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**Child Malnutrition and Antenatal Care:
Evidence from three Latin American countries**

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Abstract

The importance of ever-earlier interventions to help children reach their physical and cognitive potential is increasingly being recognized. In part, as a result of this, in developing countries, antenatal care is becoming an important element of strategies to prevent child stunting in utero and later. Notwithstanding their policy relevance and substantial expansion, empirical evidence on the role of antenatal care (ANC) programs in combating stunting is scarce. This study analyzes the role of ANC programs in determining the level and distribution of child stunting in three Andean countries - Bolivia, Colombia, and Peru - where since the 1990s, expanding access to such care has been an explicit policy intervention to tackle child malnutrition. We find that the use of such services is associated with a reduction in the level of malnutrition and at the same time access to such services is *relatively equally* distributed. While this is a positive sign, it also suggests that further expansion of ANC programs is unlikely to play a large role in reducing inequalities in malnutrition.

Keywords

Child malnutrition, antenatal care, inequality decomposition, height for age.

Child Malnutrition and Antenatal Care¹

Evidence from three Latin American countries

1 Introduction

Child malnutrition, especially amongst the poorest segments of the population, is an important policy concern in Latin America where 16 percent of children under age five are stunted (ECLAC, 2006). Despite progress, stunting in early childhood continues to display sharp disparities across urban and rural regions, and across various socio-economic characteristics (ECLAC, 2006; Ruel, 2001; Larrea and Freire, 2002). Furthermore, with regard to the Millennium Development Goals, reductions in child nutrition and improvements in related outcomes such as maternal health and access to antenatal care are yet to be reached in several Latin American countries (UN, 2008).

In the last few decades, research on the determinants of child malnutrition in developing countries has attracted substantial attention. Various papers have identified the importance of maternal physical and mental health, education and wealth, illness control, poor child care, and unstimulating home environments as determinants of child stunting, a marker of child malnutrition. While the role of such factors may be considered common-place, less common and a key implication from the literature is the importance of early interventions to help children reach their physical and cognitive potential (see, for example, Li *et al.*, 2004; Grantham-McGregor *et al.*, 2007; Victora *et al.*, 2008; Hoddinott *et al.*, 2008). On the basis of their review of the literature on developing countries covering the period 1985 to 2006, Grantham-McGregor *et al.*, (2007, p. 62) argue that patterns of growth retardation are similar across countries and that stunting “begins in utero or soon after birth, is pronounced in the first 12-18 months and could continue to around 40 months”. Related work points out that “poor fetal growth or stunting in the first two years of life leads to irreversible damage” (Victora *et al.*, 2008, p. 340), including reductions in adult height (Martorell, 2005), poor cognitive skills, lower levels of educational attainment (Alderman *et al.*, 2006), and reduced income (Chen and Zhou, 2007).

While a distinction needs to be drawn between small and healthy versus growth restricted infants who are more susceptible to post-natal episodes of morbidity and mortality, according to Kramer (1998) intra uterine growth retardation (IUGR) accounts for a majority of low birth weight infants in developing countries. Among other factors, maternal malnutrition, low gestational weight gain, weight loss due to illness, and infection during pregnancy, hypertension, smoking, drug use, and alcohol consumption increase the risk of stunting in utero and small for gestational age (SGA) children (see Falkner *et al.*, 1993; Kramer, 1998; McDermott *et al.*, 1999; Breeze and Lees, 2007). Prenatal care programmes, which typically identify high-risk mothers and include nutritional and educational interventions such as information and advice on food hygiene, diet and lifestyle advice, including cessation of

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smoking and the effects of drug use and alcohol consumption, have been designed to deal with factors that are most likely to be associated with growth stunting. Such programmes have been widely advocated as a way of alleviating the incidence of low birth weight and avoiding adverse pregnancy outcomes (Alexander and Korenbrot, 1995; Singh *et al.*, 2003; Wagstaff and Claeson, 2004).

Notwithstanding their policy relevance and substantial expansion, empirical evidence on the role of ante-natal care programs in combating stunting, especially in developing countries is scarce. This study aims to analyze the role of prenatal care in determining the level and distribution of child stunting in three Andean countries - Bolivia, Colombia, and Peru - where since the 1990s, such care has received attention as an explicit policy intervention to tackle child malnutrition, yet little is known about the effects of these policies.

For instance, in Bolivia, there have been several programs geared towards providing free health care services to mothers and children. Most recently, since 2003, the Universal Insurance for Mothers and Children (SUMI) program began providing a broader range of services and its target group includes pregnant women, and children under five. According to Moloney (2009) the Bolivian government has actively tried to discourage home births and tried to encourage pregnant women especially in rural areas to visit health clinics for prenatal checks. In Peru, the 2004 National Sexual and Reproductive Health Sanitary Strategy (ESNSSR) recognizes that sexual and reproductive health implies paying attention to intrauterine life and that one of the pathways to achieve this goal is improved access and use of prenatal care. Since 2000, in Colombia, in an effort to standardize clinical procedures relating to antenatal care, the Ministry of Health has established guidelines for antenatal care and exempted antenatal care from copayments. Although not all prenatal care services are free, the Ministry of Social Protection (2010) claims that the country has worked towards prioritizing health services for pregnant women and children under-five and enhancing access to prenatal care for women from poorer socioeconomic backgrounds. In all three countries the various policy initiatives have expanded access to prenatal care, most notably in Bolivia where it increased from 40 percent in 1990 to more than 75 percent in 2008. The corresponding figures in Peru were 60 percent in 1990 and 90 percent in 2008 and in Colombia, 81 percent in 1990 to 93.5 percent in 2005.²

While a large literature has analyzed the determinants of stunting in these and other countries, typically, the role of prenatal care has not been explicitly considered. For instance, Desai and Alva (1998) use Demographic and Health Surveys (DHS) from 22 developing countries including Bolivia and Colombia, and find that maternal secondary education has a substantial effect on height-for-age especially in Latin American countries potentially due to its effect on health-promoting behavior. In their cross-country analysis of child malnutrition covering the period 1970 to 1996, Smith and Haddad (2000) identify women's secondary school enrollment, their relative status as measured by differences in life-expectancy and the health environment as measured by access to safe water as the most important determinants of child malnutrition in Latin American countries.

