Social inequality and children's growth in Guatemala[*]

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Abstract

This paper is an investigation of the effects of social inequality in Guatemala on children's health and nutritional status as measured by attained height. Guatemala remains a highly stratified and poor society. We examine the association of land distribution, land tenure, occupation, and other aspects of family social and economic status with children's height between the ages of three months and 36 months, using data from a cross-sectional survey. An important consequence of the poverty and poor living conditions of the majority of the Guatemalan population is substantial deficits in children's growth. Our results suggest that children's growth is affected by ethnicity, their father's occupation, land distribution in the area where they live, and maternal education. Substantial growth deficits are observed among children living at altitudes above 1500 metres; we hypothesize that this is because, in Guatemala, higher altitude is associated with land scarcity, poorer agricultural conditions, and greater remoteness from transport networks and other public services.

During the past thirty years, research on variations in early childhood growth and on the effects of experimental nutritional supplementation has shown that inadequate growth in young children in poor countries is generally the consequence of infectious disease and of low nutrient intake, especially inadequate energy and protein intake, relative to nutritional requirements (Martorell and Habicht 1986; Lutter et al. 1990). These studies also indicate that genetic variation among racial and ethnic groups plays a relatively minor role in early childhood growth patterns compared with factors related to diet and infection such as social class and economic status (Habicht et al. 1974; Martorell and Habicht 1986). Ethnic differentiation in growth potential appears to be more important during adolescence (Martorell and Habicht 1986), although poverty probably has a substantial effect in poor countries during this period of life as well. Within a particular ethnic and socio-economic group, children's growth is affected by the genetic endowment they receive from their parents, as well as by the other factors mentioned above (Mueller 1986).

The prevalence of inadequate growth in young children in poor countries is a major public policy concern[1] for at least three reasons. First, children's growth patterns are a highly

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[1] Growth retardation among children through the physiological effects of living at high altitudes, generally ascribed to hypoxia, is much less of a public health concern. Healthy children born at high altitudes are shorter than those born at lower altitudes (Beall et al. 1977; Haas et al. 1982). However, the

accurate indicator of children's physical health status (Tanner 1986). For example, young children suffering from growth retardation have a much higher risk of mortality than others (Pelletier 1991; Pelletier, Frongillo and Habicht 1993), because of malnutrition and greater incidence and duration of infection. Secondly, nutritional deprivation in childhood, which is reflected in poorer growth, is associated with poorer mental development and learning ability (Balderston et al. 1981; Cravioto and Arrieta 1986; Pollitt 1990); this association may be due to the impairment of the structural and biochemical development of the brain (Bal‡zs et al. 1986; Cravioto and Arrieta 1986). The greater lethargy and lack of responsiveness often experienced by malnourished children also appears to affect cognitive development by reducing the amount of stimulation that malnourished children receive and initiate (Cravioto and Arrieta 1986). While Bal‡zs et al. (1986) note that most impairments of brain development associated with nutritional deprivation appear to be reversible by subsequent nutritional rehabilitation, even at relatively late stages of development, disruptions in cognitive development due to early malnutrition may be more difficult to compensate for in later childhood.

Thirdly, poorer growth in childhood is associated with smaller adult body size (Martorell and Habicht, 1986), which is thought to impair physical work capacity and productivity in adulthood (Spurr 1983, 1990; Martorell, 1993). This is a particularly important concern in populations which depend on physical labour to earn income. Small adolescent and adult body size may also be detrimental for the health of women during pregnancy and childbirth.

This paper is an investigation of the effects of social inequality in Guatemala on children's health and nutritional status as measured by attained height. Guatemala remains a highly stratified society. The distribution of income is extremely uneven and is thought to have worsened during the 1980s; for example, Steele (1993) reports that 66 per cent of the population was below the poverty line in 1989 and 38 per cent was classified as extremely poor.[2] Despite major social and economic changes in both urban and rural areas during the past two decades, access to agricultural land remains an important determinant of poverty in rural areas where the majority (70%) of Guatemalans still live (MSPAS and INCAP 1989: 2). Much of the agricultural land is owned by relatively few wealthy landowners and most farmers or agricultural workers depend on small plots.

In our analysis, we examine the association of land distribution, land tenure, occupation, and other aspects of family social and economic status with children's growth between the ages of three months and 36 months, using data from a cross-sectional survey. We hypothesize that the major growth deficits observed among Guatemalan children are the consequence of widespread poverty, and in rural areas, highly inequitable distribution of land. We also hypothesize, in line with previous work by Thomas, Strauss and Henriques (1991), Thomas and Strauss (1992), and Ruel et al. (1992) that parental education, particularly education of the mother, can compensate to some extent for the detrimental consequences of poverty.

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contribution of hypoxia to growth retardation as compared with poor dietary intake and disease is minor in developing countries.

[2] The poverty line was defined as $60 per person per month in 1985 purchasing power parity (PPP) US dollars, while extreme poverty is $30 PPP per person per month. Of the indigenous population, 87 per cent was below the poverty line and 61 per cent classified as extremely poor.

