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Child stunting and socio-economic inequality in Latin America and the Caribbean

Guillermo Paraje

This paper investigates the factors determining the extent of the problem of child stunting and its socio-economic distribution in eight countries of Latin America and the Caribbean. It does so using a methodology that allows a socio-economic inequality index (the concentration index) to be decomposed by the factors affecting it. In the countries analysed, household "wealth" (measured by an indicator of material well-being) and maternal education are the most important determinants in the distribution of child stunting. The biomedical factors considered may be important in explaining the level of stunting, but their contribution to explaining inequality is relatively small. Geographical, cultural, ethnic and idiosyncratic factors also play a limited explanatory role, one that apparently depends on their relationship to the distribution of the socio-economic variables mentioned.

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I
Introduction

Child stunting has enormous economic and social implications. For one thing, it is associated with negative health outcomes, particularly increased child mortality. Pelletier and others (1995), for example, showed that an average of 56% of deaths among under-5s in 53 developing countries were a direct or indirect consequence of inadequate nutrition. More recently, Black and others (2008) have reported that child stunting is responsible for some 2.2 million deaths a year and 21% of disability-adjusted life years (DALYs) lost in middle- and low-income countries.

Broadly speaking, child stunting carries both direct social costs (in the form of higher mortality, but also higher morbidity and the monetary cost this entails) and indirect ones. The latter include a permanent diminution in children's cognitive abilities, late entry into the education system and higher school drop-out rates, among other things (Victora and others, 2008). These factors are associated with a loss of labour productivity and economic growth (WHO, 2001). Given these characteristics, stunting entails a permanent loss of present and future resources and an alteration in their distribution.

At the same time, the disproportionate concentration of stunting in the lowest socio-economic strata would imply, among other things, that as the relative scale of the direct and indirect economic costs increases, stunting becomes not just a consequence of economic inequality but also a cause (owing to its impoverishing effect on sufferers), so that a vicious circle is created.

This relationship is very striking in Latin America and the Caribbean, as illustrated in figure 1, which shows the prevalence of child stunting at the national level (stunted children as a percentage of the total) and among households in the poorest quintile of a large group of middle- and low-income countries. The fact that stunting is more common among households in the poorest quintile than in an average household in all these countries (all observations are above the 45° line marked on the chart) shows that this situation is invariably related to poverty. It can also be appreciated from the chart, however, that when the average prevalence is taken (low or high relative to other developing countries), the region's countries have prevalences in the bottom quintile that are among the highest in the world.

This has immediate implications for socio-economic policies: if the aim is to reduce average stunting levels, prevalence among the poorest households needs to be reduced, which means making the distribution less unequal. Thus, not only is it necessary to understand the causes of stunting in order to act upon them, but it is crucial to understand what variables affect its socio-economic distribution, since in principle there could be variables that are unimportant in explaining the average level of stunting but very important in explaining its distribution.

The main purpose of this paper is to identify and quantify the effect that major socio-economic and biomedical variables have had not only on the level of child stunting but also on its socio-economic distribution in eight countries of Latin America and the Caribbean during the early years of the twenty-first century. Although the methodology used is not new and has been applied in other cases (Wagstaff, Van Doorslaer and Watanabe, 2003; Hosseinpoor and others, 2006; Van de Poel and others, 2007; Chen, Eastwood and Yen, 2007), this study makes a number of contributions to the literature. First, it considers a large number of countries in the region with different development levels and from different subregions (Central America, Caribbean, Andean region). Although these countries are known to have high levels of economic inequality (De Ferranti and others, 2004), the effect of this on health —and child stunting in particular— has been less studied, particularly from a regional perspective.[1]

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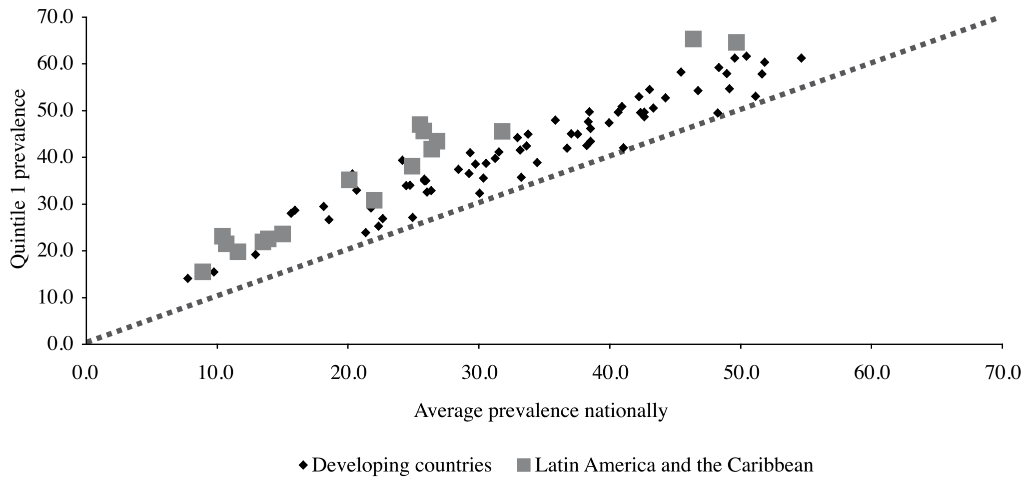
[1] We have only found three studies where socio-economic differences are compared for different groups of countries in Latin America and the Caribbean (Larrea, 2002; Larrea and Freire, 2002; Martínez, 2005). These authors use a different methodology from the present study, however.

FIGURE 1

Developing countries (49 countries, 86 observations): prevalence of child stunting in the poorest quintile, 1990-2005
(Percentages)



Source: prepared by the author on the basis of D. Gwatkin and others, *Socio-Economic Differences in Health, Nutrition, and Population within Developing Countries. An Overview*, Washington, D.C., World Bank, 2007 [online] http://go.worldbank.org/XJK7WKSE40.

Second, the new World Health Organization (WHO) reference standard is used to measure stunting (WHO, 2006). Instead of taking the United States population for comparison purposes, this new reference framework includes population groups from countries with differing degrees of development and different ethnic make-ups, such as Brazil, Ghana, India, Norway and Oman (as well as the United States). The reference population in those countries are people whose diet (chiefly in the case of newborns) and health care meets certain recommended standards. Consequently, this reference standard is broader (because it includes different populations) and at the same time more precise (because it takes specific groups within these populations) when it comes to measuring nutritional deficiencies. So far as the author is aware, this is the first study that has adopted this standard for the study of socio-economic inequality in child stunting in the region.[2]

Lastly, use is made of a simple explanatory model with variables that directly correlate to health, education and income policies. These variables are also simple to relate to models proposed for analysing the socio-economic determinants of health, like the one recommended by the recent Commission on Social Determinants of Health (WHO, 2008).

This paper is structured as follows. Section II presents the methodology used to decompose the determinants affecting stunting and its socio-economic distribution. The data sources used in this study are also described. Section III presents the results of the analyses conducted, while section IV sets forth the conclusions of the study and presents a number of policy recommendations for reducing the impact of stunting and its unequal socio-economic distribution.

[2] Paraje (2008) and ECLAC (2008) use the same methodology as this study, but child stunting is measured using the old reference standard (based only on the United States population).

II

Methodology and data source

There are a number of factors that can be related in the aggregate to stunting, whose primary cause is an inadequate intake and assimilation of nutrients. These factors could be grouped into at least four categories (Martínez and Fernández, 2006). First, there are environmental factors, such as natural phenomena (floods, earthquakes, droughts, etc.) and "entropic" ones (i.e., those caused by human action on the environment), such as environmental pollution, that can temporarily or permanently affect the ability of the families affected by them to produce food or generate income.

But even if these factors are not present or their influence is moderate, food production or income generation can be plentiful in the aggregate but inadequate at the individual level owing to the unequal distribution of entitlements.[3] Second, what are known as socio-economic and cultural factors can determine the allocation of these entitlements via the distribution of productive assets (physical and human capital) and thence income.

Third, there are production factors, including the "characteristics of production processes", "the degree to which they utilize natural resources" and "the extent to which these processes mitigate or aggravate environmental risks" (Martínez and Fernández, 2006, p. 35).

Lastly, biomedical factors include elements that can affect an individual's propensity to become malnourished, such as the mother's nutritional status (particularly during gestation and the child's early months of life), the duration of breastfeeding (a shorter period of breastfeeding tends to increase the likelihood of child stunting), the child's sex and age, congenital factors, etc.

The methodology applied in this study to approach the problem of child stunting from a quantitative perspective considers this set of factors both directly and indirectly. This methodology consists in, first, estimating a multivariate regression between the child stunting variable and a set of relevant independent variables, and then using this estimation to decompose the socio-economic inequality of stunting into the factors causing it.

