

Atlas of Hunger and Malnutrition in the Dominican Republic

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Executive Summary

Hunger and malnutrition are at the center of economic development: malnutrition is an indicator of poverty, social exclusion, and deprivation, and is a major constraint to national economic development. For this reason, the reduction in hunger is part of the first Millennium Development Goal (MDG). The Nutrition Analysis and Mapping Project, funded by the World Food Programme and implemented by Tufts University, was undertaken to assist in identifying areas of high malnutrition prevalence at a geographically disaggregated level, to assist in understanding the determinants of nutrition problems in different geographic settings and in targeting nutrition interventions, and to provide a basis for monitoring progress in the achievement of the first MDG. The output is a series of maps that show, at the *municipio* level, the estimated prevalence of childhood chronic malnutrition (low height-for-age of children 6 to 59 months), and that demonstrate associations with other geographic and economic characteristics and with the provision of services. Growth retardation was chosen as the key indicator of the nutrition situation in the Dominican Republic because it is the most commonly occurring manifestation of childhood malnutrition (low weight for height, wasting, is much less prevalent). Information on adult nutritional status, micronutrient nutrition, and diet was not available.

Estimates of the prevalence of child malnutrition were developed by taking a nationally representative sample survey, the Demographic and Health Survey (ENDESA) of 2002, and using this to create a statistical model to predict the nutritional status of children. This model was then applied to data from the 2002 National Census. The model, using variables common to the two data sets and augmented with information from secondary sources, resulted in a predicted anthropometric status for every child in the appropriate age group, and an estimated prevalence of malnutrition (defined as height-for-age, weight-for-height, and weight-for-age below -2 standard deviations of the NCHS/CDC/WHO standards for child growth)¹ for each *municipio* in the country.² These prevalences were divided into quartiles, so that high-prevalence *municipios* could be identified. Malnutrition indicators have been improving in the Dominican Republic in recent decades. The DHS finds average national prevalence of child growth retardation has fallen from 11 percent in 1996 to 8.9 percent in 2002. They found significant variation among provinces, though, with prevalence reaching close to 19 percent in some provinces. Our own provincial estimates also found great variation from one province to another, but also very significant variation by *municipio* within provinces. Prevalence by *municipio* varied from about 3.5 percent to over 46 percent of children under five, according to our estimates, indicating some areas where, despite overall improvement in the nutrition situation, a serious problem of malnutrition persists.

There is wide variation in malnutrition prevalence among the *municipios* in a province, with pockets of high malnutrition in apparently low-prevalence provinces like Dajabón in the west, and even Espaillat and Puerto Plata in the relatively well-off northwestern part of the country. Similarly, high-prevalence provinces are not uniformly affected, but have *municipios* in the

¹ These results are based on NCHS/CDC/WHO standards (Waterlow et al 1977; WHO 1995). New growth standards were issued by WHO in 2006. Use of the new standards might have changed some of the results (deOnis et al 2006).

² Prevalence is based on the mean predicted probability of falling below the -2 SD cutoff in each *municipio*.

lower two quartiles of prevalence even though the province as a whole is in the highest quartile (e.g. Independencia, Baoruco, Monte Plata). Rates of malnutrition within a province vary by as much as a factor of five.

The distribution of high-prevalence *municipios* is quite different from their distribution according to the *number* of malnourished children they contain. The *municipios* with the highest numbers of malnourished children are those containing large cities: Santo Domingo and the Distrito Nacional, Santiago and San Cristóbal, for example. If the *municipios* in the highest prevalence quartile (prevalence range 14.4 to 45.8 percent) were targeted with a nutrition intervention, 21,810 children would be reached, or about 25 percent of the 85,970 malnourished children in the country. If the ten *municipios* with the highest *number* of malnourished children were to be targeted, 34,918 children, or 41 percent would be reached. A dual strategy of targeting to reach both types of *municipio* seems to be necessary.

Malnutrition prevalence is correlated with the rates of poverty, but the correlation between the percentage of households that are poor and the percentage of children that are chronically malnourished is only 0.365, lower than might be expected ($p=0.000$, Pearson). There are 47 *municipios* out of 225 (20.9 percent) in which the prevalence of poverty is at least two quartiles different from the prevalence of malnutrition: 26 show malnutrition rates at least two quartiles higher than poverty rates, and 21 show poverty rates that are at least two quartiles higher. If we targeted a program based only on poverty, and excluded these 26 *municipios* where malnutrition prevalence is two or more quartiles greater than poverty, 20,165 children in these 26 *municipios*, or 23.4 percent of the 85,970 chronically malnourished would be missed.

If we targeted a program based on being in the highest quartile of poverty alone, we would only reach 9,971 children, or 11.64 percent of the 85,970 chronically malnourished. Poverty is an important determinant of malnutrition, but not the only one. Targeting mechanisms, such as the *Sistema Único de Beneficiarios* (SIUBEN) used to target the *Comer es Primero* program, might use these Hunger Maps to identify areas where interventions might be needed based on malnutrition rates, even where poverty rates are not high.

Health services – clinics, health centers, and hospitals – are well-distributed throughout the country. The maps showing the number of health centers per 1000 population suggest that health centers have no particular bias toward or away from high-prevalence *municipios*. There are school feeding programs throughout the country, with a very high rate of coverage of children in school. Our own analysis of Census data suggest that about two thirds of age-eligible children, 7 to 14 years of age, are attending school, and that this does not appear to be related to socioeconomic status at the *municipio* level. There are three different modalities of school feeding: two provide full meals, and one, covering more than 90 percent of school feeding recipients, provides a biscuit-and-milk snack. The distribution of these programs is determined by geography, and does not appear to be related to malnutrition prevalence. *Comer es Primero* is a relatively new program, implemented in 2004, well after the data on which this report is based were collected. The distribution of beneficiaries of this program seems to be more related to poverty rates in the *municipios* than to malnutrition rates, which is not surprising since the basis for targeting, the SIUBEN, is a poverty measure.

This report is based on data collected in 2002. In 2003-04, the country experienced an acute and severe economic crisis, resulting in a sharp drop in GNI, currency devaluation, and an increase in unemployment and in poverty. A new government took office in 2004, implementing a variety of programs aimed at improving social welfare, and the economy is on a course of recovery. Nonetheless, these recent changes in economic circumstances make it even more important to update the information on which these maps of malnutrition are based using data from the period after the crisis.

We encountered serious data limitations in undertaking this project. It would have been useful to have better information on climate and climate shocks, and we were unable to find any information on local price variability, which can be an important indicator of market function. To understand the nutrition situation of the country, it would be extremely valuable to have information on other nutrition indicators, specifically, nutritional status of adults and older children as well as pre-schoolers, direct measures of micronutrient status, and information on what foods are consumed by different population groups and what food sources are used to provision households. The usefulness of malnutrition maps for designing and targeting possible nutrition interventions, for monitoring progress in achieving the MDGs, and for understanding the distinct causes of nutritional problems in different geographic contexts, depends on periodic updating of the maps with more recent data. In implementing such updates, it would be worthwhile to invest in expanding the range of information that can be included in the analyses, by expanding the data collected.

The Dominican Republic is making significant progress in improving the health and nutritional status of its people. We hope that tools such as the Hunger Maps may contribute to the design of programs and policies that assist in continuing that positive trend.

List of Acronyms

CONARE	<i>Consejo Nacional de Reforma del Estado</i> (National Council for Reform)
DHS	Demographic and Health Survey
ENCOVI	<i>Encuesta Nacional de Condiciones de Vida</i> (National Survey of Living Conditions)
ENDESA	<i>Encuesta Demográfica y de Salud</i> (DHS)
ENGIH	<i>Encuesta Nacional de Gastos e Ingresos de Hogares</i> (National Survey of Household Expenditures and Income)
FIVMS	Food Insecurity and Vulnerability Mapping System (FAO)
HAZ	Height-for-Age Z-Scores
ICV	<i>Indice de Condiciones de Vida</i> (Standards of Living Index)
ILAE	<i>Incentivo a la Asistencia Escolar</i> (Incentive for School Attendance)
IQR	Interquartile range
LAC	Latin America and Caribbean region
LBW	Low birthweight
MDG	Millennium Development Goals
ONAPLAN	<i>Oficina Nacional de Planificación</i> (National Planning Office)
PAE	<i>Programa de Alimentación Escolar</i> (School Feeding Program)
PESA	<i>Programa Especial para Seguridad Alimentaria</i> (Special Program for Food Security, UNDP)
PROSISA	<i>Proyecto de Reforma del Sistema de Salud</i> (Project for the Reform of Health System)
SAE	Small Area Estimation
SEE	<i>Secretariado del Estado de Educación</i> (Secretariat of Education)
SESPAS	<i>Secretariado de Salud Pública y Asistencia Social</i> (Secretariat of Public Health and Social Assistance)
SIGpaS	<i>Sistema de Información Geográfica para la Salud</i> (System of Geographic Information for Health)
SIUBEN	<i>Sistema Único de Beneficiarios</i> (System of Beneficiaries)
VAM	Vulnerability Analysis and Mapping (WFP)
WAZ	Weight-for-Age Z-Scores
WFP	World Food Programme
WHZ	Weight-for-Height Z-Scores

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Introduction

This report presents the results of an effort to develop maps of malnutrition in the Dominican Republic at a high level of geographic disaggregation. Hunger and malnutrition are at the center of national development. Malnutrition is a key indicator not only of poverty, but also of deprivation more broadly conceived: where populations are malnourished, there is a failure of entitlement and of wellbeing. Further, malnutrition is an important constraint on economic development. Malnourished populations are diminished in both physical and cognitive capacity; their economic productivity is lower than in well-nourished populations, and they are subject to higher levels of illness. In the context of a modernizing and growing economy, populations that were malnourished early in life are subject to increased incidence of chronic diseases in adulthood, with implications for lost productivity and costs to the health care system.³

In 2000, the United Nations adopted the Millennium Development Goals (MDG), a set of goals for improving the well-being of populations in developing nations around the world. The very first of these goals is to reduce by half, by the year 2015, the number of people suffering from extreme poverty and hunger. ‘Hunger’ means both the chronic lack of access to sufficient food to maintain growth and health, and child malnutrition. In order to monitor progress toward achieving the MDG goal of cutting hunger by half, a clear measure of ‘hunger’ is needed. In this context, we measure hunger by the prevalence of malnutrition, as indicated by growth retardation in children: children under age five who have failed to achieve adequate growth for their age.

Hunger is a social, economic, and psychological phenomenon; hunger is presumed present when populations suffer from undernutrition due to a lack of food security, that is, inadequate availability of and access to food, or levels of morbidity that reduce people’s ability to make use of the food they consume.

Malnutrition covers a range of conditions, of which growth retardation is only one. Low height-for-age (HAZ), measured in children by reference to a universal growth standard (NCHS, 2000) indicates long-term, chronic malnutrition. Low weight-for-height (WHZ), or thinness, indicates an acute, short-term problem of inadequate food consumption often exacerbated by disease. Low weight-for-age (WAZ), often called “global” malnutrition, represents a combination of the previous two measures: a child may show low weight for age either through being chronically malnourished and short, or through being too thin due to acute malnutrition. Thus WAZ is less useful than the other two measures in diagnosing the nature of the nutrition problem in a country, although the MDG target is based on this measure.

Insufficient food consumption is the major cause of poor growth in children, but other factors contribute, most notably poor health, including acute infections, diarrheal disease, and parasitic infestation, all of which increase nutrient requirements while reducing the body’s ability to metabolize the food that is consumed. Naturally, this means that the underlying causes of malnutrition may be found not only in the availability and access to food, but also in such conditions as poor environmental sanitation, unclear water supply, and lack of access to preventive and curative health care.

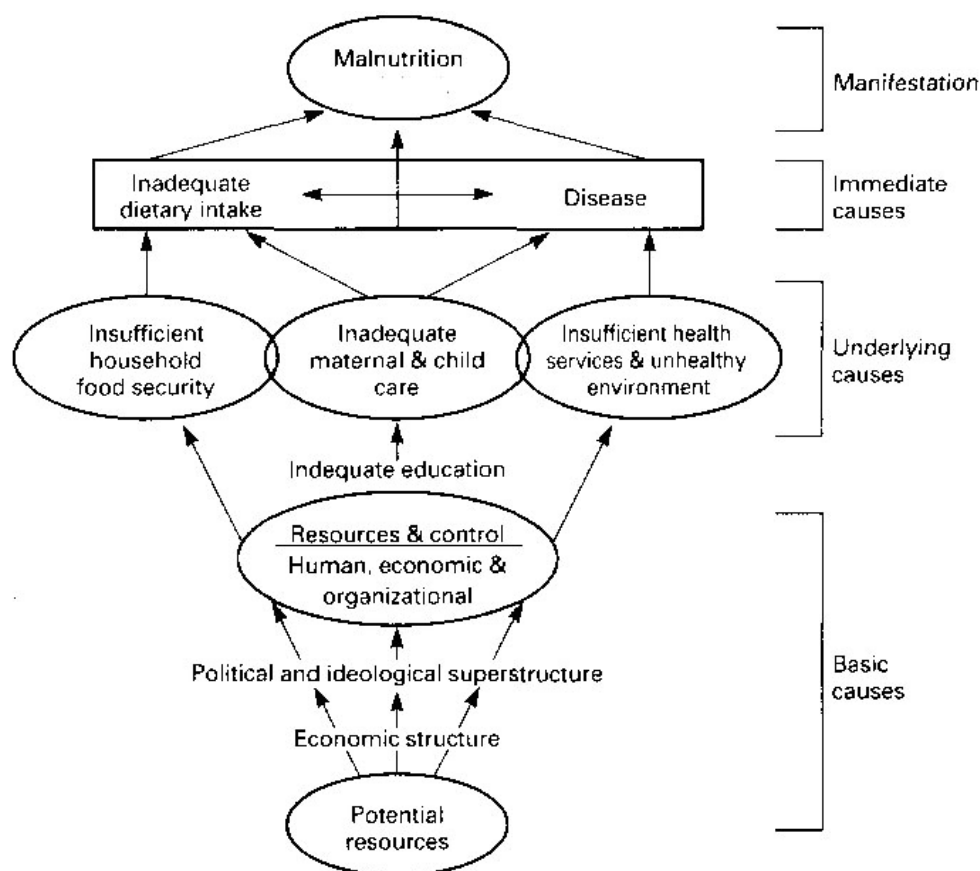
³ This literature is well-reviewed in Behrman et al., 2004, pp 1-11.

Beyond these measures of growth, malnutrition in the form of micronutrient deficiencies results from the consumption of a low-quality diet containing insufficient vitamins and minerals. Micronutrient deficiency has been referred to as “hidden hunger” because its manifestations are more subtle than simply growth failure (although growth failure may be a consequence of micronutrient malnutrition), and may be seen in physical weakness, cognitive deficit, and high levels of morbidity and mortality (McGuire and Galloway, 1994).

Measures of micronutrient malnutrition are difficult to obtain, because they depend on the collection and biochemical analysis of biological samples such as blood. In many countries, direct measures of micronutrient malnutrition in the population are lacking, but information on food consumption, which permits the analysis of micronutrient intake, is used as a proxy.

The well-known UNICEF framework (1990) for the causes of malnutrition includes causes at three levels of analysis: immediate, underlying, and basic. This framework communicates an essential point: that the immediate causes of insufficient food intake and disease can be addressed directly (through the provision of food assistance and curative care), but that sustainable efforts to reduce malnutrition need also to address more fundamental causes. These efforts include interventions to increase households’ access to food through improvements in livelihood opportunities available to the household, and stable food supply available in the market; improvements in environmental sanitation and in access to preventive health services, and improved caring practices on the part of mothers and other child caretakers.

Figure 1
UNICEF Conceptual Framework for the Causes of Malnutrition



The UNICEF framework is useful for informing an analysis of the causes of malnutrition, because it underscores the importance of a wide range of factors in addition to food consumption. But by itself, it is too general to serve as a tool to guide the allocation of resources to affected communities within a country, or to help in the development of interventions designed to meet the specific constraints to good nutrition in a particular geographic context. For this, analysis of local conditions is essential. In any country, the specific constraints to achieving adequate nutritional status can vary from one place to another, so that appropriate interventions to reduce malnutrition will not be the same everywhere. As a simple example, high prevalence of malnutrition in an urban slum may be due to poor sanitary infrastructure and high rates of infection, while in a rural area poor access to markets may limit food consumption choices and result in an inadequate diet.

Addressing the problem of malnutrition nationally requires an approach that tailors nutrition interventions to the specific binding constraints operating in each geographic context. To develop such tailored interventions, one must know where the prevalence of malnutrition is particularly high, and what characterizes the nutrition problem in each specific locality. To make best use of resources, interventions should be designed to reach the areas where need is greatest, and should address the constraints that are most important in that specific context.

This is the reason for developing a Hunger Map. The goal of a Hunger Map is to localize, at a sub-provincial level, areas of high malnutrition prevalence, and to characterize the areas in a way that allows the design of interventions most likely to be effective in reducing malnutrition and hunger. This study was conceived as a pilot project to develop the methods for combining survey, census, and geographic data and produce maps that would help to elucidate the nature of the nutrition problem in the Dominican Republic and to design and target possible interventions, and to document the presence and distribution of childhood malnutrition in the country.

Rationale for Developing a Hunger Map

Mapping is a powerful tool. A Hunger Map provides a clear and easily interpretable picture of the extent of malnutrition and the areas affected. Maps that show malnutrition at the sub-provincial level can demonstrate that national, or even provincial, averages may mask the existence of a relatively serious, but localized malnutrition problem.⁴ Through the use of visual techniques, it is possible to show how malnutrition is distributed with respect to other key variables: climate and topography; market infrastructure; availability of social services; distance from major cities; ethnic diversity; income inequality; and the distribution of poverty. Such presentations provide an intuitive understanding of the key factors associated with malnutrition in different localities, and serve as a first step toward the targeting of resources and the identification of appropriate interventions.

The present study addresses this need by developing local estimates of the prevalence of child malnutrition in the Dominican Republic, and by investigating the associated factors that might be operative in each local setting. These estimates are based on analysis of factors at four levels: the individual child; the family and household; the community in which the child lives, and the characteristics of the geographic region in which the community is located. We used this analysis in the Dominican Republic as a basis for developing maps that show estimates of the prevalence of malnutrition as indicated by growth retardation, and the number of children affected, at the level of the *municipio*, that is, the administrative unit below the level of province, and for identifying the range of possible causes that might be addressed in order to reduce malnutrition in the country. Only growth indicators are presented, because information on micronutrient malnutrition and on dietary consumption are lacking. Nonetheless, these maps, and their associated analysis, represent an important tool in the fight against hunger, by providing a guide for the allocation of resources to the most severely affected areas, and pointing out the conditions that are associated with high prevalence of malnutrition in specific regions, so that interventions may be designed for each particular context.

⁴ High variability among districts within provinces has been demonstrated in experiences with poverty mapping: in South Africa, a mapping exercise demonstrated that in Free State Province, over 70 percent of sub-provincial districts had poverty rates significantly different from the province average (Alderman et al, 2002). Henninger and Snel find similar large disparities in intra-province poverty in Ecuador (Henninger and Snel, 2002, p.1). Several studies of malnutrition prevalence find similar intra-province variation (Fujii, 2005; Larrea, 2005; Gilligan et al., 2003; Haslett and Jones, 2005).

Coordination with Other Mapping Efforts in the Dominican Republic

Many countries have developed Poverty Maps using similar statistical techniques to those used in developing the Atlas of Hunger and Malnutrition – that is, linking household income/expenditure surveys with census data to impute income and expenditure levels to each household in the census (Henninger and Snel, 2002). The *Oficina Nacional de Planificación* of the Dominican Republic (ONAPLAN) published poverty maps at the *municipio* level in 1993 and again in 2003 (Morillo, 2003), detailing the location of populations in poverty, and linking poverty with the level of unsatisfied basic needs in each locality. Poverty in these analyses was defined in terms of unsatisfied basic needs and indicators of household economic status such as possessions, housing quality, and services. The goal of poverty mapping is similar to that of the Hunger Map: to identify areas where poverty rates are high in order to assess the prevalence of poverty, identify likely causal factors, and target resources.

The Atlas complements poverty mapping efforts, but the two are distinct. Poverty is certainly linked to both food insecurity and hunger and malnutrition, but food security and nutrition are often determined by factors other than a household's income. A community's infrastructure – including roads and communications, water and sanitation, access to public services such as electricity – may be limited, and may contribute to a lack of food security or to poor nutritional outcomes, even for individual households whose economic resources are adequate. Direct interventions to address hunger may be implemented more quickly than longer-term community economic development to raise household incomes, suggesting that information to guide the design of nutrition interventions gives value-added to analyses of poverty. Comparing the geographic distribution of hunger with that of poverty through the two sets of maps can contribute to a clearer understanding of needed interventions to address hunger.

A variety of other mapping efforts have been undertaken by national and international agencies. The Food and Agriculture Organization has sponsored a series of national mapping efforts under its Food Insecurity and Vulnerability Mapping System (FIVMS) project, but the Dominican Republic has not been part of this effort, which focuses on vulnerability to climate risks, and on household coping strategies, but not specifically on nutritional outcomes.

Vulnerability Analysis and Mapping (VAM) efforts have been undertaken by the World Food Programme in many LAC countries, including the Dominican Republic (PMA, 2003). The VAM process provides a useful combination of qualitative and quantitative information to inform an understanding of the determinants of food insecurity. However, VAM is by design geographically limited: it typically focuses on areas most likely to be at risk (including, in the Dominican Republic, the *frontera*, the eastern part of the country, and peri-urban Santo Domingo), and therefore cannot be used to develop sub-provincial, nationally representative maps.

Thus, the present effort builds on the statistical techniques used in poverty mapping, and complements the results of poverty mapping as well as those of VAM, while going beyond these in its ability to identify target geographic areas and appropriate interventions directed specifically at reducing the problem of hunger and malnutrition. The present project was initiated in 2005, and this report builds on an earlier, preliminary report submitted to WFP in January 2006.

Background

The Dominican Republic is a middle-income country in the Caribbean region, sharing the island of Hispaniola with its much poorer neighbor, Haiti. According to the most recent census (2002), the population of the Dominican Republic is about 8.2 million; about half live in the southeastern part of the country (Achécar et al., 2003), and about 60 percent live in urban areas (*Atlas de la República Dominicana*, 2002). In 2004, the country had an average per capita income of US \$2,080⁵ (World Bank, 2005), putting it in the middle range of countries in Latin America and the Caribbean. Nonetheless, the Dominican Republic shows economic and social indicators below the average for Latin America and the Caribbean (LAC), and a significant proportion of the population lives in poverty. According to data provided by the *Programa Especial para Seguridad Alimentaria* (PESA), 16 percent of the population lives on less than US \$2 per day, and 25 percent live below the government-established poverty line (PESA, 2002).⁶ ONAPLAN reports that poverty, as indicated by unsatisfied basic needs, shows great geographic variation by province and within provinces (Morillo et al., 2005), but poverty rates are high overall, with a national poverty rate of 31 in urban areas and 45 percent in rural areas (World Bank, 2005). In 1998, ONAPLAN reported that all provinces except the Distrito Nacional had household poverty rates of 50 percent or more, and fifteen provinces had rates over 75 percent, based on the unsatisfied basic needs criterion (Morillo, 2003). Based on income, the World Bank estimates that in 2004, poverty rates were 42 percent at the national level, with rates just over 50 percent in rural areas and just under 40 percent in the cities (World Bank, 2006).

Health and Social Indicators

The Dominican Republic has made significant progress in improving health indicators and reducing malnutrition over the past decade. According to the most recent Demographic and Health Survey (*Encuesta Demográfica y de Salud*, ENDESA 2002, reported in Achécar et al., 2003), the infant mortality rate has fallen from 45 per 1000 live births in 1987-92 to 31 per 1000 in 1997-2002, with further decreases to 27 per 1000 in 2004, despite the economic crisis (World Bank, 2007), and the under-five mortality dropped from 65 per 1000 in 1990 to 38 per 1000 in 2002 (World Bank, 2004). The overall prevalence of growth retardation in children under five years of age (height-for-age below -2 standard deviations of a reference distribution) was found to be 8.9 percent, a notable reduction from the previous survey, which found a prevalence of 11 percent in 1996 (Achécar et al., 2003).

Despite this, the prevalence of malnutrition varies significantly by age group, with the highest proportion in 2002, 12.1 percent, found among children aged 12 to 24 months. Prevalence also varies by area of the country, with the worst affected provinces, Baoruco and Elías Piña reporting rates of 16.3 percent and 16.2 percent, respectively. This observation underscores the fact that average rates of malnutrition may mask regions and populations among whom rates may be much higher.

⁵ GNI per capita, Atlas method (see World Bank, 2006)

⁶ In 2004, the poverty line was set at monthly household income of RD \$850 per month; extreme poverty or indigence was defined as income below RD \$425, the cost of the basic food basket (ONAPLAN, 2003).

Food and Nutrition Related Programs

Social spending in the Dominican Republic represents about 7.4 percent of GNP, somewhat lower than the average of 15 percent (in 2002-03) for the Latin American region (ECLAC, 2005). Valdés (2005) reports that food assistance spending in 2005 represented 2% of the national budget, and 7% of social spending. Food-related programs include “*comedores económicos*” providing low cost meals to certain vulnerable groups, some emergency feeding programs, and programs aimed at the elderly (Arden and Price, 2004). The largest food related social program is the school feeding program, *Programa de Alimentación Escolar* (PAE), accounting for 52% of food assistance (Valdés 2005). According to a recent report (Saldarriaga, 2005), the PAE covered 88 percent of schools, and 98 percent of enrolled children in 2002-03. The program is offered in three modalities. The *PAE Urbano Marginal* provides a daily biscuit or bread and milk to children; the *PAE Fronterizo* provides a full meal based on foods donated by the WFP; and the PAE REAL (“*raciones elaboradas con alimentos locales*” – rations made with local foods) provides a full meal to children, based on community contributions of food to the program. In 2004, 91 percent of children receiving school meals participated in the *Urbano Marginal* program; 6 percent in the *Fronterizo* program, and 3 percent in the REAL program, which was specifically designed for remote and difficult-to-reach areas (Saldarriaga, 2005).⁷ Our analysis of 2002 Census data indicates that about two-thirds of the age-eligible population (7 to 14 years) is enrolled in school.

Health services are widely available (UNDP, 2005), and over 98 percent of births are attended by trained medical personnel (Achécár et al., 2003), but health services are not reliably of good quality, due to institutional weaknesses and poor management, according to the UNDP (2005). This same document reports that educational services are also of poor quality, and that fully 50 percent of first graders complete only four years of school, while only 10 percent complete secondary school (UNDP, 2005). A small complementary feeding program provides milk to poor pregnant women through 67 health posts; in 2003, 869 families received benefits from this program (Valdés 2005).

Several social welfare programs have been implemented by the new government of President Leonel Fernández, who took office in the wake of the economic crisis. The *Comer es Primero* program, started in October 2004, provides cash transfers to low-income households (identified through the *Sistema Único de Beneficiarios*, SIUBEN) for the purchase of food and other basic necessities through authorized stores. As of 2006, it is reported to reach 224,000 households in all 31 provinces plus the Distrito Nacional (*Perspectiva Ciudadana*, 2005). Also under the *Solidaridad* initiative, a conditional cash transfer program known as *Incentivo a la Asistencia Escolar* (ILAE) was started. This program provides cash benefits to households that send their school-aged children to school. As of September 2005, the program reached 171,042 households and reached all Provinces (Valdés 2005). These programs were not in place when the data used in the present study were collected, and it is not possible, therefore, to assess their effect on the nutrition situation using our estimates.

⁷ Financing for the *Urbano Marginal* and REAL programs is provided by the Government of the Dominican Republic; the World Food Programme has provided support to the *Fronterizo* program (Saldarriaga, 2005). Recently the Government of the Dominican Republic took over financial responsibility for the *Fronterizo* program.

Changing Economic Situation

The present study is based on information from 2002, the most recent year for which nutrition and census data are available. After a period of rapid economic growth in the 1990s, the country began to experience a slight economic slowdown in the early years of the new century (World Bank, 2006). However, in 2003-04, the country experienced a grave economic crisis, resulting in a precipitous drop in the GNP by 20 percent between 2002 and 2003 (UNDP, 2005), currency devaluation, increased unemployment, and extremely high rates of inflation in the subsequent years (IMF, 2005), resulting in a sharp increase in the proportion of the population living in poverty (USAID, 2006). The economy of the country is recovering, but the consequences of the crisis for food security and nutritional status have not been investigated.

To be useful as a policy tool, Hunger Maps, that is, maps reflecting the current nutrition situation, must be updated periodically. This is especially important now, during a period when the economic situation has substantially changed, with possible consequences for human health and well-being. The most recent national survey of living conditions, conducted by the Banco Central, the *Encuesta Nacional de Condiciones de Vida* (ENCOVI), completed in 2003, should provide a measure of changes in indicators of economic conditions since the previous survey, *Encuesta Nacional de Gastos e Ingresos de Hogares* (ENGIH), completed in 1998. ENCOVI collected data in the period before and during the crisis, however, not during its aftermath. The Demographic and Health Survey is normally conducted every four to six years; a new one is currently in progress, and it should provide more direct and current evidence specifically of the nutrition situation. Information on the current economic and food consumption situation of the Dominican population would be very valuable in assessing the effects of the crisis and the degree of recovery. Meanwhile, the conditions reported here based on data from 2002 may have changed as a result of the sharp economic contraction that took place after these data were collected.

Methods

The goal of a Hunger Map is to identify areas of high malnutrition prevalence, analyze the nutrition situation, and characterize these localities in ways that will help to guide the allocation of resources and the design of nutrition interventions. National nutrition surveys, such as the Demographic and Health Surveys (DHS) conducted periodically in many countries and household food consumption surveys undertaken from time to time by national governments, must be conducted on a statistically representative sample of households, because these are data-intensive and therefore time-consuming surveys. Including nutritional status and/or food consumption in a national census would be prohibitive. Typically, the samples for such surveys are designed to be able to estimate malnutrition prevalence at the provincial level, or at a larger, regional level incorporating several provinces in each region.

Analytic Method

Our statistical analysis uses the small area estimation methods (SAE) developed for the estimation of poverty rates by the World Bank, among others (Elbers, Lanjouw, and Lanjouw, 2004; Elbers, Lanjouw, and Lanjouw, 2002). These methods were originally designed for the analysis of poverty rates, but they have also been adapted for application to anthropometric measurement issues, such as the estimation of rates of stunting and wasting in Cambodia (Fujii, 2005). The statistical approach has been implemented in a stand-alone software program, *PovMap*, developed by the World Bank (Zhao, 2005), that we adapted for use with available nutrition data. To conform to the requirements of the program, we needed to make some minor adjustments in the model, discussed below.

In our analysis, the survey data set is the Demographic and Health Survey for the Dominican Republic in the year 2002, known as ENDESA. The Census data set is the country's National Census (*VIII Censo Nacional de Población y Vivienda*), also for the year 2002.

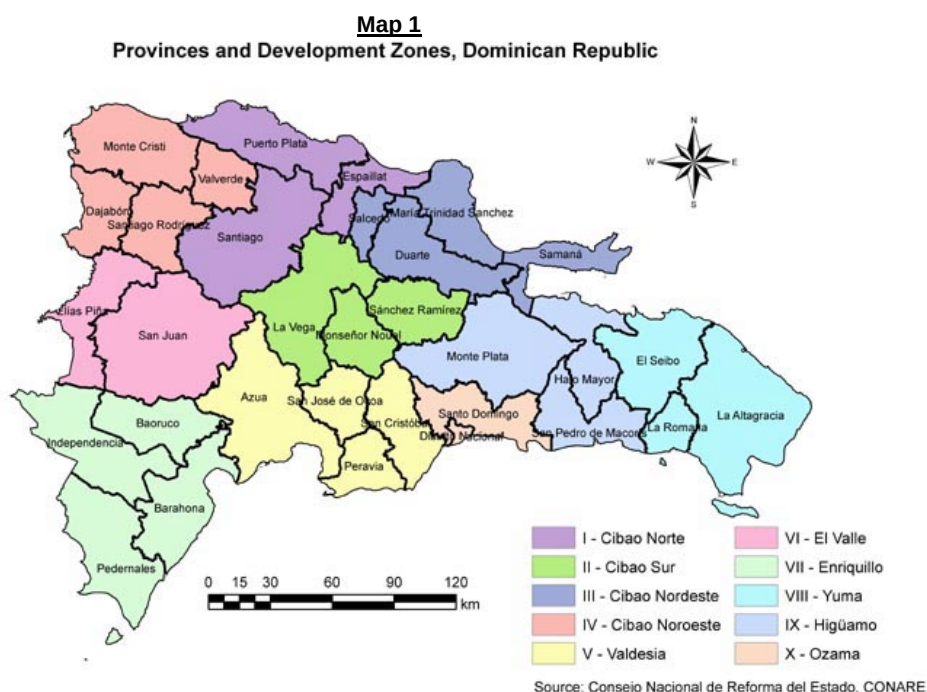
At heart, the analysis combines representative survey data (ENDESA) and Census data in a fashion that exploits the advantages and compensates for the shortcomings of each data source.

- The advantage of the *survey data source* is that it includes our anthropometric outcomes of interest and provides robust estimates at the national and provincial levels, while the disadvantage of the survey data source is that the sample size is small at the *municipio* level and not all municipalities show up in the sample.
- The advantage of the *Census data source* is that it contains observations on essentially all children, households, and municipalities in the Dominican Republic, while its disadvantage is that it has no direct information about anthropometrics.

The goal is to estimate *municipio*-level averages for height, the prevalence of low height (stunting), weight, and the prevalence of low weight (underweight, excessive thinness) among children aged 6 to 59 months. These averages can then be displayed in maps showing the geographic distribution of childhood nutrition problems. The height measure is the *height-for-age z-score* (HAZ), and stunting is defined as having $HAZ \leq -2$ standard deviations. The weight measure is the *weight-for-age z-score* (WAZ), and underweight is defined as having $WAZ \leq -2$ SD. The measure of excessive thinness is *weight-for-height* (WHZ) and is defined as having $WHZ \leq -2$ SD.

The estimation strategy has two stages: first, a regression model using the survey data determines the relationship between the outcomes and a large number of explanatory variables that are available from both the survey data and the census data; second, using the census data, forecasts are made of the *municipio*-level averages described above. In this analysis, estimates were made separately for ten Development Zones in the country. The reason is that specific variables used in the estimation may have different meaning in different regions of the country; separating the estimates by zone allows for more precision by permitting the coefficients in the predictive model to vary according to the geographic region. The regressions separated by Development Zone indeed showed higher R^2 values than the regression at the national level, but the national-level regression captures more of the variability within the country. For example, in some of the individual Development Zones, climate (droughts, floods) was not sufficiently variable within

the Zone to be retained in the model; in many cases, they could not be retained because the entire Zone was similar for these conditions.⁸ Map 1 shows the Dominican Republic divided into ten Development Zones (*Zonas de Desarrollo*) created in 2004 by the *Consejo Nacional de Reforma del Estado* (CONARE), an agency under the purview of the Presidency, and the provinces that are in each zone. The zones vary widely in terms of their level of urbanization, topography, climate, and other factors.



To interpret the *municipio*-level results correctly, the reader should keep in mind the origins of the data. The ENDESA survey is the source of all information about child height and weight. There is no height or weight information in the census. Meanwhile, the census is the source of the key information about cross-*municipio* differences in explanatory variables that lead to differences in predicted average outcomes. In the final maps, differences across municipalities in predicted anthropometric averages are due to differences across municipalities in the explanatory variables measured by the census.

⁸ The smallest sample sizes in any zone were 634 and 730; the rest were all about 900 and above. There were 104 explanatory variables included in the regressions (many of which were sets of dichotomous variables reflecting a single underlying characteristic such as type of roof, walls, or floor). In some of the regressions, variables were dropped due to lack of variability or high collinearity. Regression models for use in PovMap are designed to maximize predictive power; endogenous or collinear variables may be included if they improve the model fit, even though this may jeopardize the interpretation of individual regression coefficients.

Statistical Approach

Let y_{ch} be an outcome of interest, HAZ, WHZ, or WAZ, for child h in cluster c . Note that we use the subscript h for the child to be consistent with the existing literature on poverty mapping, in which this subscript indicates households. In our application, the cluster is a *municipio*. As a linear approximation, the outcome is modeled as a linear function of a vector of observed explanatory variables (x_{ch}^T), unobserved *municipio*-level characteristics (η_c), and unobserved child-level characteristics described by an error term (ε_{ch}).

$$(1) \quad \ln y_{ch} = x_{ch}^T \beta + \eta_c + \varepsilon_{ch}.$$

The distribution of the child-level error term ε_{ch} is permitted to be heteroskedastic, with a variance that is a function of an index that depends on a subset of the explanatory variables, $z_{ch}^T \alpha$. No heteroskedasticity correction was included in this analysis.

In the present analysis, the locational (*municipio* level) and individual-level error terms were combined. In the analysis separated by Development Zone, the PovMap program would not permit the separate estimation of *municipio* and child-level error terms for nine of the ten zones. A comparison of the estimations with and without the locational effect for the zone in which we could perform both analyses revealed only minor and insignificant differences in the prediction of prevalence of malnutrition that would not affect our results.

In the first stage of analysis, using the ENDESA survey data, estimates are derived by generalized least squares for β , the variance-covariance matrix of η_c , the variance-covariance matrix of ε_{ch} , and the parameters of the heteroskedasticity model α . In the second stage of analysis, using the census data, the estimates for the slope parameter β are used to predict the outcome level for each child in the census.

If one were only interested in average HAZ or average WAZ at the *municipio* level, this second stage would be quite simple. However, in this application it is important also to know the rates of stunting, excessive thinness, and underweight, and to estimate *municipio*-level standard errors for all of these parameters, so that we have a sense of how precise the predictions are. This additional information depends on the distribution of the outcome variable across children within municipalities. Yet there is no known closed form equation for deriving this distribution. As a consequence, the second stage of the small area estimation uses a bootstrapping or Monte Carlo approach to simulate this distribution.

In the bootstrapping approach, for each child, a random draw is made from the distributions of η_c and ε_{ch} that were estimated in the first stage. Conditional on these random draws, one may compute a prediction for y_{ch} that includes the stochastic as well as the deterministic factors that influence the outcome. For all the children in the census (about 851,000 in our application), this procedure is repeated 100 times, to generate a distribution of predicted values for y_{ch} within each *municipio*. This distribution can be used for the purpose of estimating how many children in each *municipio* have height or weight below the threshold for stunting or underweight, and also for computing the desired standard errors. Further details on the bootstrapping approach are

provided by the World Bank (Elbers, Lanjouw, and Lanjouw, 2003; Demombynes et al. 2000; Zhao, 2005).

A more complete description of the SAE method and the use of PovMap to perform the analysis is found in Rogers et al. (2007).