Previous research on children's growth in Guatemala

Over the past three decades, Guatemala has been the site of several major studies of children's growth patterns and their determinants.[3] These earlier analyses demonstrated that infectious disease often plays a major role along with dietary intake in causing poor growth, that nutritional supplementation of both mother and child can increase growth substantially, that ethnic differences in early childhood growth are mostly attributable to ethnic differences in socio-economic status, and that early growth affects adult physical work capacity.

The analysis presented here differs from and complements earlier work in two ways. First, although earlier studies often benefited from longitudinal observations, they were based on socially and geographically circumscribed, and generally small, populations. By contrast, while our data are cross-sectional, they are based on a large national sample of the Guatemalan population. Thus, we are able to evaluate the importance of patterns observed at the local level for the entire Guatemalan population.

Second, previous studies in Guatemala have generally relied on a single index of socio-economic status such as housing quality, or a very limited set of socio-economic measures, partly because the investigation of the socio-economic determinants of growth was not the central objective; instead, most earlier work focused on the effects of diet and illness on growth retardation, the consequences of poor growth, and comparisons of growth patterns between Guatemalan and other children. Thus, knowledge about the association between children's growth and social and economic characteristics is limited. In particular, little information is available on the relationship between land tenure patterns in rural areas and children's growth patterns and on the effects of recent increases in the educational attainment of parents, particularly mothers, on children's growth. While the data used in this analysis are limited in ways which are described below, they provide, for a national sample, more detailed information than many earlier studies on land ownership, occupation, the size of farms and other characteristics of the area in which the family lives, parents' education, and measures of housing quality and ownership of consumption goods.

Data

Data for this analysis come from the National Survey of Maternal and Child Health (ENSMI) conducted in Guatemala in 1987. This Survey was conducted by the Ministry of Public Health (MSPAS) and the Nutritional Institute of Central America and Panama (INCAP) in connection with the Demographic and Health Surveys (DHS) project (MSPAS and INCAP, 1989). It was based on a nationally representative sample,[4] obtained from a multi-stage cluster sampling design.[5] The sampling was carried out in 240 clusters, which correspond to census tracts in urban areas and villages or neighbourhoods in rural areas or towns. A total of 5,160 women aged 15 to 44 were interviewed between September and December of 1987. The questionnaire included items on environmental conditions in the household, social and economic status of the family, and the use of health services for prenatal care, delivery assistance, and immunization. As part of the survey, all living children of respondents

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[3] See for example, Guzman et al. (1968), Yarbrough et al. (1975), Johnston et al. (1976), Mata (1978), Martorell (1980), Valverde et al. (1981), Bogin and MacVean (1982, 1983, 1984) and Martorell (1993).

[4] However, the sample excluded the department of El Peten.

[5] The sampling design involved stratification on the basis of population size of the clusters (according to the 1981 Census) and selection of clusters within the strata, with an average cluster size of 20 and 40 in urban and rural areas respectively (MSPAS and INCAP, 1989). As described later, a clustered sample results in higher standard errors of estimates than a simple random sample.

between the ages of three months and 36 months (n=2437) were weighed and their height was measured using standard anthropometric procedures. Among these, about 8.5 per cent had missing or inconsistent information on weight and height. No information was collected on birthweight and respondents (the mothers) themselves were not weighed. Anthropometric measurements were taken using standard NCHS methods, and standardization and validation procedures developed by the Demographic and Health Survey program (see DHS 1986).

Because the data were collected over several months, seasonal variations in diet alone might have produced some variation in anthropometric measures. However, seasonality is unlikely to have an important effect on our results, since height is cumulative in nature and, therefore, less subject to acute food deficits or surpluses. Furthermore, during most of the period when the data were collected, food supply was likely to be adequate and infectious diseases were less prevalent than in the rainy season or the colder weather in January and February. The period September to December is mostly a dry period and the season of the year for a major harvest.

Municipality-level data for this analysis were obtained from other sources. Specifically, information on population size was obtained from the 1981 census of population and housing, and on the distribution of farm sizes from the 1979 agricultural census. Data on altitude (or elevation) of municipality capitals were coded from information supplied by the Guatemalan Military Geographic Institute and the National Statistical Institute.[6]

Height and weight of Guatemalan children

A comparison between Guatemalan children in the National Survey of Maternal and Child Health and data for other national surveys in Latin America in the mid-1980s indicates that Guatemalan children had the highest prevalence of chronic malnutrition or 'stunting' as measured by height-for-age (57.8 per cent) of all countries reported. In addition, Guatemalan preschool children had the second highest prevalence of 'total' malnutrition as measured by weight-for-age (33.5 per cent), exceeded only by Haiti (PAHO 1990: Tables 86 and 87).[7] As is observed in most Latin American populations (Victora 1992), however, the prevalence of acute malnutrition as measured by weight-for-height was a very low 1.4 per cent (MSPAS and INCAP 1989: Table 2.13).

Deficits in weight-for-age represent a composite of height-for-age, an index of chronic malnutrition, and weight-for-height, an index of acute malnutrition. Since the former deficit is common among Guatemalan children while the latter is rare, deficits in weight-for-age in this population reflect primarily deficits in height-for-age. Thus, we focus the analysis in this paper on variations in height-for-age.