Turning to country specific analyses, based on the 1998 DHS for Bolivia, Morales *et al.* (2004) show that child height is negatively influenced by altitude and speaking Quechua. Their work is based on parsimonious specifications and does not control for access to health infrastructure which may be correlated with altitude and region. Valdivia (2004) uses three

² All figures are from the latest edition of the World Development Indicators produced by the World Bank, <http://data.worldbank.org/data-catalog/world-development-indicators>.

rounds of the Peruvian DHS covering the period 1992 to 2000 to analyze the effect of the rapid expansion of the country's health infrastructure on child height-for-age. The analysis shows that the massive increase in the country's public health infrastructure between 1992 and 1999 is associated with a small increase in height-for-age only in urban areas.³ Attanasio *et al.* (2004) use data on poor Colombian households from a 2002 survey to investigate the effect of a range of public infrastructure variables on height-for-age. These include the presence of a public hospital, access to piped water, distance to a health care provider and the number of hours that growth and development check-ups are provided in the municipality. The presence of a public hospital has a positive and statistically significant effect on height-for-age and is associated with a 0.16 standard deviation increase while the number of hours of development check-ups is marginally significant (8 percent level). Attanasio *et al.*'s. (2004) paper is notable due to its focus on access to child health services as there is relatively little work on the effect of such measures on anthropometric outcomes. Larrea *et al.* (2005) focus on the ethnic and regional determinants of child malnutrition in Ecuador, Peru and Bolivia. Their work relies on a 1998 DHS collected in Bolivia and three DHS collected between 1992 and 2000 in Peru. Similar to the findings of Morales *et al.* (2004) they find that ethnicity and region/altitude have substantial negative effects on height-for-age in both Peru and Bolivia. They also consider the effect of an access to health services index, which includes access to prenatal care, on stunting. While their estimates suggest a positive link between health services access, at least for some of their specifications, since their index includes six items it is hard to discern the effect of access to prenatal care.

The contribution of the paper is twofold. First, it provides updated evidence on the prevalence and inequalities in child malnutrition in three Andean countries. Second, and most importantly, the paper adds to the existing literature on child malnutrition, by explicitly investigating the role of prenatal care on the level and distribution of child malnutrition. At the outset it should be clear that while our assessment of the link between prenatal care and child malnutrition controls for a number of confounding factors which may influence both the use of prenatal care and malnutrition, we do not purport to provide a causal analysis. Notwithstanding this caveat, given the rapid expansion of such services and the call for ever-earlier interventions (Grantham-McGregor *et al.*, 2007) it is relevant to enquire whether such care has a discernible effect on child malnutrition.

The paper is organized as follows. The following section lays out an empirical framework, while section III describes the data. Section IV presents the estimates, and section V concludes the paper.

³ Between 1992 and 1999 the number of public health facilities increased by 52 percent and the number of doctors by 35 percent. In terms of the effects of this increase, a 1 standard deviation increase in health infrastructure is associated with a 0.03 standard deviation increase in height-for age in urban areas while the effect in rural areas is zero.

II Empirical framework

Our empirical work is divided into three stages. First, we analyze the determinants of child malnutrition. Second, we use concentration curves and indices to describe inequalities in child malnutrition. Finally, to identify the source of inequalities we carry out decomposition analyses.

II.1 Determinants of child malnutrition

Child height-for-age is used as a long-run indicator of a child's nutritional status (Martorell and Ho, 1984; Martorell, 1999). Height-for-age z-scores (HAZ), which measure a child's deviation in height (in terms of standard deviation units) relative to a reference population, is computed as $HAZ = \frac{Height_i - Median}{SD}$, where $Height_i$ refers to the length (under two) or height (older than two) of a child, and $Median$ and SD refer to the median and standard deviation of the height values of the National Centre for Health Statistics (NCHS) reference population (Hamill et al., 1977). Values of the HAZ below two (three) standard deviations indicate chronic (severe) malnutrition.

Following a well-established literature (Mosley and Chen, 1984; Thomas and Strauss, 1992) - which invokes a child health production function, and the idea that households make decisions by attempting to maximize their welfare subject to budget and time constraints within the confines of an externally determined public health infrastructure - a child's height may be treated as a function of several initial and current individual, household, and community-level characteristics.

In the present case, individual child height (h_i), as measured by height-for-age z-scores is written as,

$$h_i = \beta_0 + \sum \beta_k^{AC} x_{ik} + \sum \beta_k^{Cb} x_{ik} + \sum \beta_k^{HC} x_{ik} + \sum \beta_k^{CC} x_{ik} + \eta_i \quad (1)$$

that is, a function of four categories of determinants: (i) access to and use of antenatal care and complementary behavior (*AC*) (ii) childrearing practices (*Cb*) (iii) household and maternal characteristics (*HC*) (iv) child characteristics (*CC*). Table 1 provides a description of the variables (x_{ik}) in each set of determinants. The β_k are coefficients to be estimated, and η_i reflects unobserved heterogeneity in child stature. To ease interpretation, the outcome variable, h_i , is the negative of the HAZ, so that the estimated coefficients may be interpreted in terms of their effect on malnourishment. Since HAZ is a continuous variable, as opposed to a discrete indicator of chronic or severe malnutrition, (1) is estimated using OLS.

Our main aim is to identify the effect of antenatal care on height-for-age. The main empirical concern is that while availability of antenatal care may be treated as exogenous to the household, actual use of such services is subject to maternal/household choice. For instance, if women with lower (higher) unobserved health status are more likely to use antenatal care, then estimates based on (1) will underestimate (overestimate) the effect of antenatal care. To deal with such concerns (1) includes a wide range of control variables such as mothers' height, age, education, and a household wealth index which are likely to influence both the use of

prenatal care and be correlated with a women’s unobserved health status. While the inclusion of a wide range of controls (as listed in Table 1), may be expected to mitigate potential bias in estimates of the effect of antenatal care on HAZ, we cannot rule out the possibility that unobserved health status may be correlated with the use of antenatal care.

II.2 Examining socioeconomic inequalities in stunting⁴

To assess socioeconomic-related inequality in child stunting we plot concentration curves which display the share of stunting accounted for by the cumulative share of children ranked on the basis of a wealth index.⁵ To provide a sense of the magnitude of inequality we compute the concentration index, which is directly linked to the concentration curve,

$$CI = \frac{2}{\mu} \text{cov}(h, r) \quad (2)$$

where, r_i is the fractional rank ($r_i = i/N$) for child i in the sample of N children in living standards (here the wealth index); h_i is the negative value of HAZ, and μ its mean. The concentration index ranges between -1 and 1 and measures twice the area between the line of equal distribution and the concentration curve. A negative value indicates that child malnutrition is concentrated among the less wealthy, in which case the curve lies above the 45 degree line.