Data Sources

The estimates of malnutrition prevalence in the present study are based on two major sources: National Census of 2002 (*VIII Censo Nacional de Población y Vivienda*), and the 2002 Demographic and Health Survey (*Encuesta Demográfica y de Salud*, ENDESA). Geographic information was obtained from a geographic database known as SIGpaS, developed for the Secretariat of Health (*SESPAS*), and from the Latin American Network of Social Studies on Disaster Prevention (*La Red*). In addition, we computed for each Census segment a set of variables reflecting the characteristics of the community in which the household was located. These included variables such as the percentage of households in the segment with particular housing characteristics and services; percentage of households with female heads; percentage of households with heads having given levels of education. These segment-level variables provide measures of the context in which an individual household lives. The data sources and their limitations are discussed further below. There are no surveys in the Dominican Republic that include information about food consumption, nor information on micronutrient status nor the nutritional status of adults in the population. This affected our selection of both predictors and outcome indicators.

The integration of data from a variety of sources in the country is in itself a benefit of the hunger mapping effort. It is common in many countries for different government agencies to collect data for their own specific uses, but the coordination of different kinds of data to produce a coherent statistical picture of the country is much less common. The development of the hunger map, involving participation of representatives of different government ministries and agencies, can focus attention on the uses of information beyond one specific application. This enhances the benefit derived from the expense of each data collection effort, and it may also result in improvement in the quality of the data, as inconsistencies and gaps in particular data sets are identified and resolved. In addition, the analysis has identified gaps in the availability of relevant information that may guide future national survey and data collection efforts.

Integrating data from different sources is challenging: variable definitions may vary from one data set to another; administrative boundaries for geographic units may change over time; documentation may be inadequate. Once the data sets have been created, and the models developed, updating the estimates when new census or survey data become available should be an easier task.

Selection of Outcome Indicators

Malnutrition and food insecurity are the key outcome indicators of interest to the development of Hunger Maps. Ideally, the analysis underlying the maps would include both anthropometric indicators and biochemical measures of micronutrient status. Food consumption, analyzed to assess the adequacy of macronutrient and micronutrient intake, is often used as a proxy for direct biochemical measures, because the latter are so difficult to collect. In recent years, increasing numbers of countries are including questionnaire-based methods of measuring household food insecurity, as distinct from nutritional outcomes (Coates et al., 2005; Frongillo et al., 2003; Coates et al., 2006).

In the Dominican Republic, there are no current national studies that reflect micronutrient status, nor is there information about food consumption patterns at the household or individual level. Food purchase data, which is a partial indicator of food consumption, may be available from the most recent Household Living Standards Survey (*Encuesta Nacional de Condiciones de Vida*, ENCOVI, conducted in 2002-03 by the *Banco Central*), but we were unable to gain access to the data. We are unaware of any surveys that have included the household food insecurity measure.

In future household surveys, data on food consumption and the means by which households supply themselves with food would be tremendously useful in understanding the nutritional situation. This gap in information is particularly relevant in the Dominican Republic, a country in which acute malnutrition is, happily, rare, and chronic malnutrition is declining (though still a significant problem in some areas), but poor quality diets, resulting in the “hidden hunger” of inadequate micronutrient intake, may still be common.

These Hunger Maps, therefore, are based on anthropometric measurements of children under age five, collected by the 2002 Demographic and Health Survey. This survey collected information on height, weight, and age of children 3 to 59 months, and calculated the prevalence of chronic (low HAZ), acute (low WHZ) and global (low WAZ) malnutrition for the Dominican Republic as a whole and for its 32 provinces. Our estimates are based on information for children 6 to 59 months, because growth retardation typically begins to be evident after six months of age, when breast milk ceases to be a sufficient source of nutrition for children.

We considered several other possible outcome indicators for undernutrition. In the Dominican Republic, fully 98 percent of births are attended by a trained health professional (Achécár et al., 2003). For this reason, we considered the possibility of using the prevalence of low birthweight (LBW) at the *municipio* level as a secondary indicator of poor nutritional status. Incidence of LBW can be an indicator of a long-term nutritional problem in a community, as it reflects the nutritional status of the mother prior to and during her pregnancy. The rate of LBW, therefore, might be useful both to confirm the results of the analysis of childhood malnutrition and to infer whether any identified nutrition problem is long-term and multigenerational. It proved to be impossible, however, to obtain information on birth weights of children according to the location where the mothers lived. Birth weight data are collected at hospitals and clinics, and SESPAS

compiles these data and reports them by hospital (SESPAS, various years) but not by where the mother lives.⁹

Many countries in Latin America conduct periodic School Height Censuses, in which the height and age of all children is recorded at entering first grade, ages 6 years through 9 years and 11 months. The most recent School Height Census in the Dominican Republic was conducted in 2002 (Soriano et al., 2002), the same year as the National Census and ENDESA. The height-for-age of children aged six or seven – the typical age at school entry – should be a good indicator of the height-for-age of children only a few years younger, and the School Height Census has the advantage of being a census, that is, every school child in the country should have been measured. This means that there would be no need to use statistical procedures to impute levels of malnutrition where they were not directly measured. Many countries have used their school height censuses successfully to analyze the geographic distribution of malnutrition (PAHO, 1997).

Preliminary analyses, however, comparing the results of the School Height Census to the results of ENDESA, were not encouraging. The levels of malnutrition (HAZ below -2 SD) measured by the School Census and ENDESA at the province level diverged significantly, and not always in the same direction: the relative position of the provinces was different according to the two measures. According to our analysis of data from the National Census, 32.8 percent of age-appropriate children (6 through 9 years) who should be at least in first grade are not enrolled in school. Using Census data, we explored the possibility that school-aged children not enrolled in school came from households of lower socioeconomic status as indicated by their possessions, housing quality, and access to services, but there was no significant difference in this measure between children in school and those not enrolled. We concluded that the School Height Census would produce results inconsistent with those using the ENDESA estimates, and we considered the ENDESA estimates to be the “gold standard”, because they measured children in the age group of greatest interest to the World Food Programme. ENDESA also has a high level of experience in collecting anthropometric data accurately.

In the end, the most informative measure is that of chronic growth retardation or low HAZ in children 6 to 59 months. Prevalence of excessive thinness or low WHZ is quite low in the Dominican Republic, which makes imputation of prevalence at the *municipio* level unreliable, and (as mentioned above) WAZ is difficult to interpret because it conflates the effects of both chronic and acute malnutrition.

Selection of Independent Variables

In the analysis, a set of variables is chosen to develop a predictive model based on ENDESA, and use the parameters to predict the anthropometric status of each child in the census. These variables must be common to ENDESA and the Census. After the estimation process is complete, malnutrition prevalence for each *municipio* is estimated based on the average

⁹ In the future, as hospital and clinic data become computerized, it could be possible to record information about the mother's home, so that LBW information could be analyzed by *municipio*, subject to the limits imposed by protection of privacy.

predicted probability of children 6 to 59 months in the *municipio* falling below -2 SD for the particular indicator. We then examine the relationships between these estimates and important, policy relevant characteristics of the *municipios* and the areas in which they are located.

The factors associated with malnutrition may be divided into those at the individual (child), household, community (cluster or segment), *municipio*, and regional level (province). A list of these variables is shown in Table 1, with the sources of data. The table includes variables included in our analysis, and those that we would have included had they been available. Variables not available for the present analysis are shaded.

A child's nutritional status is dependent on age, and in many settings, children of different sexes are treated differently. Birth order affects the ability of the child to receive the time and resources of caretakers, and of course, illness affects nutritional outcomes directly. We could not include birth order or illness in the predictive model because these variables were not available in both the Census and ENDESA data sets. At the household level, number of children under five years of age is a measure of the demand on household resources and caretaker time, and number of adult women is a measure of the availability of caretaker time. Education of adults in the household is a well-documented determinant of children's health and nutritional outcomes. This is especially true for education of the child's own mother. The ENDESA data contains information on the education of each child's mother, but in the Census it is not possible to link individual children in a household with their mothers. In our analysis, therefore, the highest educational level of any adult male and/or female in the household was used as the best available indicator of education.

In the absence of information on household income, we used available information on household possessions, housing quality, and services (e.g. phone, electricity) as indicators of economic status. Water and sanitation are, of course, determinants of children's health, a key intermediate determinant of nutrition. There is a wide literature suggesting that under economically-constrained conditions, children in female-headed households do better nutritionally than children in male-headed households (e.g., Rogers, 1995; 1996; Johnson and Rogers, 1993 for the Dominican Republic), so that headship is included in our analysis.

At the level of the community, food availability and access are important potential determinants of food security and nutrition, and access to markets affects both opportunities for employment and ability to purchase a wide variety of foods. Through a project of the Secretariat of Health called PROSISA (*Proyecto de Reforma del Sistema de Salud*), a wide variety of information on factors related to health was compiled into a publicly available geographic database called SIGpaS (*Sistema de Información Geográfica para la Salud*). From this geographic database, we were able to include information about proximity to roads and highways in the *municipio* as a marker for market access.

We had hoped to include information about the volatility of food prices over time – seasonally and year to year – as an indicator of market integration. Communities with higher price volatility may be assumed to be more isolated from markets for goods and services, and therefore more subject to the effects of local climate shocks affecting food production, for example. Surprisingly, local (even provincial) level information on prices was not available. National

level annual price series are available at a very detailed level of disaggregation by commodity, but these are not useful for a geographically disaggregated analysis.

ENDESA collected data from a sample of households representative only at the provincial level, but provides information on the specific *municipio* and *sección* in which each sample household was located. (The *sección* is the next administrative level below *municipio*.) Using census data, we were able to calculate, for each *municipio*, characteristics that we expected to be related to nutritional outcomes, and link this information to each child in the ENDESA data set based on where that child lived. The percentage of households earning income from agriculture and from remittances was the only information available on livelihoods. The census also contained information on whether individuals were of Haitian origin, allowing the calculation of a percentage of the population that is of Haitian extraction, the only available indicator of ethnic diversity in a community. ENDESA did not collect data on ethnic origin at the individual level, so only community-level ethnic diversity could be calculated. However, the *percentage* of Haitian population is of limited use in the analysis of causal factors, as it is impossible to say, for a *municipio* with a low proportion of Haitians, whether the Haitian population disproportionately suffers from malnutrition. We could also calculate the percentage of school-aged children reported to be enrolled in school. This variable was considered a measure of ‘social exclusion’ in ONAPLAN’s poverty analysis (Morillo, 2003), and may be a reflection of the community’s socioeconomic situation. From the PROSISA data set, we had information on location and availability of health centers and hospitals, and from the Secretariat of Education, information on the distribution of schools and of available school feeding programs. The latter were not included in the predictive model but were examined for their associations with imputed malnutrition.

The geographic data available from the PROSISA dataset were topography and average seasonal rainfall. From the Latin American Network of Social Studies on Disaster Prevention (*La Red*), we obtained information on whether or not a region had been affected by droughts or floods over a period of several years. This information was expected to affect livelihoods and thus food security.

Estimation Model

The predictive model is based on variables that are presumed to be associated with the nutritional status of children, and that are present in both the ENDESA and the Census data sets or can be added to both from other sources. This of course restricts the range of variables that can be included in the model. We base our analytic approach on the selection of variables representing environmental conditions, underlying economic factors, household socioeconomic status (ownership of key possessions, education levels) and individual child-level variables (age, gender).

The model included the following variables:

Child level

Age modeled as dichotomous variables for age 12 to 23 months, 24 to 35 months, and 36 to 59 months. The dichotomous variable approach was chosen to allow for non-linear associations between anthropometric status and age. The omitted category was 6 to 11 months.

Gender set to 0 if the child is male, 1 if female.

Relationship of child to household head modeled as dichotomous variables for child is either son, daughter, stepson, stepdaughter, or adopted by household head; child is otherwise related to household head; and child is not related to household head.

Household level

Education of head of household modeled as six dichotomous variables for no schooling, some primary, completed primary, some secondary, completed secondary, some tertiary education, and no information provided. The Census did not allow the association of a mother with her child; if it had, we would have chosen to include the education of each child's mother as the most relevant variable.

Highest levels of education: the highest level of education achieved by any adult male member of the household and the highest level of education achieved by any adult female member of the household, in years. The quadratic terms were also included in order to capture any non-linear effect of education.

Female headship: variable set to 1 if the respondent reported that the household head was female, 0 otherwise.

Marital status of household head modeled as dichotomous variables for single, married or in a union, separated or divorced, and widowed.

Number of children under age five in the household included as a measure of the competition for caretaker time and attention, as well as for its effect on the proportion of other household resources (food, money) available to any one child.

Number of adult women in the household included as a measure of available caretaker time, assuming that child care is typically the responsibility of female household members.

Dependency ratio modeled as the ratio of the number of dependents (household members ages 0 to 14 years and ages 65 years and older) and the total number of household members.

Household possessions taken to represent the economic status of the household, and consisting of ownership of the following items: air conditioner, computer, radio/stereo, refrigerator, stove, television, and washing machine.

Quality of housing consisting of three sets of variables representing the construction materials used for the floor, roof, and walls, as well as a variable capturing the degree of crowding, modeled as number of members per room (excluding kitchen and bathroom).

Household sanitation consisting of three sets of variables: household has access to a modern toilet, to a latrine, or does not have access to facilities; the source of household water – piped water, well, tank, river, rain; household garbage disposal methods.

Household services consisting of dichotomous variables: household has electricity; household has a telephone, and a set of variables describing fuel used by household for heating/cooking.

Environmental contaminants affecting household and surrounding areas consisting of a set of variables describing the area in which the household is located, including contaminated water, presence of garbage, smoke, chemicals.

Urban Location set to 1 if the household lives in an urban area, 0 otherwise.

Sección Level

Livelihoods consisting of two variables: percentage of households in the *sección* receiving remittances from outside the household, and percentage of households in the *sección* earning income from agricultural activities. (Individual or household livelihood information was not available in the ENDESA data set.)

Ethnic composition: percentage of individuals in the *sección* who were born in Haiti or born to Haitian parents. (This was the only variable reflecting ethnic composition available in both data sets.)

Schooling: percentage of school-aged children (7 to 14 years of age) in the *sección* enrolled in school.

Female headship: percentage of households in *sección* that have a woman as head of household.

Education consisting of three variables: percentage of households in the *sección* that have heads who have only a primary education, who have a secondary school education, and who have some higher education.

Quality of housing consisting of three variables: percentage of households in the *sección* that have cement floors, percentage of households in the *sección* that have cement roofs, and percentage of households in the *sección* that have cement walls.

Sanitation consisting of three variables: percentage of households in the *sección* that have access to a modern toilet, percentage of households in *sección* that have piped water, and percentage of households in *sección* that have regular garbage collection.

Household services: percentage of households in the *sección* that have electricity, and percentage of households in the *sección* that use natural gas or propane for fuel.

Municipio Level

Access to roads: percentage of *municipio* that is within five kilometers of a major road or highway.

Distance to nearest city: distance in kilometers to the closest of eight urban centers.

Access to hospital facilities: distance in kilometers from center of *municipio* to nearest hospital.

Availability of health care services: number of health care facilities (health posts, hospitals, general hospitals, and specialized health care facilities) per 1,000 *municipio* inhabitants.

Population density: at the *municipio* level, persons per square kilometer.

Topography: mean elevation of *municipio* in meters, and elevation range to measure slope.

Land type: a set of variables developed from data provided by the *Dirección de Información Ambiental y Recursos Naturales* (DIARENA), each of which describe the percentage of a *municipio* that falls into six land type categories – arid, semi-arid, humid, semi-humid, humid/dry, and island.

Province Level

Climate shocks consisting of two variables: number of recorded floods between 1996 and 2000, and number of recorded droughts in the same period. This was the most up-to-date information available from The Latin American Network of Social Studies on Disaster Prevention (*La Red*), but should accurately reflect whether a region tends to be prone to droughts and floods over time.

Location on the Frontera: coded 1 if the province is located on the border with Haiti, 0 if it is not.

Recall that the prediction of children's anthropometric status depends on having variables available in both the ENDESA and the Census data sets. Once we have estimates of prevalence for each *municipio*, we can explore other characteristics of particular *municipios* or the regions in which they are located, to see whether these factors appear to be associated with high levels of malnutrition.

Table 1: Variables for the Analysis of Malnutrition and Food Insecurity

Level	Variable	Source
Individual Child	Age	Census, ENDESA
	Gender	Census, ENDESA
	Relationship to household head	Census, ENDESA
	<i>Birth Order</i>	<i>ENDESA only</i>
	<i>Food consumption</i>	<i>Not available</i>
	<i>Illness</i>	<i>ENDESA only</i>
Household	Household size	Census, ENDESA
	Number of children under five years of age	Census, ENDESA
	Number of adult females	Census, ENDESA
	Number of persons per room - crowding	Census, ENDESA
	<i>Education of child's mother</i>	<i>ENDESA only</i>
	Education levels of adult household members	Census, ENDESA
	Economic status, wealth – ownership of key consumption goods	Census, ENDESA
	<i>Food consumption: Adequacy Diversity Sources – purchase, home production, etc.</i>	<i>Not available</i>
	Quality of housing	Census, ENDESA
	Household water source	Census, ENDESA
	Household sanitation: methods of garbage disposal, access to toilet facilities	Census, ENDESA
	Electricity, fuel, telephone	Census, ENDESA
	Environmental contaminants affecting household and surrounding areas	Census, ENDESA
	<i>Income, total, by source, earner</i>	<i>Not available</i>
	<i>Livelihoods: income sources, earners</i>	<i>Limited information in Census only</i>
	Female/Male household head	Census, ENDESA
	Marital status of household head	Census, ENDESA
	<i>Ethnicity of members</i>	<i>Census only</i>
	Location: urban/rural	Census, ENDESA
	<i>Household food insecurity</i>	<i>Not available</i>
Community/Sección	Local livelihoods: Dependence on agriculture (self-reported) Unemployment	Census Census, ENDESA (data not compatible) Census
	Remittances	Census
	Ethnic diversity	Census
	Access to/enrollment in school	Secretaría de Educación, Dominican Republic
	Percent female headship at the community level	Census
	Education level of heads of households	Census
	Quality of housing at the community level	Census
	Sanitation at the community level	Census
	Household services – electricity, fuel, telephone	Census

Table 1 (continued): Variables for the Analysis of Malnutrition and Food Insecurity

Level	Variable	Source
Community/Municipio	Marketing infrastructure: Access to roads (percentage of <i>municipio</i> within 5 km of a major road or highway)	PROSISA
	Transportation	Not available
	Volatility of prices	Not available
	Access to health services	PROSISA
	Distance in kilometers to health care facility	GIS
	Distance in kilometers to major urban center	GIS
	Topography	EROS System, USGS
	Land type	DIARENA
	Population density	Census
Region/Province	Province on the <i>frontera</i> with Haiti	GIS
	Climate: Rainfall Droughts Floods	PROSISA LA RED LA RED

Results

Chronic Malnutrition: Low Height-for-Age

When a regression model is developed for application to Small Area Estimation, the main purpose is to derive precise and reliable prediction; interpretation of individual regression coefficients is not a goal of the process. For example, variables that are collinear or endogenous may be included, if they improve the prediction although they may lead to bias in the estimated coefficients.

Nonetheless, the national-level estimates do show a number of expected relationships between growth retardation and various causes. Children 12 to 23 months have significantly lower HAZ than younger children, and average HAZ does not decline further in older age groups; in fact it significantly improves (-0.62 mean HAZ compared to -0.35 mean HAZ among children 24 to 59 months). These results are consistent with the ENDESA data and with studies from many other countries. Coming from a household with more young children (under age five) is associated with lower HAZ; this variable represents the competition for household resources, including parent and caretaker time and attention, as well as, possibly, food and health care. The education level of household members is significantly associated with better growth of children. Again, this result is consistent with the ENDESA data and with studies from many countries around the world.

The education variable in this analysis is the highest level of education achieved by any adult in the household; in the Census data, it was not possible to identify the mother of each child, so we were unable to look at the effect of maternal education, often found to be an even stronger predictor of children's growth status. Although previous research suggests that children in low-income female-headed households do better nutritionally than children in low-income male-headed households (Johnson and Rogers, 1993; Rogers 1995, 1996), in the population as a whole, living in a female-headed household was only weakly associated with higher nutritional status ($r=0.044$, $p=0.000$; Spearman-rho Correlation), and female children were somewhat better off than male children in this analysis (-0.35 mean HAZ compared to -0.47, respectively). Being in an urban area is associated with better nutritional status ($r=0.086$, $p=0.000$; Spearman-rho Correlation); this could be due to better access to jobs, sanitary and health services, and marketed food supply. Not surprisingly, ownership of possessions indicating higher income is consistently associated with better child growth, as is access to a modern toilet, and sanitary method of garbage disposal. Household crowding, probably associated with lower income as well as poorer environmental conditions, is associated with poorer nutritional status of children.

A complete table of regression results for HAZ, estimated at the national level and by development zone, is found in Appendix 6.

As mentioned above, ENDESA contained no information about the ethnic origin of individuals. We were able to calculate a measure of ethnic diversity for the cluster, based on data from the Census, which did collect such information. The measure used in the regression was the percentage of the *sección* population that was of Haitian origin (born in Haiti, or born to Haitian parents). By this measure, ethnic diversity at the national level showed a weak negative association with nutritional status by HAZ ($r=-0.021$, $p=0.038$; Spearman-rho correlation).

However, results for the percentage of the population of Haitian origin cannot be interpreted as a good measure of the degree of marginalization of this group. Interpretation of this variable is subject to what is called the ‘ecological fallacy’ – it may be that in areas where the Haitian population is more of a minority, there is more discrimination, so that the proportion of this population suffering from malnutrition is higher than in the non-Haitian population.

At the national level, living in a mountainous area is associated with poorer growth, although within each separate zone, this measure of topography does not explain nutritional status, presumably because there is less variability in topography within each zone. The information we have on droughts and floods suggests, surprisingly, that these factors are not determinants of nutritional status. The Dominican Republic is a small and relatively well-integrated country, so that perhaps people living in drought- or flood-prone areas may have options that protect their livelihoods and food access during climate shocks. Also, information on droughts and floods was available only at the level of the province. More disaggregated information might produce a different result.

The zone-wide results demonstrate that different factors are significant in different regions. Recall that this model was developed specifically to provide the most accurate prediction of children’s anthropometric status. Thus we have not been particularly concerned about issues of collinearity or endogeneity, which might affect the interpretation of specific regression coefficients. In fact, the goal of the model was not to be able to interpret each individual coefficient; the main goal was to estimate child anthropometric status, in order to develop predictions of the prevalence of malnutrition (anthropometric indicator below -2 standard deviations from the mean) at the *municipio* level.

Table 2 compares the prevalence of low HAZ among children ages 6 to 59 months, by province as measured by ENDESA and as estimated by using small area estimation methods linking the ENDESA data to the Census data.¹⁰

¹⁰ For comparability, these estimates are calculated from ENDESA data for our age group of interest, children ages 6 to 59 months. For this reason they differ slightly from the estimates presented in the 2002 ENDESA report, which are calculated for children 3 to 59 months of age. More detailed results are found in Appendix 4.

Table 2: Prevalence of Chronic Malnutrition among 6 to 59 month-olds, by Province

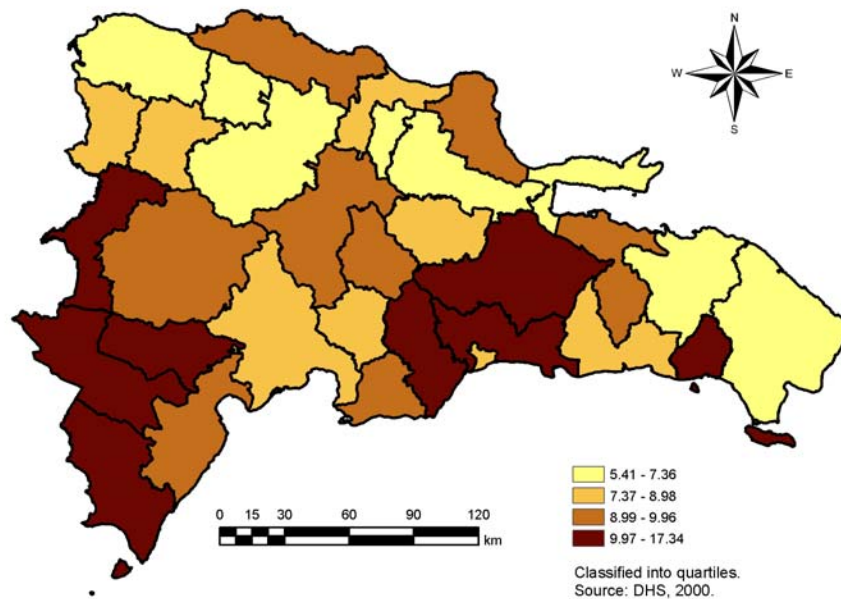
Province	Prevalence in ENDESA	Prevalence using SAE	Standard Errors on SAE Estimates
Española	8.33	8.78	0.014
Puerto Plata	9.61	9.85	0.018
Santiago	5.41	8.46	0.014
La Vega	9.78	11.95	0.014
Monseñor Nouel	9.46	7.98	0.012
Sánchez Ramírez	7.66	8.11	0.014
Duarte	5.99	9.57	0.010
Maria Trinidad Sánchez	9.16	10.31	0.011
Salcedo	7.37	8.58	0.012
Samaná	6.90	11.05	0.013
Dajabón	8.90	8.75	0.012
Monte Cristi	6.05	8.45	0.013
Santiago Rodríguez	7.95	10.54	0.017
Valverde	6.74	6.70	0.011
Azua	8.99	9.09	0.012
Peravia	9.01	9.18	0.011
San José De Ocoa	8.02	10.13	0.013
San Cristóbal	13.25	9.79	0.017
Elías Piña	17.34	19.35	0.028
San Juan	9.97	12.54	0.018
Baoruco	16.83	15.39	0.015
Barahona	9.92	11.03	0.014
Independencia	13.47	13.70	0.016
Pedernales	14.51	15.32	0.017
El Seibo	6.67	8.38	0.019
La Altagracia	6.97	11.11	0.020
La Romana	11.35	12.67	0.026
Hato Mayor	9.13	13.27	0.025
Monte Plata	14.95	14.13	0.022
San Pedro de Macorís	8.56	6.75	0.012
Santo Domingo	10.15	11.49	0.016
Distrito Nacional	8.21	7.00	0.012

Most of the estimates derived from Small Area Estimation are fairly close to the ENDESA prevalence estimates, and in very few cases is the difference sufficient to move a province from one quartile to the next. When there is a discrepancy, it is not consistently in one direction or the other, which gives added confidence that there is no bias in the SAE estimates compared with the ENDESA figures.

The following two maps provide a visual representation of the data presented in the table above. Map 2 shows the distribution of provinces into quartiles of low HAZ prevalence according to ENDESA, and Map 3 shows the same quartile estimates for the Census-based estimates.

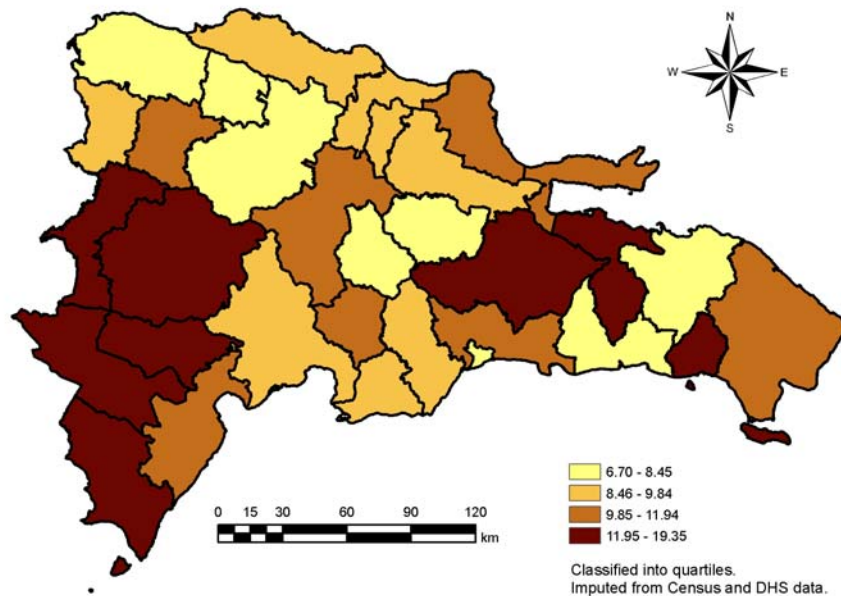
Map 2

Prevalence of Chronic Malnutrition: Estimates Based on DHS Survey Data, by Province



Map 3

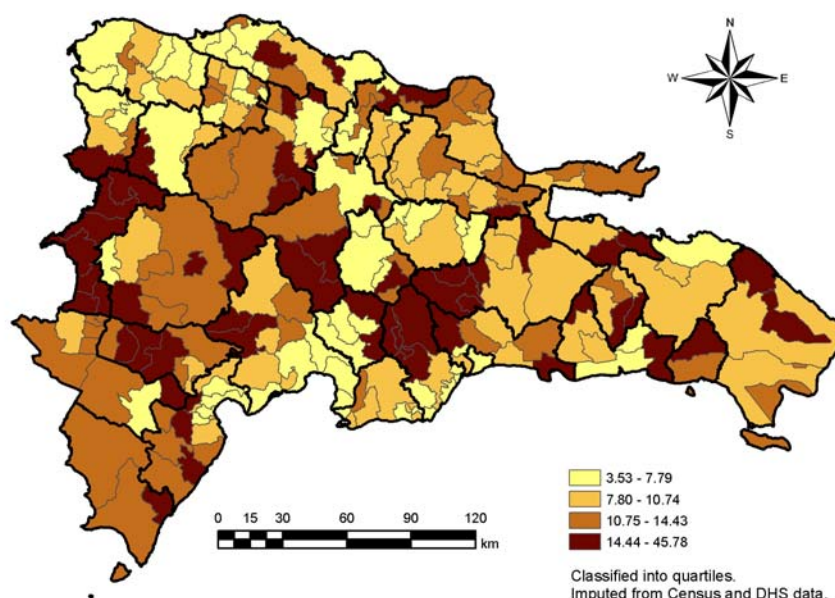
Prevalence of Chronic Malnutrition: Estimates Based on Small Area Estimation, by Province



The value of the Census-based estimates is that it is possible, using these estimates, to look at the distribution of *municipios* within a province with respect to the severity of the chronic

malnutrition problem. Map 4 presents these *municipio*-level estimates according to the national quartiles of prevalence.

Map 4
Prevalence of Chronic Malnutrition: Estimates Based on Small Area Estimation, by *Municipio*

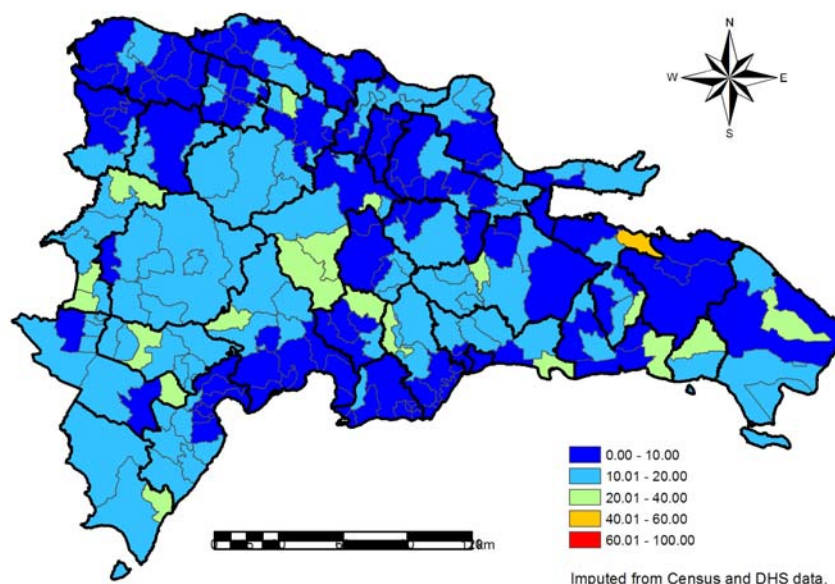


What is immediately evident from Map 4 is the large range of variation within a single province, and the fact that there are clusters of *municipios* showing high rates of chronic malnutrition that cross province boundaries. Clearly, any intervention aimed at reducing malnutrition that is based on province-level information will be poorly targeted in terms of reaching the worst affected areas. This is particularly notable in provinces such as San Juan, Baoruco, and Independencia, which appear uniformly to be in the worst quartile at the province level, but show considerable variation within the province when the estimates are disaggregated. Clusters of *municipios* with high malnutrition prevalence are also found crossing the boundaries of Santo Domingo, Monte Plata, and San Cristóbal. In the mountainous center of the country, La Vega shows wide variation in prevalence, with *municipios* ranging from the lowest to the highest quartile of prevalence. Similarly, there are pockets of high malnutrition in apparently low-prevalence provinces like San Pedro de Macorís in the east, and even Puerto Plata in the relatively well-off northwestern part of the country.

Map 5 shows the same information, but instead of using a relative measure of prevalence, it uses absolute category boundaries of prevalence that are fixed rather than calculated as quartiles relative to the national distribution. What is striking about this map is that virtually the whole country falls in the prevalence ranges below 20 percent, and all but one are below 40 percent. This map allows us to identify within national quartiles which areas are most severely affected, and picks up finer distinctions within high-quartile provinces like Elías Piña.

Map 5

Prevalence of Chronic Malnutrition: Estimates Based on Small Area Estimation, by *Municipio*



While the higher-prevalence *municipios* tend to cluster in particular regions of the country – the west on the border with Haiti, the southwest, and the mountainous center, these regions are spread widely throughout the country, reflecting the variety of conditions that may be associated with malnutrition. Table 3 shows the 15 *municipios* with the highest predicted prevalence rates. A brief look at the range of provinces in which they are located demonstrates this point. In the table, prevalence rates are matched with the estimated absolute numbers of children affected, to make the important point, discussed further below, that the locations with the highest prevalence rates are not necessarily those with the highest number of chronically malnourished children.¹¹

¹¹ A complete listing of *municipios* with their estimated prevalence rates for chronic malnutrition, and the estimated number of children affected, is in Appendix 2.

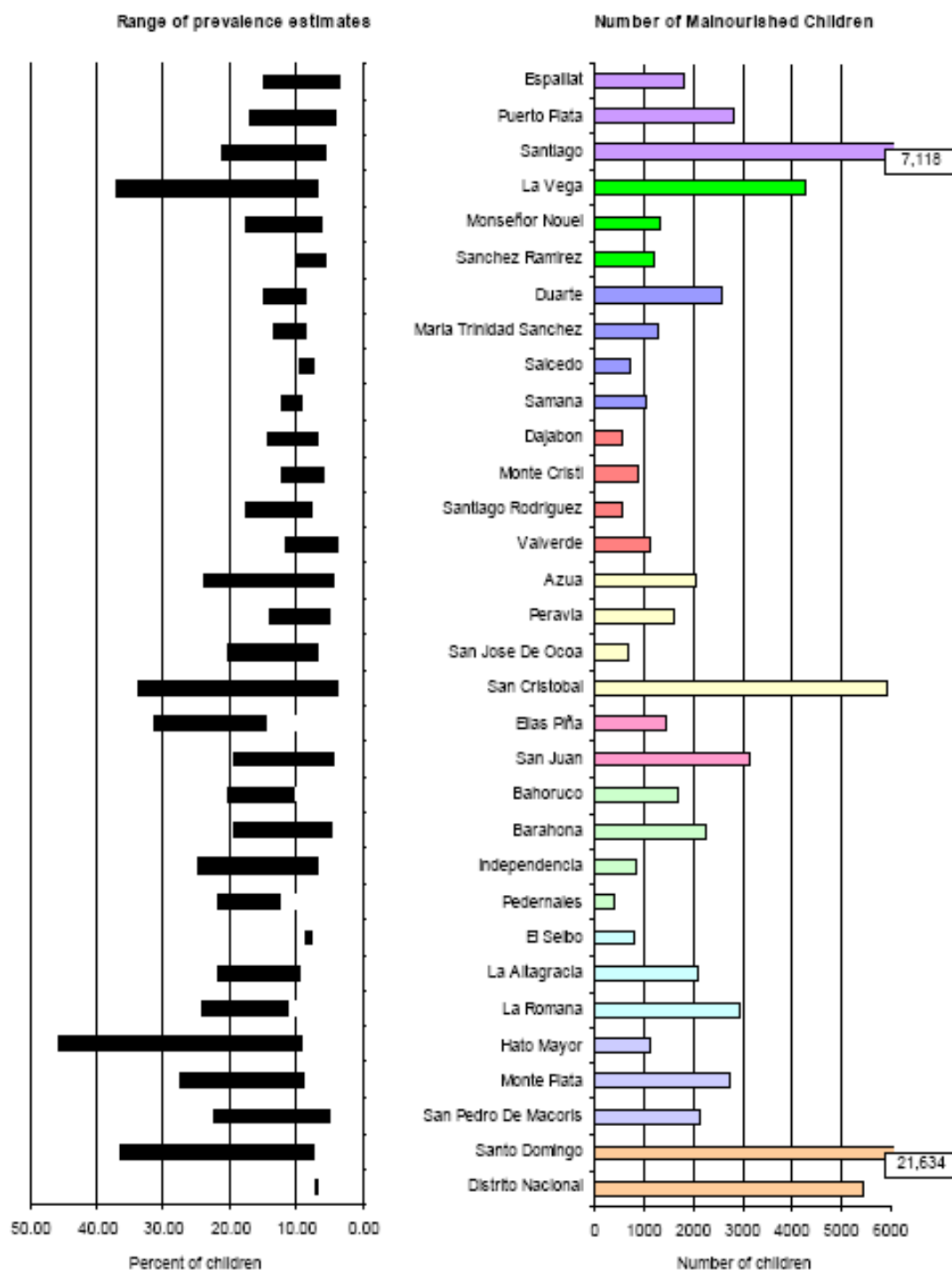
Table 3: *Municipios* with Highest Chronic Malnutrition Prevalence Rates, based on Small Area Estimation

	<i>Municipio</i>	Province	Prevalence Rates	Number of Children
1	Elupina Cordero	Hato Mayor	45.78	156
2	Tireo	La Vega	36.98	561
3	Boca Chica	Santo Domingo	36.52	4,165
4	Los Cacaos	San Cristóbal	33.84	260
5	Rincón	La Vega	31.98	349
6	El Llano	Elías Piña	31.40	333
7	Río Limpio	Elías Piña	28.51	148
8	Don Juan	Monte Plata	27.61	208
9	Cristóbal	Independencia	24.89	198
10	Guaymate	La Romana	24.13	509
11	Villarpando	Azua	24.04	199
12	Guayabo Dulce	Hato Mayor	23.88	176
13	Constanza	La Vega	22.95	1,002
14	Ramón Santana	San Pedro De Macorís	22.34	233
15	Otra Banda	La Altagracia	21.79	312

Figure 2 presents a graphic indication of how widely the estimates of malnutrition prevalence by *municipio* may diverge from one another and from the province-level mean. In several provinces, the prevalence levels of the *municipios* vary by as much as a factor of five.

Figure 2 also provides support for another important conclusion of this study. Targeting by prevalence rates at the *municipio* level is an improvement on using province-level estimates, but targeting *municipios* by prevalence rate alone may result in serious under-coverage of malnourished children. The right-hand column in Figure 2 shows the absolute numbers of malnourished children, by province, and demonstrates that the highest numbers are not necessarily in the provinces with the highest prevalence.