In our sample, the average height-for-age is 2.3 standard deviations below the NCHS/WHO reference median, reflecting a prevalence of stunting (two or more standard deviations below the reference median) of 57.8 per cent.

The pattern of stunting observed in poor countries is frequently very different during the first year of life and in subsequent years (Martorell and Habicht 1986). The typical pattern is apparent in our sample and is shown in Figure 1 and Table 1. Average height-for-age declines relative to the standard through the first year of life and levels off early in the second year at a value of about 2.6 standard deviations below the median or a prevalence of stunting of about 70 per cent. Furthermore, the determinants of growth during the first year of life are

[6] These data were coded as part of a project carried out by Haines, Avery, and Strong (see Haines et al. 1983), who generously provided them to us.

[7] No data were reported for Haiti on height-for-age. Cutoff points for all three measures of nutritional status are two or more standard deviations below the NCHS reference standard median.

considerably different from those in later years. Since we are not primarily interested in age patterns of growth, but rather differentials by social and economic characteristics, we exclude infants under one year of age from this analysis.[8] The sample of 1568 infants aged 12-36 months with reported height and weight data forms the basis for the estimates presented here.

Figure 1
Average standard deviation from NCHS/WHO reference median by age in months for children 3-36 months

[8] Our analysis (not shown) of infants aged 3-11 months indicates that the coefficients on social and economic variables are smaller in absolute value than those for older children and none are statistically significant.

Table 1
Percentage distribution and average height-for-age[a] by age (children 3-36 months) and by demographic, social and economic characteristics (children 12-36 months)

Characteristics	Per cent distribution	Average height for age (s.d)
Age of child (months)		
3- 5	10.1	-1.14
6-12	19.6	-1.73
12-17	18.8	-2.47
18+	51.5	-2.62
Family ethnicity		
Ladino	58.0	-2.21
Indigenous, Spanish-speaking	22.5	-3.03
Indigenous, no Spanish	19.5	-3.16
Education		
Mother's education		
None	48.3	-2.96
Primary	43.9	-2.39
Secondary	7.8	-1.29
Father's education		
None	32.1	-2.86
Primary	46.0	-2.58
Secondary	11.9	-1.47
Missing[b]	10.0	-3.01
Father's occupation		
Agr., self-employed	34.5	-2.88
Agr., not self-employed	24.8	-2.79
Prof., technical	5.4	-1.35
Sales, clerical	7.5	-2.15
Skilled manual	14.7	-2.40
Service	7.1	-2.10
Unskilled	2.9	-2.47
None	1.1	-2.57
Missing[b]	2.0	-2.91
Type of land[c]		
Father or family owned	29.9	-2.84
Someone else's	28.8	-2.84
Missing	41.3	-2.21

Note: see footnote 12 on page 11.

Table 1 continued next page

Table 1 continued
Percentage distribution and average height-for-age[a] by age (children 3-36 months) and by demographic, social and economic characteristics (children 12-36 months)

Characteristics	Per cent distribution	Average height for age (s.d)
Housing quality		
Floor		
Earth	65.2	-2.90
Cement, other	34.8	-1.99
Electricity		
No	61.2	-2.88
Yes	38.8	-2.10
Household water		
Not piped	63.4	-2.83
Piped	36.6	-2.15
Toilet		
Not flush or septic	79.8	-2.79
Flush, septic	20.2	-1.75
Radio		
No	39.7	-2.82
Yes	60.3	-2.42
Television		
No	77.3	-2.80
Yes, don't watch daily	5.4	-2.40
Yes, watch daily	17.4	-1.64
Refrigerator		
No	92.1	-2.69
Yes	7.9	-1.36
Bicycle		
No	86.0	-2.68
Yes	14.0	-1.94
Pregnancy care		
Traditional, other	55.4	-2.96
Modern	44.6	-2.11
Altitude		
<500m	20.9	-2.23
500-1499m	31.8	-2.39
1500-2499m	35.3	-2.74
2500+ m	12.0	-3.23
Area of residence		
Urban	28.1	-2.19
Rural	71.9	-2.73

Table 1 continued next page

Table 1 continued
Percentage distribution and average height-for-age[a] by age (children 3-36 months) and by demographic, social and economic characteristics (children 12-36 months)

Characteristics	Per cent distribution	Average height for age (s.d)
Average farm size ( )[e]		
< 1	3.6	-2.83
1- 5	28.5	-2.86
5-10	25.6	-2.80
10-20	24.6	-2.47
20+	9.8	-2.17
Missing[d]	7.8	-1.61
Total	100.0	-2.58
Number of children (12-36 months)	1568	

[a] Measured as number of standard deviations from the NCHS/WHO standard of height-for-age.

[b] Includes about 30 children without fathers.

[c] Information not collected for most non-agricultural workers.

[d] Information not available for children in Guatemala City.

[e] 1 *manzana*: 0.7 hectare.

