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Stunting in Guatemala: Analyses of Change Over 15 Years

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List of Acronyms

AIDS: Acquired ImmunoDeficiency Syndrome

CARE: Cooperative for Assistance and Relief Everywhere, Inc.

CRS: Catholic Relief Services

DHS: Demographic Health Surveys

EGSF: Encuesta Guatemalteca de Salud Familiar (Guatemalan Family Health Survey)

ENCOVI: Encuesta de Condiciones de Vida (Living Standards Measurement Study)

HAZ: Height-for-Age Z-scores

INCAP: Institute of Nutrition of Central America and Panama

INE: Instituto Nacional de Estadística

LSMS: Living Standards Measurement Study

MEASURE: Monitoring and Evaluation to ASsess and Use Results

NCHS: National Center for Health Statistics

PHN: Population, Health and Nutrition

SD: Standard Deviation

SES: Socio-Economic Status

SHARE: (World SHARE, Inc.) Self-Help And Resource Exchange

UNICEF: United Nations Children's Fund

USAID: United States Agency for International Development

WFP: World Food Programme

WHO: World Health Organization

WHZ: Weight-for-Height Z-scores

Executive Summary

The principal objectives of the report were to assess levels and trends in stunting (low height-for-age) in Guatemalan children and to understand its principal determinants. The report was produced by the Department of International Health of the Rollins School of Public Health of Emory University under a contract from Abt Associates for the USAID mission in Guatemala.

The key sources of data were Demographic Health Surveys carried out in 1987, 1995 and 1998/99, which shared similar sampling frames and data collection methods. The analysis focused on children age 3 to 36 months, the age group in common among the surveys, but data for younger and older children were also analyzed. Sample sizes were 2,229 for 1987, 5,075 for 1995 and 2,230 for 1998/99. Two School Height Censuses, for 1986 and 2001, were analyzed. However, the low first-grade enrolment rates in 1986 resulted in biases that underestimated the prevalence of stunting and that invalidated the assessment of trends. Thus, conclusions about levels and trends in stunting should be based solely on results from the DHS surveys.

Stunting, rather than wasting, was the major form of growth retardation in Guatemala. These indicators are defined as values two or more standard deviations below the mean in the reference population. Children were born already significantly stunted and continued to falter in growth until about 1½ years of age, with normal growth thereafter.

The prevalence of stunting declined across the three surveys, from 57.8% in 1987 to 48.8% in 1995, and further to 43.2% in 1998/99. Because of population growth, the gains achieved in reducing stunting were completely negated; there were approximately the same number (a half million) stunted children (aged 3-36 months) in 1998/99 as in 1987. The levels of stunting over the period examined were higher than the mean levels for Asia and Africa and markedly higher than those for Latin America. However, average rates of decline were actually faster for Guatemala than for these regions.

The annual decline in stunting was faster for Ladinos than Indians (–1.4 vs –0.8 percentage points per year, respectively). Ladinos, who make up about 60% of the population, are the dominant group and are distinguished by mixed Spanish/Indian ancestry and the use of Spanish and western dress. Indians, descendants of the Mayans, speak a variety of native languages and wear traditional dress. At these rates of decline it will take 20 years for stunting to cease to be a problem among Ladinos but over 80 years among Indians.

Univariate and multivariate analyses were carried out to identify the key determinants of stunting. The variables examined include age and gender of the child, residence (urban/rural), region, household socioeconomic status (SES), maternal characteristics (age, height, ethnicity, education, works at home, uses modern birth control), demographic variables (birth order, birth interval) and an index of feeding behaviors developed by Ruel and Menon (2002). DHS surveys, and cross sectional surveys in general, have important limitations for studying the determinants of malnutrition. While they allow for satisfactory data collection for many aspects, such as age, gender, anthropometry, education and socioeconomic status, the measures of illnesses and dietary intakes that are generally included are limited to recalls of the recent past. Illness and dietary data are best collected through repeated measures in longitudinal studies.

The multivariate results were similar across the three DHS surveys, indicating that the relationships found were robust and reproducible. The risk of stunting was over 4 times greater among Indians compared to Ladinos. However, after accounting for education, socioeconomic status and other variables, this risk was reduced to less than two but remained significant. The findings are consistent with the view that the higher rates of stunting in Indians compared to Ladinos are not the result of genetic factors, as some believe, but of poor diets and infection stemming from poverty and related conditions. Although there is a residual, unexplained effect of being Indian on stunting that could be attributed to genetics, it is more likely that lack of adequate measurement of diet and illnesses in the DHS surveys and failure to include important variables in the survey (e.g. discrimination faced in schools and health services; language barriers to use of services, etc) are the explanation.

Residence in a rural area was not related to stunting once other variables were taken into account. In general, all regions of the country had high levels of stunting relative to Guatemala City, making targeting by such a large unit as region ineffective. Education and SES had strong and independent effects on stunting. Relative to children of mothers with 1 to 6 years of education, children of mothers with no education had a greater risk of stunting, and those of mothers with at least some secondary education had a lower risk. The distributions for SES and maternal height were divided into tertiles. Low household SES increased the risk of child stunting relative to middle SES households but only moderately and only in two of three surveys; high SES, on the other hand, was a consistent, powerful protective factor. Thus, the lower and higher thirds of the distribution of maternal education were important in determining stunting but for SES, it was the upper third of the distribution that mattered most. Maternal height captures generational effects of malnutrition across generations. Relative to children of mothers of average height, children of short mothers were at greater risk of stunting and those of tall mothers at less risk. Use of modern birth control, a variable that may capture information about access to health services and receptivity to interventions, was a strong protective factor of stunting.

The importance of birth order and spacing was clear. Controlling for other factors, being first born was a protective factor while being fifth born or higher and having a birth interval less than 2 years were risk factors. The feeding index was not related to stunting once other variables were taken into account; however, several of the components of the index were significantly related to stunting in multivariate analyses. For example, among children 12 to 36 months of age, the most consistent and robust relationships were with bottle feeding (risk factor) and with frequent use of meat in child feeding and 4 or more meals per day (protective factors).

The rate of progress in education, SES and other variables was also examined, but separately for Ladinos and Indians. In general, conditions improved among both groups but more so among Ladinos, which may explain their faster rate of improvement in stunting. For example, the percentage of mothers with no education was 74 for Indians and 30 for Ladinos in 1987. These levels decreased to 56 and 18% respectively for Indians and Ladinos in 1998/99. On the other hand, the percentage of mothers with 7 years or more of education did not change among Indians

(1.2 % vs 1.6%) but improved significantly among Ladinos (12.5% vs 24.0%). There was also progress in terms of household assets owned and basic needs met, the components we used to create the SES measure. Compared to Indians, Ladinos had a greater percentage of basic needs and assets in all surveys. Both groups showed important improvements over time in terms of most items. The gap (difference between the percentage of Ladino and Indian households having the item) improved for water but increased dramatically for floor, television, refrigerator and car; the gap remained more or less as wide for other components. The use of modern birth control increased from 2.6 to 5.4. % among Indians, a level of change much inferior to that observed in Ladinos, 17.9 to 30.8%.

A number of specific conclusions stem from our research.

- Conclusions about levels and trends in stunting in Guatemala should be based on analyses of the DHS surveys and not on the School Height Censuses.
- Stunting and not wasting is the chief form of growth retardation in Guatemala.
- Stunting develops prior to age two and is the product of both prenatal and postnatal growth retardation.
- Guatemala has one of the highest rates of stunting of any country in the world, although the decline since 1987 is faster than average for developing countries.
- Stunting is more common among Indians than Ladinos and it will take 80 years to eliminate stunting among Indians compared to 20 among Ladinos.
- Maternal education and socioeconomic status are powerful, independent predictors of stunting.
- The benefit of family planning services for reducing stunting is suggested by consistent relationships between birth order and spacing with stunting.
- Appropriate child feeding practices are predictive of lower rates of stunting.
- The faster rate of decline in stunting among Ladino compared to Indians is explained by their faster rate of socioeconomic progress and improved access to education and health services.

Several general recommendations related to policies and programs stand out.

- Focus on mothers and children
  Programs should focus on mothers and children under two in order to accelerate progress in addressing the problem of child malnutrition. In addition, there must be access to basic health services, including family planning, along with primary and secondary education. These services, together with nutrition specific actions need to achieve the following crucial steps for reducing stunting rates:
  - Improve intrauterine growth
  - Promote exclusive breastfeeding in the first six months
  - Improve complementary feeding
- Improve the plight of Indians
  Although many Ladinos are poor and malnourished, Indians are much worse off and deserve special attention.

- Income generation plus health and nutrition

  Programs to promote economic development and programs to address child malnutrition should be viewed as mutually reinforcing, complementary strategies, rather than as competitors or trade offs.

1 Introduction

The overall objectives of this report were to assess levels and trends in stunting among Guatemalan children and to understand the principal determinants of stunting in Guatemalan children, particularly among indigenous children. This analysis will be useful to better target as well as to increase the effectiveness of current programs and strategies and to inform future policies. Stunting, defined as low length or height for age, is the preferred indicator of what is commonly called "chronic malnutrition." The report was produced by the Department of International Health, Rollins School of Public Health, Emory University under a contract from Abt Associates for the USAID mission in Guatemala. The scope of work provided to us stated clearly that the recommendations emanating from our analyses were to be preliminary and that our work "would be followed by a separate, subsequent study that will examine in more depth whether USAID's Title II program in Guatemala is offering the right range of services needed to prevent chronic malnutrition."

The report was based on several complementary tasks:

- Interviews with professionals from USAID, Abt Associates, USAID's cooperating agencies (CARE, CRS, SHARE, and Save the Children), UNICEF, WFP, the Institute of Nutrition of Central America and Panama (INCAP) and the Ministry of Health of Guatemala to learn, in general terms, about USAID's nutrition interventions and to obtain views about the root causes of malnutrition;
- Review of the world literature, in particular that from Guatemala, on the significance and causes of stunting and on worldwide levels and trends in stunting in developing countries;
- Analysis of levels, trends and determinants of stunting in Guatemala using nationally-representative surveys; and
- Preliminary presentations of the findings and discussions of program and policy implications with USAID (Guatemala), Ministry of Public Health personnel and USAID's cooperating agencies.

The specific objectives of the analytic component of our work were as follows:

- to identify the critical periods during which stunting develops in Guatemalan children;
- to assess current levels and trends in stunting in Guatemalan children, contrasting the situation in Ladino and Indian children.[1]
- to compare these levels and trends among Guatemalans with patterns of change in stunting in Latin America and other regions;
- to identify the key factors associated with stunting through univariate analyses;
- to identify the relative importance of these factors through multivariate analyses;
- to explore whether changes in stunting can be explained by changes in key causal factors; and

[1] The two major ethnic groups in Guatemala are Ladinos and Indians. The latter are the indigenous peoples, many of Mayan descent, who mostly conserve their languages and dress. Ladinos are generally of mixed Indian-Spanish ancestry and speak Spanish and wear western clothes.

- to assess concordance between changes measured through surveys in pre-school children with changes measured through School Height Censuses.

2 Stunting as a Public Health Problem

UNICEF's conceptual work of the causes of child malnutrition is an excellent summary of knowledge to date and served as a guide in selecting the variables for our analyses (UNICEF, 1998). A simplified version is shown in Figure 1. At societal level, poverty and associated conditions are the basic causes of malnutrition, constraining the resources and skills available to families for maintaining health and nutrition. At the family level, malnutrition can be caused by: a) insufficient access to food, b) inadequate access to health services, and to clean water and proper sanitation facilities, and c) inadequate caring practices for children and mothers. These factors alone or in combination cause the poor diets and infection that result in malnutrition at the level of the individual. Poor diets and infections interact to cause reduced nutrient availability at the cellular level, disrupting normal metabolic function. To preserve nutrients and energy as much as possible for essential metabolic functions and to fight infections, linear growth in children will slow down or cease altogether in situations of nutritional stress. Under extreme, chronic conditions, there will be catabolism of fat and lean mass tissues to increase the nutrient and energy supply, leading to emaciation or wasting. Growth is unimportant for short-term survival and for this reason it is an excellent marker of nutritional stress. When the child's nutritional state is compromised, growth will be impaired and if conditions on convalescence are not optimal, possibilities for catch up in growth will be limited. An indicator like length-for-age will therefore measure the accumulated extent of nutritional stress. In Latin America, Guatemala included, wasting is uncommon and in poor countries of the region such as Guatemala, stunting is the principal manifestation of growth failure (Victora, 1992).

Studies from around the world have documented the significance of stunting. In the 1980s an economist by the name of David Seckler advanced the notion that only children with clinical signs of malnutrition (e.g., kwashiorkor, marasmus) were to be considered "malnourished" (Seckler, 1980; Seckler, 1982). Stunted children, in his view, are "small but healthy." This notion has been discredited by overwhelming evidence showing that stunting is associated with considerable dysfunction both in early childhood and in the long term (Beaton, 1989; Martorell, 1995; Martorell, 1997). Underweight (low weight-for-age) and stunting are highly correlated and are expressions of the same underlying causes.[2] Considerable research has shown that underweight is predictive of mortality, with the risk rising sharply among those with an increasing degree of growth retardation and is highest for those with severe growth retardation (Pelletier et al, 1993; Pelletier et al, 1995). However, the greatest contribution to mortality comes from those affected with mild and moderate growth failure because these types of children are many times more numerous than those with severe growth retardation and/or clinical malnutrition. Survivors of childhood stunting pay a price as adults, as shown in the INCAP Oriente study (Martorell, 1995). Stunted children grow up to be small adults, with short stature, small body frame and reduced muscle mass. The physique of the adult who survived childhood malnutrition is characterized by a reduced capacity for physical work and possibly reduced earnings for laborers. In women, these same factors lead to poor reproductive outcomes, including low birthweight, and in this manner, the effects of childhood stunting are passed on to

[2] Where wasting is uncommon, underweight is largely a reflection of stunting. Where wasting is common, underweight reflects both stunting and wasting.

the next generation (Merchant, Villar and Kestler, 2001; Ramakrishnan et al, 1999 a, b). Possibly of even greater significance are effects of childhood stunting on intellectual functioning (Martorell, 1997; Pollitt et al, 1993). The evidence that stunting leads to reduced learning and to poorer performance on psychoeducational tests is incontrovertible, although there is some argument about mechanisms (Martorell, 1997; Brown and Pollitt, 1996; Wachs, 1995). Stunting may itself not be the causal mechanism but simply a marker; we can suppose that if nutrition conditions were severe enough to cause extreme growth failure, other domains, such as cognitive development were probably affected as well. It is also possible the stunted children are treated differently and that this impacts negatively on their cognitive development; for example, parents may delay sending short children to school because they may perceive them not to be ready and teachers and other adults may treat short children as if they were younger (Brown and Pollitt, 1996).

In summary, because of its impact of on human capital, an important determinant of economic productivity, stunting is not only a consequence of poverty but also one of its causes (Fogel, 1994; Dasgupta, 1993; Martorell, 1996). Without doubt, stunting is a marker of the most important syndrome of developmental impairment affecting humankind, and constitutes a major public health problem (Beaton, 1989).

3. Methods

This section describes the national surveys analyzed, the summary variables generated and the analytic plan followed.

3.1 Data Sources

Guatemala is very fortunate to have had several national nutrition surveys that provide data about stunting in preschool children and its determinants. In addition, two School Height Censuses have been carried out to date.

3.1.1 Preschool Surveys

Three Demographic Health Surveys (DHS) were carried in 1987, 1995 and 1998/1999. This type of survey is known in Guatemala as the "Encuesta Nacional de Salud Materno Infantil." The DHS surveys are available to users at the following web site: http://www.measuredhs.com. In addition, a rural only survey was carried out in 1995 (EGSF) and a World Bank-sponsored, national survey was completed in 2000. The latter is known in Guatemala as the ENCOVI survey (Encuesta Nacional de Condiciones de Vida).

Demographic Health Surveys

The U.S. Agency for International Development's (USAID) Bureau for Global Programs, Field Support and Research, Center for Population, Health and Nutrition (PHN Center) supports a 10-year results package entitled Monitoring and Evaluation to ASsess and Use REsults (MEASURE). The objective of MEASURE is to improve and institutionalize the collection and use of data by host countries for program monitoring and evaluation and for policy development. As a key component in the MEASURE program, the Demographic Health Surveys program is specifically charged with the task of collecting, standardizing and analyzing reliable demographic and health data for regional and national family planning and health programs. The DHS surveys are funded by USAID and implemented by Macro International, Inc in collaboration with national partners. In the case of Guatemala, the partners were INCAP for the 1987 survey and the "Instituto Nacional de Estadística" (INE) for the 1995 and 1998/1999 surveys. The 1987 survey was nationally representative, but weights were not provided with the data files released to the public; the 1995 and 1999 surveys were nationally representative and weighted by department. The three surveys are well suited for comparisons over time because of their common, rigorous, and standardized methodology.

The 1987 DHS survey was carried out between October and December and provided data for 5,459 households, 5,160 women of reproductive age (15 to 44 years) and 2,437 children (3 to 36 months of age). Data were provided for the following regions: Guatemala City and Central, Southwest, Northwest, North, Northeast and Southeast regions. The 1995 survey was carried out between June and December and provided data for 11,754 households, 12,403 women of reproductive age (15 to 49 years) and 9,952 children (0 to 59 months in age). Data were provided for the same regions as in the 1987 survey. Finally, the 1998-99 DHS survey was conducted at a different time of year, from November to April. It provided data for 5,587 households, 6,021 women of reproductive age (15 to 49 years) and 4,943 children (0 to 59 months) and was the first to provide data for the Peten region.

The "Encuesta Guatemalteca de Salud Familiar" (EGSF): Guatemalan Family Health Survey

The EGSF was designed to investigate children's illnesses, problems experienced by women during pregnancy, and the use of health services in rural Guatemala. The survey was carried out between May and October 1995 in 60 rural communities located in the departments of Chimaltenango, Jalapa, Suchitepéquez, and Totonicapán. The survey covered the respondent's background, maternal and child health, the family's social and economic background, and women's health beliefs. More information is available in a report by Goldman and collaborators (2001). The sample was selected in two stages. In the first stage, 15 small rural communities (ranging from 100 to 1,800 households each) were selected randomly from each of the four departments. Communities were selected with a probability proportional to population size to yield self-weighting samples within each department. In the second stage, 100 households were chosen randomly from each of the 60 communities. The sample was not self-weighting across departments. The total sample consisted of 4,800 households. The height and weight of 3,270 children less than 5 years old were measured. The overall response rate of the survey was 89 percent.

The "Encuesta Nacional de Condiciones de Vida" (ENCOVI): Living Standards Measurement Study (LSMS) Household Survey

The ENCOVI provides comprehensive, socio-economic information about welfare and poverty levels of people, households and communities of the different regions of Guatemala. The ENCOVI adapted the LSMS methodology developed by the World Bank (detailed information can be found at http://www.worldbank.org/lsms/country/guat/gt00docs.html). Data collection was completed between July and November 2000. The survey gathered information on the characteristics of the house, social capital, citizenship, participation in public social programs, demography and migration, health, education, use of free time, labor market and income, consumption and expenses, assets, business, agro-industry, savings and credit. The sample was selected in two stages. In the first stage, the census segments were distributed by region (same DHS regions, see above), area (urban and rural) and strata (high, medium and low) and selected with equal probability (not self-weighting sample). In the second stage, compact segments of 12 households for each rural area and 6 for each urban area were chosen randomly. The effective sample size was 8,925 households and 5,740 children less than 5 years old were weighed and measured.

3.1.2 School Height Census

School Height Censuses provide summary statistics on the distribution of growth retardation within and among geographic units. The basic methodology has been described by Valverde and colleagues (1985), and has been extensively implemented in Latin America (ACC/SCN 2000). Customarily, all children in their first year of primary education are measured by their teachers, and for analysis, the raw height measures are transformed into age- and sex-standardized measures based on the National Center for Health Statistics/World Health Organization

(NCHS/WHO) international growth reference population (WHO, 1995). These measures are referred to as height-for-age z-scores (HAZ). Primary school begins at age seven in Guatemala, however the age of children attending the first year generally ranges between six and nine years and even older. The 1986 School Height Census included 203,260 first graders. The 2001 School Height Census included 381,421 first graders.

The School Height Censuses of 1986 and 2001 provided data about school identity, type, location (county or "municipio") as well as the birth date, height, date of measurement and sex of each child. The 2001 census also included information about the child's mother tongue.

The government of Guatemala produced a poverty map in 2001 using Hentschel's method. Detailed information about the construction of the map and the estimates about the percentage of poor people at the county level can be found at: http://www.segeplan.gob.gt/Spanish/pobreza/docs/mdprobreza/SEGE_P00.HTM. We used these data to investigate the association between stunting and poverty.

3.1.3 Selection of Ages

In order to insure comparability in key statistics across the preschool surveys, we selected the age range 3 to 36 months as the key age group because all surveys included this age group. This age group is also a high risk group for the development of stunting. However, data for other age groups were used for some analyses as will be seen below. The age of the children in the School Height Census files we obtained had been restricted to the age range of 6 to 9.9 years.

3.1.4 Data Cleaning and Final Data Sets

We developed a simple method of assessing data quality of the height data, measured as in centimeters with one decimal point (XXX.X). The frequencies of the recorded values for the decimal place in the School Height Census data were compared to those in the three DHS studies. Ideally, there should be about 10% of values for each digit; poor measurement will reveal bunching around zero and five. Another approach was to inspect the standard deviation of HAZ. One would expect a standard deviation of one. If the variability in the study population is greater than in the reference population, the standard deviation will be larger and if less, the standard deviation will be smaller. From experience, studies usually find standard deviations of around 1.5. Surveys with poor measurement will inflate the variability, in which case the standard deviations will be large.

Standard deviations from the reference median for height (recumbent length for children less than 24 months old and the standing height for children born 24 or more months prior to the measurement), weight, and weight-for-height (Z-scores) were calculated by Macro International and included in the DHS datasets. The Z-scores were calculated using the NCHS/WHO reference population (http://www.cdc.gov/growthcharts/). All records with z-scores below -6 or above 6 were considered outliers and deleted, as were those cases with a combination of HAZ and WHZ values where one was below –3.09 and the other above 3.09.

The sample sizes for the cleaned data sets are given in Table 1 for preschool children 3 to 36 months. Four samples are shown: A, the total sample of children 3 to 36 months sample before deleting any cases because of data cleaning; B, the sample after deleting cases with implausible anthropometric values (referred to as the "unrestricted" sample in the presentation of results); C, complete data not only for anthropometry but for all key determinants and covariates (referred to as the "analytic sample"), and D, a special analytic sample restricted to children 12 to 36 months and to birth order greater or equal to two. Sample D was generated to explore relationships with birth interval (which has no meaning for first-born children) and for a feeding index (see section 3.1.5.5) we created for children 12 to 36 months.

The final samples sizes for the School Height Census were 203,260 for 1986 and 380,578 for 2001. Data cleaning had already been done at INCAP, where the files were prepared, and no cases were deleted by us due to implausible anthropometric values. INCAP deleted cases with age outside of the range 6 to 9.9 years or with incomplete data for the estimation of age or if missing height; in addition, cases with height values outside the range 70.0 – 151.0 cm and/or HAZ values outside the range –5.00 to +5.00 were also excluded by INCAP.

3.1.5 Key variables

Dependent variables: Stunting and birthweight

After HAZ was generated, stunting was defined as any HAZ value less than –2 as recommended by WHO (WHO, 1995). Although analyses were also carried out with HAZ as a continuous variable, we decided to present only the analyses using the categorical variable "stunting" because this was of greater interest to USAID. Birthweight was expressed in grams. Low birthweight was defined as less than 2500g (WHO, 1995).

Covariates

The child's age and gender were covariates. The age of preschool children was expressed in months and was coded as two dummy variables: age < 12 months and age 24-36 months, leaving the age group 12 to 23 months as the reference group. This was done, as will become clear later on, because children less than 12 months are less stunted than those 12 to 23 months of age, as would be expected of a cumulative process. Children aged 24 to 36 months have similar levels of stunting as children 12 to 23 months, and the variable codes only the fact that they are older. The age of school children was expressed as a continuous variable in years.

Gender is another important covariate as boys and girls may be treated differently. Child gender was coded as a dummy variable: female =1, male =0.

Ethnicity, residence and region

Ethnicity, residence and region are important variables because they help in identifying the groups, whether social or geographical, that are more affected by malnutrition.

Ethnicity and residence are related to poverty. Traditionally, the poorest of the poor in Guatemala have been the indigenous peoples who live mostly in rural areas. If we believe Indian children have the same growth potential as Ladinos, that we should be able to explain away the association between ethnicity and stunting after accounting for differences between the groups in rates of poverty, education, access to health services and other factors. Similarly, there is nothing inherent to residing in rural areas that should increase the risk of stunting. Adjustment for these same variables should also explain away the association with stunting.

Interviewers for the DHS surveys identified subjects as Indigenous or Ladino. We can envision several characteristics that could be used in this process: language, dress, surname, and appearance. Concerned by the use of an observer's assessment, we decided to compare the concordance of ethnicity as determined by the interviewer with the household's primary language. Results indicated high concordance (Kappas for the 1995 and 1999 surveys were 0.75, 95% C.I. 0.73-0.76%, and 0.79, 95% C.I. 0.77-0.80%, respectively). Therefore, we felt the DHS determination of ethnicity was valid for our analyses. The classification of ethnicity is not fixed but is fluid and for example, acculturated Indians, who have learned Spanish, obtained more education and wealth, may at some point abandon Indigenous dress and identity and "cross over" to the Ladino group. We coded ethnicity as Indian=1, Ladino=0. Rural areas was coded as Rural = 1, Urban =0.

The metropolitan area of the country is the richest in the country while the Northwest is one of the poorest. Each region was coded as a dummy variable with the metropolitan region reserved as the reference category.

Family level measures of Food, Health and Care

DHS and other surveys offer various but limited indicators of family measures of what UNICEF calls Food, Health and CARE (UNICEF, 1998).

Socioeconomic status (SES) is a powerful proxy of the family's availability of resources to acquire food, health and care. The DHS surveys do not provide information about income, which economists might consider the gold standard, but do have considerable information about basic needs and assets. We developed an index from information about four basic needs (piped or bottle water, access to a flush toilet, a finished floor, electricity) and six types of assets (radio, television, refrigerator, bicycle, motorcycle, car). These variables were chosen because all three DHS surveys provided information for these items. For example, information on tractor ownership was not included in our index because it was only collected in the 1987 survey; similarly, we ignored the type of wall and roof materials because this information was not collected in 1987 but was in 1995 and 1998/9). Using SAS® PROC FACTOR and entering the variables noted above, we conducted a factor analysis separately for each survey. Each factor has a mean of zero and a standard deviation of one (i.e., they are standardized). Our indicator of economic status thus combined both household water and sanitation information with household wealth. The factor analysis confirmed that these variables "hang together" as a cluster of interrelated variables and for this reason we did not use separate indices of sanitation and wealth. The continuous index was divided into tertiles (using PROC UNIVARIATE to determine the best cut points). The resulting tertile categories did not precisely contain 33.3% of the population each due to the fact that some combinations of needs and assets clustered and resulted in a large number of households with the same factor score. This was especially true for the 1987 survey; the lack of sample weights in the 1987 survey also contributed to more clustering.

The tertiles were further broken into two dummy variables, high SES and low SES, leaving the middle group as the reference.

