stunting between the urban and rural poor. In the richest quintile, there is no significant difference in only 13 countries. While rural-urban ratios of mortality are also generally larger in the highest wealth quintile, this is not the case in 11 countries, with the most notable examples in Sub-Saharan Africa. Under-five mortality is actually significantly *higher* among the urban poor than it is among the rural poor in 9 countries. The differences revealed in rural-urban disparities by wealth suggest that economic inequality in stunting and child mortality differ between urban and rural areas. Figure 5 plots rural against urban concentration indices for stunting and mortality.[15] By convention, a negative index indicates concentration on the poor but in Figure 5 we present the negative of the index such that a positive value indicates stunting/mortality is higher amongst the poor. A value of zero is consistent with no inequality. Most countries are positioned above the diagonal indicating that socioeconomic inequality in urban areas is generally larger than that in rural areas. Socioeconomic inequality in stunting is generally greater than that in mortality. Rural-urban differences in socioeconomic inequality in stunting are not very pronounced in the Near East, whereas they are in Sub-Saharan Africa. The median urban concentration index of stunting equals -0.17, whereas the median rural concentration index equals -0.11. The median under-five mortality concentration index for urban areas is about two times larger in absolute value than its median in rural areas (-0.06 versus -0.03).[16] The few negative values shown in the figure (positive values actual values) are not statistically significantly different from zero (see Table 4).

CONCLUSION AND DISCUSSION

There are considerable rural-urban differences in average child health outcomes in the entire developing world. The median rural-urban relative risk is 1.4 for both stunting and child mortality but rural-urban disparities in the two indicators are not strongly correlated across countries and regions. The most striking difference between the two is in the LAC region, where the rural-urban relative risk for stunting is more than 1.5 times greater than that for mortality. The magnitude of the rural-urban gap in child health outcomes reflects, to a large extent, differences in wealth. On average, the rural-urban risk ratios of stunting and under-five mortality fall by 53% and 59% after controlling for household wealth. In 15 countries, the relative rural-urban risk of stunting becomes insignificant after controlling for wealth. For mortality, this is the case in 19 countries. In SSEA, the lower rates of stunting and mortality in urban areas are entirely explained by higher levels of wealth. In LAC, we see the largest drop in the magnitude of the rural-urban risk ratio after controlling for wealth; however the rural-urban disparity generally remains significant. In Bangladesh and Namibia, stunting rates are actually higher in urban areas after controlling for wealth. For mortality, this is the case in Namibia and Paraguay. This suggests that conditional upon socioeconomic status, the rural environment is healthier than the urban one in these countries, possibly because of pollution and overcrowding (see also Fay et al, 2005).

Relative to controlling for wealth, differences in socio-demographic factors explain less of the rural-urban disparities in stunting and mortality. Controlling for these other factors reduces the relative risk ratio on average by an additional 25% for stunting and 22% for mortality. After controlling for wealth and other covariates, the rural-urban disparity is still significant in 18 countries for stunting and 17 for mortality. Community-level characteristics and the availability of health care in particular, presumably account for a large part of the residual rural-urban disparities in child health outcomes.

We confirm and substantially extend earlier findings of higher socioeconomic inequality in stunting in urban compared with rural areas and demonstrate that this also holds for under-five mortality. In a considerable number of countries (9 out of 47), the urban poor actually have *higher* mortality than their rural counterparts. For stunting, we do not see this reverse in the rural-urban disparity, but in more than half of the countries (28) there is no significant difference in stunting between the urban and rural poor. Greater socioeconomic gradients in child health outcomes in urban areas might be a reflection of the greater economic inequality that tends to prevail in urban settings, which was recognized by Kuznets as early as1965.

The answer to the question posed in the title of this paper is that on average urban children are healthier than rural children but in most countries this is simply a reflection of the advantageous household level conditions, particularly the greater wealth, experienced in urban settings. For given household level characteristics, there is an urban child health advantage in a little more than one-third of the countries studied. It is important to stress that we have controlled only for urban-rural differences in household level characteristics and not in community level and infrastructure characteristics that are more integral to the intrinsic differences between urban and rural environments.

We have used geographic groupings of countries for presentational purposes and because one might expect greater homogeneity within than across regions in the magnitude and explanation of rural-urban disparities in child health outcomes. Region dummy variables are indeed significant in explaining cross-country differences in the unadjusted rural-urban relative risks of stunting but this is not the case for mortality (see Table 4). The rural-urban disparity in stunting is largest in LAC and the reduction in the disparity after controlling for wealth and other factors is also greatest in this region. In part, the latter result is caused by the large unadjusted risk-ratio for LAC but the wealth effect remains largest in LAC even when control is made for the unadjusted risk ratio. Region differences explain 50% of the cross-country variation in rural-urban relative risks of stunting and 57% of the variation in the extent to which these disparities are accounted for by wealth and other factors. This is mainly due to the differences between LAC and the other regions. The remainder of the cross-country variation reflects the heterogeneity—economic, political, social and geographic—within each region. This within region heterogeneity is much more pronounced for mortality. Regional differences explain only 4% of the cross-country differences in the unadjusted rural-urban relative risk of mortality. Most of the variation in the magnitude, and the explanation, of rural-urban disparities in child mortality is within and not across regions.

The results were found to be quite robust. Stunting rates based upon the old NCHS growth reference are lower than those based upon new MGRS reference, but rural-urban disparities tend to be slightly larger using the old NCHS reference. Using infant instead of under-five mortality yielded qualitatively the same results as those discussed above. Because of the lower average mortality (as compared to stunting), the absolute rural-urban gap in stunting is much larger than that in mortality. However, both wealth and other socio-bio-demographic factors were equally important in explaining absolute and relative inequality, which is likely to originate from the relatively high inequality in the distribution of the determinants across urban and rural areas.

Given that average stunting and under-five mortality rates are higher in rural areas and that, on average, around three-quarters of the stunting/mortality occurs in those areas, there is a strong efficiency case for giving priority to rural based programs.[17] However, the analysis in this paper shows the importance of within sector variation. The urban poor are often as disadvantaged as the rural poor with respect to nutrition and mortality. This suggests that the urban poor are living in conditions that are equally bad (or even worse) as those in rural areas in terms of the impact on child health. Income constraints, price barriers and a lack of health insurance cover may deprive the urban poor from access to health care despite their close proximity of health care facilities. Financial barriers may also limit the advantage the poor can reap from the better food supply in urban areas, while the rural poor can benefit from their own food production and support networks. The fact that the urban rich can benefit from these food and health care advantages available in urban areas, while the rural rich cannot, can explain the larger rural-urban disparity in the highest wealth quintile and the greater socioeconomic inequality in child health outcomes in urban areas.

Urban poverty and malnutrition have been increasing, both in absolute and in relative terms. Haddad, Ruel & Garrett (1999) have shown that both the number of underweight preschoolers and the share of urban preschoolers in overall numbers of underweight children have been increasing in the past 10–15 years. Gould (1998) and Fotso (2007) also argue that the rural-urban gap has declined over the last decades because of a worsening of urban health levels. This implies that there is a need for programs that target the urban poor, and that this is becoming more necessary as the size of the urban population grows. However, policy actions that improve poor children's health status in urban areas may be distinctively different from those that address the needs of their rural counterparts. Whereas technological changes in agriculture and expansion of the rural infrastructure go a long way toward mitigating rural health problems, in urban areas greater attention needs to be given to the generation of employment, the creation of social safety nets, providing safe drinking water and public hygiene in slum dwellings and securing access to health care for the children of informal sector workers (Von Braun et al, 1993).

