Child Malnutrition, Social Development and Health Services in the Andean Region

INTER AMERICAN DEVELOPMENT BANK
FLACSO, Ecuador
March 2004

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Abstract

This study analyzes social, ethnic and regional determinants of child malnutrition, as well as the effects of access to health services in the Andean Region, through a comparison between Ecuador, Peru and Bolivia. These three countries share a profile with high stunting prevalence and strong socio-economic, regional and ethnic disparities. The analysis is conducted using DHS (Peru 1992, 1996 and 2000, Bolivia 1997) and LSMS (Ecuador 1998) surveys and it focuses on an international comparative perspective. In the case of Ecuador a detailed analysis is provided.

The main task was to identify the determinants of the z-score indicators for height and weight for age. For that matter, multiple equation models were estimated, applying instrumental variables and combining different multivariate procedures, to identify the relative importance of education, housing, ethnicity and contextual regional factors as determinants of stunting in each national case. In all cases we have found strong negative ethnic effects of indigenous ethnicity as well as contextual regional negative factors for highland regions. The results remain significant even after controlling for all relevant socio-economic determinants, such as education, housing and economic status, with few exceptions.

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Introduction

Within the Latin American context, stunting prevalence has remained traditionally high in the Andean Region, with an estimated rate of 21 % in the late 1990s. In Ecuador, Bolivia and Peru stunting is high –around 26 % - and remarkably similar, while Colombia has a notably lower rate (15 %). Among the eight countries with Demographic and Health Surveys (DHS) in Latin America, only Guatemala (46 % in 1998) and Haiti (32 % in 1994) are in worse conditions than the former Andean group.

Moreover, as the latest household surveys disclose, a well-defined declining trend, which prevailed up to the mid 1990s, seems to be vanishing and has almost flattened out. In fact, stunting rates dropped from 38 % to 27 % in Bolivia between 1989 and 1998, from 34 % to 26 % in Ecuador (1986-1998), from 26 % to 15 % in Colombia (1986-1995) and from 32 % to 26 % in Peru (1992-1996). Recent trends, however, show only small and not longer statistically significant improvements in Colombia and Peru. According to DHS surveys, stunting rates remained at 13.5 % and 25.5 % respectively in the year 2000.

In the Andean region, Peru, Bolivia and Ecuador share a profile with high stunting prevalence, strong socio-economic, regional and ethnic disparities. Furthermore, nutritional conditions in the highlands are critical. Colombia, in contrast, presents lower prevalence and smaller regional disparities. The socio-economic gradient of stunting is strong in all countries, with prevalence rates in the poorest deciles at least four times higher than those of the top decile. In addition to social factors, a regional and ethnic divide affects the highland regions –and particularly the indigenous populations- in Ecuador, Bolivia and Peru.

The contrast between Peru, Bolivia and Ecuador- with high prevalence and strong social and regional effects- and Colombia -with lower prevalence and a relatively more egalitarian regional profile- may be the result of several factors. Among them, ethnic discrimination affecting indigenous groups; a particular diet profile with low protein and micronutrient intake in the highlands; and different long-term development paths can be mentioned.

Child malnutrition severely jeopardizes, reduces or impairs prospects for productive social participation in adulthood. As such, it is a major hindrance to human development, defined as a process of enhancing human capabilities.[1] Furthermore, malnutrition perpetuates the

[1] Sen, Amartya. **Development as Freedom.** 1999, Alfred A. Knopf: New York.

intergenerational reproduction of poverty, thus creating a vicious circle that prevents social improvement and equity.
The project objective is to analyze social, ethnic and regional determinants of child malnutrition, as well as the effects of access to health services in three Andean countries with significant indigenous populations and high regional and social inequalities: Ecuador, Peru and Bolivia, using DHS (Peru 1992, 1996 and 2000, Bolivia 1997) and LSMS (Ecuador 1998) surveys.

The analysis will focus on the effects of ethnicity and regional disparities, controlling for other underlying determinants of stunting.

- The contrast between the highland and the lowland regions in Ecuador, Peru and Bolivia. Highlands stunting is consistently higher, and differences are not explained only by individual socio-economic or ethnic factors.

- The effect of ethnic and cultural factors on stunting. Indigenous peoples are the most affected by stunting in Ecuador, Bolivia and Peru.

The project focuses on an international comparative perspective, complementing specific research in Peru, Bolivia and Colombia. In the case of Ecuador a detailed analysis will be provided.

Sources

The project will analyze Demographic and Health Surveys (DHS) in Peru (1992, 1996 and 2000), Colombia (1995, 2000) and Bolivia (1997). In Ecuador the 1998 LSMS survey will be studied. Colombia's data will be included only for comparative purposes.

DHS surveys have national coverage, large stratified samples, and detailed questionnaires including anthropometric data for both children under five and women in reproductive age, as well as socio-economic information on education, housing and employment, and ethnicity questions in Peru and Bolivia.

LSMS surveys contain child anthropometric measures, socio-economic and ethnic variables. Although their sample sizes (about 5000 households with national coverage) are smaller than those of DHS, their questionnaires include also information on income and detailed information on consumption, including about 90 food items. Moreover, social information about communities is also available in LSMS surveys, in a separate questionnaire.

Methodology

Child anthropometric measures are transformed to normative z scores of height for age, weight for age and height for weight. A child is affected by chronic malnutrition or stunting, when his or her z score of height for age is lower than –2, or two standard deviations below the international normative median. Using the same criterion, global malnutrition is defined for low weight-for-age scores, and acute malnutrition corresponds to low height-for-weight.[2]

[2] ***Z*** scores of height for age, weight for age and height for weight were obtained using the program Anthro (Version 1.02, june 1999), developed by K. Sullivan and J Gorstein for the Centers for Disease Control and Prevention (CDC) USA and the World Health Organization (WHO). The program uses normative international child growth tables, adopted by WHO.

Child z scores of height for age will be used as the dependent variable to evaluate chronic malnutrition or stunting. Independent variables include individual/household socio-economic and ethnic factors, access to health services, contextual variables, and interactions. The analysis will focus on height for age, which is more representative of insufficient growth, due to persistent dietary deficiencies and/or illness susceptibility, while weight for age and weight for height often reflect short-term conditions.

The research focuses on the effects of underlying factors of stunting, such as household socio-economic status, housing conditions, maternal and paternal education, mother's fertility, access to health services and ethnicity, as well as contextual regional factors.

The methodology combines different multivariate procedures, to identify the relative importance of education, housing, ethnicity and contextual regional factors as determinants of stunting in each national case.

The first step is the construction of a set of multivariate indices of education, housing, employment, access to health services and socio-economic status, and a fertility indicator, to probe the effects of the corresponding determinants on stunting. The need of multivariate indices, beyond simple specific indicators of limited theoretical relevance, is justified not only by epistemological and methodological reasons, but also by the search for more parsimonious models, and technical advantages of avoiding multicollineality in regressions. One of the basic objectives of research in social sciences is the building of empirical variables representative of abstract theoretical concepts, such as education of socio-economic status. Multivariate indices are necessary to define an adequate correspondence between theoretical hypotheses and empirical results, overcoming the limits of empiricism (Padua, 1981, Kuhn, 1970).

Principal component analysis is probably the most widely used multivariate method to build representative multivariate indices in social and environmental sciences. The method finds the linear combination of the original variables which maximizes their explained total variance.

As most of the relevant questions of DHS and LSMS surveys are categorical, either nominal or ordinal, we applied Categorical Principal Components Analysis (CATPCA). The method simultaneously provides optimal quantification of categorical variables, and reduces the dimensionality of the data. CATPCA handles nominal, ordinal and numeric indicators. An index, estimated from the first principal component, can be interpreted as the linear combination of original indicators, which captures the maximum possible amount of information, by optimizing the explained proportion of total variance. A detailed explanation of the methodology applied in this research is available.[3] All indices were transformed to a scale for 0 to 100 points, to facilitate interpretation.

The indices will allow for gauging the relative contribution of the most important determinants of stunting using multiple regression methods. OLS Regression models may be affected by endogeneity of some determinants, as variables such as access to health services represent choices made by the family, and may be affected by the nutritional status of children. To address this problem in the models with independent variables which may have a degree of endogeneity, we

[3] Larrea, Carlos. "Inequidad Social, Salud Materno-infantil y Nutrición en Ocho Países de América Latina: Análisis Comparativo de las Encuestas DHS III".Available in: http://www.paho.org/Spanish/HPP/HPN/larrea-encuestaDHS.htm , 2002, PAHO: Washington D.C.

used both two-stage regressions with instrumental variables, and simultaneous equation models using three-stage regression with instrumental variables.

Multivariate Indices

Peru and Colombia have different surveys, which allow for a diachronic analysis of changes in child nutrition and its determinants. In both cases, integrated data bases were elaborated, combining surveys of 1992, 1996 and 2000 in Peru, and those of 1995 and 2000 in Colombia.

For DHS surveys, we developed an integrated socio-economic status (SES) index for DHS surveys, including three dimensions - education, housing and employment. Each dimensional index, in turn, derives from a particular set of indicators, as shown in Table 1.

The indices of basic housing, household assets, employment, access to health services and socio-economic status were applied in the regression models. Their structure and features in the integrated Peru case are presented below, according to the variable names of Tables 1 and 2. Although the coefficients of the indices and their explanatory capacity vary in each particular case, their basic structure is consistent.

Basic Housing Index.