We considered several measures of access and use of health services. One option was vaccination data. However, because these data were gathered largely through recall (i.e. few mothers could present health cards for inspection), the quality of these data was poor. We settled on a simple indicator based on questioning mothers whether they use a modern form of birth control or not. We coded this variable as 1 if a modern method was used and as 0 if not. This variable provides information not only about access to health services, through which family planning is provided, but willingness to use the services as well.

Several measures of "Care" were available. Foremost is maternal education, which while also related to economic status, is known to be a good predictor of caring practices, child nutrition and child survival (Smith et al, 2001). We coded the highest grade attained into three categories: no formal education (0 years), primary or less (1 to 6 years) and at least some secondary education (7 or more years of schooling). From this information, we created two dummy variables, no education and at least some secondary education (leaving the middle category as reference).

We used other measures of Care as well. We assumed that a mother who worked outside the home would be less able to care for her child than a mother who stayed home. We created a dummy variable "mother works" coded as 1 = works outside the home, and 0 = does not work. Given the interest of Guatemala's USAID mission, we also generated variables that proxied the mother/child ratio, under the assumption that better care is provided when there are fewer young children in the household. The number of children in the household under five years of age, was coded as two dummy variables contrasting the low (1 child) and high (3 or more) ends of the distribution, leaving the category of 2 children as the reference. Similarly, we generated two dummy variables as follows: low birth order (1^{st} or 2^{nd}) and high birth order (5^{th} or more), leaving the middle group, birth order 3^{rd} and 4^{th}, as the reference group.

We also created several variables that provide important information about the mother's physiological potential to provide for her child, particularly during the intrauterine period. This type of variable does not fit easily within the UNICEF's framework in Figure 1. Perhaps this type of variable can be considered to be a proxy of intrauterine nutrient availability. One variable is maternal age. The literature shows that both young as well as older mothers are at greater risk of delivering a small baby (Kline, Stein and Susser, 1989). Thus we coded maternal age as two dummy variables: young (age 20 years or less) or older (35 years or more), with the category of mothers 20 to 34 years as the reference. Maternal height information was available for all but the 1987 survey. Short maternal stature can result from genetic causes but in Guatemala, it is more likely to reflect the effects of early childhood nutrition and infection on growth. Mothers who were stunted as children most likely grew up to be very short adults (Martorell et al, 1998). Many studies have shown that maternal height predicts poor intrauterine growth (Kramer, 1998). Hence, we can use maternal height to account for generational effects. We divided the distribution into tertiles and coded maternal height into two dummy variables: short (less than 144.9 cm) and taller (greater than 150.5) with the group of mothers in the middle, 144.9 to 150.5 cm, left as the reference category.

A related variable is birth interval. Research in Guatemala has shown that short birth intervals lead to maternal depletion because of overlap of pregnancy and lactation and/or because there is little time between pregnancies during which the mother is neither pregnant nor breastfeeding (i.e. the recuperative interval is short) and therefore in a position to recuperate from these physiological stresses (Merchant et al, 1990 a, b). Short birth intervals are therefore associated with poorer fetal growth. It is also likely that having two closely spaced children will also impact on childcare. We created a dummy variable coded as "0" when the preceding birth interval was less than 24 months, and "1" when greater than or equal to 24 months.

Diet and illness at the individual level

Some types of data, such as individual measures of diet and illness, are best collected through repeated assessments, that is, through longitudinal studies. Cross-sectional surveys can provide accurate data for illnesses for a few days prior to the date of interview; extending the recall period to weeks, months or years introduces considerable error. Data from longitudinal studies in Guatemala, collected every two weeks during the child's life, showed that diarrheal diseases are powerful determinants of child growth (Martorell et al, 1975 a, b). Regrettably, given the limited quality of the illness data in the DHS surveys (a single, 2-week recall survey), we were unable to include these variables in our analyses.

A similar problem is encountered with diets. The 24-hour recall survey is often used in studies but because of large day-to-day variability, several separate such recalls are required to provide a reasonable estimate of the usual intake of the child. The DHS surveys did not include 24-hour recall surveys or other measures of actual intake. Rather, data were collected about consumption of selected food items in the previous 24 hours or 7 days, without regard to amounts. Questions asked included consumption of breastmilk, use of the bottles for feeding and meal frequency. We decided to use these data because it is likely that patterns in the recent past represent longer term patterns. Also, previous authors created an index of infant feeding based on these data and found it to be useful in analyses (Ruel and Menon, 2002). We used Ruel and Menon's (April, 2002; http://www.ifpri.org/divs/fcnd/dp.htm) methodology for creating a child feeding index. Specifically, the variables used to create the feeding index were breastfeeding, use of baby bottles in the previous 24 hours, dietary diversity, food group frequency, and meal frequency. The index was made age-specific for 6-9, 9-12, and 12-36-month age groups. Survey- and age-specific feeding tertiles were also created. Finally two dummy variables were created: low feeding index and high feeding index, with the middle group left as the reference category. A complete overview of the index construction process and a summary of the construction of the index are attached as Table 2.

3.1.6 Analytic Methods

We estimated levels of stunting and yearly rates of decline and compared these values to those published by WHO researchers for various regions of the world (de Onís, Frongillo and Blöessner, 2000). By taking into account current levels of stunting and the historical yearly decline in the rates, we computed the number of years it would take to eliminate the problem of stunting for Ladinos and Indians, that is, to reach 2.3%, the value in the reference population (i.e., the value expected below –2Z in the reference population). Census data for Guatemala was obtained to estimate the number of stunted children for 1987, 1995 and 1999. Information about the population of Guatemalan children aged 0 to 36 months was received from Patricia Rowe, Chief, Population Studies Branch, International Programs Center, Population Division, U.S. Census Bureau; we took the values for 0 to 12 months and divided them by 12 to obtain a rough estimate of the number of births per month, and then subtracted the births corresponding to 3 months from the total to arrive at an estimate for children 3 to 12 months. This was then added to the number of children from 13 to 36 months to arrive at the total for children 3 to 36 months.

We carried out univariate analysis of relationships with stunting for a few more variables than we described above. We retained only those variables that showed a statistical association with stunting in at least one of the surveys. The variables not retained included religion, childhood illnesses in the last two weeks and vaccination data. All our key variables were categorical and their association with stunting was tested by chi-square. Multiple logistic regressions were carried out to generate odds ratios of the risk of stunting corresponding to each of the predictor variables. Several models were generated. The simplest included only age, gender and ethnicity. Then, progressively, we included other variables, such as education and SES, to examine their inclusion on the magnitude of the odds ratio associated with ethnicity. Our hypothesis was that the relationship between ethnicity and stunting would disappear once we controlled for these factors.

We also examined how the predictor variables differed between Indians and Ladinos for each of the surveys. By examining these differences across the surveys (i.e., across time) we also assessed whether change (i.e., improvements) was more pronounced among Ladinos than Indians which is what we expected.

We used SAS for all analyses, specifically SAS® for Windows, version 8.12. Statistical significance was declared for probability values (P) values less than 0.05, although P values less than 0.10 were noted in the tables.

4. Results and Discussion

The results are given first for preschool children followed by those for school children.

4.1 Preschool Children

4.1.1 The development of stunting

What are the critical ages for the development of stunting in Guatemala? How much of the retardation is intrauterine and how much postnatal? These are questions that have important implications for age targeting and program design.

A commonly used measure of intrauterine growth retardation is birthweight, specifically, low birthweight. The DHS surveys contained data for birthweight, which we analyzed. We found that the prevalence of low birthweight was 12%, in the 1998/99 survey, a low figure compared to other developing countries (de Onís, Blössner and Villar, 1998). If true, this would strongly suggest that, in Guatemala, postnatal causes are more important for stunting than intrauterine growth retardation.

We reviewed in detail the nature of the birthweight data available in the DHS surveys. The results for the 1998/97 survey are given in Figure 2. Of 4915 children born in the previous 5 years to the survey, mothers reported that only 75% were actually weighed, and of these, only in 6% of cases could the mother produce a card where the weight was recorded. Most weights available for analysis, therefore, were recalled by the mother.

The birthweight data in the DHS surveys have two types of problems. First, only 72% of children were weighed and even if we knew these weights accurately, the resulting figure would likely be biased because the 28% not weighed were probably, on average, from poorer households and probably weighed less than those weighed at birth. Secondly, most of the weights were obtained by recall and the quality of these data is unknown. For these reasons, we discarded the birthweight data from further analysis.

Some of the surveys provided data for length for neonates and this allowed us to estimate the average length z-score at birth, also an indicator of intrauterine, growth retardation. Two such surveys were the 1995 EGFS survey and the 1998/99 DHS. In figure 3, we present the mean height z-score by month from birth to 36 months. The average HAZ at birth for a Guatemalan child is about 1 standard deviation below the reference mean, indicating that stunting begins in utero. Growth retardation continues until about 18 months of life and thereafter, because the z-scores remain more or less constant, we can conclude that Guatemalan children grow as fast as reference children. Data from other countries show a similar pattern, with the nadir varying somewhat but generally occurring in the second year of life (Shrimpton et al, 2001). In settings of poverty therefore, growth retardation starts before birth and continues until about 1½ years of age, and then children tend to grow normally. This has important implications in terms of directing interventions to mothers and young children.

4.1.2. Descriptive Statistics for the Dependent Variables

Descriptive statistics based on the analytic sample are given in Table 3 for all anthropometric indicators (height, weight and weight for height) for all the five surveys, and for children 3 to 36 and 37 to 60 months. Mean z-scores, corresponding standard deviations and percent of cases below the –2 SD cut off points are shown.

Stunting is the major form of growth retardation in Guatemala. For example, z-scores were around –2.0 for HAZ but near zero for WHZ. The prevalence of stunting exceeded 50% in some surveys whereas wasting never reached 5% in any (recall that the reference population has, by definition, 2.3% below –2 SDs). Underweight is a composite indicator, but in the absence of wasting, as is the case in Guatemala, it is largely a reflection of stunting. Values for children 3 to 36 months were only slightly worse than for children 37 to 60 months, suggesting that stunting develops earlier than 36 months. We analyzed two surveys from 1995, a nationally representative DHS survey and the EGSF, a rural survey. As would be expected, we found more stunting and underweight in the rural survey.

The standard deviations of the mean Z score should have a value of 1.0 if the variability in the survey population is as in the reference population. Higher values may identify a more variable population and/or large measurement error. The standard deviations in Table 3 do not look unusual compared to those from typical DHS surveys. However, the ENCOVI survey had large standard deviations before data cleaning. For HAZ, they were 1.8 for children 3 to 36 and 1.7 for children 37 to 60 months. However, after cleaning, the standard deviations were only slightly greater than for other surveys.

4.1.3. Trends in Stunting

Trends in stunting are given in Figure 4 for both the unrestricted (Panel A, sample B) as well as the analytic sample (Panel B, sample C). The prevalence of stunting clearly declined across the three DHS surveys, from 57.8% stunting in 1987 to 48.8% in 1995, and further to 43.2% in 1998/99. In the DHS surveys, the values for the unrestricted and analytic samples were nearly identical indicating that missing data patterns did not introduce any biases. The ENCOVI 2000 data set gave equivocal results. The unrestricted data set suggested that the decline in the prevalence of stunting stagnated in recent years or even increased slightly. The analytic sample, on the other hand, suggested a continued decline. We are inclined to dismiss the latter value because it may reflect missing data biases in the ENCOVI survey. Specifically, in this survey, cases missing information for one or more of the predictors had poorer anthropometric measures than cases with complete data. From Table 1, we conclude that about 20% of cases were lost in the ENCOVI survey because of missing data for the predictors, whereas this was less than 3% for the DHS surveys.

Guatemala is a country with very high fertility rates. There were 880,372 children 3 to 36 months of age in 1987, a figure that grew to 1,057,505 in 1995 and to 1,169,156 in 1998/99. Because of population growth, the gains achieved in reducing stunting over more than a decade were completely negated; there were approximately the same number (a half million) stunted Guatemalan children (aged 3-36 months) in 1998/99 as in 1987 (Figure 5).

Stunting levels and trends in Guatemala are compared in Figure 6 to values observed in three regions of the world over the last 20 years. Stunting clearly declined in Asia and Latin America but there was little or no change in Africa (de Onís, Frongillo and Blössner, 2002). In many countries in sub-Saharan Africa, rates of stunting actually increased, reflecting declining food security, deteriorating access to health systems and the emergence of HIV/AIDS. Astonishingly, the levels in Guatemala were higher than the mean levels for Asia and Africa and were extremely high compared to the mean for Latin America.

The high level of Guatemalan stunting masks important ethnic differences. The decline among Ladinos was faster than observed for Asia and Africa, while for Indians, who make up 40% of the population, the values remained high, with less change (Figure 7). While stunting is decreasing in Guatemala faster than in Asia, Africa or LAC, these improvements are enjoyed disproportionately by Ladino children (Figure 8). We will see shortly (Table 4 below) that a greater proportion of Guatemalans were identified as Ladinos as time went on, which because of the greater fertility rate of the indigenous population suggests differential migration and/or that a significant number of Indians effectively shed their identity. Thus, a possible contributing cause of the widening gap in stunting between Ladinos and Indians (see Figure 7) is that wealthier Indians may be crossing over the ethnic line such that those continuing to be recognized as Indians are the poorest. Extrapolating these rates (and ignoring social dynamics in the definition of these two groups), it will take 20 years for stunting to cease to be a problem among Ladinos (i.e. to reach a "normal" prevalence of 2.3%) but over 80 years among Indians. This is a rough estimate involving many assumptions.

4.1.4. Descriptive Statistics for Independent Variables

As noted in the methods section, we explored the relationship between many variables and stunting and retained only those variables showing a significant relationship. Further, we expressed all continuous distributions in terms of categories; thus, all our predictors are either naturally categorical (e.g. child's gender) or have been expressed as categories. We present descriptive and univariate analyses only for the nationally representative surveys: the three DHS surveys and the ENCOVI survey (leaving out the EGSF survey, which had only rural representation).

The percent distribution of the population by variable and survey is given in Table 4 using the analytic sample (as described in Table 1). It should be noted that the 1987 DHS and the ENCOVI survey did not provide data for all variables. Also, there was clearly a problem with the education information in the ENCOVI survey and for this reason, we did not use these data in further analyses. We will come back to the data in Table 4 when we note trends in the predictors of stunting (Section 4.1.8).

4.1.5. Univariate Relationships with Stunting

The percent of children stunted by category of each of the predictor variables is given in Table 5 for all four surveys. Also given are chi-square p values, which test whether the association is significant for each univariate relationship. For added emphasis, we present figures for the most interesting relationships.

For the most part there is little relationship between a child's gender and the prevalence of stunting. Only in the 1998/99 DHS survey was there a significant difference, with boys having a significantly greater prevalence than girls (Table 5).

There is considerable variability in the extent of stunting among regions at baseline and across time in the DHS surveys (Figure 9). The regions with a prevalence greater than 60% in 1987 were the Northwest, Central and Southwest regions and those with a prevalence below 45% were the Metropolitan and Northeast regions. The region that changed the most was the Metropolitan region, which dropped from 44.2% stunting in 1987 to 25.8% in 1998/99. Other regions that experienced a decline were the Southeast, Central, Southwest and Northwest regions. The two regions with stagnant values were the North and Northeast regions. The region of Petén, with a prevalence of 42.6%, was included only in the last survey. The ENCOVI 2000 regional statistics were quite different from those of the 1998/99 DHS survey, the one closest in time. The differences between both surveys for many of the regions were so large that they were unlikely to have occurred in the short span of time between 1999 and 2000 (e.g., differences were greater than 10 percentage points for the North, Northeast, Northwest and Petén regions). This suggests that the sampling procedures of DHS and ENCOVI were very different and that comparisons of rates of stunting in DHS and ENCOVI surveys may not be appropriate.

There was significantly more stunting in rural compared to urban areas in all surveys (Figure 10 and Table 5). From Figure 10, we can also observe that the level of stunting declined by a greater extent in urban areas. Thus, the decline in rural areas was from 62.0% in 1987 to 50.1% in 1998/99, a difference of 11.9 percentage points compared to a drop in urban areas from 47% in 1987 to 31.8 % in 1998/99, a difference of 15.2 percentage points.

Stunting was more common among Indians than Ladinos (Figure 11). The decline in stunting was greater for Ladinos, a difference of 16.2 percentage points between 1987 and 1998/99 values, compared to a corresponding difference of 8.3 percentage points for the Indian population.

The relationship between maternal education and stunting was among the most powerful we uncovered and, as was the case for residence and ethnicity, the rate of decline was fastest among the more educated (Figure 12). Whereas the decline in stunting between 1987 and 1998/99 was 14 percentage points among children of mothers with more than 7 years of education, it was 7.2. percentage points among children of mothers with no education. What this means is that the country became increasingly polarized in terms of stunting. By 1998/99, the degree of stunting among children of mothers with no education was 61.3%, extremely high by world standards, and among mothers with more than 7 years of education it was 11.2%, similar to levels found in better off developing countries such as Brazil.

Another strong relationship uncovered was that between SES and stunting (Figure 13). As would be expected from previous relationships, the rate of decline was more pronounced among those of higher than those with lower SES.

Several maternal characteristics were strongly related to stunting. Maternal height, available only for the last two DHS surveys and the ENCOVI survey, was a strong predictor of stunting (Table 5 and Figure 14). Maternal age tended to have a U-shaped relationship, with the lowest levels of stunting found in the middle category, women aged 20 to 34 years (Figure 15). However, differences between young mothers (< 20 years) and the middle group were not as consistent or as large as those between older mothers (≥ 35 years) and the middle group. Use of modern birth control, reflecting access to health care as well as modernity, was strongly related to less stunting (Figure 16). Working outside the home, as expected, was related to greater stunting (Figure 17).

Several demographic indicators were related to stunting. Greater birth order (Figure 18), a greater number of children under 5 in the home (Figure 19), and short birth intervals (Figure 20) were associated with greater levels of stunting.

Finally, the feeding index was related to stunting in the expected direction (Figure 21). Children 12 to 36 months with a poorer feeding index were more stunted than children with a better feeding index.

4.1.6. Multivariate Relationships With Stunting

One of our major research objectives was to assess the independent contributions of each predictor variable. Another important objective was to determine if we could “explain away” the effect of ethnicity after accounting for residence, education, poverty and so on.

We thus developed several models, the results of which are shown in Table 6 for the 1998/99 DHS survey. The first model included two covariates, child age and gender, as well as ethnicity. Being female was a protective factor associated with a 25% reduced probability of being stunted. Children younger than 12 months were likely to be more stunted than older children. Indian children were 4.2 times (420%) more likely to be stunted than Ladino children. In models 2 through 7, we introduced additional predictors to observe how the parameter for ethnicity changed and how the relative importance of each predictor changed as new information was incorporated; the order of introduction of variables was arbitrary. In model 2, residence was introduced; compared to living in the urban area, residing in the rural area nearly doubled the probability of stunting, even in a model that also included ethnicity. Ethnicity in turn became slightly attenuated after considering residence. Models 3 and 4 added maternal education and socioeconomic status. The relationship between residence and stunting disappeared at this point. In other words, there was nothing particularly unique to living in the rural area that predicted more stunting. Rather, the relationship was explained entirely by the mere fact that those from rural areas were more likely to be Indians, to have low levels of education and to be poorer. Also evident is that both education and SES were independent predictors of stunting. Low education increased the probability of stunting whereas higher levels of education and higher SES decreased it. Interestingly, low SES did not increase the probability of stunting relative to the middle SES category; there may be a threshold beyond which stunting declines rapidly. The ethnicity parameter became progressively attenuated as more information was incorporated in the model. In model 5, maternal height was added; both being shorter and taller were strongly predictive of the risk of stunting and in the expected direction. Also, the ethnicity parameter was brought to below 2 in model 5. Adding several other variables in model 6, specifically maternal age, use of modern birth control, maternal work outside the home and birth order, reduced the odds ratio for ethnicity to 1.8. Being a young mother and high birth order were predictive of higher risk whereas use of modern birth control and low birth order were protective factors. Addition of the regional dummy variables had little further impact on parameters for ethnicity or other factors. Since the reference category was the metropolitan area, which had the lowest prevalence of stunting, the parameters for the regional variables were all indicative of greater risk of stunting, and several were statistically significant.

Results from the full model are given for all three DHS surveys in Table 7. The values for 1998/99 are repeated in the third column of Table 7 for ease of comparison to 1987 and 1995 results. The most striking feature of these results is how similar they are across surveys, demonstrating the relationships to be robust and reproducible. Some minor differences in results can be noted. "No education" was not significant in the 1995 survey but was a significant risk factor in the other two surveys. Similarly, low SES was a significant predictor of risk of stunting in the 1987 and 1995 surveys but not in the 1998/99 survey. Young maternal age at birth was a significant risk factor only in the 1987 and 1995 surveys. In the 1995 survey, and in contrast to the result in the other surveys, use of modern birth control was not significant while low birth order was a significant, protective factor. Finally, the regional dummy variables were stronger and more predictive of risk in the 1998/99 survey, reflecting the greater level of reduction in stunting over time in Guatemala City, the reference category, and the increased polarization of the country.

An additional model was generated to add information about birth intervals and the feeding index, but this was restricted to the age group 12 to 36 months and to children of birth order two or more. The 1987 survey did not provide the data necessary to generate the feeding index. As shown in Table 8, short birth intervals were predictive of greater risk of stunting in both the 1995 and 1998/99 surveys but the feeding index was not associated with stunting in either survey.

The 1995 and the 1998/99 DHS surveys provided data for children 36 to 60 months of age and this allowed us to generate the equivalent of model 7 for older children (Table 9). The only change in the specification of the model in older children was the handling of age, which was expressed as a continuous variable. The pattern of relationships in older children was similar to that found for younger children. A few differences appeared. For 1998/99 and in contrast to younger children, maternal education was not significant for older children but low SES was. In general, maternal age and birth order were stronger predictors in older children.

4.1.7. Additional Analysis with Feeding Behaviors

The results presented above indicated that a better score on the feeding index was a protective factor against stunting in univariate but not multivariate analyses that controlled for household, maternal and individual characteristics. This is not entirely surprising. Maternal education and poverty influence stunting by altering variables such as feeding behaviors; adding both education and feeding behaviors to the equation would thus be expected to lessen the independent effect of each variable. Also, education and other background variables can be measured with greater precision in a cross-sectional survey than is possible for feeding behaviors, a type of information best collected through longitudinal studies. For these reasons, it is not surprising that the effect of the feeding index disappeared in the multivariate analyses.

The feeding index is a composite indicator and it is possible that some of its component behaviors were more important than others. In Table 10 we present additional univariate analyses to decompose the component effects of the feeding index. The feeding index was related to stunting not only at ages 12 to 36 months but also at ages 6 to 9 and 9 to 12 months as well, but only in the 1995 survey. Breast-feeding and bottle-feeding were associated with stunting but in the unexpected direction; that is, breastfeeding was associated with more stunting and bottle feeding with less!

Greater dietary diversity was generally associated, as expected, with less stunting except among 6 to 9 and 12 to 36 month old children in the 1998/99 survey. All other behaviors - high use of milk, the feeding of eggs, fish and poultry, high meat consumption, greater consumption of roots and tubers and greater meal frequency- were generally associated, as expected, with lower rates of stunting.

The results above suggest that different components of the feeding index had different relationships with stunting and that these cannot easily be interpreted unless one controls for potentially confounding factors. Breastfeeding, for example, was more common among Indians and the poor whereas meat consumption was greater among Ladinos and the rich. In Table 11, we examined the effect of controlling for background variables on the relationship between feeding behaviors and stunting. The unadjusted relationship indicated that breastfeeding was associated with a greater risk of stunting but, after controlling for ethnicity, maternal education, SES, maternal height, use of birth control, birth order and region, the relationship disappeared in the 1995 survey. In the 1998/99 survey, the adjusted breastfeeding relationship suggested a protective effect of breastfeeding at ages 6 to 9 but a harmful effect among children 12 to 36 months. The practice of bottle-feeding, before adjustment, would appear to have been protective at several ages but harmful in children 6 to 9 months in the 1998/99 survey. Adjustment had a dramatic impact on the odds ratio for bottle feeding, erasing its apparent protective effect, with the only remaining significant relationship being a strong, harmful effect at ages 6 to 9 months.

Table 11 also has similar analyses for high consumption of eggs, poultry and fish, frequent consumption of meat and high number of meals. These variables would be expected to be confounded by poverty such that positive relationships might be attenuated after controlling for poverty. Before adjustment, several relationships with these variables were statistically significant, all suggesting powerful protective effects. After adjustment, the benefits of meat consumption remained for children 9 to 12 and 12 to 36 months. Surprisingly, adjusted results suggest that consumption of more than 4 meals a day was associated, in both surveys, with more stunting at ages 6 to 9 months but with better growth at ages 9 to 12 and 12 to 36 in the 1995 survey.

These analyses suggest the importance of feeding patterns, particularly the benefits of breastfeeding for infants, the dangers of bottle feeding, and the critical importance of animal foods in the diets of children. Because the studies most suitable for discerning these relationships are longitudinal studies, the results from cross-sectional studies, such as ours, should be interpreted with caution.

4.1.8 Explaining Change

We have shown that there was a decline in stunting in Guatemala over the last 15 years and that this decline was faster among Ladinos. Among Indians, the initial levels were very high and the decline was slower than average for developing countries. Can we explain the differential pattern of change in Ladinos and Indians in terms of differential rates of change in key determinants of stunting? Specifically, can we document that improvements in education, poverty and so on were greater among Ladinos than among Indians?

Comparisons between Indians and Ladinos are made in Table 12 for all key determinants and for all three DHS surveys. On virtually all indicators, the situation favored Ladinos and the difference in stunting between Indians and Ladinos, as we have seen through the multivariate analyses, can be explained to a large extent by differences in poverty and related factors. But has the change over time in these determinants been faster among Ladinos than Indians? If so, this would explain the more rapid decline in stunting among Ladinos.

To facilitate the comparison over time, we created several figures from the data in Table 12. Maternal education and socioeconomic status are aspects that can change appreciably over a period of 15 and which would have an important impact on stunting. Changes in maternal education are shown in Figure 22. Earlier we had seen that "no education" was a strong risk factor of stunting and that 7 or more years of schooling was a powerful protective factor. From Figure 22 it is clear that the percentage of women with no education declined among both Indians and Ladinos; however, the percentage of women with more than seven years of schooling hardly changed among Indians while it more when doubled among Ladinos.

The SES indicator was generated by factor analysis to have a mean of zero and a standard deviation of 1 for each of the surveys. To assess change over time therefore, the specific components that went into the elaboration of the index have to be examined, as we have done in Table 12. The same data are shown in Table 13 to more easily contrast changes across time within ethnic group. Clearly, Ladinos had a greater percentage of basic needs and assets than Indians did in all surveys. Both groups showed important improvements over time in terms of most components. The gap (difference between the percentage of Ladino and Indian households having the component) actually improved for water when 1987 and 1998/99 are compared but increased dramatically for floor, television, refrigerator, and car; for other components the gap remained more or less as wide.

A greater proportion of Ladinos than Indians lived in urban areas in 1987 and over time, the shift to urban areas was more pronounced among Ladinos (Figure 23). The 1987 survey did not provide information about maternal height; dramatic change would not be expected over the short time span between 1995 and 1998/99 (Figure 24). The differences in stature between Ladinos and Indians were dramatic, reflecting long-term disparities. Noteworthy is that the shift over time into the upper tertile of height was greater among Ladinos.