ACKNOWLEDGEMENTS

The authors are grateful to the Institute for Housing and Urban Development Studies for funding the project on "Urbanization, Health and Health Inequality", from which this paper derives. We also thank three anonymous referees for their detailed and useful comments that have helped us improve the presentation of the paper.

REFERENCES

Barrington, S., Griffiths, J., Tate, R., & Dezateux, C. (2006). Are breastfeeding rates higher among mothers delivering in Baby Friendly accredited units in the UK. *International Journal of Epidemiology*, 35, 5, 1178-1186.

Berti, P., & Leonard, W. (1998). Demographic and socioeconomic determinants of variation in food and nutrient intake in an Andean community. *American Journal of Physical Anthropology*, 105, 407-417.

Bitran, R., Giedion, U., Valenzuela, R., & Monkkonen, P. (2005). Keeping health in an urban environment: public health challenges for the urban poor. In M. Fay (Ed.), The urban poor in Latin America (pp. 179-195). World Bank: Washington DC.

Brockerhoff, M. (1995). Child survival in big cities: the disadvantages of migrants. *Social Science & Medicine*, 40, 1371-1383

Cai, L., & Chongsuvivatwong, V. (2006). Rural-urban differentials of premature mortality burden south-west China. *International Journal for Equity in health*, 5.

Caldwell, J. (1979). Education as a factor in mortality decline: An examination of Nigerian data. *Population Studies*, 33, 3, 395-413.

Cameron, N., Kgamphe, S., Leschner, F., & Farrant, J. (1992). Urban-rural differences in the growth of South-African black children. *Annals of Human Biology*, 19, 23-33

Cleland, J., Bicego, J., & Fegan, G. (1992). Socioeconomic inequalities in childhood mortality: the 1970s to the 1980s. *Health Transition Review,* 2, 1-18.

Deaton, A., & Drèze, J. (2002). Poverty and inequality in India: a reexamination. Centre for Development Economics, Working paper nr. 107. Available at http://www.cdedse.org/pdf/work107.pdf [accessed February 6th, 2007].

De Meer, K., Bergman, R., Kusner, J., & Voorhoeve, H. (1993). Differences in physical growth of Aymara and Quechua children living at high altitude in Peru. *Journal of Physical Anthropology*, 90, 59-75.

de Onis, M., Onyango, A., Borghi, E., Garza, C., & Yang, H. (for the WHO Multicentre Growth Reference Study Group). (2006). Comparison of the World Health Organization child growth standards and the National Center for Health Statistics/WHO international growth reference: implications for child health programmes. *Public Health Nutrition*, 9(7), 942-947.

Dyson, T. (2003). HIV/AIDS and urbanization. *Population and Development Review*, 29, 427-442.

Erreygers, G. (2006). Correcting the concentration index. Research Paper 2006-027, November 2006, Department of Economics, Faculty of Applied Economics, University of Antwerp.

Fay, M., Leipziger, D., Wodon, Q., & Yepes, T. (2005). Achieving child health related Millenium Development Goals: The role of infrastructure. *World Development*, 33, 1267-1284.

Ferguson, B., Murray, C., Tandon, A., & Gakidou, E. (2003). Estimating permanent income using asset and indicator variables. In C. Murray, & D. Evans (Eds.), Health systems performance assessment: debate, new methods, and new empiricism. Geneva: World Health Organization.

Filmer, D., & Pritchett, L. (2001). Estimating wealth effects without expenditure data - or tears: An application to educational enrolments in states of India. *Demography*, 38, 115-132.

Filozof, C., Gonzalez, C., Sereday, M, Mazza, C., & Braguinsky, J. (2001). Obesity prevalence and trends in Latin-American countries. *Obesity Reviews*, 2(2), 99.

Fotso, J-C. (2006). Child health inequities in developing countries: differences across urban and rural areas. *International Journal for Equity in Health*, 5, 9.

Fotso, J-C. (2007). Urban-rural differentials in child malnutrition: Trends and socioeconomic correlates in sub-Saharan Africa. *Health and Place*, 13, 205-223.

Garza, C., & de Onis, M. (for the WHO Multicentre Growth Reference Study Group). (2004). Rationale for developing a new international growth reference. *Food and Nutrition Bulletin*, 25 (Suppl. 1), S5–14.

Gould, W. (1998). African mortality and the new 'urban penalty'. *Health and Place*, 4(2), 171-181.

Greksa, L. (1986). Growth patterns of European and Amerindian high-altitude natives. Current Anthropology, 27, 72–73.

Haddad, L., Ruel, M., & Garrett, J. (1999). Are urban poverty and undernutrition growing? *World Development*, 27(11), 1891-1904.

Harttgen, K., & Misselhorn, M. (2006). A Multilevel Approach to Explain Child Mortality and Undernutrition in South Asia and Sub-Saharan Africa. Paper presented at the UNU-WIDER conference on Advancing Equity in Health, 28-30 September 2006. Available at: http://opus.zbw-kiel.de/volltexte/2006/4743/pdf/Misselhorn.pdf [accessed December 15th, 2006].

Kaye, K., Mirembe, M., Bantebya, G., Johansson, A., & Ekstrom, M. (2006). Domestic violence during pregnancy and risk of low birtweight and maternal complications: A prospective cohort study at Mulago Hospital, Uganda. *Tropical Medicine and International Health*, 11, 10, 1576-1584.

Kuznets, S. (1965). Economic Growth and Income Inequality. In S. Kuznets (Ed.), Economic growth and structure (pp. 257-287). New York: Norton.

Lynch, J., Smith, G., Harper, S., & Bainbridge, K. (2006). Explaining the social gradient in coronary heart disease: comparing relative and absolute risk approaches. *Journal of Epidemiology and Community Health*, 60, 436-441.

Menon, P., Ruel, M., & Morris, S. (2000). Socio-economic differentials in child stunting: Results from 11 DHS data sets. *Food and Nutrition Bulletin,* 21(3), 282-289.

Pelletier, D. L., Frongillo, E. A., & Habicht, J.P. (1993). Epidemiological evidence for a potentiating effect of malnutrition on child mortality. *American Journal of Public Health*, 83(8), 1130-1133.

Pelletier, D. L. , Frongillo, E. A., Schroeder, D. G., & Habicht, J. P. (1995). The effects of malnutrition on child mortality in developing countries. *Bulletin of the World Health Organization*, 73, 443–448.

Ruel, M. (2000). Urbanization in Latin America: constraints and opportunities for child feeding and care. *Food and Nutrition Bulletin*, 21(1), 12-24.

Ruel, M., Haddad, L., & Garrett, J. (1999). Some urban facts of life: Implications for research and policy. *World Development*, 27(11), 1917-1938.