BASHIN = 0.864 WATER + 0.848 SEWER + 0.776 FLOOR + 0.449 ROOMS + 0.775 ELEC - 0.767 TIMEW

% total variance explained = 57. 6 %

Cronbach's Alpha = 0.853

Household Asset Index.

ASSETIN = 0.618 RADIO + 0.795 TV + 0.769 REFR + 0.543 CAR + 0.389 BIKE

% total variance explained = 41.0 %

Cronbach's Alpha = 0.641

In the integrated Peru database the question about telephone was not included because it was not available for 1992.

Table 1
Structure of the Multivariate Household SES Index

Indicators	Dimensional Indices	General Index
Education.		
1A. Illiteracy (ILIT). 1B. Years of schooling (SCHOOL). 1C. Access to higher education (ACHI). 1D. Primary level assistance ratio (PRIM). 1E. Secondary assistance ratio (SECUN). 1F.Post-secundary assistance ratio (SUPER).	**Education Index (EDUCIN)**	**Global SES Index (SESIN)**
Basic Housing Conditions.	**Basic Housing Index (BASHIN)**	
2A. Source of drinking water (WATER). 2B. Type of toilet facility (SEWER). 2C. Main material of the floor (FLOOR). 2D. Bedrooms for person (ROOMS). 2E. Does the household have electricity? (ELEC). 2F. Square root of time spent to get water (TIMEW).	**Housing Index (HOUSIN)**	
Household Assets.	**Household Asset Index (ASSETIN)**	
2G. Does the household have radio? (RADIO) 2H. Does the household have television? (TV) 2I. Does the household have a refrigerator? (REFR) 2J. Does the household have a telephone? (PHONE) 2K. Does any member of the household own a car? (CAR) 2L. Does any member of the household own a bicycle? (BIKE)		
Employment		
3A.Years of formal schooling of women aged 15-49. (WSCHOOL). 3B.Years of formal schooling of women's husband/partner. (HSCHOOL) 3C.Occupational group of women aged 15-49. (WOCGR) 3D. Occupational group of women's husband/partner (HOCGR). 3E. Occupational category of women aged 15-49 (WOCCAT) . 3F. Women's time spent working in the last 12 months (WOCTI).	**Employment Index (EMPIN)**	

Table 2

Components of Access to Maternal and Child Health Service Index (AHEIN)

I. Women's visit to a health facility in the last year (MEDVIS).
II. Previous or current use of a contraceptive method by women aged 15-49 (CONT).
III. Reception of tetanus toxoid vaccine during last completed pregnancy (TETAN).
IV. Number, opportunity and quality of prenatal health care visits during last completed pregnancy (PRENAT).
V. Place of last childbirth (PLBIRTH).
VI. Kind of health care during last childbirth (ATTBIRTH).
VII. Proportion of vaccines received by youngest child older than one year (BCG, Polio 0, DPT1, Polio1, DPT2, Polio 2, DPT3, Polio3, Measles) (VACCIN).

Housing Index.

HOUSIN = 0.795 WATER +0.834 SEWER + 0.793 FLOOR + 0.374 ROOMS + 0.789 ELEC – 0.668 TIMEW + 0.450 RADIO + 0.765 TV + 0.734 REFR + 0.413 CAR + 0.219 BIKE

% total variance explained = 42.8 %
Cronbach's Alpha = 0.866

Employment Index.

EMPIN = 0.788 WSCHOOL + 0.86 HSCHOOL + 0.567 WOCGR + 0.871 HOCGR

% total variance explained = 61.1 %

Cronbach's Alpha = 0.787

The employment index integrates education as a proxy of worker skills. In the integrated Peru database, the questions about women's occupational category and women's time spend working, were not included because they were not available in all surveys.

Access to Health Service Index.

AHEIN = 0.567 CONT + 0.432 TETAN + 0.633 PRENAT + 0.914 PLBIRTH + 0.917 ATTBIRTH + 0.466 VACCIN

% total variance explained = 46.7 %
Cronbach's Alpha = 0.772

In the integrated Peru database, the question about Women's visit to a health facility in the last year was not included because it was not available in all surveys.

Health Knowledge Index.

The index summarizes information about mother's information on menstrual cycle, contraceptives and breastfeeding and fertility.

Socio-economic Status Index.

SESIN* = 0.882 *EDUCIN* + 0.863 *HOUSIN* + 0.919 *EMPIN

% total variance explained = 78.9 %

Method: Principal Components Analysis.

The formulas and features of the indices in the cases of Colombia and Bolivia, as well as in specific surveys in Peru, are similar. In the case of Ecuador LSMS survey, the questionnaire is different, but similar housing and access to health service indices were elaborated.

Although the survey do not include a specific question about ethnicity, the language spoken at home was used as a proxy indicator to identify indigenous households, when an aboriginal language (mostly Quechua, Aymara, Shuar) was mentioned, either as the only language or combined with Spanish. The information is available in all countries, excepting Colombia, where the ethnic problem is comparatively less important.

Child Malnutrition, socio-economic, ethic and regional disparities in the Andean Region

To begin the analysis of the indices and the nutritional situation in the Andean countries, relevant variables are broken down by region, area of residence, ethnicity (excepting Colombia) and time (excepting Bolivia and Ecuador), as shown in Tables 3 to 10.

A descriptive overview of social and nutritional indicators in Peru, Ecuador and Bolivia discloses a deep regional and ethnic divide. The worst social and nutritional conditions correspond to the rural highlands and indigenous people, particularly in the cases of Peru, Ecuador and Bolivia, where stunting rates are extremely high (41 % in Ecuador's rural highlands). Regional disparities and stunting prevalence are lower in the case of Colombia.

Peru. The evolution of social and nutritional indicators in Peru suggests slow improvement between 1992 and 2000, with no significant change in regional and ethnic inequalities. While housing and household assets conditions barely improved, advances were well defined in access to health services, and somewhat smaller in education and fertility. Stunting rates declined between 1992 and 1996, and flattened out later.

Bolivia. The country shares with Peru and Ecuador strong regional, rural-urban and ethnic inequalities, as well as high stunting prevalence (Table 6).

Ecuador. In this case, information about per capita consumption and diet patterns is also available. All indicators disclose a fragmented regional, ethnic and social structure. Stunting reaches 58 % among indigenous children, and is particularly high in the rural highlands.

Colombia. Colombia has specific features compared with other Andean countries (Tables 7 and 8). Stunting prevalence is lower – 14 %, being around 26 % in Peru, Ecuador and Bolivia - . Although regional disparities are also lower, urban-rural social and nutritional inequalities remain high. Finally, social improvement between 1995 and 2000 seems also more significant than in the case of Peru.

Regional disparities and the socioeconomic gradient of stunting

The non parametric regression of stunting (LOWESS) on of SES percentiles discloses a defined socio-economic gradient, with notable similarity for Peru, Bolivia and Ecuador, and lower levels in Colombia (Figure 1).

Similar curves obtained differentiating the Highland and Lowland regions of Peru, Bolivia and Ecuador show a well defined regional difference shared by all countries. Highland regions share higher stunting levels than lowlands, even after controlling for SES. (Figure 2). The shared differences suggest specific regional factors negatively affecting nutrition in the Highlands. As most indigenous peoples live in the Highlands, ethnicity may be an important component of the difference.

Multiple Regression Models

We elaborated a set of multiple regression models for Ecuador, Peru and Bolivia, including social, regional and ethnic underlying factors of stunting. As a dependent variable, we selected the z score of height for age, because it is conventionally regarded as the best available indicator of long term nutritional deficiencies among children younger than 5 years.

The main objective of the comparative models is to analyze the effects of both indigenous ethnicity and regional factors in the specific case of highlands (the Altiplano region in the case of Bolivia). Both regional and ethnic factors may reflect the effects of specific cultural and dietary practices, ethnic discrimination factors, and diverse socio-political and environmental factors affecting highland regions.

The set of models progressively integrate independent variables, beginning with a simple specification to more complex ones. Independent variables were classified into different groups.

According to strong international evidence, “almost all of the growth retardation … documented in developing countries has its origin in the first 2 or 3 years of life. Once present, growth retardation usually remains for life, as growth deficits are generally nor recuperated.” (Semba and Bloem, 2001, p. 72).

All models include child age (in cubic form) and sex (as a dummy for female children), as control variables. They are underlying factors associated with stunting under adverse conditions. As a result of deficiencies in neurobiological development generated by persistent infections, poor food intake or other factors, child growth retardation increases mostly during the first 30 months of age, and tends to stabilize thereafter (Figure 3), shaping a curve which can be represented by a cubic polynomial function. The process affects more likely to male children.

A dummy variable for indigenous households is the next variable included, followed by contextual regional dummies, particularly one for the highlands. The effects of ethnicity and

highlands' region are then controlled for different socio-economic factors, beginning with mother's education and basic housing conditions, which are conventionally regarded as exogenous variables.

Maternal education -captured by her years of schooling- is introduced in linear form. To test for non-constant returns, additional models were elaborated with a quadratic parabolic function, but they are presented only in the case of Ecuador, where statistically significant evidence of increasing returns was found.

In the cases of Peru and Bolivia, where maternal anthropometric variables are available, maternal stature is also introduced as an exogenous variable, intended to capture mother's nutritional conditions during her early years.