Much of the literature on the subject assumes that the statistical relationship to be considered in the first step of this process is a reduced form production function for child stunting within households (Grossman, 1972), which is estimated at the country level. This function is used to consider all the factors that directly influence the average level of child stunting, along with variables which are not included directly in the estimation but whose influence on stunting is intermediated by the variables included. For example, the ethnic group to which a child belongs might be considered a decisive factor in his or her degree of stunting. If this influence arises because, for example, the ethnic group possesses genetic characteristics or unobservable factors that differentiate it from other groups and are what cause stunting, then membership or otherwise of this ethnic group ought to be treated as a relevant variable within this "child stunting production function".[4] Conversely, if this ethnic group has high levels of stunting (above the average) and it is considered that these might be caused by low incomes (below the average) or inadequate parental education, then it is these variables (income, education, etc.) that ought to be considered in the explanation rather than ethnic variables as such.

In the present study, the function it is proposed to estimate has the following linear form:

$$z_{i,t} = \beta^{0}_{t} + \Sigma\, \beta^{k}_{t}\, x^{k}_{i,t} + \Sigma\, \beta^{m}_{t}\, x^{m}_{h,t} + \varepsilon_{i,t} \qquad (1)$$

where $z_{i,t}$ is the nutritional level of individual i in country t; $x^{k}_{i,t}$ is a set of explanatory variables at the level of each individual, i; and $x^{m}_{h,t}$ is a set of explanatory variables at the level of the individual household, h. The coefficients that accompany these variables are, then, a statistical estimation of the marginal importance of each of these factors in explaining the average level of stunting.

[3] This argument is clearly set out by Drèze and Sen (1989) to explain how famines can occur even in situations where food is otherwise fairly abundant.

[4] The effect of ethnic variables on stunting was treated as irrelevant in the multicentre study by the World Health Organization (who) to determine reference standards for growth in childhood (who, 2006).

In a second stage, setting out from the estimation of this linear relationship, it is possible to use certain indicators of socio-economic inequality in the nutritional status of children and break this inequality down into its causes. The indicator chosen for this purpose is the concentration index, interpreted (and calculated) in much the same way as the well-known Gini coefficient (used to measure income inequality) and, like this, derived from a graphic tool that is easy to interpret: the concentration curve (homologous to the Lorenz curve).[5] In the case of stunting, this curve charts the cumulative nutritional status (nutritional deficiency) of children in accordance with the socio-economic position (as measured by income or wealth, for example) of their households. The concentration index is equal to twice the area between the concentration curve and the 45° line (which marks a neutral distribution of the variable under consideration).

[5] See Kakwani, Wagstaff and Van Doorslaer for a description of this index and its asymptotic properties (1997).

If the concentration curve is below the diagonal, the concentration index takes values in the range [0; 1] (indicating that the variable analysed is concentrated among households of a higher socio-economic level). If the curve is above the diagonal, the index takes values in the range [–1; 0]. The more (less) concentrated the variable is, the more (less) this index will approach the value one (as an absolute value). In the case of child stunting, the index is highly likely to be in the [–1; 0] range, indicative of concentration in poor households. Figure 2 shows the concentration curve of child stunting for Honduras (2005), with a concentration index of –0.191.

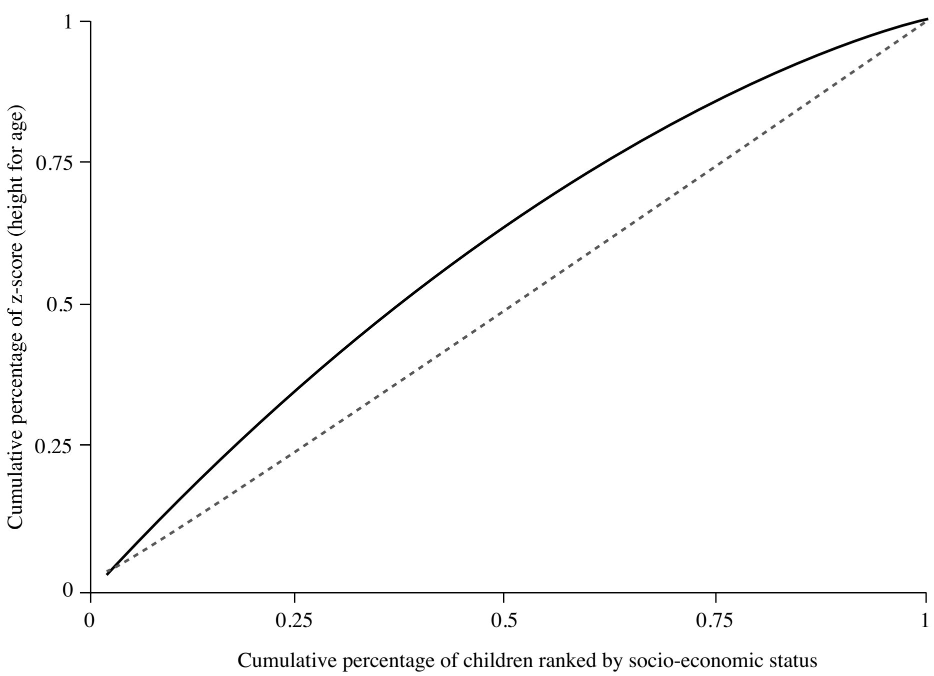
According to Wagstaff, Van Doorslaer and Watanabe (2003), if stunting can be explained by equation (1), the socio-economic inequality of that stunting, summarized in their concentration index, can be decomposed as follows:

$$CI_t^z = \sum\left(\beta_t^k \bar{x}_t^k / \bar{z}_t\right) CI_t^k + \sum\left(\beta_t^m \bar{x}_t^m / \bar{z}_t\right) CI_t^m + \left(G_\varepsilon / \bar{z}_t\right) \quad (2)$$

FIGURE 2

Honduras: concentration curve for child stunting, 2005

(Percentages)



Source: prepared by the author on the basis of demographic and health surveys (DHS).

where $CI^z{}_t$ is the stunting concentration index in country t; $CI^k{}_t$ and $CI^m{}_t$ are the concentration indices for the explanatory variables; the expressions $\left(\beta_t\,\bar{x}_t\,/\bar{z}_t\right)$ are the "elasticities" of stunting in relation to the explanatory variables; and $\left(G_\varepsilon/\bar{z}_t\right)$ is a residual term reflecting all the elements not explained by (1).[6]

Lastly, dividing both terms in (2) by $CI^z{}_t$ yields the relative influence of each variable on the socio-economic inequality of the variable explained:

$$1=\sum\left(\beta_t^k\bar{x}_t^k/\bar{z}_t\right)\left(CI_t^k/CI_t^z\right)+\sum\left(\beta_t^m\bar{x}_t^m/\bar{z}_t\right)\left(CI_t^m/CI_t^z\right)+\left[\left(G_\varepsilon/\bar{z}_t\right)/CI_t^z\right] \quad (3)$$

Equation (3) shows the contribution of each variable to total socio-economic inequality in child stunting (left-hand side of the equation), weighted by its importance as an explanatory factor in the average level of stunting.

Three elements affect this contribution. The first is the importance of this factor with respect to the average level of stunting, and it is given by the coefficient of each variable in the linear regressions reported (β coefficients). If this has a high value, the factor is going to have a greater explanatory "weight" in the inequality of stunting. The second element is the average level attained by this variable, in relation to the average level of stunting. The higher a variable's mean, the greater its relative contribution to the inequality of stunting will be. These two elements (regression coefficient and mean of the variable) serve to estimate the "elasticity" of each variable with respect to the level of stunting (and they are used to weight the influence of the socio-economic inequality of each explanatory variable on the inequality of child stunting). Lastly, the third element is the socio-economic concentration of each variable or, in other words, its index of concentration. The greater the impact of a variable on the result (i.e., the higher its elasticity in respect of stunting) and the greater its relative concentration in a specific group (such as "poor" households), the better it will explain the relative concentration of the result.

The data used to estimate equations (1), (2) and (3) are from the demographic and health surveys (DHS) compiled by Macro International Inc. and available at www.measuredhs.com, which are conducted in over 75 medium-low- and low-income countries in different regions of the world. They are nationally and subnationally representative household surveys with large sample sizes (usually between 5,000 and 30,000 households) whose main objective is to measure living conditions, health behaviour and health outcomes among women of childbearing age and children. The indicators thus compiled have the advantage of being fully comparable within countries over time and between countries. They are compiled at irregular intervals, usually every five years. The DHS used in this case are the most recent available (at the time this study was prepared) for the following countries (the survey year is given in parentheses):

1. Bolivia (2003)
2. Colombia (2005)
3. Dominican Republic (2007)
4. Haiti (2005)
5. Honduras (2005)
6. Guatemala (1999)
7. Nicaragua (2001)
8. Peru (2004)

The dependent variable to be estimated in equation (1) is a measurement often used as an indicator of children's chronic or long-term nutritional status: the standardized height-for-age coefficient or z-score. Usually, if this coefficient is more than two standard deviations below the median for the reference population, the child is considered to be stunted (i.e., to have nutritional deficiencies sustained over time with consequences for normal physical growth). Children under five (up to 59 months of age inclusive) are the population taken in all the countries except Bolivia, which has data only for children under 36 months.