Figure 2
Range and Number of Malnourished Children (based on Height-for-Age Z-scores)
by Province and Development Zone



If we were to target all the *municipios* in the highest (that is, worst) quartile of malnutrition prevalence (57 *municipios*), we would capture 21,810 chronically malnourished children, or 25.4 percent of all malnourished children in the country. By selecting the fifteen *municipios* with the largest *numbers* of such children, we would reach nearly half of the chronically malnourished children (48.7 percent), even though many of these children live in *municipios* that do not have high *percentages* of malnourished children. Not surprisingly, the largest numbers of malnourished children are found in areas with high population and high population density: Santo Domingo and the Distrito Nacional, and the cities of Santiago, La Romana, and San Cristóbal. The Distrito Nacional alone accounts for 5,434 malnourished children, 6.3 percent of the total in the country. The additional 21,634 malnourished children who are found elsewhere in the province of Santo Domingo bring the share of malnourished children in this one locality to 25.2 percent of the country total.

To emphasize this point, Table 4 shows the top 15 *municipios* in terms of the absolute numbers of children estimated to be chronically malnourished. Note that only one of these *municipios*, Boca Chica in Santo Domingo province, also appears on the list of those with the highest prevalence *rates*. One of the 15 is the Distrito Nacional, six are in the province of Santo Domingo, and the others are also in provinces with large urban centers.

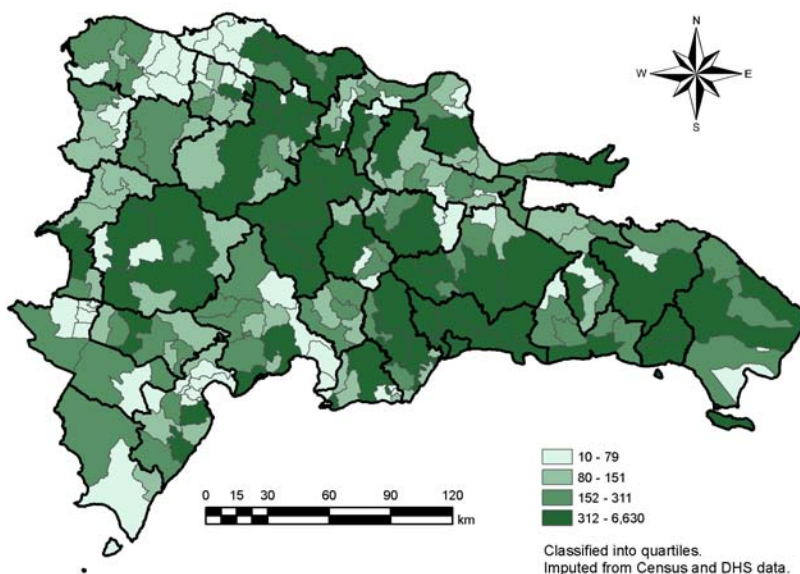
Table 4: *Municipios* with Highest Numbers of Chronically Malnourished Children, based on Small Area Estimation

	<i>Municipio</i>	Province	Number of Children	Prevalence Rates
1	Santo Domingo Este	Santo Domingo	6,630	8.84
2	Distrito Nacional	Distrito Nacional	5,434	7.00
3	Santo Domingo Norte	Santo Domingo	4,432	12.76
4	Boca Chica	Santo Domingo	4,165	36.52
5	Santiago de Los Caballeros	Santiago	3,740	6.58
6	Santo Domingo Oeste	Santo Domingo	2,519	8.56
7	La Romana	La Romana	2,424	11.52
8	San Cristóbal	San Cristóbal	1,967	8.28
9	Villa Altagracia	San Cristóbal	1,919	19.75
10	Los Alcarrizos	Santo Domingo	1,688	7.29
11	San Juan de La Maguana	San Juan	1,616	12.36
12	Salvaleón De Higüey	La Altagracia	1,422	9.74
13	Concepción de La Vega	La Vega	1,361	6.72
14	San Francisco De Macorís	Duarte	1,282	8.61
15	San Felipe De Puerto Plata	Puerto Plata	1,233	9.53

To underline the point that the numbers tell a distinct story from the prevalence figures, Map 6 shows the distribution of absolute numbers of malnourished children by quartiles, where the quartiles are calculated according to the numbers of children affected. A comparison of

Maps 5 and 6 shows how dramatically different the extent of the malnutrition problem looks when based on absolute numbers rather than percentages – this is driven by the larger number of children in the major cities and demonstrates that the largest numbers of malnourished children live in *municipios* that are not necessarily in the worst quartile of malnutrition prevalence.

Map 6
Number of Chronically Malnourished Children Based on Small Area Estimation, by *Municipio*



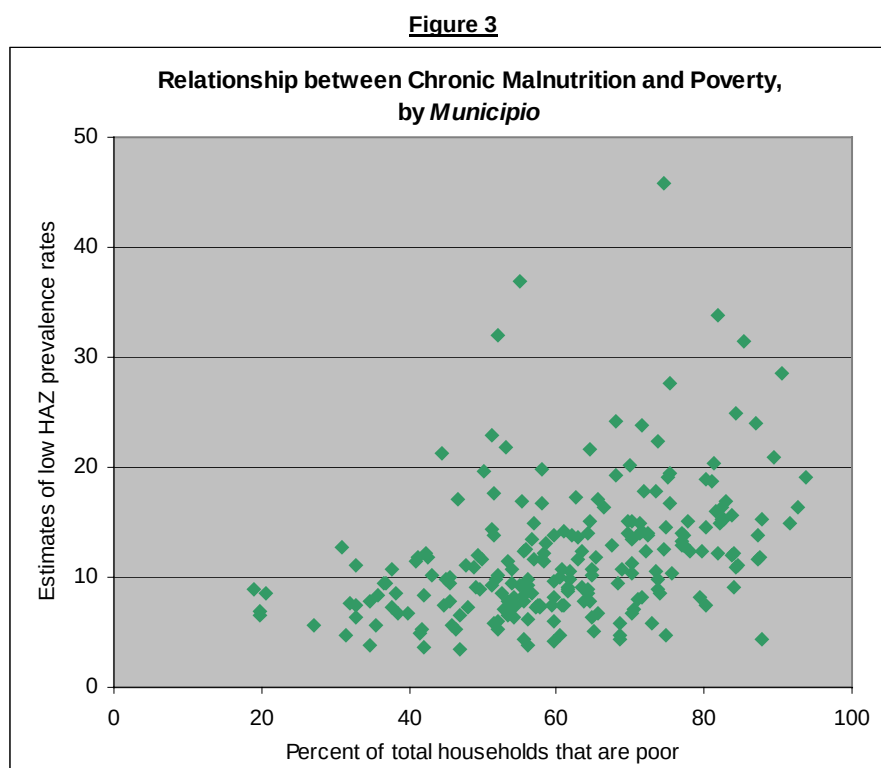
This is in no way meant to suggest that public sector interventions should ignore the plight of high-risk, less densely populated areas. Poor, isolated regions of the country with high levels of malnutrition require their own interventions. These results, though, suggest that cost-effective interventions can be developed specifically to reach the large number of malnourished children in more urbanized and heavily populated *municipios*. Such interventions would take into account the unique characteristics of these areas, and could take advantage of the fact that the vulnerable populations are easier to reach than those in areas of high prevalence but remote location and low density. We may expect, for example, that urban areas are affected more by poor sanitation and household crowding, maternal time and care-taking constraints, and less by limited access to livelihoods, or to markets and public services.

Poverty

One important predictor of poor nutrition is poverty. We expect to see a close association between areas with high poverty and areas with high rates of malnutrition. Figure 3 shows the relationship between the percentage of the population classified as poor according to the *Oficina Nacional de Planificación*, ONAPLAN, and our Census-based estimates of the percentage of children with low HAZ. In the ONAPLAN report (Morillo et al., 2005), poverty was determined with reference to an index comprised of household possessions, unsatisfied basic needs, housing

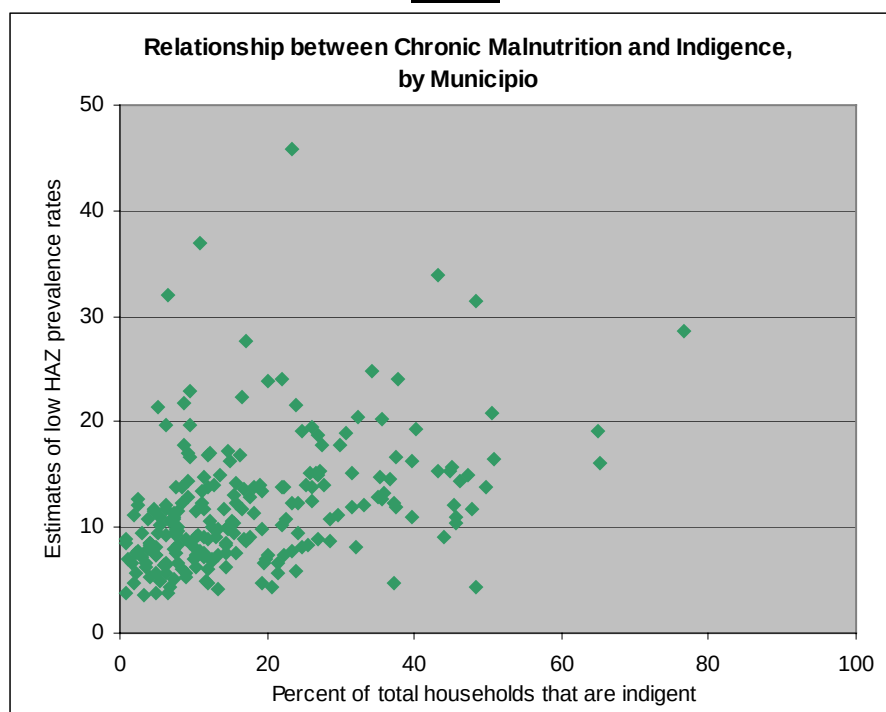
quality, and access to services, based on data from the 2002 ENDESA and the 2002 National Census.¹²

The graph shows a clear relationship, but perhaps not as strong as might be expected. The simple correlation between the percentage of households that are poor and the percentage of children with low HAZ is 0.365 ($p=0.000$, Pearson). This result confirms the fact that poverty, while central to the process, only partially accounts for levels of malnutrition.



¹² The ONAPLAN study defined poverty groups based on a system of weights developed earlier based on 1993 Census data and 1996 ENDESA, applied to more recent data sources. The earlier study (Morillo, 2003)) confirmed the definition of poverty groups by comparing the allocation of households to four categories of poverty/non-poverty with the level of household income for households in a subsample of the 1996 ENDESA that had detailed income data, and found that the median incomes of the different categories were consistent with national poverty measures. Among urban households, the group in the ENDESA subsample that were classified as "Poor I" or extreme poor (indigent) had a median monthly income of RD\$433, compared with the cost of a basic food basket of RD\$425, and the group classified as "Poor II" (poor, not extreme poverty) had a median income of RD\$751, just under the official poverty line of RD\$850, while in rural areas, the "Poor I" group had median income of RD\$482, and "Poor II" had median income of RD\$668 (Morillo, 2003). These poverty lines were updated in the 2005 report to an extreme poverty line of RD\$876, and a poverty line of RD\$1,753 for October 2002, equivalent to US\$47.10 and US\$94.20 respectively, at the 2002 exchange rate.

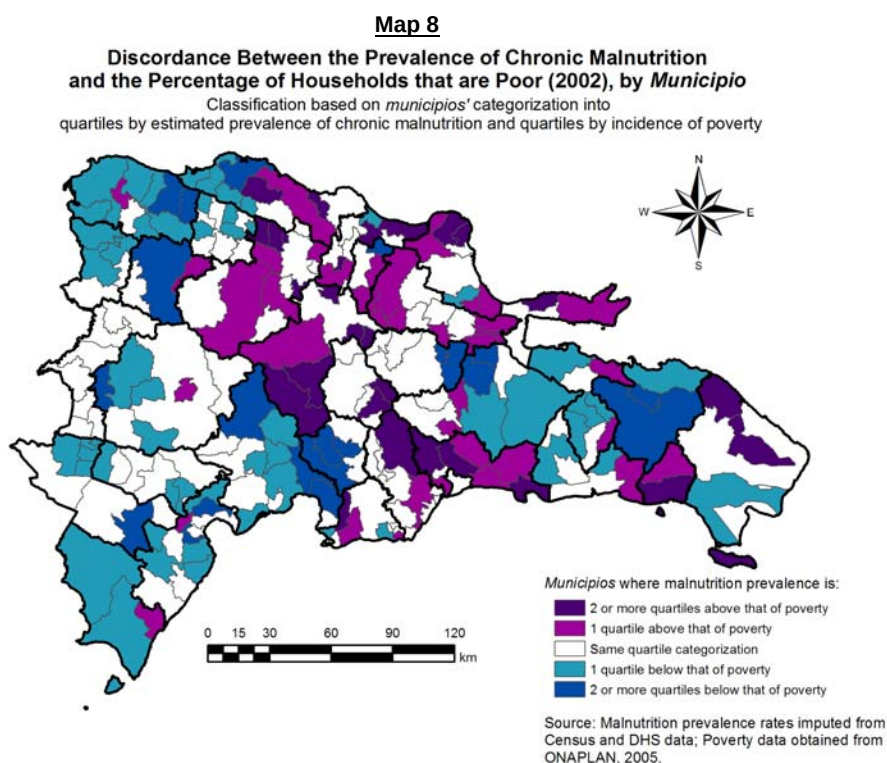
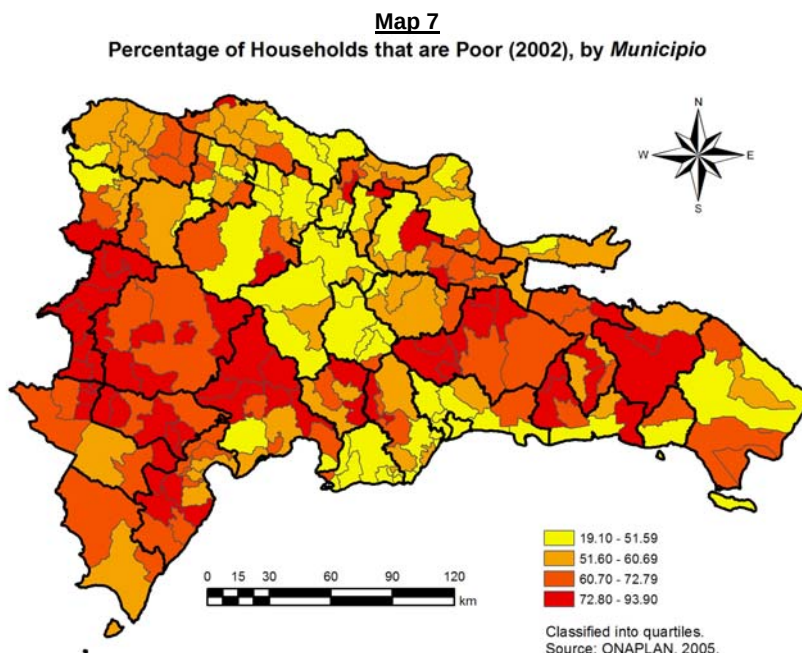
Figure 4



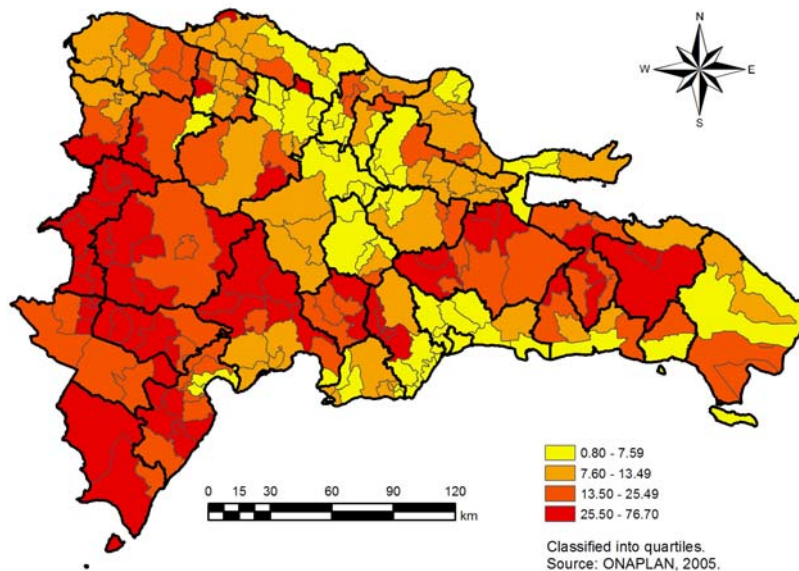
The following three maps show the distribution of poverty and indigence, as reported by ONAPLAN. Map 7 shows the distribution of poverty prevalence. In the next map, the prevalence of poverty is compared with the prevalence of malnutrition as estimated using SAE. The colors reflect the degree of difference between the level of poverty (by quartile) and the level of malnutrition. The darker colors reflect a divergence between poverty and malnutrition of two quartiles or more; the lighter colors reflect a difference of one quartile. White areas are those where the geographical area is in the same quartile for both poverty and malnutrition. The colors also show where poverty prevalence is higher than malnutrition: purple tones show malnutrition prevalence higher, while blue tones show malnutrition prevalence lower than poverty rates. A few examples are sufficient to show that poverty explains some of the prevalence of malnutrition, but not all. The area of El Seibo in the east, for example, shows high rates of poverty, but several of these *municipios* fall in the lowest quartile of malnutrition. In the province of La Vega, the reverse relationship is seen: low rates of poverty in most of the *municipios*, but some of the highest rates of malnutrition. In Elías Piña, where malnutrition prevalence is relatively high, poverty and malnutrition are comparable.

There are 47 *municipios* out of 225 (20.9 percent) in which the prevalence of poverty is at least two quartiles different from the prevalence of malnutrition: 26 show malnutrition rates at least two quartiles higher than poverty rates, and 21 show poverty rates that are at least two quartiles higher than malnutrition. If we targeted a program based only on poverty, and excluded these 26 *municipios* where malnutrition prevalence is two or more quartiles greater than poverty, 20,165 children in these 26 *municipios*, or 23.4 percent of the 85,970 chronically malnourished would be missed. If we excluded the 21 *municipios* where poverty rates are higher than malnutrition rates by 2 or more quartiles, only 2,187 malnourished children would be missed.

If we targeted a program based only on being in the worst (highest) quartile of poverty, we would reach 9,971 malnourished children, or 11.6 percent of the 85,970 chronically malnourished in the country, compared with the 25.4 percent of malnourished children reached by targeting *municipios* in the worst quartile of malnutrition prevalence.



Map 9
Percentage of Households that are Indigent (2002), by *Municipio*

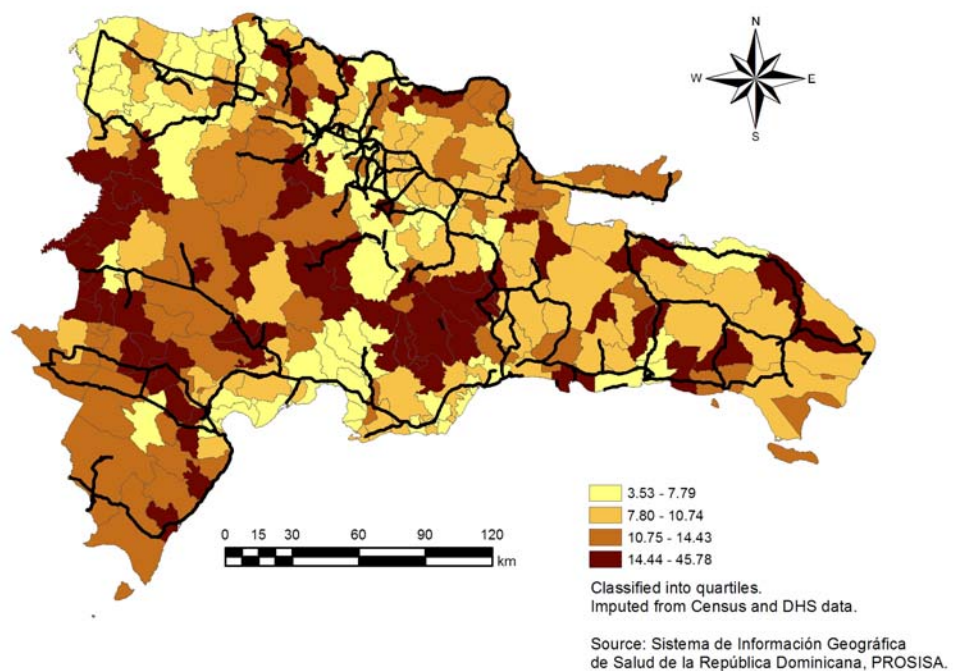


These differences underscore the importance of doing on-the-ground assessments of the nutritional situation once areas have been identified as targets for nutrition interventions based on their high numbers of malnourished children, or their high prevalence. Prevalence maps can serve as a first step in guiding the allocation of resources aimed at reducing national rates of malnutrition, but a situation assessment is needed to design the most effective intervention for a specific location. Poverty alleviation, while a worthwhile intervention in its own right, may have variable effects on malnutrition rates, depending on the specific constraints that are operating in a given place.

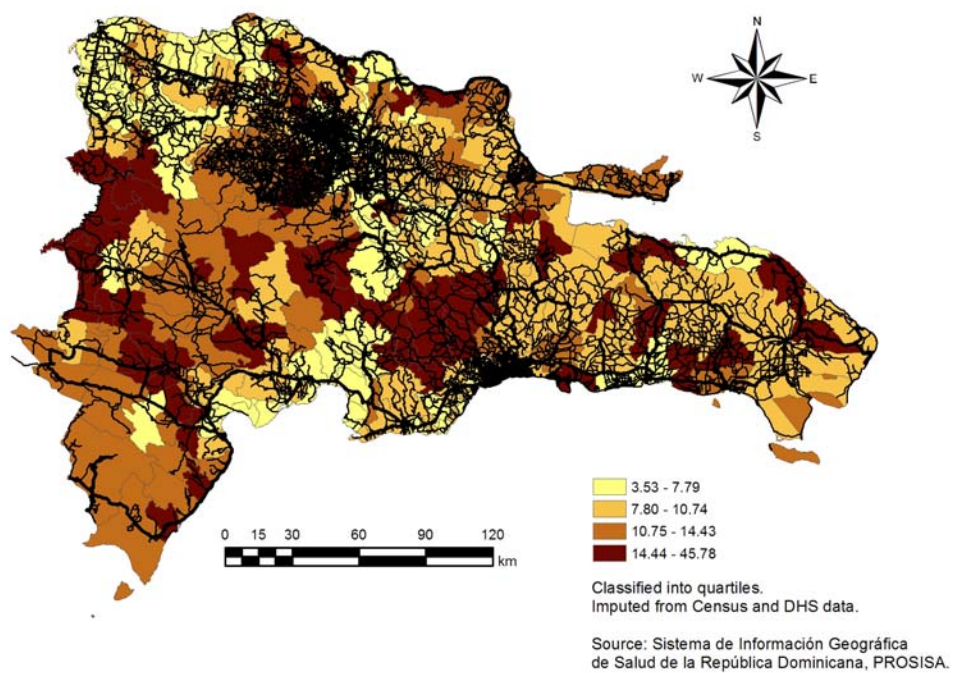
Infrastructure

In the regression analysis used to predict nutritional status in order to estimate malnutrition prevalence, access to roads was defined as the proportion of each *municipio* (by area) that is within five kilometers of a major road or highway. Although this variable was not in itself a significant predictor of child nutritional status, a simple correlation between the proportion of a *municipio* that is close to a major road and HAZ among children in the survey is weak but statistically significant ($r=0.085$, $p=0.000$; Pearson). Map 10 shows major roads superimposed on the map of malnutrition prevalence by *municipio*. Some of the low-prevalence areas seem to have a higher density of major roads, and certainly the largest clusters of high-prevalence *municipios* have few major roads, but these results are not entirely consistent, and some of the highest-prevalence *municipios* do have major highways running through them. Elías Piña, the mountainous areas of Santiago, San Juan, La Vega, Azua, and San José de Ocoa, as well as the high-prevalence *municipios* clustered in the southwestern provinces of Baharona and Pedernales, do appear to be poorly served by major road systems, and this lack of access may contribute to their nutrition problems.

Map 10
Prevalence of Chronic Malnutrition and Extensiveness of Major Road/Highway Network, by *Municipio*

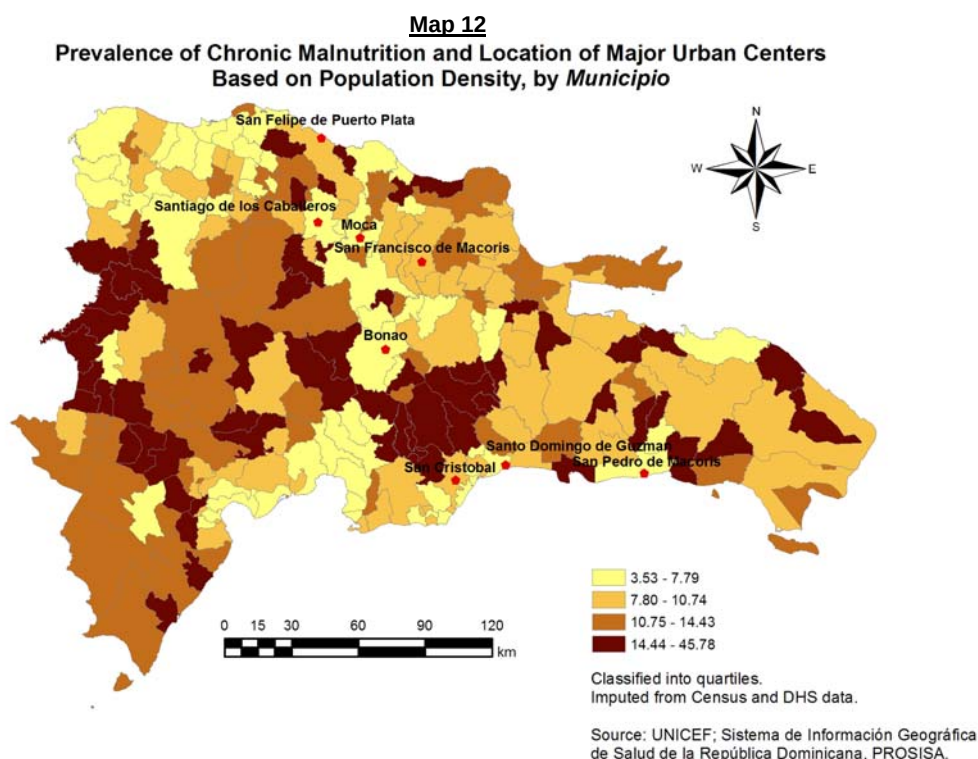


Map 11
Prevalence of Chronic Malnutrition and Extensiveness of Road Network, by *Municipio*

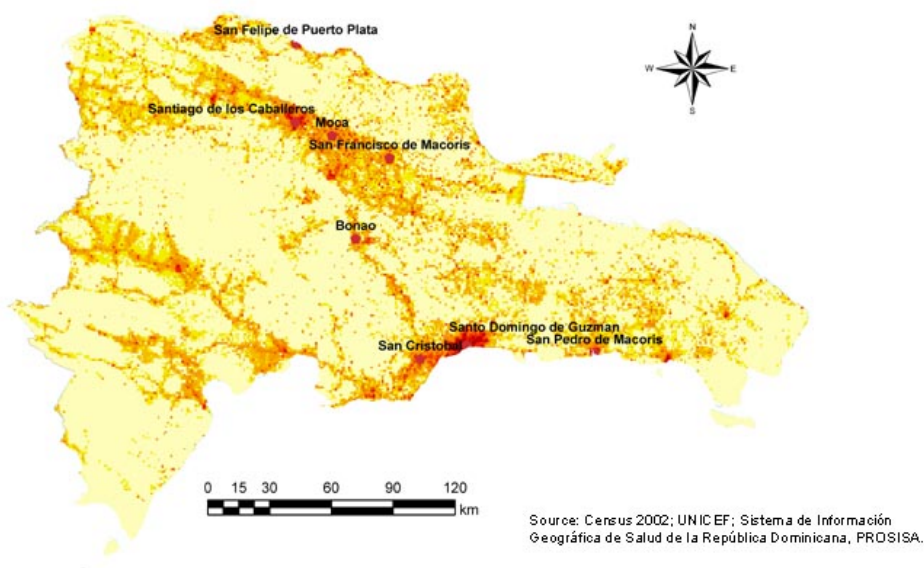


Map 11 shows the distribution of roads, including secondary roads, superimposed on the map showing the prevalence of chronic malnutrition. Clearly there are areas that are poorly served by the road network. These tend to be the more mountainous areas, and in general areas with higher malnutrition prevalence. The mountainous terrain may be a factor in both the lack of roads and the constraints on livelihoods that are associated with higher rates of malnutrition. Not all high-prevalence *municipios* lack roads, but the areas that are poorly served by roads tend to have higher prevalences of malnutrition. A simple bivariate correlation between the proportion of a *municipio* within five kilometers of a road and the percentage of chronically malnourished children in a *municipio* is -0.145 ($p=0.029$, Pearson).

We charted the locations of eight major urban centers in the Dominican Republic, to see if *municipios* that contained a densely populated area had lower rates of malnutrition (Map 12). No *municipio* with a major urban center falls in the highest (worst) quartile of malnutrition prevalence; in fact, all eight fall into the lowest two quartiles. As was discussed earlier, though, the major cities of Santo Domingo, San Cristóbal, and Santiago, are home to very large numbers of malnourished children, simply because of their large size and resulting high population density (Map 13).



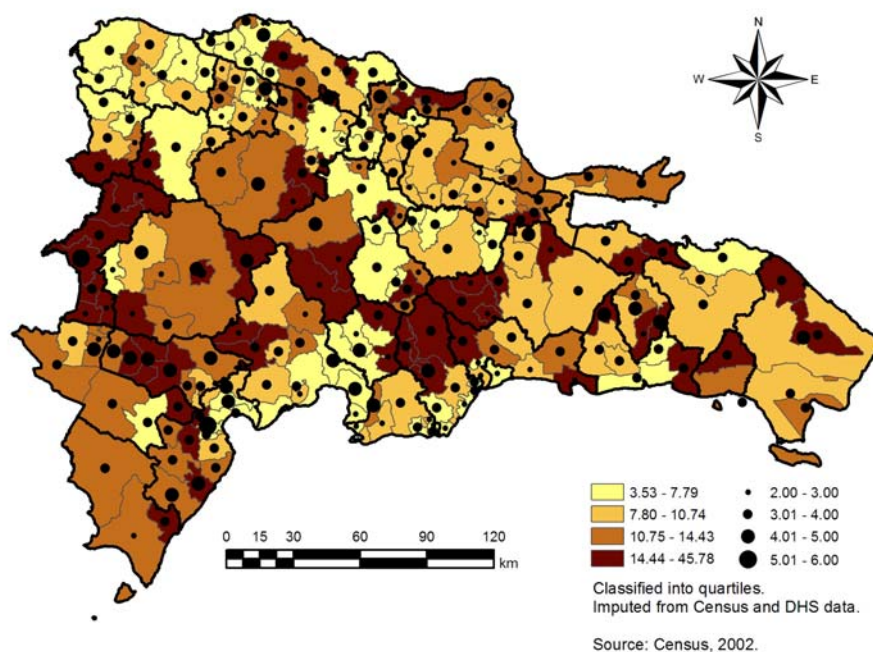
Map 13
Population Density (2002) and Location of Major Urban Centers



Inequality and Ethnic Diversity

We calculated economic inequality within a *municipio* by constructing an index of economic status, made up of variables indicating ownership of key consumer durable goods, access to key public services, and quality of the house. We then computed the interquartile range (IQR) of this index for each *municipio*, that is, the values between the 25th and 75th percentile and, therefore, the range of values within which 50 percent of the population fell. The index varied from 1 to 13, and the IQR varied from 2 to 6. Map 14 shows the distribution of the interquartile range of inequality by indicating the level of inequality with a dot, superimposed on the map of malnutrition prevalence. The size of each dot reflects the degree of inequality. The distribution of economic inequality does not show any consistent relationship with the distribution of child malnutrition. While the highest rate of inequality is found in a cluster of *municipios* in Elías Piña, where high rates of malnutrition are also found, the relationship is quite inconsistent across the country. Recall that inequality is not a measure of poverty, but simply a measure of how variable household economic status is within a *municipio*. We considered the possibility that households are more likely to be malnourished in a context in which there is extreme inequality between richer and poorer households, but this is not supported by the data.

Map 14
Prevalence of Chronic Malnutrition and Economic Inequality Interquartile Range, by *Municipio*



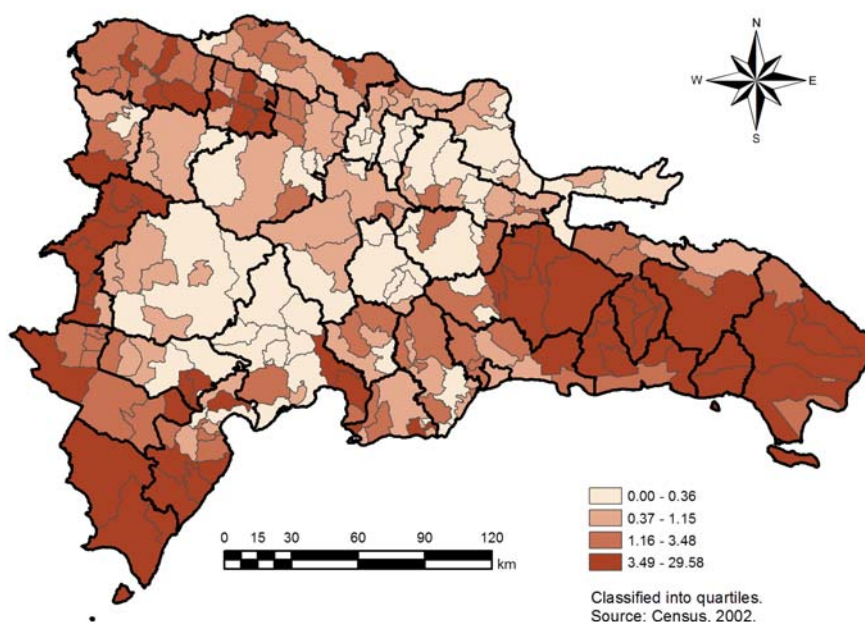
Similarly, we considered the possibility that ethnic discrimination might be a factor in predicting high prevalence of malnutrition, and therefore calculated and mapped the distribution of *municipios* according to the percentage of the population that was either born in Haiti or born of Haitian parents. This was the only indicator of ethnicity or race available in both data sets. Map 15 shows this distribution. It is quite evident that the percentage of the population of Haitian extraction is not a good predictor of malnutrition prevalence. We did, however, find a weak negative correlation between the percent Haitian population in the segment and individual predicted HAZ score ($r=-0.021$, $p=0.038$; Pearson).

While some areas with a high percentage of Haitians also have high rates of malnutrition (the *municipios* of Elías Piña, for example), other areas with a high proportion of Haitians fall into the lower quartiles of malnutrition prevalence (a cluster of *municipios* in Monte Plata, Hato Mayor, and La Altagracia, for example), and the large group of high-malnutrition *municipios* in the mountainous center of the country have generally low proportions of Haitian population.

Due to lack of data, we could not estimate the impact of being Haitian on the probability of low HAZ controlling for other factors at the individual level. At the level of the *municipio*, the percentage of the population that is Haitian shows a positive, though weak relationship with prevalence of chronic malnutrition ($r=0.198$, $p=0.003$; Pearson Correlation). In interpreting this result, we should be aware of the risk of committing what is known as the “ecological fallacy”. That is, we can see the correlation between percent Haitian population and malnutrition prevalence, but we cannot see whether the rates of malnutrition differ between the Haitian-origin and non-Haitian populations. Certainly there is evidence that the Haitian-origin population is economically worse off than the non-Haitians. We looked at the economic index, which we developed to assess economic inequality within *municipios*: the average of this index was 7.2 for

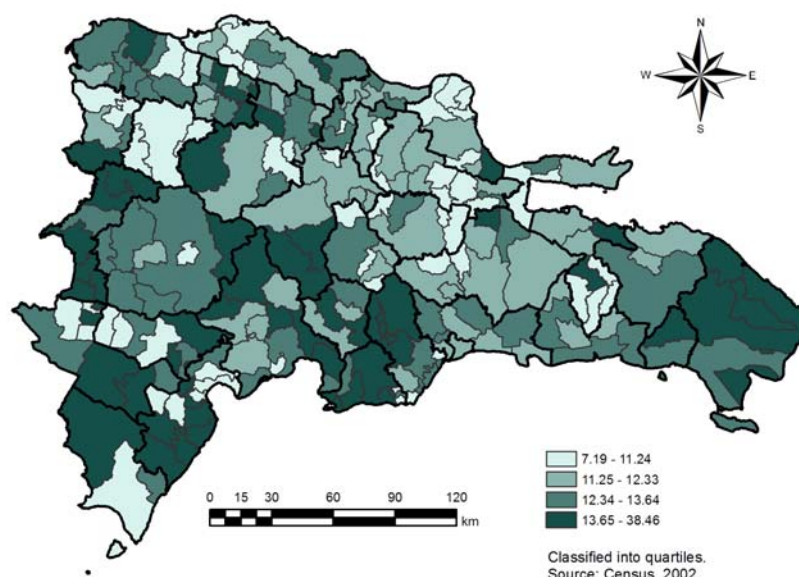
non-Haitians, and only 4.7 for Haitians ($t(11,107) = -107.4, p < 0.001$, Independent-Samples T-test, equal variances not assumed). We found that 78 percent of Haitians, and only 39 percent of non-Haitians live in households that fall below the national average economic index of 7, suggesting that people of Haitian origin face higher economic barriers.

Map 15
Percentage of the Population that is of Haitian Extraction, by *Municipio*



Another possible indicator of inequality within a community is the percentage of school-aged children not enrolled in school. Map 16 shows the distribution of *municipios* according to this indicator, which we calculated from the Census data (percentage of school-aged children reported as being enrolled). It is certainly tempting to see an association. Low enrollment coincides with high rates of malnutrition in a number of areas, including Elías Piña, the northern part of San Cristóbal, as well as in the high-prevalence *municipios* of Altagracia in the east, and some of the mountainous regions in the center of the country. Furthermore, high enrollment rates coincide with low levels of malnutrition in the cluster of low-prevalence *municipios* in the northwestern province of Santiago Rodríguez. The relationship is not highly consistent, though; there are some *municipios* showing both high malnutrition prevalence and high enrollment rates, or the opposite (low prevalence and low enrollment). It is quite likely that school enrollment is determined by factors other than those that are associated with malnutrition, for example accessibility and perhaps quality of the school, the demand for children's labor in the household, and possibly benefits such as the availability of a school feeding program. In our own analysis of census data, we found that percentage of children enrolled in school did not show any consistent relationship with *average* socio-economic status (measured by an index of possessions, housing quality, and services) in the *municipio* (data not shown); other studies have shown that, at the individual level, the likelihood of children staying in school is related to SES as well as to geographic zone (UNDP, 2005).