In the next step, we included variables which may have certain degree of endogeneity, as they are partially conditioned by decisions made at home. The variables are aggregate per capita consumption in logarithmic form (available only for Ecuador) or the index of household assets, as proxies for living standards, and the access to health service index. In Bolivia and Peru mother's body mass index (BMI) is also included, to capture mother's current nutritional conditions.

In spite of its obvious effect on nutrition, fertility was not included in the models, based on the assumption that the number of child is endogenously determined by adults at home.

The introduction of variables with a degree of endogenity may generate biases in regression coefficients and affect the consistency of OLS models. Although no easy solutions are available to deal with this problem, we implemented two kinds of regression models with instrumental variables, treating to endogenous per capita consumption, access to health services and mother's BMI (in Peru and Bolivia only).

First, a 2-stage regression model was elaborated, including as instruments for endogenous variables several indicators of household human capital and contextual variables specific for each survey, and the Hausman test of endogeneity was applied. Second, a 3-stage simultaneous equation model was developed, regarding all endogenous variables as independently co-determined by instrumental variables. All OLS and 2-stage regression models were elaborated taking into account the effect of complex sample design, with clusters, differential weights, and stratification.[4] Regression results are presented in Tables 11 to 19.

[4] Models were implemented using Stata V.8.2.

Figure 1

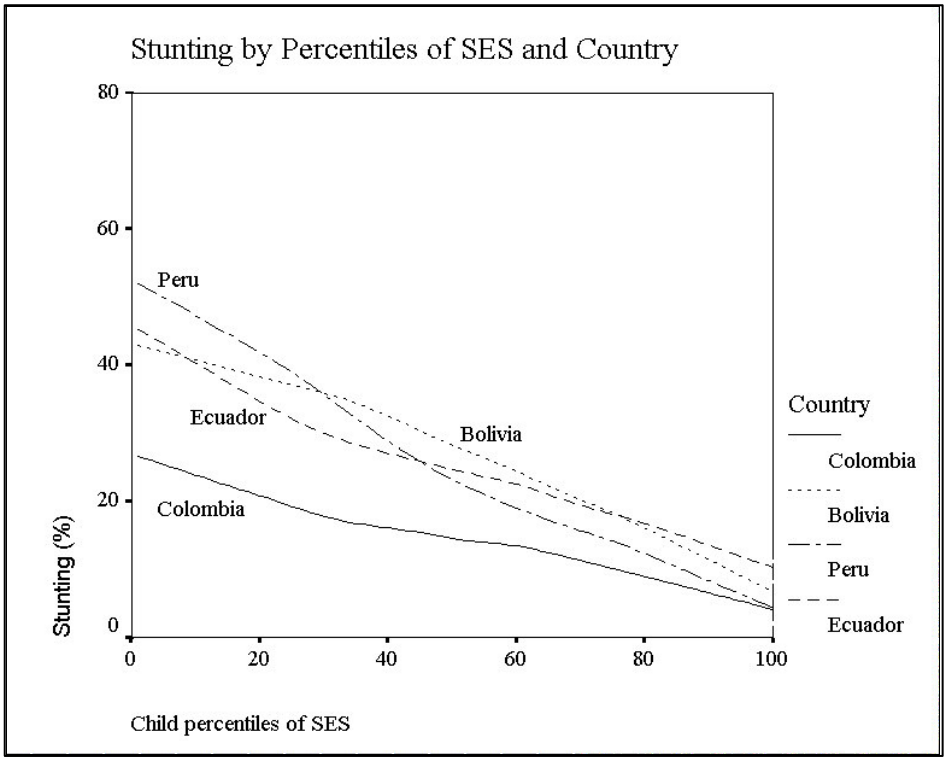
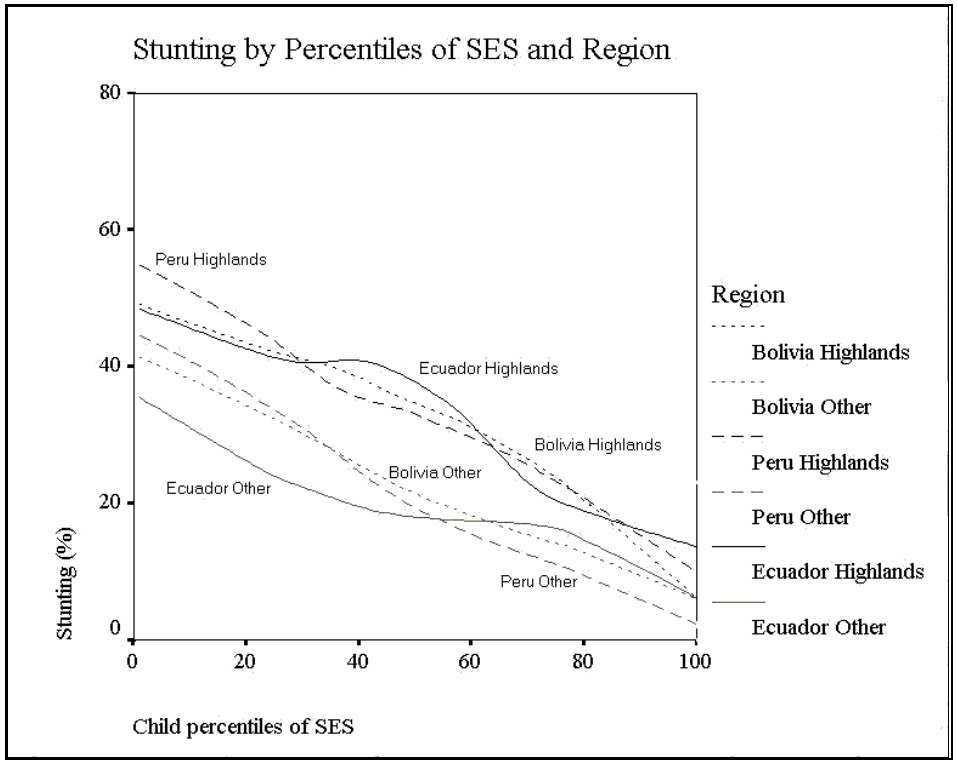
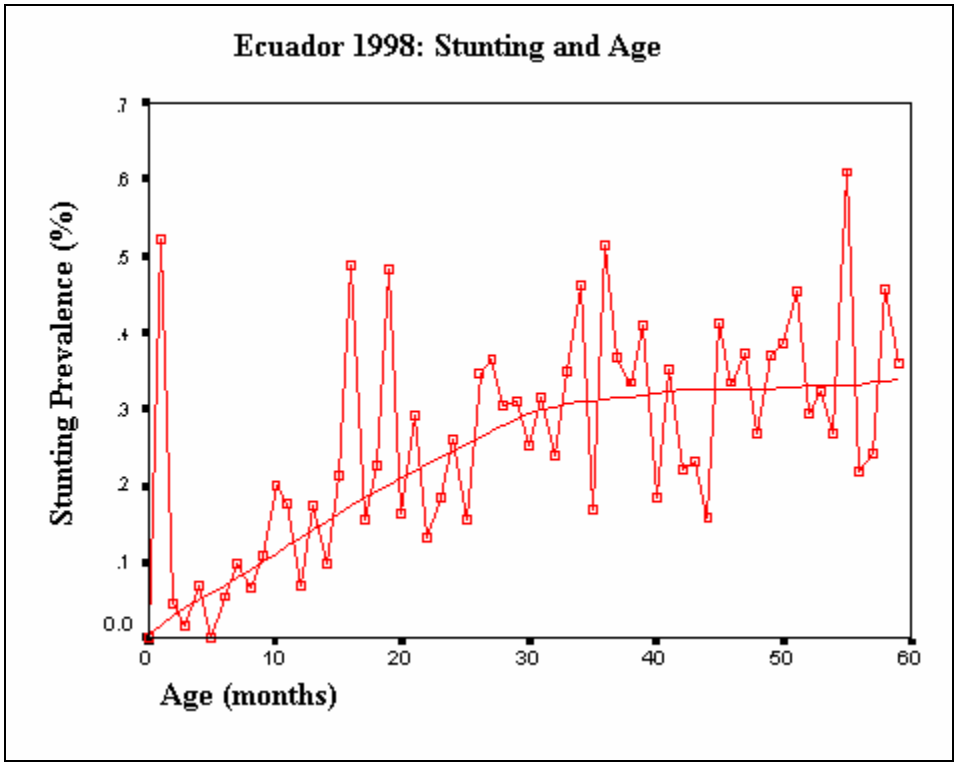


Figure 2



Source: Larrea and Freire, 2002.

Figure 3
Stunting and Child Age in Ecuador, 1998
Non parametric regression



Source: (Larrea, Freire and Luter, 2001).

Ecuador

The following conclusions can be derived from Ecuador's regression models (Tables 11 to 13).

a) A detrimental effect of indigenous ethnicity is observed in all de models, including the structural equation system. In all the cases the effect is significant at 1 ‰ level. Even after controlling for all the remaining covariates, its value remains high, roughly equivalent to 6 years of secondary maternal education. The models suggest that more than half of the total nutritional disadvantages of indigenous children can be attributed to discrimination, and the remaining part is due to differential endowments (education, housing, living standards). Obviously, international evidence supports the absence of genetic factors "There is prevailing international consensus that children of all races have the same growth potential" (Semba and Bloem, 2001, p. 76).

b) In addition to the ethnic factor, a regional dummy variable for the Highlands has a similar pattern, remaining negative and significant in all the models, albeit with a smaller effect. The regional factor can be hypothetically attributed to cultural and dietary patterns, lower availability of high protein foods for most of poor households in the region, and even the effect of altitude, as the Bolivian research paper suggests.