Additional insights on the source of this inequality may be obtained by decomposing the index and assessing the effect of individual variables on wealth-related inequality in stunting. Wagstaff, van Doorslaer, and Watanabe (2003) show that, in cases such as in the current application, the overall concentration of wealth-related inequality in stunting can be decomposed into the contributions of individual factors which enter (1) where the contribution of each factor is the product of the elasticity ($\beta_k \bar{x}_k / \mu$) of h_i with respect to the factor and the wealth-related concentration of that factor (C_k). μ is the mean of the HAZ. Hence, the concentration index (CI) may be written as,

$$CI = \sum_k \frac{\beta_k \bar{x}_k}{\mu} C_k + \frac{C_\varepsilon}{\mu} \quad (3)$$

where \bar{x}_k is the mean of each of the variables included in (1) and the second component on the right hand side of (3) is a residual term.

⁴ See O’Donnell *et al.* (2008) for an extensive account and application of these methods.

⁵ Alternative measures of living standards such as consumption or income may also be used. The DHS does not collect information on these metrics and hence we rely on the wealth index to develop the concentration curve and the concentration indices. For 19 countries, Wagstaff and Watanabe (2003) show that the concentration index for malnutrition is not particularly sensitive to the use of consumption or wealth as a living standards measure.

We also explicitly consider the effect of antenatal care on child stunting by first examining whether there is a gap in mean HAZ between children whose mothers received incomplete antenatal care (b^{LAC}), and children whose mothers received complete antenatal care (b^{CAC}).⁶ The mean gap in the HAZ is then decomposed into its constituents using an Oaxaca decomposition, that is,

$$b^{CAC} - b^{LAC} = \Delta\bar{x}\beta^{LAC} + \Delta\beta x^{CAC} + \Delta\bar{x}\Delta\beta = E + C + EC \quad (4)$$

Where $\Delta\bar{x}$ is the difference in the means of variable across the two groups and $\Delta\beta$ is the difference in the estimated coefficients across the two groups. This decomposition allows us to establish the extent to which differences in the mean child nutritional status across the two groups of children is due to differences in the mean endowments of the two groups (E), differences in the coefficients (C) or due to interactions between the endowments and the coefficients (EC).

III The data and descriptive statistics

The analysis draws on data contained in DHS conducted in Bolivia (2008), Colombia (2005) and Peru (2008). The DHS are representative at the national and the urban and rural levels, and consist of a household and a women's survey instrument. The household level information consists of demographic and educational data on all household members, the characteristics of the dwelling and a wealth index.⁷ The women's questionnaire is restricted to the age group 15 to 49 and contains information on a range of issues including maternity care, breastfeeding and nutrition and children's health. Of particular interest to this paper, for children under the age of five, the survey records height and weight and there is a module with information on the type, timing and frequency of antenatal consultations of last born children. The sample used in the paper is restricted to children under five and consists of 4,945 observations from Bolivia, 7,540 from Colombia and 4,208 from Peru.

Table 2 contains descriptive statistics for the sample used in the paper. Although there are in-country regional differences, across all three countries most women have had at least one antenatal care visit. Colombia clearly has the most comprehensive antenatal care regime with 62 percent of women receiving complete antenatal care followed by Bolivia (43 percent) and Peru (28 percent). With regard to child rearing practices, across all three countries almost all children have been breast fed. There are differences in terms of the care regime with only 17 percent of mothers serving as primary care givers in Colombia followed by 36 percent in Peru

⁶ The decomposition is restricted to the two groups - complete and incomplete antenatal care - as the proportion of mothers with no antenatal care is limited. For Bolivia 9.1 percent of mothers have not received any antenatal care while the corresponding figures for Colombia and Peru are 6 and 2.4 percent, respectively.

⁷ The wealth index developed by Macro International is based on the possession of assets such as cars, bicycles, radios, televisions, and household infrastructure which includes source of drinking water, access to toilet, type of floor, and overcrowding.

and 42 percent in Bolivia.⁸ With regard to maternal characteristics there is a fair degree of similarity across the three countries in terms of average age (28.5 to 29.8), height (1.5-1.6 meters) and education of mothers (7.7-8.7 years), although in general, Peru and Bolivia are more similar to each other as compared to Colombia. Colombia is relatively more urbanized, 72 percent versus 58 and 63 percent in Bolivia and Peru, respectively, and related to this households appear to have better access to water/sanitation infrastructure.

IV Estimates

IV.1 Prevalence of child malnutrition

The prevalence of stunting is particularly pronounced in Peru and Bolivia where about a quarter of children are more than 2 standard deviations from the median. The corresponding figure in Colombia is substantially lower (15 percent). The mean HAZ is -0.89 in Colombia followed by Bolivia (-1.20) and Peru (-1.26). Comparisons of these figures which are based on the most recent DHS with estimates based on previous DHS show very little change over time. For instance, based on the 1998 DHS, Morales *et al.* (2004) report that about 25 percent of children in Bolivia were stunted which is the same as we find based on the 2008 DHS. For Peru, the mean HAZ was -1.29 in 1996 and -1.3 in 2000 (see Valdivia, 2004). The latest figure (-1.26) does indicate a slight decline but it is clearly not remarkable. In the case of Colombia according to DHS (2000), 13.5 percent of children were classified as malnourished (Flórez, Ribero and Samper, 2003).

In all three countries there is a clear hierarchy with a lower prevalence of malnutrition and a higher mean HAZ score amongst children whose mothers received complete antenatal care, followed by mothers who received incomplete and no care. In Bolivia and Peru about half the children without access to any antenatal care are malnourished while it is about a third in Colombia (Table 3). The gap between the two extremes (complete versus no access) in terms of the incidence of malnourishment is about 25 percent in Bolivia and Peru and 18 percent in Colombia. In terms of the HAZ, there is a large 0.437 unit gap in Bolivia, followed by 0.295 in Colombia and 0.238 in Peru between those who have received complete and incomplete antenatal care.

As may be expected, there are sharp differences in HAZ across wealth quintiles in all three countries (Table 3). The differences are much sharper in Peru, a gap of -1.48 units between the richest and the poorest quintiles followed by Bolivia (gap of -1.38) and Colombia which has a substantially smaller gap (-0.88). In Peru, about 56 percent of children in the poorest quintile are malnourished while in Colombia the figure is about half of that with Bolivia lying in between these two extremes. Similar patterns are observed with regard to maternal education. About 50 to 60 percent of children who have mothers with no education are malnourished in Bolivia and Peru while in Colombia the corresponding figure is 30 percent.

