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Child malnutrition and prenatal care: evidence from three Latin American countries

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ABSTRACT

Objective. *To examine the effect of prenatal care (PNC) on the level and distribution of child stunting in three Andean countries—Bolivia, Colombia, and Peru—where expanding access to such care has been an explicit policy intervention to tackle child malnutrition in utero and during early childhood.*

Methods. *An econometric analysis of cross-sectional Demographic and Health Survey (DHS) data was conducted. The analysis included ordinary least-squares (OLS) regressions, estimates of concentration curves, and decompositions of a concentration index.*

Results. *The analysis shows that the use of PNC in Bolivia, Colombia, and Peru is only weakly associated with a reduction in the level of child malnutrition.*

Conclusions. *Further expansion of PNC programs is unlikely to play a large role in reducing inequalities in malnutrition.*

Key words Child nutrition disorders; prenatal care; health inequalities; stature by age; Latin America.

Child malnutrition is an important policy concern in Latin America, where 16% of children under 5 years old are stunted (1). In the last few decades, research on the determinants of child malnutrition in developing countries has attracted substantial attention. Various studies 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. While the role of such factors may be well documented, less commonly known and a key implication from the literature is the importance of early interventions to help children reach their physical and cognitive potential (2–5). Based on their review of the literature on developing countries, Grantham-McGregor et al. (2) assert 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" (p. 62). Related work points out that "poor fetal growth or stunting in the first two years of life leads to irreversible damage" (3, p. 340), including reductions in adult height (6), poor cognitive skills (7), lower levels of educational attainment (8), and reduced income (9).

While a distinction needs to be drawn between small and healthy infants and growth-restricted infants, who are more susceptible to postnatal episodes of morbidity and mortality, intrauterine growth restriction (IUGR) accounts for a majority of low-birth-weight infants in developing countries (10, 11). 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 (11, 12). Prenatal care (PNC) programs, which typically identify high-risk mothers, and include nutritional and educational interventions such as information and advice on food hygiene, diet, and lifestyle advice, are designed to deal with factors that are most likely to be associated with stunting. Such programs are advocated as a way of alleviating the incidence of low birth weight, and evidence on the role they

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play in reducing the incidence of adverse pregnancy outcomes in developing counties is emerging (13–16).

Notwithstanding the policy relevance of PNC programs, and their substantial expansion in recent years, empirical evidence on their role in combating stunting in developing countries is relatively scarce. This study examines the effect of PNC on the level and distribution of child stunting in three Andean countries—Bolivia, Colombia, and Peru—where since the 1990s such care has been an explicit policy intervention to tackle child malnutrition in utero and during early childhood.

In Bolivia, several programs have been geared toward providing free health care services to mothers and children. Most recently (since 2003), the program known as Universal Insurance for Mothers and Children (*Seguro Universal Materno Infantil,* SUMI) has been providing a broad range of services to pregnant women and children under 5 years old. The Bolivian government has actively tried to discourage home births and encourage pregnant women to visit health clinics for prenatal checks (17). In Peru, the 2004 National Sexual and Reproductive Health Sanitary Strategy (*Estrategia Sanitaria Nacional de Salud Sexual y Reproductiva,* ESNSSR) recognizes that maintaining good sexual and reproductive health implies paying attention to intrauterine life, and that one means of achieving this goal is improving access to PNC. Since 2000, in Colombia, the Ministry of Health has established guidelines for PNC and exempted it from copayments. In all three countries, these initiatives have expanded access to PNC, most notably in Bolivia, where PNC access increased from 40% in 1990 to about 75% in 2008. The corresponding rates of access in Peru were 60% in 1990 and 90% in 2008, and in Colombia, 81% in 1990 and 93.5% in 2005.[4]

While a large proportion of the literature has analyzed the determinants of stunting in these and other countries, the role of PNC has not been explicitly considered. Country-specific analysis for Bolivia shows that child height is relatively lower when living at high altitude and for Quechua speakers (18). Peruvian Demographic and Health Survey (DHS) data covering the period 1992–2000 shows that a rapid expansion of public health infrastructure is associated with a small increase in height-for-age only in urban areas (19), whereas in Colombia the presence of a public hospital has a positive and statistically significant effect on height-for-age (20). Analysis of the ethnic and regional determinants of child malnutrition in Peru and Bolivia reveals that ethnicity, region, and altitude have substantial negative effects on height-for-age in both countries (21).