Table 3

Ecuador: Initial OLS Models and 2-Stage Regression Models -- Dependent variable: Height for age z score

Dependent : Height / Age	Model 1		Model 2		Model 3		Model 4		Model 5		Model 6 (OLS)		Model 7 (OLS)		Model 8 (OLS)		Model 9 (2-	
	No. Obs	R2	No.	R2	No.	R2	No.	R2	No.	R2	No.	R2	No.	R2	No.	R2	No.	R2
	2751	0.0853	2751	0.135	2751	0.1457	2751	0.1875	2751	0.196	2745	0.219	2742	0.229	2742	0.235	2650	0.224
Variables	Coeff.	P>|t|	Coeff.	P>|t|	Coeff.	P>|t|	Coeff.	P>|t|	Coeff.	P>|t|	Coeff.	P>|t|	Coeff.	P>|t|	Coeff.	P>|t|	Coeff.	P>|t|
Child's age	-0.988	0.023	-0.966	0.032	-0.945	0.043	-0.950	0.041	-0.933	0.051	-0.952	0.053	-0.942	0.065	-0.946	0.062	-0.921	0.067
Child's age squared	0.258	0.141	0.247	0.174	0.239	0.204	0.236	0.202	0.229	0.229	0.238	0.222	0.232	0.249	0.233	0.245	0.225	0.259
Child's age cubic	-0.024	0.238	-0.023	0.282	-0.022	0.320	-0.021	0.327	-0.020	0.360	-0.021	0.340	-0.021	0.373	-0.021	0.367	-0.020	0.382
Sex of child	0.129	0.007	0.123	0.007	0.135	0.003	0.122	0.006	0.131	0.003	0.111	0.016	0.103	0.019	0.101	0.022	0.112	0.015
Ethnicity			-1.135	0.000	-0.980	0.000	-0.811	0.000	-0.690	0.000	-0.718	0.000	-0.678	0.000	-0.663	0.000	-0.584	0.000
Dummy Highlands					-0.303	0.003			-0.261	0.002	-0.267	0.000	-0.272	0.000	-0.264	0.000	-0.220	0.005
Dummy Amazon					-0.055	0.694												
Mother´s Schooling							0.073	0.000	0.072	0.000	0.054	0.000	0.035	0.000	-0.019	0.409	-0.027	0.268
Mother´s Schooling Sq.															0.003	0.020	0.004	0.012
Persons per room											-0.103	0.000	-0.077	0.000	-0.079	0.000	-0.093	0.002
Ln(P.C. Consumption)													0.234	0.000	0.193	0.000	0.023	0.914
Health Service Access Index															0.004	0.012	0.011	0.129
Constant	-0.192	0.496	-0.118	0.698	-0.029	0.934	-0.706	0.040	-0.615	0.109	-0.143	0.645	-2.960	0.000	-2.534	0.000	-0.848	0.708

Hausman test: Chi2(11) = 4.07. P(Ho) = 0.9678.

Note on Model 9

Instrumented: Ln (P.C. consumption), Access to Health Service Index.

Instrumental: Household head schooling, household head labor experience, Dummy household head with social security, Dummy household head non-skilled agricultural worker, Per capita health personnel in municipality, dummy rural area.

Source for the analysis: INEC-World Bank, Ecuador LSMS Survey, 1998.

Table 4

Ecuador: Three-stage Simultaneous Equation Regression Model

Equation	**Obs**	**Parms**	**RMSE**	**R-sq**	**chi2**	**P**
Height / Age z score	2650	11	1.1383	0.2318	781.46	0
Ln (P.C.	2650	4	0.5769	0.3787	1516.30	0
Health Service	2650	2	18.3276	0.2337	743.07	0
Variables	**Coef.**	**Std. Err.**	**z**	**P>|z|**	**[95% Conf.**	**Interval]**
Height / Age						
Child's age	-0.90	0.15	-5.91	0.00	-1.20	-0.60
Child's age squared	0.22	0.07	3.11	0.00	0.08	0.35
Child's age cubic	-0.02	0.01	-2.11	0.04	-0.04	0.00
Dummy female child	0.11	0.04	2.43	0.02	0.02	0.20
Ethnicity	-0.65	0.11	-5.87	0.00	-0.87	-0.44
Dummy Highlands	-0.25	0.05	-4.57	0.00	-0.36	-0.14
Mother´s Schooling	-0.02	0.02	-0.76	0.44	-0.06	0.02
Mother´s Schooling sq.	0.00	0.00	2.57	0.01	0.00	0.01
Person per room	-0.08	0.02	-4.16	0.00	-0.12	-0.04
Ln (P.C. Consumption)	0.12	0.16	0.74	0.46	-0.19	0.42
Health Service Access	0.01	0.01	1.44	0.15	0.00	0.02
Constant	-1.84	1.68	-1.09	0.27	-5.14	1.46
PC Consumption						
Household head	0.08	0.00	25.97	0.00	0.08	0.09
Household head	0.00	0.00	1.19	0.24	0.00	0.00
Dummy Household	0.20	0.03	6.68	0.00	0.14	0.25
Dummy Household	-0.27	0.03	-7.97	0.00	-0.34	-0.20
Constant	11.73	0.04	273.91	0.00	11.65	11.82
Health Service						
Local PC Health	0.09	0.02	4.45	0.00	0.05	0.13
Dummy Rural	-16.00	1.04	-15.40	0.00	-18.04	-13.97
Constant	67.52	1.01	66.70	0.00	65.54	69.51

Correlation Matrix of Predicted Values and Residuals

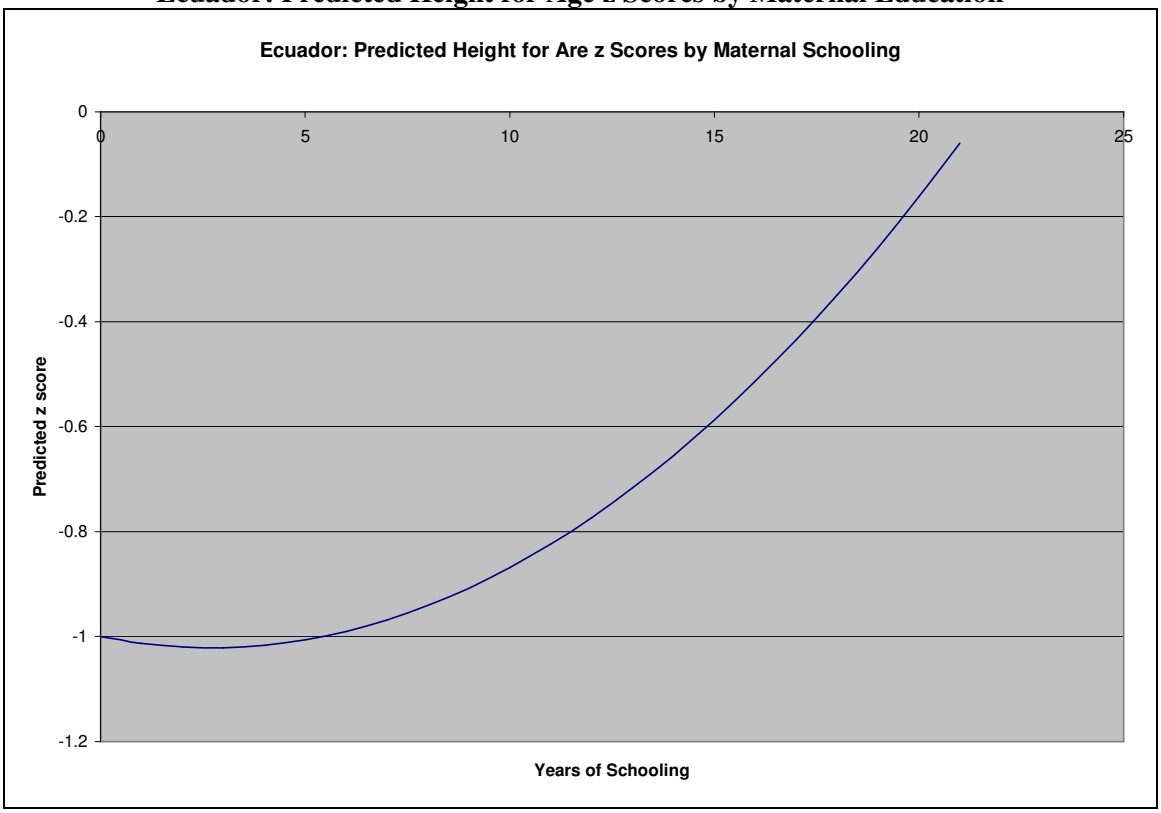
	hazpred	**res1**	**res2**	**res3**
hazpred	1			
res1	-0.01	1		
res2	0.37	0.02	1	
res3	0.43	-0.04	0.18	1

Hausman test: Chi2(11) = 5.72 P(Ho) = 0.8916

Source for the analysis: INEC-World Bank, Ecuador LSMS Survey, 1998.