There is clear evidence of urban-rural disparities in all three countries with rural areas recording at least twice the level of malnourishment as compared to urban areas (Table 3). While gender differences are limited, there are sharp differences in HAZ across indigenous

⁸ The variable takes value of 1 if the mother is the primary care giver and zero otherwise. The options include, partner; older female child; older male child; other relatives; neighbors; friends; housekeeper; child is in school; other.

and non-indigenous children. In Peru, 23 percent of non-indigenous children are malnourished while amongst the indigenous the figure is 55 percent. While the level is lower in Bolivia, indigenous children are still twice as likely to be malnourished as compared to their non-indigenous counterparts (31 versus 16 percent).

IV.2 Determinants of child malnutrition

As discussed in section II, child malnutrition is treated as function of four sets of variables. Table 4 provides OLS estimates of the determinants of height-for-age z-scores.

The strongest association, statistically significant at the 1 percent level, between access to antenatal care and malnutrition is in Colombia where access to (complete or incomplete) such care is associated with a large 0.23 to 0.25 point reduction in malnutrition. In Peru, the results are similar, yet less precise - although there is a negative link (0.21 to 0.26) between malnutrition and antenatal care, it is not statistically significant for complete antenatal care. In contrast to these two countries, in Bolivia, there seems to be no link between the use of such services and a reduction in malnutrition. The large effect in Colombia is notable as it is the effect of ANC visits after controlling for other aspects such as the use of iron, calcium, folic acid supplements and the incidence of tetanus injections. As a proxy for access to supply of medical care in the region the specification includes a variable indicating the percentage of women who have had at least one antenatal care visit. Access to health services is associated with a reduction in malnutrition but the effect is quite small ranging from a z-score reduction of 0.005 points to 0.024 points.⁹

As may be expected, a mother's height has a strong influence on child stunting and a one centimeter increase in maternal height is associated with a z-score reduction of 0.05 to 0.06 units. The effects of maternal age are also similar across countries and indicate that older mothers are less likely to have stunted children till about the age of fifty. Beyond that, age is positively associated with malnutrition. Across all three countries wealth and maternal education are strongly associated with reductions in malnutrition. In terms of location effects, after controlling for wealth, living in a rural area does not seem to hamper malnutrition expect in the case of Peru. In Colombia living in the capital city seems to jeopardize child nutritional status. This may be associated with the high levels of displaced population living in the capital due to violence in rural areas.

Gender differences are limited, except in Colombia where boys are more likely to be malnourished. Across the three countries, there are clear birth-order effects with later-born children more likely to be malnourished. The effects are large and show that being a fourth born child is associated with 0.23 to 0.40 point increase in malnutrition. In addition to the birth-order effect the presence of a larger number of siblings also works towards increasing stunting. The "siblings" variable indicates the diminishing per-capita availability of resources (financial, parental time) in general in a large family while the birth-order variables show that the effect of reduced resources, including reduced maternal health, falls increasingly on later born children. Even after controlling for a range of characteristics, indigenous children are more likely to be malnourished. The effect is statistically significant for both Bolivia and Peru although the effect is about three times larger in Peru.

⁹ This variable may also capture other influences such as externalities associated with access to antenatal care as well as more generally the availability of medical services.

Overall, consistent with previous work (discussed in the introduction) maternal height, wealth, educational status, ethnicity and birth order are strongly associated with child stunting. The relatively novel element, use of antenatal care is strongly associated with a reduction in child stunting in Colombia, less so in Peru and not at all in Bolivia. This variation may be due to cross-country differences in the quality of prenatal care. Given the range of additional vitamin supplements, other complementary measures and the longer history of ANC provision in Colombia it is likely that such services are of a higher quality in the country as compared to Bolivia and Peru. The expansion of access to ANC services is also of more recent vintage in Bolivia and likely to be relatively poorer in quality. The size of the antenatal care coefficient is large and suggests that ensuring complete antenatal care could compensate for wealth differences.

IV.3 Inequality in child malnutrition

In order to assess wealth-related inequalities in child malnutrition, concentration curves and their corresponding concentration indices are estimated. As discussed in section II, the outcome variable is the negative of the HAZ and the proxy for living standards is the wealth index. Given the main concern of this paper, the concentration curves are estimated separately for three groups of children – no ANC, incomplete ANC and complete ANC (see Figure 1) and concentration indices are presented in the top row of Table 5.

Based on an examination of the concentration index and the concentration curve two points may be made. First, based on the concentration index, the distribution of malnourishment across countries is quite similar and across the three countries and ranges between -0.21 and -0.24. In general, the bottom 20 percent of children account for roughly 35 percent of observed malnourishment while the top 20 percent account for about 10 percent. Second, in all three countries, wealth-related inequality in malnourishment is more pronounced amongst those who have access to complete ANC as compared to those who have incomplete or no ANC. This suggests that access to complete ANC is more equally distributed than wealth. For example, in Colombia the 90-10 percentile ratio in the wealth distribution is 4.7 while 80 percent of the richest quintile accesses complete prenatal care as compared to 40 percent amongst the poorest quintile. Similarly, in the case of Peru, the 90-10 percentile ratio is 2.57 as compared to the prenatal care access ratio across wealth quintiles of about 1.8.

To explore the contribution of various factors to the wealth-related inequality in malnourishment we carry out the decomposition described in section II. The decomposition allows us to distinguish between the direct effect of wealth on inequality in malnourishment and the indirect effect of wealth on malnutrition due to the correlation between wealth and other factors that determine malnutrition. As may be expected, in all three countries the direct effect of wealth dominates and accounts for between 38 to 54 percent of the inequality in malnourishment (see Table 5). This is followed by the effect of the various child controls which together account for between 16 to 19 percent of wealth-related inequality in malnourishment. Amongst these characteristics, the largest effects emanate from the fourth born and siblings variables and indicates that wealth has a large effect on determining family size which in turn, due to diminished resources accounts for a substantial proportion of inequality in malnourishment. The third important factor is maternal height (16-18 percent). The large effect of this variable is driven by its importance in determining child stunting

(elasticity) and not due to wealth-related concentration in height.¹⁰ Wealth-related differentials in child-rearing practices are limited and these variables are not responsible for the inequality in malnourishment.

Finally, with regard to prenatal care access and the general availability of antenatal services in a region, in the case of Bolivia, jointly these variables account for about 6 percent of wealth-related inequality. While the wealth-related concentration of “complete ANC” is relatively high (0.202) the concentration of medical services (0.007) is quite small. The relative importance of the latter variable stems from its importance (elasticity) in determining malnutrition. In the Colombian case these variables account for about 10 percent of wealth-related inequality in malnutrition. The concentration index of complete ANC is 0.116 which is considerably smaller than the concentration indices of the family size variables (absolute values of 0.355 and 0.193 for the fourth born and the siblings variables). The concentration index of the medical service availability variable is 0.017. The role of these variables in determining inequality in Peru is very limited (about 2 percent).