Ruel, M., Garrett, J., Morris, S., Maxwell, D., Oshaug, O., Engle, P., Menon, P., Slack, A., & Haddad, L. (1998). Urban challenges to food and nutrition security: A review of food security, health, and caregiving in the cities. Food Consumption and Nutrition Division Discussion Paper 51, International Food Policy Research Institute, Washington, DC.

Sahn D., & Stifel, D. (2003). Urban-rural inequality in living standards in Africa. *Journal of African Economies*, 12, 4, 564-597.

Sastry, N. (1997). What explains rural-urban differentials in child mortality in Brazil? *Social Science and Medicine*, 44(7), 989-237.

Schroeder D., & Brown K. (1994). Nutritional status as a predictor of child survival: summarizing the association and quantifying its global impact. *Bulletin of the World Health Organization*, 72, 569–579

Smith, L., Ruel, M., & Ndiaye, A. (2005). Why is child malnutrition lower in urban than in rural areas? Evidence from 36 developing countries. *World Development*, 33(8), 1285-1305.

Toselli, S., Tarazona-Santos, E., & Pettener, D. (2001). Body size, composition, and blood pressure of high-altitude Quecha from the Peruvian Central Andes (Huancavelica, 3680m). *American Journal of Human Biology*, 13, 539-547.

Uauy, R., Albala, C., & Kain, J. (2001). Obesity trends in Latin America: Transiting from under- to overweight. *Journal of Nutrition*, 131(3), 839S-899S.

United Nations. (2005). UN Population Division Report. Available at: http://www.un.org/esa/population/unpop.htm [accessed 29th March, 2007]

Victora, C., Fenn, B., Bryce, J., & Kirkwood, B. (2005). Co-coverage of preventive interventions and implications for child-survival strategies: evidence from national surveys. *The Lancet*, 366, 1460-1466.

von Braun, J., McComb, J., Fred-Mensah, B., & Pandya-Lorch, R. (1993). Urban food insecurity and malnutrition in developing countries: Trends, policies, and research implications. Washington, DC: International Food Policy Research Institute.

Wagstaff, A., Paci, P., & van Doorslaer, E. (1991). On the measurement of inequalities in health. *Bulletin of the World Health Organization,* 33, 545–7.

Wagstaff, A. (2000). Socioeconomic inequalities in child mortality: Comparisons across nine developing countries. *Bulletin of the World Health Organization*, 78, 19–29.

Wagstaff, A., & Watanabe, N. (2000). Socioeconomic inequalities in Child Malnutrition in the Developing World. World Bank, Policy Research Working Paper 2434.

Wagstaff, A. (2005). The bounds of the concentration index when the variable of interest is binary, with an application to immunization inequality. *Health Economics*, 14, 429–32.

Wang, L. (2003). Determinants of child mortality in LDCs. Empirical findings from demographic and health surveys. *Health Policy*, 65, 277-299.

World Health Organization (WHO). (1995). Physical Status: The Use and Interpretation of Anthropometry,WHO Technical Report Series No. 854, World Health Organization, Geneva.

World Health Organisation (WHO). (1993). Health and urbanization in developing countries. UN Department of Economic and Social Affairs, UN Expert Group Meeting on Population Distribution and Migration. Santa Cruz, Bolivia.

World Health Organization Multicentre Growth Reference Study Group. (2006). WHO Child Growth Standards: Length/height-for-age, Weight-forage, Weight-for-length, Weight-for-height and Body mass index-for-age: Methods and Development. Geneva: World Health Organization.

World Resources Institute (WRI), United Nations Environment Programme (UNEP), United Nations Development Programme (UNDP), & World Bank (WB). (1996). The urban environment. A guide to the global environment. New York: Oxford University Press.

Zou, G. (2004). A modified Poisson regression approach to prospective studies with binary data. *American Journal of Epidemiology*, 159(7), 702-706.

FIGURES AND TABLES

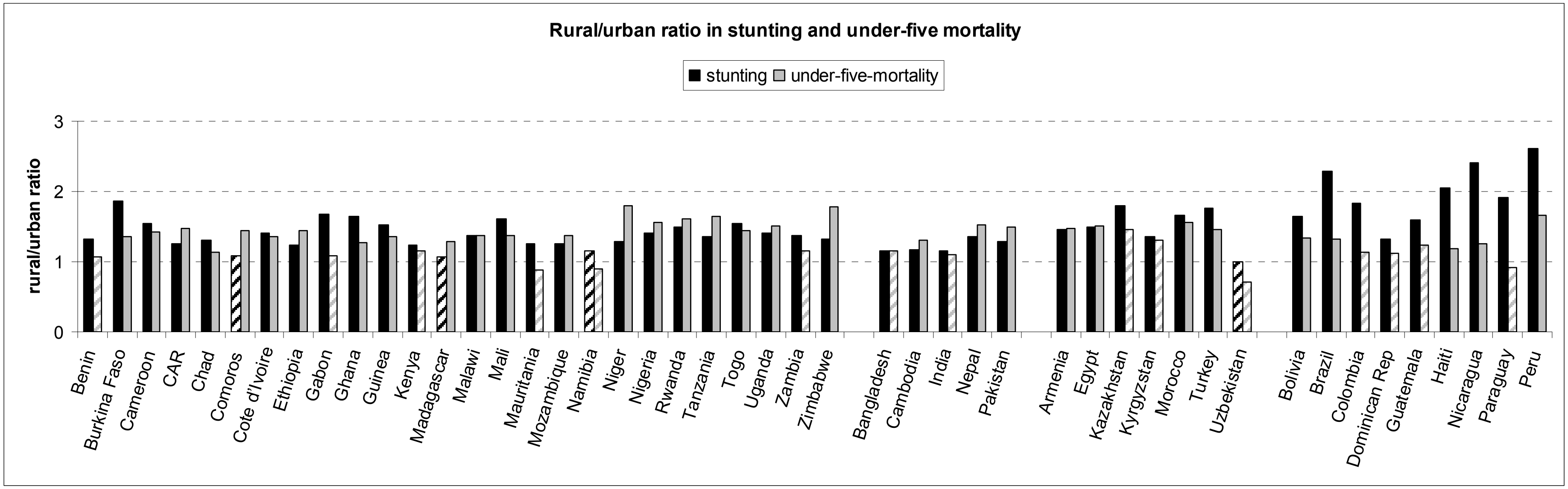
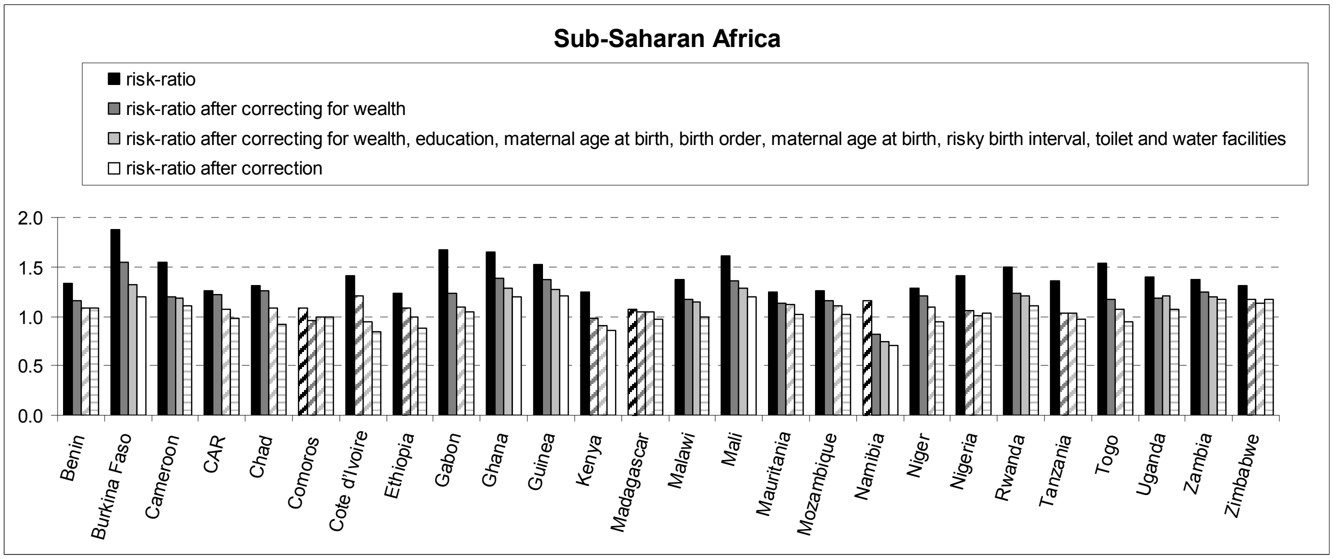