Figure 4

Ecuador: Predicted Height for Age z Scores by Maternal Education



Source for the analysis: Table 13.

d) Maternal education, included in parabolic form, has also a strong and significant effect, but presents increasing returns (Figure 4). In other words, at low levels of education, effects on stunting are small or negligible, and they increase only at secondary or higher levels. This result is the opposite to the cases of most Latin American and Andean countries, including Peru, Bolivia and Colombia, where educational returns are decreasing or constant. (Larrea, 2002). If decreasing returns prevail, the best investments are in basic maternal education. In Ecuador, as the model suggests, only interventions at higher levels seem effective.

e) This paradoxical finding can be attributed to low basic educational quality. According to a recent Harvard University research, the quality of basic education in Ecuador is the worst among 19 Latin American countries (Fretes-Cibils, Guigale and López-Calix, 2003). Other complementary hypothesis points out to the bad quality of education among the poor, who attend mostly to public schools, while higher social strata will benefit from adequate returns in private institutions.

e) The housing index did not reach a significant value, and was eliminated from the regression. This lack of fit may be explained because lowland regions in Ecuador (the Coast and the Amazon), populated mostly form the second half of the twentieth century, combine bad housing conditions with relatively low stunting rates, while in the traditional Highlands stunting is the highest, but housing conditions are better (Table 9). The best association of housing conditions with stunting was observed with overcrowding,

captured by the number of persons per room. The indicator was integrated into the model, with a significant effect.

f) Differences in regression coefficients between OLS Model 8 and models wi5th instrumental variables to threat endogeneity of per capita consumption and access to health services are rather small. Moreover, in both cases (Model 9 and Table 13) the Hausman test for endogeniety does not reject the hypothesis of consistency of OLS coefficients. The results suggest, therefore, a weak degree of endogeneity.

g) The conclusion, however, must be qualified, taking into account that the test depends on the selection of instrumental variables. It is possible that, using a different set of instruments, a higher degree of endogeneity could exist.

h) Leaving aside the discussion about OLS consistency, in the 3-stage regression model the effects of access to health services and per capita income are smaller than in OLS models, and in the latter case, no longer significant.

Summarizing, Ecuador is still affected by high stunting prevalence, combined with regional, social and ethnic inequalities. Both regional and ethnic differences remain significant, affecting the Highlands and indigenous communities. In addition to a strong socio-economic gradient, other determinants affect stunting. Maternal education, albeit positively associated with nutrition, does not seem to produce effective returns at basic levels of schooling. Access to health services has a significant effect, mostly attributed to vaccines and child delivery care.

Several social investment strategies may be suggested from the findings. Among them, improving in the quality of female basic education seems a priority. Specific programs combining nutritional education and access to nutritional and health services are a priority, and they must be targeted mostly to indigenous communities in the rural Highlands. Food supplementation programs to children younger than three years and pregnant women are also needed.

Finally, as stunting is associated with poverty and social inequality, nutritional policies must be integrated into a broader and integrated policy of social equity and poverty reduction, including employment, promotion of human and social capital, broader access to land, credit and technical assistance.

Peru

In spite of its higher per capita income[5], Peru shares with Ecuador and Bolivia a high stunting prevalence, with strong ethnic, regional and social inequalities. Moreover, as mentioned, social improvement in the 1990s was slow and mostly visible in access to health services (Tables 3 to 5). Regression models for Peru and Bolivia are presented in Tables 14 to 19.

Broadly speaking, results are similar to the case of Ecuador, and confirm both a strong and significant negative indigenous ethnic effect, partially related to discrimination, and significant regional differences affecting both the Highlands and the Amazon basin, which remain significant even after controlling for all additional covariates.

[5] Peruvian per capita income was 4570 PPP dollars in 2002, compared to 3280 in Ecuador and 2300 in Bolivia. (UNDP. **Human Development Report,** 2003)

Table 5

Peru: Initial OLS Models and Additional OLS and 2-Stage Regression Models

Dependent : Height / Age	Model 1		Model 2		Model 3		Model 4		Model 5		Model 6 OLS		Model 7 OLS		Model 8 OLS		Model 9 OLS		Model 10 2-stage Iv reg	
	No. Obs	R2	No.	R2	No.	R2	No.	R2	No.	R2	No.	R2	No.	R2	No.	R2	No.	R2	No.	R2
	33937	0.0656	33900	0.1141	33900	0.172	30558	0.1966	30558	0.226	30203	0.295	29871	0.302	29003	0.297	29003	0.304	8509	0.2469
Variables	**Coeff.**	**P>|t|**	**Coeff.**	**P>|t|**	**Coeff.**	**P>|t|**	**Coeff.**	**P>|t|**	**Coeff.**	**P>|t|**	**Coeff.**	**P>|t|**	**Coeff.**	**P>|t|**	**Coeff.**	**P>|t|**	**Coeff.**	**P>|t|**	**Coeff.**	**P>|t|**
Child's age	-1.449	0.000	-1.442	0.000	-1.432	0.000	-1.434	0.000	-1.422	0.000	-1.438	0.000	-1.450	0.000	-1.430	0.000	-1.418	0.000	-1.915	0.000
Child's age squared	0.491	0.000	0.486	0.000	0.480	0.000	0.497	0.000	0.489	0.000	0.493	0.000	0.496	0.000	0.483	0.000	0.478	0.000	0.625	0.000
Child's age cubic	-0.054	0.000	-0.053	0.000	-0.052	0.000	-0.055	0.000	-0.054	0.000	-0.054	0.000	-0.055	0.000	-0.053	0.000	-0.052	0.000	-0.065	0.000
Dummy female child	0.041	0.018	0.043	0.010	0.036	0.026	0.048	0.004	0.043	0.009	0.054	0.001	0.052	0.001	0.053	0.001	0.050	0.001	0.061	0.045
Ethnicity			-0.849	0.000	-0.474	0.000	-0.344	0.000	-0.121	0.003	-0.099	0.008	-0.060	0.115	-0.160	0.000	-0.057	0.123	-0.149	0.023
Dummy Highlands					-0.731	0.000			-0.528	0.000	-0.411	0.000	-0.327	0.000			-0.314	0.000		
Dummy Amazon					-0.659	0.000			-0.427	0.000	-0.325	0.000	-0.235	0.000			-0.201	0.000		
Mother's Schooling							0.099	0.000	0.086	0.000	0.043	0.000	0.031	0.000	0.032	0.000	0.033	0.000	0.030	0.000
Mother's Height											0.056	0.000	0.055	0.000	0.056	0.000	0.056	0.000	0.057	0.000
Basic Housing Index											0.008	0.000	0.005	0.000	0.005	0.000	0.005	0.000	0.001	0.656
Household Asset													0.008	0.000	0.009	0.000	0.008	0.000	0.020	0.060
Health Service Access													0.006	0.000	0.008	0.000	0.005	0.000	0.005	0.427
Mother's BMI - 15															0.024	0.000	0.021	0.000	0.027	0.000
Constant	-0.028	0.407	0.098	0.004	0.438	0.000	-0.759	0.000	-0.414	0.000	-8.924	0.000	-9.327	0.000	-10.055	0.000	-9.646	0.000	-10.116	0.000

Hausman test: Chi2(11) = 146.64 P(Ho) = 0

Note: In Model 10 Household Assets, Health Service Access and BMI are endogenous, instrumented by education index, type of toiled facility quantification, availability of electricity, type of floor material quantification, time to get water, sister BMI, cluster BMI, Health knowledge index, child morbidity and proportion of dead children.

Source for the analysis: Peru DHS Surveys (1992, 1996 and 2000), children database.

Table 6

Peru: Three-stage Simultaneous Equation Regression Model

Equation	**Obs**	**Parms**	**RMSE**	**R-sq**	**chi2**	**P**
Height / Age z score	8509	11	1.1855	0.2496	2873.2	0
Household Asset	8509	5	8.9827	0.365	4509.4	0
Health Service	8509	2	1.5851	0.7808	30110	0
Mother's BMI - 15	8509	1	17.2	0.1825	1842.8	0

Variables	**Coef.**	**Std. Err.**	**z**	**P>|z|**	**[95% Conf.**	**Interval]**
Height / Age						
Child's age	-1.93	0.09	-21.21	0.00	-2.10	-1.75
Child's age squared	0.63	0.04	14.75	0.00	0.55	0.71
Child's age cubic	-0.07	0.01	-11.61	0.00	-0.08	-0.06
Sex of child	0.06	0.03	2.43	0.02	0.01	0.11
Ethnicity	-0.14	0.04	-3.28	0.00	-0.22	-0.05
Mother's Schooling	0.03	0.01	5.24	0.00	0.02	0.04
Mother's Height	0.06	0.00	22.61	0.00	0.05	0.06
Basic Housing Index	0.00	0.00	1.35	0.18	0.00	0.01
Household Asset	0.02	0.01	1.99	0.05	0.00	0.03
Health Service Access	0.01	0.00	1.87	0.06	0.00	0.02
Mother's BMI - 15	0.03	0.01	6.07	0.00	0.02	0.04
Constant	-10.06	0.41	-24.43	0.00	-10.87	-9.26
Household Asset						
Education index	0.13	0.01	12.50	0.00	0.11	0.15
Type of toilet facility	-3.21	0.19	-17.13	0.00	-3.58	-2.84
Dummy electricity	3.72	0.11	34.52	0.00	3.51	3.93
Type of floor material	2.81	0.16	17.63	0.00	2.50	3.12
Time spent to get	0.03	0.01	5.10	0.00	0.02	0.04
Constant	47.09	0.54	87.46	0.00	46.04	48.15
Mother's BMI - 15						
Sister's BMI	0.87	0.01	156.90	0.00	0.86	0.88
Cluster's BMI	0.13	0.02	8.62	0.00	0.10	0.16
Constant	0.03	0.14	0.21	0.84	-0.24	0.30
Health Service						
Health Knowledge	8.33	0.19	42.93	0.00	7.95	8.71
Constant	46.55	0.20	238.80	0.00	46.17	46.94

Correlation Matrix of Predicted Values and Residuals

	hazpred	**res1**	**res2**	**res3**
hazpred	1			
res1	-0.02	1		
res2	0.26	-0.055	1	
res3	0.04	-0.020	0.02	1

Hausman test: Chi2(11)= 5240.43 P(H0)= 0

Source for the analysis: Peru DHS Surveys (1992, 1996 and 2000), children database.