Maternal age at birth was slightly greater in Indian women and there was a tendency for age to increase over time in both groups. The best age group in terms of child outcomes is the middle group, which did not change over time among Ladinos but which decreased somewhat among Indians between 1987 and 1995 (Table 12).

The use of modern birth control was higher among Ladinos in 1987 and increased markedly over time only among Ladinos (Figure 25). The practice of working outside the home was greater among Ladinos in 1987; significant increases took place over time among both groups but more so among Indians such that the prevalence of this practice was only slightly greater among Ladinos in 1998/99 (Figure 26).

Ladinos have a slightly lower number of children under 5 and, over time, the number of households with only one child increased among Ladinos but decreased among Indians (Figure 27). The percent of children with a short birth interval was not significantly different between Ladino and Indians for any of the surveys, despite the large differences in use of modern methods of birth control; however, there was a small decline over time in short birth intervals among Ladinos (Figure 28).

Finally, Ladinos had higher values of the feeding index in the last two DHS surveys and the small degree of change that occurred from 1995 to 1998/99 did not alter this difference appreciably (Figure 29). Differences in the components of the feeding index and in the use of milks in child feeding are given in Table 12. Except for breastfeeding and use of grains, Ladinos had higher values for all feeding practices than Indians do. Except for the higher use of bottles and the lower rates of breastfeeding among Ladinos, which we can view as "bad" practices, all other differences favored Ladino children.

The results we have reviewed strongly suggest that there was more rapid improvement in household and individual conditions among Ladinos than Indians over the last 15 years and may help explain why improvements in stunting have proceeded at a faster pace among Ladinos.

4.1.9 School Height Census Results

The School Height Census is a low-cost approach, which provides disaggregated data on growth retardation at the local level. National nutrition surveys rarely provide representative findings at a lower level of disaggregation than that of large sub-national regions. The School Height Census can be a reliable and valid tool for small-area targeting of nutrition interventions (Morris and Flores, in press). However, in this analysis, our objective was to observe if the data provided by School Height Censuses showed the same trends in stunting observed in the DHS data.

By their nature and objective, School Height Censuses provide limited information on determinants of undernutrition. In addition, the measurement of height in the school census is done by teachers, and measurement error would be expected to be greater than in the DHS surveys where the measurement is done by trained technicians. This is exactly what is shown in Figure 30 which uses data from the 2001 school census and the 1998/99 DHS survey. The frequencies of the recorded values of the terminal digit clustered at 0 and 5 in the School Height

Census but were more evenly distributed in the DHS survey. This indicates better measurement in the DHS survey.

The prevalence of stunted children between the ages of 6 and 9, estimated from a particular School Height Census, is a reflection of growth retardation which occurred 4 to 7 years prior to the census date. This is due to the fact that stunting develops largely before age 2 years (see Section 4.1.1.).

When school enrolment rates are low, results from a School Height Census are likely to underestimate the extent of stunting. This is because children who do not attend school tend to be poorer and more stunted. Also, variable enrolment rates by region will distort inter-regional comparisons of stunting. Furthermore, variable enrolment rates over time will lead to biased estimates of changes in stunting.

According to the School Height Census data, there was practically no change in stunting from 1986 to 2001. The percent of children stunted in the 1986 School Height Census was 50.1% and in 2001 it was 48.8% (Figure 31). However, during the same period, school enrolment rates increased substantially from 70.4% for 1986 to 97.2% in 2001 (Ministerio de Educación, 2002). There was an increase of 87.2% in the number of children 6-9 years old measured in the two censuses, as compared to an increase of 39% in the estimated population of children 5-9 years (census data were available for 5 to 9 year olds only). Furthermore, the lack of schools in 1986 was concentrated in the poorest areas of the country, which raises the probability that the rate of stunting amongst 6 to 9 year olds was considerably higher than 50.1%. Thus estimates of change based on the school census data are biased downward and should not be believed, either for a specific county or region or for the entire country. Estimates of change for the country should be derived from the DHS surveys only.

Since school enrolment rates for 2001 were very high, we can compare the prevalence of stunting in the school census (48.8%) with the 1995 DHS unrestricted sample prevalence of stunting (48.8%) and, as expected, they agree remarkably well.

The female protective factor, identified in analyses with preschool children, is also shown to hold true among school children (Figure 32).

Finally, in Figure 33, we show a plot of the percentage of poverty versus the percentage of stunting at county level, using the School Height Census data of 2001. A clear relationship between poverty and stunting was evident in the expected direction ($r = 0.59$; $p < .0001$).

5. Conclusions and Recommendations

We present below our key conclusions, followed by preliminary recommendations for policies and programs.

5.1 Key Conclusions

5.1.1 Stunting is the Problem

Stunting was the major manifestation of malnutrition throughout the span of time examined, 1987 to 2000. We found that Guatemalan children were very short for their age but that their weight for height was normal. Wasting has never been recorded to be a public health problem in Guatemala. Recently, dramatic calls for attention to emerging hunger, wasting and clinical cases of severe protein energy malnutrition were made through the media, and this galvanized government, as well as bilateral and international agencies, to both measure the problem and to launch remedial programs. We did not examine the data to support the claim that wasting is now a problem and can only note that if indeed it is, it represents a new phenomenon. The recent experience needs to be reviewed systematically and monitored. In the meantime, attention should not be deviated from known existing problems, such as childhood chronic malnutrition.

5.1.2 Stunting Develops Before 2 Years

Stunting begins in intrauterine life and the process is essentially completed by two years of age. We were able to reach this conclusion despite the lack of valid birthweight data from the DHS surveys; we documented that children measured in the first month of life were already short by about one standard deviation of the reference population. Programs that reach older preschool children or are school-based may have their own desirable outcomes, but they will not make a dent on the problem of stunting.

5.1.3 Guatemala Has One of the Highest Levels of Stunting in the World

Guatemala has levels of stunting that are higher than the average for Africa and Asia, although it has greater per capita incomes. These findings should cause great concern among the press, the public, government and supporting partners.

5.1.4 Stunting Has Declined But the Gains Have Been Wasted

The good news is that social and economic progress has reduced the extent of stunting from 58% in 1987 to 44% in 1998/99 at rates faster than average for developing countries. We based these conclusions on analyses of three DHS data sets (the ENCOVI survey showed a number of methodological deficiencies and data oddities which led us to value it less than the DHS data sets). The bad news is that population growth completely negated these gains. There were as many stunted children in 1987 as in 1998/99. Striking relationships between demographic factors (a high number of children under 5, high birth order, short birth interval) and stunting provided additional support for family planning programs.

5.1.5 Stunting has Declined Faster Among the More Privileged

There was much greater progress in reducing stunting among children of Ladino ethnicity, urban and wealthier households and of better-educated mothers than among Indian children, from rural, poor households and from illiterate mothers. Over time, there was increased polarization of the country in terms of stunting. The worst off continued to show among the highest levels of stunting in the world while stunting was disappearing as a public health problem among the better off. We showed that the faster rate of decline among Ladinos was explained by their more rapid progress as measured by household assets and basic needs, maternal education and access to health services.

5.1.6 It is not "Natural" for Mayans to be Stunted

A common belief in Guatemala is that the Mayan indigenous peoples are naturally short and that genetic factors, not malnutrition and infection, explain their shortness. This is false. By taking into account poverty, maternal education, maternal stunting, and health, nutrition and demographic characteristics, we are able to explain most of the differences in stunting between Ladinos and Indians. We are not able to explain all of the differences however, and this may be due to unmeasured variables in the national surveys such as lack of access to services and diminished opportunities because of discrimination and prejudice. In Chile, where social and economic conditions are much better than in Guatemala, researchers have shown that there are no differences between Indians and non-Indians within poverty strata and that among Mapuches residing in Santiago, the capital city, there is virtually no stunting (Bustos et al, 2001). Therefore, the unusually high levels of stunting of Guatemalan Indian children can only be viewed as a reflection of the abject poverty, poor diets and heavy, infectious disease burden that afflict them.

5.1.7 Trends in Stunting Cannot Be Ascertained From the School Height Census Data

We showed that biases in the 1986 School Height Census, due to the fact that only about 70% of children went to school at that time, leaving out of the school system those more likely to be stunted, do not permit valid estimates of change. The 1986 and 2001 census should not be compared at national, regional or county level. Because enrolment rates in 2001 were approaching 100%, comparisons of data on stunting from the 2001 census with future exercises should be valid.

5.1.8 All Regions But the Metropolitan Region Have High Levels of Stunting

The metropolitan region had 26% stunting in 1998/99 and only 5% extreme poverty (Figure 33). At the other extreme, the northwest region had 66% stunting and 50% extreme poverty. All other regions had stunting levels which were very high and which ranged between 42 and 54%; their rates of extreme poverty were more variable and ranged from 17 to 52%. Thus, from a regional perspective, levels were high everywhere except in Guatemala City and this suggests that targeting by region for nutritional reasons has limited value. Targeting by smaller geographical units, residence (urban/rural) and by household and maternal characteristics (e.g., poverty) will be more useful.

5.1.9 Tackling Poverty Will Be Important But Not Enough

We estimated that at current rates of progress, it would take 20 years to eliminate the problem of stunting among Ladinos and over 80 years among Indians. As stressed by van Haeften (2000) and by Castro and Hernández (2001) in reports to USAID, poverty is a powerful determinant of malnutrition. Poverty alleviation needs to be a major goal of development programs but it should not be the sole approach to combating malnutrition. The data in Figure 33 tell us that although the relationship is powerful, other factors also play a role such that it is unlikely that poverty improvements alone will result in rapid declines in stunting. Maternal education had a powerful and independent effect on stunting which suggests that wisdom about how resources are used is also important. Feeding behaviors, such as breastfeeding for infants and the consumption of animal protein also proved important in explaining stunting levels. By accelerating economic change as well as promoting appropriate health and nutrition practices, the pace of change can be quickened.

5.2 Recommendations

It was not the objective of this study to assess and propose policies and programs in Guatemala to decrease child malnutrition. However, based on our results and on conversations with reports by representatives of USAID's cooperating agencies, we offer some suggestions for future focus.

5.2.1 Assessment

We recommend that the recent experience with the rising specter of famine and acute malnutrition be carefully documented and analyzed. We were impressed by reports of recent cases with clinical, severe protein-energy malnutrition, which had practically disappeared from pediatric wards of Guatemala. We did not examine the anthropometric data in detail but did observe possible inappropriate use and interpretation of indicators and cut off points. For example, WHO's recommendation to include only moderately and severely wasted children (red and orange in the Nabarro chart) was ignored and mild cases were also included (yellow part of the chart). At a minimum, the analysis of the data needs improvement. Possibly the problem of wasting is not as serious as believed, at least at a national level. If this assessment is important for policies and programs and for resource allocation, then it is important to make it correctly. In particular, it needs to be documented whether the phenomenon was a temporary shock or a more lasting change in the epidemiology of malnutrition in Guatemala.

5.2.2 Focus on Mothers and Young Children

The most elementary but most powerful recommendation we make is to focus on mothers and children under two in order to accelerate progress in addressing the problem of child malnutrition. There must be access to effective preventive and curative care, as well as effective family planning programs. These services, together with nutrition-specific actions, need to achieve the following three crucial steps for reducing stunting rates:

- improve intrauterine growth
- promote exclusive breastfeeding in the first six months
- improve complementary feeding

Existing programs should be examined in light of how well they address these objectives.

5.2.3 Income Generation Plus Health and Nutrition

Programs to promote economic development and programs to address child malnutrition should be viewed as mutually reinforcing, complementary strategies, rather than as competitors or trade-offs. There is considerable evidence and much of it from Guatemala that improved child nutrition is best viewed as a long-term economic investment. School achievement is one example. Evidence from Guatemala shows that the impact of schooling on learning and intellectual functioning is magnified when early childhood nutritional status is improved (Pollitt et al, 1993). In the short term, the family's economic well-being will also be enhanced by improved child nutrition. For example, diets such as those from rural Guatemala, which are corn-based, are low in protein quality and in micronutrients such as iron and zinc (Brown, Dewey and Allen, 1998a). Thus, we were not surprised that the consumption of animal foods (which are rich in zinc) was found to be an important protective factor against stunting. Recent evidence indicates that daily zinc supplementation reduces infant mortality (Sazawal et al, 2001), decreases stunting (Brown, Peerson and Allen, 1988b) and prevents diarrhea and pneumonia (Bhutta et al, 1999). The decrease in diarrheal disease incidence was around 20% and equivalent to that achieved by introducing water, while the decrease in pneumonia rates was large, around 40%. Clearly, the savings to families to be achieved through less diarrhea and pneumonia will be huge. Since daily zinc supplementation is impractical as a program, the consumption of animal foods by young children should be promoted. Another approach for zinc as well as other micronutrients is to promote consumption of fortified, complementary foods (e.g., Incaparina).

5.2.4 Options to Consider

Of the three key actions, the promotion of exclusive breastfeeding during the first six months and its maintenance into the second year is well developed and its benefits well known, as shown by a large randomized trial conducted in Belarus (Kramer et al, 2001). One would need to examine how effective and widespread these promotional efforts are in Guatemala.

Improving birthweight is not easy to achieve. Family planning can have significant returns. Postponing age at first birth to avoid teenage pregnancies and spacing births by at least two years will improve birthweights. Research from Guatemala shows that improving food intake during pregnancy reduced low birthweight by half (Lechtig et al, 1975). Also, iron-folate supplementation, as well as multiple micronutrient supplementation may improve birthweight (Ramakrishnan et al, 1999c). The control of reproductive tract infections may be important as well (Gichangi et al, 1997).

To improve postnatal growth, complementary feeding must be necessarily improved. The INCAP longitudinal study demonstrated that food supplementation with an "Atole" made up of Incaparina and milk reduced dramatically the extent of stunting and had important repercussions on adult size and composition, work capacity, reproductive health, and intellectual functioning (Martorell, 1995). The use of fortified complementary foods to improve child nutrition in national programs appears promising and several experiences in Mexico, Ecuador and other parts of Latin America with industrially prepared foods are being evaluated for cost effectiveness (Rivera-Dommarco and Lutter, 2001). In Guatemala, the use of food aid may have improved child nutrition (IDEAS, undated; Burdick, undated) but the impact on children under two years of age is likely to have been limited. Little effort has been made to date to direct the use of donated foods specifically to improve complementary feeding of infants and the program, despite intentions, has operated in practice more as a family food supplement. To have an impact on the diets of children under two, the foods provided must be appropriate for use for them and must have adequate nutrient profiles and bioavailability; further, concerted efforts in nutrition education must be taken to impress on caretakers the value of improving child feeding and to provide them with information about well-tested recipes and preparations.

With or without donated foods, the role of growth promotion and nutrition education is of great importance. Applied research in Guatemala has shown that these are effective interventions when well designed (Rivera-Dommarco, Santizo and Hurtado, 1998). We view current efforts to adapt the AIN program of Honduras as an important step in the right direction.

In conclusion, the next step is to examine programs to make sure they are well poised to promote breastfeeding and to improve birthweight and complementary feeding as well as to assure access to family planning and basic health services. If this is done in addition to implementing effective basic education and poverty alleviation actions, rates of stunting, as well as the absolute number of stunted children, will decline.

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Tables

Table 1. Sample sizes for the nationally representative preschool surveys

1. Sample sizes, DHS 1987

A. All, age 3-36 months (N=2331)	
B. Cleaned data for HAZ & WHZ, 3-36 months (unrestricted) (N=2229)	Not in sample B (N=102)
C. Complete data for final model, 3-36 months (analytic) (N=2229)	Not in sample C (N=0)
D. Restricted analytic sample, 12-36 months, birth order ≥ 2 (N=1291)	Not in sample D (N=938)

2. Sample sizes, DHS 1995

A. All age 3-36 months (N=5246)	
B. Cleaned data for HAZ & WHZ, 3-36 months (unrestricted) (N=5075)	Not in sample B (N=171)
C. Complete data for final model, 3-36 months (analytic) (N=4952)	Not in sample C (N=123)
D. Restricted analytic sample, 12-36 months, birth order ≥ 2 (N=2777)	Not in sample D (N=2175)

3. Sample sizes, DHS 1998/99

A. All age 3-36 months (N=2353)	
B. Cleaned data for HAZ & WHZ, 3-36 months (unrestricted) (N=2230)	Not in sample B (N=123)
C. Complete data for final model, 3-36 months (analytic) (N=2187)	Not in sample C (N=43)
D. Restricted analytic sample, 12-36 months, birth order ≥ 2 (N=1225)	Not in sample D (N=962)

4. Sample sizes, ENCOVI 2000

A. All age 3-36 months (N=3271)	
B. Cleaned data for HAZ & WHZ, 3-36 months (unrestricted) (N=3108)	Not in sample B (N=163)
C. Complete data for final model, 3-36 months (analytic) (N=2510)	Not in sample C (N=598)
D. Restricted analytic sample, 12-36 months, birth order ≥ 2 (N=1309)	Not in sample D (N=1201)

Table 2. Methods used in generating the feeding index (Ruel and Menon, 2002)

Variables	**6-9 mo**	**9-12 mo**	**12-36 mo**
Breastfeeding	No = 0; Yes = +2	No = 0; Yes = +2	No = 0; Yes = +1
Uses bottle	No = 1; Yes = 0	No = 1; Yes = 0	No = 1; Yes = 0
Dietary diversity (in past 24 hours)	**Sum of**: (grains + tubers + milk + egg/fish/poultry + meat + other): 0 = 0 1-3 = 1 4+ = 2	**Sum of**: (grains + tubers + milk + egg/fish/poultry + meat + other): 0 = 0 1-3 = 1 4+ = 2	**Sum of**: (grains + tubers + milk + egg/fish/poultry + meat + other): 0 = 0 1-3 = 1 4+ = 2
Food group frequency (past 7 days)	**For each of:** **- egg/fish/poultry** **- meat** 0 times in past 7 d=0 1-3 times in past 7 d=1 4+ times in past 7 d=2 **For staples (grains or tubers)** **0-2 times = 0** **3+ times = 1** **Food group frequency** =sum of scores for staples + egg/fish/poultry + meat	**For each of:** **- egg/fish/poultry** **- meat** 0 times in past 7 d=0 1-3 times in past 7 d=1 4+ times in past 7 d=2 **For staples (grains or tubers)** **0-3 times = 0** **4+ times = 1** **Food group frequency** =sum of scores for staples + egg/fish/poultry + meat	**For each of:** **- milk** **- egg/fish/poultry** **- meat** 0 times in past 7 d=0 1-3 times in past 7 d=1 4+ times in past 7 d=2 **Food group frequency** =sum of scores for milk + egg/fish/poultry + meat
Meal frequency (past 24 hours)	**0 meals/d = 0** **1 meal/d = 1** **2 meals/d = 2**	**0 meals/d = 0** **1-2 meals/d = 1** **3+ meals/d = 2**	**0-1 meal/d = 0** **2-3 meal/d = 1** **4+ meals/d = 2**
Total score	**12 points**	**12 points**	**12 points**

Table 3. Descriptive statistics (analytic sample) for anthropometric data by survey: Mean (SD) or Percentages[§]

	DHS 1987	DHS 1995	EGSF 1995	DHS 1998/9	ENCOVI 2000
Children 3 to 36 months					
VARIABLE	**N=2229**	**N=4952**	**N=1552**	**N=2187**	**N=2510**
HAZ	-2.3 (1.4)	-2.0 (1.4)	-2.4 (1.3)	-1.8 (1.3)	-1.6 (1.5)
Stunted[1]	57.8	48.7	63.7	43.3	38.5
WAZ	-1.5 (1.2)	-1.3 (1.2)	-1.6 (1.1)	-1.1 (1.2)	-1.1 (1.3)
Underweight[2]	33.2	29.4	37.1	24.9	21.5
WHZ	-0.02 (0.9)	-0.09 (1.1)	0.02 (1.0)	0.02 (1.1)	-0.04 (1.3)
Wasted[3]	1.3	4.3	1.0	3.2	3.9
Children 37 to 60 months[†]					
VARIABLE	N/A	**N=2974**	**N=944**	**N=1480**	**N=806**
HAZ	N/A	-2.2 (1.3)	-2.6 (1.2)	-2.2 (1.4)	-1.7 (1.5)
Stunted[1]	N/A	56.9	67.3	53.8	42.7
WAZ	N/A	-1.3 (1.0)	-1.6 (0.9)	-1.2 (1.2)	-1.0 (1.2)
Underweight[2]	N/A	25.3	31.4	24.9	17.4
WHZ	N/A	0.01 (0.9)	-0.08 (0.7)	0.16 (1.0)	0.11 (1.1)
Wasted[3]	N/A	1.8	0.2	1.6	2.4

[†] 37-59 months for DHS 1995 and DHS 1998-99, 37-60 months for EGSF and ENCOVI.
[§] Results are weighted for DHS-III and DHS+
NA = Not Available
[1] HAZ < -2
[2] WAZ < -2
[3] WHZ < -2

Table 4. Distribution of the population by independent variable and survey[§]

VARIABLE	DHS 1987 N=2229	DHS 1995 N=4952	DHS 1998/9 N=2187	ENCOVI 2000 N=2510
Gender				
Male	49.4	50.5	50.9	51.4
Female	50.6	49.5	49.1	48.6
Age Group				
3-11 months	29.7	28.1	27.4	33.4
12-23 months	35.0	35.5	34.9	40.0
24-36 months	35.4	36.4	37.7	26.5
Ethnicity				
Indian	41.3	42.8	36.5	NE
Ladino	58.7	57.2	63.5	NE
Residence				
Urban	28.0	32.3	37.1	39.2
Rural	72.1	67.7	62.9	60.8
Maternal Education[†]				
None	48.3	37.8	31.7	0.1
Primary (1-6 yrs)	43.9	49.9	52.5	99.7
Secondary + (7 or more)	07.8	12.3	15.9	0.2
Economic Status				
Low	28.7	47.3	46.6	NA
Middle	52.7	34.4	31.0	NA
High	18.6	18.4	22.4	NA
Maternal Height, cm				
< 144.9	NA	34.9	31.9	32.3
144.9 - 150.5	NA	36.6	34.4	35.4
> 150.5	NA	28.6	33.7	32.4
Maternal Age at Birth				
< 20 years	18.4	20.7	19.0	29.4
20-34 years	70.3	66.7	68.3	60.9
≥ 35 years	11.3	12.6	12.7	09.6
Modern Birth Control				
Yes	NA	11.6	16.7	21.5
No	NA	88.4	83.3	78.5
Mother Works				
Yes	NA	13.2	21.9	23.2
No	NA	86.6	78.1	76.8
Birth Order				
1st or 2nd	35.1	40.0	43.6	41.9
3rd or 4th	29.1	25.8	26.1	28.6
5th or higher	35.9	34.2	30.3	29.6
Number of Children in Household Under 5 Years of Age				
0 or 1	23.9	24.2	27.6	NA
2	44.6	42.2	39.9	NA
3 or more	31.5	33.6	32.6	NA
Birth Interval*				
≥ 24 months	69.4	70.6	70.5	NA
< 24 months	30.6	29.4	29.5	NA
Feeding Index*				
Low	NA	29.7	26.5	NA
Average	NA	21.4	19.0	NA
High	NA	48.9	54.5	NA

[§]Percentages are weighted for DHS-1995 and DHS 1998/99.
*Based on restricted sample: age 12-36 months and birth order ≥ 2. Sample sizes are 1291, 2777, and 1225 for DHS 1987, DHS 1995, and DHS 1998/99 respectively.
[†]Based on restricted sample for ENCOVI 2000, N=1648.
NA = Not available; NE = Not estimated

Table 5. Univariate associations with stunting in children 3-36 months; Percentages[§], ?[2] p-value

VARIABLE	DHS1987 %	P	DHS 1995 %	p	DHS 1998/9 %	p	ENCOVI, 2000 %	p
Gender								
Male	58.8	0.34	49.5	0.27	46.1	0.008	39.2	0.43
Female	56.8		47.9		40.3		37.7	
Region								
Metropolitan	44.2	<.0001	34.6	<.0001	25.8	<.0001	20.4	<.0001
North	49.7		52.6		54.3		33.9	
Northeast	42.9		42.5		43.5		27.9	
Southeast	53.9		42.1		41.7		38.4	
Central	67.4		45.7		45.0		39.8	
Southwest	62.8		58.8		52.0		45.8	
Northwest	77.7		67.5		65.7		52.5	
Petén	NA		NA		42.6		29.0	
Residence								
Urban	47.0	<.0001	35.6	<.0001	31.8	<.0001	28.9	<.0001
Rural	62.0		54.9		50.1		44.6	
Ethnicity							NA	
Indian	71.5	<.0001	65.9	<.0001	63.2	<.0001	NA	
Ladino	48.1		35.8		31.9		NA	
Maternal Education[†]								
None (0 yrs)	68.5	<.0001	60.8	<.0001	61.3	<.0001	NA	
Primary (1-6y)	51.8		47.7		42.1		NA	
Secondary+ (≥ 7y)	25.3		15.7		11.2		NA	
Economic Status							NA	
Low	68.3	<.0001	59.8	<.0001	55.5	<.0001	NA	
Middle	60.7		48.9		45.5		NA	
High	33.3		19.8		14.8		NA	
Maternal Height, cm	NA							
< 144.9			67.5	<.0001	66.0	<.0001	56.3	<.0001
144.9 – 150.5			48.5		42.3		37.7	
> 150.5			26.0		22.8		21.4	
Maternal Age at Birth								
< 20 years	56.9	0.51	48.6	<.0001	44.1	0.03	38.4	0.01
20-34 years	57.5		46.9		41.7		37.1	
≥ 35 years	61.1		58.3		50.6		47.1	
Modern Birth Control								
Uses	39.9	<.0001	29.5	<.0001	23.0	<.0001	NA	
Does not use	60.1		52.5		48.8			
Mother Works								
Yes	52.5	0.05	43.0	<.0001	39.1	0.03	NA	
No	58.6		50.3		44.6			
Birth Order								
1st or 2nd	50.9	<.0001	39.5	<.0001	35.5	<.0001	30.5	<.0001
3rd or 4th	57.6		47.7		41.3		39.1	
5th or higher	64.7		60.1		56.2		49.2	
Number of Children Under 5								
0 or 1	51.0	0.001	38.1	<.0001	27.8	<.0001	NA	
2	59.2		49.4		48.8			
3 or more	61.0		55.4		49.7			
Birth Interval*								
≥ 24 months	70.7	1.00	58.4	0.004	50.7	0.001	NA	
< 24 months	70.6		64.7		61.8			
Feeding Index*								
Low	NA		71.1	<.0001	64.1	<.0001	NA	
Average			66.5		60.6			
High			50.9		46.8			

[§]Results are weighted for DHS 1995 and DHS 1998/99. NA = Not Available. [†]Sample reduced for ENCOVI 2000 to N=1648 due to missing values.

*Based on restricted sample: age 12-36 months and birth order ≥ 2. Sample sizes 1291, 2777 and 1225 for DHS 1989, DHS 1995 and DHS1998/99 respectively.