The objectives and contributions of this study are twofold. First, it provides updated evidence on the prevalence and inequalities in child malnutrition in three Andean countries. Second, it adds to the existing literature on child malnutrition by explicitly investigating the role of PNC on the level and distribution of child stunting.

MATERIALS AND METHODS

This report is based on an econometric analysis of cross-sectional DHS data gathered from female survey participants in Bolivia (2008), Colombia (2005), and Peru (2008).[5] The surveys contain household-level information on demographic and educational traits, the characteristics of the dwelling, and a wealth index.[6] The DHS women's questionnaire is administered to females 15–49 years old and collects information on maternity care, breast-feeding, and nutrition and children's health. The sample used in this report was restricted to children under 5 years old and consists of 4 945 observations from Bolivia, 7 540 from Colombia, and 4 208 from Peru.[7]

For all children under 5 years old, the survey collects data on height and weight; for last-born children it also collects information on type, timing, and frequency of prenatal consultations.

Child height-for-age was used as a long-run indicator of a child's nutritional status (22). 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, were computed as

$$HAZ = \frac{Height_i - Median}{SD}$$

where $Height_i$ refers to the height of a child, and *Median* and *SD* refer to the median and standard deviation of the height values of the U.S. Centers for Disease Control and Prevention (CDC) National Center for Health Statistics (NCHS) reference population (23), respectively. Values of the HAZ below two (three) standard deviations indicate chronic (severe) malnutrition.

Using the protocol applied in well-established literature (24), individual child height (h_i) was measured by HAZ as a function of 1) access to and use of prenatal care and complementary behavior (*PC*); 2) child-rearing practices (*Ch*); 3) household and maternal characteristics (*HC*); and 4) child characteristics (*CC*):

$$h_i = \beta_0 + \sum \beta_k^{PC} x_{ik}^{PC} + \sum \beta_k^{Ch} x_{ik}^{Ch} + \sum \beta_k^{HC} x_{ik}^{HC} + \sum \beta_k^{CC} x_{ik}^{CC} + \eta_i \quad \text{(A)}$$

The β_k variables are coefficients to be estimated, and η_i reflects unobserved heterogeneity. Table 1 provides a description of the variables (x_{ik}). To ease interpretation of the estimated coefficients in terms of their effect on child malnutrition, h_i is the negative of HAZ. As HAZ is a continuous variable, Equation A was estimated using ordinary least-squares (OLS) regression.

The main empirical concern was that while availability of PNC may be exogenous to the household, actual use of such services is subject to maternal/household choice. For instance, if women with lower (higher) unobserved health characteristics were more likely to use PNC, then OLS estimates of Equation A would underestimate (overestimate) the effect of PNC. To address these concerns, Equation A included a wide range of characteristics (controls), such as mother's height, age, and education, and a household wealth index, that are likely to both 1) influence the use of PNC and 2) be correlated with a woman's unobserved health characteristics. While the inclusion of these controls mitigates potential bias, the possibility that unobserved health characteristics may be correlated with the use of PNC can not be ruled out.

[4] All data are from the latest edition of World Bank World Development Indicators (http://data.worldbank.org/data-catalog/world-development-indicators).

[5] The data sets for all three countries are available at: www.dhsprogram.com/data/

[6] The wealth index developed by ICF Macro 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.

[7] A number of observations are lost in the regressions due to missing observations for some variables, including the anthropometric measures, the place of residence, and education.