In contrast with Ecuador, the share of indigenous population is higher in Peru and Bolivia. Regional disparities are also higher in Peru, as a result of a concentrated historical pattern of urbanization and industrialization in the Coast, and particularly in Lima. Conversely, in the cases of Ecuador and Bolivia the capital is located in the Highlands, and urbanization followed a more decentralized pattern.

Indigenous ethnicity keeps a negative coefficient, significant in almost all the models. Its magnitude, however, is smaller than that of Ecuador. The coefficient declines by 80 % after controlling for socio-economic factors, and becomes no longer significant when regional variables for Highlands and Amazon basin (where most of indigenous people live) are included. Therefore, most of ethical differences on stunting in Peru are due to differential endowments, and the share of a discrimination factor is smaller.

Regional inequalities are higher than those of Ecuador, and remain significant in all the models. The Highland region is the most affected, as in the case of Ecuador.

Among social determinants of stunting, maternal education has a positive and significant effect in all models. Educational returns are diminishing as in most countries (results are no presented in the models). Basic housing has a positive and significant in all OLS models, but it is no longer significant in models with instrumental variables to control endogeneity. Mother's height has its expected and robust positive effect.

Three variables were regarded as endogenous and treated with instrumental variables in Model 10 and Table 16. They are the household asset index as a proxy for SES, access to health services and Mother's BMI. According to the Hausman test, OLS estimates are not constant when endogenous variables are included. All endogenous variables remain positive and significant in the 3-stage regression model, regarded as more efficient that the 2-stage model. Albeit a small degree of correlation between predicted z scores and residuals of the second equation remains, results seems to be as adequate as possible.

Bolivia

Being the poorest Andean country, Bolivia presents one of the most critical social conditions in South America. Although its stunting prevalence is similar to those of Ecuador and Peru, social determinants differ somewhat form the mentioned countries.

The effects of both regional and ethnic factors seems to be stronger than in the Peruvian case, as both the indigenous and Highland dummies remain negative and significant in all the models (excepting ethnicity in the 2-stage model), including the simultaneous-equation system.

The importance of household assets and basic housing indices is higher, while the access to health service index has a slightly lower coefficient, and the effects of education are reduced compared to other countries, and in the 2-stage model, no longer significant. These changes are consistent with the observed in other low income countries in Central America, such as Nicaragua and Guatemala (Larrea, 2000).

Table 7

Bolivia: Initial OLS Models and Additional OLS and Instrumental Variable Models

	Model 1		Model 2		Model 3		Model 4		Model 5		Model 6 OLS		Model 7 OLS		Model 8 OLS		Model 92-stage I.V. reg.	
Dependent :	**No. Obs**	**R2**	**No. Obs**	**R2**	**No. Obs**	**R2**	**No. Obs**	**R2**	**No. Obs**	**R2**	**No. Obs**	**R2**	**No. Obs**	**R2**	**No. Obs**	**R2**	**No. Obs**	**R2**
Height / Age	**5994**	**0.0649**	**5993**	**0.1153**	**5993**	**0.126**	**5254**	**0.1344**	**5254**	**0.151**	**5219**	**0.2**	**5219**	**0.216**	**5121**	**0.228**	4754	0.22
Variables	**Coeff.**	**P>|t|**	**Coeff.**	**P>|t|**	**Coeff.**	**P>|t|**	**Coeff.**	**P>|t|**	**Coeff.**	**P>|t|**	**Coeff.**	**P>|t|**	**Coeff.**	**P>|t|**	**Coeff.**	**P>|t|**	**Coeff.**	**P>|t|**
Child's age	-1.785	0.000	-1.867	0.000	-1.864	0.000	-1.789	0.000	-1.784	0.000	-1.812	0.000	-1.819	0.000	-1.796	0.000	-1.831	0.000
Child's age squared	0.656	0.000	0.690	0.000	0.690	0.000	0.662	0.000	0.661	0.000	0.673	0.000	0.676	0.000	0.662	0.000	0.672	0.000
Child's age cubic	-0.075	0.000	-0.079	0.000	-0.079	0.000	-0.076	0.000	-0.076	0.000	-0.077	0.000	-0.078	0.000	-0.076	0.000	-0.076	0.000
Sex of child	0.059	0.164	0.074	0.076	0.078	0.059	0.050	0.237	0.056	0.183	0.050	0.202	0.055	0.158	0.062	0.115	0.057	0.153
Ethnicity			-0.745	0.000	-0.708	0.000	-0.475	0.000	-0.419	0.000	-0.384	0.000	-0.212	0.001	-0.160	0.012	-0.095	0.235
Dummy Highlands					-0.299	0.000			-0.366	0.000	-0.274	0.000	-0.293	0.000	-0.230	0.000	-0.135	0.032
Mother's Schooling							0.062	0.000	0.064	0.000	0.048	0.000	0.026	0.000	0.016	0.011	-0.002	0.864
Mother's Height											0.054	0.000	0.052	0.000	0.056	0.000	0.055	0.000
Basic Housing Index													0.011	0.000	0.005	0.005	-0.001	0.915
Household Asset															0.010	0.000	0.017	0.213
Health Service Access															0.003	0.010	0.012	0.022
Mother's BMI - 15															0.018	0.001	0.013	0.334
Constant	0.127	0.480	0.344	0.004	0.453	0.000	-0.506	0.000	-0.394	0.000	-8.319	0.000	-8.371	0.000	-9.417	0.000	-9.627	0.000

Hausman test:Chi2(12) = 3.59 P(H0) = 0.9898

Note on Model 9:

Intrumented variables: Household Asset Index, Access to Health Service Index, Mother's BMI.

Intrumental variables: Employment Index, Type of toilet quantification, Floor material quantification, Cluster (PSU) BMI, Health Knowledge Index, Dummy rural.

Source for the analysis: Bolivia DHS Survey (1997), children database.

Table 8

Bolivia: Three-stage Simultaneous Equation Regression Model

Equation	**Obs**	**Parms**	**RMSE**	**R-sq**	**chi2**	**P**
Height / Age z score	4736	12	1.2134	0.2205	1506.5	0
Household Asset	4736	4	8.7687	0.5732	6232.1	0
Health Service	4736	1	3.5999	0.2342	1438.2	0
Mother's BMI - 15	4736	3	16.176	0.3692	2710.6	0
Variables	**Coef.**	**Std. Err.**	**z**	**P>|z|**	**[95%**	**Interval**
Height / Age						
Child's age	-1.81	0.13	-14.26	0.00	-2.06	-1.56
Child's age squared	0.66	0.06	11.10	0.00	0.54	0.77
Child's age cubic	-0.07	0.01	-9.46	0.00	-0.09	-0.06
Sex of child	0.05	0.04	1.55	0.12	-0.02	0.12
Ethnicity	-0.11	0.06	-1.74	0.08	-0.23	0.01
Dummy Highlands	-0.23	0.05	-4.52	0.00	-0.33	-0.13
Mother's Schooling	0.01	0.01	1.66	0.10	0.00	0.03
Mother's Height	0.06	0.00	17.10	0.00	0.05	0.06
Basic Housing Index	0.00	0.00	1.12	0.26	0.00	0.01
Household Asset	0.01	0.01	0.79	0.43	-0.01	0.03
Health Service Access	0.01	0.00	2.65	0.01	0.00	0.02
Mother's BMI - 15	0.01	0.01	1.24	0.21	-0.01	0.03
Constant	-9.51	0.53	-17.85	0.00	-10.55	-8.47
Household Asset						
Employment index	0.08	0.01	12.74	0.00	0.07	0.10
Type of toilet facility	-4.01	0.17	-24.25	0.00	-4.34	-3.69
Dummy electricity	10.17	0.34	29.64	0.00	9.49	10.84
Type of floor material	3.15	0.17	18.48	0.00	2.82	3.49
Constant	28.56	0.63	45.50	0.00	27.33	29.79
Mother's BMI - 15						
Cluster's BMI	1.02	0.03	37.92	0.00	0.97	1.08
Constant	-0.31	0.29	-1.06	0.29	-0.87	0.26
Health Service						
Health Knowledge	0.43	0.01	32.49	0.00	0.40	0.46
Dummy rural	-13.27	0.61	-21.95	0.00	-14.46	-12.09
Migration indicator	-1.52	0.24	-6.49	0.00	-1.99	-1.06
Constant	34.62	0.85	40.58	0.00	32.95	36.29

Correlation Matrix of Predicted Values and Residuals

	hazpred	**res1**	**res2**	**res3**
hazpred	1			
res1	-0.05	1		
res2	0.20	-0.006	1	
res3	0.02	0.020	0.006	1

Source for the analysis: Bolivia DHS Survey (1997), children database.