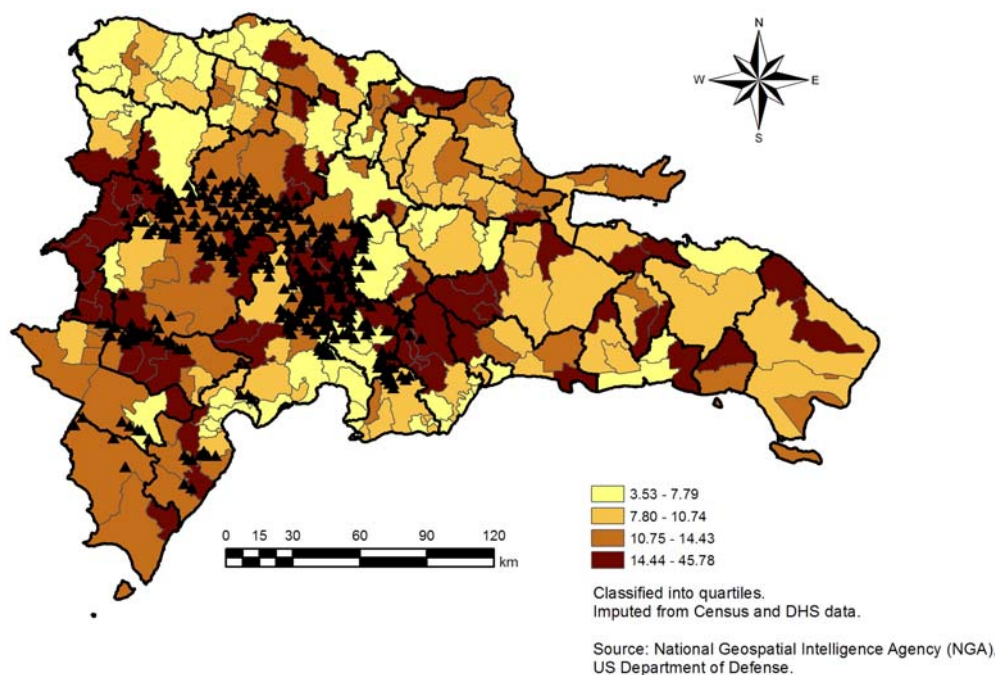
Map 16
Percentage of School-Aged Children Not Enrolled in School, by *Municipio*



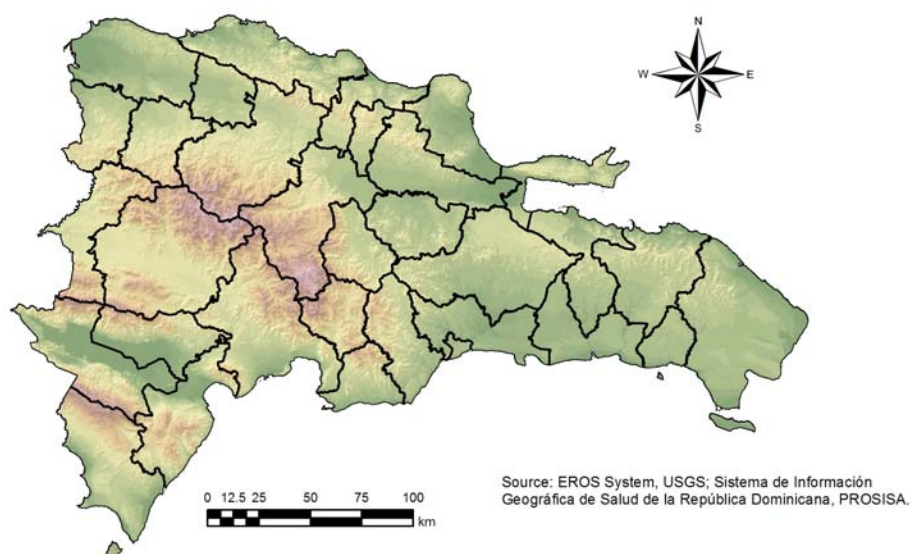
Topography and Climate

Mountainous terrain is significantly associated with lower HAZ: both mean elevation and slope of the terrain (elevation range) show weak but significant associations with nutrition status ($r=-0.086$, $p=0.000$ for elevation, and $r=-0.074$, $p=0.000$ for slope; Pearson Correlations). Map 17 shows the distribution of mountain peaks over 1000 meters above sea level, superimposed over the map showing the distribution of malnutrition measured by low HAZ. The association is immediately visible. In interpreting the map, it is important to note that each symbol represents a peak over 1000 meters, but in the areas immediately around these peaks there is likely to be mountainous terrain of slightly lower elevation. A comparison of this map with Map 10 showing major roads clearly indicates that the mountainous areas are also those that are less well served by major roads and highways. Mountainous terrain makes access to markets difficult, both for goods and for labor; this terrain is also inhospitable for agriculture. Poverty prevalence does not appear to be as closely related to mountainous terrain: several of the *municipios* with the lowest poverty rates are in the mountainous areas of Santiago, La Vega, and Monseñor Nouel provinces. This suggests that the causal factors for malnutrition specific to these mountainous regions need to be investigated further, and may have to do with aspects of food security such as the ability to produce a variety of foods and access to food markets.

Map 17
Prevalence of Chronic Malnutrition and Location of Mountains
Over 1000 Meters Elevation, by *Municipio*



Map 18
Topographical Map of the Dominican Republic, by Province

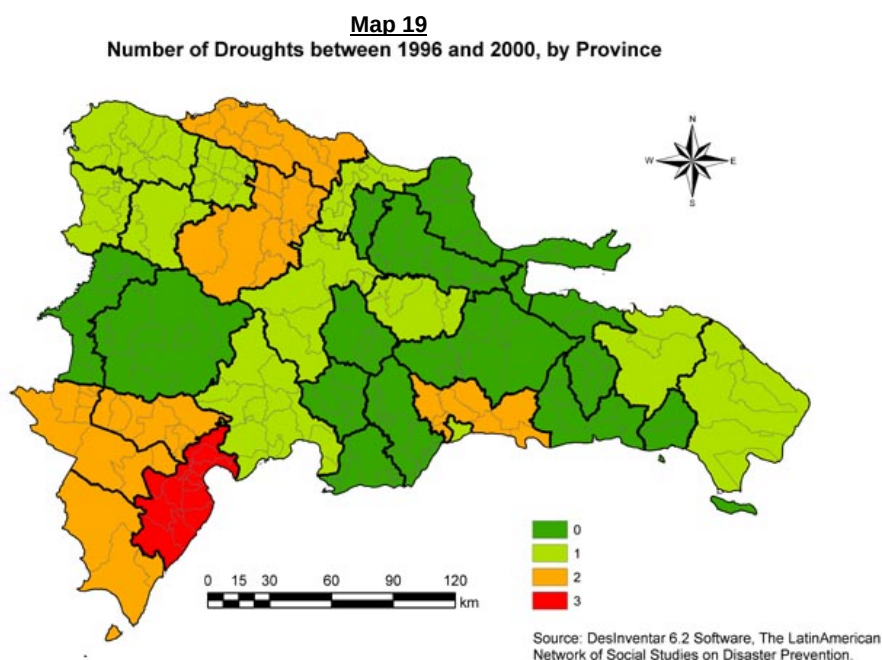


Historical information on whether an area has been subject to droughts or to floods was available only at the level of the province, and only through the year 2000. The information, available

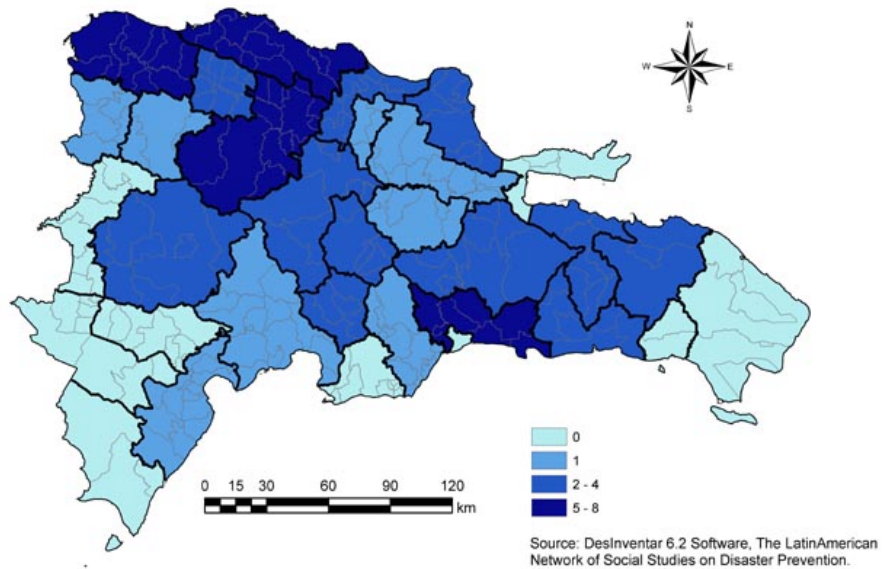
from The LatinAmerican Network of Social Studies on Disaster Prevention (*La Red*) reported the dates of various climatological events (officially-declared droughts, floods, earthquakes, and hurricanes). The number of droughts in the Dominican Republic between the years 1996 and 2000 ranged from none to three; the number of floods ranged from none to eight for the same reference period. Map 19 shows the distribution, by province, of droughts, and Map 20 shows the distribution of the number of floods for the five-year period. Neither droughts nor floods show any consistent relationship to the prevalence of chronic malnutrition. Frequency of floods was in fact, weakly, but positively associated with HAZ of children ($r=0.054$, $p=0.000$; Pearson Correlation), a relationship that deserves further investigation. It may be the case that, since the Dominican Republic is a small and relatively well-integrated country, resources can flow to those affected by climate shocks, and populations may have greater mobility to escape the consequences of these shocks.

Investments in disaster preparedness and disaster response are critical in mitigating the consequences of these climate shocks, and addressing the issue of acute malnutrition before the next likely shock would help to buffer the population against some of the worst consequences.

As noted above, a more disaggregated measure of droughts and floods might provide additional useful information.

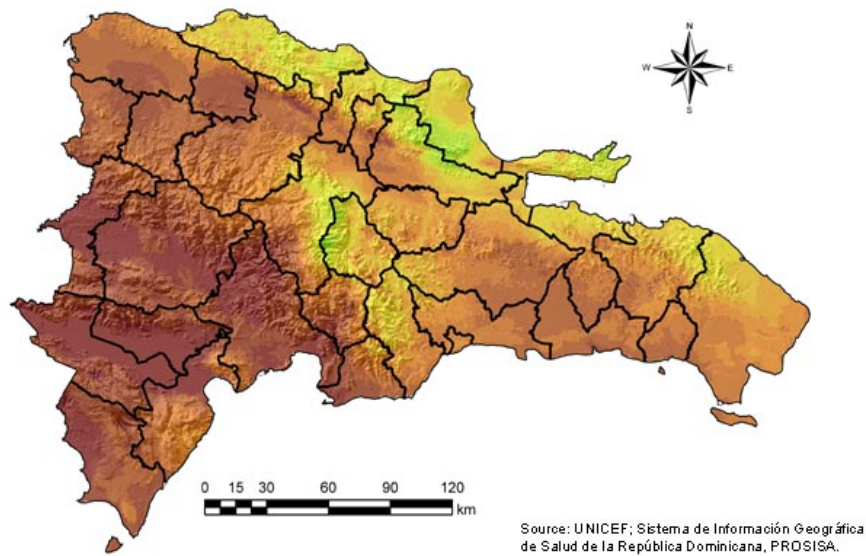


Map 20
Number of Floods between 1996 and 2000, by Province

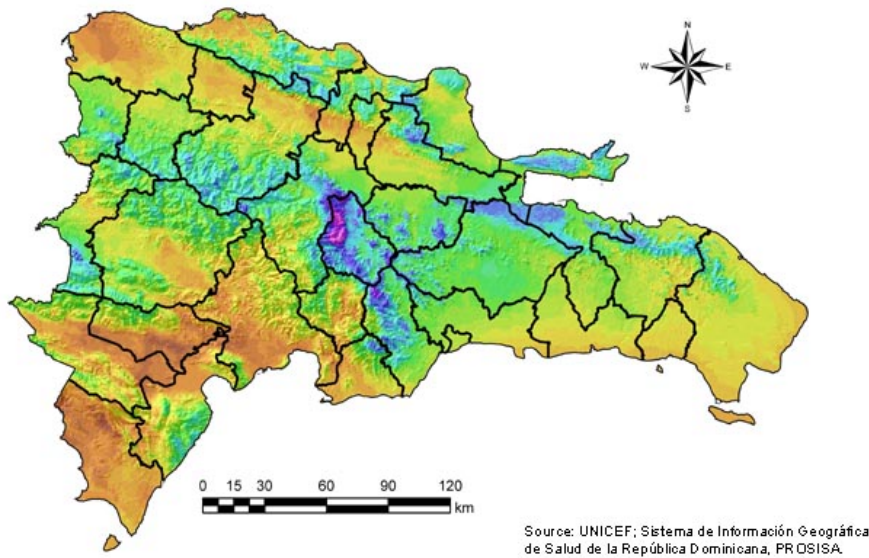


The following two maps show average rainfall in the rainy and dry seasons throughout the country.

Map 21
Average Precipitation in January (Dry Season), by Province



Map 22
Average Precipitation in May (Rainy Season), by Province

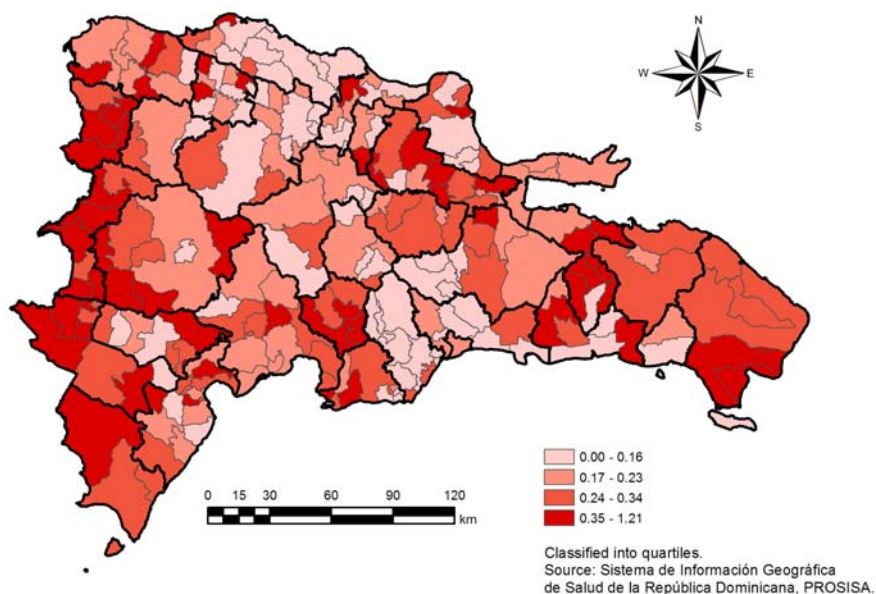


Health Services

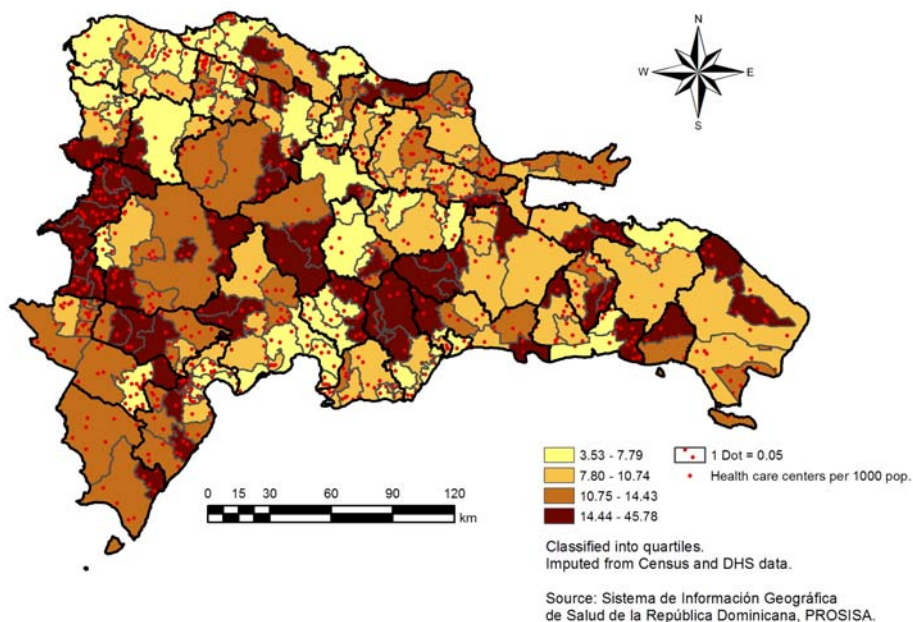
Based on the national-level regression, availability of health centers was positively and significantly related to nutritional status ($\beta=0.463$, $p<0.000$). Map 23 shows the distribution of health centers (including all SESPAS, IDSS, and ISSFAPOL primary health facilities, hospitals, general hospitals, and specialized health care facilities at the *municipio* level), and Map 24 shows the availability of health services as icons representing number of clinics/hospitals per 1000 population, superimposed on the map showing malnutrition prevalence by HAZ.

There is a high density of health centers in the *municipios* along the border with Haiti, and relatively high density as well in the eastern part of the country. Recall that each dot represents not an absolute number of health centers, but the number of health centers adjusted for the population. In general, health centers appear to be well distributed throughout the country, and available in the high-prevalence *municipios* as well as in those with low prevalence.

Map 23
Number of Health Care Centers per 1000 Inhabitants (2002), by *Municipio*



Map 24
Prevalence of Chronic Malnutrition and Availability of Health Care Centers, by *Municipio*

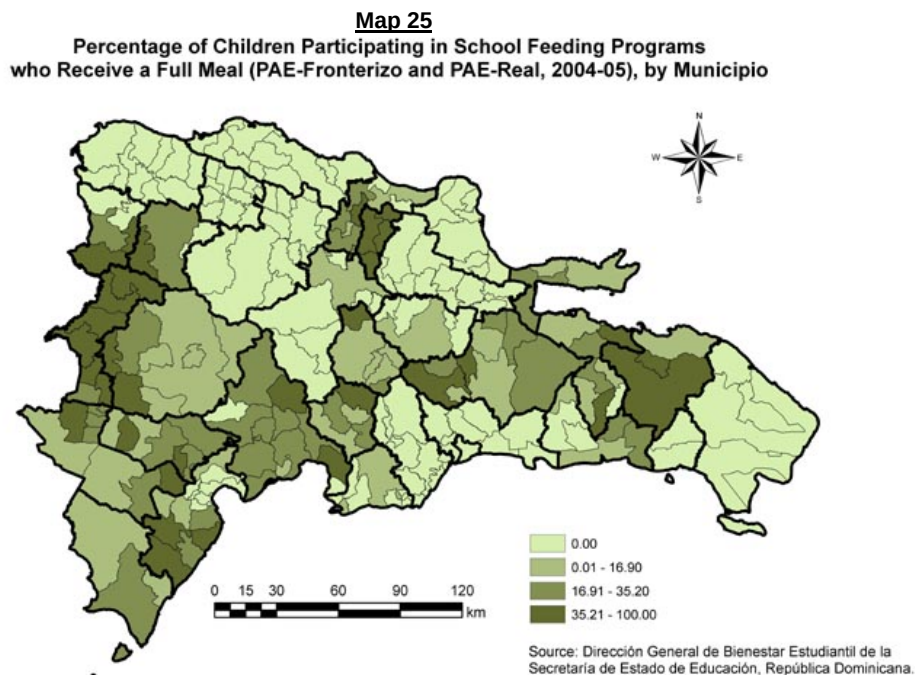


School Feeding Programs

As described above, there are three modalities of school feeding in the Dominican Republic: *Urbano Marginal*, *Fronterizo*, and *REAL*. The *Urbano Marginal* program covers by far the largest number of children, and provides a biscuit or bread and a glass of milk daily. The *REAL* and *Fronterizo* programs provide a full meal.¹³

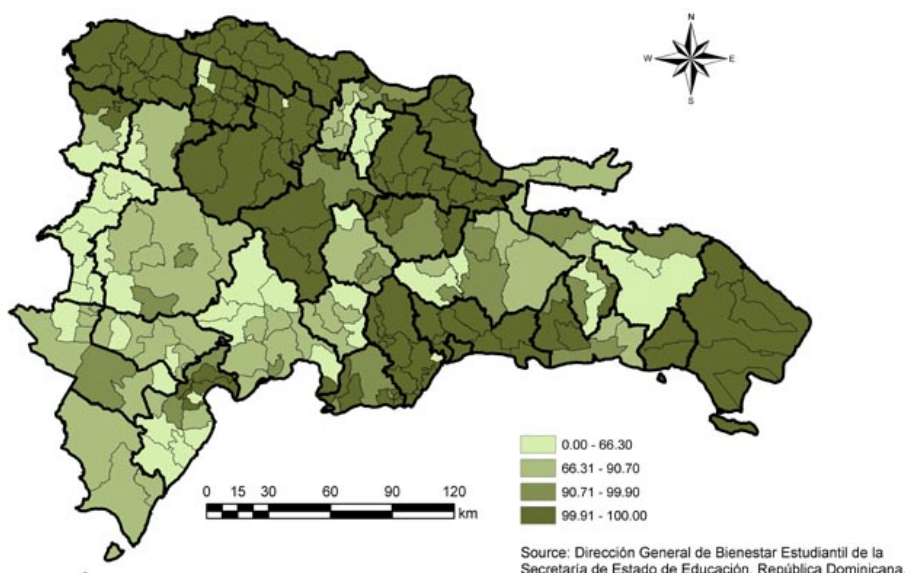
The following two maps show the percentage of children being reached by each type of program, calculated as a percentage of children receiving any school feeding program at all. Given that the coverage is quite high (Saldarriaga, 2005), these figures are a good representation of the percentage of all enrolled children receiving each type of program. According to Saldarriaga (2005), coverage of enrolled children is close to 100 percent. These maps show that there are *municipios* in which both programs operate, but in most of the *municipios*, the school feeding program is very much skewed toward one type or the other.

Full meals are available to the majority of children in the high-prevalence province of Elías Piña and Barahona in the east and southeast, but also in the low prevalence province of El Seibo. Snacks are concentrated in the northern part of the country where malnutrition rates are low, but also in the high prevalence *municipios* of La Vega in the central part of the country. The type of school meal program is determined by administrative considerations, and does not appear to be linked to malnutrition rates.



¹³ The government of the Dominican Republic provides financing for the *Programa Urbano Marginal* and the *Programa REAL*. The World Food Programme provided financing for the *Programa Fronterizo* (Saldarriaga, 2005). In 2005, the Dominican government took responsibility for the *Programa Fronterizo* as well.

Map 26
Percentage of Children Participating in School Feeding Programs
who Receive a Snack (PAE- Urbano-Marginal, 2004-05), by Municipio

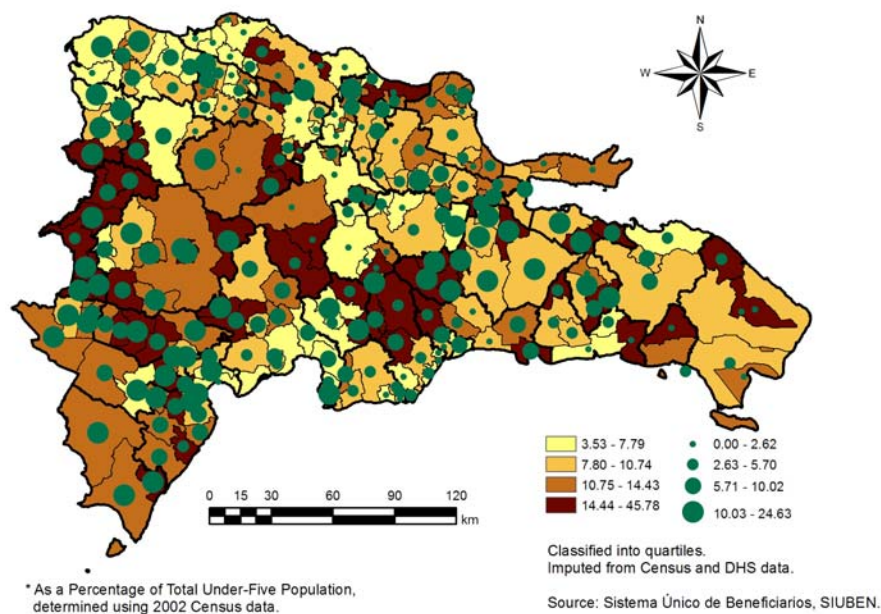


Comer es Primero

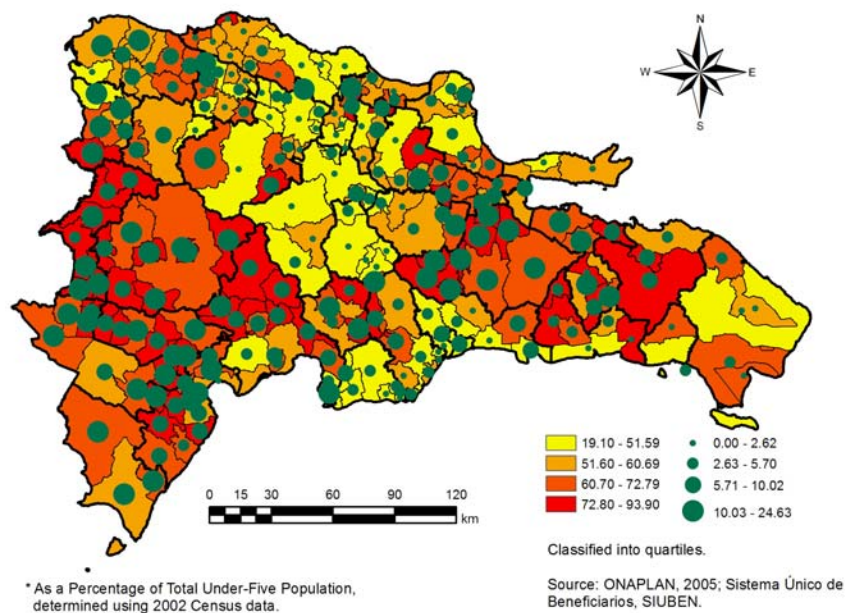
We mentioned above that several food-related initiatives were started after the time when the data were collected on which this report is based. The most important of these is the *Comer es Primero* program, which provides low-income households with a cash transfer by means of a credit card that can be used for the purchase of staple foods and other basic necessities in authorized stores. The following two maps show data from 2005 on the distribution of benefits from this program, superimposed on the maps of malnutrition prevalence and poverty prevalence estimated from 2002 data.

The size of each symbol on the map represents the percentage of children under age five who live in households benefiting from the *Comer es Primero* program. In line with our earlier discussion of the relationship between poverty and malnutrition, it seems that this program is more closely tied to poverty prevalence than it is to our estimate of malnutrition prevalence, particularly in the northwestern part of the country (Dajabón, for example, where poverty and malnutrition prevalence diverge), and in La Vega and Monseñor Nouel, where estimated poverty rates are low while malnutrition rates are high. The program is well distributed throughout the country except in the far eastern provinces, where coverage is low even in the *municipios* with relatively high malnutrition rates. It is not surprising that the coverage of this program is more closely related to poverty than to malnutrition, since the targeting system, SIUBEN, is based on a poverty measure. The World Bank (2006) has suggested that SIUBEN's poverty estimates might be improved with the addition of a proxy means test. These results suggest there might be benefit as well to adding *municipios* with high malnutrition rates to the SIUBEN system of eligibility, even if the poverty rates are lower.

Map 27
Prevalence of Chronic Malnutrition and Children under Five Years of Age*
Whose Families are Beneficiaries of "Comer es Primero" (2005), by Municipio



Map 28
Percentage of Households that are Poor (2002) and Children under Five Years of Age*
Whose Families are Beneficiaries of "Comer es Primero" (2005), by Municipio



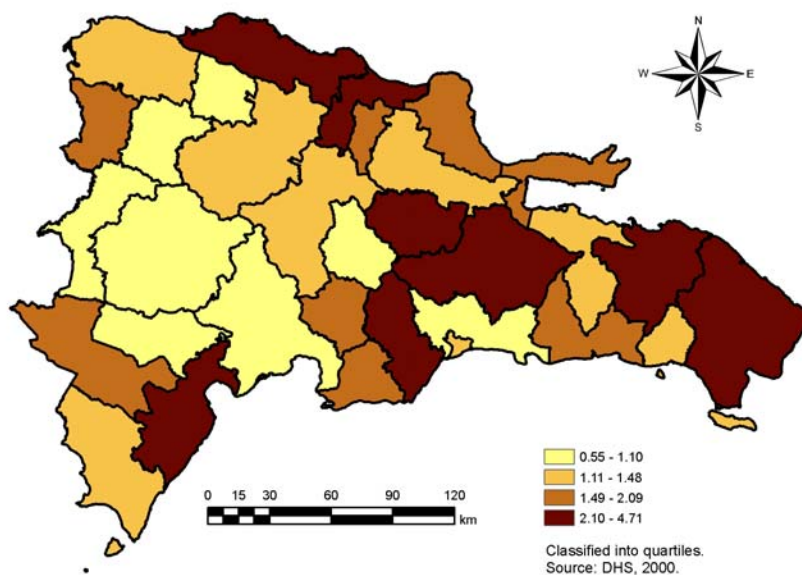
Acute Malnutrition: Low Weight-for-Height

It was discussed briefly above that malnutrition is commonly measured according to three anthropometric indicators. Low height-for-age is a measure of chronic undernutrition resulting from inadequate food consumption, early nutritional insult (including low birth weight), and morbidity over the long term. Low weight-for-height (WHZ) is a measure of acute food shortage or an acute illness that interferes with a child's ability to ingest and metabolize food. The bulk of our discussion has dealt with growth retardation or chronic malnutrition, because that is the condition that is most common in the Dominican Republic. As in most countries of the Latin America and Caribbean region, growth retardation is a far more frequent manifestation of nutritional problems than is excessive thinness. ENDESA reported an overall prevalence of 1.8 percent of children 3 to 59 months suffering from low weight-for-height (Achécár et al., 2003). This is a slight increase from the 1.2 percent reported in 1996, but is still a very low percentage compared to that for low HAZ.

Nonetheless, we conducted the analysis to develop predictions for the prevalence of low WHZ and map its distribution at the level of the *municipio*, using the same common predictors that were used in the estimation of HAZ. Appendix 7 shows the results of the estimation of the predictive equation for WHZ. The amount of explained variance is much lower than was the case for the HAZ equations. The reliability of the *municipio*-level estimates of prevalence is also lower, as indicated by the larger standard errors around the estimate than was the case for HAZ. Excessive thinness is an indicator of an acute nutrition problem, often with causes that are distinct from those for chronic malnutrition. It should not be surprising, then, to see that the distribution of low WHZ is quite different from that for low HAZ, as shown in Map 31. The *municipios* in the northern area of Elías Piña and the southern *municipio* of Dajabón, and much of the mountainous interior, areas of high chronic malnutrition, generally show a low prevalence of acute malnutrition, and there is a surprising cluster of *municipios* along the northern coast in Espaillat and Puerto Plata provinces that show relatively high prevalences of excessive thinness, although they were in the lower quartiles of prevalence of low HAZ. It is particularly worth noting that two *municipios* in the easternmost province of La Altagracia are in the highest quartile of prevalence for both HAZ and WHZ, although the absolute numbers of children identified by either indicator are small. Given the relatively low overall prevalence (average of 4.0 percent for the country according to our estimates), the precision of these estimates is quite low. On-the-ground assessment of the situation would be needed to determine whether a significant problem existed in those areas where the analysis predicts relatively higher prevalences of acute malnutrition.

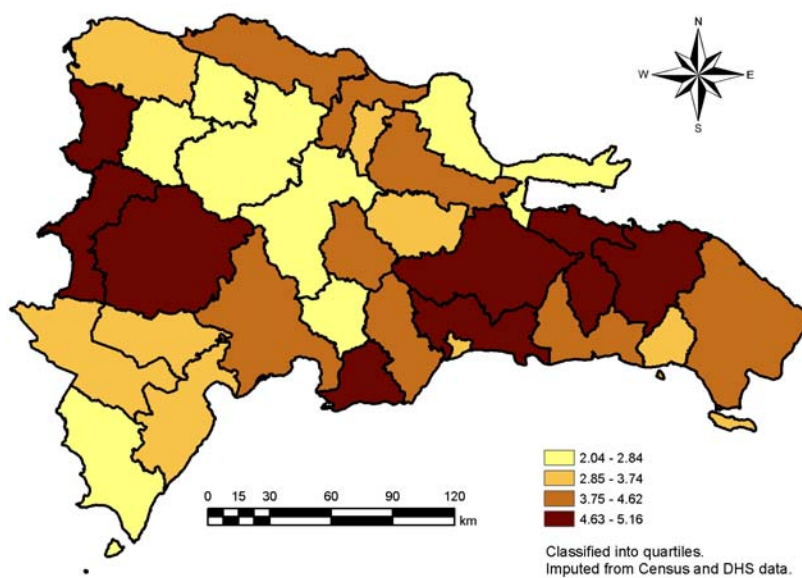
Map 29

Prevalence of Acute Malnutrition: Estimates Based on DHS Survey Data, by Province



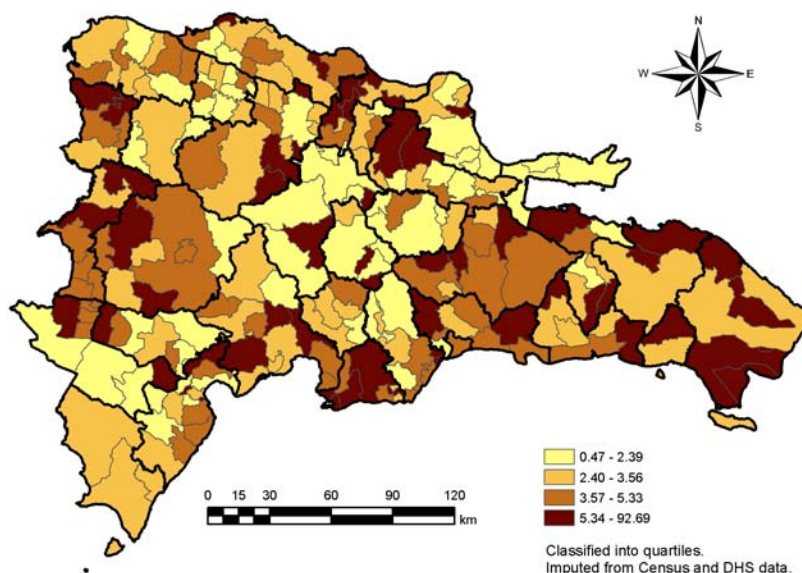
Map 30

Prevalence of Acute Malnutrition: Estimates Based on Small Area Estimation, by Province



Map 31

Prevalence of Acute Malnutrition: Estimates Based on Small Area Estimation, by *Municipio*

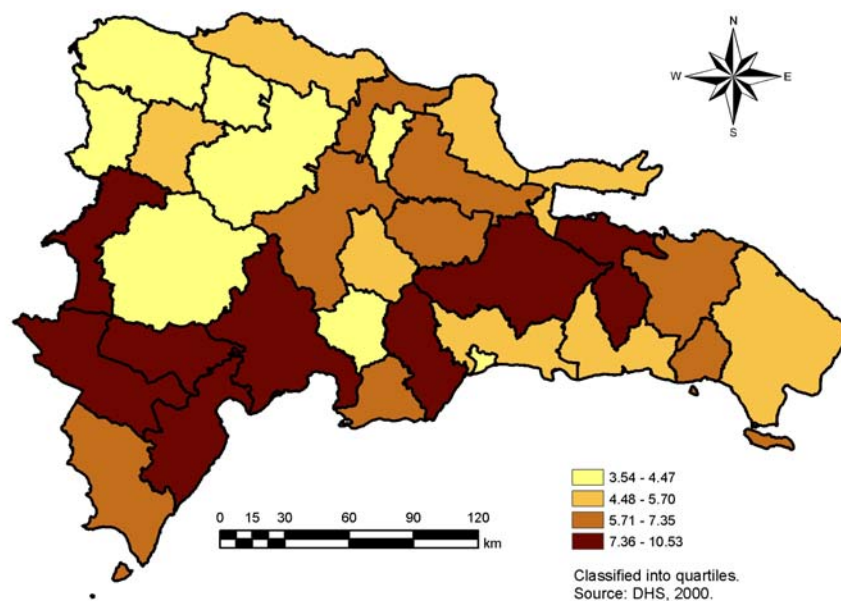


Global Malnutrition: Low Weight-for-Age

It was mentioned above that low weight-for-age (WAZ) is not a very useful tool for the diagnosis of nutrition problems, since it conflates two different measures, that for acute and that for chronic malnutrition. Despite this lack of specificity, global malnutrition is often used in international comparisons of nutritional status because weight and age are easier to measure than height, and therefore WAZ is more widely available. For this reason, we did perform the analysis needed to predict prevalences of low WAZ for the Dominican Republic.

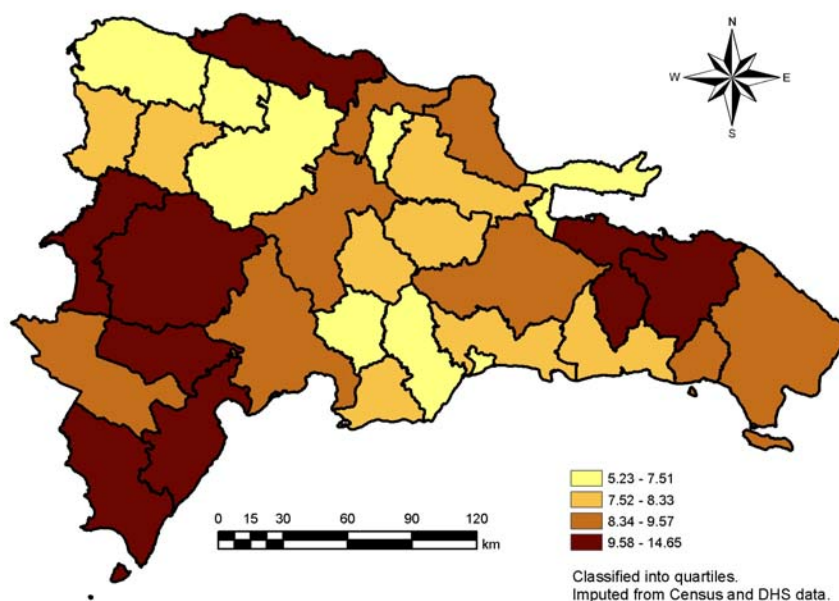
The results of the estimation are presented in Appendix 8, and the distribution of low prevalence by *municipio* is shown in Map 34. Maps 32 and 33 compare province-level estimates by SAE with those from ENDESA. There are few surprises in these maps: areas that showed high prevalence of either low HAZ or low WHZ are reflected in the higher prevalence of global malnutrition.