The upshot of this analysis is that access to prenatal care services and more generally to medical services are not as heavily influenced by the distribution of wealth as compared to other variables. These variables do account for some of the wealth-related inequality in malnutrition but play a relatively limited role as access to such services is more equally distributed than wealth. While this is a positive sign it also suggests that the increasing spread of such services (with no changes in quality) will have a limited role in reducing wealth-related inequality in malnutrition.

IV.4 Oaxaca decomposition

Based on the preceding discussion, antenatal care is associated with a reduction in child stunting (in Colombia and Peru) yet accounts for a relatively small proportion of wealth-related inequality in malnourishment. This section rounds out our empirical work by using a Oaxaca decomposition to examine the sources of the observed gap between those who have received complete ANC versus incomplete ANC.¹¹ The main idea is to examine whether the factors that explain the gap in HAZ between these two groups are different from those that explain the wealth-related variation in HAZ.

Estimates of the decomposition provided in Table 6 show that across all three countries the overwhelming proportion of the difference in HAZ scores is explained by differences in endowments across complete and incomplete ANC users. In Peru the figure is practically 100 percent followed by 89 percent in Bolivia and 62 percent in Colombia. In terms of the individual variables, similar to the preceding discussions, wealth accounts for the largest proportion of the endowment effect followed by maternal height and at least in the case of Bolivia and Colombia by the family size variables. Taken together with the estimates from the preceding discussion, these estimates imply that while the contribution of the antenatal care variables to inequality in malnourishment is quite modest, the same factors that determine

¹⁰ The elasticity and concentration of each of the individual factors which in turn determines their contribution to the concentration index is not reported for all three countries. Figures for Colombia are provided in a supplemental appendix.

¹¹ We focus on these two groups as the proportion of mothers who have not made use of any antenatal care is quite small (see Table 2).

inequality in malnourishment are also responsible for the observed HAZ gap between users of complete and incomplete ANC.

V. Concluding remarks

Motivated by the spread of ANC programs in three Andean countries - Bolivia, Colombia, and Peru - where since the 1990s, increasing access to such services has been an explicit policy intervention designed to tackle child malnutrition, and limited evidence on the effects of such programs, this study examined the link between use of ANC and the level and distribution of child stunting.

While there are differences across countries, our overall assessment is that the use of ANC is weakly associated with a reduction in the level of child stunting. We find that access to antenatal care has a statistically significant and large effect on reducing malnutrition in Colombia, in Peru the magnitude of the effect is similar to that found in Colombia although it is not precisely estimated. In the case of Bolivia there is no association between ANC access and child stunting. The variation across countries is probably due to differences in the quality of such care.

Analysis of the distribution of ANC services showed that it is more equally distributed than wealth. We also found that wealth-related concentration in access to ANC services plays a small role in explaining the overall wealth-related concentration in malnutrition. While this is a positive aspect, it also indicates that further expansion of ANC programs can only play a limited role in reducing inequalities in malnutrition. Given the strong direct and indirect influence of the concentration of wealth in determining inequalities in malnutrition, this suggests that from the perspective of reducing inequalities, additional attention needs to be paid at least to those components of the wealth index, such as access to water and sanitation services which are amenable to public policy.

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Tables and figures

TABLE 1
Classification of the determinants of child malnutrition

	Variables	Description
Antenatal care and complementary behavior (AC)	Complete antenatal care; Incomplete antenatal care	Complete antenatal care = 1; no antenatal care = 0 Incomplete antenatal care = 1; no antenatal care = 0 Complete antenatal care is defined as six visits to a doctor or nurse during pregnancy with initiation during the first trimester; incomplete antenatal care is at least 1 visit but less than 6
	Tetanus	Number of tetanus injections during pregnancy
	Iron	Mother took iron supplements during pregnancy = 1; 0, otherwise
	Calcium	Number of months mother took calcium during pregnancy (only Colombia)
	Folic acid	Number of months mother took folic acid during pregnancy (only Colombia)
	Vision difficulties	Mother had vision difficulties while pregnant = 1; 0, otherwise
	Alcohol	Mother consumed alcohol during pregnancy = 1; 0, otherwise (only Colombia)
	Smoke	Mother smoked during pregnancy = 1; 0, otherwise (only Colombia)
	Pregnancy duration	Pregnancy duration in months (only Colombia).
	% Antenatal Care	Percentage of women who receive some antenatal care (complete and incomplete) in the region/department
Childrearing attitudes (Ch)	Nutrition	Child was given infant formula in the first three days of life = 1; 0, otherwise
	Breastfeeding	Child has ever been breastfed = 1; 0, otherwise
	Mothers are (primary) care givers	Mother is (primary) care giver = 1; 0, otherwise. For Bolivia, this variable was replaced by whether a mother works at home/doesn't work, assuming that if she doesn't work/works at home she takes care of the child.
Household and maternal controls (HC)	Mother's height	Mother's height in meters
	Mother's age	Mother's age and age squared
	Mother's education	Mother's years of education
	Wealth index	A wealth index based on household assets
	Marital status	Mother is married = 1; 0, otherwise
	Zone	Urban = 1, rural = 0
	Capital	Household lives in the capital city = 1; 0, otherwise
Source of water	Piped drinking water = 1; 0, otherwise.	
Child controls (CC)	Age, Age2	Child age and age squared
	Gender	Boy = 1, girl = 0
	Growth Program	Child attends Growth and Development Program (Colombia) or growth controls (Peru) = 1; 0, otherwise
	2 nd , 3 rd , 4 th born+	Dummy variables indicating birth order of child. The reference category is being the first born.
	Siblings	Number of living siblings.
	Indigenous	Child belongs to an indigenous group = 1; 0, otherwise