Figure 1: Rural-urban relative risk-ratio of stunting and under-five mortality. Estimated by Poisson regression taking into account clustering and population weights.
Note: Striped bars indicates ratio is not significantly different from 1 at the 10% level.



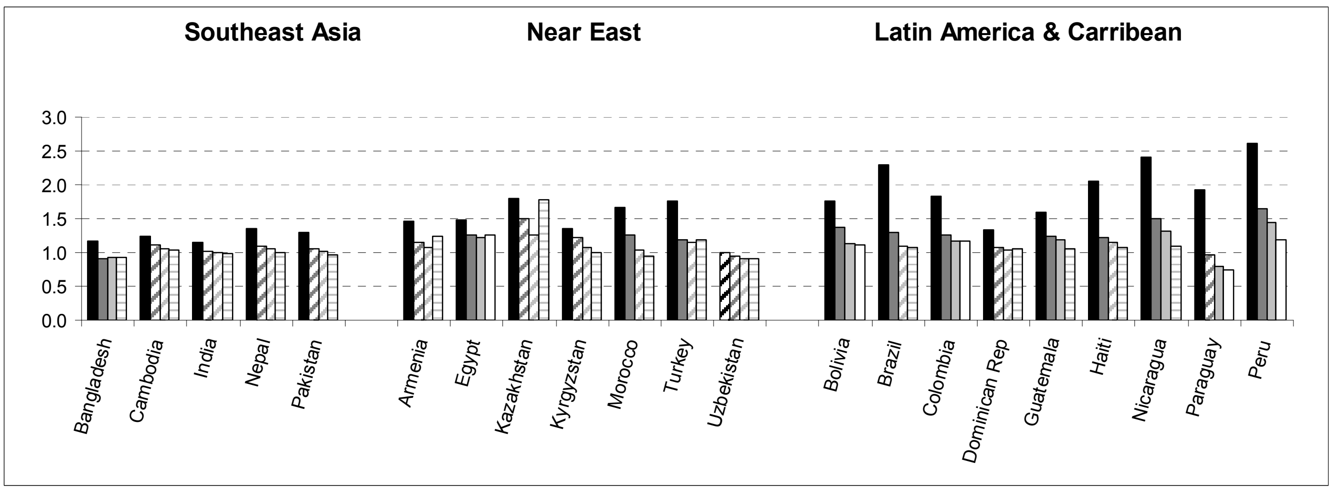


Figure 2: Rural-urban relative risk-ratio of stunting. Estimated by Poisson regression taking into account clustering and population weights.
Note: Striped bars indicates ratio is not significantly different from 1 at the 10% level.

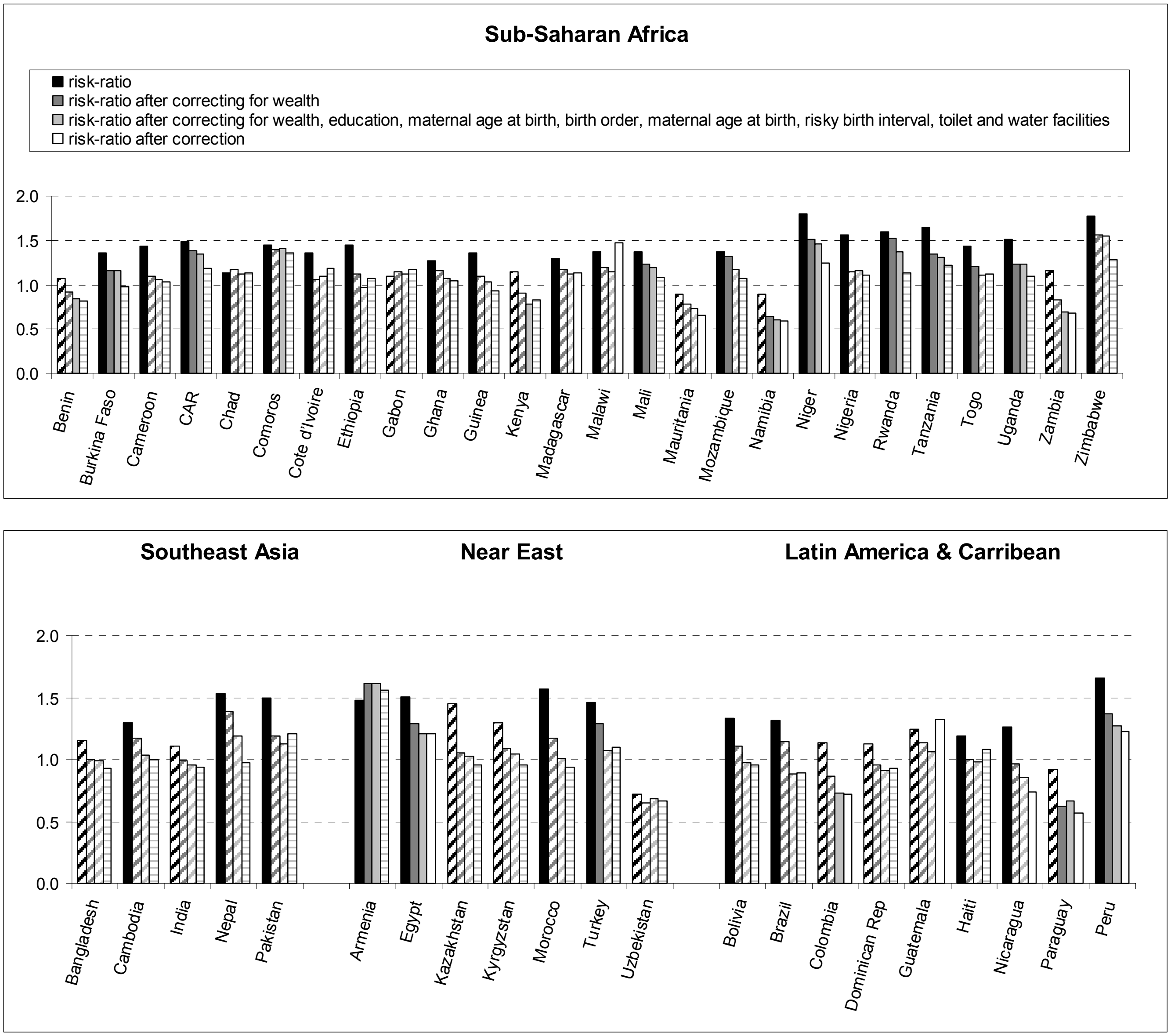


Figure 3: Rural-urban relative risk-ratio of under-five-mortality. Estimated by Poisson regression taking into account clustering and population weights.
Note: Striped bars indicate ratio is not significantly different from 1 at the 10% level.