Map 32
Prevalence of Global Malnutrition: Estimates Based on DHS Survey Data, by Province



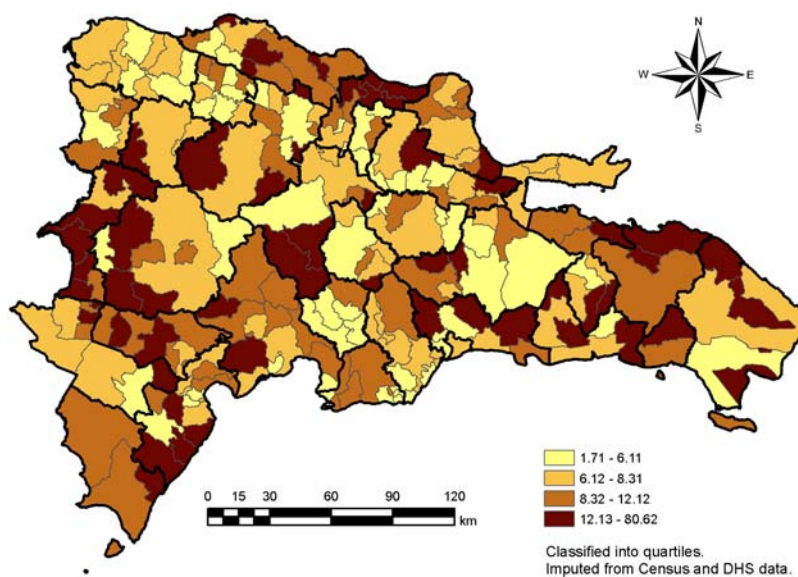
Map 33

Prevalence of Global Malnutrition: Estimates Based on Small Area Estimation, by Province



Map 34

Prevalence of Global Malnutrition: Estimates Based on Small Area Estimation, by *Municipio*



Discussion

These maps present levels of malnutrition and associated characteristics in the Dominican Republic. The results suggest that relatively low average levels of chronic malnutrition nationally mask geographic areas in which higher malnutrition rates merit concern and action. Malnutrition, like poverty, is not distributed evenly across the country or even within a province. It is hardly surprising that high and low prevalence rates fail to conform to administrative boundaries like provinces: clusters of high-prevalence *municipios* cross province boundaries, and even in high-prevalence provinces, there are severely affected areas, and areas in which malnutrition is relatively less prevalent. Dajabón, for example, shows a sharp division between the better off (in terms of malnutrition) northern part and the worse off south. Equally important is the observation that targeting *municipios* based on prevalence rates would miss the majority of malnourished children in the country. The greatest numbers of malnourished children, according to our estimates, are in the few larger cities where the percentages are relatively low. This means that to address malnutrition in the country, a dual strategy is called for: reaching children in urban areas with targeted interventions designed to meet their specific needs, and developing a different set of interventions for malnourished children in the more remote and rural areas where prevalences are higher and narrow targeting may be less of a concern. Within the cities, further analysis at the *barrio* level (as was done in the Atlas of Poverty, ONAPLAN 1993) would help to target interventions.

Poverty rates are somewhat correlated with malnutrition prevalence, but there is significant divergence between the two. Of the 225 *municipios* in the country, 47 show poverty rates that diverge by more than two quartiles from the rates of malnutrition. This is important for targeting: targeting a nutrition intervention based solely on poverty would miss *municipios* with a significant number of malnourished children. The Dominican Republic has a system for targeting social programs, the *Sistema Único de Beneficiarios- Índice de Condiciones de Vida* (SIUBEN - ICV), which is based on assessment of poverty rates by *municipio* and *barrio*. The results of nutrition mapping can be used for targeting by identifying *municipios* in which malnutrition prevalence is high even while poverty prevalence is relatively low. These *municipios* should probably be identified as high priority for SIUBEN to investigate using a house-by-house assessment of program eligibility. This is particularly relevant for the use of SIUBEN in identifying beneficiaries for the transfer program, *Comer es Primero*, that delivers a monthly cash benefit for food purchases of needy families.

Direct interpretation of the results of the multivariate analysis is risky because the goal of the model is prediction, not interpretation of individual coefficients. Any specific interventions would need to be designed based on a local situation assessment. The present analysis was restricted to variables included in both the Census and ENDESA, and variables that could be added to both data sets. Therefore, many factors known to be associated with child malnutrition, such as maternal knowledge and caring practices, or food access and availability, for example, could not be included in our estimation model.

We found that health centers are well distributed throughout the country, and that school feeding programs are widely available, including in the areas most subject to malnutrition. *Municipios* with easier access to a hospital had lower rates of malnutrition, as did *municipios* well served by

health centers. Most of the country, with the exception of the mountainous center, is well served by roads, and road access was associated with better nutritional status. Mountainous terrain (elevation and slope) and location near the border with Haiti were both found to be associated with poorer growth, and both these factors are associated with poorer roads and transportation.

Ethnic diversity (percentage of the population of Haitian extraction) did show an association with prevalence of malnutrition at the *municipio* level, though the association was weak and inconsistent across development zones. With data only at the community level, though, there is a risk of committing the “ecological fallacy”: for a given level of malnutrition in a community, we cannot say whether individuals of Haitian origin are more likely to be malnourished or not. In an area with a low percentage of Haitians in the population, there might be a low prevalence of malnutrition, but we cannot say if the prevalence is equally low among the Haitian and non-Haitian populations. Our data suggest that persons of Haitian origin are far more likely to live in households with low economic status, as indicated by an index of possessions, housing quality, and services.

Similarly, the level of economic inequality, as measured by variability in the distribution of an index of economic status, showed no clear relationship with malnutrition prevalence. This is not so surprising: inequality in itself might indicate a problem of social exclusion of the poor, but it is possible that households of poor economic status and lacking basic necessities are more likely to have malnourished children than better off households, irrespective of whether they are surrounded by richer households.

The fact that girls are less likely to be malnourished than boys is an indicator that the common pattern of gender discrimination is not practiced, though we have no explanation for the fact that boys are actually somewhat worse off than girls in terms of chronic malnutrition.

Assessment of the nutritional situation and its determinants in the Dominican Republic could be improved with better information. While reliable data on the growth of children is available on a regular basis from ENDESA, information on adults is lacking, and there is no source of information on patterns of food consumption, dietary quality or adequacy, nor on local food availability. In the Dominican Republic, acute malnutrition is rare, and the rate of chronic malnutrition is declining, but a significant proportion of the population lives below the poverty line. This means that micronutrient adequacy due to a poor quality diet may be a greater problem than growth retardation. Data on food consumption, and direct measurement of micronutrient status, would permit an assessment of this situation.

We were surprised to find no available information on food prices at the local level, although availability of price information at the national level suggests that such data are collected. Information on the volatility of prices, seasonally and year-to-year, would indicate the degree to which improvements in market function might contribute to improvements in nutrition.

This report is based on survey and census data collected in 2002. We were fortunate to find appropriate survey and census data collected at the same time, in order to produce estimates of malnutrition rates. However, the Dominican Republic has experienced great economic changes since 2002: the economic crisis of 2003-04 resulted in high inflation, currency devaluation, a

severe economic contraction, and increased unemployment and poverty – all factors that would be expected to make the nutrition situation worse by reducing purchasing power and thus access to an adequate diet. While the economy is now recovering, analysis of the prevalence of malnutrition using more recent data, and concomitant mapping efforts, would be valuable for assessing the consequences of the economic crisis for nutritional well-being.

One motivation for undertaking this project was to be able to monitor progress toward the achievement of the Millennium Development Goals related to hunger. Updating the data on which the maps are based, based on the new ENDESA survey currently being implemented, for example, is critical to this objective.

Recommendations and Next Steps

Updating the maps with more current data is a high priority, given the many changes that have taken place since 2002. Not only was there a severe economic crisis in 2003-04, but also a new government that took office in May of 2004, and several new food-based programs implemented by the new government. There may well have been significant changes in the prevalence of malnutrition in the intervening years. The 2007 ENDESA will provide updated information that could be used to develop a new predictive model, though new census data will not be available for some time.

In this context, it would be important to identify an institution – whether government entity, academic or donor institution – to take responsibility for future such mapping efforts. Capacity building is an essential element in this process. In the development of the next generation of maps describing the nutritional situation of the country, professional staff of the selected agency or agencies should work with people experienced in the statistical analysis and geographic information techniques used to develop estimates of malnutrition prevalence, so that in future, that capacity will reside in the country, and not be dependent on external support.

The development of a formal training program that would cover the implementation of the specific techniques used to match census and survey data, development of malnutrition estimates, and mapping of the results, is planned as part of the larger Nutrition and Food Security Mapping Project. Such training would increase the potential of institutional capacity building. In this process, we expect that some of the statistical challenges encountered in the present effort will be resolved, to allow more flexibility in the design of the model and in the estimation process. The key is to ensure that there are sufficient trained professionals to maintain the capacity to undertake this kind of analysis.

If monitoring the nutrition situation in the Dominican Republic is indeed a priority, then it would be extremely useful to have a wider range of food and nutrition related information than is currently available in the country. Specifically, information on the anthropometric status of adults (BMI) as well as children, and information on food consumption patterns of individuals, would give a more complete picture of nutrition, food insecurity, and their determinants. If a nationally-representative sample survey were to be undertaken for this purpose, the direct biochemical assessment of micronutrient status through biological samples would be an

important tool to validate conclusions drawn by analyzing food consumption. In a middle-income country like the Dominican Republic, dietary quality and micronutrient status are likely to be problems as important to the health and well-being of the population as is chronic undernutrition. And more effective policies can be designed based on specific knowledge of what foods the population consumes, and where they obtain their food.

Current systems for identifying the beneficiaries of food-related programs like *Comer es Primero* depend on assessments of poverty. While this is a useful first cut at targeting transfer programs, SIUBEN might consider ways to incorporate, in a systematic way, the results of this and future nutrition maps, to ensure that malnourished populations living in communities with relatively lower rates of measured poverty are not excluded from the benefits they need to ensure adequate food consumption and nutritional status.

We have identified areas in which data are difficult to find or lacking. Among these are information on the variability of food prices over time, and more disaggregated and detailed data on climate, land use, and related environmental factors. It should be possible to find such data with some additional effort.

The Dominican Republic is making significant progress in improving the health and nutritional status of its people. We hope that tools such as the Hunger Maps may contribute to the design of programs and policies that assist in continuing that positive trend.

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Appendices

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Appendix 1: Estimates of Prevalence of Chronic Malnutrition among 6 to 59 Month-Olds Compared to Prevalence of Poverty, by *Municipio*

Province	<i>Municipio</i>	Prevalence of Chronic Malnutrition (HAZ < -2 z-scores)	Standard Error of the Estimate	Prevalence of Poverty ^a
Azua	Azua de Compostela	6.87	0.013	53.40
	Guayabal	12.19	0.049	81.80
	Las Charcas	4.44	0.016	68.60
	Las Yayas de Viajama	16.31	0.033	82.50
	Padre Las Casas	10.42	0.023	75.60
	Peralta	12.36	0.040	78.00
	Nuevo Sabana Yegua	9.06	0.018	49.00
	Villa Tabara Arriba	9.79	0.038	61.90
	Estebania	4.76	0.015	74.70
	Pueblo Viejo	7.90	0.024	64.50
	Palmar de Ocoa	5.63	0.019	35.50
	Villarpando	24.04	0.065	87.10
Baoruco	Neiba	20.19	0.021	70.00
	Galvan	18.85	0.027	80.30
	Los Rios	12.91	0.022	77.30
	Tamayo	10.79	0.027	64.70
	Ubilla	10.51	0.021	73.40
	Villa Jaragua	15.32	0.023	82.50
	El Palmar	11.90	0.022	87.60
Barahona	Santa Cruz de Barahona	8.24	0.014	54.30
	Cabral	17.76	0.029	73.50
	Enriquillo	13.95	0.031	71.40
	Las Salinas	13.76	0.039	77.20
	Paraiso	19.29	0.041	67.90
	Polo	11.04	0.049	84.50
	Vicente Noble	8.89	0.023	64.20
	El Penon	16.33	0.062	66.50
	Fundacion	8.25	0.028	71.50
	La Cienaga	12.62	0.032	74.60
	Canoa	4.78	0.021	68.60
	Jaquimeyes	7.51	0.038	57.80
	El Cachon	7.01	0.027	70.50
	Pescaderia	5.20	0.020	52.00
Dajabón	Dajabón	6.63	0.013	47.00
	Loma de Cabrera	8.71	0.017	61.60
	Partido	7.42	0.023	54.40
	Restauracion	14.46	0.040	80.10
	El Pino	12.27	0.027	58.30
Duarte	San Francisco de Macoris	8.61	0.013	38.30
	Arenoso	12.96	0.027	67.40

**Appendix 1 (continued): Estimates of Prevalence of Chronic Malnutrition among 6 to 59 Month-Olds
Compared to Prevalence of Poverty, by *Municipio***

Province	<i>Municipio</i>	Prevalence of Chronic Malnutrition (HAZ < -2 z-scores)	Standard Error of the Estimate	Prevalence of Poverty ^a
Duarte (con't)	Castillo	8.90	0.018	61.40
	Hostos	13.99	0.036	76.90
	Pimentel	9.64	0.019	59.70
	Villa Riva	9.02	0.016	63.30
	Las Guaranas	9.24	0.028	55.00
	Agua Santa del Yuna	13.83	0.031	59.70
	Cristo Rey de Guaraguo	15.01	0.031	64.60
	La Pena	12.95	0.038	77.10
	Cenovi	8.55	0.016	56.60
Elías Piña	Comendador	14.59	0.028	74.80
	Banica	15.63	0.040	83.70
	El Llano	31.40	0.071	85.50
	Hondo Valle	20.85	0.038	89.50
	Pedro Santana	16.06	0.051	81.50
	Juan Santiago	19.14	0.046	93.90
	Rio Limpio	28.51	0.084	90.40
El Seibo	El Seibo	8.62	0.019	74.00
	Miches	7.75	0.028	55.60
	Pedro Sanchez	8.13	0.109	79.50
Españillat	Moca	7.80	0.013	34.70
	Cayetano Germosen	3.53	0.019	46.80
	Gaspar Hernandez	14.84	0.049	57.00*
	Jose Contreras	12.31	0.063	79.80
	Jamao al Norte	13.60	0.049	62.80
	San Victor	6.48	0.029	53.50
	Joba Arriba	14.26	0.073	71.60
	Veragua	7.23	0.034	57.70
	Juan Lopez	11.18	0.040	32.70*
Independencia	Jimani	13.43	0.026	70.20
	Duverge	13.02	0.024	58.60
	La Descubierta	8.09	0.020	71.10
	Mella	6.67	0.031	65.60
	Postrer Rio	10.98	0.027	84.20
	Cristobal	24.89	0.037	84.30
	Guayabal	13.84	0.029	87.20
La Altagracia	Salvaleon de Higüey	9.74	0.018	45.00
	San Rafael del Yuma	10.32	0.037	70.10
	Las Lagunas de Nisibon	17.11	0.055	65.60*
	La Otra Banda	21.79	0.089	53.20*
	Boca de Yuma	13.83	0.227	62.10

**Appendix 1 (continued): Estimates of Prevalence of Chronic Malnutrition among 6 to 59 Month-Olds
Compared to Prevalence of Poverty, by *Municipio***

Province	<i>Municipio</i>	Prevalence of Chronic Malnutrition (HAZ < -2 z-scores)	Standard Error of the Estimate	Prevalence of Poverty ^a
La Romana	La Romana	11.52	0.026	40.80*
	Guaymate	24.13	0.060	68.10
La Vega	Concepcion de La Vega	6.72	0.013	38.40
	Constanza	22.95	0.055	51.10*
	Jarabacoa	11.70	0.022	49.90
	Jima Abajo	11.02	0.036	47.80*
	Tireo	36.98	0.117	55.10*
	Rio Verde Arriba	12.18	0.036	42.20*
	Rincon	31.98	0.172	52.10*
María Trinidad Sánchez	Nagua	8.85	0.012	49.60
	Cabrera	11.73	0.031	41.20*
	El Factor	8.59	0.018	64.10
	Rio San Juan	13.37	0.023	56.70
	San Jose de Matanzas	12.37	0.030	72.10
	Arroyo Salado	9.87	0.021	56.00
	La Entrada	10.79	0.025	54.00*
	El Pozo	11.60	0.024	56.80
Monte Cristi	San Fernando de Monte Cristi	7.01	0.018	53.50
	Castanuelas	12.29	0.032	55.60
	Guayubin	7.10	0.024	52.80
	Las Matas de Santa Cruz	9.12	0.021	55.80
	Pepillo Salcedo	7.36	0.020	47.90
	Villa Vasquez	10.65	0.025	60.70
	Villa Elisa	6.33	0.023	64.80
	Hatillo Palma	5.74	0.019	68.60
	Cana Chapeton	7.85	0.017	63.80
Pedernales	Pedernales	14.10	0.023	61.00
	Oviedo	12.50	0.030	55.80
	Juancho	21.66	0.041	64.40
Peravia	Bani	9.96	0.014	45.60
	Nizao	8.30	0.022	35.90
	Matanzas	7.89	0.023	45.50
	Fundacion de Sabana Buey	13.87	0.034	51.60*
	Sabana Buey	7.52	0.037	60.90
	Pizarrete	8.36	0.023	55.60
	Santana	4.91	0.014	41.50
	Paya	5.35	0.018	46.30
Puerto Plata	San Felipe de Puerto Plata	9.53	0.018	36.70
	Altamira	13.91	0.046	69.70
	Guananico	6.00	0.049	59.50

**Appendix 1 (continued): Estimates of Prevalence of Chronic Malnutrition among 6 to 59 Month-Olds
Compared to Prevalence of Poverty, by *Municipio***

Province	<i>Municipio</i>	Prevalence of Chronic Malnutrition (HAZ < -2 z-scores)	Standard Error of the Estimate	Prevalence of Poverty ^a
Puerto Plata (con't)	Imbert	16.91	0.046	55.20*
	Los Hidalgos	6.27	0.033	56.20
	Luperon	4.19	0.021	59.60
	Sosua	7.37	0.020	32.90
	Villa Isabela	4.67	0.021	60.50
	Villa Monte Llano	17.09	0.091	46.50*
	Estero Hondo	5.01	0.034	65.10
	La Isabela	13.22	0.099	77.10
Salcedo	Salcedo	9.43	0.014	45.50
	Tenares	7.89	0.014	53.50
	Villa Tapia	8.20	0.015	59.70
	Blanco	7.45	0.021	80.20
Samaná	Santa Barbara de Samana	11.63	0.016	58.10
	Sanchez	9.19	0.014	56.00
	Las Terrenas	12.09	0.019	49.40*
San Cristóbal	San Cristobal	8.28	0.014	41.90
	Bajos de Haina	7.67	0.017	32.10
	Los Cacaos	33.84	0.102	81.80
	Cambita Garabitos	14.96	0.045	71.40
	San Gregorio de Nigua	3.79	0.012	56.00
	Sabana Grande de Palenque	4.72	0.016	31.50
	Yaguata	4.41	0.012	55.60
	Villa Altagracia	19.75	0.040	57.90*
	El Carril	3.81	0.014	34.60
San Juan	San Juan de La Maguana	12.36	0.019	63.50
	Bohechio	15.17	0.055	77.90
	El Cercado	15.27	0.043	87.80
	Juan de Herrera	19.18	0.048	75.00
	Las Matas de Farfan	10.75	0.032	68.80
	Vallejuelo	11.70	0.036	87.30
	Matayaya	4.43	0.021	87.90
	Pedro Corto	12.10	0.060	84.10
San Pedro de Macorís	San Pedro de Macoris	5.24	0.012	41.60
	San Jose de Los Llanos	9.77	0.040	73.60
	Ramon Santana	22.34	0.086	73.80
	Consuelo	6.06	0.023	51.90
	Quisqueya	10.61	0.032	61.80
	El Puerto	16.69	0.100	75.40
Sánchez Ramírez	Cotui	10.13	0.020	52.10
	Cevicos	5.81	0.024	72.80

**Appendix 1 (continued): Estimates of Prevalence of Chronic Malnutrition among 6 to 59 Month-Olds
Compared to Prevalence of Poverty, by *Municipio***

Province	<i>Municipio</i>	Prevalence of Chronic Malnutrition (HAZ < -2 z-scores)	Standard Error of the Estimate	Prevalence of Poverty ^a
Sánchez Ramírez (con't)	Fantino	5.63	0.018	45.90
	La Cueva	7.52	0.031	60.60
	La Mata	6.41	0.017	54.20
Santiago	Santiago de Los Caballeros	6.58	0.012	19.90
	Bisono	11.78	0.034	42.50*
	Janico	17.28	0.064	62.60
	Licey al Medio	5.70	0.024	27.10
	San Jose de las Matas	14.44	0.050	51.10
	Tamboril	10.71	0.027	37.70
	Villa Gonzalez	21.35	0.060	44.40*
	Pedro Garcia	15.07	0.083	70.30
	Sabana Iglesia	8.55	0.047	52.50
	Baitoa	16.76	0.091	58.00*
	La Canela	9.52	0.032	36.80
	Canafistol	13.97	0.067	72.40
	Juncalito	15.29	0.120	82.60
	Palmar Arriba	11.44	0.048	53.30*
Santiago Rodríguez	San Ignacio de Sabaneta	7.54	0.015	59.30
	Villa Los Almacigos	17.75	0.046	71.70
	Moncion	10.15	0.017	43.20
Valverde	Mao	3.72	0.012	42.10
	Esperanza	5.76	0.015	51.60
	Laguna Salada	9.20	0.021	51.10
	Amina	9.78	0.019	51.80
	Maizal	7.21	0.017	57.10
	Jaibon (Pueblo Nuevo)	11.19	0.030	70.10
	Guatapanal	11.69	0.029	62.90
	Jicome	11.45	0.032	58.30
	Jaibon	11.77	0.039	65.20
	La Caya	9.95	0.037	60.40
Monseñor Nouel	Monseñor Nouel	6.32	0.012	32.70
	Maimon	10.91	0.028	48.70*
	Piedra Blanca	17.71	0.045	51.40*
	Villa de Sonador	6.69	0.022	39.80
	Jima (Sabana del Puerto)	7.41	0.026	44.70
	Juan Adrian	13.80	0.194	72.30
Monte Plata	Monte Plata	10.11	0.026	64.80
	Bayaguana	9.38	0.023	68.40
	Sabana Grande de Boya	8.89	0.026	73.80
	Yamasa	19.42	0.045	75.30

**Appendix 1 (continued): Estimates of Prevalence of Chronic Malnutrition among 6 to 59 Month-Olds
Compared to Prevalence of Poverty, by *Municipio***

Province	<i>Municipio</i>	Prevalence of Chronic Malnutrition (HAZ < -2 z-scores)	Standard Error of the Estimate	Prevalence of Poverty ^a
Monte Plata (con't)	Don Juan	27.61	0.064	75.40
	Esperalvillo	18.70	0.062	80.90
	Gonzalo	16.42	0.058	92.80
	Los Botados	16.84	0.074	82.90
	Majagual	9.16	0.051	84.10
Hato Mayor	Hato Mayor del Rey	9.41	0.019	54.00
	Sabana de La Mar	9.10	0.022	61.60
	El Valle	15.09	0.062	69.70
	Elupina Cordero	45.78	0.218	74.50
	Yerba Buena	11.99	0.096	83.70
	Mata Palacio	14.83	0.057	91.50
	Guayabo Dulce	23.88	0.069	71.60
San José de Ocoa	San Jose de Ocoa	7.41	0.015	57.40
	Sabana Larga	6.69	0.017	70.30
	Rancho Arriba	20.40	0.049	81.40
	La Cienaga	14.93	0.051	82.00
Santo Domingo	Santo Domingo Este	8.84	0.016	19.10
	Guerra	13.92	0.107	64.20
	Santo Domingo Oeste	8.56	0.015	20.70
	Los Alcarrizos	7.29	0.020	37.70
	Pedro Brand	19.72	0.224	50.10*
	Santo Domingo Norte	12.76	0.034	30.90*
	La Victoria	10.52	0.107	57.40
	Boca Chica	36.52	0.074	41.20*
	Distrito Nacional	7.00	0.012	19.70

^a 2002 Poverty data obtained from ONAPLAN. Both malnutrition prevalence estimates and poverty prevalence rates were classified into quartiles. Bolded prevalence rates indicate a discordance between quartile classifications characterized by malnutrition prevalence estimates that are one or more quartiles above those of poverty.

* Indicates a discordance of two or more quartiles.

Appendix 2: Estimates of Prevalence of Malnutrition among 6 to 59 Month-Olds, by *Municipio*

Province	<i>Municipio</i>	Chronic Malnutrition (HAZ < -2)	Number of Children Chronically Malnourished	Acute Malnutrition (WHZ < -2)	Global Malnutrition (WAZ < -2)
Azua	Azua de Compostela	6.87	626	3.48	7.26
	Guayabal	12.19	69	1.95	8.98
	Las Charcas	4.44	38	3.77	8.97
	Las Yayas de Viajama	16.31	184	3.49	8.59
	Padre Las Casas	10.42	261	3.34	10.98
	Peralta	12.36	152	6.28	11.45
	Nuevo Sabana Yegua	9.06	227	5.64	13.02
	Villa Tabara Arriba	9.79	120	4.21	7.12
	Estebania	4.76	43	6.09	9.95
	Pueblo Viejo	7.90	89	2.76	1.83
	Palmar de Ocoa	5.63	17	4.03	5.62
	Villarando	24.04	199	4.82	15.56
Baoruco	Neiba	20.19	582	1.77	9.84
	Galvan	18.85	311	3.48	12.58
	Los Rios	12.91	122	7.83	9.11
	Tamayo	10.79	121	0.91	10.03
	Ubilla	10.51	172	1.38	8.00
	Villa Jaragua	15.32	210	4.70	14.22
	El Palmar	11.90	137	4.31	8.72
Barahona	Santa Cruz de Barahona	8.24	710	3.90	8.16
	Cabral	17.76	300	3.29	14.74
	Enriquillo	13.95	214	3.04	19.47
	Las Salinas	13.76	77	1.61	10.27
	Paraiso	19.29	346	4.64	20.51
	Polo	11.04	115	0.61	5.26
	Vicente Noble	8.89	150	5.82	7.93
	El Penon	16.33	74	0.47	6.71
	Fundacion	8.25	37	6.34	6.58
	La Cienaga	12.62	127	5.06	16.09
	Canoa	4.78	20	5.27	10.03
	Jaquimeyes	7.51	33	0.67	9.24
	El Cachon	7.01	16	2.23	6.08
	Pescaderia	5.20	20	3.57	5.46
Dajabón	Dajabón	6.63	176	5.36	7.62
	Loma de Cabrera	8.71	138	4.18	5.94
	Partido	7.42	46	6.45	8.57
	Restauracion	14.46	115	2.67	10.67
	El Pino	12.27	69	3.83	7.10
Duarte	San Francisco de Macoris	8.61	1282	5.82	8.12
	Arenoso	12.96	193	3.11	13.79

Appendix 2 (continued): Estimates of Prevalence of Malnutrition among 6 to 59 Month-Olds, by *Municipio*

Province	<i>Municipio</i>	Chronic Malnutrition (HAZ < -2)	Number of Children Chronically Malnourished	Acute Malnutrition (WHZ < -2)	Global Malnutrition (WAZ < -2)
Duarte (con't)	Castillo	8.90	120	2.06	3.07
	Hostos	13.99	71	5.33	10.26
	Pimentel	9.64	168	2.70	3.02
	Villa Riva	9.02	158	1.90	6.62
	Las Guaranas	9.24	110	0.79	2.65
	Agua Santa del Yuna	13.83	72	2.08	6.26
	Cristo Rey de Guaraguo	15.01	126	3.78	10.33
	La Pena	12.95	147	6.10	14.90
	Cenovi	8.55	121	2.43	5.14
Elías Piña	Comendador	14.59	446	4.91	12.67
	Banica	15.63	116	5.54	15.15
	El Llano	31.40	333	4.51	19.89
	Hondo Valle	20.85	237	4.63	15.95
	Pedro Santana	16.06	88	3.02	6.56
	Juan Santiago	19.14	99	4.32	8.62
	Rio Limpio	28.51	148	7.53	26.56
El Seibo	El Seibo	8.62	577	3.00	9.23
	Miches	7.75	184	8.64	13.41
	Pedro Sanchez	8.13	33	9.20	28.17
Españat	Moca	7.80	906	3.72	7.46
	Cayetano Germosen	3.53	21	2.24	4.02
	Gaspar Hernandez	14.84	280	2.89	12.28
	Jose Contreras	12.31	62	5.89	10.31
	Jamao al Norte	13.60	98	7.33	12.19
	San Victor	6.48	131	5.67	8.74
	Joba Arriba	14.26	52	5.75	21.15
	Veragua	7.23	107	12.15	19.96
	Juan Lopez	11.18	135	2.84	4.58
Independencia	Jimani	13.43	181	2.40	6.65
	Duverte	13.02	280	1.80	6.35
	La Descubierta	8.09	63	6.26	6.57
	Mella	6.67	16	1.64	3.47
	Postrer Rio	10.98	42	4.45	11.52
	Cristobal	24.89	198	6.02	22.50
	Guayabal	13.84	51	4.61	18.09
La Altagracia	Salvaleon de Higüey	9.74	1422	2.70	7.75
	San Rafael del Yuma	10.32	176	5.43	4.64
	Las Lagunas de Nisibon	17.11	153	9.47	23.70
	La Otra Banda	21.79	312	16.34	22.18
	Boca de Yuma	13.83	38	10.93	13.88

Appendix 2 (continued): Estimates of Prevalence of Malnutrition among 6 to 59 Month-Olds, by *Municipio*

Province	<i>Municipio</i>	Chronic Malnutrition (HAZ < -2)	Number of Children Chronically Malnourished	Acute Malnutrition (WHZ < -2)	Global Malnutrition (WAZ < -2)
La Romana	La Romana	11.52	2424	2.58	8.50
	Guaymate	24.13	509	7.59	20.35
La Vega	Concepcion de La Vega	6.72	1361	1.31	7.06
	Constanza	22.95	1002	2.32	15.45
	Jarabacoa	11.70	624	1.67	5.06
	Jima Abajo	11.02	142	8.55	19.79
	Tireo	36.98	561	7.14	25.95
	Rio Verde Arriba	12.18	244	1.54	7.59
	Rincon	31.98	349	2.28	9.25
María Trinidad Sánchez	Nagua	8.85	449	2.02	7.53
	Cabrera	11.73	119	2.08	6.37
	El Factor	8.59	116	1.57	7.72
	Rio San Juan	13.37	190	2.87	9.63
	San Jose de Matanzas	12.37	150	1.98	13.23
	Arroyo Salado	9.87	69	6.83	9.89
	La Entrada	10.79	54	2.59	9.33
	El Pozo	11.60	133	0.87	8.74
Monte Cristi	San Fernando de Monte Cristi	7.01	161	3.47	6.93
	Castanuelas	12.29	148	4.01	7.08
	Guayubin	7.10	41	2.66	6.80
	Las Matas de Santa Cruz	9.12	157	2.47	4.55
	Pepillo Salcedo	7.36	69	4.53	7.84
	Villa Vasquez	10.65	160	1.40	3.86
	Villa Elisa	6.33	36	3.90	8.32
	Hatillo Palma	5.74	48	4.39	5.10
	Cana Chapeton	7.85	60	1.38	3.41
Pedernales	Pedernales	14.10	227	2.60	8.66
	Oviedo	12.50	55	2.68	11.83
	Juancho	21.66	109	2.46	17.21
Peravia	Bani	9.96	1086	5.37	9.10
	Nizao	8.30	103	2.81	2.25
	Matanzas	7.89	129	6.84	8.60
	Fundacion de Sabana Buey	13.87	120	4.33	8.62
	Sabana Buey	7.52	12	10.26	1.75
	Pizarrete	8.36	49	2.74	5.28
	Santana	4.91	38	5.86	5.32
	Paya	5.35	75	4.11	5.88
Puerto Plata	San Felipe de Puerto Plata	9.53	1233	2.74	10.15
	Altamira	13.91	283	3.24	10.61
	Guananico	6.00	28	5.04	13.71

Appendix 2 (continued): Estimates of Prevalence of Malnutrition among 6 to 59 Month-Olds, by *Municipio*

Province	<i>Municipio</i>	Chronic Malnutrition (HAZ < -2)	Number of Children Chronically Malnourished	Acute Malnutrition (WHZ < -2)	Global Malnutrition (WAZ < -2)
Puerto Plata (con't)	Imbert	16.91	377	4.02	12.46
	Los Hidalgos	6.27	76	2.24	5.94
	Luperon	4.19	60	3.43	7.20
	Sosua	7.37	344	3.95	8.84
	Villa Isabela	4.67	55	1.49	6.07
	Villa Monte Llano	17.09	311	12.96	19.17
	Estero Hondo	5.01	17	4.24	11.71
	La Isabela	13.22	18	8.96	17.46
Salcedo	Salcedo	9.43	326	2.84	5.53
	Tenares	7.89	184	3.59	8.51
	Villa Tapia	8.20	168	2.86	5.94
	Blanco	7.45	36	1.98	2.65
Samaná	Santa Barbara de Samana	11.63	618	2.15	7.03
	Sanchez	9.19	231	2.35	7.60
	Las Terrenas	12.09	187	2.23	8.22
San Cristóbal	San Cristobal	8.28	1967	4.67	8.03
	Bajos de Haina	7.67	716	6.93	8.06
	Los Cacaos	33.84	260	1.13	7.33
	Cambita Garabitos	14.96	489	2.54	7.21
	San Gregorio de Nigua	3.79	125	4.73	3.19
	Sabana Grande de Palenque	4.72	81	3.67	2.77
	Yaguate	4.41	196	2.29	1.77
	Villa Altagracia	19.75	1919	2.27	10.65
	El Carril	3.81	152	10.01	7.93
San Juan	San Juan de La Maguana	12.36	1616	4.49	7.79
	Bohechio	15.17	150	1.34	4.84
	El Cercado	15.27	424	2.54	12.44
	Juan de Herrera	19.18	241	4.01	10.24
	Las Matas de Farfan	10.75	420	9.04	14.97
	Vallejuelo	11.70	139	6.71	12.23
	Matayaya	4.43	44	4.30	5.40
	Pedro Corto	12.10	80	3.02	12.13
San Pedro de Macorís	San Pedro de Macoris	5.24	1168	3.96	6.87
	San Jose de Los Llanos	9.77	232	3.28	8.02
	Ramon Santana	22.34	233	5.74	20.63
	Consuelo	6.06	205	3.03	3.91
	Quisqueya	10.61	216	3.57	12.33
	El Puerto	16.69	80	22.66	26.48
Sánchez Ramírez	Cotui	10.13	714	2.37	8.12
	Cevicos	5.81	59	3.30	6.07

Appendix 2 (continued): Estimates of Prevalence of Malnutrition among 6 to 59 Month-Olds, by *Municipio*

Province	<i>Municipio</i>	Chronic Malnutrition (HAZ < -2)	Number of Children Chronically Malnourished	Acute Malnutrition (WHZ < -2)	Global Malnutrition (WAZ < -2)
Sánchez Ramírez (con't)	Fantino	5.63	112	1.44	5.34
	La Cueva	7.52	41	0.66	2.00
	La Mata	6.41	252	5.34	11.47
Santiago	Santiago de Los Caballeros	6.58	3740	2.13	3.58
	Bisono	11.78	526	2.47	5.05
	Janico	17.28	215	5.40	8.39
	Licey al Medio	5.70	139	3.22	9.68
	San Jose de las Matas	14.44	434	3.57	8.20
	Tamboril	10.71	503	3.15	7.79
	Villa Gonzalez	21.35	599	2.72	8.05
	Pedro Garcia	15.07	59	10.58	23.14
	Sabana Iglesia	8.55	89	3.20	2.34
	Baitoa	16.76	125	5.72	15.43
	La Canela	9.52	437	4.39	9.96
	Canafistol	13.97	120	3.94	12.74
	Juncalito	15.29	82	16.71	22.12
	Palmar Arriba	11.44	55	4.16	9.36
Santiago Rodríguez	San Ignacio de Sabaneta	7.54	213	2.41	6.55
	Villa Los Almacigos	17.75	219	2.22	12.63
	Moncion	10.15	109	2.30	8.15
Valverde	Mao	3.72	183	1.99	5.56
	Esperanza	5.76	328	1.83	4.82
	Laguna Salada	9.20	141	3.57	8.82
	Amina	9.78	87	2.06	5.37
	Maizal	7.21	73	2.27	4.47
	Jaibon (Pueblo Nuevo)	11.19	86	4.72	6.94
	Guatapanal	11.69	96	2.42	6.42
	Jicome	11.45	50	4.64	12.12
	Jaibon	11.77	72	2.00	5.98
	La Caya	9.95	10	3.51	8.66
Monseñor Nouel	Monseñor Nouel	6.32	709	1.67	5.60
	Maimon	10.91	190	2.00	8.15
	Piedra Blanca	17.71	237	2.21	6.96
	Villa de Sonador	6.69	58	5.35	8.49
	Jima (Sabana del Puerto)	7.41	87	2.60	6.92
	Juan Adrian	13.80	54	92.69	80.62
Monte Plata	Monte Plata	10.11	375	4.64	5.94
	Bayaguana	9.38	332	4.71	5.62
	Sabana Grande de Boya	8.89	242	4.31	5.13
	Yamasa	19.42	823	4.76	11.66

Appendix 2 (continued): Estimates of Prevalence of Malnutrition among 6 to 59 Month-Olds, by *Municipio*

Province	<i>Municipio</i>	Chronic Malnutrition (HAZ < -2)	Number of Children Chronically Malnourished	Acute Malnutrition (WHZ < -2)	Global Malnutrition (WAZ < -2)
Monte Plata (con't)	Don Juan	27.61	208	6.58	15.82
	Esperalvillo	18.70	344	6.35	18.00
	Gonzalo	16.42	105	7.67	9.24
	Los Botados	16.84	290	3.16	7.72
	Majagual	9.16	22	2.57	8.00
Hato Mayor	Hato Mayor del Rey	9.41	378	2.97	7.59
	Sabana de La Mar	9.10	127	6.18	9.69
	El Valle	15.09	126	4.63	8.76
	Elupina Cordero	45.78	156	1.69	14.67
	Yerba Buena	11.99	32	2.02	1.71
	Mata Palacio	14.83	120	6.47	31.43
	Guayabo Dulce	23.88	176	11.82	21.96
San José de Ocoa	San Jose de Ocoa	7.41	251	2.44	4.50
	Sabana Larga	6.69	94	2.79	4.11
	Rancho Arriba	20.40	226	4.84	11.66
	La Cienaga	14.93	83	1.48	6.12
Santo Domingo	Santo Domingo Este	8.84	6630	3.60	6.73
	Guerra	13.92	501	23.75	21.25
	Santo Domingo Oeste	8.56	2519	1.20	3.07
	Los Alcarrizos	7.29	1688	3.64	3.14
	Pedro Brand	19.72	1147	55.26	64.05
	Santo Domingo Norte	12.76	4432	2.92	5.12
	La Victoria	10.52	541	3.87	25.29
	Boca Chica	36.52	4165	3.59	10.82
	Distrito Nacional	7.00	5434	3.71	6.20

Appendix 3: Country Descriptive Statistics on Malnutrition Prevalence

	Chronic Malnutrition (HAZ < -2)	Acute Malnutrition (WHZ < -2)	Global Malnutrition (WAZ < -2)
Mean ^a	12.04	4.87	10.30
Median	10.75	3.57	8.32
IQR	7.78 – 14.45	2.39 – 5.34	6.10 – 12.16
Minimum	3.53	0.47	1.71
Maximum	45.78	92.69	80.62
National Prevalence (mean prevalence, weighted)	10.10	3.99	8.03

^a Simple mean based on small area estimates at the *municipio* level.