Table 6. Odds ratios from logistic regression models predicting stunting (< -2Z) Guatemalan children, 3-36 months, in the 1998/99 DHS Survey[+]

Predictors	**Model 1**	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**	**Model 7**
Female	0.75***	0.73****	0.71****	0.73***	0.73***	0.73***	0.71***
< 12 mos	0.21****	0.21****	0.19****	0.19****	0.20****	0.19****	0.19****
≥ 24 mos	0.87	0.87	0.82*	0.85	0.88	0.87	0.86
Indian	4.22****	3.77****	2.64****	2.33****	1.90****	1.78****	1.76****
Rural		1.92****	1.41***	1.14	1.17	1.09	0.88
No education			1.65****	1.54****	1.37***	1.34**	1.40***
Secondary education (≥ 7 yrs)			0.23****	0.36****	0.42****	0.44****	0.43****
Low SES				1.14	1.09	1.04	1.08
High SES				0.34***	0.37****	0.42****	0.45****
Maternal height, lower 3rd					2.14****	2.20****	2.14****
Maternal height, upper 3rd					0.62****	0.63****	0.64****
Age at birth <20 yrs						1.33*	1.25
Age at birth > 35 yrs						0.77	0.78
Modern birth control						0.66***	0.69**
Mother works						1.24	1.23
1st/2nd born						0.77*	0.81
5th + born						1.30*	1.30*
North							1.28
Northeast							1.53**
Southeast							1.83***
Central							2.03****
Southwest							1.84****
Northwest							2.26****
Petén							1.14

[+] Reference category is always the middle category for variables coded as two dummy variables: child age, maternal education, SES and maternal height. The reference category for region is the Metropolitan region.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$, **** $p < 0.001$

Table 7. Odds ratios from full logistic regression models (Model 7, Table 6) predicting stunting (< -2Z) in Guatemalan children, 3-36 months, in the DHS surveys[+]

Predictors	DHS 1987	DHS 1995	DHS 1998/9
Female	0.85*	0.88*	0.71***
< 12 mos	0.17****	0.20****	0.19****
≥ 24 mos	0.96	0.96	0.86
Indian	2.11****	1.97****	1.76****
Rural	1.08	0.90	0.88
No education	1.46****	1.02	1.40***
Secondary education (≥ 7 yrs)	0.64**	0.57****	0.43****
Low SES	1.27**	1.29***	1.08
High SES	0.54****	0.50****	0.45****
Maternal height, lower 3^{rd}	NA	1.87****	2.14****
Maternal height, upper 3^{rd}	NA	0.54****	0.64****
Age at birth < 20 yrs	1.33*	1.49****	1.25
Age at birth > 35 yrs	0.82	0.85	0.78
Modern birth control	0.73**	0.90	0.69**
Mother works	0.95	0.91	1.23
$1^{st}/2^{nd}$ born	0.80	0.75***	0.81
5^{th} + born	1.31**	1.52****	1.30*
North	0.33****	0.70**	1.28
Northeast	0.76	1.04	1.53**
Southeast	1.11	1.24	1.83***
Central	1.81***	1.16	2.03****
Southwest	1.11	1.51****	1.84****
Northwest	1.62**	1.60****	2.26****
Petén	NA	NA	1.14

[+] Reference category is always the middle category for variables coded as two dummy variables: child age, maternal education, SES and maternal height. The reference category for region is the Metropolitan region.

* p < 0.10, ** p < 0.05, *** p < 0.01, **** p < 0.001

NA = Not available.

Table 8. Odds ratios from logistic regression models incorporating birth interval and the feeding index and restricted to children 12-36 months and birth order ≥ 2 for the DHS 1995 and DHS 1998/99 surveys+

Predictors	DHS 1995	DHS 1998/9
Female	1.00	0.70**
≥ 24 mos	0.91	0.84
Indian	1.92****	1.67***
Rural	0.87	0.78
No education	0.90	1.38*
Secondary education (≥ 7 yrs)	0.54***	0.17****
Low SES	1.23*	1.06
High SES	0.50****	0.62**
Maternal height, lower 3rd	1.71****	2.78****
Maternal height, upper 3rd	0.51****	0.79
Age at birth < 20 yrs	1.24	1.46
Age at birth > 35 yrs	0.91	0.73
Modern birth control	0.89	0.60***
Mother works	0.98	1.08
1st/2nd born	0.72**	0.67**
5th + born	1.38***	1.41*
North	0.99	1.29
Northeast	1.34	1.37
Southeast	1.74***	1.91**
Central	1.48**	1.76**
Southwest	2.17****	1.95***
Northwest	2.90****	1.72*
Petén	NA	0.86
Birth interval < 24 months	1.53****	1.83****
Low feeding index	1.14	1.13
High feeding index	0.84	1.14

+ Reference category is always the middle category for variables coded as two dummy variables: child age, maternal education, SES and maternal height, age at birth and birth order. The reference category for region is the Metropolitan region.
* p < 0.10, ** p < 0.05, *** p < 0.01, **** p < 0.001
NA = Not available.

Table 9. Odds ratios from full logistic regression models predicting stunting (< -2Z) in Guatemalan children, 37-60 months for the 1995 and 1998/99 DHS surveys[+]

Predictors	DHS, 1995	DHS, 1998/9
Female	0.99	1.09
Age (mos)	1.01	0.97***
Indian	2.06****	2.58****
Rural	1.02	0.93
No education	1.25**	1.19
Secondary education (≥ 7 yrs)	0.47****	0.80
Low SES	1.68****	2.14****
High SES	0.47****	0.46****
Maternal height, lower 3rd	1.94****	2.64****
Maternal height, upper 3rd	0.50****	0.50****
Age at birth < 20 yrs	1.65****	1.84***
Age at birth > 35 yrs	0.95	0.52***
Modern birth control	0.79*	0.69**
Mother works	0.99	0.99
1st/2nd born	0.70***	0.49****
5th + born	1.45***	1.31
North	0.57***	0.84
Northeast	0.81	1.84**
Southeast	1.14	2.00***
Central	0.97	1.06
Southwest	1.62***	1.23
Northwest	1.75***	1.22
Petén	NA	0.90

[+] Reference category is always the middle category for variables coded as two dummy variables: child age, maternal education, SES, and maternal height. The reference category for region is the Metropolitan region.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$, **** $p < 0.001$
NA = Not available.

Table 10. Percent stunting (< -2 Z) by category of feeding index and its components for children 6-36 months, by age group and by survey

Variables	DHS, 1995			DHS, 1998/9		
	6-9 mo	**9-12 mo**	**12-36 mo**	**6-9 mo**	**9-12 mo**	**12-36 mo**
Feeding Index						
Low	38.7	48.6	69.1	24.5	32.7	63.2
Average	26.3	33.8	67.3	33.8	33.8	61.8
High	24.5**	33.4**	48.3****	20.2	26.4	43.0****
Breastfeeding						
Yes	30.9	40.3	64.3	22.7	33.1	60.7
No	15.1**	21.8***	55.0****	31.3	14.2*	46.5****
Uses bottle						
Yes	26.0	34.4	47.6	30.5	21.0	43.8
No	31.9	39.3	64.9****	17.3**	36.5**	59.6****
Dietary diversity						
0 types of foods	36.1	68.6	67.7	16.9	73.2	28.7
1-3	30.6	36.2	65.2	27.4	31.3	57.5
4+	13.3****	28.6****	49.0****	21.9	19.9***	46.4****
Milk frequency						
0	NA	NA	68.2	NA	NA	63.7
1-3	NA	NA	63.4	NA	NA	66.6
4+	NA	NA	37.8****	NA	NA	29.4****
Eggs/fish/poultry						
0 times past 7 d	33.5	45.8	64.7	25.3	34.9	69.5
1-3 times	28.4	37.4	64.2	18.9	35.5	57.0
4+ times	15.9***	28.2***	49.2****	27.0	20.9	42.6****
Meat frequency						
0 times past 7 d	31.0	41.0	62.7	25.7	31.8	52.9
1-3 times	25.5	35.2	61.5	14.7	30.7	56.3
4+ times	19.7	14.8**	28.2****	SCS	SCS	19.3****
Grains or tubers						
0-2/0-3/NA	36.0	44.5	NA	22.1	36.7	NA
3+/4+/NA	22.3****	30.0***	NA	25.2	26.8	NA
Meal frequency						
0/0/0-1 meals day	33.7	64.5	70.6	19.8	78.5	77.1
1/1-2/2-3 meals d	47.5	41.5	62.2	20.4	43.9	61.5
2/3+/4+ meals d	24.9***	34.2**	48.8****	26.0	25.9**	41.6****

* p < 0.10, ** p < 0.05, *** p < 0.01, **** p < 0.001
p-values refer to comparison within age group
NA = not applicable for this age group
SCS = small cell size

Table 11. The impact of breast and bottle-feeding on the odds of being stunted (< -2 Z) versus not (≥ - 2 Z) after controlling for known associated variables, by age, group & survey

Variables	DHS, 1995			DHS, 1998/9		
	6-9 mo	**9-12 mo**	**12-36 mo**	**6-9 mo**	**9-12 mo**	**12-36 mo**
Breastfeeding						
Unadjusted	2.50**	2.39***	1.48****	0.74	3.38**	1.79****
Adjusted	0.99	1.63	0.99	0.31*	0.91	1.27*
Uses bottle						
Unadjusted	0.74	0.82	0.49****	1.89**	0.48**	0.53****
Adjusted	1.21	1.00	0.94	3.16***	0.69	1.10
Eggs/Poultry/Fish ≥ 4/week						
Unadjusted	0.41***	0.56***	0.54****	1.13	0.48*	0.52****
Adjusted	0.63	0.72	0.95	2.50*	0.72	0.87
Meat ≥ 4/week						
Unadjusted	0.65	0.26**	0.24****	NA	NA	0.19****
Adjusted	1.27	0.34*	0.67***	NA	NA	0.49***
Meals ≥ 4/day						
Unadjusted	0.99	0.45****	0.57****	1.59	0.53*	0.44****
Adjusted	1.75**	0.53**	0.85*	2.79**	1.17	0.93

* p < 0.10, ** p < 0.05, *** p < 0.01, **** p < 0.001
NA = not estimable due to fact no children in this age group ate 4 or more meats in the course of a week.
Unadjusted models include gender.
Adjusted models include gender, ethnicity, maternal education, SES, maternal height, birth control, birth order, and region.

Table 12. Characteristics of Indian and Ladino Guatemalan children, 3-36 month (percentages§, ?^{2} p-value)

VARIABLE	**DHS, 1987**			**DHS, 1995**			**DHS, 1998/9**		
	Indian	Ladino	P	Indian	Ladino	P	Indian	Ladino	P
Education									
None	74.4	30.0	<.0001	57.8	22.9	<.0001	56.4	17.5	<.0001
Primary	24.5	57.6		40.0	57.2		41.9	58.5	
Secondary +	1.2	12.5		2.3	19.9		1.6	24.0	
Economic Status (SES)									
Low	36.3	23.4	<.0001	62.6	35.8	<.0001	67.9	34.4	<.0001
Middle	57.6	49.2		31.3	36.6		26.8	33.5	
High	6.1	27.4		6.1	27.7		5.3	32.2	
SES Components									
Piped/bottled water	33.5	52.3	<.0001	68.2	73.2	0.0002	68.6	76.9	<.0001
Flush toilet access	7.8	29.3	<.0001	7.0	33.6	<.0001	13.5	49.5	<.0001
Finished Floor	1.9	1.5	0.46	14.2	30.3	<.0001	24.5	65.8	<.0001
Has electricity	22.2	50.7	<.0001	36.8	61.3	<.0001	45.5	73.4	<.0001
Has radio	55.9	63.3	0.0004	68.7	77.4	<.0001	69.9	76.8	0.0006
Has television	8.5	32.9	<.0001	21.3	53.8	<.0001	27.0	61.0	<.0001
Has refrigerator	1.1	12.5	<.0001	3.0	22.4	<.0001	4.3	29.2	<.0001
Has bicycle	8.9	17.8	<.0001	19.9	26.5	<.0001	25.9	31.0	0.0140
Has motorcycle	1.0	5.4	<.0001	1.0	4.5	<.0001	0.3	6.1	<.0001
Has car	1.3	7.9	<.0001	3.5	12.1	<.0001	3.1	17.9	<.0001
Residence									
Urban	19.0	34.2	<.0001	19.1	42.1	<.0001	23.5	44.8	<.0001
Rural	81.0	65.8		80.9	57.9		76.5	55.2	
Maternal height									
< 144.9 cm	NA	NA	NA	52.7	21.5	<.0001	50.1	21.5	<.0001
144.9-150.5 cm	NA	NA	NA	36.7	36.5		37.7	32.6	
>150.5 cm	NA	NA	NA	10.5	42.0		12.2	46.0	
Maternal age at birth									
< 20 years	16.4	19.9	0.05	20.3	21.0	<.0001	18.4	19.3	0.0013
20-34 years	71.0	69.8		63.5	69.2		65.4	70.0	
≥ 35 years	12.6	10.4		16.2	9.8		16.3	10.7	
Modern birth control use	2.6	17.9	<.0001	3.6	26.5	<.0001	5.4	30.8	<.0001
Mother works	10.1	15.4	0.0003	19.7	23.5	0.003	21.5	24.3	0.15
Number < 5yr									
0 or 1	21.2	25.8	0.03	18.7	28.3	<.0001	16.1	34.1	<.0001
2	45.2	44.2		40.1	43.8		45.4	36.7	
> 2	33.6	30.0		41.1	27.9		38.5	29.2	
Birth spacing*									
≥ 24 mos	70.5	68.6	0.47	71.8	69.5	0.22	68.2	72.0	0.17
< 24 mos	29.5	31.4		28.2	30.5		31.8	28.0	
Feeding index*	NA	NA							
Low				37.3	23.1	<.0001	38.8	18.9	<.0001
Average				26.8	16.9		20.1	18.4	
High				35.9	60.0		41.2	62.8	
Feeding index components*	NA	NA							
Currently breastfeeding				49.5	33.4	<.0001	53.4	35.8	<.0001
Egg/fish/poultry > 1X past 7d				70.0	79.9	<.0001	69.4	83.0	<.0001
Grains > 1X in past 7 days				46.3	53.0	0.0009	67.1	65.2	0.51
Meat > 1X in past 7 days				33.1	45.1	<.0001	30.7	41.6	0.0003
≥ 4 meals in past 24 hrs				20.4	35.5	<.0001	36.7	58.2	<.0001
Drank from a bottle				23.2	41.7	<.0001	39.5	50.7	0.0003
Powder/tinned milk				8.4	31.2	<.0001	11.1	38.1	<.0001
Baby formula				2.2	4.4	0.0018	1.3	2.6	0.15
Fresh milk				5.6	17.8	<.0001	7.1		0.0044

§Results are weighted for DHS, 1995 and DHS, 1998/9.

*Based on restricted sample: age 12-36 months and birth order ≥ 2. Sample sizes 1291, 2777 and 1225 for DHS, 1987, DHS, 1995 and DHS, 1998/9 respectively. NA = Not Available

Table 13. Percent of Guatemalan household with basic needs and assets by ethnicity and by survey, 1987-1999

	DHS'87	DHS'95	DHS'99	DHS'87	DHS'95	DHS'99
	Indian			Ladino		
Basic Needs						
Piped/bottled water	33.5	68.2	68.6	52.3	73.2	76.9
Flush toilet access	7.8	7.0	13.5	29.3	33.6	49.5
Finished floor	1.9	14.2	24.5	1.5	30.3	65.8
Has electricity	22.2	36.8	45.5	50.7	61.3	73.4
Assets						
Has radio	55.9	68.7	69.9	63.3	77.4	76.8
Has television	8.5	21.3	27.0	32.9	53.8	61.0
Has refrigerator	1.1	3.0	4.3	12.5	22.4	29.2
Has bicycle	8.9	19.9	25.9	17.8	26.5	31.0
Has motorcycle	1.0	1.0	0.3	5.4	4.5	6.1
Has car	1.3	3.5	3.1	7.9	12.1	17.9

Figure 1. The Causes of Malnutrition (adapted from UNICEF, 1998)

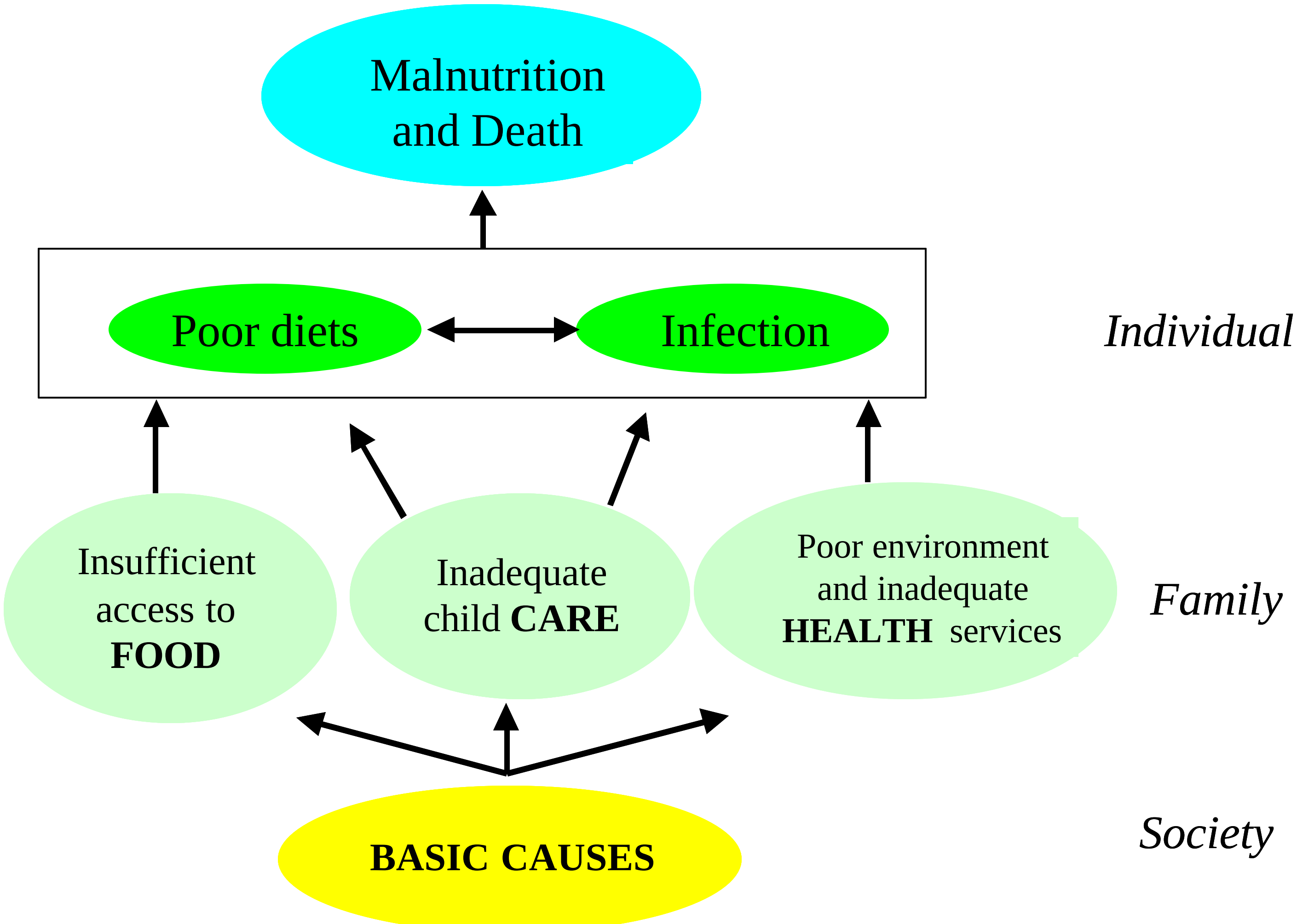


Figure 2. Birthweight data available in the 1998-99 DHS survey

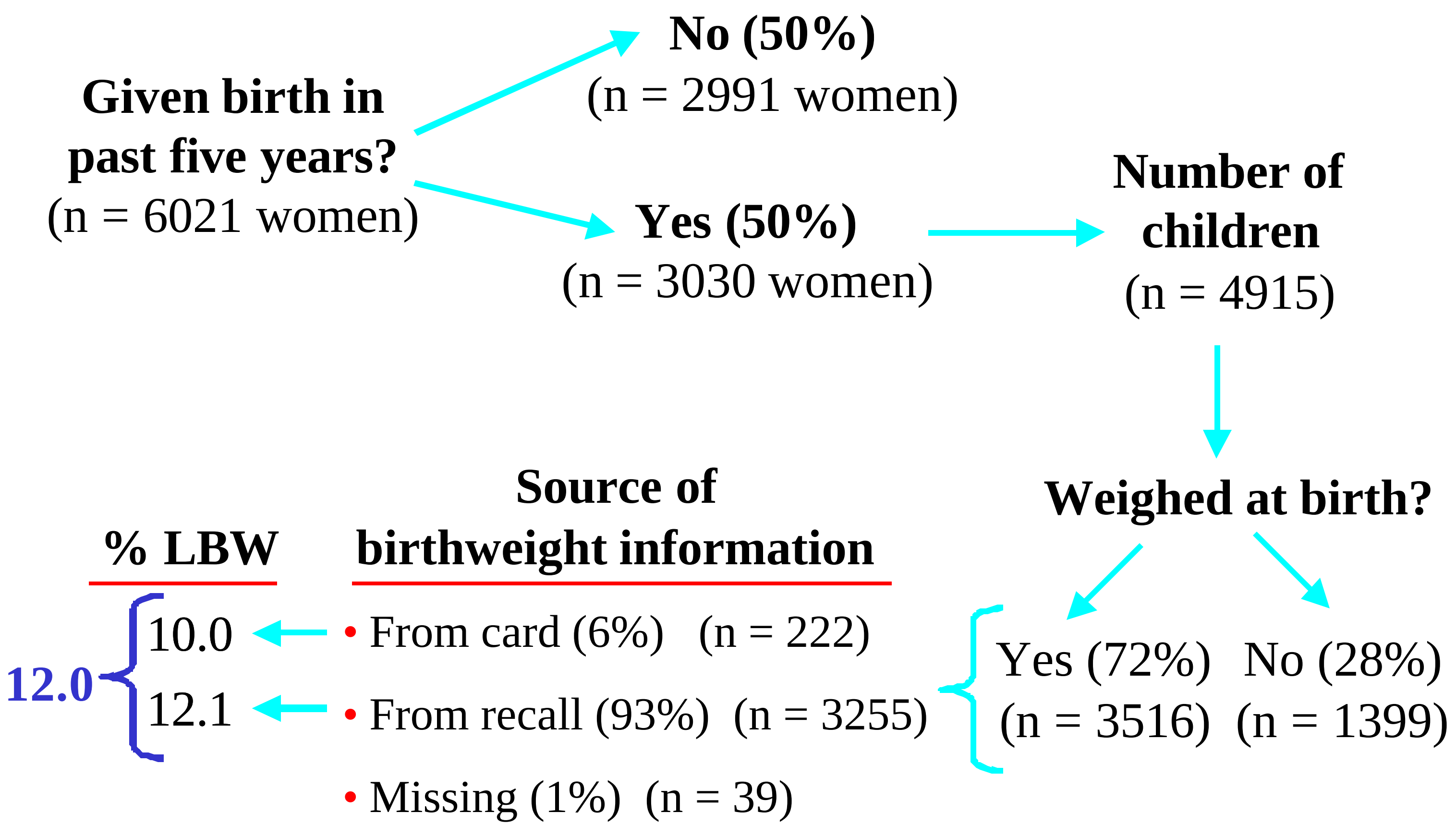


Figure 3. Mean Height Z-Scores in the 1995 EGSF (Rural) and 1998/99 DHS (National) Surveys by Age

Figure 4. Percent of stunting (< -2Z) among Guatemalan children, 3-36 months, by survey, 1987-2000

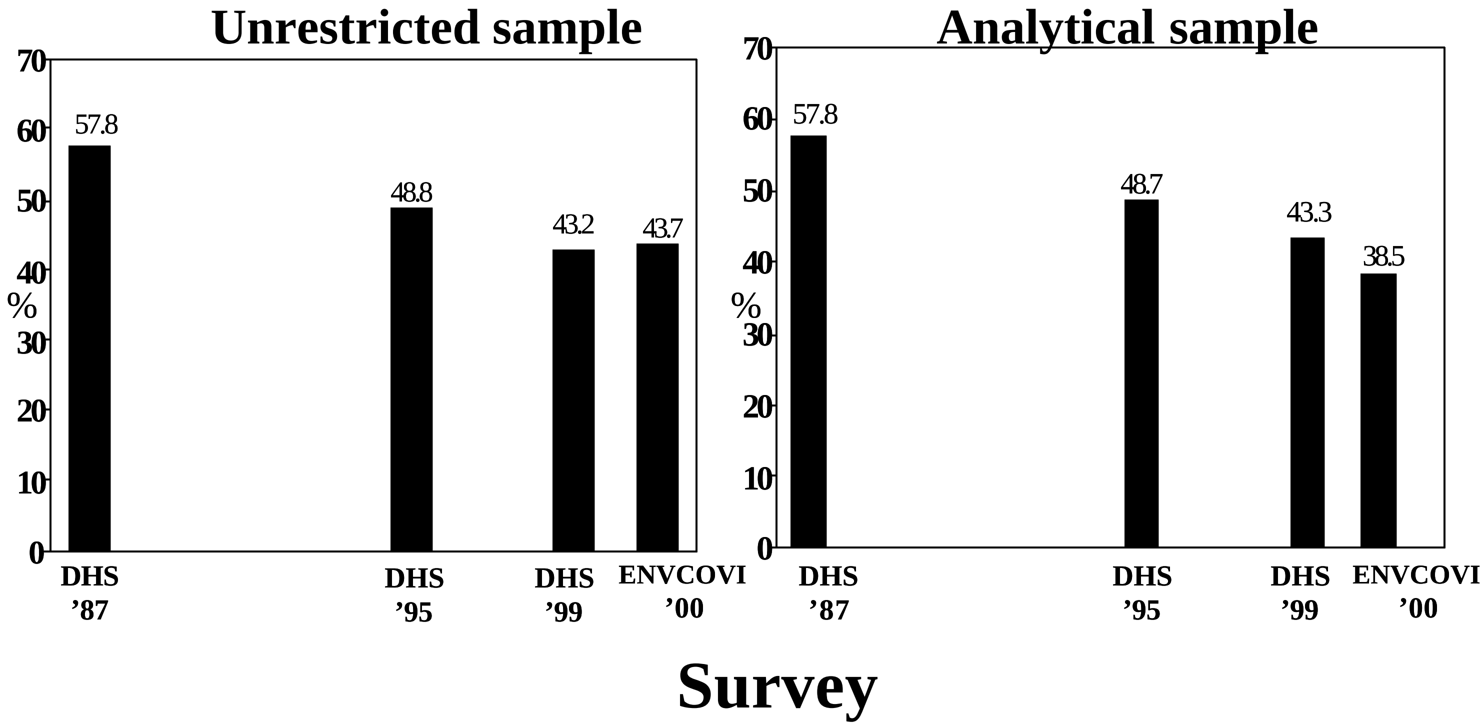


Figure 5. Number of stunted (< -2Z) Guatemalan children, 3-36 months, by corresponding survey year