TABLE 1. Classification of determinants of child malnutrition in study on effect of prenatal care (PNC) on child stunting, Bolivia, Colombia, and Peru, 2005–2008

Variable	Description
Prenatal care and complementary behavior	
Complete PNC;	Complete PNC = 1; no PNC = 0
Incomplete PNC	Incomplete PNC = 1; no PNC = 0
	Complete PNC defined as six visits to doctor or nurse during pregnancy with initiation during the 1st trimester; incomplete PNC defined as ≥ 1 visit but < 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)
PNC (%)	Percentage of women who receive some PNC (complete and incomplete) in the region/department
Child-reading practices	
Nutrition	Child was given infant formula in the first three days of life = 1; 0, otherwise
Breast-feeding	Child has ever been breast-fed = 1; 0, otherwise
Mothers are (primary) caregivers[a]	Mother is (primary) caregiver = 1; 0, otherwise
Household and maternal characteristics	
Mother's height (m)	Mother's height in meters
Mother's age; mother's age, squared	Mother's age and mother's 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 city	Household lives in the capital city =1; 0, otherwise
Source of water	Piped drinking water = 1; 0, otherwise
Child characteristics	
Age; age, squared	Child's age and child's age squared
Gender	Boy = 1, girl = 0
Growth program	Child attends Growth and Development Program (Colombia) or growth control program (Peru) = 1; 0, otherwise
2nd-, 3rd-, 4th-born+ [b]	Dummy variables indicating birth order of child
Siblings	Number of living siblings
Indigenous	Child belongs to an indigenous group = 1; 0, otherwise

[a] For Bolivia, this variable was replaced by whether a mother works at home/does not work, assuming that if she does not work/works at home she takes care of the child.
[b] Reference = 1st-born.

To assess socioeconomic-related inequality in child stunting, concentration curves were plotted to display the share of stunting accounted for by the cumulative share of children, ranked according to a wealth index.[8] The magnitude of inequality illustrated by the concentration curves can be expressed by the concentration index (CI)

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

where r_i is the fractional rank for child i in the sample of N children along the distribution of the wealth index, h_i is the negative value of HAZ, and μ its mean. The concentration index ranges between –1 and 1, and a negative value indicates that child malnutrition is concentrated among the less wealthy.

To obtain insights on the source of this inequality, the index was decomposed and the effect of individual variables on wealth-related inequality in stunting was assessed (25). The overall concentration of wealth-related inequality in stunting can be decomposed into the contributions of individual factors that enter Equation A, 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). The CI may be written as

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

Where $\bar{x}_k$ is the mean of the variables included in Equation A, and the second component on the right-hand side of Equation C is a residual term.

RESULTS

Table 2 contains descriptive statistics. Across all three countries, most women have had at least one PNC visit. Colombia has the most comprehensive PNC regime, with 61.6% of women receiving complete PNC, followed by Bolivia (43.1%) and Peru (28.1%). 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, however, with 16.9% of mothers serving as primary caregivers in Colombia followed by 36.5% in Peru and 42.5% in Bolivia.[9] With regard to maternal characteristics, the three countries are similar in terms of the average

[8] An extensive account and application of these methods is provided in (25). Alternative measures of living standards, such as consumption or income, may also be used. The concentration index for malnutrition is not particularly sensitive to the use of consumption or wealth as a living standards measure (25).

[9] The variable takes a value of 1 if the mother is the primary caregiver and zero otherwise. The response options include: "partner"; "older female child"; "older male child"; "other relatives"; "neighbors"; "friends"; "housekeeper"; "child is in school"; and "other."