TABLE 2
Descriptive statistics

		Bolivia	Colombia	Peru
Antenatal care and complementary behavior	% of mothers receiving complete antenatal care	43.1	61.6	28.1
	% of mothers receiving incomplete antenatal care	47.8	32.3	69.6
	% of mothers receiving no antenatal care	9.1	6.0	2.4
	% of mothers who received tetanus injections	70.8	89.8	76.5
	Average number of tetanus injections	1.3	1.8	1.4
	% of mothers who took iron during pregnancy	77.6	75.0	77.5
	Average number of months the mother took calcium	-	2.1	-
	Average number of months the mother took folic acid	-	2.1	-
	% of mothers who had vision diff, during pregnancy	13.7	10.9	14.4
	% of mothers who consumed alcohol during pregnancy	-	9.1	-
	% of mothers who smoked during pregnancy	-	3.5	-
	Average pregnancy duration	-	8.8	-
Childrearing attitudes	% of children who were given infant formula in the first three days of life	5.1	25.3	16.2
	% of children who were ever breastfed	99	97.8	98.0
	% of mothers who are the caregivers	42.5	16.9	36.5
Household and maternal controls	Average height of the mother	1.5	1.6	1.5
	Average age of the mother	29.5	28.5	29.8
	Average years of the mother's education	7.7	8.3	8.7
	Wealth index	2.52	2.40	2.91
	% of married women (or those who live with their partner)	85.4	74.6	84.6
	% of women in urban areas	57.9	71.7	63.0
	% of women in the capital city	27.9	14.5	22.9
	% of women who access piped water	75.3	83.5	69.6
Children controls	Average age of the children (months)	27.8	34.4	30.2
	% of girls	48.7	48.4	50.7
	% of children who attend growth and development program	-	43.6	64.8
	Average number of siblings	2.0	1.3	1.6
	% of indigenous children	62.9	-	11.7

TABLE 3
Distribution of HAZ scores

	Bolivia		Colombia		Peru	
	Average HAZ	Malnourished children (percentage)	Average HAZ	Malnourished children (percentage)	Average HAZ	Malnourished children (percentage)
Overall	-1.20	25.12	-0.89	15.15	-1.26	27.00
<u>Antenatal care</u>						
No Antenatal Care	-1.76	42.20	-1.35	29.00	-1.84	47.92
Complete Antenatal care (CAC)	-0.981	18.13	-0.76	11.24	-1.06	22.25
Incomplete Antenatal Care (IAC)	-1.418	28.16	-1.05	19.74	-1.29	27.88
<i>Difference CAC and IAC</i>	<i>0.437</i>		<i>0.295</i>		<i>0.238</i>	
<u>Mother is primary care giver</u>						
Yes	-1.15	23.48	-0.90	15.65	-1.34	28.84
No	-1.23	26.33	-0.89	15.03	-1.21	25.60
<u>Wealth index quintiles</u>						
Poorest	-1.82	44.18	-1.28	25.96	-2.06	55.78
Poorer	-1.46	32.33	-1.00	16.64	-1.70	42.08
Middle	-1.15	21.73	-0.88	13.83	-1.26	24.91
Richer	-0.85	14.55	-0.64	9.22	-0.99	14.12
Richest	-0.44	6.25	-0.40	4.95	-0.58	8.51
<u>Mother's education</u>						
No education	-1.94	48.98	-1.40	30.47	-2.15	61.94
Primary	-1.45	32.30	-1.13	20.45	-1.73	41.03
Secondary	-0.93	15.96	-0.82	13.29	-1.12	21.21
Higher	-0.55	9.16	-0.46	6.23	-0.66	9.66
<u>Residence</u>						
Urban	-0.88	16.38	-0.77	12.03	-0.97	16.78
Rural	-1.63	37.13	-1.19	22.66	-1.75	43.79
<u>Sex</u>						
Male	-1.25	27.11	-0.82	17.22	-1.25	28.16
Female	-1.14	23.01	-0.96	13.00	-1.26	25.45
<u>Ethnicity</u>						
Indigenous	-1.44	30.71	-	-	-2.01	55.03
Non-Indigenous	-0.78	15.62	-	-	-1.16	23.04
Number of Observations		4945		7540		4208

TABLE 4
Determinants of height-for-age z-scores (OLS)

	Bolivia		Colombia		Peru	
	β_k	P-value	β_k	P-value	β_k	P-value
Complete antenatal care	0.002	0.980	-0.250***	0.000	-0.207	0.152
Incomplete antenatal care	0.082	0.328	-0.225***	0.000	-0.262*	0.064
Tetanus injections	-0.020	0.289	0.008	0.589	0.041**	0.031
Iron	0.029	0.484	-0.104***	0.003	-0.063	0.168
Calcium	-	-	0.010	0.168	-	-
Folic acid	-	-	0.008	0.204	-	-
Vision difficulties	-0.039	0.391	0.010	0.813	0.053	0.328
Alcohol	-	-	0.039	0.439	-	-
Smoke	-	-	-0.022	0.802	-	-
Pregnancy duration	-	-	-0.141***	0.000	-	-
% antenatal care in the region	-0.024***	0.000	-0.009***	0.000	-0.005**	0.016
Nutrition supplement first days	0.057	0.506	-0.042	0.202	-0.033*	0.070
Breast feeding	-0.078	0.678	0.068	0.550	-0.051	0.758
Mother is prime care giver	-0.014	0.725	-0.089**	0.017	0.068	0.101
Mother's height	-5.477***	0.000	-6.062***	0.000	-5.985***	0.000
Mother's age	-0.069***	0.007	-0.057***	0.002	-0.062**	0.012
Mother's age - squared	0.001*	0.087	0.000	0.145	0.001	0.156
Mother's education (years)	-0.014**	0.014	-0.013***	0.005	-0.025***	0.000
Wealth index	-0.277***	0.000	-0.180***	0.000	-0.221***	0.000
Mother is married	-0.006	0.914	0.031	0.341	-0.052	0.305
Urban	0.026	0.689	0.026	0.537	-0.121**	0.042
Capital	-0.089	0.126	0.464***	0.000	0.197**	0.047
Age in months	0.038***	0.000	0.035***	0.000	0.005	0.594
Age in months - squared	0.000***	0.000	0.000***	0.000	0.000	0.483
Gender	0.061	0.108	0.077***	0.005	-0.034	0.368
2nd born	0.121**	0.040	0.229***	0.000	0.258***	0.000
3rd born	0.155**	0.050	0.314***	0.000	0.281***	0.000
4th born	0.233**	0.024	0.398***	0.000	0.397***	0.001
Number of living siblings	0.069***	0.001	0.034	0.137	0.060**	0.017
Indigenous	0.101**	0.028	-	-	0.278***	0.002
Growth Program	-	-	-0.039	0.187	0.023	0.545
Constant	12.314***	0.000	13.320***	0.000	12.420***	0.000
Observations	3,001		5,134		2,728	
R-squared	0.294		0.247		0.337	