Social and economic determinants of growth

Guatemala is geographically, socially, economically, and ethnically diverse. Despite its relatively small land area, it includes lowland tropical areas on both Atlantic and Pacific coasts, a large tropical rain forest in the north, a high semi-desert area in the east, and cool mountain areas in the west and north. Elevations range from sea level to about 3800 metres. A substantial proportion of the population is partly or wholly dependent on agriculture, as self-employed farmers, as farm labourers, or as workers on plantations. However, most rural areas have undergone major structural transformation to an economy at least partly based on markets, cash and wages during the past twenty years, as is true throughout Latin America.

The Guatemalan population is roughly evenly divided into two ethnic groups: Indians or the indigenous population who are descendants of Mayan and other pre-conquest groups and who have maintained a separate cultural identity and separate languages, and *ladinos*. *Ladinos* are those who, irrespective of ethnic origin, regard themselves as part of the national Guatemalan culture, speak Spanish exclusively, and wear Western clothing. Ethnicity and social class are closely intertwined in the sense that the members of the indigenous population, who are predominantly poor and rural, are usually of low social status (see Steele 1993); *ladinos*, on the other hand, are members of all social classes.

Dietary intake and infectious disease, as well as the interactive effects of these two factors, are the primary biological determinants of children's growth patterns in poor countries. The effects of the family's social and economic status on these two variables is complex. Parents' ability to provide their children with a better diet is generally severely constrained by lack of money; in addition, parents frequently lack relatives and friends who are able to provide them with financial assistance in lean periods. Inadequate knowledge and information about appropriate diets for young children (such as the appropriate duration of breastfeeding) may lead to additional constraints. The same sets of factors also limit parents' ability to maintain a clean environment in which children are less exposed to disease and to provide effective treatment to children who become ill.

However, even in the presence of severely limited resources, parents and other family members affect children's diets, exposure to illness, and treatment during illness by making choices about the use of the resources that are available (Thomas, Strauss and Enriques 1990; Thomas and Strauss 1992; Thomas 1993; Cebu Project Team 1991; Behrman 1990). For example, research on the effects of the economic downturn in Guatemala by Ruel and Garrett (1992), and in other countries by Cornia, Jolly and Stewart (1987, 1988) and Palloni (1992), suggests that many families have used a variety of adaptive strategies to blunt some of the more serious health effects of deteriorating economic conditions. These strategies include changing dietary composition and allocation, spending less on 'luxuries' such as cigarettes and alcohol, borrowing more from others, and increasing or reallocating labour supply. Since the ENSMI data provide only a limited picture of household consumption and intra-household allocation patterns, we focus primarily on the relationship of children's growth to social and economic factors which are likely to constrain access to resources and which may affect parents' skill in allocating resources to improve their children's well-being.

Most of the variables examined in this analysis (shown in Table 1) are measures of a family's economic status and social class: occupation of the respondent's husband and land ownership for those in agriculture, housing quality, possession of consumer goods, whether the family lives in an urban or rural area, and, for those outside Guatemala city, the average size of farms in the municipality. Occupation is included not only as a determinant of income,[9] but as an indicator of social class and access to social resources and information associated with class. For example, because of a high degree of social stratification, individuals typically marry, and have as family members, persons of their own social class.

For husbands in agricultural occupations, we examine differences between those farming their own or family land (farmers) and those farming land owned by others (agricultural workers or labourers). While ownership of agricultural land in rural areas is itself a reflection of wealth and is likely to be correlated with income, we hypothesize that there are also other differences in living conditions between farmers working their own or family land and landless labourers. Specifically, despite the expansion of wage labour and cash-based commodity markets into many rural areas in Guatemala during the 1980s, many small farmers who work their own or family land remain relatively insulated from economic fluctuations, because they produce the majority of food for family consumption with relatively little dependence on purchased inputs. By contrast, agricultural labourers are very much exposed to variations in wages and prices, since they are either employed by large *fincas* (plantations) or face very thin local labour markets — or both, since work on *fincas* is often seasonal. Furthermore, the serious economic downturn during the middle and late 1980s in Guatemala (Ruel and Garrett 1992) undoubtedly reduced the demand for agricultural labour and wage rates. Thus, we hypothesize that relative to farmers, agricultural workers were much harder hit by the poor economic conditions during the late 1980s.

There is a caveat: many farmers working their own or family land have access to less land than is necessary to produce sufficient food for their families. The ENSMI did not collect information on the amount of land owned. However, areas of land scarcity and parcel fragmentation are highly geographically clustered in Guatemala, although of course, there is

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[9] Hourly wage differentials vary markedly by occupation and are lowest for those in agriculture. For example, average hourly wages for *ladinos* measured in quetzales in 1989 (one quetzal = $0.36 US) were Q1.93 for office workers, Q1.54 for transport workers, and Q1.08 for manual labourers, but only Q0.68 for those in agriculture (Steele 1993). Although self-employed farmers are most likely to underreport earnings, misreporting is unlikely to account entirely for the large wage differential between persons in agriculture and those in other occupations.