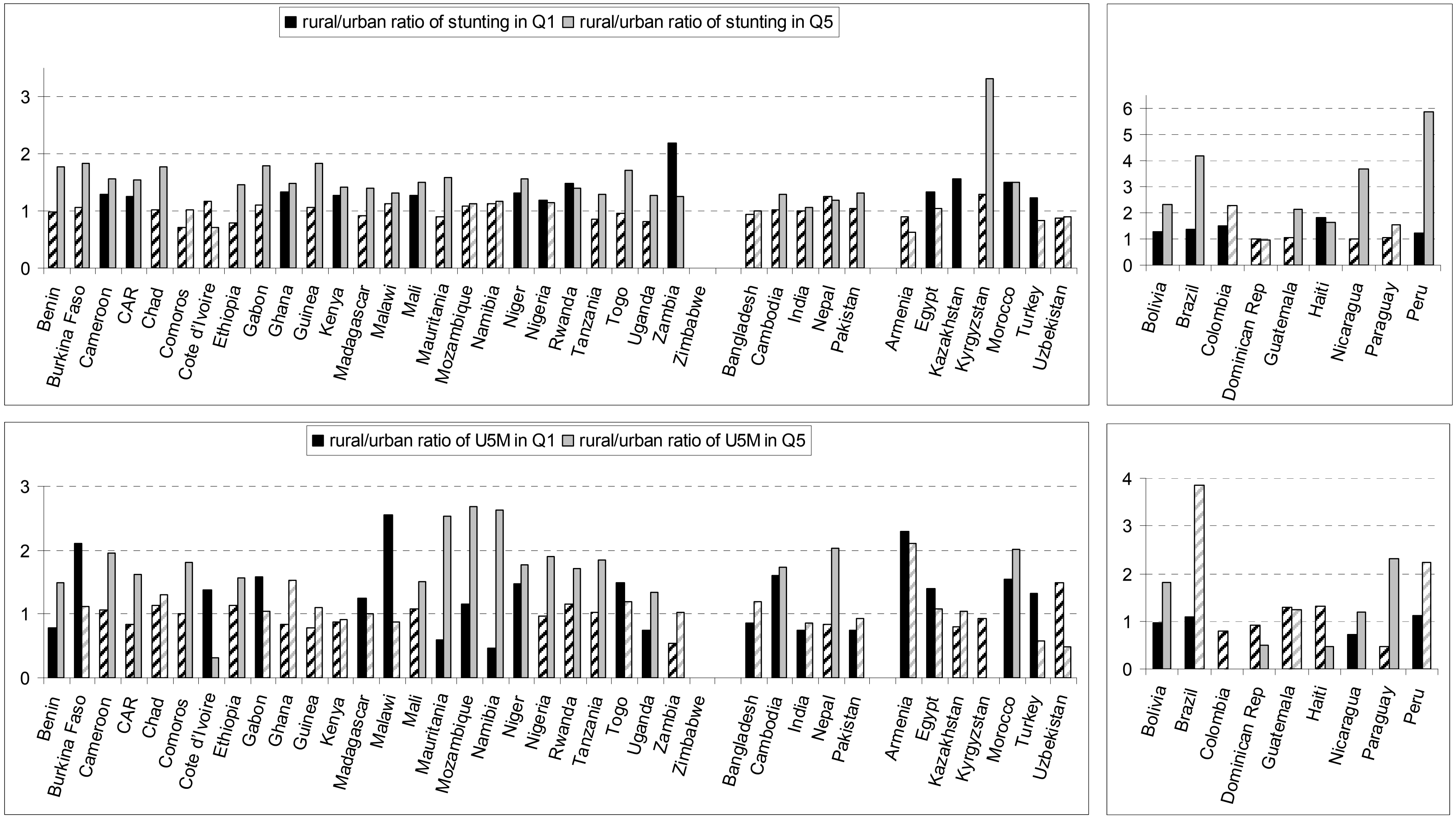
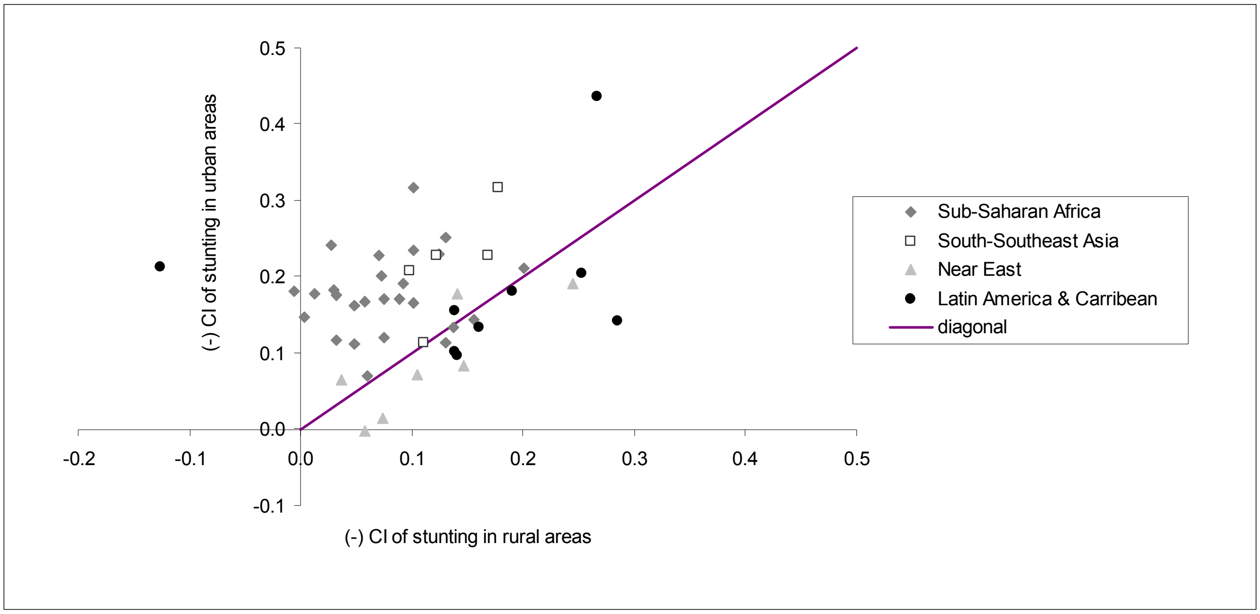


Figure 4: Rural-urban relative risk of stunting and under-five mortality in poorest (Q1) and richest (Q5) wealth quintiles.