Note: Statistical significance: *** 1%; **5%; * 10%

TABLE 5
Decomposition of HAZ concentration indices

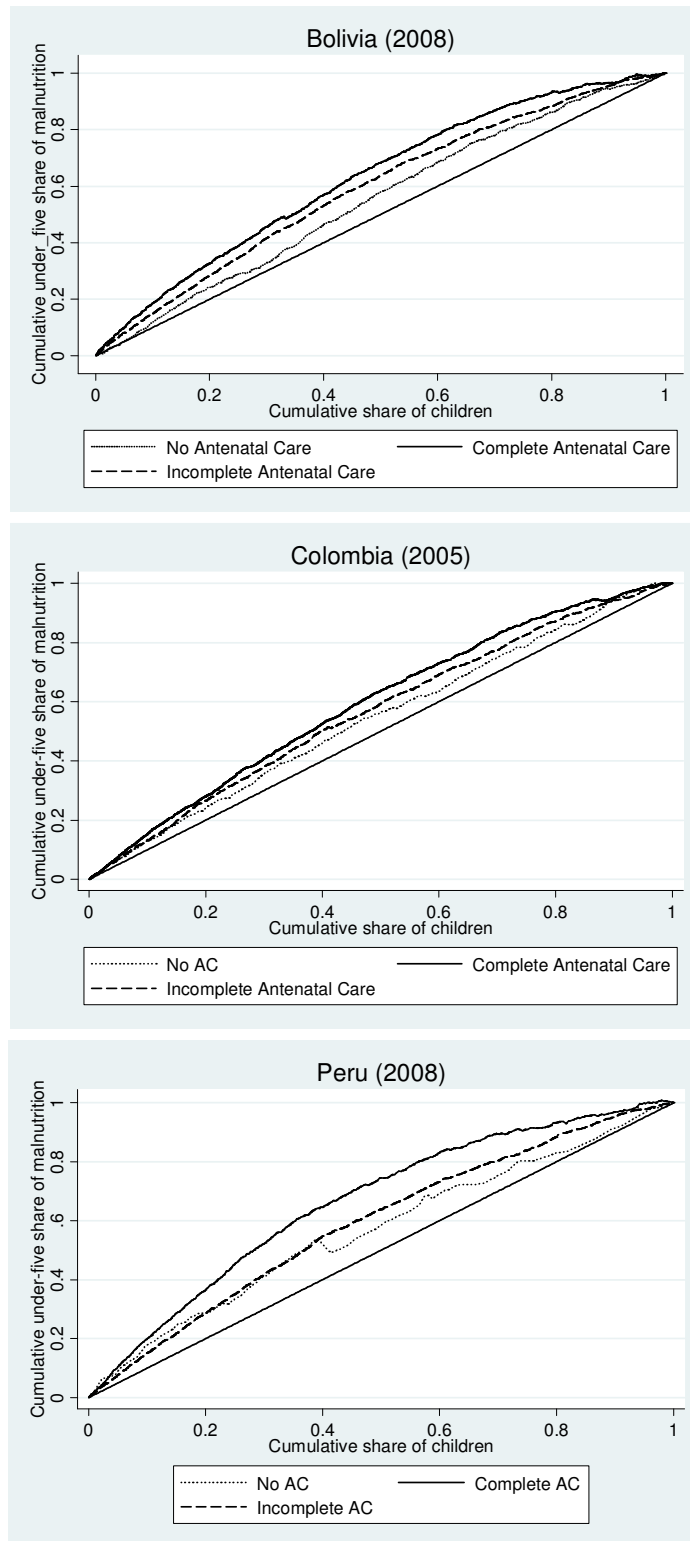
	Bolivia	Colombia	Peru
Concentration Index	-0.236	-0.208	-0.229
Decomposition (percentage)			
Complete antenatal care	-0.07	9.95	2.47
Incomplete antenatal care	1.68	-5.09	-2.29
Tetanus injections	0.16	-0.08	0.06
Iron	-0.25	2.59	0.48
Calcium	-	-1.79	-
Folic acid	-	-1.52	-
Vision difficulties	-0.28	0.08	0.14
Alcohol	-	0.07	-
Smoke	-	-0.04	-
Pregnancy duration	-	-1.20	-
% antenatal care in the region	3.98	5.86	1.74
Nutrition supplement first days	-0.45	0.32	0.95
Breast feeding	-0.02	0.02	-0.08
Mother is prime care giver	0.06	-0.28	0.37
Mother's height	16.31	15.56	18.08
Mother's age	-1.22	7.93	1.72
Mother's age - squared	2.03	-3.05	-0.33
Mother's education (years)	8.60	8.73	13.09
Wealth index	54.22	50.73	38.44
Mother is married	-0.01	0.06	-0.37
Urban	-1.89	-2.04	7.68
Capital	0.36	-6.01	-1.51
Age in months	-1.74	-2.99	0.26
Age in months - squared	2.41	3.57	-0.03
Gender	-0.06	-0.11	-0.05
2nd born	-1.57	-2.96	-2.23
3rd born	-0.46	0.12	-0.32
4th born	7.04	12.76	9.76
Number of living siblings	9.18	4.73	6.54
Indigenous	2.21	-	5.27
Growth Program	-	0.57	0.18
Residual	-0.23	3.52	-0.02
Total	100%	100%	100%