Appendix 4: Prevalence of Chronic Malnutrition and Mean HAZ Scores among 6 to 59 Month-Olds, Estimates Based on Small Area Estimation Compared to DHS Survey Data, by Province

Development Zone ^a	Province	n	Prevalences Based on SAE	Standard Errors on SAE estimates	Malnutrition Prevalence Rates (DHS Survey)	Mean HAZ Scores Based on SAE	Mean HAZ Scores (DHS Survey)
Cibao Norte N = 1014							
K = 98	Españillat	252	8.78	0.0136	8.33	-0.30	-0.33
R ² = 0.2175	Puerto Plata	281	9.85	0.0181	9.61	-0.29	-0.25
	Santiago	481	8.46	0.0139	5.41	-0.25	-0.24
Cibao Sur N = 991							
K = 97	La Vega	368	11.95	0.0142	9.78	-0.41	-0.55
R ² = 0.2630	Monseñor Nouel	349	7.98	0.0115	9.46	-0.20	-0.40
	Sánchez Ramírez	274	8.11	0.0137	7.66	-0.36	-0.41
Cibao Nordeste N = 1170							
K = 97	Duarte	334	9.57	0.0097	5.99	-0.38	-0.34
R ² = 0.1534	María Trinidad Sánchez	261	10.31	0.0114	9.16	-0.30	-0.24
	Salcedo	285	8.58	0.0119	7.37	-0.31	-0.28
	Samaná	290	11.05	0.0127	6.90	-0.36	-0.32
Cibao Noroeste N = 938							
K = 101	Dajabón	280	8.75	0.0124	8.90	-0.22	-0.24
R ² = 0.2463	Monte Cristi	215	8.45	0.0130	6.05	-0.25	-0.31
	Stgo Rodríguez	176	10.54	0.0168	7.95	-0.42	-0.49
	Valverde	267	6.70	0.0112	6.74	-0.22	-0.38
Valdesia N = 1419							
K = 102	Azua	377	9.09	0.0121	8.99	-0.45	-0.55
R ² = 0.1728	Peravia	322	9.18	0.0114	9.01	-0.41	-0.40
	San Cristóbal	483	9.79	0.0127	13.25	-0.48	-0.47
	San José de Ocoa	237	10.13	0.0167	8.02	-0.43	-0.49
El Valle N = 634							
K = 97	Elías Piña	323	19.35	0.0275	17.34	-0.73	-0.79
R ² = 0.2960	San Juan	311	12.54	0.0179	9.97	-0.44	-0.45
Enriquillo N = 1380							
K = 103	Baoruco	396	15.39	0.0148	16.83	-0.64	-0.74
R ² = 0.2350	Barahona	363	11.03	0.0139	9.92	-0.44	-0.42
	Independencia	297	13.70	0.0164	13.47	-0.38	-0.52
	Pedernales	324	15.32	0.0170	14.51	-0.63	-0.72

Appendix 4 (continued): Prevalence of Chronic Malnutrition and Mean HAZ Scores among 6 to 59 Month-Olds, Estimates Based on Small Area Estimation Compared to DHS Survey Data, by Province

Development Zone ^a	Province	n	Prevalences Based on SAE	Standard Errors on SAE estimates	Malnutrition Prevalence Rates (DHS Survey)	Mean HAZ Scores Based on SAE	Mean HAZ Scores (DHS Survey)
Yuma N = 966							
K = 96	El Seibo	300	8.38	0.0192	6.67	-0.29	-0.40
R ² = 0.1443	La Altagracia	287	11.11	0.0198	6.97	-0.27	-0.23
	La Romana	379	12.67	0.0263	11.35	-0.47	-0.45
Higuamo N = 889							
K = 96	Hato Mayor	241	13.27	0.0246	9.13	-0.51	-0.44
R ² = 0.2277	Monte Plata	321	14.13	0.0222	14.95	-0.52	-0.53
	San Pedro de Macorís	327	6.75	0.0121	8.56	-0.13	-0.28
Ozama N = 730							
K = 81	Distrito Nacional	268	7.00	0.0116	8.21	0.03	-0.11
R ² = 0.2014	Santo Domingo	462	11.49	0.0157	10.15	-0.12	-0.18

^a Statistics presented are those of the individual Development Zone regression models used to impute malnutrition prevalence rates.

Appendix 5: Descriptive Statistics of Dependent Variables in Model, 6 to 59 Month-Olds

Variables	Type ^a	DHS Mean ^{b,c}	SD ^d	Actual Range	Possible Range	Census Mean ^b
<i>Child Characteristics</i>						
Age 6 to 11 months (base case, excluded from model)	D	0.11	0.317	0, 1	0, 1	0.10
Age 12 to 23 months	D	0.22	0.416	0, 1	0, 1	0.21
Age 24 to 35 months	D	0.22	0.417	0, 1	0, 1	0.23
Age 36 to 59 months	D	0.44	0.496	0, 1	0, 1	0.46
Child is female	D	0.49	0.500	0, 1	0, 1	0.49
Child is son/daughter of head of household (base case, excluded from model)	D	0.67	0.471	0, 1	0, 1	0.77
Child is related to head of household, but not son/daughter	D	0.31	0.463	0, 1	0, 1	0.22
Child is not related to head of household	D	0.02	0.141	0, 1	0, 1	0.00
<i>Household Demographics</i>						
Household head has no formal education (base case, excluded from model)	D	0.11	0.315	0, 1	0, 1	0.01
Household head has some primary education	D	0.39	0.488	0, 1	0, 1	0.35
Household head has completed primary education	D	0.11	0.309	0, 1	0, 1	0.09
Household head has some secondary education	D	0.10	0.303	0, 1	0, 1	0.15
Household head has completed secondary education	D	0.07	0.256	0, 1	0, 1	0.09
Household head has tertiary education	D	0.08	0.268	0, 1	0, 1	0.13
Household head provided no education information	D	0.14	0.347	0, 1	0, 1	0.17
Highest number of years of education completed by an adult male in household	C	6.02	4.920	0 - 20	unrestricted	7.00
Highest number of years of education completed by an adult male in household, squared	C	60.46	71.823	0 - 400	unrestricted	77.49
Highest number of years of education completed by an adult female in household	C	7.57	4.627	0 - 22	unrestricted	8.45
Highest number of years of education completed by an adult female in household, squared	C	78.72	75.217	0 - 484	unrestricted	96.31
Female-headed household	D	0.21	0.411	0, 1	0, 1	0.31
Household head is married or has a partner/is in a union (base case, excluded from model)	D	0.81	0.389	0, 1	0, 1	0.83
Household head is single	D	0.02	0.127	0, 1	0, 1	0.05
Household head is divorced or is not living together with partner/is separated	D	0.11	0.318	0, 1	0, 1	0.14
Household head is widowed	D	0.05	0.223	0, 1	0, 1	0.04
Number of children under 5 years of age	C	1.65	0.762	1 - 5	unrestricted	1.62
Number of adult females	C	1.44	0.814	0 - 8	unrestricted	1.34
Dependency ratio	C	0.52	0.151	0.08 - 1.00	unrestricted	0.51
<i>Household Possessions</i>						
Air conditioner	D	0.02	0.152	0, 1	0, 1	0.05
Computer	D	0.05	0.220	0, 1	0, 1	0.04
Radio or Stereo	D	0.62	0.485	0, 1	0, 1	0.46
Refrigerator	D	0.55	0.498	0, 1	0, 1	0.58
Stove	D	0.86	0.346	0, 1	0, 1	0.84
Television	D	0.75	0.435	0, 1	0, 1	0.69
Washing machine	D	0.55	0.498	0, 1	0, 1	0.54
<i>Household Dwelling/Environmental Health Indicators</i>						
Home has floor made from cement (base case, Excluded from model)	D	0.85	0.360	0, 1	0, 1	0.83
Home has floor made from marble/tile	D	0.03	0.160	0, 1	0, 1	0.08
Home has floor made from earth/dirt	D	0.11	0.316	0, 1	0, 1	0.08

Appendix 5 (continued): Descriptive Statistics of Dependent Variables in Model, 6 to 59 Month-Olds

Variables	Type ^a	DHS Mean ^{b,c}	SD ^d	Actual Range	Possible Range	Census Mean ^b
<i>Household Dwelling/Environmental Health (con't)</i>						
Home has floor made of wood, other materials, or information was not provided	D	0.01	0.117	0, 1	0, 1	0.01
Home has roof made from zinc (base case, excluded from model)	D	0.78	0.417	0, 1	0, 1	0.70
Home has roof made from cement	D	0.18	0.387	0, 1	0, 1	0.26
Home has roof made from asbestos	D	0.01	0.076	0, 1	0, 1	0.01
Home has roof made from palm materials	D	0.03	0.163	0, 1	0, 1	0.02
Home has roof made from other materials or information was not provided	D	0.01	0.084	0, 1	0, 1	0.00
Home has walls made from cement/cement blocks (base case, excluded from model)	D	0.50	0.500	0, 1	0, 1	0.62
Home has walls made from shingles	D	0.01	0.114	0, 1	0, 1	0.01
Home has walls made from wood	D	0.35	0.476	0, 1	0, 1	0.28
Home has walls made from palm materials	D	0.10	0.303	0, 1	0, 1	0.07
Home has walls made from other materials, including dung, or information was not provided	D	0.04	0.191	0, 1	0, 1	0.02
Number of persons per room - crowding	C	2.04	1.046	0.33 - 10.00	unrestricted	2.06
Household has access to a toilet (base case, excluded from model)	D	0.36	0.481	0, 1	0, 1	0.49
Household has access to a latrine	D	0.53	0.499	0, 1	0, 1	0.41
Household has no access to sanitary facilities or information on facilities not provided	D	0.11	0.307	0, 1	0, 1	0.09
Source of household water – Piped water (base case, excluded from the model)	D	0.75	0.430	0, 1	0, 1	0.78
Source of household water – Well water	D	0.08	0.273	0, 1	0, 1	0.07
Source of household water – Tanker truck water	D	0.06	0.233	0, 1	0, 1	0.07
Source of household water – Surface water, river	D	0.07	0.261	0, 1	0, 1	0.05
Source of household water – Rainwater	D	0.03	0.161	0, 1	0, 1	0.01
Source of household water – Other sources, or information not provided	D	0.01	0.077	0, 1	0, 1	0.01
Household garbage collected (base case, excluded from model)	D	0.51	0.500	0, 1	0, 1	0.56
Household garbage burnt	D	0.30	0.458	0, 1	0, 1	0.25
Household garbage thrown in yard /near dwelling	D	0.14	0.345	0, 1	0, 1	0.06
Household garbage thrown outside homestead	D	0.04	0.188	0, 1	0, 1	0.11
Household garbage information not provided	D	0.01	0.116	0, 1	0, 1	0.02
Household has electricity	D	0.88	0.328	0, 1	0, 1	0.94
Household has telephone service	D	0.24	0.429	0, 1	0, 1	0.28
Household uses natural gas/propane for fuel (base case, excluded from model)	D	0.81	0.389	0, 1	0, 1	0.87
Household uses charcoal for fuel	D	0.03	0.181	0, 1	0, 1	0.03
Household uses firewood for fuel	D	0.14	0.347	0, 1	0, 1	0.09
Household uses no fuel because there is no cooking	D	0.01	0.102	0, 1	0, 1	0.01
Household uses other fuel sources (incl. Kerosene and electricity) or provided no information	D	0.00	0.047	0, 1	0, 1	0.00
Contamination near home: Stagnant water	D	0.19	0.396	0, 1	0, 1	0.18
Contamination near home: Garbage dump	D	0.19	0.393	0, 1	0, 1	0.21
Contamination near home: Stream/river with garbage	D	0.16	0.366	0, 1	0, 1	0.16
Contamination near home: Traffic noise	D	0.37	0.484	0, 1	0, 1	0.29
Contamination near home: Pigsty/farm	D	0.14	0.346	0, 1	0, 1	0.08
Contamination near home: Smoke and/or gas	D	0.03	0.170	0, 1	0, 1	0.03
Contamination near home: Noise from factory	D	0.04	0.193	0, 1	0, 1	0.04

Appendix 5 (continued): Descriptive Statistics of Dependent Variables in Model, 6 to 59 Month-Olds

Variables	Type ^a	DHS Mean ^{b,c}	SD ^d	Actual Range	Possible Range	Census Mean ^b
<i>Household Dwelling/Environmental Health (con't)</i>						
Contamination near home: Waste from factory	D	0.02	0.148	0, 1	0, 1	0.01
Contamination near home: Noise from plant	D	0.05	0.212	0, 1	0, 1	0.03
Contamination near home: Gas/LP fill station	D	0.01	0.099	0, 1	0, 1	0.01
Contamination near home: Gasoline station	D	0.01	0.094	0, 1	0, 1	0.01
Contamination near home: Music	D	0.13	0.334	0, 1	0, 1	0.12
Contamination near home: No contamination	D	0.04	0.202	0, 1	0, 1	0.33
Urban residence	D	0.58	0.493	0, 1	0, 1	0.62
<i>Sección Characteristics</i>						
Percentage of households receiving remittances	C	9.46	5.128	0 - 44.30	0 - 100	9.98
Percentage of households engaged in agriculture	C	9.67	9.887	0.39 - 67.38	0 - 100	6.80
Percentage of population of Haitian extraction	C	2.41	5.258	0 - 40.89	0 - 100	1.75
Percentage of school-aged children matriculated	C	87.17	4.478	33.07 - 100	0 - 100	87.34
Percentage of households that are female-headed	C	32.98	7.970	4.21 - 59.63	0 - 100	34.96
Percentage of household heads who have completed only primary school	C	7.30	2.605	0 - 19.07	0 - 100	8.03
Percentage of household heads who have completed through secondary school	C	6.81	3.548	0 - 22.65	0 - 100	8.01
Percentage of household heads who have at least some tertiary education	C	9.25	7.074	0 - 30.55	0 - 100	12.58
Percentage of households that have dwellings with floors made of cement	C	82.25	14.504	0 - 98.28	0 - 100	82.17
Percentage of households that have dwellings with roofs made of cement	C	20.90	17.338	0 - 64.23	0 - 100	30.09
Percentage of households that have dwellings with walls made of cement	C	57.81	22.301	0 - 94.86	0 - 100	65.17
Percentage of households with access to a toilet	C	38.55	28.377	0 - 91.14	0 - 100	52.45
Percentage of households with access to piped water	C	73.50	28.782	0 - 100	0 - 100	78.50
Percentage of households with garbage collection	C	52.25	34.191	0 - 97.70	0 - 100	58.51
Percentage of households that have electricity	C	87.53	21.543	0 - 98.80	0 - 100	92.76
Percentage of households that use natural gas or propane for fuel	C	75.79	23.062	0 - 97.35	0 - 100	83.45
<i>Municipio Characteristics</i>						
Percentage of area within 5 km of a major road	C	59.89	27.221	0 - 100	0 - 100	73.25
Distance in kilometers to nearest major urban center	C	50.09	46.182	0 - 174.83	unrestricted	26.82
Distance in kilometers to nearest hospital	C	6.56	4.371	0.51 - 28.20	unrestricted	4.99
Number of health care facilities per 1000 persons	C	0.24	0.124	1 - 1.21	unrestricted	0.19
Population density	C	844	2034	5 - 9,930	unrestricted	2,244
Mean elevation in meters	C	307.13	316.50	6 - 1,765	unrestricted	221.44
Elevation range – slope	C	915.74	725.08	44 - 2,972	unrestricted	677.18
Land type: Percentage of area that is humid/dry (base case, excluded from model)	C	42.91	39.277	0 - 100	0 - 100	48.09
Land type: Percentage of area that is arid	C	11.91	27.619	0 - 100	0 - 100	5.90
Land type: Percentage of area that is humid	C	2.54	9.879	0 - 93.41	0 - 100	1.91
Land type: Percentage of area that is semi-arid	C	13.77	24.968	0 - 100	0 - 100	12.78
Land type: Percentage of area that is semi-humid	C	27.71	37.579	0 - 100	0 - 100	30.51
Land type: Percentage of area that is island	C	1.07	5.487	0 - 29.90	0 - 100	0.74
<i>Province Characteristics</i>						
Number of droughts from 1996-2000	C	0.87	0.890	0 - 3	unrestricted	1.10
Number of floods from 1996-2000	C	2.04	2.164	0 - 8	unrestricted	2.98
Province on the <i>frontera</i> with Haiti	D	0.14	0.351	0, 1	0, 1	0.04

^a C = continuous; D = dichotomous. ^b For dichotomous variables, reported value represents response probability, i.e., the proportion of the sample for whom the response takes a value of 1. ^c Weights applied. ^d For dichotomous variables, standard deviations have no meaning.

Appendix 6: Regression Models^a for the Estimation of Height-for-Age Z-scores

	National-level Regression Model		Zone I Cibao Norte		Zone II Cibao Sur	
N	10,131		1,014		991	
R-Squared	0.114		0.217		0.261	
Adj. R-Squared	0.113		0.212		0.252	
	B	SE	B	SE	B	SE
Constant	-0.913***	0.162	4.134***	0.945	-6.183***	1.356
Age 12 to 23 months	-0.260***	0.015	-0.047	0.038	-0.231***	0.047
Age 24 to 35 months	0.119***	0.015	0.431***	0.037	0.198***	0.048
Age 36 to 59 months	0.079***	0.014	0.355***	0.035	0.079	0.043
Child is female	0.091***	0.008	0.092***	0.020	0.067**	0.026
Child is related to head of household, but not son/daughter	-0.012	0.013	0.208***	0.033	0.269***	0.044
Child is not related to head of household	-0.057	0.032	-0.346***	0.072	-0.234*	0.114
Household head has some primary education	0.010	0.017	-0.349***	0.039	0.251***	0.056
Household head has completed primary education	0.035	0.021	-0.159**	0.047	0.183**	0.070
Household head has some secondary education	0.006	0.021	-0.192***	0.049	0.689***	0.076
Household head has completed secondary education	0.078**	0.024	-0.135*	0.057	0.476***	0.080
Household head has tertiary education	-0.012	0.028	-0.074	0.067	0.203*	0.091
Household head provided no education information	0.203***	0.019	-0.283***	0.044	0.283***	0.060
Highest number of years of education completed by an adult male in household	0.010**	0.003	0.004	0.008	-0.023*	0.011
Highest number of years of education completed by an adult male in household, squared	0.000	0.000	-0.001	0.001	0.001	0.001
Highest number of years of education completed by an adult female in household	-0.019***	0.003	-0.005	0.008	0.012	0.011
Highest number of years of education completed by an adult female in household, squared	0.002***	0.000	0.001*	0.000	0.001	0.001
Female-headed household	0.125***	0.016	0.246***	0.036	0.081	0.058
Household head is single	0.092**	0.034	-0.062	0.084	0.220*	0.108
Household head is divorced or is not living together with partner/is separated	-0.107***	0.018	-0.172***	0.042	-0.148*	0.062
Household head is widowed	-0.097***	0.023	-0.367***	0.056	0.008	0.077
Number of children under 5 years of age	-0.063***	0.006	-0.124***	0.017	-0.071***	0.019
Number of adult females	-0.020**	0.007	0.019	0.018	-0.166***	0.025
Dependency ratio	-0.481***	0.038	-0.667***	0.090	-0.320**	0.121
Air conditioner	-0.034	0.025	0.329**	0.064	-0.583***	0.111
Computer	0.108***	0.017	-0.033	0.049	0.021	0.087
Radio or Stereo	0.105***	0.009	0.116***	0.023	0.107***	0.030
Refrigerator	0.055***	0.011	0.150***	0.027	0.192***	0.034
Stove	0.190***	0.021	0.459***	0.060	0.175*	0.072
Television	0.028*	0.012	-0.137***	0.032	-0.107**	0.038
Washing machine	0.036**	0.011	-0.208***	0.024	0.024	0.033
Home has floor made from marble/tile	-0.108***	0.023	0.013	0.055	-0.081	0.090
Home has floor made from earth/dirt	-0.049*	0.019	-0.089	0.049	-0.356***	0.068
Home has floor made of wood, other materials, or information was not provided	-0.179***	0.039	-0.570***	0.097	-0.471**	0.165
Home has roof made from cement	0.139***	0.013	0.230***	0.031	0.177***	0.045
Home has roof made from asbestos	0.209**	0.076	0.270	0.254	0.398*	0.162
Home has roof made from palm materials	0.009	0.037	0.621***	0.100	-	-
Home has roof made from other materials or information was not provided	-0.348***	0.061	1.171**	0.412	-0.004	0.183

†: $p < 0.06$; *: $p < 0.05$; **: $p < 0.01$; ***: $p < 0.001$

^a Models may differ somewhat from zone to zone due to collinearity concerns and constant values.

Appendix 6 (continued): Regression Models^a for the Estimation of Height-for-Age Z-scores

	National-level Regression Model		Zone I Cibao Norte		Zone II Cibao Sur	
N	10,131		1,014		991	
R-Squared	0.114		0.217		0.261	
Adj. R-Squared	0.113		0.212		0.252	
	B	SE	B	SE	B	SE
Home has walls made from shingles	0.148**	0.054	-	-	0.598	0.318
Home has walls made from wood	-0.002	0.011	-0.057*	0.027	-0.002	0.035
Home has walls made from palm materials	-0.054**	0.019	-0.068	0.049	0.082	0.053
Home has walls made from other materials, including dung, or information was not provided	0.010	0.024	0.296**	0.094	-0.256**	0.082
Number of persons per room - crowding	-0.062***	0.005	-0.041**	0.014	-0.117***	0.021
Household has access to a latrine	-0.083***	0.012	0.001	0.029	-0.218***	0.038
Household has no access to sanitary facilities or information on facilities not provided	-0.092***	0.020	-0.275***	0.054	-0.332***	0.075
Source of household water – Well water	0.034	0.018	0.011	0.063	-0.132**	0.047
Source of household water – Tanker truck water	0.069***	0.019	-0.157*	0.068	-0.615***	0.121
Source of household water – Surface water, river	-0.001	0.023	0.135	0.074	-0.193**	0.062
Source of household water – Rainwater	0.037	0.030	0.227**	0.080	-0.220	0.122
Source of household water – Other sources, or information not provided	0.118*	0.054	-1.290***	0.270	-0.313	0.177
Household garbage burnt	-0.085***	0.014	-0.181***	0.034	-0.179***	0.042
Household garbage thrown in yard /near dwelling	-0.142***	0.016	0.126**	0.041	-0.135*	0.055
Household garbage thrown outside homestead	-0.112***	0.022	-0.442***	0.045	-0.420***	0.109
Household garbage information not provided	0.046	0.032	-0.123	0.083	0.219	0.156
Household has electricity	-0.015	0.025	0.023	0.089	-0.016	0.077
Household has telephone service	0.045***	0.011	0.178***	0.025	0.095**	0.035
Household uses charcoal for fuel	0.106**	0.034	-1.126***	0.171	-0.426	0.349
Household uses firewood for fuel	-0.080***	0.022	-0.217***	0.056	-0.149*	0.066
Household uses no fuel because there is no cooking	0.034	0.044	-0.275**	0.093	0.401**	0.139
Household uses other fuel sources (incl. Kerosene and electricity) or provided no information	0.023	0.129	-	-	-	-
Contamination near home: Stagnant water	-0.025*	0.011	0.021	0.029	-0.205***	0.040
Contamination near home: Garbage dump	0.011	0.011	0.156***	0.031	0.259***	0.041
Contamination near home: Stream/river with garbage	-0.030*	0.013	-0.100***	0.028	-0.067	0.042
Contamination near home: Traffic noise	-0.029**	0.009	-0.176***	0.023	0.062*	0.028
Contamination near home: Pigsty/farm	0.049***	0.013	0.028	0.030	-0.134**	0.039
Contamination near home: Smoke and/or gas	0.135***	0.023	0.255***	0.053	0.072	0.074
Contamination near home: Noise from factory	0.026	0.021	-0.249***	0.055	0.004	0.069
Contamination near home: Waste from factory	0.023	0.027	0.617***	0.065	-0.079	0.107
Contamination near home: Noise from plant	-0.021	0.019	-0.103*	0.047	0.054	0.061
Contamination near home: Gas/LP fill station	-0.053	0.035	-0.869***	0.116	0.098	0.163
Contamination near home: Gasoline station	0.346***	0.049	1.360***	0.154	0.166	0.152
Contamination near home: Music	-0.040**	0.012	0.158***	0.032	-0.416***	0.041
Contamination near home: No contamination	-0.082***	0.019	0.035	0.048	0.206**	0.065
Urban residence	-0.113***	0.018	0.287**	0.088	-0.942***	0.154
Percentage of households receiving remittances	0.004**	0.001	0.030***	0.006	0.002	0.010
Percentage of households engaged in agriculture	0.006***	0.001	0.039***	0.006	0.018**	0.006
Percentage of population of Haitian extraction	0.013***	0.001	-0.051**	0.017	-0.307***	0.046
Percentage of school-aged children matriculated	0.001	0.002	-0.059***	0.008	0.044**	0.014
Percentage of households that are female-headed	0.003**	0.001	0.022***	0.004	0.020**	0.007

†: $p < 0.06$; *: $p < 0.05$; **: $p < 0.01$; ***: $p < 0.001$

^a Models may differ somewhat from zone to zone due to collinearity concerns and constant values.

Appendix 6 (continued): Regression Models^a for the Estimation of Height-for-Age Z-scores

	National-level Regression Model		Zone I Cibao Norte		Zone II Cibao Sur	
N	10,131		1,014		991	
R-Squared	0.114		0.217		0.261	
Adj. R-Squared	0.113		0.212		0.252	
	B	SE	B	SE	B	SE
Percentage of household heads who have completed only primary school	0.010**	0.003	0.044*8	0.014	0.006	0.014
Percentage of household heads who have completed through secondary school	0.015***	0.003	-0.013	0.013	-0.018	0.017
Percentage of household heads who have at least some tertiary education	-0.002	0.002	0.000	0.011	-0.013	0.011
Percentage of households that have dwellings with floors made of cement	-0.002*	0.001	-0.015**	0.005	0.015*	0.006
Percentage of households that have dwellings with roofs made of cement	0.000	0.001	-0.005	0.005	0.016**	0.005
Percentage of households that have dwellings with walls made of cement	0.000	0.000	-0.010**	0.003	0.014***	0.004
Percentage of households with access to a toilet	-0.001	0.001	0.004	0.004	-0.004	0.004
Percentage of households with access to piped water	0.002***	0.000	0.010***	0.001	0.004***	0.001
Percentage of households with garbage collection	0.000	0.000	0.000	0.002	0.005 [†]	0.003
Percentage of households that have electricity	0.002**	0.001	-0.003	0.004	0.007*	0.003
Percentage of households that use natural gas or propane for fuel	0.000	0.001	0.002	0.003	-0.014**	0.004
Percentage of area within 5 km of a major road	-0.001	0.000	0.000	0.002	-0.022***	0.006
Distance in kilometers to nearest major urban center	0.003***	0.000	0.014***	0.003	0.036***	0.007
Distance in kilometers to nearest hospital	-0.003*	0.002	0.017*	0.008	-0.004	0.022
Number of health care facilities per 1000 persons	0.463***	0.057	-1.128***	0.302	1.886	1.225
Population density	0.000***	0.000	0.000**	0.000	0.003***	0.001
Mean elevation in meters	0.000***	0.000	0.000	0.000	0.000*	0.000
Elevation range – slope	0.000**	0.000	0.000***	0.000	-0.001**	0.000
Land type: Percentage of area that is arid	-0.001***	0.000	-	-	-	-
Land type: Percentage of area that is humid	-0.004***	0.001	-	-	-	-
Land type: Percentage of area that is semi-arid	0.001***	0.000	0.004***	0.001	-	-
Land type: Percentage of area that is semi-humid	0.000**	0.000	-0.004	0.002	-0.002	0.002
Land type: Percentage of area that is island	-0.005***	0.001	-	-	-	-
Number of droughts from 1996-2000	-0.062***	0.008	2.184***	0.480	-0.490*	0.211
Number of floods from 1996-2000	0.029***	0.003	-0.625***	0.138	0.291*	0.140
Province on the <i>frontera</i> with Haiti	-0.171***	0.028	-	-	-	-

[†]: $p < 0.06$; *: $p < 0.05$; **: $p < 0.01$; ***: $p < 0.001$

^a Models may differ somewhat from zone to zone due to collinearity concerns and constant values.

Appendix 6: Regression Models^a for the Estimation of Height-for-Age Z-scores

	Zone III Cibao Nordeste		Zone IV Cibao Noroeste		Zone V Valdesia	
N	1,170		938		1,419	
R-Squared	0.155		0.242		0.172	
Adj. R-Squared	0.142		0.223		0.164	
	B	SE	B	SE	B	SE
Constant	2.274	1.361	-1.160	0.981	-2.850***	0.494
Age 12 to 23 months	-0.276***	0.051	-0.282***	0.064	-0.225***	0.041
Age 24 to 35 months	0.144**	0.052	0.267***	0.066	0.056	0.041
Age 36 to 59 months	-0.005	0.048	-0.009	0.059	-0.049	0.038
Child is female	0.136***	0.029	0.066 [†]	0.035	0.166***	0.023
Child is related to head of household, but not son/daughter	0.191***	0.046	0.017	0.057	-0.071 [†]	0.037
Child is not related to head of household	0.111	0.117	0.131	0.127	0.679***	0.094
Household head has some primary education	-0.061	0.061	0.055	0.068	0.226***	0.046
Household head has completed primary education	-0.228**	0.078	-0.055	0.089	0.343***	0.061
Household head has some secondary education	-0.070	0.080	-0.042	0.096	0.412***	0.062
Household head has completed secondary education	-0.283**	0.088	-0.024	0.112	0.437***	0.071
Household head has tertiary education	-0.751***	0.099	-0.178	0.127	0.263**	0.081
Household head provided no education information	-0.160*	0.069	0.084	0.076	0.244***	0.054
Highest number of years of education completed by an adult male in household	-0.048***	0.011	-0.025	0.015	-0.002	0.009
Highest number of years of education completed by an adult male in household, squared	0.005***	0.001	0.002	0.001	0.000	0.001
Highest number of years of education completed by an adult female in household	0.015	0.012	0.029 [†]	0.015	-0.043***	0.010
Highest number of years of education completed by an adult female in household, squared	0.001	0.001	0.000	0.001	0.002***	0.001
Female-headed household	0.261***	0.060	-0.419***	0.068	-0.190***	0.044
Household head is single	-0.380**	0.141	0.343*	0.148	-0.556***	0.114
Household head is divorced or is not living together with partner/is separated	-0.173**	0.064	0.287***	0.076	0.047	0.052
Household head is widowed	-0.268**	0.081	0.488***	0.109	0.134*	0.065
Number of children under 5 years of age	-0.117***	0.025	-0.051	0.031	-0.083***	0.020
Number of adult females	-0.110***	0.028	0.013	0.037	0.169***	0.021
Dependency ratio	-0.125	0.134	-0.623***	0.170	0.384**	0.111
Air conditioner	-0.144	0.104	0.935***	0.242	-0.099	0.095
Computer	0.006	0.067	0.169	0.103	-0.074	0.056
Radio or Stereo	-0.032	0.034	-0.016	0.041	0.128***	0.027
Refrigerator	-0.028	0.041	0.105*	0.046	-0.046	0.032
Stove	0.478***	0.069	-0.131	0.089	0.238***	0.053
Television	-0.059	0.045	0.105*	0.049	-0.135***	0.035
Washing machine	0.011	0.037	-0.078	0.047	0.044	0.029
Home has floor made from marble/tile	0.187*	0.084	-0.201	0.149	-0.046	0.110
Home has floor made from earth/dirt	-0.071	0.091	-0.268***	0.073	0.149**	0.055
Home has floor made of wood, other materials, or information was not provided	-0.046	0.105	0.321	0.189	0.269**	0.103
Home has roof made from cement	0.079	0.054	0.351***	0.076	0.288***	0.036
Home has roof made from asbestos	-0.177	0.306	3.950***	0.511	-1.249***	0.307
Home has roof made from palm materials	-0.344*	0.146	-0.390***	0.090	-0.122	0.090
Home has roof made from other materials or information was not provided	-0.024	0.168	-0.096	0.231	0.242	0.199

[†]: $p < 0.06$; *: $p < 0.05$; **: $p < 0.01$; ***: $p < 0.001$

^a Models may differ somewhat from zone to zone due to collinearity concerns and constant values.

Appendix 6 (continued): Regression Models^a for the Estimation of Height-for-Age Z-scores

	Zone III Cibao Nordeste		Zone IV Cibao Noroeste		Zone V Valdesia	
N	1,170		938		1,419	
R-Squared	0.155		0.242		0.172	
Adj. R-Squared	0.142		0.223		0.164	
	B	SE	B	SE	B	SE
Home has walls made from shingles	-	-	0.150	0.504	-0.142	0.099
Home has walls made from wood	0.013	0.042	0.066	0.048	-0.069*	0.032
Home has walls made from palm materials	-0.115*	0.052	-0.177**	0.068	0.042	0.060
Home has walls made from other materials, including dung, or information was not provided	-0.278**	0.101	0.193	0.153	-0.018	0.064
Number of persons per room - crowding	-0.049*	0.025	-0.133***	0.026	-0.117***	0.015
Household has access to a latrine	-0.327***	0.047	0.102 [†]	0.053	0.091**	0.033
Household has no access to sanitary facilities or information on facilities not provided	-0.352***	0.074	-0.006	0.099	0.206***	0.059
Source of household water – Well water	0.143**	0.051	0.220	0.135	0.032	0.086
Source of household water – Tanker truck water	-0.240**	0.090	0.090	0.057	0.123*	0.049
Source of household water – Surface water, river	-0.046	0.058	0.025	0.082	0.134	0.086
Source of household water – Rainwater	0.068	0.063	-0.247*	0.101	-0.397***	0.088
Source of household water – Other sources, or information not provided	1.153***	0.244	-0.641**	0.209	0.248	0.155
Household garbage burnt	-0.209***	0.053	0.043	0.054	0.185***	0.042
Household garbage thrown in yard /near dwelling	-0.090	0.062	-0.081	0.084	-0.048	0.047
Household garbage thrown outside homestead	-0.163	0.090	0.787**	0.228	-0.248**	0.077
Household garbage information not provided	-0.370*	0.155	-0.292	0.191	-0.264*	0.114
Household has electricity	-0.181*	0.079	-0.020	0.092	0.245**	0.089
Household has telephone service	0.126**	0.039	0.260***	0.049	0.244***	0.033
Household uses charcoal for fuel	0.612***	0.156	-0.123	0.135	-0.047	0.079
Household uses firewood for fuel	0.047	0.063	-0.251**	0.094	-0.003	0.056
Household uses no fuel because there is no cooking	1.203***	0.148	-0.251*	0.122	0.837***	0.160
Household uses other fuel sources (incl. Kerosene and electricity) or provided no information	0.447	0.348	-0.468*	0.219	-3.863***	0.352
Contamination near home: Stagnant water	0.029	0.043	0.197***	0.055	0.050	0.032
Contamination near home: Garbage dump	-0.084 [†]	0.044	-0.021	0.057	0.254***	0.032
Contamination near home: Stream/river with garbage	0.102*	0.049	0.002	0.061	-0.141***	0.037
Contamination near home: Traffic noise	-0.073*	0.032	-0.172***	0.039	-0.131***	0.026
Contamination near home: Pigsty/farm	-0.061	0.042	0.056	0.052	-0.010	0.035
Contamination near home: Smoke and/or gas	-0.133	0.151	0.055	0.181	0.223***	0.060
Contamination near home: Noise from factory	-0.496***	0.085	0.274*	0.135	0.586***	0.104
Contamination near home: Waste from factory	0.343	0.214	0.155	0.185	-0.351***	0.083
Contamination near home: Noise from plant	0.472***	0.068	-0.418***	0.095	0.057	0.058
Contamination near home: Gas/LP fill station	-0.381	0.240	2.066***	0.278	-0.109	0.095
Contamination near home: Gasoline station	-0.329	0.181	-1.404**	0.445	-0.064	0.157
Contamination near home: Music	0.113*	0.044	-0.265	0.069	0.074*	0.035
Contamination near home: No contamination	-0.185*	0.077	0.128	0.079	0.220***	0.062
Urban residence	0.210	0.131	0.044	0.121	0.017	0.067
Percentage of households receiving remittances	0.017**	0.005	0.011	0.009	0.012*	0.006
Percentage of households engaged in agriculture	-0.001	0.006	0.002	0.006	0.008	0.005
Percentage of population of Haitian extraction	0.102*	0.050	0.113***	0.018	0.068***	0.013
Percentage of school-aged children matriculated	-0.028*	0.012	0.031***	0.008	0.016*	0.007
Percentage of households that are female-headed	-0.012*	0.005	0.044***	0.007	-0.003	0.003

[†]: $p < 0.06$; *: $p < 0.05$; **: $p < 0.01$; ***: $p < 0.001$

^a Models may differ somewhat from zone to zone due to collinearity concerns and constant values.