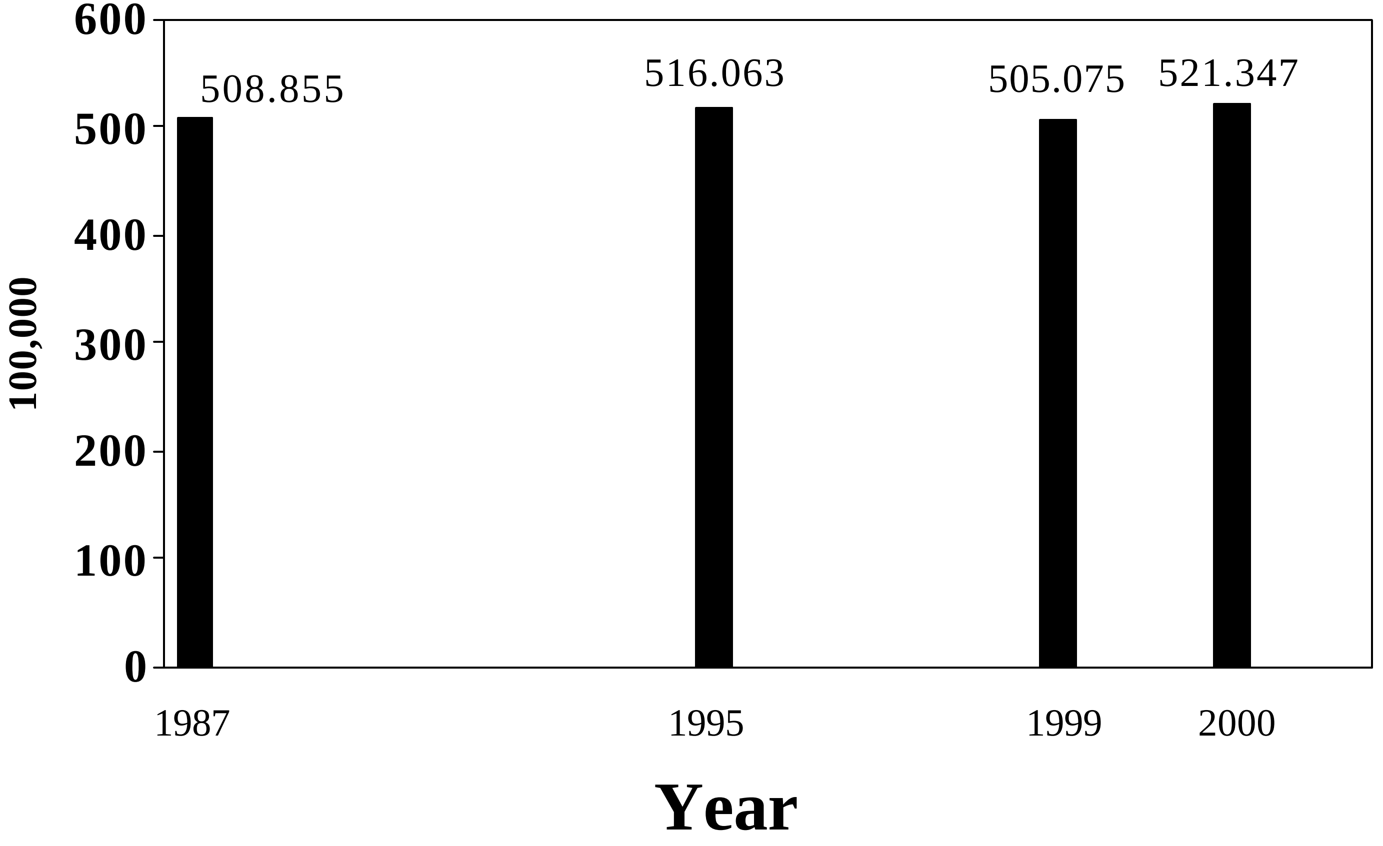
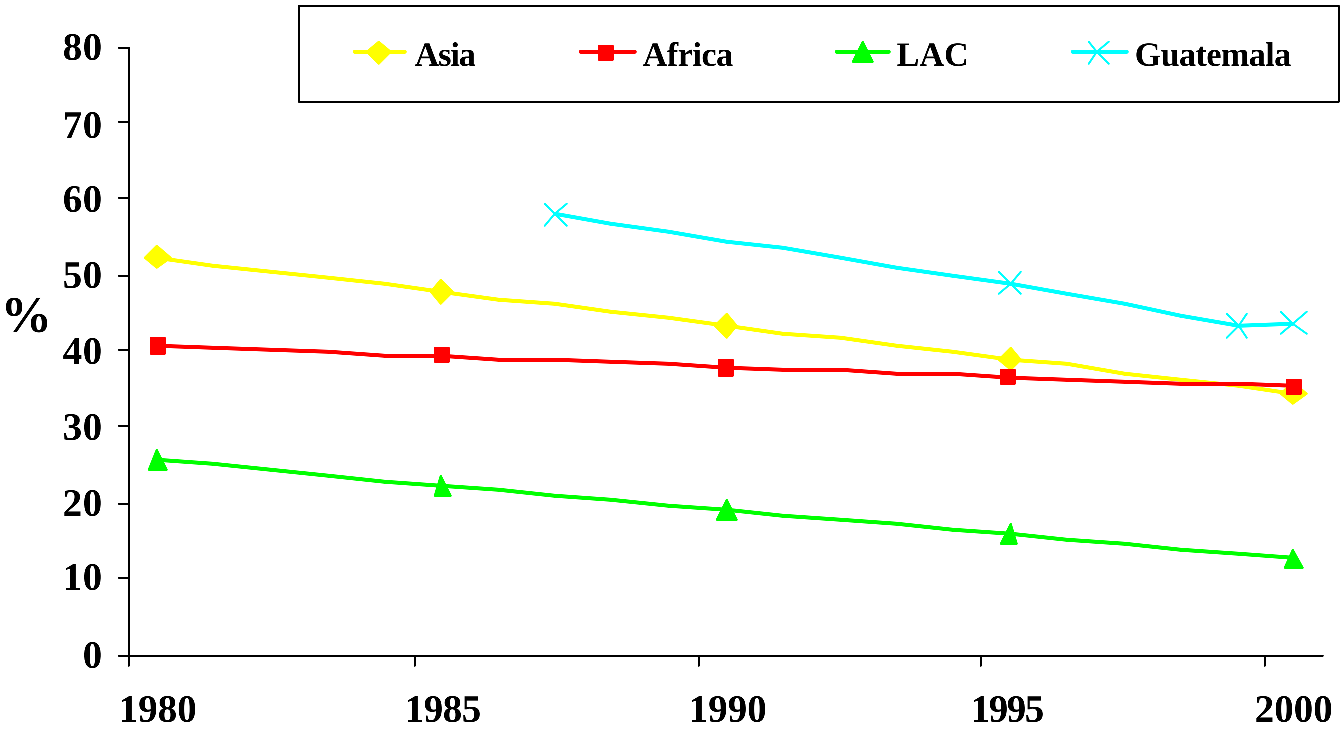
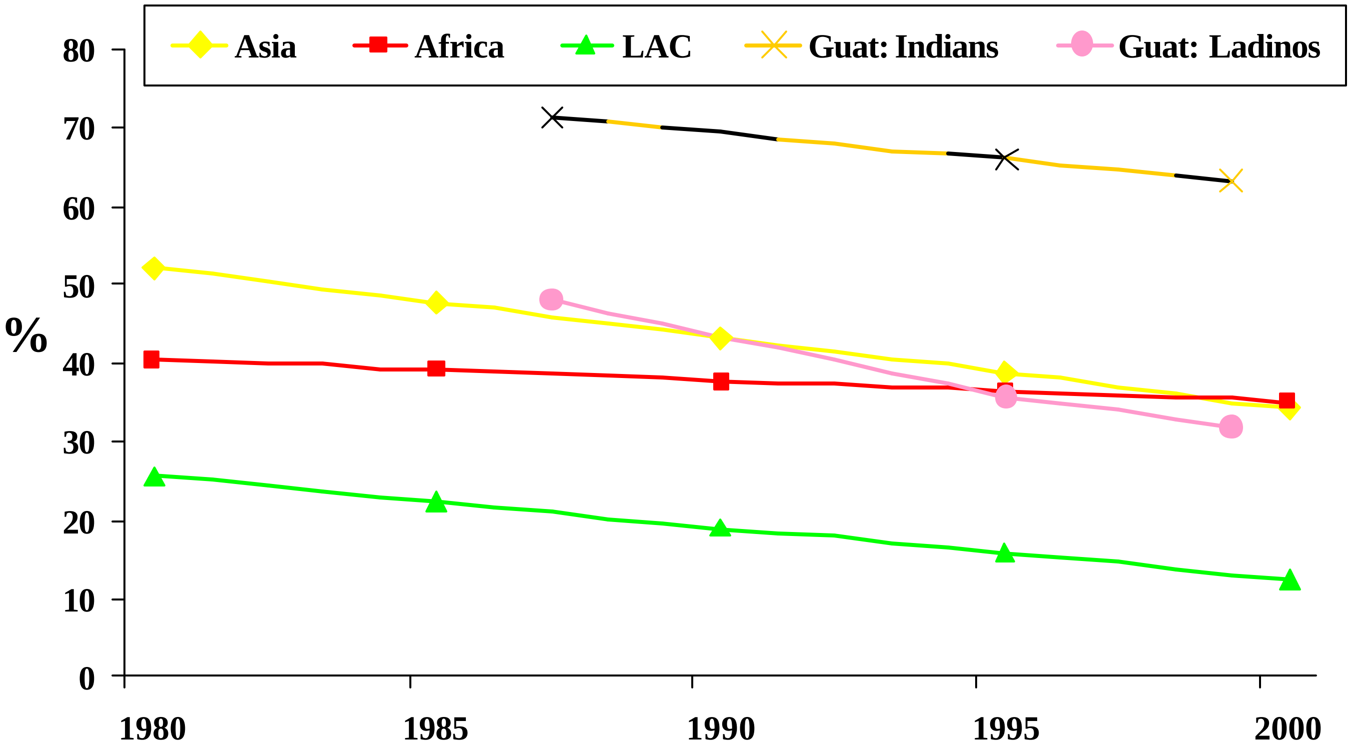


Figure 6. Comparison of trends in percent of children stunted in Guatemala and in three world regions+



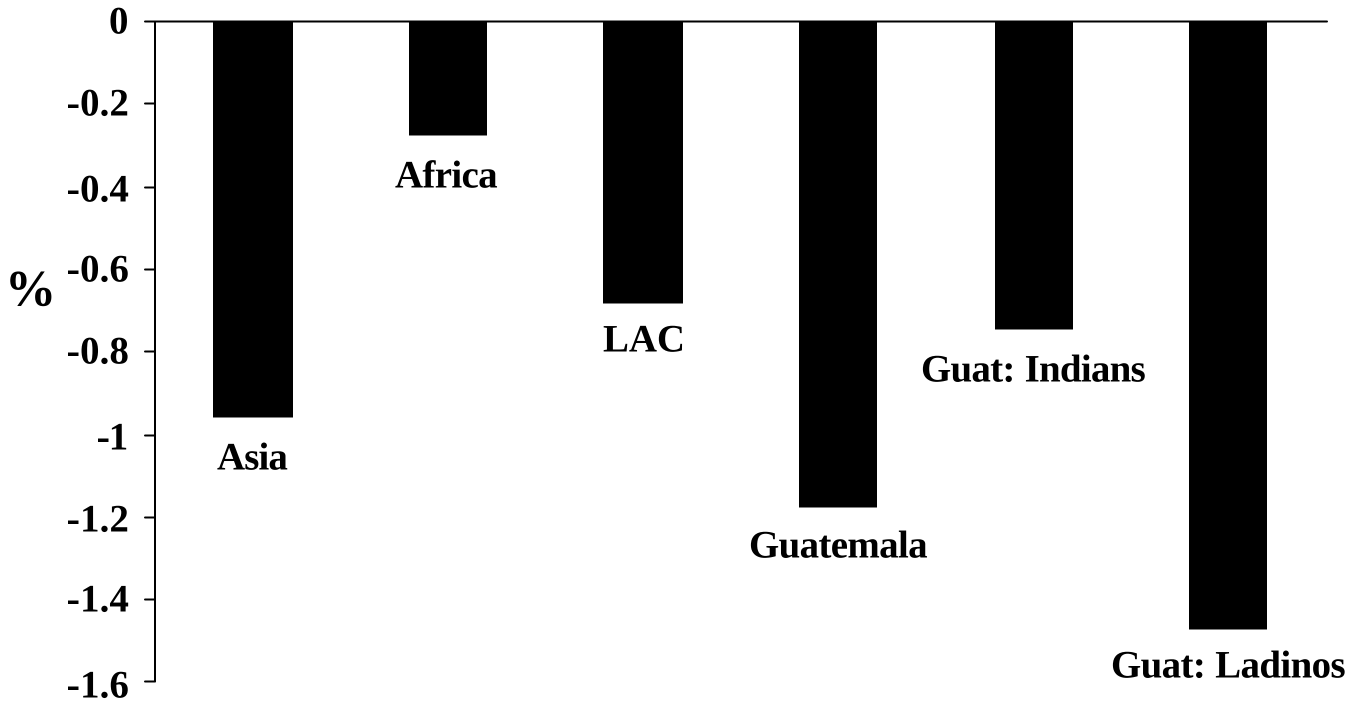
+ *World data from de Onís, Frongillo and Blössner, 2000*

Figure 7. Comparison of trends in percent of children stunted in Ladino and Guatemalan indigenous children and in three world regions[+]



[+] *World data from de Onís, Frongillo and Blössner, 2000*

Figure 8. Average yearly decrease in percent of children stunted in Guatemala and in three world regions[+]



[+] *World data from de Onís, Frongillo and Blössner, 2000*

Figure 9. Percent of stunting (< -2Z) among Guatemalan children, 3-36 months, by region, 1987-1999

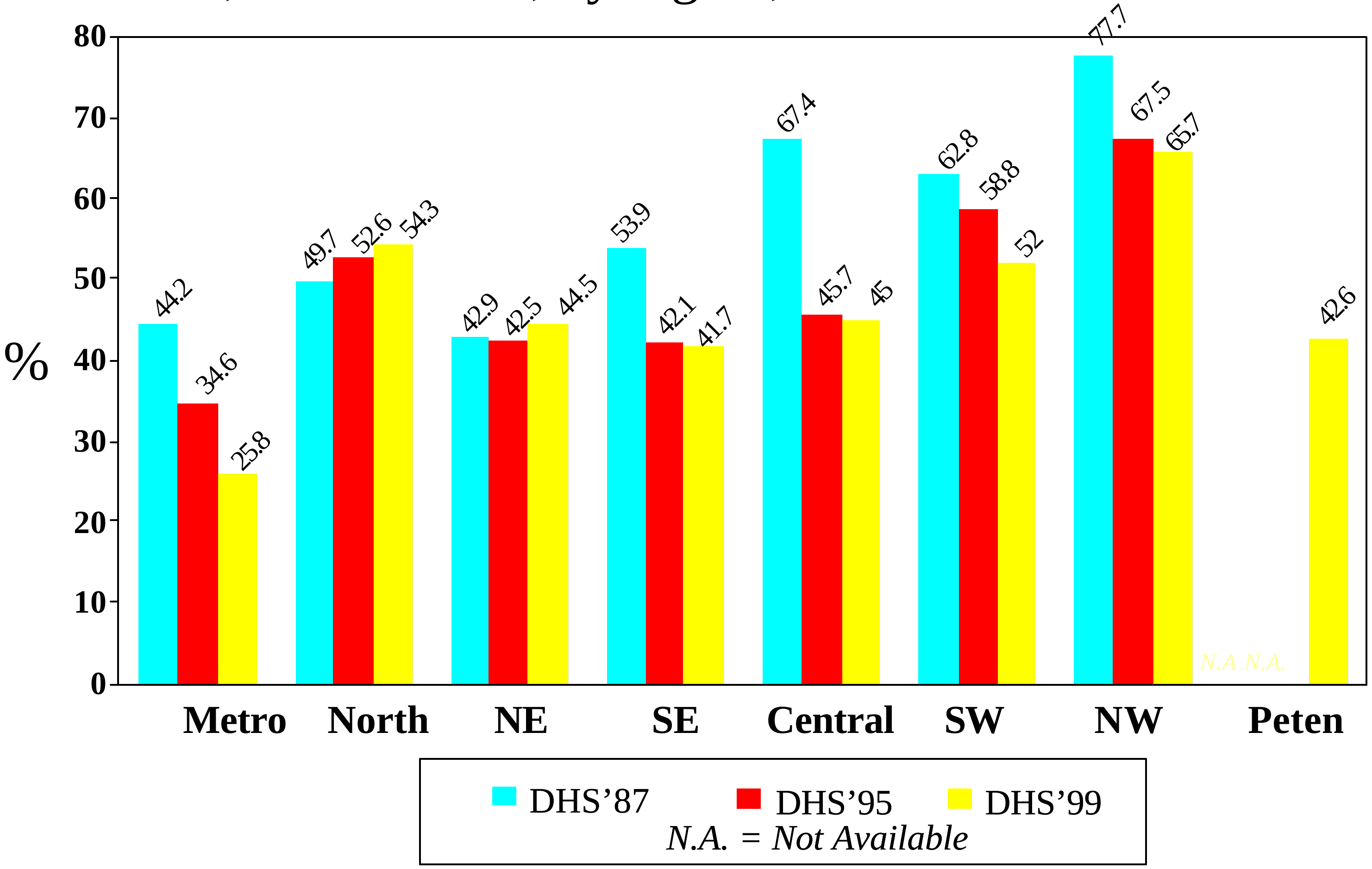


Figure 10. Percent of stunting (< -2Z) among Guatemalan children, 3-36 months, by residence, 1987-1999

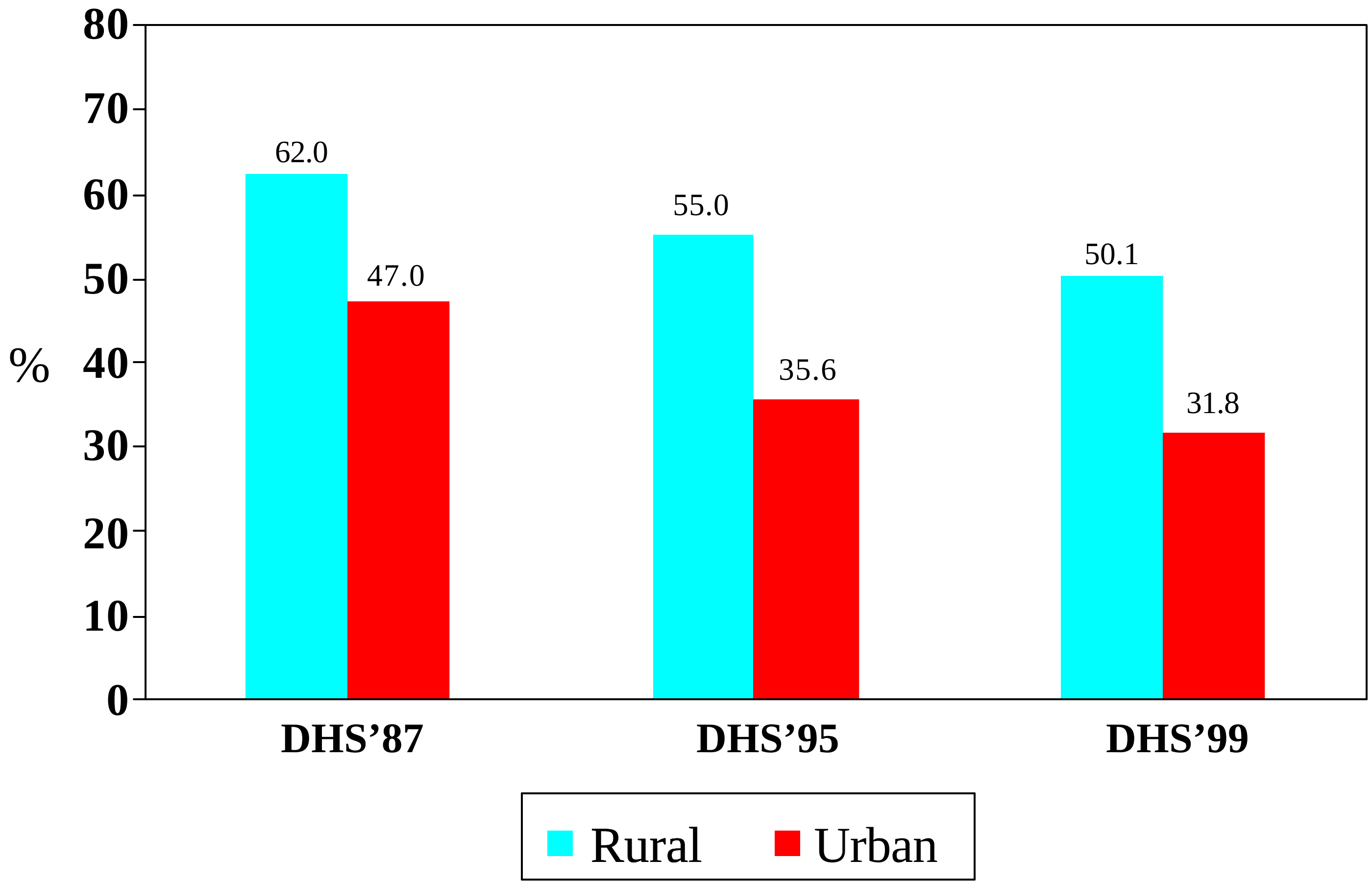


Figure 11. Percent of stunting (< -2Z) among Guatemalan children, 3-36 months, by ethnicity, 1987-1999

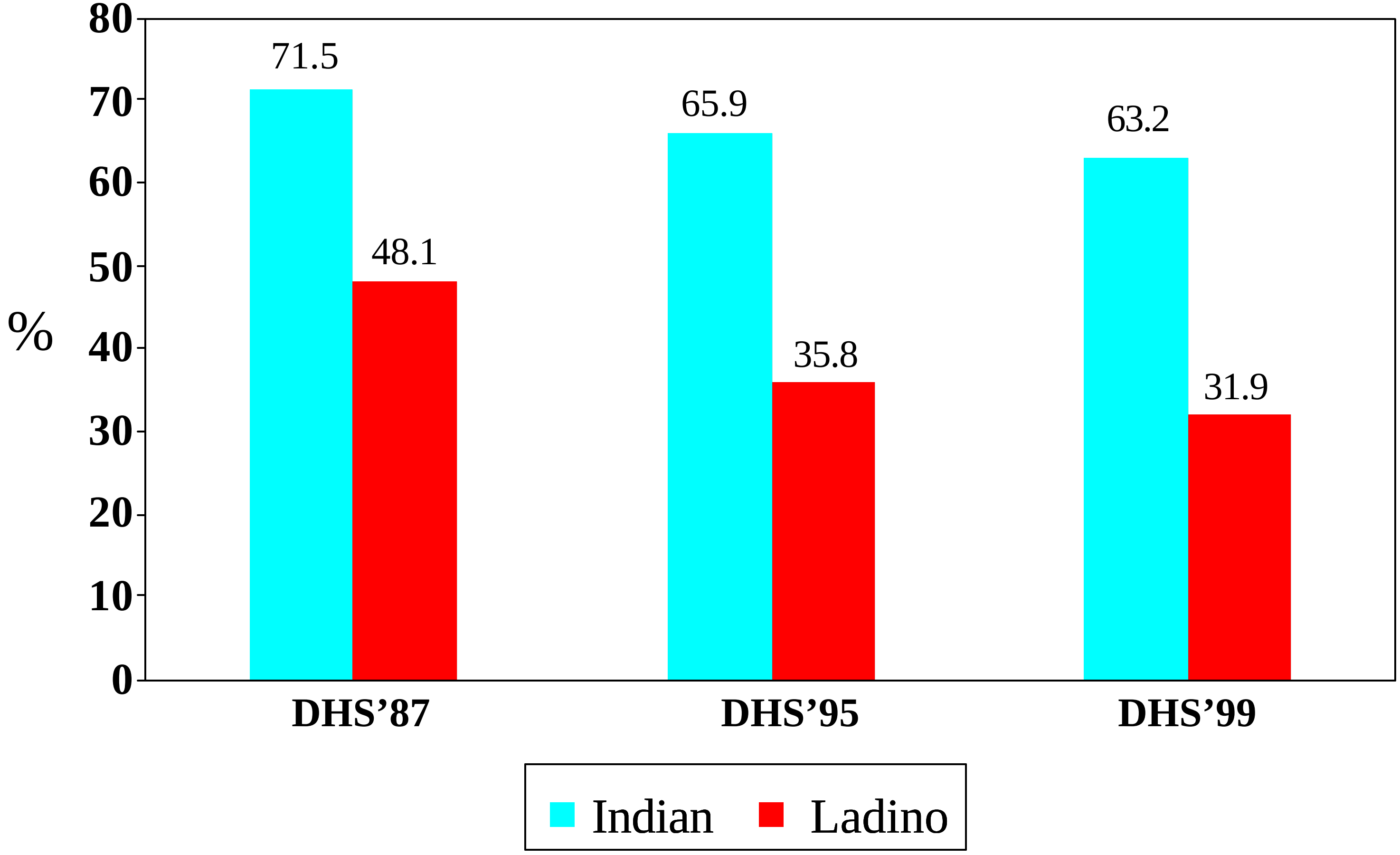


Figure 12. Percent of stunting (< -2Z) among Guatemalan children, 3-36 months, by maternal education, 1987-1999

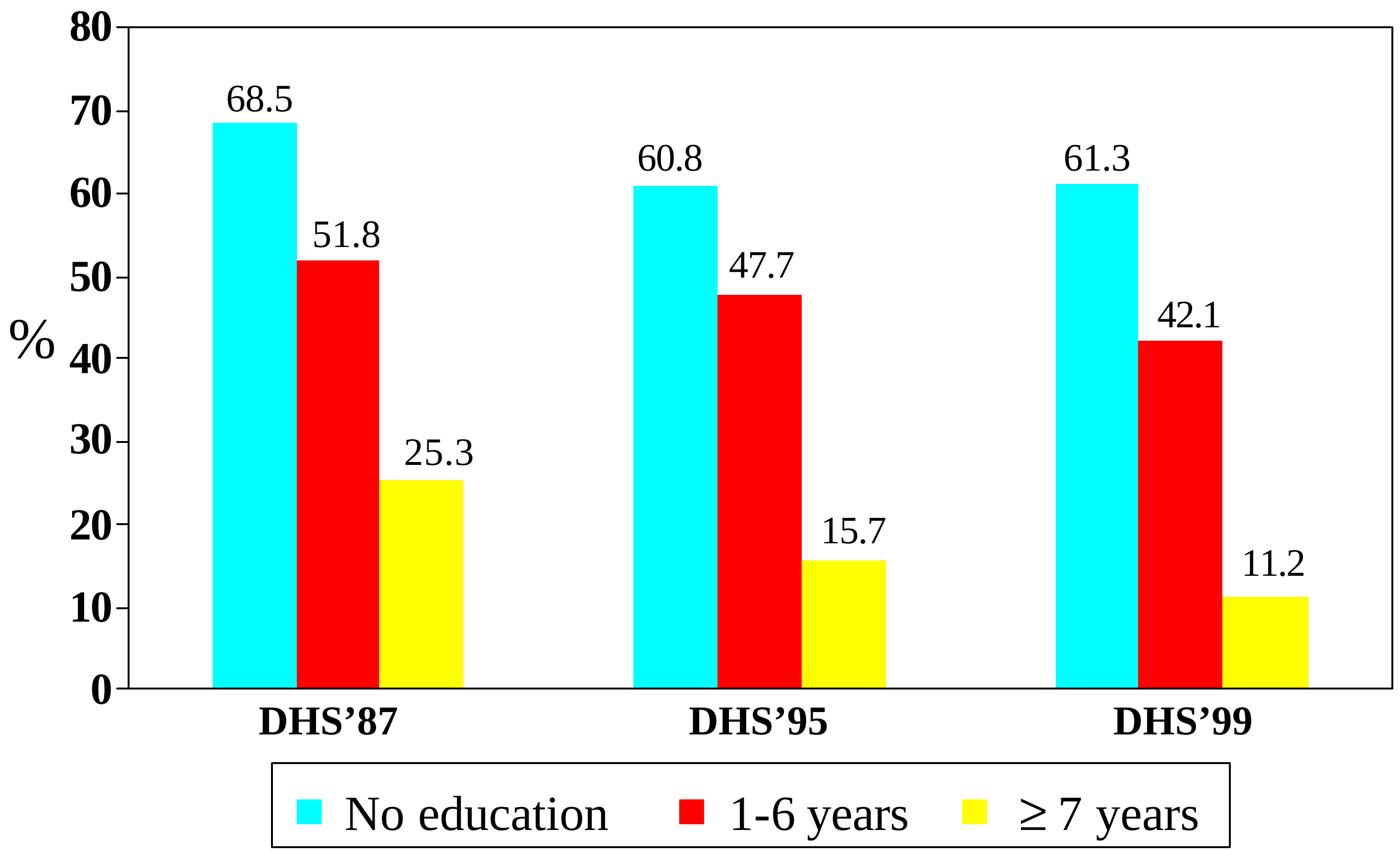


Figure 13. Percent of Guatemalan children, 3-36 months, stunted (< -2Z) by socioeconomic status (SES), 1987-1999