TABLE 6
Oaxaca decomposition

	Bolivia			Colombia			Peru		
	E	C	CE	E	C	CE	E	C	CE
Tetanus inj.	0.002	-0.131	0.018	0.007	0.115	-0.010	-0.002	0.079	0.003
Iron	-0.004	0.042	-0.004	0.018	-0.071	0.013	0.003	0.063	-0.002
Calcium	-	-	-	-0.024	-0.030	0.013	-	-	-
Folic acid	-	-	-	-0.005	0.020	-0.008	-	-	-
Vision diff.	0.000	-0.004	0.000	0.000	0.009	0.001	-0.001	0.034	0.001
Alcohol	-	-	-	-0.001	0.015	0.005	-	-	-
Smoke	-	-	-	-0.004	0.004	0.003	-	-	-
Pregn. duration	-	-	-	0.006	-1,003	0.007	-	-	-
% AC in the region	0.050	0.657	-0.018	0.013	1,049	-0.012	-0.003	-0.148	0.003
Nutrition 1st days	-0.004	-0.010	0.006	0.002	0.019	-0.002	0.000	0.008	-0.002
Breast feeding	0.000	-0.045	-0.000	-0.002	-0.363	0.002	0.002	0.496	-0.002
Mother cares	0.001	-0.010	-0.001	0.000	-0.015	0.000	0.007	0.009	0.003
Mother's height	0.102	0.664	-0.008	0.045	-0.232	0.001	0.064	1,407	-0.008
Mother's age	-0.018	0.512	0.003	0.040	-0.553	0.025	0.019	-0.713	0.042
Mother's age Squared	0.023	-0.205	-0.005	-0.002	0.128	-0.010	0.028	0.405	-0.045
Mother's education	-0.011	-0.227	0.056	0.003	-0.226	0.046	0.010	-0.242	0.032
Wealth	0.161	-0.122	0.026	0.079	-0.006	0.012	0.080	0.053	-0.022
Married	0.000	-0.009	0.000	-0.006	-0.154	0.016	0.002	0.079	-0.002
Urban	0.017	0.150	-0.035	-0.000	0.026	-0.004	0.011	0.138	-0.008
Capital	-0.000	-0.024	-0.004	-0.005	0.012	-0.001	0.007	0.075	-0.008
Age in months	0.004	0.846	0.005	-0.068	-0.135	0.006	0.002	-0.142	0.001
Age in months squared	0.000	-0.515	0.001	0.057	-0.011	0.001	-0.000	0.174	-0.000
Gender	-0.000	0.010	-0.000	-0.000	0.054	-0.000	0.002	0.001	-0.000
Growth program	-	-	-	0.003	0.008	-0.002	-0.002	-0.046	0.005
2nd born	-0.009	0.005	-0.001	-0.016	0.006	-0.001	-0.008	-0.020	0.002
3rd born	0.003	-0.008	-0.001	-0.004	-0.020	0.001	0.007	-0.025	-0.003
4th born	0.004	0.049	0.022	0.044	0.017	0.014	0.010	-0.008	-0.001
Siblings	0.055	-0.060	-0.018	0.004	0.026	0.008	0.003	0.009	0.000
Indigenous	0.011	0.005	0.002	-	-	-	-0.004	-0.004	0.001
Constant	0.000	-1,567	0.000	0.000	1,294	0.000	0.000	-1,672	0.000
Total Contributions	0.388	0.003	0.046	0.184	-0.016	0.127	0.236	0.011	-0.010
Total Difference		0.437			0.295			0.237	

Notes: E (Endowments). C (coefficient), CE (Interaction between endowments and coefficients)

Figure 1
Concentration Curves by groups of children



Appendices

TABLE A1
Decomposition of HAZ concentration index for Colombia

	Elasticity	CI	Contribution	Percent
Complete antenatal care	-0.179	0.116	-0.021	9.95
Incomplete antenatal care	-0.077	-0.138	0.011	-5.09
Tetanus injections	0.016	0.010	0.0002	-0.08
Iron	-0.087	0.062	-0.005	2.59
Calcium	0.022	0.169	0.004	-1.79
Folic acid	0.020	0.161	0.003	-1.52
Vision difficulties	0.001	-0.134	-0.0002	0.08
Alcohol	0.004	-0.036	-0.0001	0.07
Smoke	-0.001	-0.109	0.0001	-0.04
Pregnancy duration	-1.400	-0.002	0.002	-1.20
% antenatal care in the region	-0.722	0.017	-0.012	5.86
Nutrition supplement first days	-0.012	0.056	-0.001	0.32
Breast feeding	0.074	-0.001	-0.00005	0.02
Mother is prime care giver	-0.017	-0.034	0.001	-0.28
Mother's height	-10.568	0.003	-0.032	15.56
Mother's age	-1.822	0.009	-0.017	7.93
Mother's age - squared	0.419	0.015	0.006	-3.05
Mother's education (years)	-0.121	0.150	-0.018	8.73
Wealth index	-0.552	0.191	-0.106	50.73
Mother is married	0.026	-0.005	-0.0001	0.06
Urban	0.021	0.204	0.004	-2.04
Capital	0.075	0.166	0.013	-6.01
Age in months	1.371	0.005	0.006	-2.99
Age in months - squared	-0.728	0.010	-0.007	3.57
Gender	0.045	0.005	0.0002	-0.11
2nd born	0.077	0.080	0.006	-2.96
3rd born	0.066	-0.004	-0.0002	0.12
4th born	0.075	-0.355	-0.027	12.76
Number of living siblings	0.051	-0.193	-0.010	4.73
Indigenous	-	-	-	-
Growth Program	-0.019	0.062	-0.001	0.57
Residual			-0.007	3.52

FIGURE A1
Concentration curves

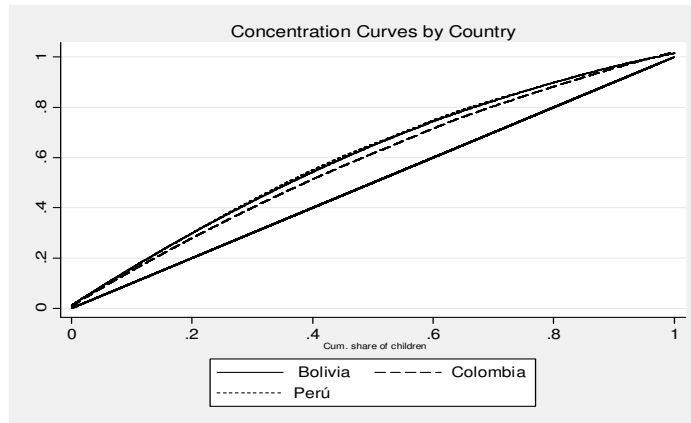


FIGURE A2
Incomplete Antenatal Care

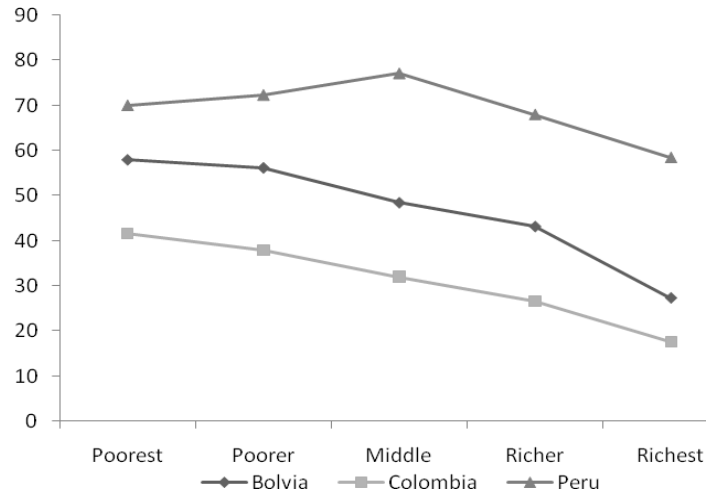


FIGURE A3
Complete Antenatal Care