Notes: Striped bars indicate that there is no significant difference in rural-urban proportions at the 10% level.

For Comoros, Ethiopia, Nepal, Zambia and Zimbabwe there are less than 100 urban children in the poorest quintile. For Cote d'Ivoire, Kazakhstan, Kyrgyzstan and Turkey there are less than 100 rural children in the highest quintile. Zimbabwe is not shown, because of 0% stunting and under-five mortality among urban children in the lowest wealth quintile.



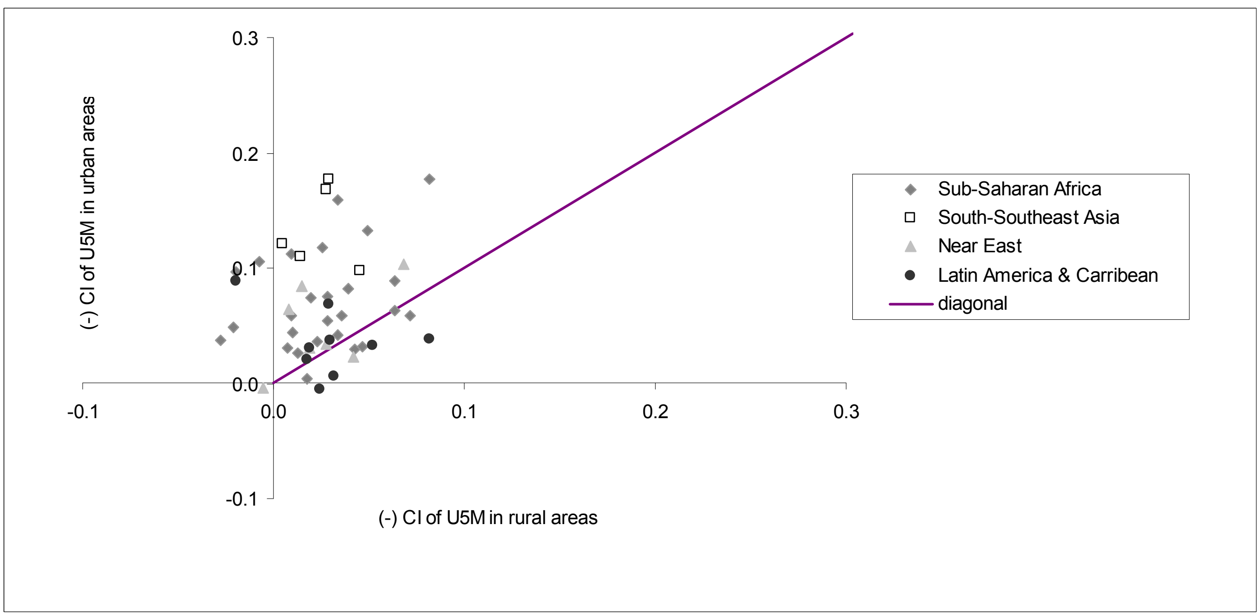


Figure 5: Socioeconomic inequality in under-five mortality and stunting: rural versus urban.
Note: Erreygers (2006) concentration index is used since it is invariant to the mean of the binary variable (see Data and Methods section).
For presentational purposes both graphs do not have the same scaling.

Authors	Year	Data	Health outcome	Rural-urban disparity	Socioeconomic inequality
Fotso	2006	Demographic and Health Surveys (DHS) from 15 Sub-Saharan African countries	stunting (height-for-age z-score<-2)	median of rural-urban odds ratio=1.6	-within-urban OR of poorest to richest quintile: 2.3 -within-rural OR of poorest to richest quintile: 1.7
Smith et al	2005	DHS from 36 countries	height-for-age z-scores	mean z-scores significantly higher in urban areas	
Sahn & Stiffel	2003	DHS from 14 Sub-Saharan African countries	height-for-age z-scores	median absolute difference in stunting rate between urban and rural areas=11.5%	
Menon et al	2000	DHS from 10 countries	stunting	median rural-urban OR=2.2	-within-urban OR of poorest to richest quintile: 4 -within-rural OR of poorest to richest quintile: 1.8
Ruel et al	1999	DHS from 11 countries	prevalence of diarrhea	median rural-urban ratio=1.06 (<1 in Bangladesh, Pakistan, Tanzania)	-median low to high SES ratio within urban=2.07 -median low to high SES ratio within rural=1.2 -the prevalence of diarrhea among the urban low SES group was greater than among the rural low SES group in 7 of the 11 countries studied.
von Braun et al	1993	UNICEF data from 31 countries	stunting, underweight and wasting	median rural-urban odds ratio in stunting=1.4; in underweight=1.4, in wasting=1.2	
Wang	2003	DHS from 41 developing countries Countries combined with World Development Indicators	child mortality	-early 90s: average rural-urban ratio in IMR is 1.3 and 1.36 in U5MR -end 90s: average rural-urban ratio in IMR is 1.33 and 1.41 in U5MR	

Table 1: Literature on cross-country comparisons of rural-urban disparity in child health outcomes in developing countries.
Notes: Only papers using data after 1990 are included in this review.
Fotso (2007) uses the same data as Fotso (2006) and is therefore not included in this Table.

country (region)	year of survey	n stunting	n mortality	country (region)	year of survey	n stunting	n mortality
Sub-Saharan Africa				**Near East**			
Benin	2001	4465	6619	Armenia	2000	1533	1054
Burkina Faso	2003	8521	14264	Egypt	2000	10560	11815
Cameroon	2004	3258	8762	Kazakhstan	1999	579	976
Central African Republic	1994/95	2395	4120	Kyrgyzstan Republic	1997	984	1074
Chad	2004	4552	7223	Morocco	2003/04	5573	6696
Comoros	1996	987	1849	Turkey	1998	2830	3091
Cote d'Ivoire	1998/99	1568	2315	Uzbekistan	1996	1026	1039
Ethiopia	2000	8867	13797	**South & Southeast Asia**			
Gabon	2000	3543	4704	Bangladesh	2004	6003	6717
Ghana	2003	3154	4615	Cambodia	2000	3678	11950
Guinea	1999	4500	7962	India	1998/99	30594	7214
Kenya	2003	4804	6153	Nepal	2001	6214	7352
Madagascar	2003/04	3063	5285	Pakistan	1990/91	4426	9179
Malawi	2000	9407	11019	**Latin America & Caribbean**			
Mali	2001	9618	17855	Bolivia	2003	9240	11518
Mauritania	2000/01	3874	5756	Brazil	1996	4146	4065
Mozambique	2003	3893	6012	Colombia	2005	12460	11012
Namibia	2000	3001	3839	Dominican Republic	2002	9397	8923
Niger	1998	3996	8675	Guatemala	1998/99	3972	5495
Nigeria	2003	4554	7098	Haiti	2000	5593	8047
Rwanda	2000	6240	8911	Nicaragua	2001	6014	7233
Tanzania	2004	7231	9766	Paraguay	1990	3661	4601
Togo	1998	3723	7077	Peru	2000	11721	14722
Uganda	2000/01	5206	7937				
Zambia	2001/02	1944	2600				
Zimbabwe	1999	2746	3572				

Table 2: Description of DHS datasets.