TABLE 2. Descriptive statistics for sample in study on effect of prenatal care (PNC) on child stunting, Bolivia, Colombia, and Peru, 2005–2008

Variable	Bolivia	Colombia	Peru
Prenatal care and complementary behavior			
Mothers receiving complete PNC (%)	43.1	61.6	28.1
Mothers receiving incomplete PNC (%)	47.8	32.3	69.6
Mothers receiving no PNC (%)	9.1	6.0	2.4
Mothers who received tetanus injections (%)	70.8	89.8	76.5
Average number of tetanus injections	1.3	1.8	1.4
Mothers who took iron during pregnancy (%)	77.6	75.0	77.5
Average number of months the mother took calcium	nc[a]	2.1	nc
Average number of months the mother took folic acid	nc	2.1	nc
Mothers who had vision difficulty during pregnancy (%)	13.7	10.9	14.4
Mothers who consumed alcohol during pregnancy (%)	nc	9.1	nc
Mothers who smoked during pregnancy (%)	nc	3.5	nc
Average pregnancy duration	nc	8.8	nc
Child-rearing practices			
Children given infant formula in first three days of life (%)	5.1	25.3	16.2
Children ever breast-fed (%)	99	97.8	98.0
Mothers who are primary caregivers (%)	42.5	16.9	36.5
Household and maternal characteristics			
Average height of mother	1.5	1.6	1.5
Average age of mother	29.5	28.5	29.8
Average years of mother's education	7.7	8.3	8.7
Wealth index	2.52	2.40	2.91
Married women (or those who live with partner) (%)	85.4	74.6	84.6
Women in urban areas (%)	57.9	71.7	63.0
Women in capital city (%)	27.9	14.5	22.9
Women who access piped water (%)	75.3	83.5	69.6
Child characteristics			
Average age of children (months)	27.8	34.4	30.2
Girls (%)	48.7	48.4	50.7
Children who attend Growth program (%)	nc	43.6	64.8
Average number of siblings	2.0	1.3	1.6
Indigenous children (%)	62.9	nc	11.7

[a] nc: not collected (data not gathered for this variable in survey).

age (28.5–29.8 years), height (1.5–1.6 m), and education of mothers (7.7–8.7 years). Colombia is relatively more urbanized, however, and Colombian households appear to have better access to water and sanitation infrastructure.

Stunting is pronounced in Peru and Bolivia, where about one-quarter (25.12% and 27.00% respectively) of children are more than two standard deviations from the median. The corresponding rate in Colombia is lower (15.15%). There is a similar pattern for the HAZ mean, which is –0.89 for Colombia, followed by –1.20 for Bolivia, and –1.26 for Peru.

In all three countries there is a hierarchy with regard to malnutrition, with a lower prevalence and higher mean HAZ score among children whose mothers received complete PNC, followed by those receiving incomplete care and those receiving no care. In Bolivia and Peru, about half (42.20% and 47.92% respectively) of the children with no access to PNC are malnourished versus about one-third (29.00%) in Colombia (Table 3). The gap between the two extremes (complete access to PNC versus no access) in terms of the incidence of malnourishment is about 25% in Bolivia and Peru and about 18% in Colombia. For the HAZ, the gap between those who have received complete PNC and those who have received incomplete PNC is 0.437 in Bolivia, 0.295 in Colombia, and 0.238 in Peru.

There are sharp differences in HAZ across wealth quintiles (Table 3). The differences are much sharper in Peru (a gap of –1.48 units between the richest and poorest quintiles), followed by Bolivia (–1.38) and Colombia (–0.88). In Peru, 55.78% of children in the poorest quintile are malnourished. In Colombia, the percentage is about half that (25.96%). The percentage for Bolivia falls between the previous two (44.18%). Similar patterns are observed with regard to maternal education. About 50%–60% of children who have mothers with no education (48.98% and 61.94% respectively) are malnourished in Bolivia and Peru, whereas in Colombia the corresponding rate is 30.47%.

There is evidence of urban–rural disparities, with rural areas recording twice the level of malnourishment compared to urban areas (Table 3). Gender differences are limited. There are sharp differences in HAZ between indigenous and nonindigenous children. In Peru, 23.04% of nonindigenous children are malnourished, whereas among the indigenous the rate is 55.03%. While the level is lower in Bolivia, indigenous children are still twice as likely to be malnourished compared to their nonindigenous counterparts (30.71% versus 15.62%).