Appendix 6 (continued): Regression Models^a for the Estimation of Height-for-Age Z-scores

	Zone III Cibao Nordeste		Zone IV Cibao Noroeste		Zone V Valdesia	
N	1,170		938		1,419	
R-Squared	0.155		0.242		0.172	
Adj. R-Squared	0.142		0.223		0.164	
	B	SE	B	SE	B	SE
Percentage of household heads who have completed only primary school	0.066***	0.012	0.060***	0.014	0.009	0.014
Percentage of household heads who have completed through secondary school	-0.024	0.013	-0.049*	0.022	0.032**	0.012
Percentage of household heads who have at least some tertiary education	0.058***	0.009	0.048**	0.014	0.007	0.009
Percentage of households that have dwellings with floors made of cement	0.004	0.006	-0.023***	0.005	-0.004	0.003
Percentage of households that have dwellings with roofs made of cement	0.004	0.004	-0.007	0.006	-0.009**	0.003
Percentage of households that have dwellings with walls made of cement	-0.004	0.003	-0.003	0.004	-0.002	0.002
Percentage of households with access to a toilet	-0.010**	0.004	-0.008*	0.004	0.004	0.003
Percentage of households with access to piped water	0.004***	0.001	0.007***	0.001	0.003*	0.001
Percentage of households with garbage collection	-0.006*	0.002	-0.001	0.002	-0.005***	0.001
Percentage of households that have electricity	0.000	0.003	0.006	0.004	-0.010***	0.002
Percentage of households that use natural gas or propane for fuel	-0.005	0.004	-0.014	0.008	0.021***	0.003
Percentage of area within 5 km of a major road	0.006***	0.002	-0.008**	0.003	-0.001	0.001
Distance in kilometers to nearest major urban center	-0.003	0.003	-0.010**	0.003	0.003	0.005
Distance in kilometers to nearest hospital	0.020	0.011	0.062***	0.011	-0.012	0.007
Number of health care facilities per 1000 persons	-1.061**	0.334	0.387	0.306	0.347	0.252
Population density	-0.001	0.000	0.001*	0.000	0.000	0.000
Mean elevation in meters	0.001 [†]	0.000	0.000	0.001	0.000*	0.000
Elevation range – slope	0.000*	0.000	0.000	0.000	0.000	0.000
Land type: Percentage of area that is arid	-	-	-0.018***	0.004	-0.006**	0.002
Land type: Percentage of area that is humid	-	-	-	-	-0.009***	0.002
Land type: Percentage of area that is semi-arid	-	-	-0.014***	0.004	-0.003*	0.002
Land type: Percentage of area that is semi-humid	0.005**	0.002	-0.084***	0.014	-0.006***	0.002
Land type: Percentage of area that is island	-	-	-	-	-	-
Number of droughts from 1996-2000	-	-	-	-	0.276*	0.140
Number of floods from 1996-2000	-0.067*	0.033	0.115**	0.034	0.078	0.065
Province on the <i>frontera</i> with Haiti	-	-	0.099	0.211	-	-

[†]: $p < 0.06$; *: $p < 0.05$; **: $p < 0.01$; ***: $p < 0.001$

^a Models may differ somewhat from zone to zone due to collinearity concerns and constant values.

Appendix 6: Regression Models^a for the Estimation of Height-for-Age Z-scores

	Zone VI El Valle		Zone VII Enriquillo		Zone VIII Yuma	
N	634		1,380		966	
R-Squared	0.289		0.240		0.145	
Adj. R-Squared	0.268		0.221		0.131	
	B	SE	B	SE	B	SE
Constant	-1.394	1.072	-1.367	0.958	5.571*	2.285
Age 12 to 23 months	-0.117	0.076	-0.460***	0.069	-0.275***	0.059
Age 24 to 35 months	-0.206**	0.072	-0.285***	0.067	0.021	0.059
Age 36 to 59 months	-0.280***	0.068	-0.323***	0.062	0.000	0.055
Child is female	0.034	0.043	0.214***	0.039	0.050	0.031
Child is related to head of household, but not son/daughter	0.641***	0.065	-0.112 [†]	0.057	-0.019	0.048
Child is not related to head of household	1.730***	0.226	-0.447*	0.195	-0.173	0.099
Household head has some primary education	0.164*	0.076	-0.189**	0.062	-0.097	0.068
Household head has completed primary education	0.224	0.124	-0.475***	0.103	-0.309***	0.084
Household head has some secondary education	0.139	0.125	-0.082	0.101	-0.108	0.088
Household head has completed secondary education	0.019	0.142	-0.578***	0.121	-0.285**	0.103
Household head has tertiary education	0.649***	0.167	-0.654***	0.142	-0.195	0.120
Household head provided no education information	0.201*	0.079	-0.311***	0.069	0.138 [†]	0.072
Highest number of years of education completed by an adult male in household	-0.008	0.020	0.026	0.015	0.030*	0.013
Highest number of years of education completed by an adult male in household, squared	0.000	0.001	0.001	0.001	-0.001	0.001
Highest number of years of education completed by an adult female in household	-0.033*	0.016	-0.018	0.014	0.040**	0.012
Highest number of years of education completed by an adult female in household, squared	0.003**	0.001	0.002*	0.001	-0.002**	0.001
Female-headed household	0.295**	0.108	0.036	0.072	0.044	0.060
Household head is single	0.218	0.269	-0.229	0.175	0.234*	0.116
Household head is divorced or is not living together with partner/is separated	-0.310**	0.118	0.107	0.085	0.070	0.068
Household head is widowed	-0.847***	0.136	0.208 [†]	0.106	0.081	0.100
Number of children under 5 years of age	-0.040	0.030	-0.062*	0.028	-0.091***	0.026
Number of adult females	-0.192***	0.044	-0.053	0.031	-0.060*	0.029
Dependency ratio	-0.086	0.211	0.343	0.182	-0.493**	0.145
Air conditioner	0.023	0.422	1.043***	0.207	-0.069	0.102
Computer	-	-	0.210	0.161	0.055	0.076
Radio or Stereo	0.148**	0.049	0.062	0.042	0.078*	0.037
Refrigerator	-0.051	0.072	0.147**	0.052	0.291***	0.044
Stove	0.229**	0.076	0.122	0.088	-0.260**	0.079
Television	0.184**	0.059	0.066	0.052	-0.024	0.045
Washing machine	-0.413***	0.068	0.167**	0.052	0.176***	0.042
Home has floor made from marble/tile	0.124	0.433	0.228	0.203	0.090	0.111
Home has floor made from earth/dirt	-0.144*	0.061	-0.134*	0.064	0.156 [†]	0.080
Home has floor made of wood, other materials, or information was not provided	-0.450**	0.157	0.228	0.188	0.235	0.151
Home has roof made from cement	-0.118	0.118	-0.009	0.085	-0.028	0.049
Home has roof made from asbestos	-	-	0.017	0.130	0.129	0.366
Home has roof made from palm materials	-1.013***	0.137	0.228*	0.091	0.156	0.175
Home has roof made from other materials or information was not provided	0.830***	0.194	0.024	0.226	0.912***	0.176

[†]: $p < 0.06$; *: $p < 0.05$; **: $p < 0.01$; ***: $p < 0.001$

^a Models may differ somewhat from zone to zone due to collinearity concerns and constant values.

Appendix 6 (continued): Regression Models^a for the Estimation of Height-for-Age Z-scores

	Zone VI El Valle		Zone VII Enriquillo		Zone VIII Yuma	
N	634		1,380		966	
R-Squared	0.289		0.240		0.145	
Adj. R-Squared	0.268		0.221		0.131	
	B	SE	B	SE	B	SE
Home has walls made from shingles	1.153***	0.110	-0.094	0.146	-	-
Home has walls made from wood	-0.245***	0.060	0.125*	0.054	-0.110*	0.045
Home has walls made from palm materials	0.136	0.090	0.079	0.070	-0.398***	0.076
Home has walls made from other materials, including dung, or information was not provided	-0.088	0.144	0.057	0.140	-0.003	0.065
Number of persons per room - crowding	0.059*	0.026	-0.100***	0.018	-0.042*	0.018
Household has access to a latrine	-0.253**	0.084	-0.059	0.067	-0.165***	0.046
Household has no access to sanitary facilities or information on facilities not provided	-0.341**	0.100	0.077	0.090	-0.131	0.074
Source of household water – Well water	0.278*	0.139	0.052	0.088	0.023	0.057
Source of household water – Tanker truck water	0.947*	0.419	0.108	0.096	-0.047	0.056
Source of household water – Surface water, river	0.170	0.091	-0.330**	0.099	0.073	0.116
Source of household water – Rainwater	-	-	-0.194	0.171	0.158	0.111
Source of household water – Other sources, or information not provided	-0.660**	0.196	-0.170	0.349	-1.571*	0.650
Household garbage burnt	0.137	0.091	0.159*	0.064	-0.026	0.051
Household garbage thrown in yard /near dwelling	-0.062	0.106	0.022	0.073	0.006	0.059
Household garbage thrown outside homestead	-0.698***	0.118	-0.074	0.115	0.440***	0.122
Household garbage information not provided	-0.917***	0.247	-0.020	0.185	0.011	0.129
Household has electricity	0.109	0.094	-0.279*	0.111	0.232*	0.091
Household has telephone service	0.069	0.095	-0.116	0.062	-0.051	0.044
Household uses charcoal for fuel	-0.268*	0.126	0.037	0.101	0.043	0.098
Household uses firewood for fuel	-0.309**	0.092	-0.418***	0.092	0.087	0.087
Household uses no fuel because there is no cooking	-0.515	0.444	0.262	0.211	-0.637***	0.178
Household uses other fuel sources (incl. Kerosene and electricity) or provided no information	-1.009*	0.452	1.049	0.672	1.475**	0.497
Contamination near home: Stagnant water	0.105	0.087	0.011	0.063	-0.065	0.043
Contamination near home: Garbage dump	-0.186*	0.077	0.288***	0.055	-0.076	0.042
Contamination near home: Stream/river with garbage	0.162*	0.082	0.101	0.067	0.036	0.058
Contamination near home: Traffic noise	0.039	0.050	-0.049	0.045	0.065	0.036
Contamination near home: Pigsty/farm	0.144	0.088	-0.088	0.062	-0.115*	0.057
Contamination near home: Smoke and/or gas	-1.047***	0.243	0.120	0.123	-0.332***	0.093
Contamination near home: Noise from factory	0.124	0.175	-0.117	0.146	-0.236**	0.089
Contamination near home: Waste from factory	0.383	0.255	0.456**	0.157	0.857***	0.127
Contamination near home: Noise from plant	0.019	0.141	-0.199	0.193	0.346***	0.067
Contamination near home: Gas/LP fill station	1.084 [†]	0.563	-0.957***	0.225	-0.012	0.294
Contamination near home: Gasoline station	-0.150	0.333	0.383*	0.193	0.320	0.185
Contamination near home: Music	-0.307***	0.071	-0.077	0.064	-0.109*	0.050
Contamination near home: No contamination	-0.020	0.100	-0.038	0.145	0.014	0.078
Urban residence	0.445	0.269	-0.156	0.151	-0.675	0.359
Percentage of households receiving remittances	0.078*	0.031	-0.007	0.006	0.033	0.029
Percentage of households engaged in agriculture	0.014*	0.007	-0.029***	0.007	-0.023	0.013
Percentage of population of Haitian extraction	-0.042*	0.018	0.048***	0.009	-0.011	0.008
Percentage of school-aged children matriculated	-0.010	0.007	0.019**	0.006	-0.042*	0.016
Percentage of households that are female-headed	-0.002	0.013	-0.020***	0.005	0.021	0.012

[†]: $p < 0.06$; *: $p < 0.05$; **: $p < 0.01$; ***: $p < 0.001$

^a Models may differ somewhat from zone to zone due to collinearity concerns and constant values.

Appendix 6 (continued): Regression Models^a for the Estimation of Height-for-Age Z-scores

	Zone VI El Valle		Zone VII Enriquillo		Zone VIII Yuma	
N	634		1,380		966	
R-Squared	0.289		0.240		0.145	
Adj. R-Squared	0.268		0.221		0.131	
	B	SE	B	SE	B	SE
Percentage of household heads who have completed only primary school	0.049	0.036	-0.017	0.011	-0.022	0.028
Percentage of household heads who have completed through secondary school	-0.050	0.043	0.038*	0.016	-0.190*	0.083
Percentage of household heads who have at least some tertiary education	0.093**	0.032	-0.067***	0.018	-0.006	0.038
Percentage of households that have dwellings with floors made of cement	-0.012	0.009	0.008*	0.004	-0.007	0.011
Percentage of households that have dwellings with roofs made of cement	0.046***	0.009	0.001	0.006	0.025**	0.010
Percentage of households that have dwellings with walls made of cement	0.003	0.004	0.009*	0.004	0.009	0.008
Percentage of households with access to a toilet	-0.030**	0.010	0.008	0.006	-0.012	0.012
Percentage of households with access to piped water	0.006**	0.002	-0.006***	0.002	0.007	0.004
Percentage of households with garbage collection	0.008*	0.004	-0.002	0.003	0.007	0.005
Percentage of households that have electricity	0.004	0.003	-0.001	0.003	0.024**	0.008
Percentage of households that use natural gas or propane for fuel	-0.023***	0.006	0.006	0.004	-0.021	0.011
Percentage of area within 5 km of a major road	-0.007 [†]	0.004	0.002	0.002	-0.021***	0.005
Distance in kilometers to nearest major urban center	0.021**	0.008	-0.013**	0.005	-0.012	0.011
Distance in kilometers to nearest hospital	0.018	0.015	0.021	0.014	0.128**	0.038
Number of health care facilities per 1000 persons	1.288**	0.492	0.943**	0.281	-	-
Population density	0.005	0.003	0.000	0.000	-0.002*	0.001
Mean elevation in meters	0.000	0.000	0.001*	0.000	-0.002	0.004
Elevation range – slope	0.000	0.000	0.000	0.000	-0.001*	0.000
Land type: Percentage of area that is arid	0.130	0.074	0.000	0.003	-	-
Land type: Percentage of area that is humid	-	-	0.011	0.007	-	-
Land type: Percentage of area that is semi-arid	-0.011**	0.003	0.002	0.002	-	-
Land type: Percentage of area that is semi-humid	0.000	0.002	-0.010**	0.004	-0.014 [†]	0.007
Land type: Percentage of area that is island	-	-	-0.234**	0.074	-	-
Number of droughts from 1996-2000	-	-	0.311	0.171	-	-
Number of floods from 1996-2000	-	-	-	-	0.272*	0.125
Province on the <i>frontera</i> with Haiti	-1.138***	0.245	-0.159	0.144	-	-

[†]: $p < 0.06$; *: $p < 0.05$; **: $p < 0.01$; ***: $p < 0.001$

^a Models may differ somewhat from zone to zone due to collinearity concerns and constant values.

Appendix 6: Regression Models^a for the Estimation of Height-for-Age Z-scores

	Zone IX Higüamo		Zone X Ozama	
N	889		730	
R-Squared	0.229		0.202	
Adj. R-Squared	0.217		0.200	
	B	SE	B	SE
Constant	-3.769**	1.120	-45.803***	6.560
Age 12 to 23 months	-0.433**	0.053	-0.277***	0.032
Age 24 to 35 months	-0.071	0.053	0.225***	0.032
Age 36 to 59 months	-0.231***	0.049	0.264***	0.030
Child is female	0.025	0.031	0.137***	0.016
Child is related to head of household, but not son/daughter	-0.087	0.052	-0.286***	0.026
Child is not related to head of household	1.062***	0.112	-0.492***	0.068
Household head has some primary education	0.083	0.073	0.275***	0.045
Household head has completed primary education	0.233*	0.090	0.439**	0.048
Household head has some secondary education	0.141	0.091	0.198***	0.049
Household head has completed secondary education	0.056	0.099	0.476***	0.051
Household head has tertiary education	-0.122	0.131	0.467***	0.058
Household head provided no education information	0.233**	0.081	0.702***	0.049
Highest number of years of education completed by an adult male in household	-0.007	0.014	0.030***	0.006
Highest number of years of education completed by an adult male in household, squared	0.003**	0.001	-0.003***	0.000
Highest number of years of education completed by an adult female in household	-0.061***	0.014	-0.077***	0.007
Highest number of years of education completed by an adult female in household, squared	0.006***	0.001	0.006***	0.000
Female-headed household	0.446***	0.065	-0.009	0.030
Household head is single	0.019	0.135	0.317***	0.063
Household head is divorced or is not living together with partner/is separated	-0.474***	0.072	-0.069*	0.033
Household head is widowed	-0.142	0.099	0.032	0.047
Number of children under 5 years of age	-0.064*	0.025	0.094***	0.014
Number of adult females	0.053	0.034	-0.038**	0.013
Dependency ratio	-0.050	0.156	-1.235***	0.073
Air conditioner	0.396**	0.137	-0.266***	0.034
Computer	0.098	0.112	0.218***	0.025
Radio or Stereo	0.193***	0.036	0.227***	0.019
Refrigerator	0.083*	0.039	-0.094***	0.024
Stove	0.181*	0.074	0.125	0.073
Television	0.227***	0.046	0.045	0.028
Washing machine	-0.059	0.039	0.171***	0.022
Home has floor made from marble/tile	0.191	0.133	-0.271***	0.031
Home has floor made from earth/dirt	-0.133 [†]	0.070	0.269***	0.052
Home has floor made of wood, other materials, or information was not provided	-0.046	0.189	-0.087	0.096
Home has roof made from cement	0.176**	0.057	0.101***	0.022
Home has roof made from asbestos	-	-	-	-
Home has roof made from palm materials	1.163***	0.231	-	-
Home has roof made from other materials or information was not provided	-0.186	0.336	-2.279***	0.126

[†]: $p < 0.06$; *: $p < 0.05$; **: $p < 0.01$; ***: $p < 0.001$

^a Models may differ somewhat from zone to zone due to collinearity concerns and constant values.

Appendix 6 (continued): Regression Models^a for the Estimation of Height-for-Age Z-scores

	Zone IX Higüamo		Zone X Ozama	
N	889		730	
R-Squared	0.229		0.202	
Adj. R-Squared	0.217		0.200	
	B	SE	B	SE
Home has walls made from shingles	-	-	-	-
Home has walls made from wood	0.107**	0.041	-0.052*	0.025
Home has walls made from palm materials	0.154*	0.068	-0.967***	0.193
Home has walls made from other materials, including dung, or information was not provided	0.251***	0.072	-0.078	0.052
Number of persons per room - crowding	-0.055**	0.019	-0.032**	0.012
Household has access to a latrine	0.036	0.047	-0.016	0.025
Household has no access to sanitary facilities or information on facilities not provided	-0.067	0.067	0.050	0.048
Source of household water – Well water	-0.059	0.054	-0.046	0.064
Source of household water – Tanker truck water	0.782***	0.087	0.379***	0.043
Source of household water – Surface water, river	0.078	0.089	-	-
Source of household water – Rainwater	0.940***	0.105	-0.029	0.107
Source of household water – Other sources, or information not provided	0.645***	0.150	0.339***	0.094
Household garbage burnt	-0.078	0.051	-0.317***	0.069
Household garbage thrown in yard /near dwelling	-0.183**	0.059	-0.182***	0.039
Household garbage thrown outside homestead	1.240***	0.139	-0.022	0.039
Household garbage information not provided	0.479**	0.143	0.117*	0.049
Household has electricity	0.023	0.080	1.149***	0.154
Household has telephone service	-0.133**	0.046	-0.031	0.021
Household uses charcoal for fuel	0.154	0.107	1.006***	0.210
Household uses firewood for fuel	0.105	0.079	-0.143	0.220
Household uses no fuel because there is no cooking	0.102	0.240	-0.377***	0.102
Household uses other fuel sources (incl. Kerosene and electricity) or provided no information	1.122	0.650	-	-
Contamination near home: Stagnant water	0.230***	0.038	-0.086***	0.022
Contamination near home: Garbage dump	-0.056	0.046	-0.144***	0.022
Contamination near home: Stream/river with garbage	-0.003	0.052	-0.033	0.026
Contamination near home: Traffic noise	-0.063	0.037	0.011	0.019
Contamination near home: Pigsty/farm	-0.159**	0.048	0.434***	0.054
Contamination near home: Smoke and/or gas	-0.127	0.117	0.223***	0.041
Contamination near home: Noise from factory	0.479***	0.093	0.079*	0.033
Contamination near home: Waste from factory	0.239*	0.105	-0.207***	0.043
Contamination near home: Noise from plant	-0.195 [†]	0.101	-0.139***	0.035
Contamination near home: Gas/LP fill station	0.345**	0.120	0.053	0.052
Contamination near home: Gasoline station	1.544***	0.226	0.548***	0.084
Contamination near home: Music	-0.218***	0.053	-0.045*	0.021
Contamination near home: No contamination	-0.277	0.069	-0.235***	0.037
Urban residence	0.224	0.162	-0.269**	0.082
Percentage of households receiving remittances	-0.016	0.013	-	-
Percentage of households engaged in agriculture	-0.005	0.006	0.499***	0.057
Percentage of population of Haitian extraction	0.047***	0.005	-0.219***	0.037
Percentage of school-aged children matriculated	0.032*	0.014	0.099*	0.046
Percentage of households that are female-headed	0.015	0.009	-0.097***	0.015

[†]: $p < 0.06$; *: $p < 0.05$; **: $p < 0.01$; ***: $p < 0.001$

^a Models may differ somewhat from zone to zone due to collinearity concerns and constant values.

Appendix 6 (continued): Regression Models^a for the Estimation of Height-for-Age Z-scores

	Zone IX Higüamo		Zone X Ozama	
N	889		730	
R-Squared	0.229		0.202	
Adj. R-Squared	0.217		0.200	
	B	SE	B	SE
Percentage of household heads who have completed only primary school	0.074***	0.020	-	-
Percentage of household heads who have completed through secondary school	0.005	0.025	-0.010	0.023
Percentage of household heads who have at least some tertiary education	0.018	0.015	-	-
Percentage of households that have dwellings with floors made of cement	-0.011	0.011	-	-
Percentage of households that have dwellings with roofs made of cement	-0.026***	0.007	0.016***	0.002
Percentage of households that have dwellings with walls made of cement	0.008	0.005	-	-
Percentage of households with access to a toilet	0.023**	0.007	-	-
Percentage of households with access to piped water	0.001	0.002	0.018***	0.004
Percentage of households with garbage collection	-0.014***	0.004	-0.020**	0.006
Percentage of households that have electricity	0.015**	0.005	0.382***	0.042
Percentage of households that use natural gas or propane for fuel	-0.020**	0.007	-	-
Percentage of area within 5 km of a major road	-0.003 [†]	0.002	-	-
Distance in kilometers to nearest major urban center	0.001	0.005	-	-
Distance in kilometers to nearest hospital	-0.041**	0.013	-	-
Number of health care facilities per 1000 persons	0.002	0.352	-0.376	0.300
Population density	0.000	0.000	0.000***	0.000
Mean elevation in meters	0.000	0.001	-0.005	0.003
Elevation range – slope	-0.001	0.000	-	-
Land type: Percentage of area that is arid	-	-	-	-
Land type: Percentage of area that is humid	0.004	0.004	-	-
Land type: Percentage of area that is semi-arid	-	-	-	-
Land type: Percentage of area that is semi-humid	0.007**	0.003	0.003	0.002
Land type: Percentage of area that is island	-	-	-	-
Number of droughts from 1996-2000	-	-	-	-
Number of floods from 1996-2000	-	-	-	-
Province on the <i>frontera</i> with Haiti	-	-	-	-

[†]: $p < 0.06$; *: $p < 0.05$; **: $p < 0.01$; ***: $p < 0.001$

^a Models may differ somewhat from zone to zone due to collinearity concerns and constant values.

Appendix 7: Regression Models^a for the Estimation of Weight-for-Height Z-scores

	National-level Regression Model		Zone I Cibao Norte		Zone II Cibao Sur	
N	10,266		1,021		999	
R-Squared	0.062		0.140		0.140	
Adj. R-Squared	0.061		0.135		0.130	
	B	SE	B	SE	B	SE
Constant	0.590***	0.143	-1.724 [†]	0.900	3.1588	1.237
Age 12 to 23 months	-0.232***	0.014	-0.306***	0.036	-0.422***	0.043
Age 24 to 35 months	-0.335***	0.013	-0.374***	0.035	-0.546***	0.044
Age 36 to 59 months	-0.147***	0.013	-0.124***	0.033	-0.512***	0.039
Child is female	0.095***	0.007	0.105***	0.019	0.070**	0.024
Child is related to head of household, but not son/daughter	0.009	0.011	0.241***	0.031	-0.049	0.040
Child is not related to head of household	0.038	0.028	0.137*	0.066	-0.291**	0.100
Household head has some primary education	0.115***	0.015	0.159***	0.037	0.177**	0.052
Household head has completed primary education	0.089***	0.018	0.098*	0.045	-0.002	0.064
Household head has some secondary education	0.069***	0.019	0.235***	0.047	0.361***	0.070
Household head has completed secondary education	0.180***	0.021	0.242***	0.054	0.183*	0.073
Household head has tertiary education	0.119***	0.025	0.614***	0.064	-0.117	0.084
Household head provided no education information	0.080***	0.017	0.041	0.041	0.142*	0.055
Highest number of years of education completed by an adult male in household	0.002	0.003	0.006	0.008	-0.049***	0.010
Highest number of years of education completed by an adult male in household, squared	0.000	0.000	-0.001*	0.001	0.003***	0.001
Highest number of years of education completed by an adult female in household	-0.017***	0.003	-0.003	0.007	-0.038***	0.010
Highest number of years of education completed by an adult female in household, squared	0.002***	0.000	0.000	0.000	0.003***	0.001
Female-headed household	-0.127***	0.014	0.034	0.035	0.013	0.052
Household head is single	0.228***	0.030	0.385***	0.080	-0.042	0.100
Household head is divorced or is not living together with partner/is separated	0.097***	0.016	-0.199***	0.039	0.106	0.056
Household head is widowed	0.028	0.021	-0.169**	0.053	-0.187*	0.072
Number of children under 5 years of age	-0.004	0.006	0.049**	0.016	-0.103***	0.018
Number of adult females	-0.010	0.006	0.042*	0.017	0.027	0.023
Dependency ratio	-0.344***	0.033	-0.519***	0.086	-0.065	0.112
Air conditioner	-0.184***	0.022	-0.246***	0.061	-0.003	0.101
Computer	0.016	0.016	-0.067	0.047	-0.309***	0.080
Radio or Stereo	0.017*	0.008	0.047*	0.022	-0.008	0.027
Refrigerator	0.002	0.010	-0.272***	0.025	-0.001	0.031
Stove	0.004	0.019	0.233***	0.056	0.121	0.066
Television	-0.010	0.011	0.214***	0.031	0.033	0.035
Washing machine	0.107***	0.009	0.172***	0.023	-0.007	0.031
Home has floor made from marble/tile	-0.064**	0.020	0.023	0.052	0.142	0.083
Home has floor made from earth/dirt	-0.096***	0.017	-0.092*	0.047	0.161*	0.063
Home has floor made of wood, other materials, or information was not provided	0.084*	0.034	0.037	0.093	0.789***	0.152
Home has roof made from cement	0.052***	0.011	-0.143***	0.030	0.082 [†]	0.042
Home has roof made from asbestos	0.383***	0.067	2.041***	0.242	0.061	0.149
Home has roof made from palm materials	0.020	0.033	0.067	0.094	-	-
Home has roof made from other materials or information was not provided	-0.162**	0.054	0.855*	0.392	-0.294	0.169

[†]: $p < 0.06$; *: $p < 0.05$; **: $p < 0.01$; ***: $p < 0.001$

^a Models may differ somewhat from zone to zone due to collinearity concerns and constant values.

Appendix 7 (continued): Regression Models^a for the Estimation of Weight-for-Height Z-scores

	National-level Regression Model		Zone I Cibao Norte		Zone II Cibao Sur	
N	10,266		1,021		999	
R-Squared	0.062		0.140		0.140	
Adj. R-Squared	0.061		0.135		0.130	
	B	SE	B	SE	B	SE
Home has walls made from shingles	-0.021	0.047	-	-	0.037	0.294
Home has walls made from wood	0.076***	0.010	0.011	0.026	0.048	0.032
Home has walls made from palm materials	0.164***	0.017	0.231***	0.046	0.008	0.048
Home has walls made from other materials, including dung, or information was not provided	0.050*	0.021	0.416***	0.089	-0.309***	0.076
Number of persons per room - crowding	-0.038***	0.005	-0.138***	0.013	-0.041*	0.019
Household has access to a latrine	-0.101***	0.011	-0.191***	0.027	-0.127***	0.035
Household has no access to sanitary facilities or information on facilities not provided	-0.054**	0.018	-0.022	0.052	-0.315***	0.069
Source of household water – Well water	0.022	0.016	0.284***	0.059	-0.023	0.043
Source of household water – Tanker truck water	-0.155***	0.017	0.035	0.062	-0.140	0.111
Source of household water – Surface water, river	-0.098***	0.021	-0.135	0.070	-0.049	0.057
Source of household water – Rainwater	-0.104***	0.027	-0.234**	0.076	0.227*	0.113
Source of household water – Other sources, or information not provided	0.072	0.047	0.913***	0.258	-0.412*	0.163
Household garbage burnt	-0.068***	0.013	-0.286***	0.033	-0.071	0.038
Household garbage thrown in yard /near dwelling	-0.094***	0.014	-0.063	0.039	-0.214***	0.051
Household garbage thrown outside homestead	-0.036	0.019	-0.158***	0.043	-0.342**	0.100
Household garbage information not provided	-0.130***	0.028	-0.057	0.079	0.188	0.144
Household has electricity	0.044*	0.022	0.121	0.083	0.148*	0.071
Household has telephone service	0.123***	0.010	0.219***	0.024	-0.013	0.032
Household uses charcoal for fuel	-0.045	0.030	0.158	0.163	-0.566	0.322
Household uses firewood for fuel	-0.101***	0.019	-0.240***	0.052	-0.035	0.060
Household uses no fuel because there is no cooking	0.216***	0.039	0.373***	0.089	0.561***	0.128
Household uses other fuel sources (incl. Kerosene and electricity) or provided no information	-0.335**	0.115	-	-	-	-
Contamination near home: Stagnant water	-0.017	0.010	-0.018	0.028	0.012	0.037
Contamination near home: Garbage dump	-0.076***	0.010	-0.125***	0.029	-0.177***	0.038
Contamination near home: Stream/river with garbage	0.018	0.011	0.093***	0.026	-0.069	0.039
Contamination near home: Traffic noise	0.030***	0.008	0.058**	0.022	0.049 [†]	0.026
Contamination near home: Pigsty/farm	0.038**	0.012	-0.099***	0.028	-0.010	0.036
Contamination near home: Smoke and/or gas	-0.105***	0.020	0.043	0.050	0.165*	0.068
Contamination near home: Noise from factory	-0.013	0.019	0.127*	0.053	0.132*	0.064
Contamination near home: Waste from factory	0.140***	0.024	0.225***	0.061	0.082	0.099
Contamination near home: Noise from plant	0.021	0.017	-0.278***	0.046	0.096	0.056
Contamination near home: Gas/LP fill station	-0.087**	0.031	-0.771***	0.110	0.174	0.150
Contamination near home: Gasoline station	-0.101*	0.044	-0.584***	0.147	0.251	0.140
Contamination near home: Music	-0.037**	0.011	-0.061*	0.030	-0.042	0.038
Contamination near home: No contamination	0.025	0.017	-0.170***	0.046	0.070	0.059
Urban residence	0.067***	0.016	-0.448***	0.084	-0.135	0.142
Percentage of households receiving remittances	0.001	0.001	0.008	0.006	0.049***	0.009
Percentage of households engaged in agriculture	-0.002 [†]	0.001	0.021***	0.006	0.028***	0.005
Percentage of population of Haitian extraction	-0.009***	0.001	-0.070***	0.016	-0.045	0.042
Percentage of school-aged children matriculated	0.004*	0.002	0.032***	0.008	-0.053***	0.013
Percentage of households that are female-headed	0.001	0.001	0.005	0.004	0.021**	0.006

[†]: $p < 0.06$; *: $p < 0.05$; **: $p < 0.01$; ***: $p < 0.001$

^a Models may differ somewhat from zone to zone due to collinearity concerns and constant values.

Appendix 7 (continued): Regression Models^a for the Estimation of Weight-for-Height Z-scores

	National-level Regression Model		Zone I Cibao Norte		Zone II Cibao Sur	
N	10,266		1,021		999	
R-Squared	0.062		0.140		0.140	
Adj. R-Squared	0.061		0.135		0.130	
	B	SE	B	SE	B	SE
Percentage of household heads who have completed only primary school	-0.004	0.003	-0.018	0.013	0.038**	0.013
Percentage of household heads who have completed through secondary school	0.001	0.003	0.008	0.012	0.095***	0.016
Percentage of household heads who have at least some tertiary education	-0.010***	0.001	0.011	0.010	-0.029**	0.010
Percentage of households that have dwellings with floors made of cement	-0.001	0.001	-0.014**	0.005	0.012*	0.006
Percentage of households that have dwellings with roofs made of cement	-0.001	0.001	0.011*	0.005	0.011*	0.005
Percentage of households that have dwellings with walls made of cement	0.002***	0.000	-0.001	0.003	0.018***	0.004
Percentage of households with access to a toilet	0.000	0.001	-0.009**	0.003	-0.006	0.003
Percentage of households with access to piped water	-0.001*	0.000	0.002	0.001	0.000	0.001
Percentage of households with garbage collection	0.000	0.000	0.000	0.002	-0.002	0.002
Percentage of households that have electricity	-0.002**	0.001	-0.014**	0.004	0.001	0.003
Percentage of households that use natural gas or propane for fuel	-0.003***	0.001	0.014***	0.003	-0.020***	0.004
Percentage of area within 5 km of a major road	-0.001*	0.000	0.000	0.002	0.031***	0.006
Distance in kilometers to nearest major urban center	-0.001**	0.000	-0.008**	0.003	-0.026***	0.006
Distance in kilometers to nearest hospital	-0.012***	0.001	-0.037***	0.008	-0.170***	0.020
Number of health care facilities per 1000 persons	-0.142**	0.050	-0.086	0.287	-6.856***	1.128
Population density	0.000***	0.000	0.000**	0.000	-0.002***	0.001
Mean elevation in meters	0.000	0.000	0.000	0.000	0.001***	0.000
Elevation range – slope	0.000***	0.000	0.000	0.000	0.001***	0.000
Land type: Percentage of area that is arid	0.000	0.000	-	-	-	-
Land type: Percentage of area that is humid	0.002***	0.000	-	-	-	-
Land type: Percentage of area that is semi-arid	-0.001***	0.000	0.001	0.001	-	-
Land type: Percentage of area that is semi-humid	0.000*	0.000	0.010***	0.002	0.010***	0.002
Land type: Percentage of area that is island	0.001	0.001	-	-	-	-
Number of droughts from 1996-2000	-0.013	0.007	0.935*	0.457	0.889***	0.194
Number of floods from 1996-2000	0.029***	0.003	-0.140	0.131	-0.751***	0.129
Province on the <i>frontera</i> with Haiti	0.060*	0.025	-	-	-	-

[†]: $p < 0.06$; *: $p < 0.05$; **: $p < 0.01$; ***: $p < 0.001$

^a Models may differ somewhat from zone to zone due to collinearity concerns and constant values.

Appendix 7 (continued): Regression Models^a for the Estimation of Weight-for-Height Z-scores

	Zone III Cibao Nordeste		Zone IV Cibao Noroeste		Zone V Valdesia	
N	1,179		952		1,438	
R-Squared	0.122		0.195		0.101	
Adj. R-Squared	0.109		0.174		0.093	
	B	SE	B	SE	B	SE
Constant	0.230	1.284	-1.549	0.890	0.365	0.444
Age 12 to 23 months	-0.154**	0.048	-0.230 [†]	0.058	-0.066*	0.037
Age 24 to 35 months	-0.402***	0.049	-0.361 [†]	0.059	-0.082*	0.037
Age 36 to 59 months	-0.229***	0.045	-0.188 [†]	0.054	-0.093*	0.034
Child is female	0.190***	0.027	0.118*	0.031	-0.077*	0.021
Child is related to head of household, but not son/daughter	-0.031	0.043	0.055 [†]	0.052	-0.040*	0.033
Child is not related to head of household	0.209 [†]	0.108	-0.039	0.110	0.136	0.081
Household head has some primary education	0.079	0.057	0.012	0.061	0.124*	0.041
Household head has completed primary education	0.017	0.073	0.160	0.081	0.079 [†]	0.055
Household head has some secondary education	-0.087	0.075	0.159	0.086	-0.028 [†]	0.056
Household head has completed secondary education	0.075	0.082	0.038	0.102	0.163	0.064
Household head has tertiary education	-0.105	0.093	0.223	0.115	0.585	0.073
Household head provided no education information	0.053	0.065	0.007	0.069	0.153*	0.049
Highest number of years of education completed by an adult male in household	-0.074***	0.011	0.042*	0.013	0.026**	0.008
Highest number of years of education completed by an adult male in household, squared	0.006***	0.001	-0.003**	0.001	-0.003**	0.001
Highest number of years of education completed by an adult female in household	0.013	0.012	-0.033*	0.013	-0.002**	0.009
Highest number of years of education completed by an adult female in household, squared	0.000	0.001	0.003**	0.001	0.000**	0.001
Female-headed household	-0.156**	0.055	-0.206	0.061	-0.320*	0.040
Household head is single	0.549***	0.133	-0.475	0.126	0.374	0.097
Household head is divorced or is not living together with partner/is separated	0.045	0.060	0.175	0.068	0.297*	0.047
Household head is widowed	0.078	0.076	0.058	0.099	0.380 [†]	0.059
Number of children under 5 years of age	-0.001	0.023	0.088*	0.028	0.025*	0.018
Number of adult females	-0.052*	0.026	-0.096*	0.033	-0.093*	0.019
Dependency ratio	-0.210	0.126	-0.519	0.153	-0.948	0.100
Air conditioner	0.463***	0.098	0.381	0.220	0.087	0.086
Computer	0.099	0.063	-0.037	0.093	-0.019 [†]	0.051
Radio or Stereo	-0.051	0.032	-0.147*	0.037	0.051*	0.024
Refrigerator	-0.026	0.038	0.175*	0.041	0.056*	0.029
Stove	0.103	0.064	0.234	0.080	-0.177*	0.047
Television	0.205***	0.042	0.137*	0.045	-0.154*	0.032
Washing machine	0.111**	0.035	-0.076*	0.042	0.114*	0.026
Home has floor made from marble/tile	0.006	0.079	0.752	0.136	-0.155	0.101
Home has floor made from earth/dirt	-0.284**	0.086	-0.087	0.065	-0.098*	0.049
Home has floor made of wood, other materials, or information was not provided	-0.338**	0.099	-0.259	0.172	0.099	0.093
Home has roof made from cement	0.078	0.051	-0.168	0.069	-0.007*	0.033
Home has roof made from asbestos	-0.293	0.290	3.220	0.464	0.201	0.278
Home has roof made from palm materials	0.279*	0.138	-0.011	0.081	-0.298	0.078
Home has roof made from other materials or information was not provided	-0.264	0.159	-0.787	0.210	-0.202	0.181

[†]: $p < 0.06$; *: $p < 0.05$; **: $p < 0.01$; ***: $p < 0.001$

^a Models may differ somewhat from zone to zone due to collinearity concerns and constant values.