The effect of mother's height, as an indicator of mother's malnutrition in her infancy, is very strong and does not decline including other covariates, reflecting not only a trend to intergenerational transition of stunting, as a result of an unequal social distribution of opportunities, but also a genetic effect. Those features seem common with the case of Peru.

Concluding remarks

The main objective of this paper is to analyze the effects of both regional and ethnic detrimental factors on stunting in three South American countries with high indigenous populations, mostly concentrated in high altitude regions in the Andean mountains.

In all cases we have found strong negative ethnic effects of indigenous ethnicity as well as contextual regional negative factors for highland regions. The results remain significant even after controlling for all relevant socio-economic determinants, such as education, housing and economic status, with few exceptions.

Differences in nutritional conditions of indigenous children can be decomposed into two broad categories: those attributed to lower endowments of indigenous households - such as education, skills or physical assets – and a remaining component which can be attributed to different forms of ethnic discrimination due to cultural and linguistic barriers and negative attitudes, difficulties in the provision of social services of education and health, and so on. Discrimination seems to account for an important fraction of ethnic inequalities in all countries.

Regional detrimental factors are diverse and can be hypothetically related to specific cultural and dietary patterns prevailing in South American highlands, with low protein intake and a high proportion of carbohydrates from potatoes, cassava and other tubers and cereals, as well as adverse environmental and productive conditions, such as lack of irrigation, poor and eroding soils, and an extremely unequal land distribution structure inherited from the colonial period. An effect of altitude may also play a significant role, particularly in the Southern Andes. Further research is needed to explore, understand and design specific policies to avoid these ethnic and regional inequalities.

In spite of the rhetoric, ethic discrimination is still pervasive in the Andean region. Nutritional and health promotion policies must specifically target rural highland regions and indigenous communities, which continue to be the poorest among the poor. To be effective, nutritional programs must be integrated with female education and nutritional training, as well as broader redistributive policies to increase human and physical capital of rural indigenous households.

Appendices

Table 9

Peru: Child Malnutrition and Social Indicators by Region and Year

Year	Natural regions	Indices				Variables					Child Anthropometric Measures			
		Basic Housing	Hhld. Assets	Employ-ment	Access to Health	Mother's education	Father's education	Fertility	Mother's BMI	Mother's height	Height for age z	Stun-ting	Under-Weight	Wasting
1992	Metropolitan Lima	71.8	63.6	66.6	64.2	11.1	12.4	0.4	25.4	152.2	-0.523	8.9	2.5	0.8
	Rest of Coast	50.1	53.4	50.3	53.3	7.4	8.7	1.2	25.4	149.8	-1.097	24.3	7.9	1.6
	Highlands	33.5	46.4	38.1	37	5.1	7.2	1.6	24.5	149.1	-1.836	46.4	15.4	2.2
	Amazonian	36.3	45	40.9	42.4	5.9	7.6	1.9	23.7	150.1	-1.518	35.1	16.1	2.8
	Total	45.3	51.1	46.8	47.2	6.9	8.6	1.3	24.7	150	-1.344	31.7	11.2	1.9
1996	Metropolitan Lima	61.9	60.7	60.1	69.9	9.5	10.9	0.5	25.9	150.9	-0.576	10.1	1.1	0.5
	Rest of Coast	50.6	56	53	60.8	8.1	9.2	1	25.8	150.8	-0.931	17.2	3.7	0.4
	Highlands	35.9	47.5	44.1	42.3	5.4	7.4	1.4	24.6	149.4	-1.508	38.5	11.9	1.5
	Amazonian Basin	36.3	45.9	44.7	46.9	5.7	7.2	1.8	23.6	150.2	-1.417	33	15.9	4.1
	Total	45.1	52.1	49.7	53.5	7	8.5	1.2	25	150.2	-1.14	26.1	8	1.4
2000	Metropolitan Lima	67.6	62.4	63.6	72.5	10.7	11.5	0.2	26.2	151.7	-0.535	7.8	1.1	0
	Rest of Coast	53.3	56.2	56.4	63.6	9.2	10	0.6	26.7	150.7	-0.845	16.8	3.9	0.9
	Highlands	38.9	48.4	46.1	46.8	6	8	1.2	24.7	149.5	-1.607	38.8	10.9	1.4
	Amazonian Basin	35.4	45.5	46.2	50.5	6.6	8	1.6	24.3	149.8	-1.361	29.2	12.1	1.4
	Total	47.8	52.7	52.1	56.8	7.8	9.2	0.9	25.4	150.3	-1.165	25.6	7.4	1
Total	Metropolitan Lima	66.7	62.1	63.1	68.9	10.4	11.5	0.4	25.8	151.5	-0.548	9	1.5	0.4
	Rest of Coast	51.2	55.1	52.9	58.9	8.2	9.2	1	25.9	150.4	-0.961	19.5	5.2	1
	Highlands	35.9	47.4	42.6	41.8	5.5	7.5	1.4	24.6	149.3	-1.645	41.1	12.7	1.7
	Amazonian Basin	36.1	45.5	43.6	46.1	6	7.6	1.8	23.8	150	-1.437	32.6	14.9	2.8
	Total	45.9	51.9	49.4	52.2	7.2	8.7	1.1	25	150.2	-1.214	27.8	8.9	1.4

Source for the analysis: Peru DHS Surveys, children database.

Table 10

Peru: Child Malnutrition and Social Indicators by Ethnicity and Year

Year	Ethnicity	Indices				Variables					Child Anthropometric Measures			
		Basic Housing	Hhld. Assets	Employ-ment	Access to Health	Mother's Education	Father's education	Fertility	Mother's BMI	Mother's height	Height for age z	Stuntin g	Under-Weight	Wasting
1992	Non indigenous	48.9	52.8	51	50.5	7.7	9.3	1.2	24.9	150.3	-1.21	27.3	9.2	1.8
	Indigenous	24	41.3	23.8	27.7	2.4	4.9	1.9	24.1	148.5	-2.16	58.6	23.2	2.3
	Total	45.2	51.1	46.8	47.2	6.9	8.6	1.3	24.7	150	-1.34	31.7	11.2	1.9
1996	Non indigenous	48.6	53.8	52.5	56.9	7.7	9.1	1.1	25.2	150.4	-1.03	22.6	6.7	1.3
	Indigenous	25.6	42.8	34.8	33.9	2.7	5.3	1.8	24.1	148.9	-1.76	46.9	16.1	1.8
	Total	45.1	52.1	49.7	53.5	7	8.5	1.2	25	150.2	-1.14	26.1	8	1.4
2000	Non indigenous	51.3	54.4	54.8	59.9	8.6	9.7	0.8	25.6	150.5	-1.03	21.3	5.9	0.9
	Indigenous	29.7	44.2	38.4	40.1	3.7	6.3	1.6	24.3	149.1	-1.88	48.6	15	1.6
	Total	47.8	52.7	52.1	56.8	7.8	9.2	0.9	25.4	150.3	-1.17	25.6	7.4	1
Total	Non indigenous	49.4	53.6	52.6	55.5	8	9.3	1	25.2	150.4	-1.09	23.7	7.3	1.3
	Indigenous	26.3	42.7	32.1	33.7	2.9	5.5	1.8	24.2	148.8	-1.93	51.1	17.9	1.9
	Total	45.9	51.9	49.4	52.2	7.2	8.7	1.1	25	150.2	-1.2	27.8	8.8	1.4

Source for the analysis: Peru DHS Surveys, children database.

Table 11

Peru: Child Malnutrition and Social Indicators by Place of Residence and Year

Year	Type of Place of Residence	Indices				Variables					Child Anthropometric Measures			
		Basic Housing	Hhld. Assets	Employ-ment	Access to Health	Mother's Education	Father's education	Fertility	Mother´s BMI	Mother's height	Height for age z	Stuntin g	Under-Weight	Wasting
1992	Urban	58.9	57.3	58.4	56.1	8.9	10.4	0.9	10.2	150.8	-1.013	21.5	7.0	1.6
	Rural	24.7	41.7	29.7	33.3	4.0	5.9	2.0	9.1	148.9	-1.864	47.8	17.7	2.3
	Total	45.3	51.1	46.8	47.2	6.9	8.6	1.3	9.7	150.0	-1.344	31.7	11.2	1.9
1996	Urban	58.9	58.1	58.1	63.8	9.0	10.4	0.8	10.6	150.8	-0.834	16.4	4.1	1.1
	Rural	25.3	43.5	38.0	38.1	4.0	5.9	1.8	9.2	149.3	-1.607	40.8	14.0	1.9
	Total	45.1	52.1	49.7	53.5	7.0	8.5	1.2	10.0	150.2	-1.14	26.1	8.0	1.4
2000	Urban	62.3	59.1	61.2	67.4	10.1	11.0	0.5	11.1	151.2	-0.759	13.7	3.5	0.7
	Rural	30.4	45.1	41.5	43.8	5.1	7.0	1.5	9.6	149.3	-1.656	40.1	12.1	1.2
	Total	47.8	52.7	52.1	56.8	7.8	9.2	0.9	10.4	150.3	-1.165	25.6	7.4	1.0
Total	Urban	59.8	58.1	59.0	62.0	9.3	10.6	0.7	10.6	150.9	-0.872	17.3	4.9	1.2
	Rural	26.6	43.4	36.3	38.3	4.3	6.2	1.7	9.3	149.1	-1.703	42.7	14.5	1.8
	Total	45.9	51.9	49.4	52.5	7.2	8.7	1.1	10.0	150.2	-1.214	26.8	8.8	1.4

Source for the analysis: Peru DHS Surveys, children database.