variation in the amount of land owned among individual farmers within a given area. As measures of land tenure, we employ three variables in the analysis presented below that reflect the size of farms in the municipality of the respondent at the last agricultural census (1979) which took place about eight years before the ENSMI survey. While we would have preferred more recent information, the distribution of agricultural land is unlikely to have changed markedly during this period. The variables are: the average size of farms; the density of very large landholdings, that is, the number of farms greater than 20 *caballer'as* (about 894 hectares) per person; and the density of very small farms, under one *manzana* (about 0.7 hectare) per person. These variables are also likely to provide an indication of the demand for agricultural labour, since larger farms are much more likely to employ agricultural workers than small farms.[10]

As an indicator of family wealth, consumption, and living conditions, we examine family possession of several consumer durables, radio, television, refrigerator, bicycle; and variables measuring housing quality: the presence of a non-earth floor, electricity, piped household water, and a modern toilet. With regard to the possession of a television, we also distinguish those who watch television daily from those who own a television but watch less frequently. Work by Thomas et al. (1991) suggests that access to information, including watching TV, plays an important role in explaining the association between maternal education and children's height. Measures of housing quality and sanitation may also have a direct effect on growth by affecting the level of environmental contamination.

While parents' education is correlated with occupation and current economic status, and reflects family background, previous researchers have suggested that more educated parents, especially mothers, are more effective at using the available resources to improve the health of their children (Caldwell, Reddy and Caldwell 1983; Cleland 1990; Lindenbaum 1990; Thomas et al. 1991; Elo 1992). We examine both the mother's and father's education in this analysis.

As suggested above, it is likely that ethnicity, land tenure and occupation are highly correlated with parental education. For example, indigenous families are more likely to be poor, to work as agricultural labourers, and to have little formal education. In the analysis, we examine the interactions among these variables.

We also examine the effects of the geographical altitude of the child's residence: more precisely, the altitude of the capital of the municipality in which the mother lives. Initial analyses of the ENSMI indicated that there is a strong, negative relationship between height-for-age and altitude in Guatemala. Previous research elsewhere in Latin America found that children living at altitudes of above 3000 metres are shorter at a given age than those at lower altitudes (Beall et al. 1977; Haas et al. 1982), apparently because of the effects of hypoxia, or oxygen scarcity (Bailee and Haas 1986; Mayhew, Jackson and Haas 1990). However, hypoxia is unlikely to account for the association in Guatemala because only a very small portion of the Guatemalan population lives at altitudes greater than 3000 metres. We hypothesize that the apparent altitude effects are due to the close relation between altitude and poverty, specifically land scarcity, in Guatemala. Results not shown here[11] indicate that, for

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[10] It is important to note that agricultural labourers working on large plantations frequently have to migrate long distances to the Pacific Coast, where many of the plantations are located. The variables included in the analysis reflect the size distribution of local farms and plantations only in the area where the family lives. However, employment on the coast is generally available to labourers from all areas of the country and employment requirements are often advertised by plantation owners over the national radio station.

[11] These results are based partly on data from the ENSMI community survey, conducted in about two-thirds of the sample clusters in which the individual survey took place.

the ENSMI sample, communities at high altitudes are more likely to have very small farms, high levels of illiteracy, a lack of sewers and paved roads, and a high proportion indigenous compared with communities at lower elevations. Miller (1993) and de Meer (1993) have shown similar associations in Bolivia and in Peru.

Results

In the first column of Table 1, we show the per cent distribution by age, ethnicity, altitude and the social and economic variables for children in our sample. In the second column, we present the average standard deviation in height-for-age from the NCHS reference median, in each of the categories. Although the first panel of numbers (by age of child) includes all children aged 3-36 months, the remaining numbers refer to children aged 12-36 months, who form the sample for the subsequent multivariate analysis.

The results indicate substantial variation in height-for age by demographic, social and economic characteristics. On average, indigenous children are substantially shorter than *ladinos*, with little difference between children of Spanish and non-Spanish speaking indigenous mothers; and children residing in rural areas are shorter than those in urban areas. The difference in average height-for-age between urban and rural areas is considerably smaller if children living in Guatemala City are excluded from the urban group. Children of poorly educated mothers and fathers[12] and of fathers employed in agriculture or unskilled occupations are considerably shorter than children of educated and skilled parents. Heights for age also vary systematically with farm size in the community — in general, the smaller the average farm size, the greater the deficit in height — although there is no difference in height by land tenure of persons employed in agriculture, that is, self-employed or not self-employed agricultural workers. The estimates also indicate that children living in higher-quality homes and in families with modern possessions consistently have smaller height deficits than their less well-off counterparts.

The data in Table 1 suggest that use of modern health care during pregnancy is positively associated with children's height: mothers who relied on a physician or nurse for prenatal care or for assistance at delivery have taller children, by almost a standard deviation on average, than do those who used other forms of health care, primarily a midwife. Finally, the estimates reveal a monotonic relation between altitude and height: the higher the altitude of the community, the shorter the child, on average.