Region	Country	UNDER-FIVE STUNTING						UNDER-FIVE MORTALITY					
		proportion of stunted under-5 children		absolute difference	relative risk	concentration index		proportion of children that died before age 5		absolute difference	relative risk	concentration index	
		urban (1)	rural (2)	(2)-(1)	(2)/(1)	urban	rural	urban (1)	rural (2)	(2)-(1)	(2)/(1)	urban	rural
SSA	Benin	0.32	0.42	**0.10**	**1.33**	**0.20**	**0.07**	0.17	0.19	0.01	1.07	**0.16**	**0.03**
	Burkina Faso	0.24	0.46	**0.21**	**1.87**	**0.17**	**0.06**	0.16	0.22	**0.06**	**1.35**	0.04	**0.02**
	Cameroon	0.28	0.43	**0.15**	**1.55**	**0.19**	**0.09**	0.13	0.18	**0.05**	**1.43**	**0.09**	**0.06**
	CAR	0.35	0.44	**0.09**	**1.26**	**0.12**	0.03	0.12	0.18	**0.06**	**1.48**	**0.08**	0.03
	Chad	0.35	0.46	**0.11**	**1.31**	**0.15**	0.00	0.19	0.21	**0.03**	**1.13**	0.03	**0.05**
	Comoros	0.38	0.41	0.03	1.08	**0.23**	**0.10**	0.09	0.14	**0.04**	**1.45**	0.03	0.01
	Cote d'Ivoire	0.24	0.35	**0.10**	**1.41**	**0.11**	**0.13**	0.13	0.17	**0.05**	**1.36**	**0.06**	**0.06**
	Ethiopia	0.47	0.58	**0.11**	**1.23**	**0.24**	0.03	0.13	0.19	**0.06**	**1.44**	**0.11**	-0.01
	Gabon	0.22	0.37	**0.15**	**1.67**	**0.14**	**0.16**	0.09	0.09	0.01	1.09	**0.04**	-0.03
	Ghana	0.25	0.41	**0.16**	**1.65**	**0.17**	**0.09**	0.10	0.12	**0.03**	**1.27**	**0.05**	-0.02
	Guinea	0.25	0.38	**0.13**	**1.53**	**0.12**	**0.07**	0.17	0.23	**0.06**	**1.36**	**0.08**	**0.04**
	Kenya	0.30	0.37	**0.07**	**1.24**	**0.25**	**0.13**	0.11	0.12	0.02	1.15	0.03	**0.04**
	Madagascar	0.53	0.57	0.03	1.06	**0.18**	-0.01	0.15	0.19	**0.04**	**1.29**	**0.06**	**0.07**
	Malawi	0.41	0.56	**0.15**	**1.38**	**0.23**	**0.12**	0.07	0.10	**0.03**	**1.37**	0.00	**0.02**
	Mali	0.28	0.46	**0.17**	**1.62**	**0.17**	**0.07**	0.20	0.27	**0.07**	**1.37**	**0.12**	**0.03**
	Mauritania	0.34	0.43	**0.08**	**1.25**	**0.18**	0.01	0.04	0.03	0.00	0.89	**0.03**	0.01
	Mozambique	0.43	0.54	**0.11**	**1.26**	**0.16**	**0.05**	0.18	0.24	**0.07**	**1.37**	**0.10**	-0.02
	Namibia	0.25	0.29	0.04	1.15	**0.13**	**0.14**	0.06	0.06	-0.01	0.90	**0.06**	0.01
	Niger	0.38	0.49	**0.11**	**1.28**	**0.18**	0.03	0.20	0.37	**0.16**	**1.80**	**0.11**	0.01
	Nigeria	0.34	0.48	**0.14**	**1.40**	**0.21**	**0.20**	0.17	0.26	**0.09**	**1.56**	**0.18**	**0.08**
	Rwanda	0.33	0.50	**0.16**	**1.49**	**0.23**	**0.07**	0.13	0.21	**0.08**	**1.60**	**0.05**	**0.03**
	Tanzania	0.34	0.46	**0.12**	**1.35**	**0.32**	**0.10**	0.10	0.16	**0.06**	**1.65**	**0.07**	0.02
	Togo	0.21	0.33	**0.12**	**1.54**	**0.17**	**0.10**	0.12	0.18	**0.05**	**1.44**	**0.04**	**0.03**
	Uganda	0.33	0.46	**0.13**	**1.40**	**0.18**	0.03	0.11	0.17	**0.06**	**1.50**	**0.06**	**0.04**
	Zambia	0.42	0.57	**0.16**	**1.37**	0.11	0.05	0.15	0.17	0.02	1.15	**0.13**	**0.05**
	Zimbabwe	0.26	0.34	**0.08**	**1.31**	0.07	**0.06**	0.05	0.09	**0.04**	**1.78**	**0.04**	0.01
	median	0.33	0.45	0.11	1.36	0.17	0.07	0.13	0.18	0.05	1.37	0.06	0.03
SSEA	Bangladesh	0.44	0.51	**0.07**	**1.16**	**0.32**	**0.18**	0.12	0.14	0.02	1.15	**0.08**	**0.03**
	Cambodia	0.40	0.50	**0.10**	**1.24**	**0.24**	**0.11**	0.10	0.14	**0.03**	**1.30**	**0.07**	**0.05**
	India	0.45	0.52	**0.07**	**1.15**	**0.11**	**0.11**	0.07	0.07	0.01	1.10	0.01	0.01
	Nepal	0.43	0.57	**0.15**	**1.35**	**0.23**	**0.17**	0.11	0.16	**0.06**	**1.53**	**0.14**	**0.03**
	Pakistan	0.45	0.59	**0.13**	**1.29**	**0.23**	**0.12**	0.10	0.15	**0.05**	**1.49**	**0.06**	0.00
	median	0.44	0.52	0.10	1.24	0.23	0.12	0.10	0.14	0.03	1.30	0.07	0.03
NE	Armenia	0.15	0.22	**0.07**	**1.45**	**0.06**	0.04	0.06	0.09	**0.03**	**1.48**	0.00	-0.01
	Egypt	0.18	0.28	**0.09**	**1.49**	**0.07**	**0.11**	0.08	0.11	**0.04**	**1.50**	0.02	**0.04**
	Kazakhstan	0.09	0.17	**0.07**	**1.80**	0.00	0.06	0.08	0.12	0.04	1.45	**0.08**	0.01
	Kyrgyzstan	0.26	0.35	**0.09**	**1.36**	**0.18**	**0.14**	0.09	0.12	0.03	1.30	**0.10**	**0.07**
	Morocco	0.18	0.29	**0.12**	**1.66**	**0.08**	**0.15**	0.06	0.09	**0.03**	**1.57**	**0.03**	**0.03**
	Turkey	0.15	0.26	**0.11**	**1.75**	**0.19**	**0.24**	0.08	0.11	**0.04**	**1.46**	**0.03**	0.02
	Uzbekistan	0.38	0.37	0.00	1.00	0.01	**0.07**	0.08	0.06	-0.02	0.72	**0.06**	0.01
	median	0.18	0.28	0.09	1.49	0.07	0.11	0.08	0.11	0.03	1.46	0.03	0.02
LAC	Bolivia	0.24	0.43	**0.19**	**1.77**	**0.23**	**0.13**	0.11	0.15	**0.04**	**1.34**	**0.09**	-0.02
	Brazil	0.10	0.23	**0.13**	**2.29**	**0.14**	**0.28**	0.08	0.11	**0.03**	**1.32**	**0.04**	**0.08**
	Colombia	0.12	0.23	**0.10**	**1.83**	**0.10**	**0.14**	0.04	0.04	0.00	1.13	**0.02**	**0.02**
	Dominican	0.11	0.14	**0.03**	**1.33**	**0.10**	**0.14**	0.06	0.06	0.01	1.12	**0.03**	**0.05**
	Guatemala	0.38	0.61	**0.23**	**1.60**	**0.44**	**0.27**	0.07	0.09	0.02	1.24	0.01	**0.03**
	Haiti	0.16	0.32	**0.16**	**2.05**	**0.13**	**0.16**	0.15	0.18	**0.03**	**1.19**	0.00	0.02
	Nicaragua	0.15	0.35	**0.20**	**2.40**	**0.18**	**0.19**	0.06	0.07	**0.01**	**1.26**	**0.03**	**0.02**
	Paraguay	0.12	0.23	**0.11**	**1.92**	**0.16**	**0.14**	0.06	0.06	0.00	0.92	**0.07**	**0.03**
	Peru	0.18	0.47	**0.29**	**2.60**	**0.20**	**0.25**	0.07	0.12	**0.05**	**1.66**	**0.04**	**0.03**
	median	0.15	0.32	0.16	1.92	0.16	0.16	0.07	0.09	0.02	1.24	0.03	0.03
TOTAL	**median**	0.28	0.43	0.11	1.40	0.17	0.11	0.10	0.14	0.03	1.36	0.06	0.03