Table 4 provides OLS estimates of Equation A. The strongest association between access to PNC and malnutrition (statistically significant at the 1% level) is in Colombia, where access to it (complete or incomplete) is associated with a large (0.23- to 0.25-point) reduction in malnutrition. In Peru, the magnitude of the effect is similar, but the estimates are not as precise. In contrast, in Bolivia, there is no link between the use of PNC and a reduction in malnutrition. The large effect in Colombia is

TABLE 3. Distribution of height-for-age z-scores (HAZ) in study on effect of prenatal care (PNC) on child stunting, Bolivia, Colombia, and Peru, 2005–2008

Variable	Bolivia		Colombia		Peru	
	Average HAZ	Malnourished children (%)	Average HAZ	Malnourished children (%)	Average HAZ	Malnourished children (%)
Overall	–1.20	25.12	–0.89	15.15	–1.26	27.00
PNC						
No PNC	–1.76	42.20	–1.35	29.00	–1.84	47.92
Complete PNC	–0.981	18.13	–0.76	11.24	–1.06	22.25
Incomplete PNC	–1.418	28.16	–1.05	19.74	–1.29	27.88
Difference between complete and incomplete PNC	0.437		0.295		0.238	
Mother is primary caregiver						
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
Wealth index quintiles						
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
Mother's education						
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
Residence						
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
Sex						
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
Ethnicity						
Indigenous	–1.44	30.71	nc[a]	nc	–2.01	55.03
Nonindigenous	–0.78	15.62	nc	nc	–1.16	23.04
Number of observations	4 945		7 540		4 208	

[a] nc: not collected (data not gathered for this variable in the survey).

notable because it is the effect of PNC after controlling for other factors, such as the use of iron, calcium, folic acid supplements, and tetanus injections. As a proxy for access to supply of medical care, Equation A includes a variable indicating the percentage of women who have had at least one PNC visit. Access to health services is associated with a reduction in malnutrition, but the effect is small, ranging from a z-score reduction of 0.005–0.024 points.[10]

Mother's height has a strong influence on child stunting. A 1-cm increase in maternal height is associated with a z-score reduction of 0.05–0.06 units. Across all three countries 1) the effects of maternal age are similar, and indicate that older mothers are less likely to have stunted children until about the age of 50, and 2) wealth and maternal education are strongly associated with reductions in malnutrition. In terms of location, after controlling for wealth, living in an urban area does not seem to limit malnutrition, except in the case of Peru.

For all 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 a 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 toward increasing stunting. 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 but about three times larger in Peru.

To assess wealth-related inequalities in child malnutrition, concentration curves and their corresponding concentration indices are estimated separately for three groups of children—"no PNC," "incomplete PNC," and "complete PNC" (Figure 1). The concentration indices are presented in Table 5.

Two points emerge. First, the indices show that the distribution of malnourishment is quite similar across countries, although it is slightly higher in Bolivia and Peru (concentration indices of –0.24 and –0.23, respectively) than in Colombia (–0.21). The bottom 20% of children account for roughly 35% of observed malnourishment while the top 20% account for about 10%. Second, Figure 1 shows that wealth-related inequality in child malnourishment is more pronounced among those who have access to complete PNC compared to those with incomplete or no PNC. This suggests that access to complete PNC is more equally distributed than wealth. For example, in Colombia, the ratio of the 90th to the 10th percentile in terms of wealth distribution

[10] This variable may also capture other influences, such as externalities associated with access to PNC, and, more generally, the availability of medical services.