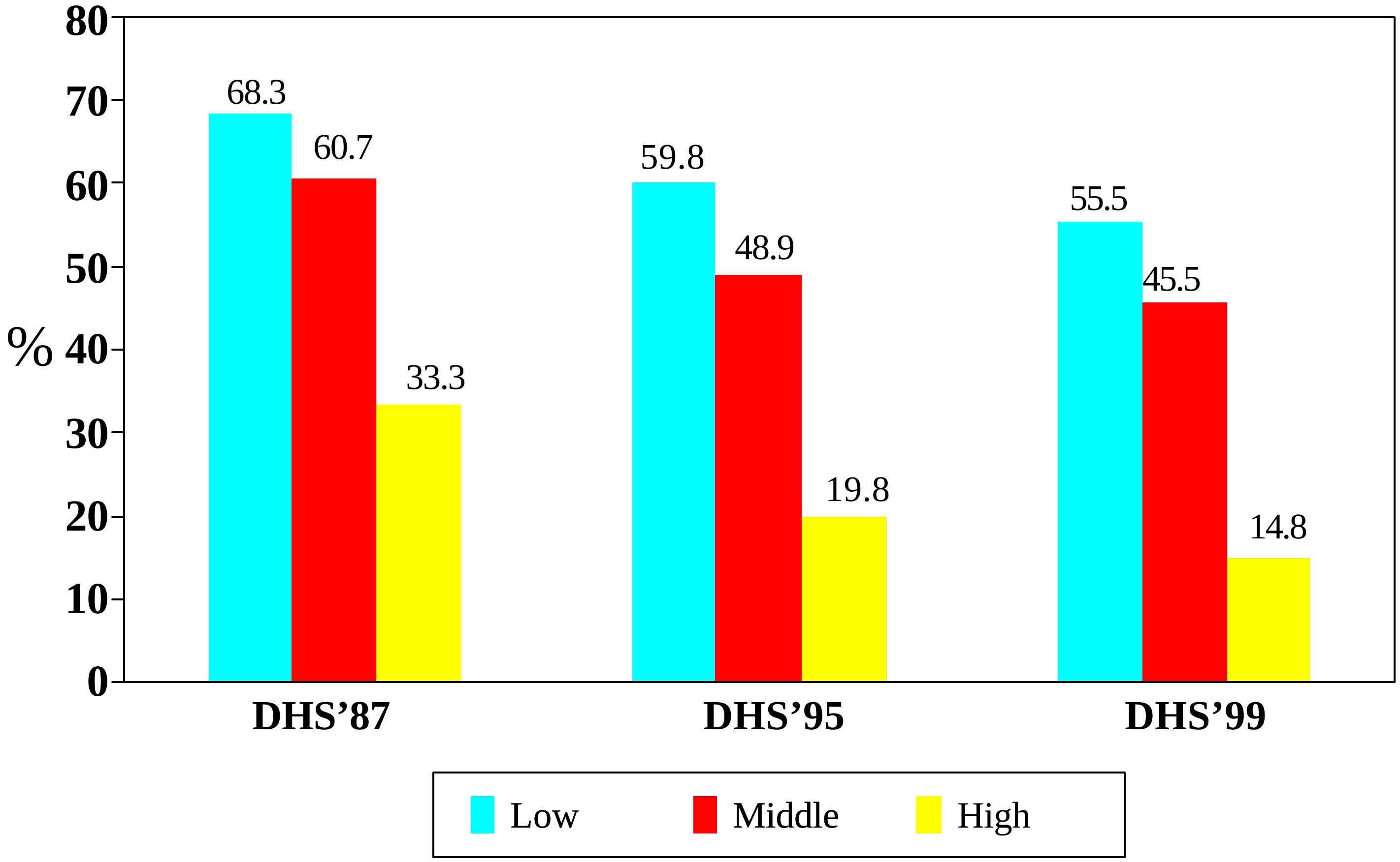


Figure 14. Percent of Guatemalan children, 3-36 months, stunted (< -2Z) by maternal height 1995-1999

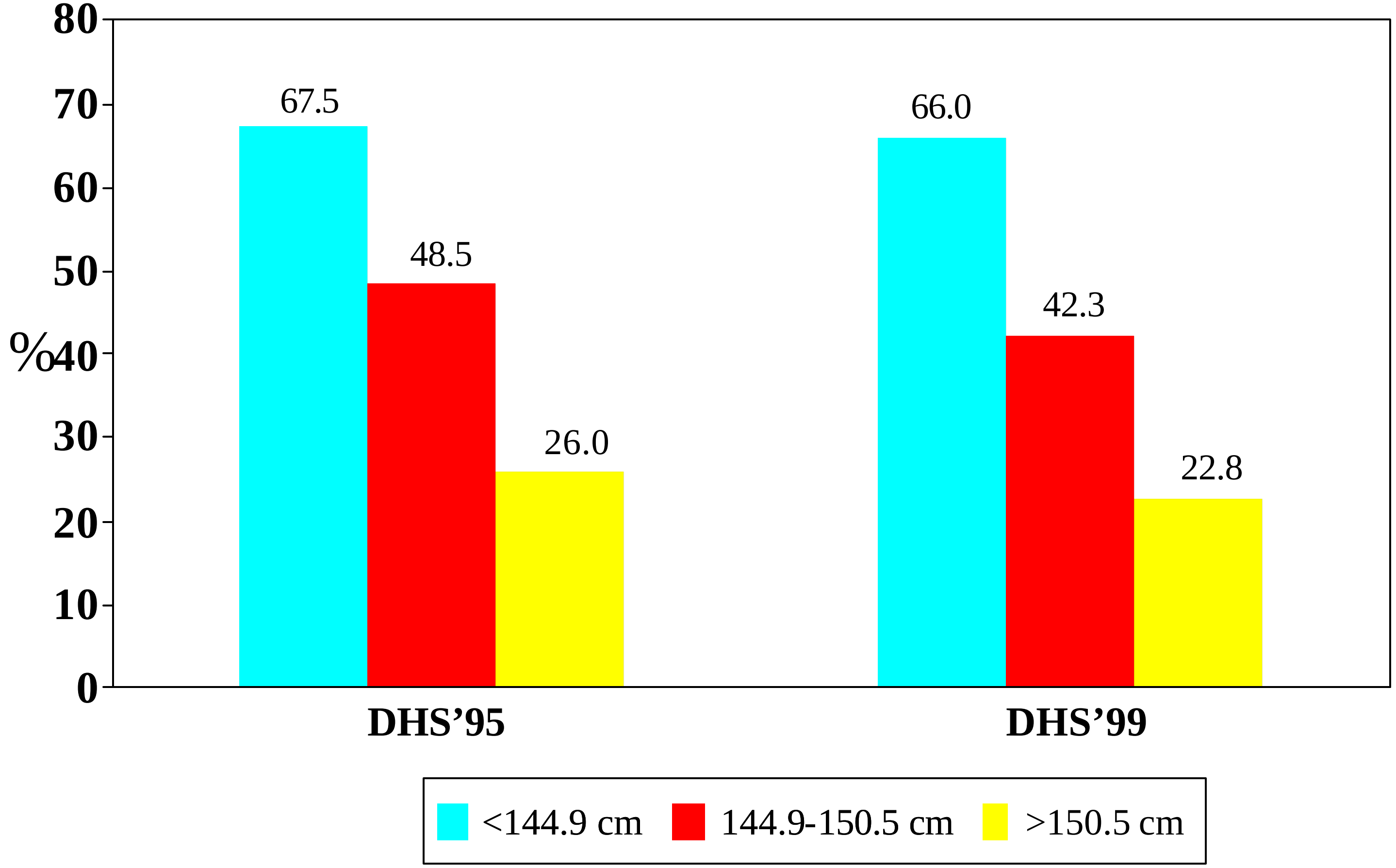


Figure 15. Percent of Guatemalan children, 3-36 months, stunted (< -2Z) by maternal age at birth, 1987-1999

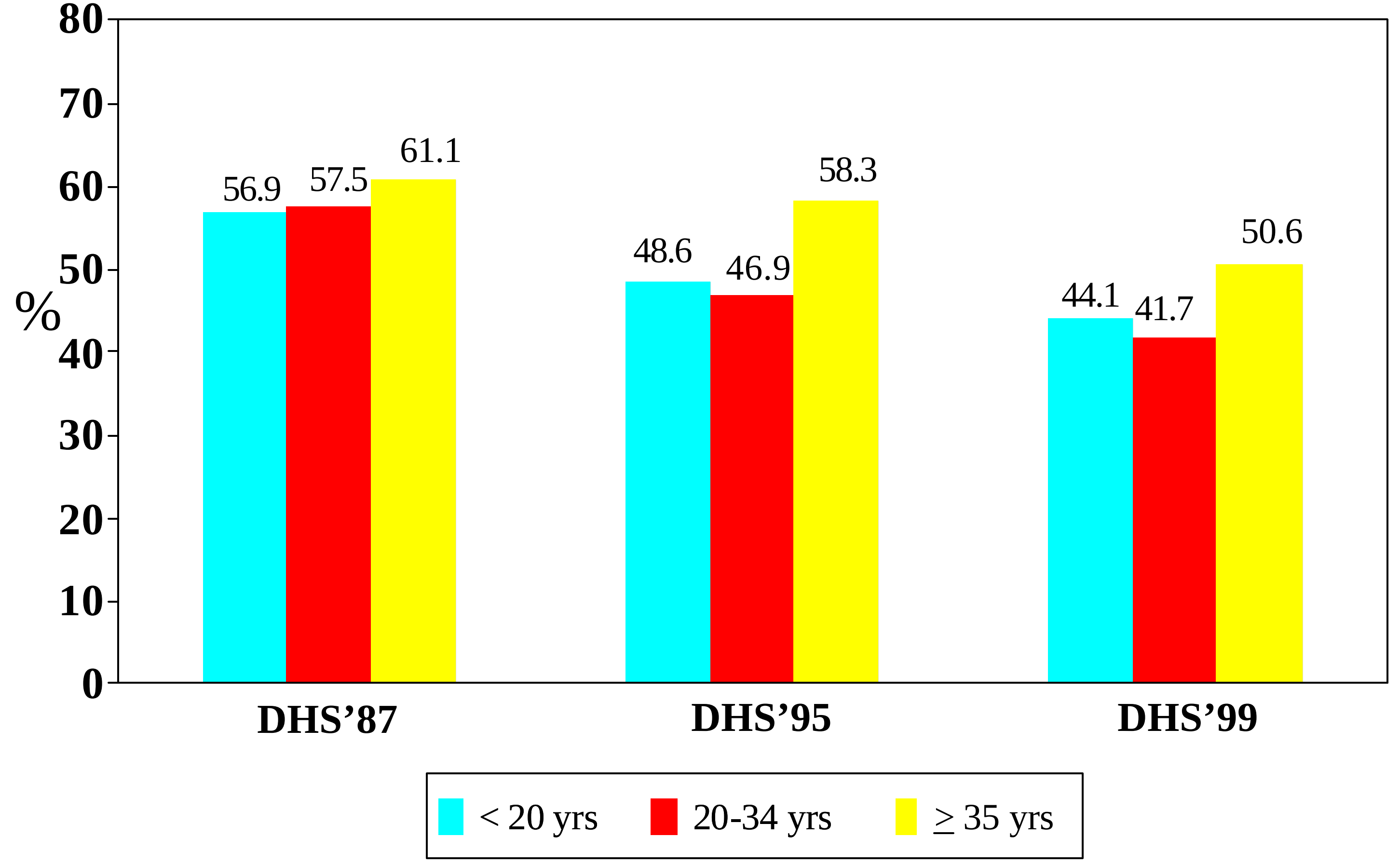


Figure 16. Percent of Guatemalan children, 3-36 months, stunted (< -2Z) by maternal use of modern birth control, 1987-1999

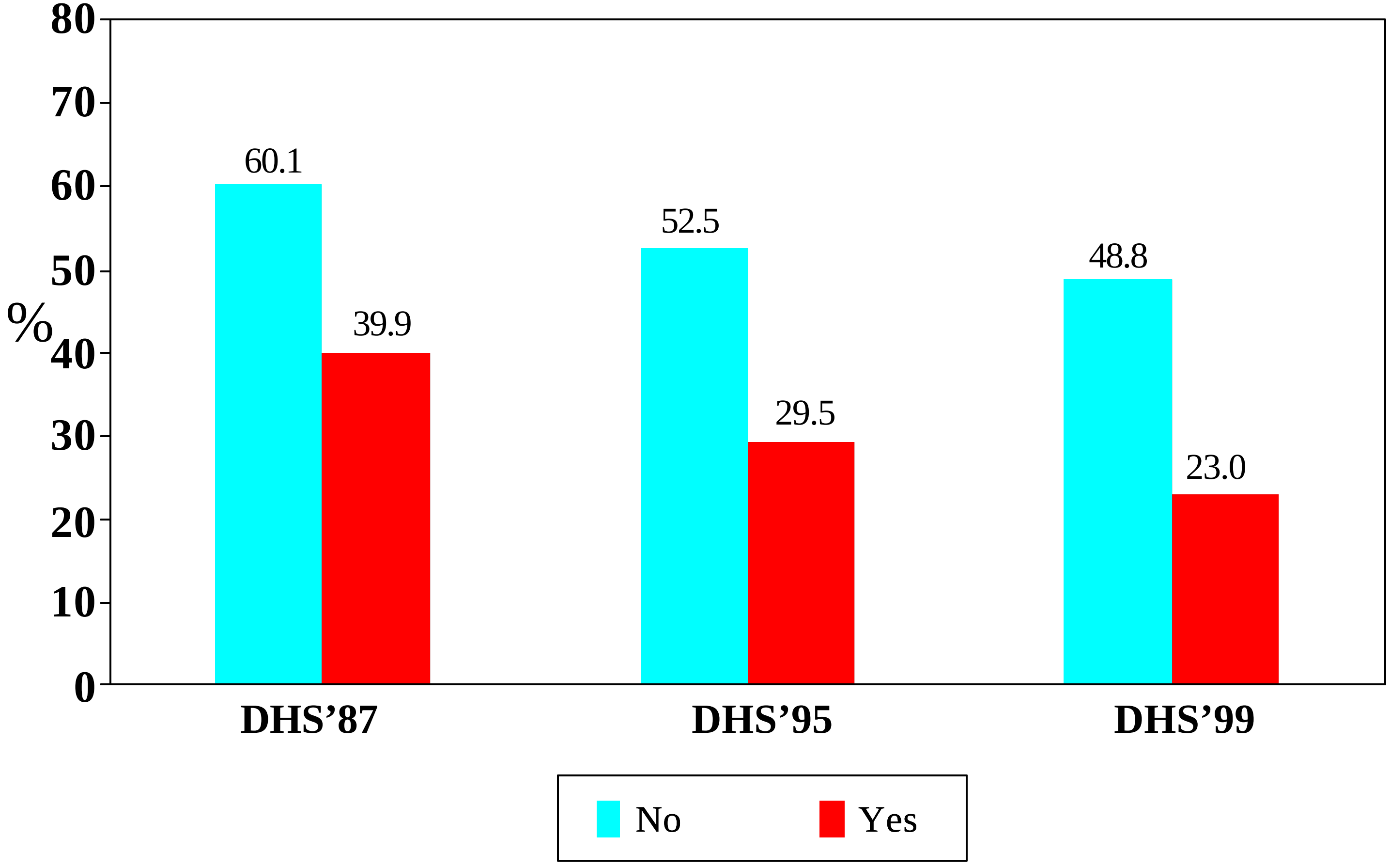


Figure 17. Percent of Guatemalan children, 3-36 months, stunted (< -2Z) by maternal employment outside the home, 1987-1999

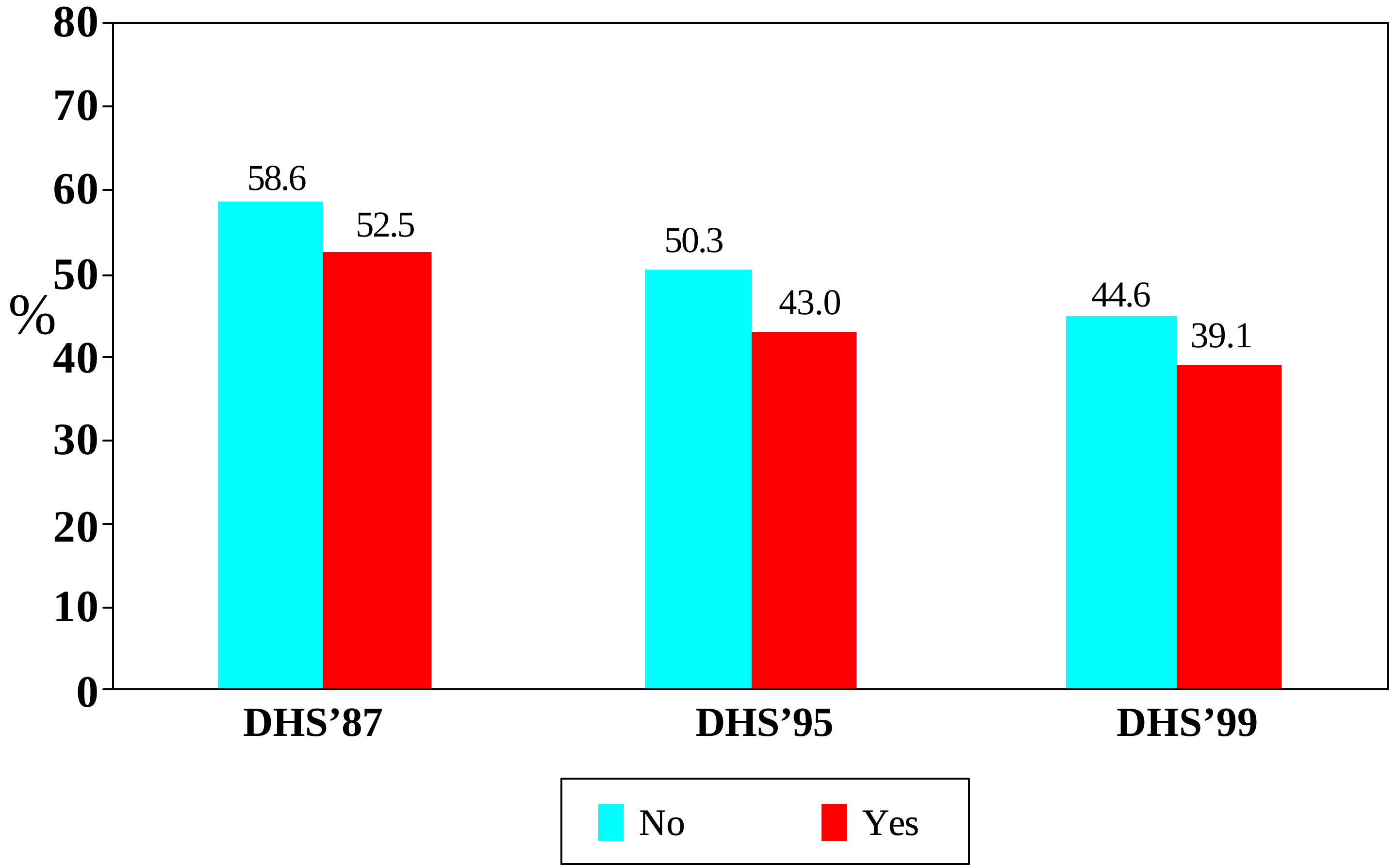


Figure 18. Percent of Guatemalan children, 3-36 months, stunted (< -2Z) by birth order, 1987-1999

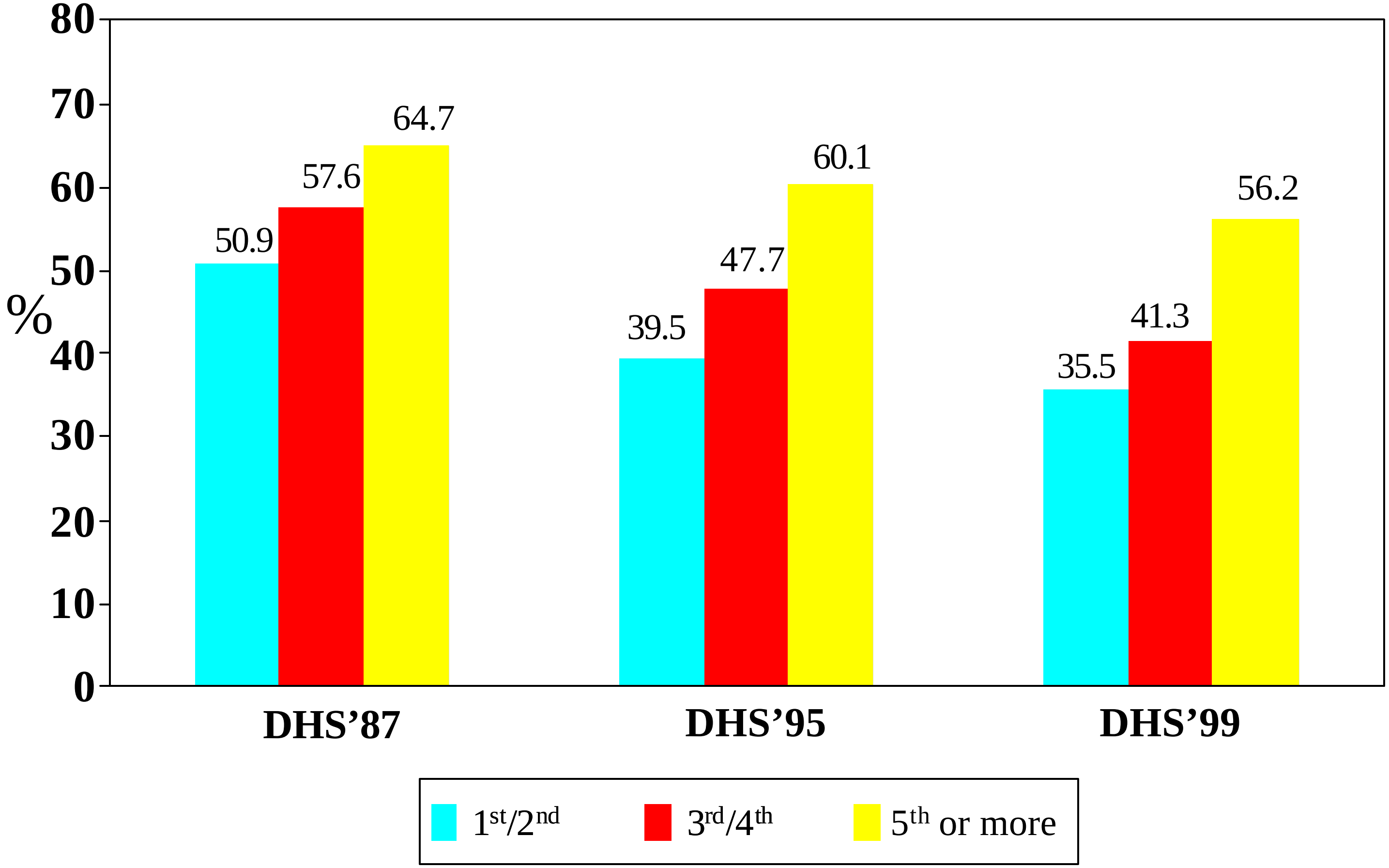


Figure 19. Percent of Guatemalan children, 3-36 months, stunted (< -2Z) by number of children under 5 years, 1987-1999

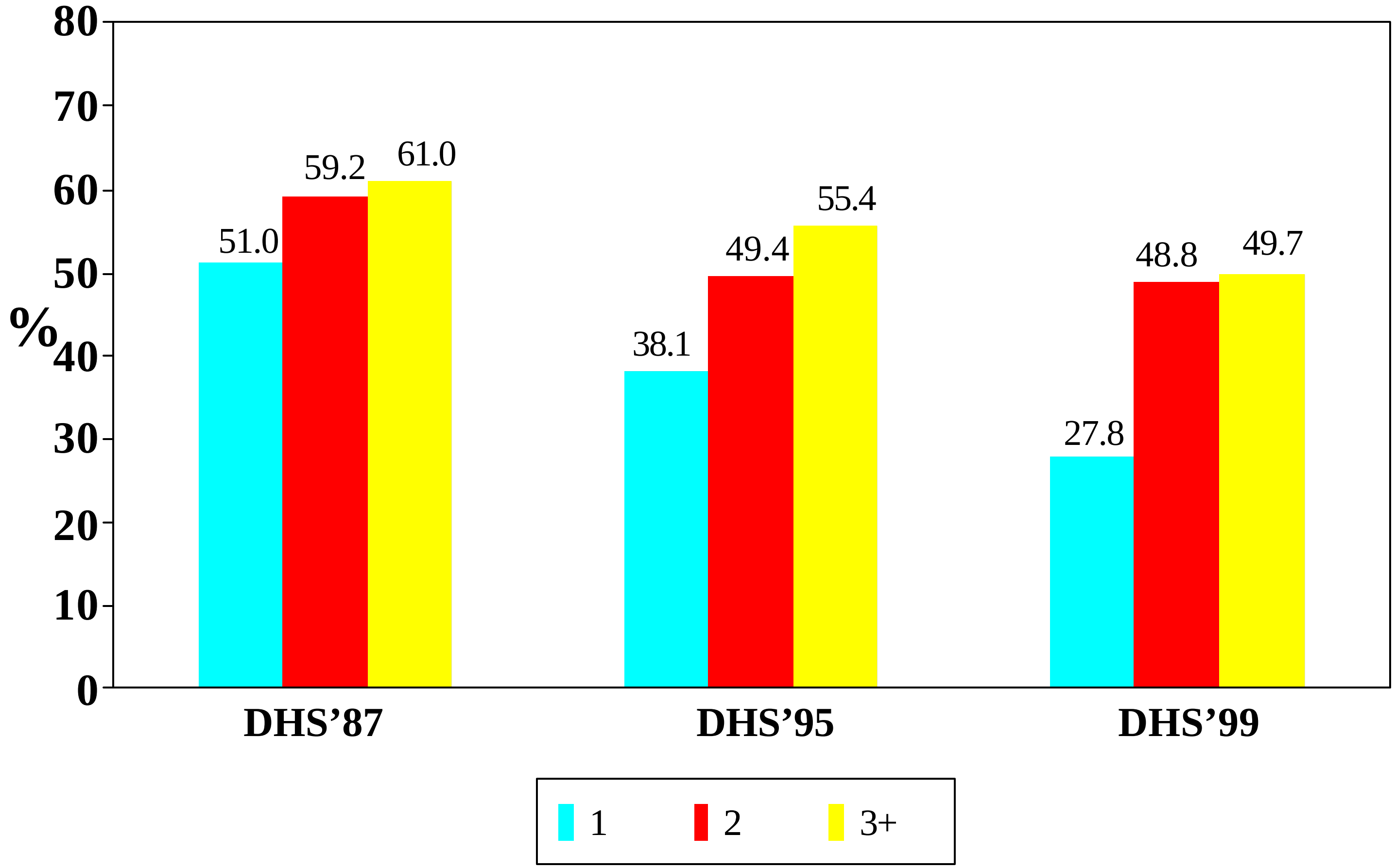


Figure 20. Percent of Guatemalan children, 12-36 months, birth order ≥ 2, stunted (< -2Z) by birth interval, 1995-1999