This paper does not use a dichotomous variable to measure stunting or its absence, but employs the z-score itself (or more precisely its negative to facilitate interpretation of the results). Thus, it is possible to capture all information on a child's nutritional situation (nutritional status and, where stunting exists, its severity), which would not be the case if a dichotomous variable were used (all that would be measured would be the existence or otherwise of stunting in the child).

The explanatory variables of equation (1) have been selected on the basis of the theoretical and empirical evidence provided by the economic literature and the

[6] The appendix to Wagstaff, Van Doorslaer and Watanabe (2003) details how equation (2) is obtained, but it is a well-known result in the income distribution literature. The residual term can be interpreted as the concentration index of the error in regression (1), ε. A small remainder or none would thus mean that the regression error had no specific distribution in relation to the socio-economic variable used to stratify households.

information available in the source selected. This being so, the relationships estimated between child stunting and the set of explanatory variables constitute "reduced form" estimates that implicitly incorporate a number of relationships between stunting and variables that are not directly used. Relevant variables not measured by the DHS, such as culture or idiosyncratic differences between groups, are considered tangentially via the region or country or the parents' education variables. As mentioned earlier, the fact that these variables do not explicitly appear in the ratios estimated does not mean their relative importance is overlooked; rather, there is a supposition that they act indirectly by influencing other, more direct channels.

The explanatory variables used can be grouped, following Martínez and Fernández (2006), into socio-economic factors, environmental factors and biomedical factors.[7] Among the former, measured at the household level, is the "wealth" or "material well-being" index. This index is constructed using principal components analysis (a methodology described in Filmer and Pritchett, 2001), which draws upon information about households' material conditions (availability of electricity, people per room, the materials used in floors, walls and roofs, etc.) and ownership of certain assets (car, motorcycle, bicycle, television set, refrigerator, etc.). The DHS do not report on any kind of monetary variable (such as income or spending), and the "wealth" indicator is the only one that can be used to measure households' material wealth.[8] The expectation must be that the greater the value of this index (the greater the household's "wealth"), the lower the level of child stunting will be, given households' greater opportunities to ensure a stable source of nourishment for their children.[9]

Also used is the mother's formal education measured in completed years of schooling; the formal education of the husband or partner, likewise measured in completed years of schooling (where women are single or without a partner, the educational level of the household head is taken); and the mother's occupational status (skilled versus unskilled employment, the reference group being non-participants in the labour market). Educational variables, especially in the case of maternal education, must also be expected to have a negative influence on stunting, and indeed on health outcomes in general, as is shown by Armar-Klemesu and others (2000) and Harttgen and Misselhorn (2006). The channels through which this variable acts are often manifold and complex and may include good hygiene practices, a greater ability to learn best practices in childcare, better use of public or private health services, etc. (Cleland and Van Ginneken, 1998). Again, better maternal education is often a source of higher income for the household, which reinforces its positive influence. Given the possible existence of non-linear effects, the maternal education variable is also squared (as in Larrea and Kawachi, 2005). A positive (negative) coefficient for this variable would show increasing (decreasing) marginal returns on maternal education for stunting.

Where labour variables are concerned, there are at least two opposing effects that could influence the nutritional situation of children. On the one hand, having the mother working outside the home means higher incomes and thus a better socio-economic situation (and less child stunting). On the other, it means that children will have to be left in the care of other people who will not necessarily be as well qualified as the mother, affecting (negatively) their health.[10] For low-skilled occupations, this negative effect will probably exceed the positive effect referred to, with maternal employment ultimately being a cause of child stunting (all other factors being constant). Larrea and Kawachi (2005) consider these channels for the case of Ecuador and find a (non-significant) negative relationship between stunting and children not being cared for by their parents. Unfortunately, this variable is not part of the DHS and thus cannot be included in this study.

The (household-level) environmental factors considered include the area where the house is situated (urban versus rural) and the politico-geographical region. In general, the literature documents better health indicators in urban areas than rural ones, particularly where child stunting is concerned (Smith,

[7] There is no direct correspondence between the variables used in this study and those proposed by Martínez and Fernández (2006), mainly owing to the absence of data for some of them. For example, the environmental variables employed here (actually geographic variables) are meant to capture some of the causes proposed in that study.

[8] See Rutstein and Johnson (2004) and Paraje (2008) for a description of the advantages and drawbacks of this indicator.

[9] Many studies have found a close relationship between indicators of material well-being (whether the "wealth" indicator used here or household income/spending figures from other surveys) and child stunting, among them Wagstaff, Van Doorslaer and Watanabe (2003), Harttgen and Misselhorn (2006), Van de Poel and others (2007) and Chen, Eastwood and Yen (2007).

[10] It is very likely that the person left in charge of the child when the mother is out at work will have fewer occupational qualifications than her and, very probably, less education.

Ruel and Ndiaye, 2005). However, these differences usually conceal large disparities within these groups, caused among other things by the distribution of socio-economic characteristics such as income, education, household composition, etc. When these characteristics are taken into account the health disparities between urban and rural households disappear or greatly diminish (Van de Poel and others, 2007).

The politico-geographical region can also determine health outcomes. In countries where, for example, ethnic groups, particular economic activities or health services are geographically concentrated, the incidence of child stunting can display large regional differences (Martínez, 2005; Chen, Eastwood and Yen, 2007). For the purposes of this study, subnational regions and districts have been grouped as proposed by the DHS. A definition of these groups can be found in table A of the Annex.

Biomedical factors (for individual children) include sex (boys being the reference group), age in months at the time of the survey, age squared (to take account of non-linear relationships between this variable and child stunting), birth order (first children being the reference group) and birth weight in grams.[11] Sex is included to cover the possibility of gender bias. Generally speaking, there is little evidence of this and when such differences are encountered, they tend to show boys being more affected by stunting than girls (Marcoux, 2002; Chen, Eastwood and Yen, 2007).

Age tends to be positively related with stunting, but in a non-linear fashion: stunting increases sharply during the early months of life and later stabilizes (Valdivia, 2004; Larrea and Kawachi, 2005; Chen, Eastwood and Yen, 2007). Among children in Bolivia, Colombia, Ecuador and Peru, for example, this stabilization point occurs around the twentieth month of life (Martínez, 2005; Valdivia, 2004).

Birth order can also be related to stunting. The further down in this order children are, the more likely they are to be stunted, as they have to "compete" with their older siblings for maternal care and food, among other things (Martínez, 2005). Lastly, birth weight is closely related to morbidity in the early months of life, the ability to absorb nutrients properly, and future development in general (Jewell, Triunfo and Aguirre, 2007; Victora and others, 2008). This indicator is more direct and has a greater impact on stunting than, for example, the mother's body mass index as used by Smith, Ruel and Ndiaye (2005) and Harttgen and Misselhorn (2006), and is preferred for that reason.

Lastly, a variable measuring households' access to the health-care system is considered. Assuming the other variables are constant and there is a properly functioning health-care system that provides high-quality services at a low price, it is to be expected that access to these services will reduce child stunting. Unfortunately, there is no variable in the DHS that measures that aspect and can be theoretically linked to the problem of stunting. One of the alternatives available is to use prenatal care (with appropriate care it would be possible to detect, for example, congenital factors that might cause low birth weight, or maternal nutrition could be improved). However, this type of care would require at least four visits to trained professionals, entailing an economic cost for the mother (in time, transport, etc.) even if these did not charge for their services. The decision as to whether or not to receive proper care would thus come to depend on the relative amount of this cost and, ultimately, on the socio-economic situation of the mother. Statistically, including a variable like this one would entail a problem of endogeneity (Schultz, 1984).

To avoid this, an alternative variable was chosen: skilled attendants at birth (professional care compared to non-professional care).[12] Although this variable is not strictly related to the child's immediate nutritional outcome, it can affect it since skilled attendants at birth can reduce infant and maternal morbidity after the birth and help the mother obtain information on how best to care for the child (Smith, Ruel and Ndiaye, 2005). This variable is thus included not only because it has this consequence for stunting but, crucially, to measure the availability of (access to) basic health services (health care, vaccinations, etc.). The implicit assumption is that if the mother has access to the health system at the time she gives birth, she also has such access in less critical circumstances.

For information purposes, table 1 gives percentages for the prevalence of child stunting (stunted children

[11] A child's birth weight is a variable with many unreported values. So as not to lose this important variable, imputation was carried out using the "hot-deck" method with the child's birth size as reported by the mother (very large, larger than average, average, smaller than average, very small) and maternal education (no education, incomplete/complete primary, incomplete/complete secondary, tertiary). Because categories are used for maternal education, the resulting variable does not present problems of colinearity with maternal education in years.

[12] A birth is considered to have been attended by a professional when it has taken place in the presence of a qualified doctor, a qualified nurse or midwife, an auxiliary midwife or some other professional as defined by each country.