TABLE 4. Determinants of height-for-age z-scores based on ordinary least-squares regressions in study on effect of prenatal care (PNC) on child stunting, Bolivia, Colombia, and Peru, 2005–2008

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

[a] Statistically significant at *P* = 0.01.
[b] Statistically significant at *P* = 0.05.
[c] Statistically significant at *P* = 0.10.
[d] nc: not collected (data not gathered for this variable in the survey).

is 4.7, while 80% of the richest quintile accesses complete PNC compared to 40% among the poorest quintile. In the case of Peru, the ratio of the 90th to the 10th percentile is 2.57, compared to the PNC access ratio for the richest and poorest wealth quintiles of about 1.8.

The decomposition of the index (Table 5) shows that in the case of Bolivia, access to PNC and the general availability of prenatal services in a region jointly account for six percentage points of wealth-related inequality.[11] In Colombia, the corresponding rate is 10 percentage points, whereas in Peru the role of these variables in determining inequality is limited (just two percentage points). Hence, while PNC is associated with a reduction in child stunting (in Colombia and Peru), it accounts for a relatively small proportion of wealth-related inequality in malnourishment. In all cases, the direct effect of wealth dominates, accounting for 38–54 percentage points of inequality in malnourishment. This is followed by the effect of various child controls, which together account for 16–19 percentage points. Among these characteristics, the largest effects emanate from the fourth-born and siblings variables, indicating that wealth has a large effect on determining family size, which in turn accounts for a substantial proportion of inequality in malnourishment. The third important factor is maternal height (16–18 percentage points). Wealth-related differentials in child-rearing practices are limited and these variables are not responsible for the inequality in malnourishment.[12]