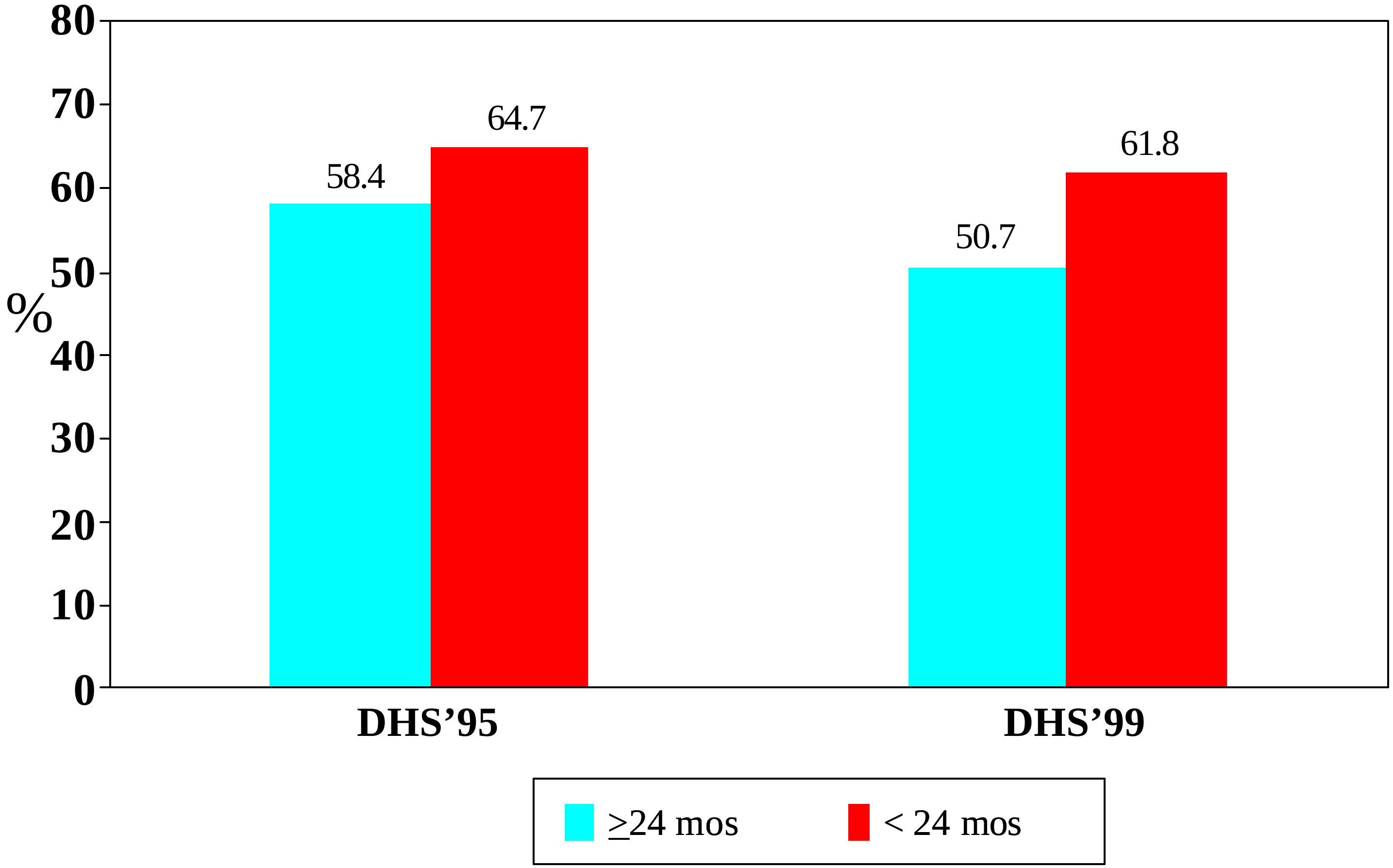


Figure 21. Percent of Guatemalan children, 12-36 months, birth order ≥ 2, stunted (< -2Z) by feeding index, 1995-1999

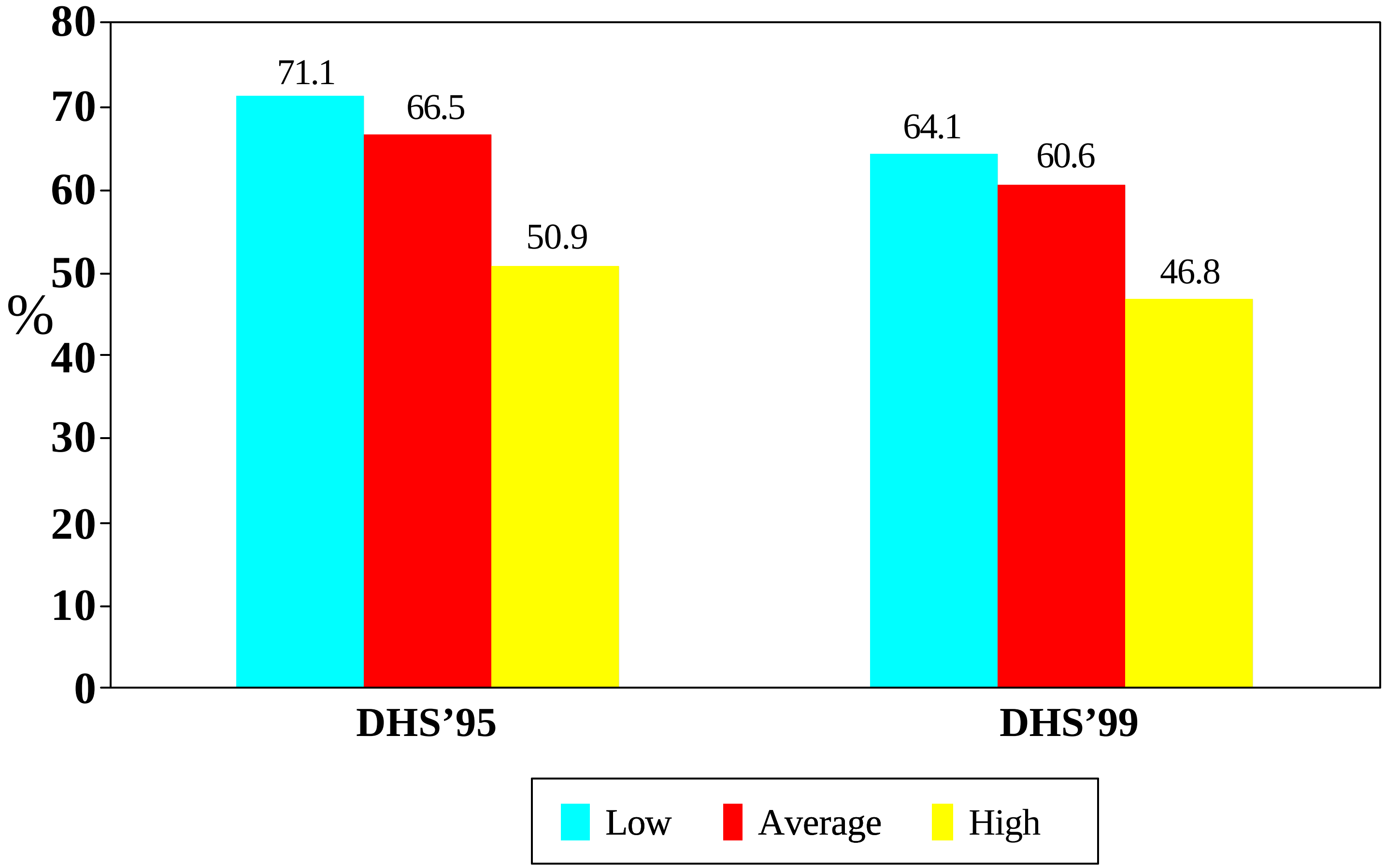


Figure 22. Distribution of years of maternal education by ethnicity and survey

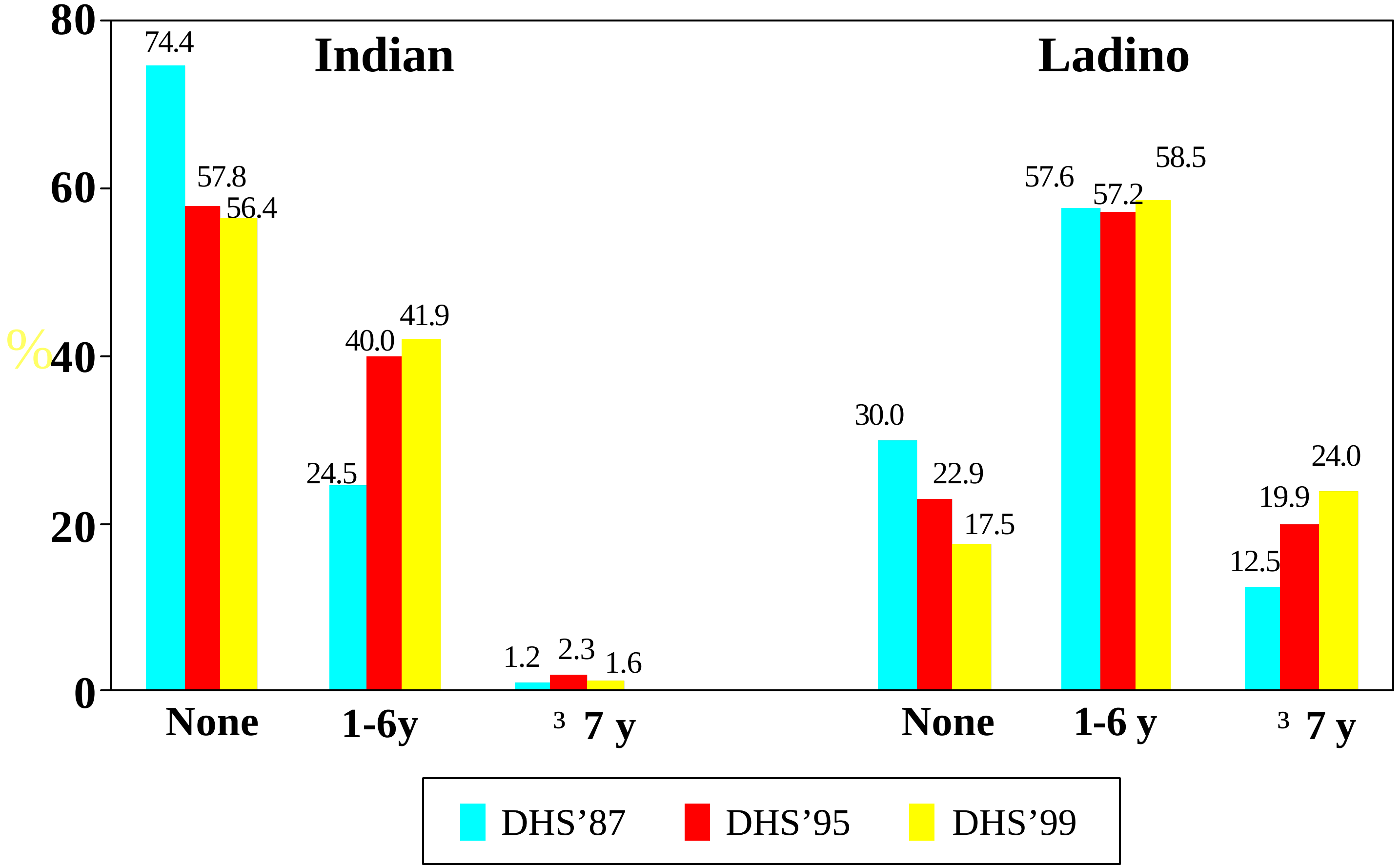


Figure 23. Percent of households residing in rural areas by ethnicity and survey

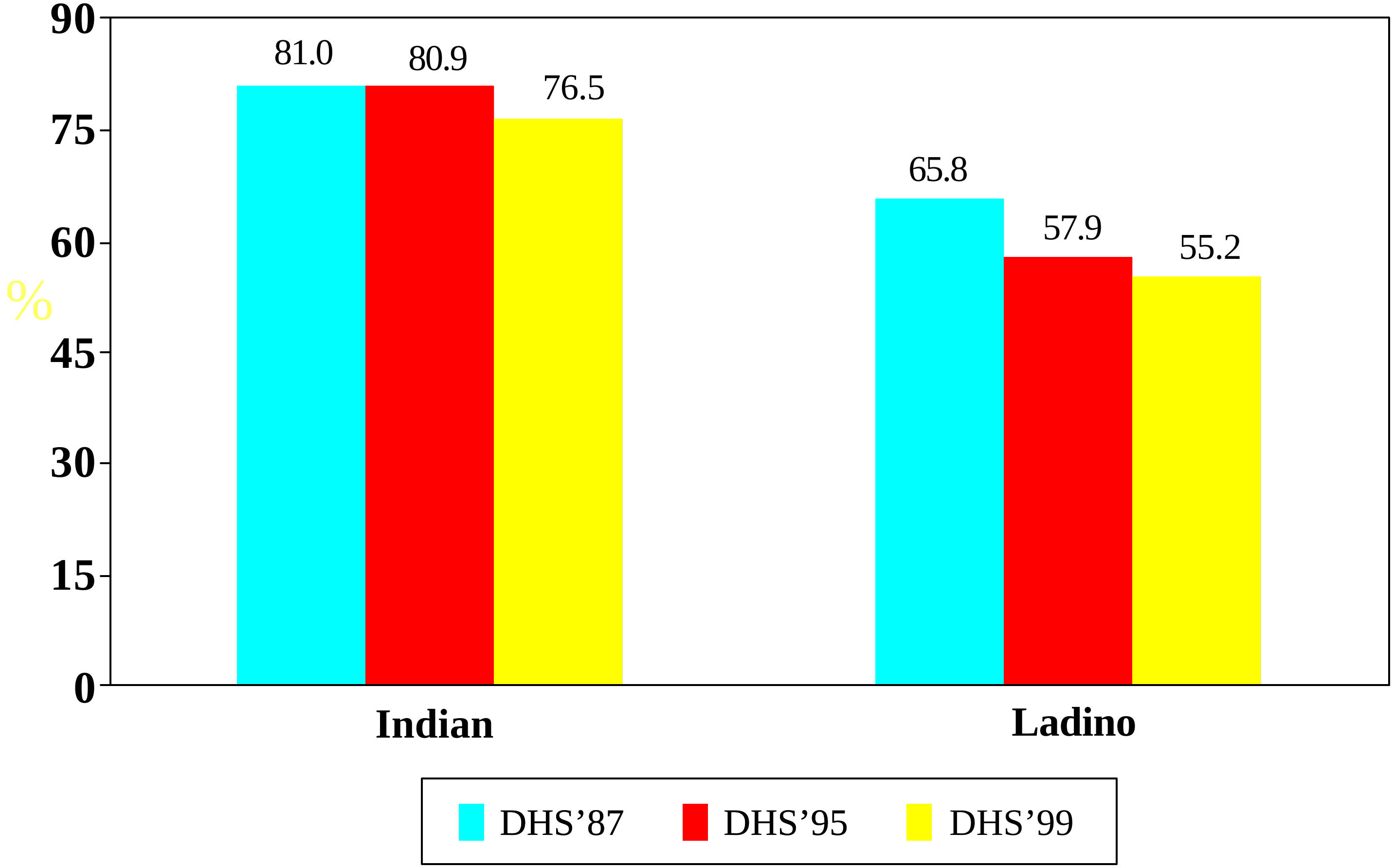


Figure 24. Distribution of maternal height by ethnicity and survey

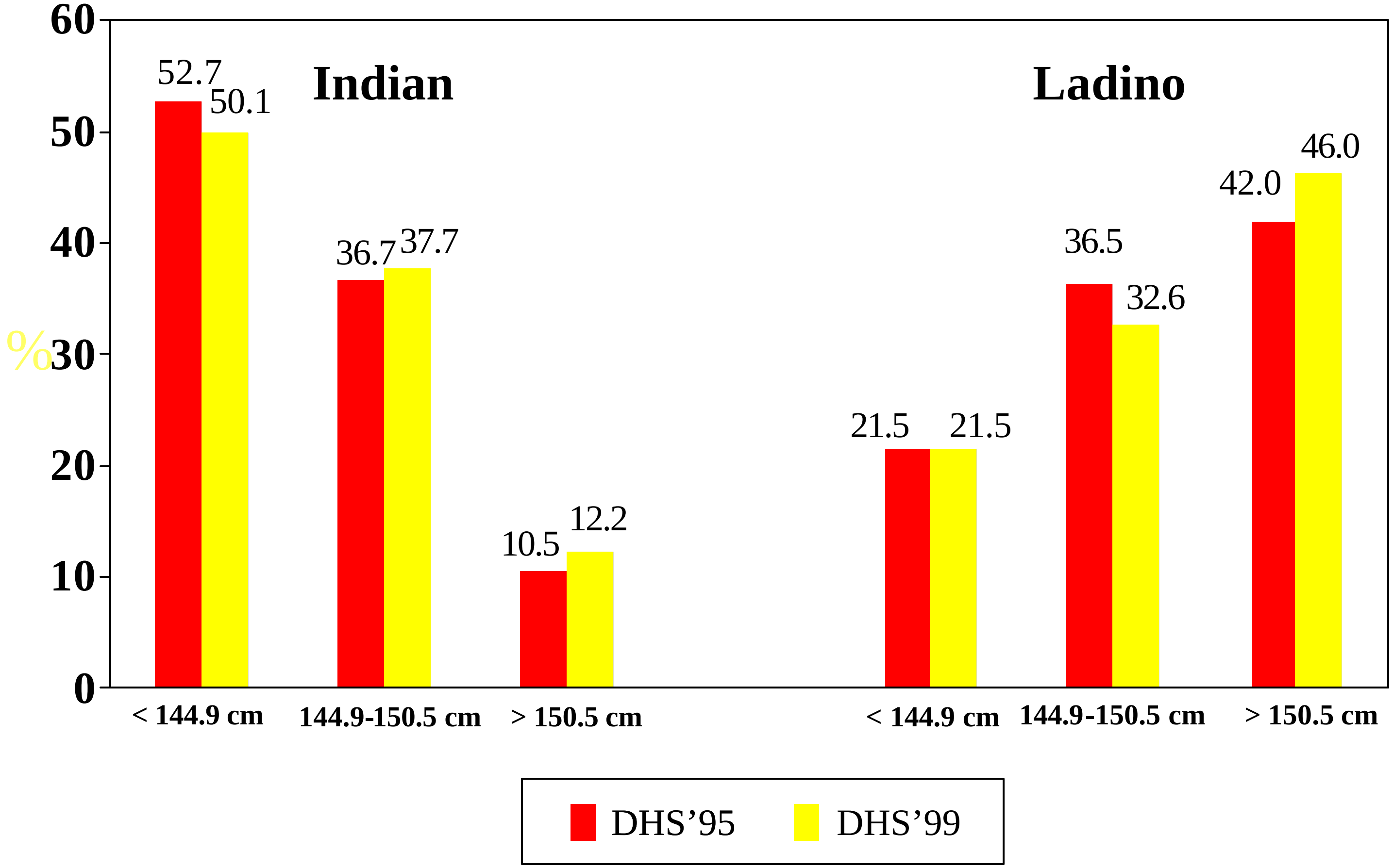


Figure 25. Percent of mothers using modern birth control method by ethnicity and survey.

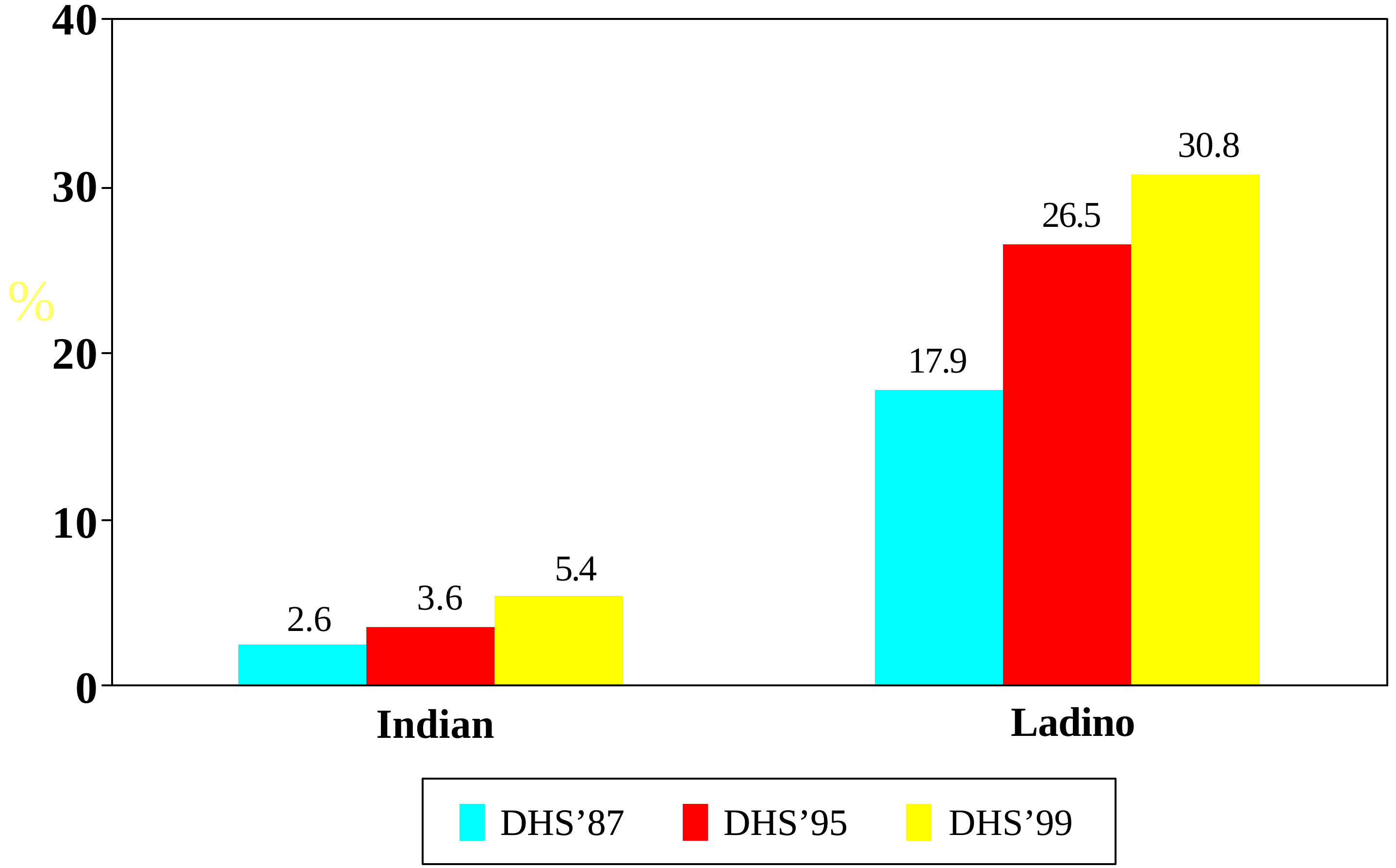


Figure 26. Percent of mothers working outside the home by ethnicity and survey.