Multivariate models

In order to assess the relative contributions of family economic and social status, parental education, land distribution, and altitude to children's growth deficits, we estimate multivariate models. The dependent variable is height-for-age, expressed as the number of standard deviations from the NCHS/WHO reference median multiplied by 100. Like most nationally representative surveys, the ENSMI was a multi-stage sample rather than a simple random sample. For example, the 1,568 children included in the multivariate analysis reside in 155 sample clusters, resulting in an average cluster size of about ten. To the extent that children living in the same area experience similar deficits in height, estimated standard errors derived from the conventional assumption of simple random sampling are likely to be too small, although the coefficients obtained from ordinary regression models are unbiased. In order to take the actual sampling design into account, we obtain our estimates in two

[12] The information in the ENSMI refers to the most recent husband of the child's mother, who may or may not be the father of the child. For convenience, however, we refer to the most recent husband as the child's father.

stages. The first consists of estimating the classic linear regression model (based on the assumption of independent observations), including the individual-level, household-level and community-level covariates listed in Table 2 as explanatory variables. The second stage uses the observed clustering design to adjust the standard errors obtained from the classic regression model.[13] The sample size for the multivariate analysis is about ten per cent smaller than the full sample of children with anthropometric information because we excluded children in Guatemala City, for whom we have no information on land size in the municipality, and children with missing information on fathers'education or occupation.

Each of the variables presented in Table 1 was included in a preliminary set of regression models (not shown). Subsequently, several of the housing quality and consumer durable variables with coefficients not significantly different from zero were dropped from the model. In addition, for some of the variables retained in the model, the number of categories was reduced. For example, since there were no significant differences among different groups of non-agricultural workers, the occupation variable was collapsed to three categories: agricultural workers who farm their own or family land, agricultural workers on other land, and non-agricultural workers. Instead of using average farm size in the multivariate models, we included two continuous variables to capture the potentially different effects of large (predominantly commercial) farms and small holdings: the number of farms greater than 20 *caballer'as* (894 hectares) per capita and the number of farms smaller than one *manzana* (0.7 hectare) per capita.

We also explored the potential contribution of interaction terms to the multivariate model. In particular, we examined interaction terms between ethnicity and education, ethnicity and wealth (ownership of goods and housing quality), and ethnicity and occupation; between education and wealth; and between occupation and land size. The interaction terms were calculated as the product of the respective variables. Sets of interaction terms that did not significantly enhance the fit of the model, as determined by the appropriate F-test, were subsequently dropped. The only two sets that were retained in the final model reflect interactions between ethnicity and wealth and between occupation and land size.

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[13] We use a regression procedure known as *hreg* in the statistical package STATA that provides robust and consistent estimates of standard errors. This procedure is based on an adaptation of Huber's formula to handle clustered observations (Computing Resource Center 1993).

Table 2
Estimated coefficients and t-values[a] for regression of height-for-age[b], children aged 12-36 months

Covariates	All covariates Coefficient	t-value	Reduced-form Coefficient	t-value
Ethnicity				
(Ladino)				
Indigenous	-3.6	-0.31	-23.6*	-2.03
Altitude				
(<1500m)				
1500-2499 m.	-55.3*	-5.80	-57.5*	-5.51
2500 m.	-54.0*	-4.12	-57.8*	-4.03
Pregnancy care				
(No modern pregnancy care)				
Modern pregnancy care	29.1*	3.94	-	-
Education				
(Mother no education)				
Mother primary education	10.4	1.45	20.8*	2.89
Mother secondary+ educ.	40.2*	2.94	82.9*	5.51
(Father< secondary educ.)				
Father ≥ secondary educ.	24.3	1.93	48.4*	3.80
Housing quality				
(Earth floor)				
Cement, other floor	35.1*	3.64	-	-
(No flush/septic toilet)				
Flush/septic toilet	41.9*	2.59	-	-
Consumer durables				
(No TV, don't watch daily)				
Watch TV daily	41.9*	3.63	-	-
Area of residence				
(Rural)				
Urban	-18.2	-1.61	-5.6	-0.46
Ethnicity interactions				
Indigenous x cement floor	-5.5	-0.35	-	-
Indigenous x flush toilet	-56.3*	-2.19	-	-
Indigenous x watch TV often	-20.6	-0.59	-	-

Table 2 continued next page

Table 2 continued
Estimated coefficients and t-values[a] for regression of height-for-age[b], children aged 12-36 months

	All covariates		Reduced-form	
Covariates	**Coefficient**	**t-value**	**Coefficient**	**t-value**
Farm size and occupation				
No. of farms > 20 cab per capita[c]	73394.9*	3.09	67708.0*	2.56
No. of farms < 1mz per capita	292.9	1.31	-45.8	-0.17
(Non-agricultural occupation)				
Ag. worker, own land	37.7	1.81	-8.6	-0.37
Ag. worker, not own land	17.1	1.05	-28.3	-1.66
(Ag. own land) x (farms<1mz p.c.)	-999.2*	-1.97	-429.5	-0.78
(Ag. not own land) x (farms<1mz p.c.)	-828.6*	-2.21	-287.8	-0.70
Constant	-291.9*	-24.74	-232.2*	-18.23
Number of observations[d]	1419		1419	
R^2	0.241		0.198	

* $p < .05$

[a] Huber regression which takes into account the cluster-based sampling design.