TABLE 1

Latin America and the Caribbean (selected countries): prevalence of stunting by determinant. 1999-2007
(Percentages)

Variable	Bolivia 2003	Colombia 2005	Dominican Republic 2007	Guatemala 2002	Haiti 2005	Honduras 2005	Nicaragua 2001	Peru 2004
National average	*30.9*	*15.6*	*9.8*	*52.5*	*27.6*	*29.3*	*24.4*	*29.9*
Region								
Region 0	34.0	16.4	7.4	32.7	19.9	18.6	8.7	8.7
Region 1	40.1	18.1	8.2	63.9	31.5	23.4	20.1	22.9
Region 2	31.3	14.5	11.5	55.4	31.6	27.5	33.6	42.2
Region 3	41.9	13.3	9.0	52.2	-	35.4	32.6	32.4
Region 4	46.6	15.8	9.0	54.6	-	47.1	-	-
Region 5	22.2	-	15.5	61.7	-	17.9	-	-
Region 6	16.6	-	8.9	74.2	-	30.0	-	-
Region 7	36.5	-	17.4	-	-	32.6	-	-
Region 8	30.2	-	12.0	-	-	53.6	-	-
Region 9	-	-	11.6	-	-	50.8	-	-
Region 10	-	-	-	-	-	55.2	-	-
Region 11	-	-	-	-	-	48.6	-	-
Region 12	-	-	-	-	-	27.9	-	-
Region 13	-	-	-	-	-	32.9	-	-
Region 14	-	-	-	-	-	23.6	-	-
Region 15	-	-	-	-	-	24.9	-	-
Area								
Rural	40.3	22.1	12.7	61.5	32.3	38.0	34.7	47.4
Urban	24.0	12.5	8.4	37.2	18.5	17.2	14.2	13.2
Wealth								
Quintile 1	46.2	25.3	16.5	72.8	37.7	49.8	41.1	57.0
Quintile 2	38.6	16.4	9.8	67.4	35.8	38.5	31.3	40.8
Quintile 3	25.2	13.5	7.2	60.2	31.5	24.9	20.5	18.7
Quintile 4	19.5	9.8	7.7	33.6	19.9	14.3	10.3	7.3
Quintile 5	12.9	4.9	4.5	12.2	6.2	7.2	5.7	6.0
Mother's education								
No education	48.6	31.6	16.2	70.8	37.9	52.6	41.3	61.1
Incomplete/complete primary	37.7	19.9	12.6	49.1	26.8	31.4	25.7	47.6
Incomplete/complete secondary	18.8	11.6	9.2	19.3	14.2	13.8	10.6	17.5
Incomplete/complete tertiary	13.8	5.7	4.7	3.3	2.6	5.4	6.6	5.5
Occupational situation of mother								
Does not work outside the home	27.3	20.1	10.3	54.8	25.9	31.9	26.8	20.2
Skilled work	28.0	6.0	6.5	41.0	9.0	21.6	13.0	10.8
Unskilled work	34.0	15.7	10.6	49.4	30.4	26.7	23.3	37.8
Partner's education								
No education	43.1	21.5	16.9	66.3	37.2	47.7	36.5	57.3
Incomplete/complete primary	40.3	19.5	12.5	57.6	32.0	30.6	27.3	47.8
Incomplete/complete secondary	22.7	11.3	8.3	22.9	16.4	15.4	27.1	24.5
Incomplete/complete tertiary	14.0	6.1	7.1	15.5	8.8	8.8	7.2	9.7
Sex								
Male	34.0	16.9	11.2	54.0	30.2	31.3	25.7	34.4
Female	27.6	14.3	8.3	50.8	25.2	27.3	23.1	25.3
Birth order								
First child	22.2	11.1	7.9	42.4	22.1	20.6	18.5	20.8
Second child	28.1	15.8	8.2	41.8	20.9	24.7	20.3	22.1
Third child	30.1	16.0	10.9	49.7	24.6	28.0	20.9	27.4
Fourth or subsequent child	38.4	23.5	14.2	63.8	35.7	40.8	34.4	48.9
Age								
Under 12 months	14.6	9.3	8.2	30.5	14.7	13.2	9.6	12.9
Between 12 and 24 months	35.2	18.5	12.7	55.2	31.6	28.9	24.5	32.9
Over 24 months	41.5	16.8	9.4	58.6	30.9	33.8	29.1	35.1
Skilled birth attendance								
Unattended	45.3	26.0	25.2	66.4	35.1	49.3	40.5	52.6
Attended	23.0	14.5	9.7	50.0	21.8	28.3	22.7	20.4

Source: prepared by the author on the basis of demographic and health surveys (DHS).

TABLE 2

Latin America and the Caribbean (selected countries): mean and standard errors of the variables used, 1999-2007

Variable	Bolivia 2003		Colombia 2005		Dominican Republic 2007		Guatemala 2002		Haiti 2005		Honduras 2005		Nicaragua 2001		Peru 2004	
	Mean	Std error[a]	Mean	Std error[a]	Mean	Std error[a]	Mean	Std error[a]	Mean	Std error[a]	Mean	Std error[a]	Mean	Std error[a]	Mean	Std error[a]
Z-score for chronic malnutrition (height for age)	1.43	0.028	1.03	0.014	0.74	0.018	2.14	0.084	1.37	0.039	1.44	0.022	1.25	0.029	1.44	0.058
Region 1	0.08	0.010	0.25	0.010	0.26	0.026	0.08	0.020	0.47	0.038	0.04	0.007	0.27	0.021	0.24	0.036
Region 2	0.19	0.017	0.18	0.010	0.12	0.012	0.09	0.024	0.19	0.025	0.04	0.006	0.35	0.024	0.43	0.040
Region 3	0.04	0.006	0.24	0.011	0.17	0.017	0.10	0.028	–	–	0.06	0.009	0.17	0.019	0.14	0.027
Region 4	0.09	0.012	0.18	0.010	0.06	0.006	0.11	0.023	–	–	0.05	0.007	–	–	–	–
Region 5	0.04	0.006	–	–	0.05	0.005	0.22	0.033	–	–	0.19	0.018	–	–	–	–
Region 6	0.24	0.020	–	–	0.09	0.009	0.11	0.022	–	–	0.05	0.008	–	–	–	–
Region 7	0.04	0.007	–	–	0.03	0.005	–	–	–	–	0.05	0.008	–	–	–	–
Region 8	0.01	0.002	–	–	0.05	0.005	–	–	–	–	0.04	0.005	–	–	–	–
Region 9			–	–	0.08	0.010	–	–	–	–	0.03	0.004	–	–	–	–
Region 10	–	–	–	–	–	–	–	–	–	–	0.05	0.006	–	–	–	–
Region 11	–	–	–	–	–	–	–	–	–	–	0.02	0.003	–	–	–	–
Region 12	–	–	–	–	–	–	–	–	–	–	0.07	0.010	–	–	–	–
Region 13	–	–	–	–	–	–	–	–	–	–	0.05	0.008	–	–	–	–
Region 14	–	–	–	–	–	–	–	–	–	–	0.02	0.003	–	–	–	–
Region 15	–	–	–	–	–	–	–	–	–	–	0.07	0.010	–	–	–	–
Urban	0.58	0.023	0.67	0.012	0.67	0.019	0.38	0.051	0.34	0.033	0.42	0.019	0.50	0.026	0.51	0.040
Wealth	1.70	0.038	2.56	0.027	2.49	0.032	0.00	0.000	1.55	0.065	1.43	0.031	0.00	0.000	1.60	0.075
Mother's education (years)	6.70	0.136	7.77	0.079	9.00	0.120	3.34	0.254	3.86	0.216	5.61	0.102	5.34	0.151	8.11	0.268
Mother's education squared	65.16	2.060	76.76	1.297	98.81	2.275	25.07	2.761	32.08	2.764	49.85	1.654	46.71	1.850	84.79	4.383
Mother: skilled work (ref. not working)	0.12	0.008	0.08	0.005	0.14	0.007	0.08	0.013	0.06	0.009	0.09	0.005	0.10	0.007	0.10	0.012
Mother: unskilled work (ref. not working)	0.51	0.013	0.77	0.007	0.30	0.010	0.20	0.019	0.61	0.019	0.33	0.008	0.27	0.010	0.61	0.023
Partner's education (years)	7.89	0.125	7.09	0.082	8.50	0.116	4.42	0.284	5.26	0.234	5.43	0.107	5.29	0.153	9.24	0.238
Child's sex: female	0.49	0.008	0.50	0.006	0.48	0.008	0.49	0.014	0.51	0.011	0.49	0.006	0.49	0.008	0.49	0.013
Second child	0.21	0.007	0.28	0.005	0.27	0.007	0.19	0.011	0.19	0.009	0.23	0.005	0.21	0.007	0.25	0.010
Third child	0.16	0.006	0.17	0.005	0.21	0.006	0.16	0.009	0.13	0.009	0.16	0.005	0.15	0.006	0.17	0.011
Fourth or subsequent child	0.38	0.010	0.18	0.006	0.19	0.009	0.42	0.021	0.40	0.018	0.33	0.008	0.32	0.011	0.27	0.018
Child's age (months)	17.94	0.159	28.93	0.200	29.64	0.260	29.08	0.339	27.82	0.379	30.28	0.189	28.94	0.237	28.42	0.408
Child's age squared	427.60	5.650	1 127.21	11.857	1 168.73	15.745	1 122.21	22.936	1 055.76	22.798	1 180.34	12.041	1 113.18	14.474	1 097.33	25.825
Birth weight (grams)	3 371.22	11.930	–	–	3 295.80	10.715	3 260.60	22.475	3 519.78	37.981	3 273.83	8.739	3 230.84	11.429	3 190.52	18.379
Skilled birth attendance	0.65	0.017	0.91	0.005	0.99	0.002	0.85	0.019	0.57	0.022	0.95	0.004	0.91	0.007	0.70	0.030
Sample size	*5 044*		*10 159*		*8 272*		*2 942*		*2 368*		*9 116*		*5 626*		*2 237*	

Source: prepared by the author on the basis of demographic and health surveys (DHS).