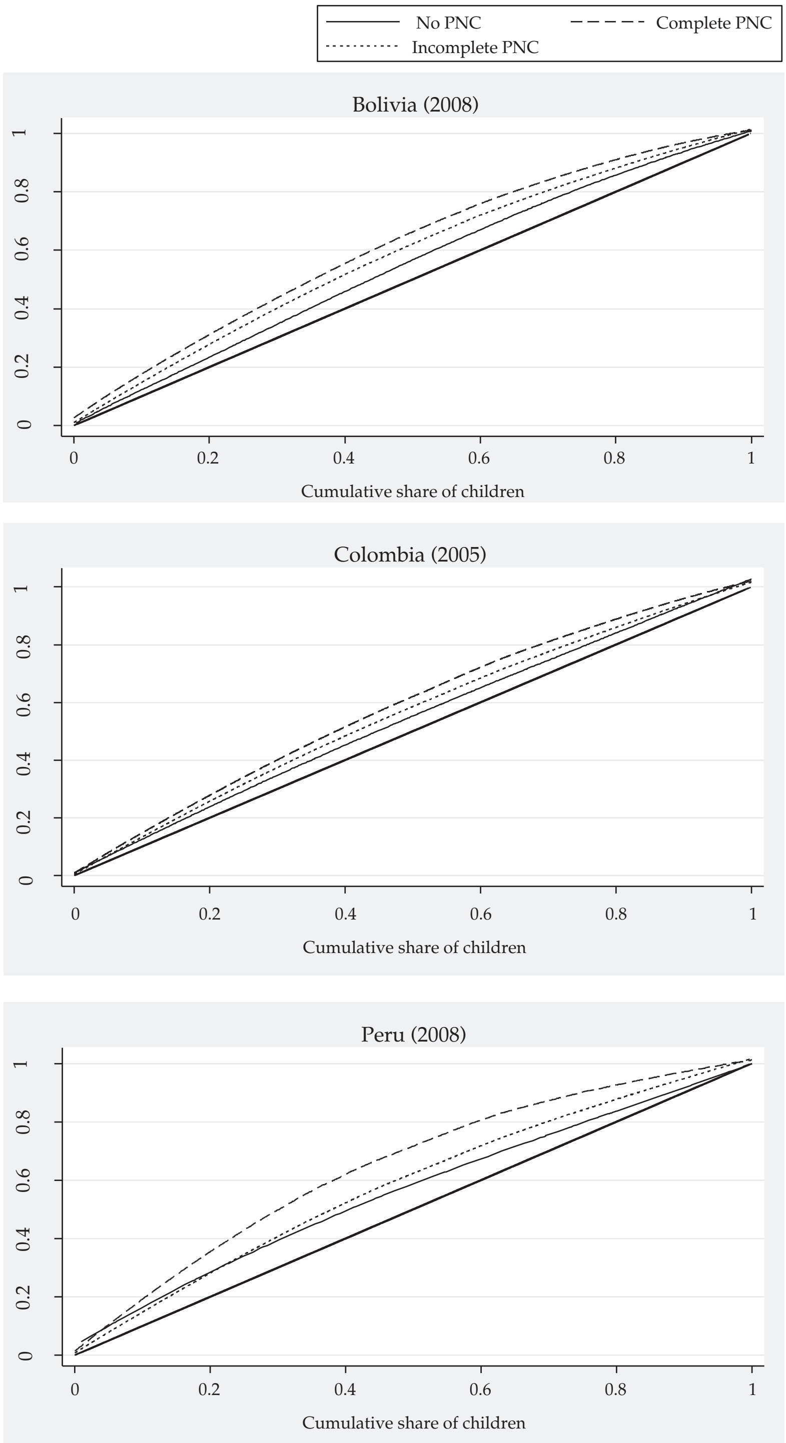
DISCUSSION

This analysis of the determinants of malnutrition, which is based on the most recent DHS, shows that there has been very little change in the incidence of malnutrition over time. For instance, analysis of the 1998 DHS for Bolivia shows the same percentage of stunting among chil-

[11] The elasticity and concentration of each of the individual factors, which determines their contribution to the concentration index, is provided in the Supplementary material.

[12] The effect of PNC on child stunting was explored further by examining what drives the gap in mean HAZ between children whose mothers received incomplete PNC and children whose mothers received complete PNC. An Oaxaca decomposition of this mean HAZ gap shows that the same factors that determine inequality in stunting are also responsible for the observed HAZ gap between users of complete and incomplete PNC. Details are reported in the Supplementary material.

FIGURE 1. Concentration curves by groups of children in study on effect of prenatal care (PNC) on child stunting, Bolivia, Colombia, and Peru, 2005–2008



dren as the current study—about 25% (20). For Peru, the mean HAZ was –1.29 in 1996 and –1.3 in 2000 (21). While the mean HAZ found in the current study (–1.26) does indicate a slight decline, it is not remarkable. In Colombia, 13.5% of children were classified as malnourished, according to data from the 2000 DHS (26), versus the rate of 15% found in the current study. Consistent with previous studies in Latin American countries (20–23), the current results indicate that maternal height, wealth, educational status, ethnicity, and birth order are strongly associated with child stunting. A novel finding in the current study was that the use of PNC is strongly associated with a reduction in child stunting in Colombia, less so in Peru, and not at all in Bolivia. This variation is most likely driven by cross-country differences in the quality of PNC. As mentioned in the beginning of this report, and displayed in Table 2 (see also 27–29), given Colombia's substantially higher access to complete PNC, range of additional vitamin supplements, other complementary measures, and longer history of PNC provision, it is likely that its services are of a higher quality compared to Bolivia and Peru. The expansion of access to PNC services is also of more recent vintage in Bolivia and likely to be relatively poorer in quality. The relative differences in the effect of PNC found here and the hypothesized effect of the quality of PNC in determining outcomes is consistent with prior studies that have linked differences in the quality of PNC care to cognitive outcomes (7) and low birth weight (16). The latter study (16) argues that without adequate PNC, defined according to World Health Organization criteria (30), desired outcomes are unlikely.

The analysis of the distribution of child stunting and access to PNC shows that such services are more equally distributed than wealth. Wealth-related concentration in access to PNC services has a relatively small effect on the overall wealth-related concentration in malnutrition. While this is a positive outcome, it indicates that further expansion of PNC programs can only play a limited role in reducing wealth-related inequalities in malnutrition, as any subsequent nutritional improvement would be equally distributed across wealth quintiles, unless the expansion is targeted to specific population groups.