[b] Number of standard deviations from the NCHS/WHO standard of height-for-age.

[c] Twenty *caballer'as* (cab) is approximately equal to 894 hectares. One *manzana* (mz) is approximately equal to 0.7 hectare.

[d] The numbers of observations in the regression models are about 10% smaller than the full sample size (n=1568) because of missing values on the father's occupation and education variables and on farm sizes for some municipalities in Guatemala City.

A statistical problem arises with regard to the inclusion of several variables in our model: type of pregnancy-related care, housing quality, and consumer durables. A mother's decisions about the type of health care to receive during pregnancy and delivery, and parents' decisions about the acquisition of modern possessions in the household, may be affected by the same unobserved factors as are decisions about a child's nourishment and health care that presumably affect a child's growth.

The potential endogeneity[14] of several of our covariates poses complications in this analysis since adequate identifying variables, such as average wage rates, needed to estimate

[14] Endogeneity means that some of the variables thought to affect nutritional status are themselves 'determined' or influenced by other variables within the model. For example, holding level of income constant, some parents may choose to spend less of their income on better housing quality or durable goods and more on food. In this case, both housing quality and dietary intake are 'jointly determined', i.e. decisions about the two types of expenditures are made jointly and are both affected by parents' characteristics. Statistical models which do not take endogeneity into account may produce misleading results. A typical procedure used by economists to deal with endogeneity is to use 'instrumental variables' which are correlated with the predictor variable but uncorrelated with the dependent variable, and are typically exogenous variables, such as the average female wage rate, which are not under the control of the family decision-makers (Wonnacott and Wonnacott 1970).

a simultaneous equation model are not readily available in these data. At the same time, inclusion of the variables describing pregnancy care, housing quality and consumer possessions on the right-hand side of the height equation may lead to biased estimates of all coefficients. In order to determine how sensitive our findings are to the inclusion of potentially endogenous variables, we estimate two regression models: the first includes modern pregnancy-related care, housing quality and possession of consumer durables along with the other covariates, and the second excludes these potentially endogenous variables, that is, it represents a reduced-form model.

Multivariate results

The multivariate results confirm many — but not all — of the bivariate results shown in Table 1. Recall that height-for-age is measured in terms of standard deviations multiplied by 100, so that the estimated coefficients in Table 2 need to be divided by 100 to reflect the number of standard deviations.

The results in Table 2 substantiate the importance of family economic status and social class and inequitable land distribution for childhood growth. Estimates for the full model indicate that higher-quality homes and possession of modern conveniences are usually associated with smaller deficits in height. However, the interaction terms indicate that the effects are typically greater for *ladino* than for indigenous children. For example, estimates in Table 2 indicate that *ladino* children living in homes with modern toilets are 0.419 standard deviations taller, on average, than those without flush toilets or septic tanks in the household. On the other hand, indigenous children do not experience a growth advantage from this improvement in housing quality, as indicated by adding the coefficient for the main effect of a flush or septic toilet to the associated interaction term for indigenous children (0.419 - 0.563 = -0.144).

The estimated coefficients in the full model indicate that, apart from modest interactions between ethnicity and wealth, there is virtually no association between ethnicity and height. That is, once controls for demographic, social, economic and community characteristics are included, ethnic differences in children's height are substantially reduced; much of the greater deficit in height observed among the indigenous population (e.g., in Table 1) can be accounted for by ethnic differences in social and economic factors and in altitude. This finding is consistent with results from earlier small-scale investigations of ethnic differences in growth of Guatemalan children (Johnston et al. 1976; Bogin and MacVean 1982).

In both the full and reduced-form models, the occupational and land variables, occupation, farm size and their interactions, are jointly significant ($p < 0.01$), even though some of the individual coefficients have relatively small t-ratios. The estimated coefficients indicate that higher densities of large landholdings in a community are associated with smaller deficits in height. Moreover, higher densities of very small farms are associated with larger deficits in height, although only for those employed in agriculture, irrespective of whether or not they farm their own land. Since the interaction terms by themselves are not jointly significant in the reduced-form model, we re-estimated this model excluding these two terms (results not shown). The estimates indicate that children of fathers in agriculture, irrespective of land ownership, have significantly larger deficits in height than do children of fathers in other occupations, but that the density of very small farms is not significantly associated with children's growth.

In both models, mothers with more years of education have children with smaller deficits in height; the differentials are considerable between children whose mothers have no education and those whose mothers have a secondary education. As hypothesized, this result suggests that maternal education has a strong effect on children's growth, even when other aspects of a family's social and economic status are held constant. Thus, it appears that more educated mothers can use limited resources more effectively than mothers with less education. More educated mothers may also have better information on health and nutrition-related practices. The effect of father's higher education is smaller than that of the mother and is significant only in the reduced-form model. When housing quality and consumer durable variables are included, that is, in the full model, the independent effects of father's education on children's growth are relatively small; in the absence of these variables, children whose fathers have more than a secondary education are about a half of a standard deviation taller than those whose fathers have lower levels of education.