[a] Robust standard errors, considering the sample design.

as a percentage of the total) when the population is divided into groups on the basis of the explanatory variables proposed.

In all cases, levels of stunting are higher in rural households than in urban ones and it is not uncommon to find that they are twice (in Colombia, Haiti and Nicaragua, for example) or even four times (Peru) as high in the former as in the latter. Furthermore, the lower the "wealth" quintile a household belongs to and the less education the mother or her partner has, the greater the prevalence of stunting. The relationship between stunting and the mother's occupational situation is less clear. In some countries (for example, Colombia, the Dominican Republic, Guatemala and Nicaragua), the highest rates of stunting are found among children whose mothers are not in paid employment. However, in others (Bolivia, Haiti, Peru) the greatest prevalence is among children whose mothers are in unskilled employment.

Where biomedical variables are concerned, there is always a greater prevalence among boys than among girls and this increases down the birth order (chiefly among boys who come third or later) and with age (it is much greater among boys over one than among those under one). In all the countries, lastly, the prevalence of stunting is considerably lower among children who were delivered by professionals than among those who were not.

It should be noted that the table 1 percentages do not consider the different interactions between the variables. These will be dealt with in the multivariate analysis below.

Table 2 presents descriptive statistics (mean and robust standard errors) for all the variables used. The first line, for example, gives the mean of the z-score for stunting. After the transformation mentioned earlier (which consists in multiplying the original z-score by –1), the countries with the highest means for this indicator are those where children's average nutritional status is most deficient. Thus, countries such as Guatemala, Peru, Honduras and Bolivia present a worse average nutritional status than Colombia and the Dominican Republic.

Of the explanatory variables chosen, maternal education (one of the main determinants of child stunting, as discussed in the next section) also displays large discrepancies between the countries analysed. In the Dominican Republic, for example, the mothers in the sample have an average of nine years' schooling, while in Guatemala the figure is only 3.3 years.

III

Inequality in stunting and its causes

1. The determinants of child stunting

Table 3 summarizes the results of the linear regressions using ordinary least squares (OLS) for the eight countries considered, together with the value of their t-ratios (estimated using robust standard errors).

The model estimated has a good explanatory capacity for all the countries, with R2 ranging from 0.10 for the Dominican Republic to 0.39 for Peru.[13] Even in cases where this indicator is comparatively low, high values were obtained for the F-statistic (which measures the statistical significance of all the ratios jointly).

The ratio that goes with the material well-being indicator, the "wealth" indicator in this case, is significant and negative for all the countries.[14] Nonetheless, given the nature of this index (of ownership of assets and services), the individual significance of the ratio cannot be analysed. It is highly likely that certain of the variables composing it, such as the existence of secure sources of water and waste disposal, may have a large individual impact on child stunting, something that is also recognized in the literature (Smith, Ruel and Ndiaye, 2005).

The maternal education variable has the expected sign in all cases (greater education has a negative effect on stunting levels), although it is significant

[13] How good a model adjustment is depends on the type of model being estimated. The adjustments obtained are within the levels observed in studies similar to this one (Wagstaff, Van Doorslaer and Watanabe, 2003; Harttgen and Misselhorn, 2006; Larrea and Kawachi, 2005).

[14] This finding is consistent with what is reported, among others, by Wagstaff, Van Doorslaer and Watanabe (2003); Valdivia (2004); Smith, Ruel and Ndiaye (2005); Larrea and Kawachi (2005); Chen, Eastwood and Yen (2007).

TABLE 3

Latin America and the Caribbean (selected countries): determinants of child stunting, 1999-2007

Variable	Bolivia 2003		Colombia 2005		Dominican Republic 2007		Guatemala 2002		Haiti 2005		Honduras 2005		Nicaragua 2001		Peru 2004	
	Coefficient	T-value[a]	Coefficient	T-value[a]	Coefficient	T-value[a]	Coefficient	T-value[a]	Coefficient	T-value[a]	Coefficient	T-value[a]	Coefficient	T-value[a]	Coefficient	T-value[a]
Region 1	0.123	1.64	–0.274[b]	–5.93	–0.093	–1.27	–0.099	–0.44	0.007	0.10	0.027	0.34	0.104[b]	2.10	0.109	1.20
Region 2	–0.062	–0.97	–0.355[b]	–7.31	–0.037	–0.54	–0.155	–0.74	–0.035	–0.41	0.063	1.08	0.219[b]	3.96	0.186[c]	2.10
Region 3	0.233[b]	3.15	–0.375[b]	–7.94	0.024	0.35	–0.098	–0.44	–	–	0.137[c]	2.40	0.077	1.08	–0.034	–0.35
Region 4	0.308[b]	3.64	–0.358[b]	–7.13	0.003	0.04	0.134	0.74	–	–	0.267[b]	4.11	–	–	–	–
Region 5	–0.287[b]	–3.82	–	–	0.078	1.05	0.241	1.38	–	–	0.020	0.37	–	–	–	–
Region 6	–0.402[b]	–7.02	–	–	–0.094	–1.42	0.219	1.04	–	–	0.004	0.06	–	–	–	–
Region 7	0.059	0.65	–	–	0.056	0.64	–	–	–	–	–0.068	–0.92	–	–	–	–
Region 8	–0.092	–0.93	–	–	–	–	–	–	–	–	0.462[b]	5.46	–	–	–	–
Region 9	–	–	–	–	–	–	–	–	–	–	0.364[b]	4.78	–	–	–	–
Region 10	–	–	–	–	–	–	–	–	–	–	0.363[b]	4.66	–	–	–	–
Region 11	–	–	–	–	–	–	–	–	–	–	0.246[b]	3.11	–	–	–	–
Region 12	–	–	–	–	–	–	–	–	–	–	–0.204[b]	–2.83	–	–	–	–
Region 13	–	–	–	–	–	–	–	–	–	–	0.007	0.11	–	–	–	–
Region 14	–	–	–	–	–	–	–	–	–	–	–0.129	–1.85	–	–	–	–
Region 15	–	–	–	–	–	–	–	–	–	–	0.024	0.36	–	–	–	–
Urban	0.102	1.61	0.003	0.08	0.024	0.63	0.099	0.92	0.094	1.14	0.063	1.64	0.006	0.11	0.077	1.04
Wealth	–0.219[b]	–6.22	–0.154[b]	–8.30	–0.145[b]	–6.33	–5 0013.430[b]	–9.10	–0.238[b]	–4.85	–0.315[b]	–12.14	–22 785.180[b]	–7.71	–0.346[b]	–8.00
Mother's education	–0.055[b]	–3.74	–0.033[b]	–2.92	–0.014	–1.15	–0.074[b]	–3.62	–0.020	–1.00	–0.079[b]	–8.38	–0.050[b]	–3.94	–0.034	–1.28
Mother's education squared	0.002[c]	2.43	0.001	1.09	0.000	0.55	0.002	1.39	0.001	0.41	0.003[b]	5.40	0.001	1.65	–0.000	–0.04
Mother: skilled work (ref. not working)	–0.005	–0.08	–0.164[b]	–2.75	0.041	0.90	0.277	1.88	0.045	0.35	0.001	0.01	–0.032	–0.55	0.122	1.12
Mother: unskilled work (ref. not working)	0.042	1.06	–0.075[c]	–2.25	0.030	0.90	0.075	0.89	–0.011	–0.17	0.014	0.51	–0.013	–0.35	0.170[b]	2.81
Partner's education	–0.013[c]	–2.21	–0.009[b]	–2.62	–0.005	–1.09	–0.017	–1.55	–0.017	–1.42	–0.011[b]	–2.75	–0.007	–1.34	–0.007	–0.77
Child's sex: female	–0.170[b]	–4.46	–0.092[b]	–4.32	–0.114[b]	–4.52	–0.164[b]	–3.41	–0.198[b]	–3.21	–0.124[b]	–5.36	–0.103[b]	–3.25	–0.194[b]	–4.15
Second child	0.040	0.73	0.095[b]	3.60	0.101[b]	2.74	0.044	0.72	–0.071	–0.85	0.108[b]	3.90	0.046	1.31	–0.004	–0.08
Third child	0.038	0.72	0.087[b]	2.62	0.110[b]	2.64	0.139	1.72	–0.148	–1.81	0.135[b]	3.59	0.062	1.42	0.029	0.39
Fourth or subsequent child	0.030	0.60	0.178[b]	4.72	0.182[b]	3.83	0.175[c]	2.40	0.071	0.85	0.152[b]	4.68	0.152[b]	3.89	0.206[b]	2.98
Age in months	0.094[b]	14.42	0.035[b]	13.69	0.013[b]	4.13	0.088[b]	14.19	0.050[b]	6.76	0.056[b]	18.49	0.054[b]	14.80	0.054[b]	8.99
Age in months squared	–0.002[b]	–8.95	–0.000[b]	–11.94	–0.000[b]	–4.07	–0.001[b]	–13.60	–0.001[b]	–6.09	–0.001[b]	–15.38	–0.001[b]	–11.39	–0.001[b]	–7.87
Birth weight (grams)	–0.000[b]	–7.00	–	–	–0.000[b]	–11.17	–0.000[b]	–5.35	–0.000[c]	–3.29	–0.000[b]	–12.02	–0.000[b]	–9.47	–0.000[b]	–8.60
Skilled birth attendance	–0.150[b]	–3.38	–0.002	–0.05	–0.227	–1.76	0.106	1.28	–0.179[b]	–2.82	–0.106	–1.89	–0.051	–0.72	–0.125	–1.51
Constant	2.036[b]	13.81	1.565[b]	17.78	2.249[b]	12.72	2.585[b]	8.58	1.676[b]	10.63	2.106[b]	19.64	1.769[b]	12.79	2.601[b]	11.67
R-squared	*0.293*		*0.130*		*0.100*		*0.364*		*0.137*		*0.295*		*0.250*		*0.393*	
F-test	*67.39*[b]		*48.73*[b]		*16.74*[b]		*64.78*[b]		*18.04*[b]		*88.41*[b]		*67.39*[b]		*40.75*[b]	
Number of observations	*5 044*		*10 159*		*8 272*		*2 942*		*2 368*		*9 116*		*5 626*		*2 237*	