Limitations

This study had some limitations. Foremost among them is that due to the cross-sectional nature of the DHS data it was not possible to identify the causal effects of expanding PNC on malnutrition. In addition, a comprehensive understanding of the role of PNC as a policy intervention for improving nutrition outcomes requires detailed information on cross-country differences in the design and quality of PNC interventions.

TABLE 5. Decomposition of height-for-age z-scores concentration indices in study on effect of prenatal care (PNC) on child stunting, Bolivia, Colombia, and Peru, 2005–2008

Variable	Bolivia	Colombia	Peru
Concentration index	–0.236	–0.208	–0.229
Decomposition (%)			
Complete PNC	–0.07	9.95	2.47
Incomplete PNC	1.68	–5.09	–2.29
Tetanus injections	0.16	–0.08	0.06
Iron	–0.25	2.59	0.48
Calcium	nc[a]	–1.79	nc
Folic acid	nc	–1.52	nc
Vision difficulties	–0.28	0.08	0.14
Alcohol	nc	0.07	nc
Smoke	nc	–0.04	nc
Pregnancy duration	nc	–1.20	nc
PNC in 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 primary caregiver	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 city	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	nc	5.27
Growth program	nc	0.57	0.18
Residual	–0.23	3.52	–0.02
Total	100%	100%	100%

[a] nc: not collected (data not gathered for this variable in the survey).

Conclusions

This study was motivated by 1) the spread of PNC programs in three Andean countries—Bolivia, Colombia, and Peru—and 2) the limited evidence on the effects of such programs on child malnutrition. The results provide updated evidence on the prevalence and inequalities in child malnutrition in these three countries and, more importantly, add to the existing literature by explicitly investigating the effect of PNC on the level and distribution of child malnutrition.

Over time, changes in malnutrition have been very modest. While the use of PNC is strongly associated with a reduction in child stunting in Colombia, it has a more limited effect in Peru and no effect in Bolivia. The authors of the current study believe this variation is most likely driven by differences in the quality of PNC across countries. According to the results of the current study, access to PNC services is not as heavily influenced by the distribution of wealth as other variables. While this is a positive outcome in terms of health, it suggests that achieving a reduction in wealth-related inequalities in malnutrition requires alternative interventions. Two policy implications can be derived from the results of this analysis. First, access to adequate PNC, defined in terms of the number and timing of the visits, is needed to ensure desirable outcomes. Second, given the strong direct and indirect influence of the concentration of wealth in determining inequalities in malnutrition, attention should be paid to components of the wealth index that may be directly influenced by public policy, such as access to water and sanitation services.

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Conflicts of interest. None.

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RESUMEN

Desnutrición infantil y atención prenatal: datos probatorios de tres países latinoamericanos

Objetivo. Analizar el efecto de la atención prenatal sobre el nivel y la distribución del retraso del crecimiento infantil en tres países andinos (Bolivia, Colombia y Perú) donde la ampliación del acceso a este tipo de atención ha constituido una intervención política explícita con objeto de afrontar la desnutrición intrauterina y durante la primera infancia.
Métodos. Se llevó a cabo un análisis econométrico de la Encuesta de Demografía y Salud, de carácter transversal. Este análisis incluyó regresiones ordinarias de mínimos cuadrados, cálculos de curvas de concentración y descomposiciones de un índice de concentración.
Resultados. El análisis demuestra que la atención prenatal en Bolivia, Colombia y Perú se asocia solo débilmente con una reducción del nivel de desnutrición infantil.
Conclusiones. Es poco probable que una mayor extensión de los programas de atención prenatal tenga un amplio efecto en la reducción de las desigualdades en materia de desnutrición.

Palabras clave Trastornos de la nutrición del niño; atención prenatal; desigualdades en la salud; estatura por edad; América Latina.