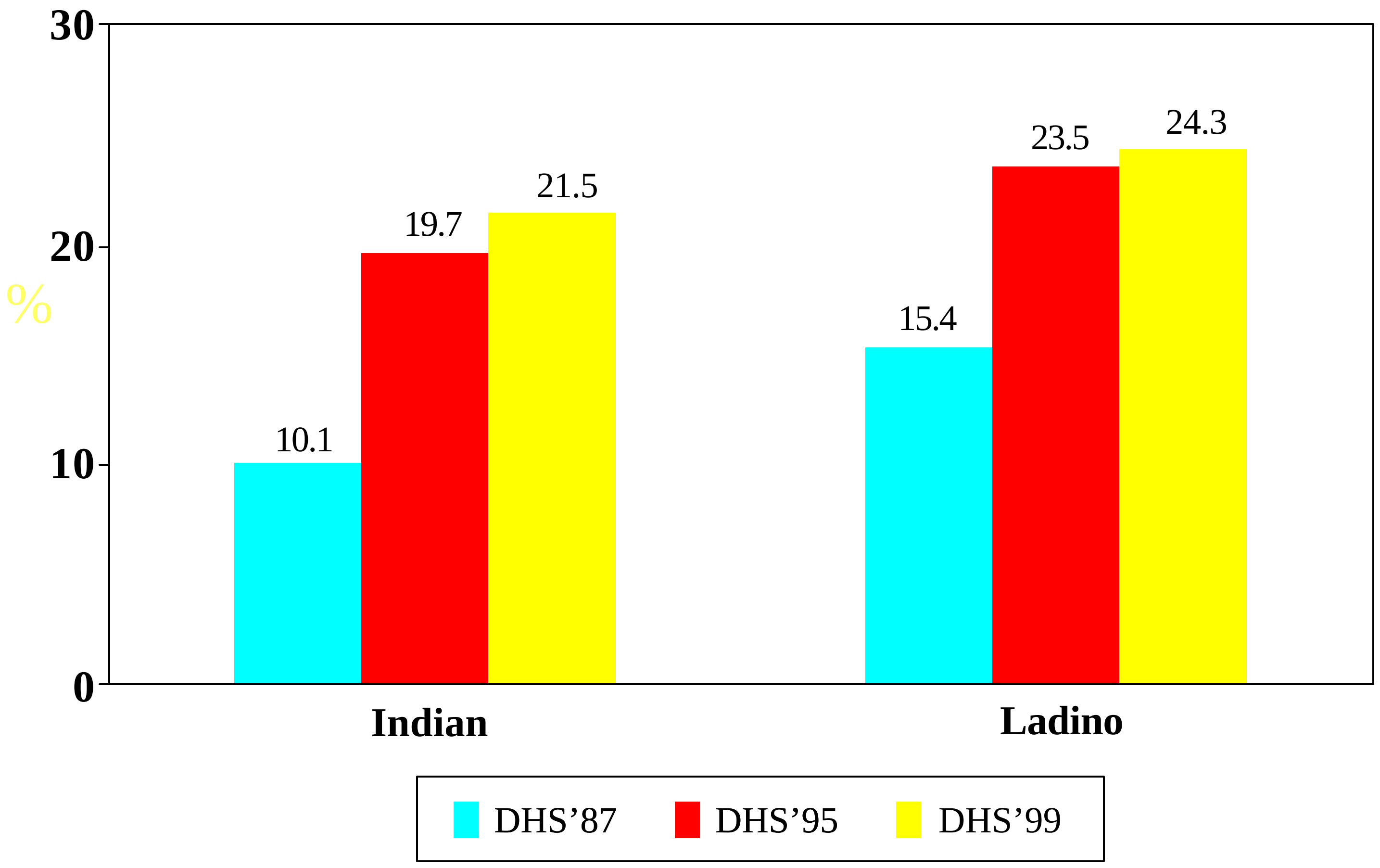


Figure 27. Distribution of number of children under 5 years old in household by ethnicity and survey

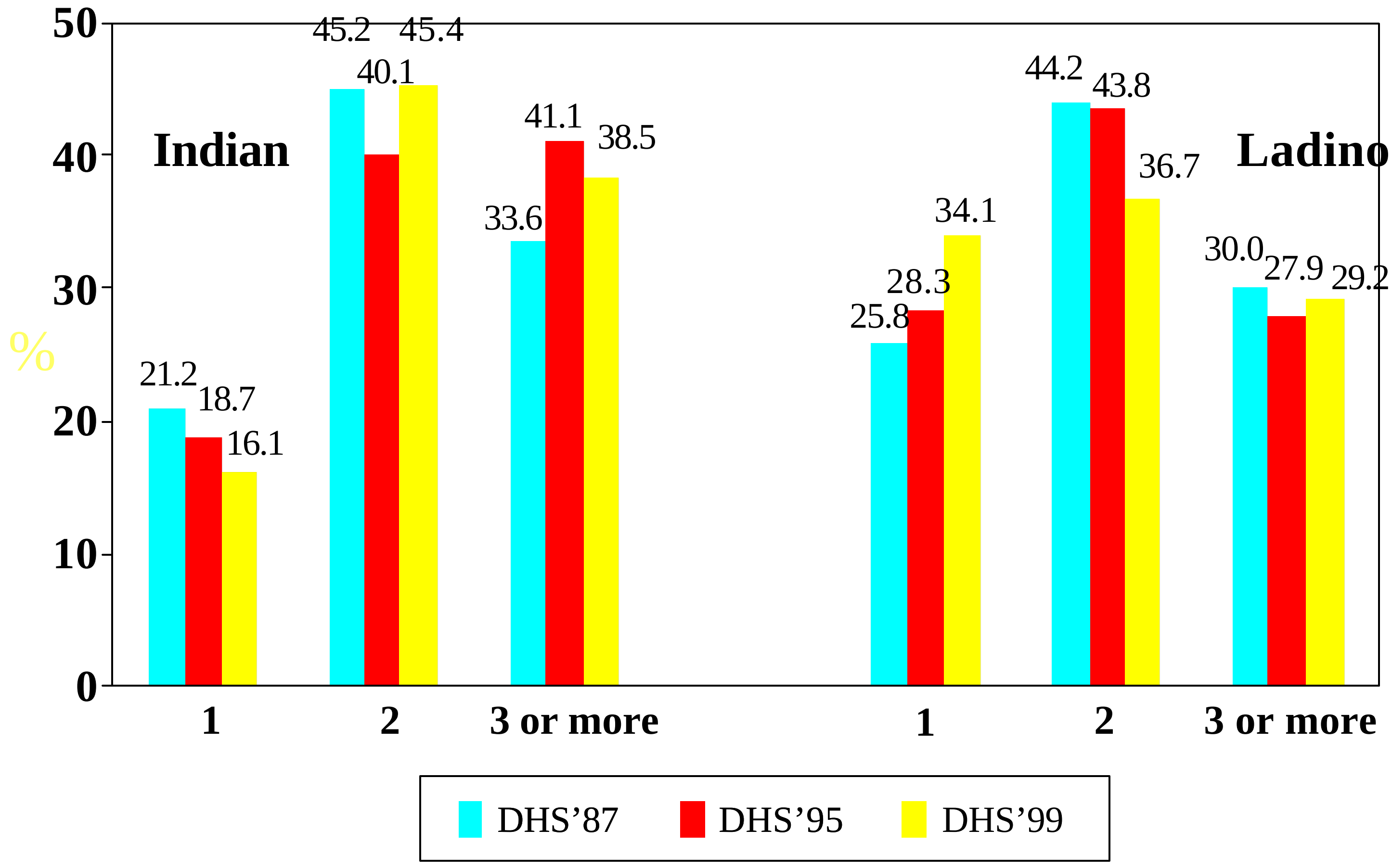


Figure 28. Percent of children born within 24 months of sibling by ethnicity and survey

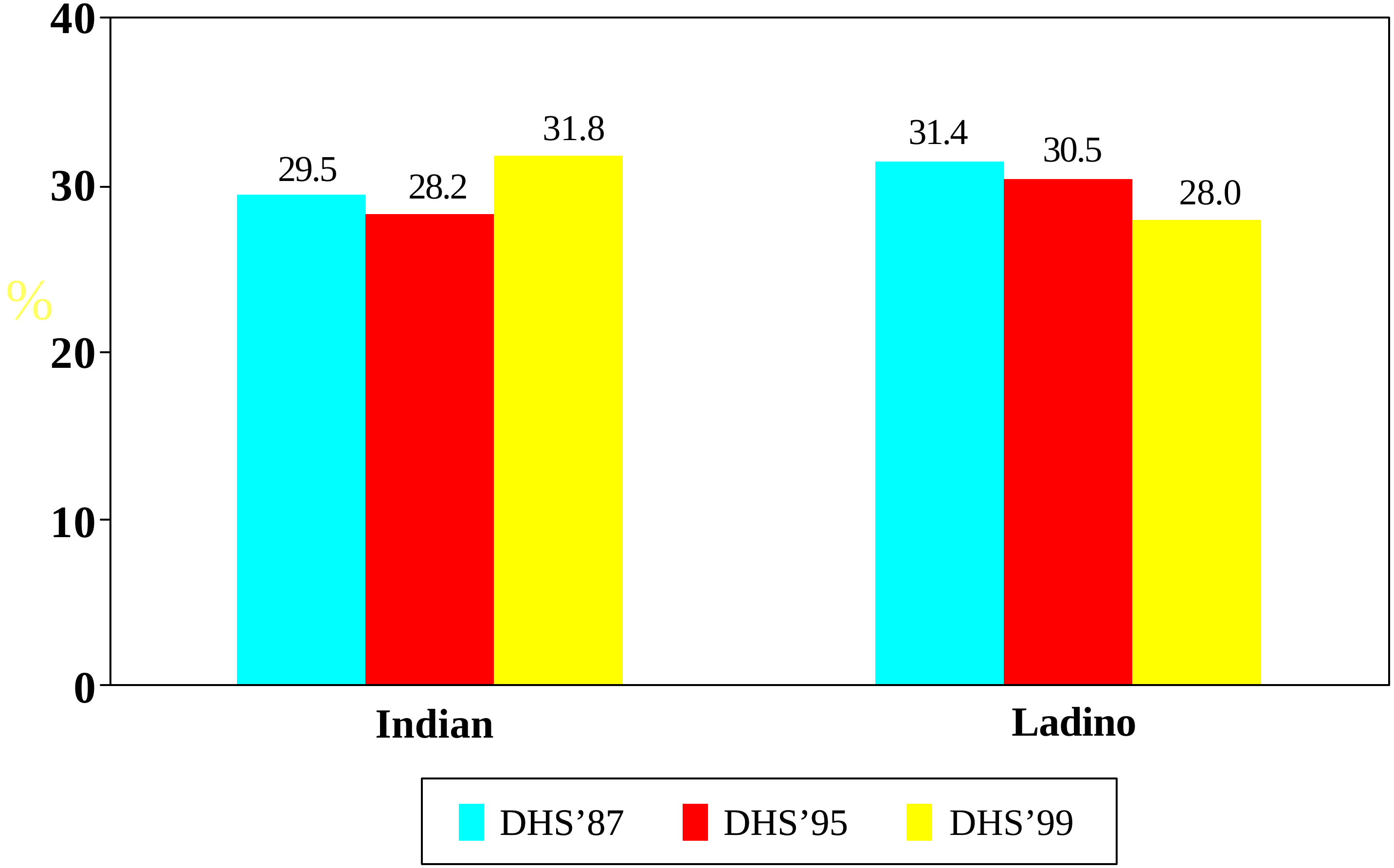


Figure 29. Distribution of feeding index by ethnicity and survey

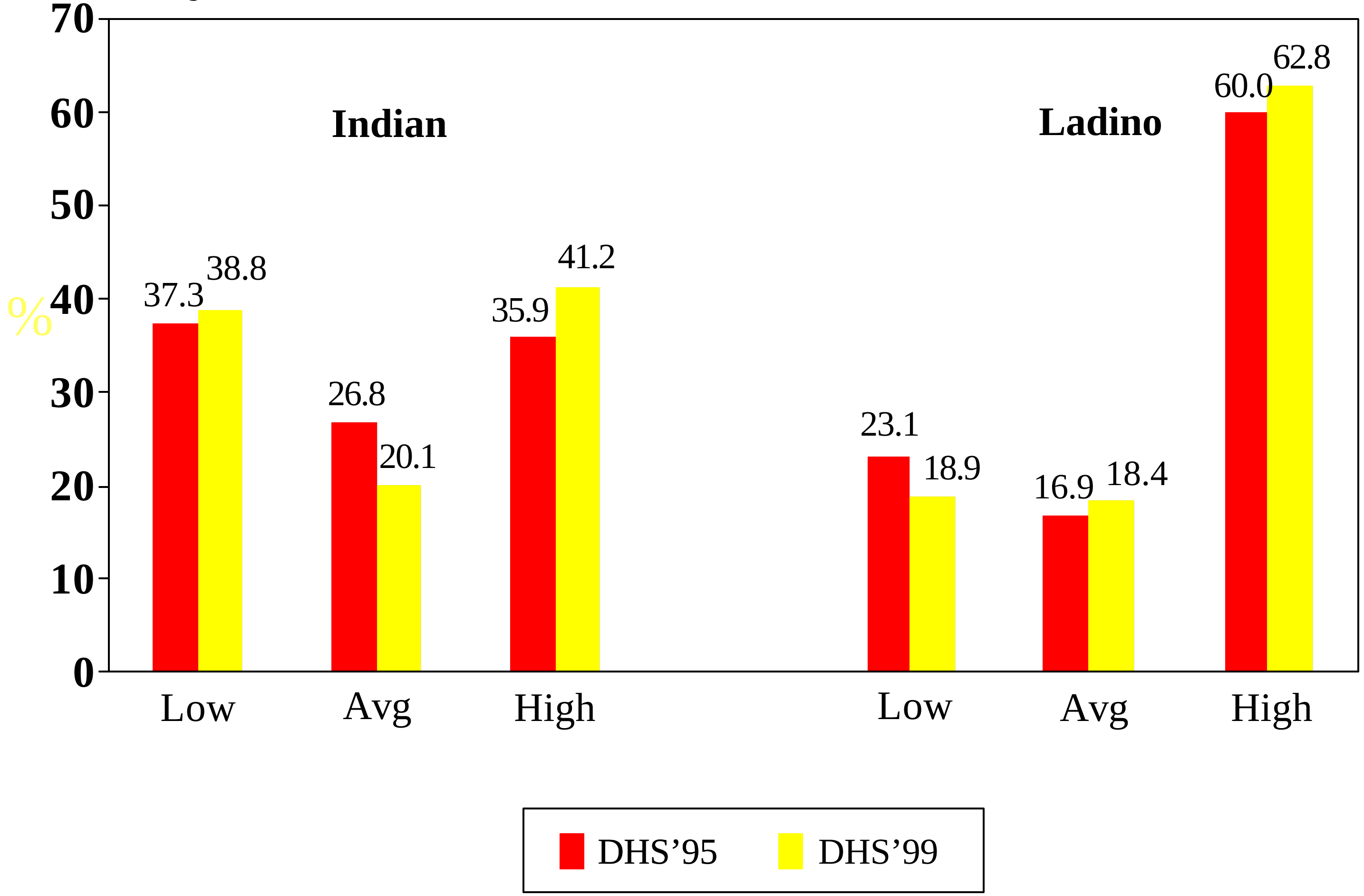


Figure 30. Digit preference (% distribution by ending digit) for height in the 1998-99 DHS survey and the 2001 School Height Census

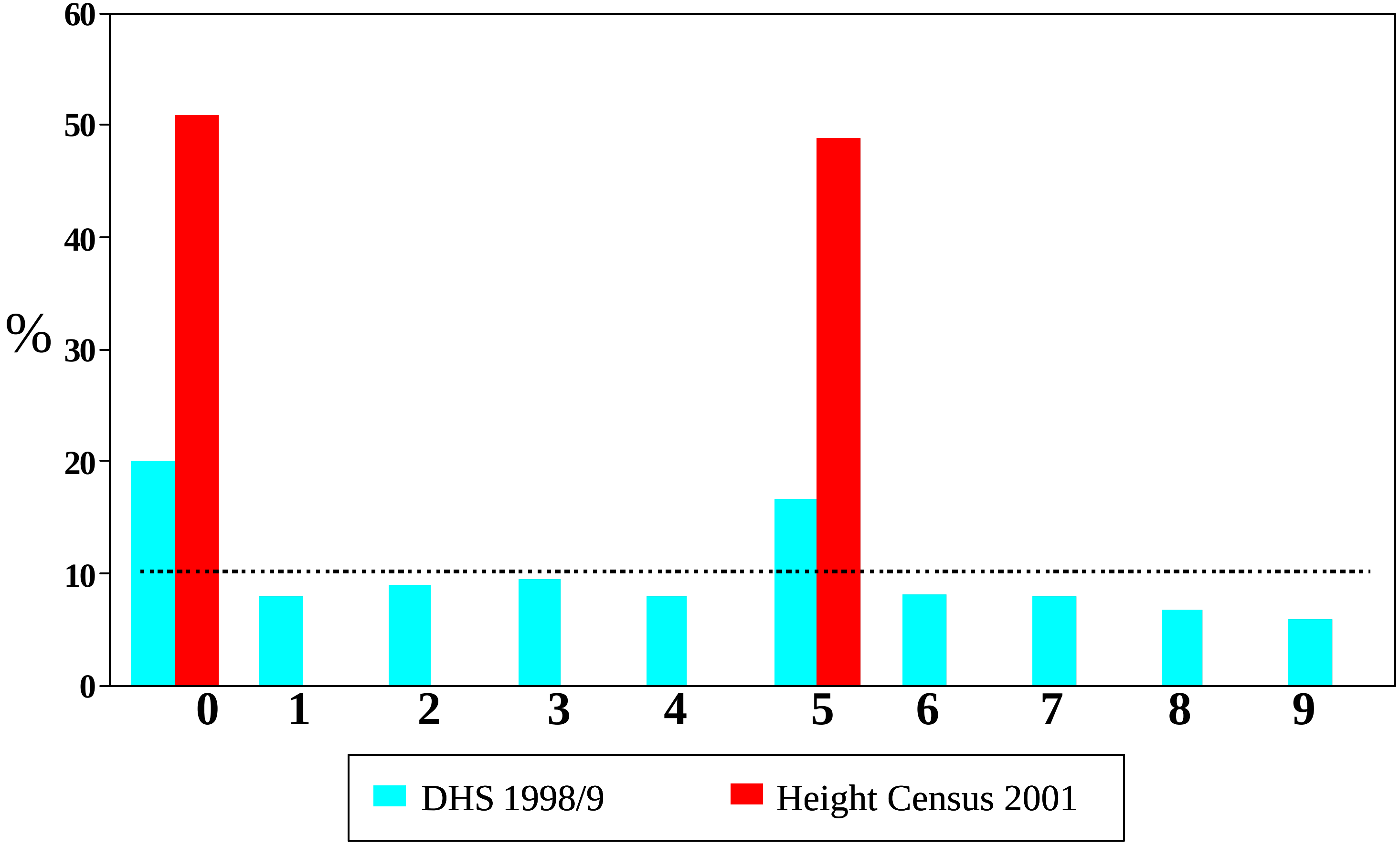


Figure 31. Percent stunted (< -2Z) in the 1986 and 2001 School Height Census

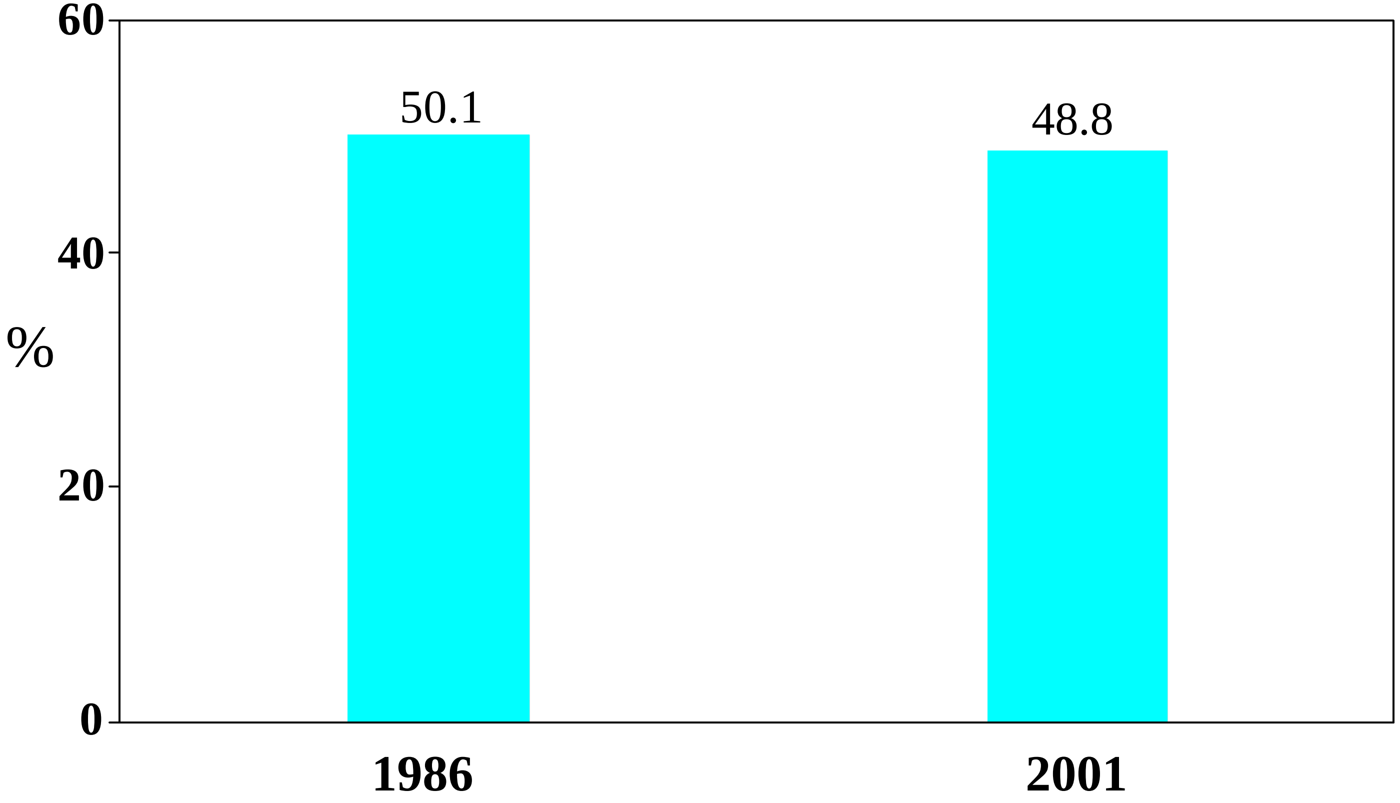


Figure 32. Percent stunted (<-2Z) by gender in the 1986 and 2001 School Height Census

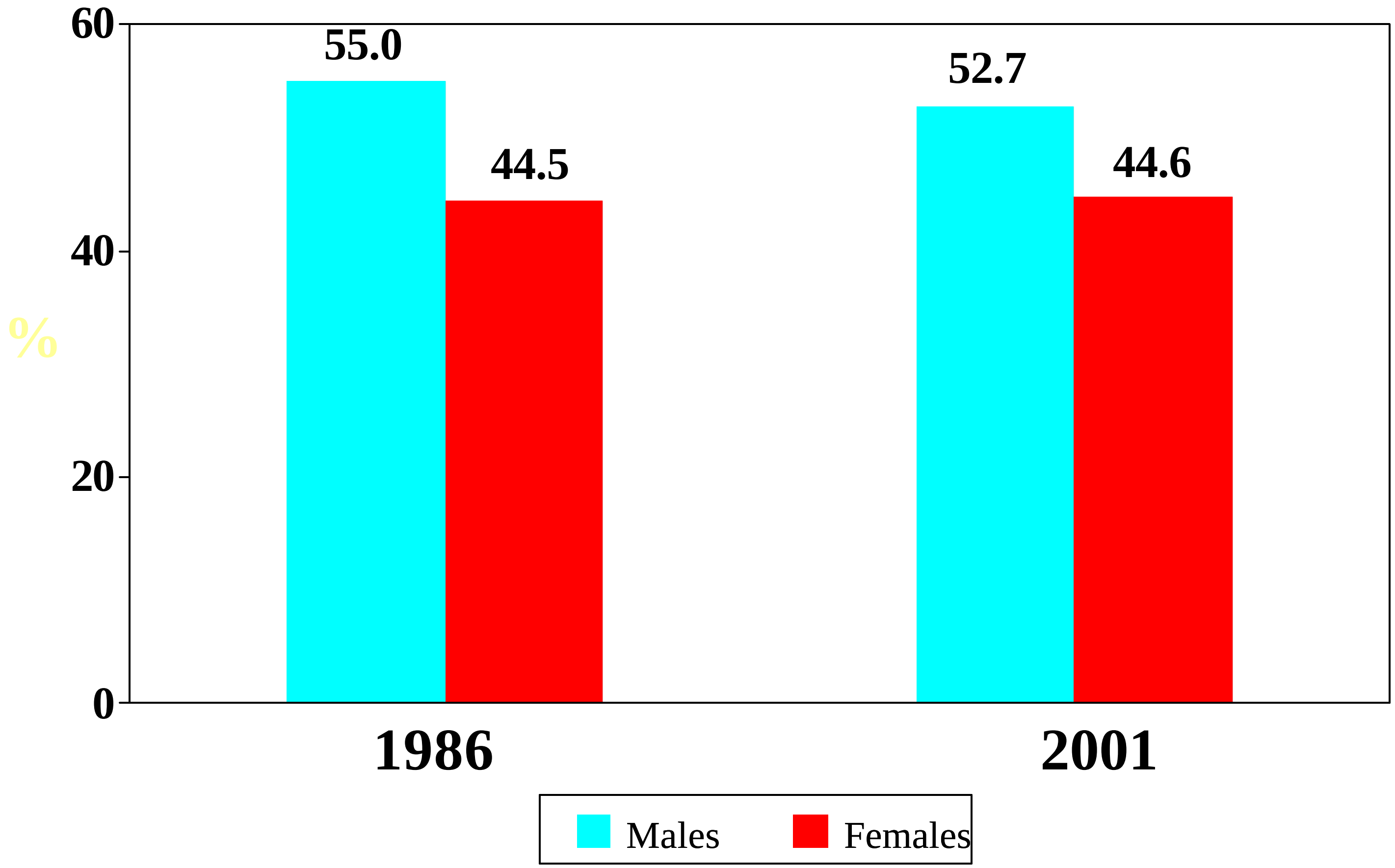
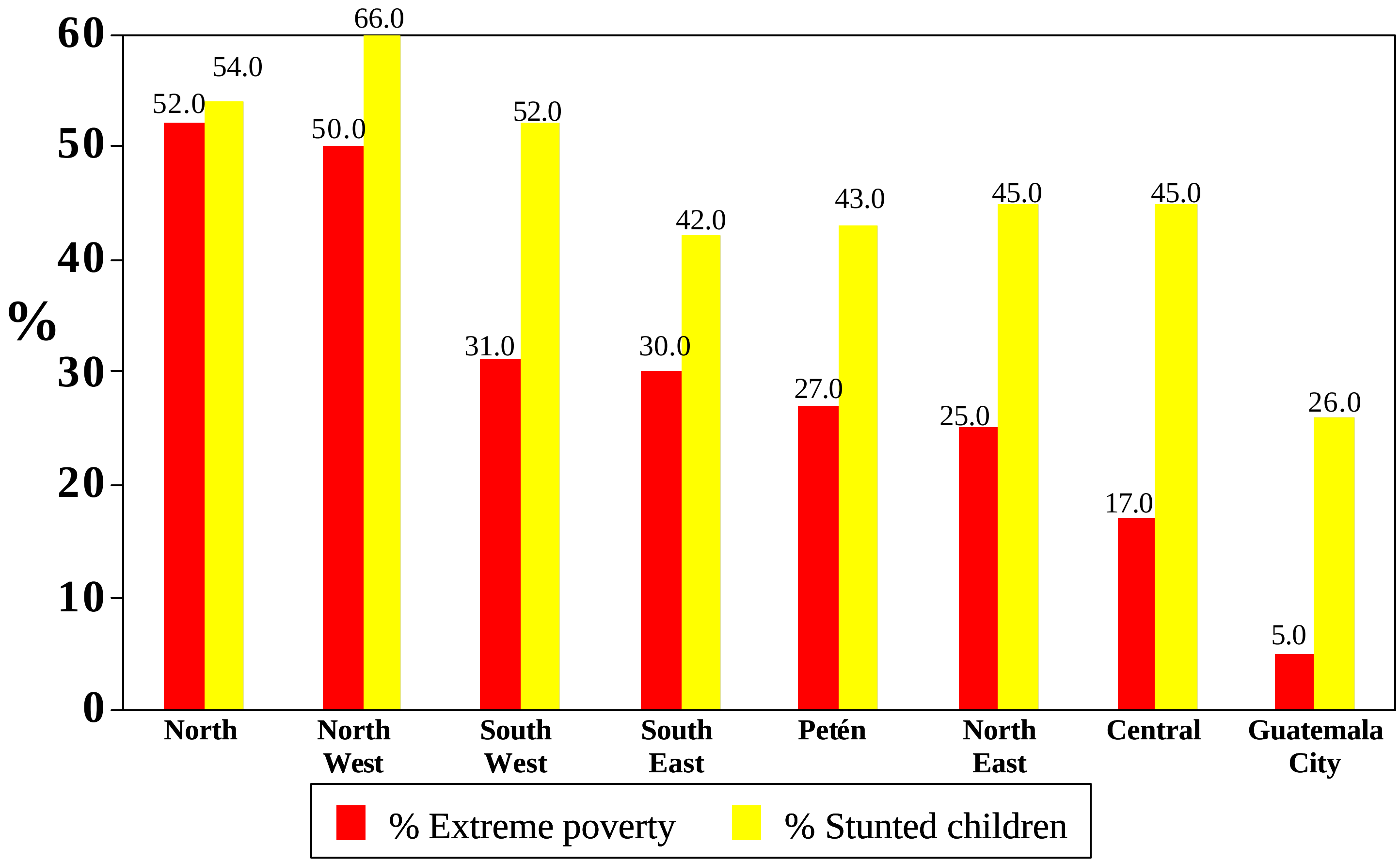


Figure 33. Prevalence of extreme poverty and stunting in children 3 to 36 months by region in 1998



+ Extreme poverty data from van Haeften, 2000 and stunting data from our analysis of DHS 1998-99.