Source: prepared by the author on the basis of demographic and health surveys (DHS).

[a] Calculated using robust standard errors.
[b] Different from zero with a 99% significance level.
[c] Different from zero with a 95% significance level.

[a], [b] and [c]: The dependent variable is the negative of the height-for-age ratio for children under 60 months (except in Bolivia, where it is for children under 36 months).

only in the cases of Bolivia, Colombia, Guatemala, Honduras and Nicaragua. This fact that this ratio is not significant in the Dominican Republic, for example, is unsurprising given the high average level and low variability of this variable (see table 2). In the case of Haiti, for example, average levels of schooling are very low, but so is variability: just over 35% of mothers have no formal education, while the next 40% are divided practically equally by year of schooling (i.e., just over 6% of the sample of mothers have attained each year of schooling). This means that much of the population (just over 75%) is very poorly educated and the distribution of this variable is compressed, which reduces its explanatory power.

The coefficient that goes with maternal education squared shows decreasing marginal returns on education for child stunting, which would appear to indicate that, at least where stunting is concerned, money would be better spent increasing primary enrolment than secondary enrolment.[15] In all cases, furthermore, the coefficient associated with maternal education is higher than the one associated with the partner's education (which is only significant in Bolivia, Colombia and Honduras).

The child's age and age squared are also highly significant and present the expected signs in all cases. The incidence of stunting increases with age, although with a slowing rate of increase.[16] Again, stunting tends to affect boys more than girls and this effect is significant in most cases (such as Marcoux, 2002). At the same time, birth order does not seem to be important (except in the cases of Colombia, Honduras and the Dominican Republic), unless we take high birth order numbers (fourth child onward), whereupon the coefficients become positive and significant (except in Bolivia and Haiti).

The level of stunting does not seem to differ between urban and rural areas when controlled for the remaining independent variables, as in Smith, Ruel and Ndiaye (2005) and Van de Poel and others (2007). This does not mean it may not be more frequent in a specific geographical area (table 1 shows that it is in fact more common in rural areas) but that its greater or lesser frequency is due to the concomitant existence of other characteristics, such as the greater or lesser level of "wealth" and maternal education in these areas. In other words, the dispersal observed in stunting levels is not explained in most countries by differences between geographical areas, but by variables reflecting differences within them.

The limited influence of this variable probably owes something to regional fixed effects as well, although these are not significant in all cases and are only important in a few countries. In Bolivia, for example, stunting levels were significantly higher in Oruro and Potosí than in La Paz, when controlled for the other variables. In Colombia, all regions had lower average levels of stunting than the Bogotá area (controlling for the other variables). In Peru, stunting levels were higher in the Sierra than in the Lima region. It is likely that unconsidered variables such as "culture" or idiosyncratic factors more generally are acting through regional variables in some countries that present large cultural/ethnic differences between the Andean region and the other regions (such as Bolivia and Peru).

Lastly, the coefficient associated with the health system access variable (skilled attendants at birth) is only significant in two cases (Bolivia and Haiti).[17] It is no coincidence that these are the countries with the least access to this service in the sample considered. Whereas in Bolivia and Haiti just 65% and 57%, respectively, of births are attended by a professional, coverage is over 90% in countries such as Colombia, the Dominican Republic, Honduras and Nicaragua. With these levels of coverage, amounting practically to universal access to this service, this variable ceases to be relevant as an explanation for the average level of stunting in most cases.

2. Causes of inequality in stunting

As was mentioned in section I, a key aspect of the situation with stunting at the present time (and in future since, as explained earlier, the problem can persist strongly into the long term) is its socio-economic distribution and the causes of this. To design policies, then, it is essential to understand how certain determinants of stunting affect its distribution.

Table 4 shows the elasticities, as defined in equation (2), and the concentration indices (CIs) of

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[15] This finding is the opposite of the one reported by Larrea and Kawachi (2005) for Ecuador, although consistent with most of the literature consulted.

[16] This finding is consistent with the one found by Valdivia (2004), Larrea and Kawachi (2005) and Harttgen and Misselhorn (2006), although not with that of Wagstaff, Van Doorslaer and Watanabe (2003).

[17] Harttgen and Misselhorn (2006) find that health infrastructure access variables are of relatively low importance in explaining child stunting (although not child mortality).

TABLE 4

Latin America and the Caribbean (selected countries): relevant elasticities and concentration indices, 1999-2007

Variable	Elasticities								Concentration indices							
	Bolivia 2003	Colombia 2005	Dominican Republc 2007	Guatemala 2002	Haiti 2005	Honduras 2005	Nicaragua 2001	Peru 2004	Bolivia 2003	Colombia 2005	Dominican Republc 2007	Guatemala 2002	Haiti 2005	Honduras 2005	Nicaragua 2001	Peru 2004
Region 1	0.007	–0.065	–0.032	–0.004	0.002	0.001	0.022	0.018	–0.338	–0.195	0.117	–0.484	–0.160	0.238	0.132	0.141
Region 2	–0.008	–0.064	–0.006	–0.007	–0.005	0.002	0.061	0.056	0.052	–0.035	–0.139	–0.294	–0.265	0.050	–0.217	–0.198
Region 3	0.007	–0.087	0.005	–0.004	–	0.006	0.010	–0.003	–0.008	–0.031	0.114	–0.177	–	–0.154	–0.416	–0.304
Region 4	0.020	–0.063	0.000	0.007	–	0.009	–	–	–0.217	–0.010	–0.125	0.128	–	–0.285	–	–
Region 5	–0.008	–	0.005	0.025	–	0.003	–	–	0.251	–	–0.392	–0.087	–	0.454	–	–
Region 6	–0.068	–	–0.012	0.012	–	0.000	–	–	0.177	–	–0.075	–0.441	–	–0.215	–	–
Region 7	0.002	–	0.002	–	–	–0.002	–	–	–0.222	–	–0.541	–	–	–0.292	–	–
Region 8	–0.000	–	0.001	–	–	0.012	–	–	–0.207	–	–0.138	–	–	–0.477	–	–
Region 9	–	–	0.008	–	–	0.007	–	–	–	–	–0.034	–	–	–0.437	–	–
Region 10	–	–	–	–	–	0.012	–	–	–	–	–	–	–	–0.618	–	–
Region 11	–	–	–	–	–	0.003	–	–	–	–	–	–	–	–0.323	–	–
Region 12	–	–	–	–	–	–0.010	–	–	–	–	–	–	–	–0.340	–	–
Region 13	–	–	–	–	–	0.000	–	–	–	–	–	–	–	–0.171	–	–
Region 14	–	–	–	–	–	–0.002	–	–	–	–	–	–	–	–0.173	–	–
Region 15	–	–	–	–	–	0.001	–	–	–	–	–	–	–	0.113	–	–
Urban	0.041	0.002	0.022	0.017	0.023	0.018	0.002	0.027	0.367	0.279	0.174	0.424	0.520	0.469	0.420	0.428
Wealth	–0.261	–0.382	–0.490	–0.381	–0.269	–0.312	–0.319	–0.384	0.330	0.235	0.208	0.359	0.344	0.377	0.327	0.364
Mother's education	–0.258	–0.250	–0.169	–0.116	–0.057	–0.307	–0.214	–0.194	0.237	0.177	0.157	0.406	0.377	0.270	0.318	0.214
Mother's education squared	0.102	0.056	0.045	0.027	0.013	0.099	0.050	–0.004	0.378	0.287	0.250	0.572	0.519	0.456	0.448	0.346
Mother: skilled work (ref. not working)	–0.000	–0.013	0.008	0.011	0.002	0.000	–0.003	0.009	0.238	0.440	0.312	0.316	0.532	0.275	0.385	0.496
Mother: unskilled work (ref. not working)	0.015	–0.056	0.012	0.007	–0.005	0.003	–0.003	0.072	–0.047	0.006	0.014	0.246	–0.102	0.134	0.122	–0.132
Partner's education	–0.071	–0.061	–0.054	–0.035	–0.066	–0.040	–0.029	–0.043	0.184	0.186	0.154	0.340	0.290	0.274	0.329	0.155
Child's sex: female	–0.059	–0.044	–0.073	–0.038	–0.074	–0.042	–0.040	–0.066	–0.005	0.002	0.008	–0.029	–0.006	0.011	–0.004	0.011
Second child	0.006	0.026	0.038	0.004	–0.010	0.017	0.008	–0.001	0.127	0.076	0.090	0.158	0.150	0.139	0.115	0.086
Third child	0.004	0.014	0.031	0.010	–0.014	0.015	0.007	0.003	0.004	–0.007	–0.037	0.091	0.039	0.045	0.055	0.062
Fourth or subsequent child	0.008	0.032	0.047	0.035	0.021	0.035	0.039	0.039	–0.216	–0.353	–0.274	–0.202	–0.237	–0.244	–0.245	–0.322
Age in months	1.181	0.979	0.508	1.194	1.007	1.173	1.254	1.067	–0.003	0.006	0.011	0.006	0.009	0.002	–0.011	–0.010
Age in months squared	–0.469	–0.538	–0.328	–0.661	–0.547	–0.591	–0.608	–0.576	–0.006	0.007	0.015	0.009	0.011	0.004	–0.014	–0.020
Birth weight (grams)	–0.548	–	–1.312	–0.352	–0.171	–0.501	–0.615	–0.769	0.003	–	0.003	0.001	–0.023	0.012	0.011	0.015
Skilled birth attendance	–0.068	–0.002	–0.304	0.042	–0.074	–0.070	–0.037	–0.061	0.223	0.066	0.007	0.090	0.178	0.025	0.052	0.215
Total									*–0.148*	*–0.126*	*–0.142*	*–0.168*	*–0.126*	*–0.191*	*–0.196*	*–0.231*