As noted above, altitude is strongly associated with the distributions of farm sizes, ethnicity, literacy, and public services, such as sewers and paved roads, across the communities in the ENSMI sample. The regression coefficients in Table 2 indicate that the effects of altitude are significant and substantial even when social and economic factors are included in the model. The estimates from the full and reduced-form models are almost identical: children living in communities over 1500 metres of elevation have height deficits of at least half of a standard deviation greater than children at lower elevations. As noted earlier, these elevations are generally too low to reflect hypoxia effects on growth. Contrary to estimates from the bivariate results and the possible influence of hypoxia at the higher elevations, there is no difference in height between children at moderate and at high altitudes. The difference between the bivariate and multivariate results is due largely to the exclusion of children in Guatemala City in the multivariate analysis: children in Guatemala city are substantially taller, that is, have smaller height deficits, than children of the same age living in other urban and rural areas at a similar elevation, just over 1500 metres.

The results described above do not change markedly if altitude is omitted from the models (results not shown). The most notable difference is that the coefficient for ethnicity becomes more negative, indicating that indigenous children are substantially shorter than *ladinos*. The coefficients for the variables denoting the density of large farm sizes and the interactions between agricultural occupations and small farm sizes become larger in absolute value, a result which suggests that the effects of altitude may be partly due to variations in land distribution across different elevations.

Although the bivariate results in Table 1 indicate that children in rural areas are substantially shorter than urban children, the estimated coefficients in Table 2 suggest no significant difference in height between urban and rural children, once social and economic factors and altitude are included as control variables. This result is partly due to the exclusion from the multivariate analysis of children in Guatemala City, who are considerably taller than children living in both urban and rural areas outside of Guatemala City. With regard to health care, the full model indicates that the relation between use of modern pregnancy-related care and children's height persists in the presence of control variables: mothers who used modern health care during pregnancy or delivery have children with significantly smaller deficits in height.

Conclusions

The objective of this paper has been to examine the association between a set of social and economic factors — family social class, economic status and land distribution —and children's growth deficits in a poor and highly stratified society. Our results indicate that an important consequence of the poverty and poor living conditions of the majority of the Guatemalan population is substantial deficits in children's growth. Despite the limitations of the measures of family economic status available from the ENSMI, approximately one-quarter of the variation in height-for-age is accounted for by the variables included in our models of children's growth. Differences in growth by father's occupation and by measures of living conditions and durable goods are substantial. The children of fathers in agriculture, regardless of whether or not they farm their own land, are disadvantaged relative to other children.

The results also suggest that the distribution of farm sizes in the municipality affects children's growth. Children living in areas with a higher density of plantation-sized farms per capita experience substantially better growth than other children, presumably because the availability of regular employment in agricultural labour is greater than in other areas. In contrast, children in agricultural families suffer greater growth deficits if they live in areas where the density of small farms is high. Surprisingly, whether or not an agricultural family was farming its own land did not have a significant effect on children's growth. However, information on type of land tenure and land use was very limited in the ENSMI.

We hypothesized that parents with more education, especially mothers, are more effective at using available resources to improve the health of their children. As in previous research, our results show that even when other indicators of family social and economic status are held constant, children of more educated mothers are significantly taller.

An interesting result from the analysis is the strong association between altitude and growth, even when social and economic variables are held constant. As indicated earlier, growth deficits due to the stress of high-altitude environments are thought to occur only above 3000 metres, an altitude at which very few children live in Guatemala. Nonetheless, we observe substantial growth deficits among children living at altitudes above 1500 metres. Children living above this elevation are more than half a standard deviation shorter than children at lower altitudes. Haas (1994) suggests that the use of smoky cooking fires at altitudes less than 3000 metres may also reduce oxygen availability and children's growth. However, we hypothesize that the primary reason for the observed relationship is that, in Guatemala, higher altitude is associated with land scarcity, poorer agricultural conditions, and greater remoteness from transport networks and other public services, and that the effects of altitude partly reflect these unmeasured variables. Our results and those of Miller (1993) and de Meer (1993) suggest that further investigation of the association between altitude, social and economic conditions, and poor children's growth in Latin America is warranted. However, such an investigation would require better information on land ownership, use and productivity, family income, and public services than is available to us or to the authors of the other two studies.

A final result concerns the role of ethnicity in determining differences in height. Indigenous children are significantly shorter in Guatemala than *ladinos*, a fact which is often attributed by lay observers to genetic differences in growth potential. However, our results are consistent with those of previous research in showing that these ethnic differences are substantially reduced when social class, economic status, and altitude are held constant. Altitude is likely to represent unmeasured aspects of rural poverty, such as poorer land, lower family income, or remoteness. In fact, the high concentration of the indigenous population at higher elevations is partly due to the fact that, over the past two centuries, more productive, accessible, and desirable land at moderate elevations was frequently appropriated by *ladino* settlers. Thus, the shorter stature of indigenous as compared with *ladino* children is likely to result principally from greater poverty.

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