Table 3: Under-five mortality and stunting: urban/rural proportions, rural-urban absolute difference, rural-urban relative risk and urban/rural concentration indices.

Notes: The CI's are calculated as suggested by Erreygers (2006).

Figures in bold are significantly different from 0 (from 1 in the case of risk ratios) at the 10% level.

	STUNTING			MORTALITY		
	Model 1	Model 2	Model 3	Model 1	Model 2	Model 3
dependent variable	rural-urban RR	Δ rural-urban RR by wealth	Δ rural-urban RR by all covariates	rural-urban RR	Δ rural-urban RR by wealth	Δ rural-urban RR by all covariates
Sub-Saharan Africa	-0.591***	-0.478***	-0.546***	0.113	-0.034	-0.071
South-South East Asia	-0.739***	-0.489***	-0.603***	0.072	-0.056	-0.062
Near East	-0.474***	-0.399***	-0.429***	0.111	-0.035	-0.057
Constant	1.975***	0.687***	0.830***	1.243***	0.225***	0.318***
Observations	47	47	47	47	47	47
R-squared	0.5	0.57	0.57	0.04	0.02	0.04

* significant at 10%; ** significant at 5%; *** significant at 1%

Table 4: Cross-country regressions. The dependent variable is respectively the urban-rural risk ratio (1), the absolute reduction in the urban-rural risk ratio by controlling for wealth (2), the absolute reduction in the rural-urban risk ratio by controlling for all covariates (3). All models only use region dummies and a constant as regressors, with the Latin American & Caribbean region as reference category.

ENDNOTES

[1] Since anthropometric deficits accumulate over time, the average malnutrition rates for these countries will be biased downwards compared to those of the other countries.

[2] This is also true for the urban-rural classification. Households that are living in an urban area at the time of survey may have been living in a rural area at the time the child was born, either because they have moved or because their community has become urbanized. In the developing world the percentage of the population that is urbanized has increased by about 5 points over the time period 1980-2000 (UN, 2005).

[3] As the data are retrospective, there are fewer observations for children born earlier in time. Moreover, the thinning of the data does not occur randomly, but is a function of maternal age at birth. Conditioning on maternal age at birth (and birth order) should address this problem.

[4] We could not include information on breastfeeding practices because DHS only contain the relevant data for the 5 lastborn children. To preserve consistency in the set of covariates, we also excluded breastfeeding from the stunting analysis. Breastfeeding may be considered endogenous in stunting/mortality regressions.

[5] Caldwell (1979) argued that the protective effect of education manifests at junior high school level. It is not possible to use an education dummy defined at this level since no, or very few, rural women reach it in many countries. We did conduct the analysis using a binary variable that equals 1 if the mother had no or incomplete primary education. This gave comparable results: controlling for other covariates (after wealth) reduced the urban-rural RR's of stunting and mortality by 28% and 23%. We chose to distinguish between no and any education because in a lot of countries – especially in Sub-Saharan Africa – almost no rural women had finished primary school. The education variable is not used in Armenia and Kazakhstan because all women had at least incomplete primary education.

[6] Also other assets like microwave, mobile phone, etc. were used if available. Age and sex of the household head is included since it can be expected to be correlated with socioeconomic status (see Ferguson, Murray, Tandon & Gakidou (2003)). The weights of these assets and living conditions are provided through principal component analysis. Deriving a wealth index for both urban and rural areas from a common set of assets may understate the wealth of rural households because the DHS generally contain more information on assets that are more common

to urban areas (eg, fridge, television). Households in rural areas may have a range of resources that are often not recorded in DHS, like land, rights to fishing, gathering or grazing, or the space and resources to keep animals.

[7] Although Menon et al (2000) find no clear evidence of assets having different relationships with wealth across urban and rural areas.

[8] For Comoros and Uzbekistan, this could be related to the small sample size (see Table 2 for sample sizes). The small sample size of Comoros is partly due to the fact that there is only data for children aged 0 to 3 years.

[9] Figures are available on request.

[10] There is closer association between stunting and infant mortality in the relative ranking of countries, with the Spearman correlation coefficient being 0.36 (p-value=0.013).

[11] We also did the analysis using odds-ratios estimated by logistic regression. Results were generally the same and therefore not discussed.

[12] To give an idea of the overlap in the wealth distribution: for 5 countries, there were less than 100 urban children in the poorest wealth quintile; and for 4 countries there were less than 100 rural children in the richest wealth quintile.

[13] Results are available on request.

[14] To check sensitivity to the order in which covariates are controlled for, we did the same analysis including first the set of socio-demographic covariates and thereafter adding wealth. If included first, the contribution of the set of socio-demographic covariates is generally larger but the contribution of wealth remains large and significant.

[15] Actual values of the rural and urban concentration indices are give in Table 3.

[16] Here we give the actual and not the absolute values of the indices that are given in the figure. Regarding infant mortality, we also found that socioeconomic inequality is greater in urban areas.

[17] The median percentage of rural stunted/dead children (out of the total stunted/dead) in our data is about 75%, although there is variation both within and across regions. In 7 countries, including e.g. Brazil and Turkey, the rural population accounts for less than half of all cases of stunting and child deaths.