Source: prepared by the author on the basis of demographic and health surveys (DHS).

child stunting and its explanatory variables, all with the expected sign. Those variables that are mainly found in households with a better socio-economic situation, such as "wealth", education, residence in urban areas and access to the health system, have positive CIs. Those that are mainly concentrated among households with a worse socio-economic situation, such as stunting itself or a position well down the birth order (fourth or subsequent), have a negative CI. Other variables that do not have an established pattern of socio-economic concentration, such as the child's sex or age, may have CIs that are positive or negative but in any event are close to zero, thereby showing that there is no clear pattern of socio-economic concentration.

In addition, the CIs of child stunting, which are broken down as per equations (2) and (3), show different situations in the group of countries analysed. Colombia and Haiti, for example, are the countries that have CIs closest to zero, and thus have the lowest level of socio-economic inequality where stunting is concerned. This does not imply that their situations are similar, however, since while the national prevalence of stunting in the former is 15.6% (i.e., 15.6% of children under 60 months present some degree of stunting), the figure in Haiti is 27.6%. Thus, the lower national prevalence combined with the relatively low degree of socio-economic inequality in the distribution of stunting make the situation of Colombia "preferable" to that of Haiti.

At the other extreme are Guatemala, Nicaragua and Peru, with CIs of –0.191, –0.196 and –0.231, respectively, for child stunting. In the particular case of Guatemala, the country's relatively high CI is also associated with greater national prevalence for the whole sample, indicating the existence of a pattern of "mass deprivation" with a high concentration in the households with the worst material living conditions.

Table 5 presents a decomposition of the CI for stunting by cause, as per equation (3).

In all cases, "wealth" is by far the most important variable in explaining socio-economic inequality in child stunting. The marginal contribution of this variable (all other factors being constant) ranges from 53% in Nicaragua to 81% in Guatemala. Even in countries with a relatively low prevalence of stunting, such as the Dominican Republic, the marginal contribution of "wealth" exceeds 71%. This means that, in the case of the Dominican Republic, if disparities in the distribution of "wealth" disappeared (all other factors being constant), inequality in child stunting would fall by 71%.

This large marginal contribution is explained by the high "wealth" elasticities of stunting (see table 4) and, above all, by the high concentration of "wealth" (as the respective CIs in table 4 show). There is an abundant literature showing that the region's countries have high levels of socio-economic inequality (De Ferranti and others, 2004), but the finding that this high inequality has such a large impact on a health problem like child stunting is a new one. Accordingly, reducing stunting (by reducing its socio-economic inequality) means not only adopting appropriate health policies (for example, to quickly detect cases of child stunting and put corrective mechanisms in place) but addressing basic material inequalities that are factors in stunting, in addition to such health policies. The range of policies that ought to be applicable to this problem thus extends well beyond health policies to encompass, for example, housing, employment, income and macroeconomic policies that set out to provide poorer households with a stable economic environment.

Educational variables (mother's and partner's education) are the next-greatest contributors to inequalities in child stunting, with the education of the mother being the variable with the greatest marginal impact. As was mentioned in the previous section, the more highly educated the mother is (in years of schooling), the lower the prevalence of child stunting tends to be. Because education is relatively concentrated among the "wealthiest" households (their CI is strongly positive in all cases), this contributes positively to explaining inequality in stunting. But this pro-inequality effect of education is offset by the existence of another, non-linear relationship between maternal education and stunting: the effect of this variable on stunting tends to disappear as years of schooling rise (and they do rise in more prosperous households), so that the final outcome of this variable is less than the effect that would be found if only years of maternal education were considered. The final result (considering both effects) ranges from 10% in the Dominican Republic to 23% in Colombia and Nicaragua.[18]

As might be expected, biomedical variables (sex, age, birth order, birth weight) are not very important when it comes to explaining inequality in child stunting,

[18] This would mean that, in the case of Nicaragua for example, if all mothers had had the same level of education (the national average), inequality in stunting would have been 23% lower than the actual figure, other things being equal.

TABLE 5

Latin America and the Caribbean (selected countries): determinants of inequality in child stunting, 1999-2007
(Percentages)

Variable	Bolivia 2003	Colombia 2005	Dominican Republic 2007	Guatemala 2002	Haiti 2005	Honduras 2005	Nicaragua 2001	Peru 2004
Region 1	1.51	–10.13	2.67	–1.09	0.30	–0.10	–1.50	–1.11
Region 2	0.29	–1.75	–0.58	–1.16	–1.04	–0.04	6.73	4.74
Region 3	0.04	–2.13	–0.44	–0.47	–	0.48	2.20	–0.45
Region 4	2.96	–0.51	0.02	–0.51	–	1.36	–	–
Region 5	1.39	–	1.33	1.28	–	–0.61	–	–
Region 6	8.13	–	–0.62	3.04	–	0.02	–	–
Region 7	0.25	–	0.84	–	–	–0.37	–	–
Region 8	–0.06	–	0.09	–	–	3.04	–	–
Region 9		–	0.20	–	–	1.66	–	–
Region 10		–	–	–	–	3.82	–	–
Region 11		–	–	–	–	0.54	–	–
Region 12		–	–	–	–	–1.79	–	–
Region 13		–	–	–	–	0.02	–	–
Region 14		–	–	–	–	–0.18	–	–
Region 15		–	–	–	–	–0.07	–	–
Urban	–10.24	–0.40	–2.63	–4.39	–9.60	–4.51	–0.50	–5.07
Wealth	58.27	71.31	71.41	81.80	73.62	61.59	53.22	60.39
Mother's education	41.33	35.32	18.65	28.21	17.09	43.43	34.75	17.95
Mother's education squared	–25.91	–12.73	–7.95	–9.35	–5.33	–23.67	–11.36	0.53
Mother: skilled work (ref. not working)	0.07	4.53	–1.76	–2.03	–0.79	–0.01	0.52	–1.88
Mother: unskilled work (ref. not working)	0.48	0.29	–0.12	–1.01	–0.41	–0.23	0.17	4.13
Partner's education	8.86	8.99	5.85	7.14	15.20	5.70	4.83	2.88
Child's sex: female	–0.21	0.05	0.41	–0.66	–0.35	0.24	–0.08	0.30
Second child	–0.51	–1.58	–2.38	–0.38	1.21	–1.26	–0.46	0.03
Third child	–0.01	0.08	0.83	–0.55	0.45	–0.35	–0.21	–0.09
Fourth or subsequent child	1.18	8.88	9.06	4.18	3.89	4.43	4.92	5.45
Age in months	2.17	–4.86	–3.87	–4.30	–6.85	–0.97	6.81	4.72
Age in months squared	–1.98	2.86	3.45	3.42	4.74	1.27	–4.21	–4.86
Birth weight (grams)	1.15	–	2.68	0.29	–3.06	3.05	3.35	5.13
Skilled birth attendance	10.27	0.10	1.48	–2.25	10.49	0.92	0.97	5.68
Total explained decomposition	*99.41*	*98.30*	*98.63*	*101.23*	*99.55*	*97.42*	*100.16*	*98.45*
Residual	*0.59*	*1.70*	*1.37*	*–1.23*	*0.45*	*2.58*	*–0.16*	*1.55*
Total	*100.00*	*100.00*	*100.00*	*100.00*	*100.00*	*100.00*	*100.00*	*100.00*

Source: prepared by the author on the basis of demographic and health surveys (DHS).

although some of them are relevant to its level. Children's sex, for example, does not have a set pattern of socio-economic distribution (for example, girls are no more or less common in "poor" households than in "wealthy" ones), so that in this context they have no explanatory power. The remaining variables have a small effect taken separately (birth order variables are the ones with the greatest explanatory power, especially in the case of children who are well down it), but taken together they never account for more than 10% of inequality in stunting levels.