Table 12

Bolivia 1997: Child Malnutrition and Social Indicators by Region

Natural Region	Indices				Variables					Child Anthropometric Measures			
	Basic Housing	Hhld. Assets	Employ-ment	Access to Health	Mother's Education	Father's Education	Fertility	Mother's BMI	Mother's Height (cm)	Height for age %	Stunting	Under - Weight	Wasting
Altiplano	48.6	47.8	44.9	42.5	5.5	7.7	0.7	25.3	150.2	-1.374	31.1	8.1	1.3
Valle	44.8	48.6	40.1	47.3	5.2	6.4	0.8	25.2	150.6	-1.172	27.2	7.6	1.5
Llano	52.2	50.1	41.2	58.1	6.2	7.3	1	25.9	153	-0.84	20.3	6	1.6
Total	48.5	48.7	42.4	48.5	5.6	7.2	0.8	25.4	151.1	-1.157	26.8	7.4	1.4

Bolivia 1997: Child Malnutrition and Social Indicators by Place of Residence

Place of Residence	Indices				Variables					Child Anthropometric Measures			
	Basic Housing	Hhld. Assets	Employ-ment	Access to Health	Mother's Education	Father's Education	Fertility	Mother's BMI	Mother's Height (cm)	Height for age %	Stunting	Under - Weight	Wasting
Capital, large city	65.3	58.9	50.5	60.9	8	9.4	0.5	25.7	151.8	-0.84	18.5	5.2	1.3
Small city	60.5	52.4	45.5	54	6.4	8.1	0.8	26	151.1	-1.09	20.3	5.5	0.8
Town	50.7	47.8	40.3	52	5.6	7.1	0.9	26.3	151.1	-1.04	22.4	4.7	1.4
Countryside	30.4	39.1	35.2	37.3	3.3	5.2	1.2	24.9	150.6	-1.49	37.2	10.3	1.8
Total	48.4	48.6	42.3	49.5	5.6	7.2	0.8	25.4	151.1	-1.16	26.9	7.4	1.4

Bolivia 1997: Child Malnutrition and Social Indicators by Ethnicity

Ethnicity	Indices				Variables					Child Anthropometric Measures			
	Basic Housing	Hhld. Assets	Employ-ment	Access to Health	Mother's Education	Father's Education	Fertility	Mother's BMI	Mother's Height (cm)	Height for age %	Stunting	Under - Weight	Wasting
Non indigenous	55.1	52.2	44.6	54.8	6.7	8.1	0.8	25.7	151.7	-0.99	21.6	5.8	1.3
Indigenous	29.6	38.8	36.2	29.9	2.5	4.7	1.1	24.8	149.6	-1.685	43.1	12.2	2
Total	48.5	48.7	42.4	48.5	5.6	7.2	0.8	25.4	151.1	-1.156	26.7	7.4	1.4

Source for the analysis: Bolivia DHS Surveys, children database

Table 13

Colombia: Child Malnutrition and Social Indicators by Region and Area of Residence

Region and Area	Indices				Variables					Child Anthropometric Measures			
	Basic Housing	Hhld. Assets	Employ-ment	Access to Health	Mother's Education	Father's Education	Fertility	Mother's BMI	Mother's Height	Height for age %	Stunting	Under - Weight	Wasting
	Mean												
Atlantica Capital, large city	67.4	60.2	51	66.3	9.2	9.4	0.91	24.3	156.4	-0.73	10.69	7.6	0.77
Atlantica Small city	65.5	60	50.3	66.8	8.6	9.2	0.97	24.4	156.6	-0.66	10.98	6.52	1.49
Atlantica Town	57.3	55.9	46.5	64.6	7.9	8.3	1.24	23.8	156.2	-0.84	14.48	8	1.85
Atlantica Countryside	29.9	44.2	30	53.4	4.2	4.4	2.12	23.7	155.6	-0.98	16.88	12.29	1.74
Oriental large city	75.7	66.4	50.9	69.1	9.4	9.2	0.82	23.7	156.2	-0.15	4.75	1.51	0
Oriental Small city	74.8	63	48.4	68	8.6	8.8	0.88	24.7	155.1	-0.56	7.25	5.84	1.53
Oriental Town	73	63.5	45.3	67	8.5	8.4	0.98	25.2	154.9	-0.82	13.29	3.54	0
Oriental Countryside	43	53.8	27.9	59.8	5	4.8	1.47	24.7	153.3	-1.09	17.41	8.58	1.71
Central Capital, large city	75.5	65.4	48.6	70.3	8.6	8.7	0.61	24.3	154.9	-0.58	9.17	5.26	0.95
Central Small city	73.9	62.8	48.9	68	8.6	8.9	0.93	24.8	154.3	-0.71	10.83	6.03	1.43
Central Town	71.1	58.6	43.3	64.5	7.6	7.2	1.15	24.8	153.4	-0.89	13.84	8.66	0.61
Central Countryside	44.3	50.6	26	54.6	4.4	4.1	1.63	25	152.2	-1.12	18.54	8.5	1.42
Pacifica Capital, large city	74.3	64.3	50	68.9	8.5	9.4	0.85	25.4	155.6	-0.44	6.93	4.38	1
Pacifica Small city	70.3	61.3	50.1	65.3	8.8	9.5	0.91	25	155.7	-0.5	9.79	6.36	1.99
Pacifica Town	69.4	56.9	43.8	64.7	7.9	7.6	0.82	24.7	153.1	-0.97	17.11	5.77	0.83
Pacifica Countryside	33.9	44.4	25.8	48.8	4	4.1	1.78	24.7	152	-1.17	24.74	12.2	2.02
Bogota Capital, large city	76.4	63.5	51.7	68.9	9.5	9.5	0.65	24.7	153.8	-0.96	15.47	6.17	0.56
Total	60.2	57.3	41.6	63	7.2	7.4	1.2	24.6	154.4	-0.85	14.2	7.59	1.29

Source for the analysis: Colombia DHS Surveys, children database.

Table 14

Colombia: Child Malnutrition and Social Indicators by Place of Residence and Year

Year	Type of place of residence	Indices				Variables					Child Anthropometric Measures			
		Basic Housing	Hhld. Assets	Employ-ment	Access to Health	Mother's Education	Father's Education	Fertility	Mother's BMI	Mother's Height	Height for age %	Stunting	Under - Weight	Wasting
1995	Urban	71.3	61.2	48.8	65.8	8.4	8.8	0.9	9.5	155	-0.742	12.3	6.467	1.393
	Rural	35.5	49.2	27.1	52.8	4.2	4.1	1.9	9.5	153.2	-1.08	19.25	11.11	2.24
	Total	58.5	56.9	40.8	61.2	6.9	7.1	1.3	9.5	154.3	-0.867	14.86	8.179	1.705
2000	Urban	71.6	62.5	49.1	69.3	8.9	9	0.8	9.8	155.1	-0.706	10.98	5.932	0.7463
	Rural	41.5	47.2	28.2	56.7	4.7	4.7	1.5	9.6	153.4	-1.1	18.97	9.266	1.041
	Total	62.2	57.7	42.4	65.4	7.6	7.6	1	9.7	154.6	-0.829	13.49	6.977	0.8387
Total	Urban	71.5	61.9	48.9	67.6	8.7	8.9	0.9	9.6	155	-0.722	11.59	6.179	1.045
	Rural	38.2	48.3	27.6	54.6	4.4	4.4	1.7	9.5	153.3	-1.09	19.11	10.23	1.668
	Total	60.2	57.3	41.6	63.2	7.2	7.4	1.2	9.6	154.4	-0.847	14.15	7.558	1.257

Source for the analysis: Colombia DHS Surveys, children database.

Table 15

Ecuador 1998: Child Malnutrition and Social Indicators by Region and Area

Region and area	Housing Index	Per Capita Consumption	Mother's Schooling	Health Service Index	Fertility	Height for age z	Stunting	Underweight	Wasting
Urban Coast	47.39	356234	9.14	72.01	-0.05	-0.92	21.27	11.7	2.33
Rural Coast	35.49	214049	6.18	58.2	0.03	-1.15	23.33	20.23	3.82
Urban Highlands	59.26	483714	9.52	71.25	-0.51	-1.12	22.96	9.4	0.91
Rural Highlands	39.56	193217	5.2	48.23	0.26	-1.73	41.34	18.74	2.78
Urban Amazonian B.	57.35	377398	10.05	71.76	-0.19	-0.84	18.42	8.33	0
Rural Amazonian B.	35.66	226681	5.83	50.55	0.51	-1.29	27.81	10.56	0
Total	45.4	314173	7.74	63.63	-0.03	-1.18	26.54	14.23	2.34

Source for the analysis: INEC-World Bank, Ecuador LSMS Survey, 1998.

Table 16

Ecuador 1998: Child Malnutrition and Social Indicators by Ethnicity

Ethnicity	Housing Index	Per Capita Consumption	Mother's Schooling	Health Service Index	Fertility	Height for age z	Stunting	Underweight	Wasting
Non indigenous	46.01	325589	8.04	65.42	-0.07	-1.1	24.18	13.05	2.26
Indigenous	37.25	161531	3.67	39.77	0.5	-2.23	58.15	30.04	3.46
Total	45.4	314173	7.74	63.63	-0.03	-1.18	26.54	14.23	2.34

Source for the analysis: INEC-World Bank, Ecuador LSMS Survey, 1998.

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