Regional and geographic variables do not have a set general pattern either, but depend on the country. Whereas in the Dominican Republic, Guatemala and Honduras neither regional variables nor area (urban/rural) make any significant contribution to explaining inequality in the distribution of stunting (stunted children are not found to be concentrated in any specific region or area, for example, if the other variables are left unchanged), in countries such as Colombia their contribution is considerable. For example, region 1 (Atlantic) has a substantially lower level of stunting than the reference region (Bogotá) and contains a large proportion of poor households. The combined effect of these two factors is that their contribution to inequality in stunting is negative (i.e., other things being equal, the lower level of stunting in the Atlantic region would translate into less inequality in stunting nationally). In Bolivia, meanwhile, urban households have better material conditions than rural ones (the area CI for Bolivia is strongly positive and shows that urban households are concentrated in the "wealthier" households category), although children from those households have worse nutritional indicators than the average (when the other explanatory variables remain constant). This means that the effect of this variable on inequality in child stunting is also negative (10%).

Lastly, the behaviour of the health system access variable (skilled attendants at birth) differs between countries. In those where coverage is relatively low (Bolivia, Haiti and Peru, for example, where only 65%, 57% and 70% of births, respectively, are attended by health-care professionals), the contribution of this factor to explaining inequality in stunting levels ranges from 6% to 10%. Again, in those countries such as Colombia and the Dominican Republic where a large proportion of births are attended by professionals (and health system access is high generally), the effect is naturally small since socio-economic inequalities tend to disappear in the distribution, which also removes the explanatory effect on average stunting levels by eliminating the variance of the variable. Nonetheless, the fact that the great majority of the population in these countries does have access to skilled attention during childbirth, for example, does not mean there are not still socio-economic differences in the quality of the service they receive. Unfortunately, there are no instruments in the DHS to incorporate this aspect.

IV

Conclusions

There are many causes determining the level of child stunting in a country, and these causes are usually interrelated in complex ways. Geographic or area variables may seem important when it comes to explaining the level and inequality of stunting, but once they are considered as part of broad models with additional explanatory factors, their relative importance diminishes. This study shows what variables are the most important when it comes to explaining the average level of stunting and its socio-economic distribution. In the countries studied, where socio-economic inequalities are important, stunting can only be permanently reduced by attacking the socio-economic factors underlying it. Accordingly, the public policies needed to reduce the incidence of this problem have to be wide-ranging: while stunting is a health problem, with major economic consequences, policies to reduce it need to deal not only with health but also with income, education, housing and other things.

Of all these socio-economic factors, "wealth" (as measured in the DHS) makes the greatest contribution to explaining inequalities in child stunting. The "wealth" indicator used does not measure family income/expenditure but living conditions in the home, asset ownership and services available. Thus, improved distribution of "wealth" (which has been shown here to have a substantial effect on the distribution and level of stunting) does not necessarily mean taking resources away from one group to give to another but, for example, improving access to drinking water and adequate sanitation for households that lack it. Naturally, policies of this type can have a potentially redistributive effect depending on the progressiveness of the tax structure.

The educational level of the parents, and particularly the mother, is another variable that decisively influences the level and distribution of stunting. For improvements in education to have their full effect on stunting, however, they must mainly benefit the "poorest" households and focus on the basic education level. Countries such as Bolivia, Guatemala, Haiti, Honduras and Nicaragua are still far from achieving universal primary schooling (although some have made progress towards this) and have a long way to go; further advances will surely bring an improvement in indicators like child stunting. Similarly, policies to improve women's position in the labour market, involving for example the provision of childcare for mothers working outside the home, may also have a positive effect on child stunting, and the more that policies are focused on mothers in poor or low-income households, the greater this effect will be.

Geographical, cultural, ethnic and idiosyncratic factors play some explanatory role, but this apparently derives from their relationship with the distribution of socio-economic variables, mainly "wealth" and maternal education. This does not mean they are unimportant when it comes to designing sectoral policies, or that public policies should overlook them. What this means is that public policies to reduce child stunting should be designed on the basis not of households' location but of their socio-economic characteristics (material well-being, education of the mother and her partner, etc.). Only by reducing these inequalities can the region's countries aspire to leave child stunting and its dreadful consequences behind them.

(Original: Spanish)

APPENDIX

TABLE A

Latin America and the Caribbean (selected countries): regional grouping of departments or provinces

Country	Region	Department/Province
Bolivia		
	La Paz (Region 0)	
	Chuquisaca (Region 1)	
	Cochabamba (Region 2)	
	Oruro (Region 3)	
	Potosí (Region 4)	
	Tarija (Region 5)	
	Santa Cruz (Region 6)	
	Beni (Region 7)	
	Pando (Region 8)	
Colombia		
	Bogotá (Region 0)	
	Atlantic (Region 1)	
	Eastern (Region 2)	
	Central (Region 3)	
	Pacific (Region 4)	
Dominican Republic		
	National District (Region 0)	
	0 (Region 1)	
		Santo Domingo
		Monte Plata
	I (Region 2)	
		Azua
		Peravia
		San Cristóbal
		San José de Ocoa
	II (Region 3)	
		Espaillat
		Puerto Plata
		Santiago
	III (Region 4)	
		Duarte
		Hermanas Mirabal
		María Trinidad Sánchez
		Samaná
	IV (Region 5)	
		Bahoruco
		Barahona
		Independencia
		Pedernales
	V (Region 6)	
		El Seibo
		La Altagracia
		La Romana
		Hato Mayor
		San Pedro de Macorís

(continues overleaf)

(continued)

Country	Region	Department/Province
	VI (Region 7)	
		Elías Piña
		San Juan
	VII (Region 8)	
		Dajabón
		Monte Cristi
		Santiago Rodríguez
		Valverde
	VIII (Region 9)	
		La Vega
		Monseñor Nouel
		Sánchez Ramírez
Guatemala		
	Metropolitan (Region 0)	
	North (Region 1)	
	North-East (Region 2)	
	South-East (Region 3)	
	Central (Region 4)	
	South-West (Region 5)	
	North-West (Region 6)	
Haiti		
	Metropolitan Area (Region 0)	
	North (Region 1)	
		North
		North-East
		Antibonite
		Centre
		North-West
	South (Region 2)	
		South
		South-East
		Grande-Anse
Honduras		
	Francisco Morazán (Region 0)	
	Atlantic (Region 1)	
	Colón (Region 2)	
	Comayagua (Region 3)	
	Copán (Region 4)	
	Cortés (Region 5)	
	Choluteca (Region 6)	
	El Paraíso (Region 7)	
	Intibucá (Region 8)	
	La Paz (Region 9)	
	Lempira (Region 10)	
	Ocotepeque (Region 11)	
	Olancho (Region 12)	
	Santa Bárbara (Region 13)	
	Valle (Region 14)	
	Yoro (Region 15)	
Nicaragua		
	Managua (Region 0)	
	Pacific (Region 1)	
		Chinandega
		León
		Masaya
		Granada
		Carazo
		Rivas

(continues overleaf)

(continued)

Country	Region	Department/Province
	North Central (Region 2)	
		Boaco
		Chontales
		Jinotega
		Matagalpa
		Estelí
		Madriz
		Nueva Segovia
	Atlantic (Region 3)	
		Río San Juan
		Northern Atlantic Region (RAAN)
		Southern Atlantic Region (RAAS)
Peru		
	Lima (Region 0)	
	Costa (Region 1)	
		Callao
		Ica
		La Libertad
		Lambayeque
		Moquegua
		Piura
		Tacna
		Tumbes
	Sierra (Region 2)	
		Ancash
		Apurimac
		Arequipa
		Ayacucho
		Cajamarca
		Cusco
		Huncavelica
		Huanuco
		Junín
		Pasco
		Puno
	Selva (Region 3)	
		Amazonas
		Loreto
		Madre de Dios
		San Martín
		Ucayali

Source: prepared by the author on the basis of demographic and health surveys (DHS).

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