Appendix 7 (continued): Regression Models^a for the Estimation of Weight-for-Height Z-scores

	Zone III Cibao Nordeste		Zone IV Cibao Noroeste		Zone V Valdesia	
N	1,179		952		1,438	
R-Squared	0.122		0.195		0.101	
Adj. R-Squared	0.109		0.174		0.093	
	B	SE	B	SE	B	SE
Home has walls made from shingles			-0.449	0.458	-0.126	0.088
Home has walls made from wood	0.103**	0.039	0.041*	0.044	-0.037*	0.029
Home has walls made from palm materials	0.136**	0.049	0.215	0.062	-0.060 [†]	0.054
Home has walls made from other materials, including dung, or information was not provided	0.071	0.095	0.415	0.139	-0.074 [†]	0.058
Number of persons per room - crowding	-0.048*	0.023	0.010*	0.023	0.018*	0.013
Household has access to a latrine	-0.001	0.044	0.089*	0.048	-0.090*	0.030
Household has no access to sanitary facilities or information on facilities not provided	0.057	0.070	-0.332	0.090	0.047 [†]	0.053
Source of household water – Well water	0.115*	0.048	-0.043	0.123	-0.321	0.078
Source of household water – Tanker truck water	0.138	0.086	0.015 [†]	0.052	-0.059*	0.044
Source of household water – Surface water, river	0.220***	0.054	-0.197	0.073	-0.229	0.077
Source of household water – Rainwater	-0.072	0.059	-0.451	0.092	0.152	0.078
Source of household water – Other sources, or information not provided	0.866***	0.208	0.149	0.190	0.128	0.140
Household garbage burnt	-0.187***	0.050	-0.066*	0.049	0.001*	0.038
Household garbage thrown in yard /near dwelling	-0.197**	0.058	-0.084	0.076	-0.018*	0.043
Household garbage thrown outside homestead	-0.080	0.085	-0.330	0.208	0.093	0.069
Household garbage information not provided	-0.878***	0.147	0.326	0.173	-0.261	0.103
Household has electricity	-0.177*	0.074	-0.179	0.084	0.385	0.078
Household has telephone service	0.082*	0.037	-0.036*	0.044	0.304*	0.030
Household uses charcoal for fuel	0.360*	0.144	0.109	0.121	-0.268	0.071
Household uses firewood for fuel	-0.122*	0.059	-0.160	0.085	0.122*	0.050
Household uses no fuel because there is no cooking	0.464**	0.135	0.138	0.111	-1.232	0.145
Household uses other fuel sources (incl. Kerosene and electricity) or provided no information	-0.001	0.330	-1.033	0.199	-1.001	0.319
Contamination near home: Stagnant water	-0.171***	0.040	0.166*	0.049	-0.128*	0.029
Contamination near home: Garbage dump	-0.012	0.041	-0.178 [†]	0.052	0.069*	0.029
Contamination near home: Stream/river with garbage	0.110*	0.046	0.044 [†]	0.055	-0.220*	0.033
Contamination near home: Traffic noise	-0.112***	0.030	0.007*	0.035	-0.008*	0.024
Contamination near home: Pigsty/farm	0.169***	0.040	0.153*	0.046	0.185*	0.031
Contamination near home: Smoke and/or gas	-0.169	0.143	-0.171	0.165	-0.058 [†]	0.054
Contamination near home: Noise from factory	-0.027	0.080	0.607	0.123	-0.025	0.095
Contamination near home: Waste from factory	-0.380	0.203	-0.386	0.168	0.108	0.075
Contamination near home: Noise from plant	0.056	0.064	-0.049	0.086	-0.165 [†]	0.052
Contamination near home: Gas/LP fill station	-0.374	0.226	0.925	0.253	0.457	0.086
Contamination near home: Gasoline station	0.077	0.171	-0.682	0.405	-0.827	0.143
Contamination near home: Music	0.224***	0.041	-0.011	0.062	-0.112*	0.032
Contamination near home: No contamination	-0.010	0.073	0.029	0.071	-0.253 [†]	0.056
Urban residence	-0.284*	0.123	-0.144	0.109	-0.134 [†]	0.060
Percentage of households receiving remittances	0.008	0.005	0.048**	0.009	-0.005**	0.005
Percentage of households engaged in agriculture	-0.014**	0.005	0.006**	0.006	0.014**	0.004
Percentage of population of Haitian extraction	0.360***	0.048	0.012*	0.016	-0.025*	0.011
Percentage of school-aged children matriculated	-0.001	0.011	-0.006**	0.007	0.025**	0.006
Percentage of households that are female-headed	-0.004	0.005	-0.007**	0.006	-0.001**	0.002

[†]: $p < 0.06$; *: $p < 0.05$; **: $p < 0.01$; ***: $p < 0.001$

^a Models may differ somewhat from zone to zone due to collinearity concerns and constant values.

Appendix 7 (continued): Regression Models^a for the Estimation of Weight-for-Height Z-scores

	Zone III Cibao Nordeste		Zone IV Cibao Noroeste		Zone V Valdesia	
N	1,179		952		1,438	
R-Squared	0.122		0.195		0.101	
Adj. R-Squared	0.109		0.174		0.093	
	B	SE	B	SE	B	SE
Percentage of household heads who have completed only primary school	-0.027*	0.011	-0.003*	0.012	-0.007*	0.013
Percentage of household heads who have completed through secondary school	-0.029*	0.012	-0.034*	0.020	-0.005*	0.011
Percentage of household heads who have at least some tertiary education	0.033***	0.009	-0.038*	0.013	0.032**	0.008
Percentage of households that have dwellings with floors made of cement	0.012*	0.005	-0.005**	0.005	-0.008**	0.003
Percentage of households that have dwellings with roofs made of cement	0.001	0.004	0.002**	0.006	-0.008**	0.002
Percentage of households that have dwellings with walls made of cement	-0.001	0.003	-0.009**	0.004	-0.011**	0.002
Percentage of households with access to a toilet	-0.003	0.003	0.010**	0.003	0.008**	0.002
Percentage of households with access to piped water	0.001	0.001	0.008**	0.001	-0.005**	0.001
Percentage of households with garbage collection	0.004	0.002	-0.001**	0.002	0.003**	0.001
Percentage of households that have electricity	0.000	0.003	0.001**	0.003	0.001**	0.002
Percentage of households that use natural gas or propane for fuel	-0.007*	0.004	0.013**	0.008	-0.002**	0.003
Percentage of area within 5 km of a major road	0.004**	0.002	0.002**	0.002	0.002**	0.001
Distance in kilometers to nearest major urban center	-0.003	0.003	0.007**	0.003	-0.017**	0.004
Distance in kilometers to nearest hospital	-0.002	0.011	0.017*	0.010	0.015**	0.006
Number of health care facilities per 1000 persons	-0.820**	0.314	-0.379	0.277	-0.732	0.227
Population density	0.000	0.000	0.000***	0.000	0.000***	0.000
Mean elevation in meters	0.000	0.000	0.000**	0.001	0.000***	0.000
Elevation range – slope	0.000	0.000	0.000***	0.000	0.000***	0.000
Land type: Percentage of area that is arid	-	-	0.007**	0.004	0.003**	0.002
Land type: Percentage of area that is humid	-	-	-	-	0.010**	0.002
Land type: Percentage of area that is semi-arid	-	-	0.003**	0.004	0.000**	0.002
Land type: Percentage of area that is semi-humid	0.002	0.002	0.028*	0.012	-0.015**	0.001
Land type: Percentage of area that is island	-	-	-	-	-	-
Number of droughts from 1996-2000	-	-	-	-	0.087	0.126
Number of floods from 1996-2000	-0.030	0.031	0.016*	0.031	0.205 [†]	0.059
Province on the <i>frontera</i> with Haiti	-	-	0.273	0.191	-	-

[†]: $p < 0.06$; *: $p < 0.05$; **: $p < 0.01$; ***: $p < 0.001$

^a Models may differ somewhat from zone to zone due to collinearity concerns and constant values.

Appendix 7 (continued): Regression Models^a for the Estimation of Weight-for-Height Z-scores

	Zone VI El Valle		Zone VII Enriquillo		Zone VIII Yuma	
N	644		1,413		979	
R-Squared	0.226		0.166		0.170	
Adj. R-Squared	0.204		0.146		0.157	
	B	SE	B	SE	B	SE
Constant	1.148	0.877	0.776	0.733	0.685	1.848
Age 12 to 23 months	-0.595***	0.062	-0.345***	0.052	-0.103*	0.049
Age 24 to 35 months	-0.855***	0.059	-0.430***	0.051	-0.291***	0.048
Age 36 to 59 months	-0.699***	0.056	-0.291***	0.047	-0.261***	0.045
Child is female	0.095**	0.035	0.026	0.029	0.129***	0.026
Child is related to head of household, but not son/daughter	-0.064	0.052	0.002	0.043	0.116**	0.039
Child is not related to head of household	-0.269	0.178	0.551***	0.143	0.105	0.078
Household head has some primary education	0.067	0.061	-0.303***	0.047	0.110*	0.053
Household head has completed primary education	-0.065	0.101	-0.367***	0.079	0.075	0.066
Household head has some secondary education	-0.308**	0.101	-0.430***	0.077	0.093	0.071
Household head has completed secondary education	-0.076	0.115	-0.457***	0.093	0.223**	0.083
Household head has tertiary education	0.536***	0.136	-0.229*	0.109	-0.344**	0.100
Household head provided no education information	0.063	0.063	-0.190***	0.052	0.082	0.058
Highest number of years of education completed by an adult male in household	0.015	0.016	0.039**	0.012	-0.072***	0.011
Highest number of years of education completed by an adult male in household, squared	-0.001	0.001	-0.002*	0.001	0.005***	0.001
Highest number of years of education completed by an adult female in household	0.000	0.013	-0.009	0.011	-0.004	0.010
Highest number of years of education completed by an adult female in household, squared	0.000	0.001	0.002**	0.001	0.002**	0.001
Female-headed household	-0.345***	0.088	0.234***	0.054	-0.136**	0.049
Household head is single	1.146***	0.220	0.151	0.135	0.175	0.096
Household head is divorced or is not living together with partner/is separated	0.070	0.096	-0.185**	0.064	0.024	0.055
Household head is widowed	0.347**	0.110	-0.285***	0.080	0.241**	0.083
Number of children under 5 years of age	0.125***	0.025	0.119***	0.021	0.025	0.021
Number of adult females	-0.075*	0.035	-0.081**	0.024	-0.123***	0.024
Dependency ratio	-0.552**	0.170	0.114	0.138	-0.573***	0.118
Air conditioner	-1.589***	0.345	0.447**	0.159	-0.048	0.084
Computer	-	-	0.394**	0.124	-0.265***	0.063
Radio or Stereo	-0.140***	0.039	-0.134***	0.032	-0.008	0.030
Refrigerator	0.108	0.059	0.233***	0.040	0.042	0.036
Stove	0.173**	0.062	0.269***	0.067	-0.154*	0.064
Television	-0.090 [†]	0.047	-0.062	0.040	-0.034	0.036
Washing machine	-0.062	0.055	-0.063	0.040	0.144***	0.035
Home has floor made from marble/tile	-2.735***	0.354	-0.292	0.156	0.622***	0.092
Home has floor made from earth/dirt	-0.061	0.049	0.022	0.049	-0.069	0.065
Home has floor made of wood, other materials, or information was not provided	0.644***	0.124	-0.469**	0.137	0.062	0.124
Home has roof made from cement	0.441***	0.096	-0.056	0.064	0.002	0.040
Home has roof made from asbestos	-	-	0.222*	0.099	1.427*	0.302
Home has roof made from palm materials	0.210 [†]	0.111	-0.107	0.070	-0.066	0.144
Home has roof made from other materials or information was not provided	-0.188	0.158	0.935***	0.165	-0.686***	0.145

[†]: $p < 0.06$; *: $p < 0.05$; **: $p < 0.01$; ***: $p < 0.001$

^a Models may differ somewhat from zone to zone due to collinearity concerns and constant values.

Appendix 7 (continued): Regression Models^a for the Estimation of Weight-for-Height Z-scores

	Zone VI El Valle		Zone VII Enriquillo		Zone VIII Yuma	
N	644		1,413		979	
R-Squared	0.226		0.166		0.170	
Adj. R-Squared	0.204		0.146		0.157	
	B	SE	B	SE	B	SE
Home has walls made from shingles	-0.085	0.090	-0.107	0.110	-	-
Home has walls made from wood	-0.135**	0.049	0.087*	0.042	-0.055	0.037
Home has walls made from palm materials	0.050	0.073	0.180**	0.054	0.014	0.063
Home has walls made from other materials, including dung, or information was not provided	-0.063	0.112	-0.055	0.102	0.119*	0.053
Number of persons per room - crowding	-0.140***	0.021	-0.024	0.014	-0.018	0.014
Household has access to a latrine	-0.122	0.068	-0.073	0.050	-0.103**	0.037
Household has no access to sanitary facilities or information on facilities not provided	0.104	0.081	-0.108	0.068	-0.212***	0.060
Source of household water – Well water	-0.024	0.114	0.031	0.067	-0.140**	0.046
Source of household water – Tanker truck water	-0.390	0.342	-0.044	0.074	0.226***	0.046
Source of household water – Surface water, river	0.030	0.072	0.271***	0.076	-0.466***	0.093
Source of household water – Rainwater	-	-	0.205	0.122	0.195*	0.091
Source of household water – Other sources, or information not provided	0.953***	0.160	1.185***	0.223	0.498	0.536
Household garbage burnt	-0.063	0.074	-0.032	0.048	0.020	0.042
Household garbage thrown in yard /near dwelling	-0.060	0.085	-0.223***	0.056	-0.082	0.048
Household garbage thrown outside homestead	-0.147	0.096	-0.257**	0.087	0.338**	0.100
Household garbage information not provided	-0.063	0.202	-0.222	0.142	-0.164	0.107
Household has electricity	0.203**	0.076	0.094	0.084	0.269***	0.074
Household has telephone service	-0.243**	0.078	0.123*	0.048	0.014	0.036
Household uses charcoal for fuel	0.008	0.103	0.150 [†]	0.077	0.004	0.081
Household uses firewood for fuel	0.031	0.074	0.104	0.070	0.216**	0.070
Household uses no fuel because there is no cooking	-0.481	0.362	0.022	0.163	-0.163	0.147
Household uses other fuel sources (incl. Kerosene and electricity) or provided no information	0.766*	0.369	-0.420	0.519	1.424***	0.409
Contamination near home: Stagnant water	0.214**	0.070	-0.013	0.047	-0.118**	0.035
Contamination near home: Garbage dump	-0.186**	0.063	0.155***	0.042	-0.015	0.035
Contamination near home: Stream/river with garbage	-0.138*	0.067	-0.006	0.051	-0.116*	0.047
Contamination near home: Traffic noise	0.010	0.040	0.109**	0.034	0.067*	0.029
Contamination near home: Pigsty/farm	0.155*	0.072	0.131**	0.048	0.149**	0.047
Contamination near home: Smoke and/or gas	-0.396*	0.199	0.024	0.094	-0.274***	0.077
Contamination near home: Noise from factory	-0.030	0.143	0.132	0.113	-0.074	0.073
Contamination near home: Waste from factory	-0.273	0.208	0.008	0.117	0.848***	0.105
Contamination near home: Noise from plant	0.144	0.115	0.212	0.155	0.138*	0.055
Contamination near home: Gas/LP fill station	-1.266**	0.460	-0.035	0.172	0.093	0.243
Contamination near home: Gasoline station	-0.751**	0.272	-0.426**	0.147	0.033	0.153
Contamination near home: Music	0.414***	0.058	0.073	0.049	-0.128**	0.042
Contamination near home: No contamination	0.238**	0.081	0.070	0.112	-0.277***	0.066
Urban residence	0.462*	0.219	0.232*	0.115	0.558 [†]	0.294
Percentage of households receiving remittances	-0.095***	0.025	-0.016**	0.005	-0.026	0.023
Percentage of households engaged in agriculture	-0.001	0.006	0.012*	0.005	0.009	0.010
Percentage of population of Haitian extraction	-0.027	0.015	-0.034***	0.007	0.013 [†]	0.007
Percentage of school-aged children matriculated	0.010	0.006	-0.017***	0.005	0.011	0.013
Percentage of households that are female-headed	0.035***	0.011	0.011*	0.004	0.016	0.010

[†]: $p < 0.06$; *: $p < 0.05$; **: $p < 0.01$; ***: $p < 0.001$

^a Models may differ somewhat from zone to zone due to collinearity concerns and constant values.

Appendix 7 (continued): Regression Models^a for the Estimation of Weight-for-Height Z-scores

	Zone VI El Valle		Zone VII Enriquillo		Zone VIII Yuma	
N	644		1,413		979	
R-Squared	0.226		0.166		0.170	
Adj. R-Squared	0.204		0.146		0.157	
	B	SE	B	SE	B	SE
Percentage of household heads who have completed only primary school	-0.038	0.029	0.011	0.008	-0.029	0.023
Percentage of household heads who have completed through secondary school	0.012	0.035	0.007	0.012	-0.102	0.067
Percentage of household heads who have at least some tertiary education	-0.034	0.026	0.022	0.013	0.025	0.031
Percentage of households that have dwellings with floors made of cement	-0.012	0.008	0.003	0.003	0.003	0.009
Percentage of households that have dwellings with roofs made of cement	-0.015*	0.007	0.003	0.004	0.016*	0.008
Percentage of households that have dwellings with walls made of cement	-0.007 [†]	0.004	0.004	0.003	-0.011	0.006
Percentage of households with access to a toilet	0.003	0.008	0.001	0.005	0.034**	0.010
Percentage of households with access to piped water	0.001	0.002	0.002*	0.001	0.005	0.003
Percentage of households with garbage collection	-0.001	0.003	-0.007**	0.002	-0.015**	0.004
Percentage of households that have electricity	-0.004	0.003	-0.006**	0.002	0.003	0.006
Percentage of households that use natural gas or propane for fuel	0.014**	0.005	0.000	0.003	-0.010	0.009
Percentage of area within 5 km of a major road	0.010***	0.003	0.004*	0.002	-0.010**	0.004
Distance in kilometers to nearest major urban center	-0.011	0.006	-0.004	0.004	-0.004	0.009
Distance in kilometers to nearest hospital	-0.007	0.012	0.002	0.011	0.035	0.031
Number of health care facilities per 1000 persons	0.318	0.401	0.105	0.216	-	-
Population density	-0.004	0.003	0.000	0.000	-0.002**	0.001
Mean elevation in meters	0.000	0.000	0.000	0.000	-0.009**	0.003
Elevation range – slope	0.000	0.000	0.000	0.000	-0.001*	0.000
Land type: Percentage of area that is arid	-0.014	0.059	0.003	0.002	-	-
Land type: Percentage of area that is humid	-	-	0.021***	0.005	-	-
Land type: Percentage of area that is semi-arid	-0.004	0.003	0.004*	0.002	-	-
Land type: Percentage of area that is semi-humid	0.003	0.002	0.005	0.003	-0.001	0.006
Land type: Percentage of area that is island	-	-	0.036	0.057	-	-
Number of droughts from 1996-2000	-	-	-0.077	0.130	-	-
Number of floods from 1996-2000	0.048	0.050	-	-	0.334**	0.101
Province on the <i>frontera</i> with Haiti	-	-	0.200	0.110	-	-

[†]: $p < 0.06$; *: $p < 0.05$; **: $p < 0.01$; ***: $p < 0.001$

^a Models may differ somewhat from zone to zone due to collinearity concerns and constant values.

Appendix 7 (continued): Regression Models^a for the Estimation of Weight-for-Height Z-scores

	Zone IX Higüamo		Zone X Ozama	
N	904		737	
R-Squared	0.214		0.171	
Adj. R-Squared	0.203		0.169	
	B	SE	B	SE
Constant	1.015	0.969	-75.500***	11.244
Age 12 to 23 months	-0.291***	0.046	-0.248***	0.028
Age 24 to 35 months	-0.316***	0.046	-0.257***	0.028
Age 36 to 59 months	-0.153***	0.043	0.035	0.026
Child is female	0.064*	0.027	0.185***	0.014
Child is related to head of household, but not son/daughter	0.022	0.044	-0.047*	0.022
Child is not related to head of household	-0.048	0.098	0.108	0.059
Household head has some primary education	0.087	0.063	0.289***	0.039
Household head has completed primary education	0.166*	0.078	0.174***	0.041
Household head has some secondary education	0.167*	0.078	0.050	0.042
Household head has completed secondary education	0.085	0.085	0.218***	0.044
Household head has tertiary education	-0.199	0.114	0.081	0.051
Household head provided no education information	0.240**	0.070	0.148**	0.043
Highest number of years of education completed by an adult male in household	-0.009	0.012	-0.001	0.006
Highest number of years of education completed by an adult male in household, squared	0.002	0.001	0.000	0.000
Highest number of years of education completed by an adult female in household	0.029*	0.012	-0.051***	0.006
Highest number of years of education completed by an adult female in household, squared	0.001	0.001	0.004***	0.000
Female-headed household	-0.238***	0.055	-0.256***	0.027
Household head is single	0.167	0.117	0.194***	0.053
Household head is divorced or is not living together with partner/is separated	-0.028	0.062	0.199***	0.029
Household head is widowed	0.182*	0.085	-0.059	0.041
Number of children under 5 years of age	-0.050*	0.021	0.028*	0.012
Number of adult females	-0.087**	0.029	-0.001	0.012
Dependency ratio	-0.300*	0.132	-0.340***	0.064
Air conditioner	0.479***	0.116	-0.303***	0.030
Computer	0.038	0.096	0.105***	0.022
Radio or Stereo	0.043	0.031	0.081***	0.017
Refrigerator	0.037	0.033	0.125***	0.021
Stove	-0.090	0.063	-0.360***	0.061
Television	-0.010	0.040	-0.008	0.024
Washing machine	0.002	0.034	0.212***	0.019
Home has floor made from marble/tile	0.031	0.110	-0.073**	0.027
Home has floor made from earth/dirt	0.037	0.060	-0.191***	0.045
Home has floor made of wood, other materials, or information was not provided	0.522**	0.164	0.062	0.083
Home has roof made from cement	0.216***	0.049	0.157***	0.019
Home has roof made from asbestos	-	-	-	-
Home has roof made from palm materials	0.557**	0.201	-	-
Home has roof made from other materials or information was not provided	-0.900**	0.292	0.031	0.110

†: $p < 0.06$; *: $p < 0.05$; **: $p < 0.01$; ***: $p < 0.001$

^a Models may differ somewhat from zone to zone due to collinearity concerns and constant values.

Appendix 7 (continued): Regression Models^a for the Estimation of Weight-for-Height Z-scores

	Zone IX Higüamo		Zone X Ozama	
N	904		737	
R-Squared	0.214		0.171	
Adj. R-Squared	0.203		0.169	
	B	SE	B	SE
Home has walls made from shingles	-	-	-	-
Home has walls made from wood	-0.057	0.036	0.335***	0.022
Home has walls made from palm materials	0.142*	0.058	-0.147	0.169
Home has walls made from other materials, including dung, or information was not provided	-0.104	0.062	0.214***	0.044
Number of persons per room - crowding	-0.050**	0.016	0.005	0.010
Household has access to a latrine	-0.033	0.040	-0.127***	0.022
Household has no access to sanitary facilities or information on facilities not provided	0.150**	0.057	-0.130**	0.042
Source of household water – Well water	0.059	0.046	0.785***	0.056
Source of household water – Tanker truck water	-0.173*	0.076	-0.675***	0.037
Source of household water – Surface water, river	0.153*	0.077	-	-
Source of household water – Rainwater	-0.169 [†]	0.088	-0.677***	0.093
Source of household water – Other sources, or information not provided	0.068	0.130	-0.388***	0.082
Household garbage burnt	-0.184***	0.044	0.020	0.059
Household garbage thrown in yard /near dwelling	-0.246***	0.051	-0.114**	0.034
Household garbage thrown outside homestead	-0.566***	0.121	0.021	0.034
Household garbage information not provided	0.377**	0.124	-0.080 [†]	0.042
Household has electricity	0.153*	0.069	1.083***	0.134
Household has telephone service	0.008	0.039	0.057**	0.018
Household uses charcoal for fuel	-0.220*	0.088	0.670***	0.183
Household uses firewood for fuel	-0.222**	0.068	0.612**	0.192
Household uses no fuel because there is no cooking	1.411***	0.209	-0.078	0.088
Household uses other fuel sources (incl. Kerosene and electricity) or provided no information	0.017	0.565	-	-
Contamination near home: Stagnant water	-0.059	0.033	0.109***	0.019
Contamination near home: Garbage dump	-0.064	0.039	-0.105***	0.019
Contamination near home: Stream/river with garbage	-0.149**	0.045	0.002	0.022
Contamination near home: Traffic noise	0.046	0.032	0.040*	0.016
Contamination near home: Pigsty/farm	0.088*	0.042	-0.433***	0.047
Contamination near home: Smoke and/or gas	-0.175	0.101	-0.188***	0.035
Contamination near home: Noise from factory	0.496***	0.081	-0.160***	0.028
Contamination near home: Waste from factory	0.066	0.091	0.083*	0.038
Contamination near home: Noise from plant	0.547***	0.090	0.159***	0.031
Contamination near home: Gas/LP fill station	-0.190	0.104	0.033	0.046
Contamination near home: Gasoline station	0.631**	0.186	-0.167*	0.078
Contamination near home: Music	-0.095*	0.046	-0.083***	0.018
Contamination near home: No contamination	0.302***	0.060	0.093**	0.032
Urban residence	-0.204	0.137	0.252*	0.099
Percentage of households receiving remittances	0.009	0.011	-0.463***	0.065
Percentage of households engaged in agriculture	-0.025***	0.006	-	-
Percentage of population of Haitian extraction	-0.003	0.005	-	-
Percentage of school-aged children matriculated	-0.010	0.012	0.736***	0.125
Percentage of households that are female-headed	0.000	0.008	0.218***	0.024

[†]: $p < 0.06$; *: $p < 0.05$; **: $p < 0.01$; ***: $p < 0.001$

^a Models may differ somewhat from zone to zone due to collinearity concerns and constant values.

Appendix 7 (continued): Regression Models^a for the Estimation of Weight-for-Height Z-scores

	Zone IX Higüamo		Zone X Ozama	
N	904		737	
R-Squared	0.214		0.171	
Adj. R-Squared	0.203		0.169	
	B	SE	B	SE
Percentage of household heads who have completed only primary school	0.135***	0.017	-0.227***	0.032
Percentage of household heads who have completed through secondary school	0.087***	0.022	0.076 [†]	0.040
Percentage of household heads who have at least some tertiary education	-0.052***	0.012	-	-
Percentage of households that have dwellings with floors made of cement	-0.001	0.010	-	-
Percentage of households that have dwellings with roofs made of cement	-0.012 [†]	0.006	-	-
Percentage of households that have dwellings with walls made of cement	0.013**	0.004	-0.023***	0.003
Percentage of households with access to a toilet	-0.008	0.006	-	-
Percentage of households with access to piped water	-0.003	0.002	-0.022*	0.010
Percentage of households with garbage collection	0.002	0.003	0.032***	0.007
Percentage of households that have electricity	0.005	0.004	-	-
Percentage of households that use natural gas or propane for fuel	-0.028***	0.006	0.051***	0.009
Percentage of area within 5 km of a major road	0.003*	0.001	0.081***	0.010
Distance in kilometers to nearest major urban center	0.000	0.004	-	-
Distance in kilometers to nearest hospital	0.001	0.011	-	-
Number of health care facilities per 1000 persons	1.392***	0.301	-4.503***	0.679
Population density	0.000	0.000	0.000***	0.000
Mean elevation in meters	0.002	0.001	-0.024***	0.003
Elevation range – slope	0.000	0.000	-	-
Land type: Percentage of area that is arid	-	-	-	-
Land type: Percentage of area that is humid	0.001	0.003	-	-
Land type: Percentage of area that is semi-arid	-	-	-	-
Land type: Percentage of area that is semi-humid	0.002	0.002	-	-
Land type: Percentage of area that is island	-	-	-	-
Number of droughts from 1996-2000	-	-	-	-
Number of floods from 1996-2000	-	-	-	-
Province on the <i>frontera</i> with Haiti	-	-	-	-

[†]: $p < 0.06$; *: $p < 0.05$; **: $p < 0.01$; ***: $p < 0.001$

^a Models may differ somewhat from zone to zone due to collinearity concerns and constant values.

Appendix 8: Regression Models^a for the Estimation of Weight-for-Age Z-scores

	National-level Regression Model		Zone I Cibao Norte		Zone II Cibao Sur	
N	10,149		1,015		990	
R-Squared	0.108		0.196		0.191	
Adj. R-Squared	0.107		0.191		0.181	
	B	SE	B	SE	B	SE
Constant	-0.212	0.158	0.820	0.929	-1.327	1.409
Age 12 to 23 months	-0.283***	0.015	-0.134***	0.037	-0.335***	0.049
Age 24 to 35 months	-0.209***	0.015	-0.012	0.036	-0.227***	0.050
Age 36 to 59 months	-0.040**	0.014	0.178***	0.034	-0.262***	0.045
Child is female	0.079***	0.008	0.093***	0.019	0.051 [†]	0.027
Child is related to head of household, but not son/daughter	0.008	0.013	0.385***	0.032	0.131*	0.045
Child is not related to head of household	0.000	0.031	-0.035	0.070	-0.416***	0.118
Household head has some primary education	0.088***	0.016	-0.077*	0.038	0.327***	0.059
Household head has completed primary education	0.099***	0.020	0.014	0.046	0.153*	0.072
Household head has some secondary education	0.055**	0.021	0.103*	0.048	0.674***	0.079
Household head has completed secondary education	0.183***	0.023	0.149**	0.056	0.507***	0.083
Household head has tertiary education	0.068*	0.027	0.486***	0.066	0.097	0.095
Household head provided no education information	0.183***	0.018	-0.071	0.043	0.273***	0.063
Highest number of years of education completed by an adult male in household	0.001	0.003	0.024**	0.008	-0.055***	0.012
Highest number of years of education completed by an adult male in household, squared	0.000	0.000	-0.003***	0.001	0.003***	0.001
Highest number of years of education completed by an adult female in household	-0.019***	0.003	-0.020**	0.007	-0.016	0.012
Highest number of years of education completed by an adult female in household, squared	0.002***	0.000	0.001**	0.000	0.002***	0.001
Female-headed household	0.007	0.015	0.203***	0.036	-0.028	0.060
Household head is single	0.186***	0.033	0.202*	0.083	0.070	0.113
Household head is divorced or is not living together with partner/is separated	-0.046**	0.017	-0.368***	0.041	-0.043	0.065
Household head is widowed	-0.034	0.023	-0.447***	0.055	0.055	0.080
Number of children under 5 years of age	-0.043***	0.006	-0.060***	0.016	-0.113***	0.020
Number of adult females	-0.039***	0.007	0.015	0.018	-0.093***	0.026
Dependency ratio	-0.645***	0.037	-0.893***	0.089	-0.220	0.126
Air conditioner	-0.208***	0.024	0.023	0.063	-0.362**	0.115
Computer	0.073***	0.017	-0.014	0.048	-0.246**	0.090
Radio or Stereo	0.063***	0.009	0.092***	0.023	0.061*	0.031
Refrigerator	0.044***	0.011	-0.106***	0.026	0.156***	0.036
Stove	0.109***	0.021	0.547***	0.058	0.116	0.074
Television	-0.001	0.012	0.044	0.032	-0.028	0.040
Washing machine	0.096***	0.010	0.035	0.024	-0.013	0.035
Home has floor made from marble/tile	-0.086***	0.022	0.053	0.054	0.020	0.093
Home has floor made from earth/dirt	-0.097***	0.018	-0.086	0.049	-0.009	0.070
Home has floor made of wood, other materials, or information was not provided	-0.001	0.037	-0.194*	0.096	0.368*	0.171
Home has roof made from cement	0.116***	0.012	0.047	0.031	0.280***	0.047
Home has roof made from asbestos	0.317***	0.074	1.730***	0.250	0.123	0.168
Home has roof made from palm materials	0.017	0.036	0.251*	0.098	-	-
Home has roof made from other materials or information was not provided	-0.335***	0.059	1.788***	0.404	-0.247***	0.191

[†]: $p < 0.06$; *: $p < 0.05$; **: $p < 0.01$; ***: $p < 0.001$

^a Models may differ somewhat from zone to zone due to collinearity concerns and constant values.

Appendix 8 (continued): Regression Models^a for the Estimation of Weight-for-Age Z-scores

	National-level Regression Model		Zone I Cibao Norte		Zone II Cibao Sur	
N	10,149		1,015		990	
R-Squared	0.108		0.196		0.191	
Adj. R-Squared	0.107		0.191		0.181	
	B	SE	B	SE	B	SE
Home has walls made from shingles	0.061	0.052	-	-	0.365	0.330
Home has walls made from wood	0.048***	0.011	-0.069**	0.027	0.048	0.036
Home has walls made from palm materials	0.086***	0.019	0.161**	0.048	0.021	0.055
Home has walls made from other materials, including dung, or information was not provided	-0.030	0.023	0.502***	0.092	-0.304***	0.085
Number of persons per room - crowding	-0.055***	0.005	-0.098***	0.014	-0.092***	0.022
Household has access to a latrine	-0.114***	0.012	-0.132***	0.028	-0.185***	0.040
Household has no access to sanitary facilities or information on facilities not provided	-0.083***	0.019	-0.217***	0.054	-0.393***	0.078
Source of household water – Well water	0.039*	0.018	0.178**	0.061	-0.075	0.049
Source of household water – Tanker truck water	-0.059**	0.019	0.043	0.066	-0.453***	0.125
Source of household water – Surface water, river	-0.076**	0.023	-0.115	0.073	-0.098	0.064
Source of household water – Rainwater	-0.019	0.029	-0.101	0.078	0.057	0.127
Source of household water – Other sources, or information not provided	0.175**	0.052	0.224	0.266	-0.394*	0.184
Household garbage burnt	-0.120***	0.014	-0.295***	0.034	-0.165***	0.043
Household garbage thrown in yard /near dwelling	-0.166***	0.016	0.054	0.041	-0.206***	0.058
Household garbage thrown outside homestead	-0.102***	0.021	-0.385***	0.044	-0.550***	0.113
Household garbage information not provided	-0.080*	0.031	-0.060	0.082	0.321*	0.162
Household has electricity	0.041	0.024	0.137	0.087	0.072	0.080
Household has telephone service	0.127***	0.011	0.219***	0.025	0.062	0.036
Household uses charcoal for fuel	-0.008	0.033	-0.540**	0.168	-0.647	0.362
Household uses firewood for fuel	-0.099***	0.021	-0.185**	0.055	-0.094	0.069
Household uses no fuel because there is no cooking	0.175***	0.042	0.239**	0.092	0.652***	0.144
Household uses other fuel sources (incl. Kerosene and electricity) or provided no information	-0.259*	0.125	-	-	-	-
Contamination near home: Stagnant water	-0.027*	0.011	0.027	0.029	-0.186***	0.042
Contamination near home: Garbage dump	-0.054***	0.011	0.013	0.030	0.003	0.042
Contamination near home: Stream/river with garbage	0.012	0.012	0.028	0.027	-0.061	0.044
Contamination near home: Traffic noise	0.012	0.009	-0.054**	0.022	0.077**	0.029
Contamination near home: Pigsty/farm	0.066***	0.013	-0.031	0.030	-0.093*	0.041
Contamination near home: Smoke and/or gas	-0.019	0.022	0.132*	0.052	0.193*	0.077
Contamination near home: Noise from factory	0.041*	0.020	-0.037	0.055	0.118	0.072
Contamination near home: Waste from factory	0.145***	0.026	0.664***	0.064	-0.016	0.112
Contamination near home: Noise from plant	0.004	0.019	-0.379***	0.047	0.113	0.063
Contamination near home: Gas/LP fill station	-0.107**	0.034	-1.048***	0.114	0.243	0.169
Contamination near home: Gasoline station	0.277***	0.048	0.184	0.152	0.287	0.158
Contamination near home: Music	-0.038**	0.012	0.009	0.031	-0.290***	0.043
Contamination near home: No contamination	-0.013	0.019	-0.117*	0.047	0.219**	0.067
Urban residence	-0.017	0.018	-0.181*	0.087	-0.511**	0.160
Percentage of households receiving remittances	0.004***	0.001	0.031***	0.006	0.039***	0.010
Percentage of households engaged in agriculture	0.002*	0.001	0.040***	0.006	0.030***	0.006
Percentage of population of Haitian extraction	0.000	0.001	-0.070***	0.016	-0.133**	0.048
Percentage of school-aged children matriculated	0.004*	0.002	-0.014	0.008	-0.020	0.015
Percentage of households that are female-headed	0.003**	0.001	0.018***	0.004	0.026***	0.007

†: $p < 0.06$; *: $p < 0.05$; **: $p < 0.01$; ***: $p < 0.001$

^a Models may differ somewhat from zone to zone due to collinearity concerns and constant values.

Appendix 8 (continued): Regression Models^a for the Estimation of Weight-for-Age Z-scores

	National-level Regression Model		Zone I Cibao Norte		Zone II Cibao Sur	
N	10,149		1,015		990	
R-Squared	0.108		0.196		0.191	
Adj. R-Squared	0.107		0.191		0.181	
	B	SE	B	SE	B	SE
Percentage of household heads who have completed only primary school	-0.004	0.003	-0.015	0.014	0.035*	0.014
Percentage of household heads who have completed through secondary school	0.014***	0.003	0.014	0.012	0.063***	0.018
Percentage of household heads who have at least some tertiary education	-0.009***	0.002	0.010	0.010	-0.018	0.011
Percentage of households that have dwellings with floors made of cement	-0.002*	0.001	-0.019***	0.005	0.023***	0.006
Percentage of households that have dwellings with roofs made of cement	-0.001	0.001	0.001	0.005	0.016**	0.005
Percentage of households that have dwellings with walls made of cement	0.001**	0.000	-0.008*	0.003	0.019***	0.004
Percentage of households with access to a toilet	-0.001*	0.001	-0.001	0.004	-0.010*	0.004
Percentage of households with access to piped water	0.001***	0.000	0.006***	0.001	0.003*	0.001
Percentage of households with garbage collection	0.001	0.000	-0.001	0.002	0.000	0.003
Percentage of households that have electricity	0.000	0.001	-0.013**	0.004	0.003	0.003
Percentage of households that use natural gas or propane for fuel	-0.002**	0.001	0.013***	0.003	-0.020***	0.004
Percentage of area within 5 km of a major road	0.000	0.000	0.003	0.002	0.019**	0.006
Distance in kilometers to nearest major urban center	0.001*	0.000	0.001	0.003	-0.008	0.007
Distance in kilometers to nearest hospital	-0.011***	0.002	-0.008	0.008	-0.150***	0.023
Number of health care facilities per 1000 persons	0.241***	0.055	-0.674*	0.296	-4.754***	1.273
Population density	0.000***	0.000	0.000	0.000	-0.001	0.001
Mean elevation in meters	0.000***	0.000	0.001**	0.000	0.001**	0.000
Elevation range – slope	0.000***	0.000	0.000**	0.000	0.001***	0.000
Land type: Percentage of area that is arid	-0.001*	0.000	-	-	-	-
Land type: Percentage of area that is humid	0.001	0.001	-	-	-	-
Land type: Percentage of area that is semi-arid	0.000	0.000	0.005***	0.001	-	-
Land type: Percentage of area that is semi-humid	0.000	0.000	0.008***	0.002	0.007***	0.002
Land type: Percentage of area that is island	0.000	0.001	-	-	-	-
Number of droughts from 1996-2000	-0.040***	0.008	2.502***	0.472	0.456*	0.219
Number of floods from 1996-2000	0.032***	0.003	-0.631***	0.135	-0.524***	0.145
Province on the <i>frontera</i> with Haiti	-0.024	0.027	-	-	-	-

[†]: $p < 0.06$; *: $p < 0.05$; **: $p < 0.01$; ***: $p < 0.001$

^a Models may differ somewhat from zone to zone due to collinearity concerns and constant values.

Appendix 8 (continued): Regression Models^a for the Estimation of Weight-for-Age Z-scores

	Zone III Cibao Nordeste		Zone IV Cibao Noroeste		Zone V Valdesia	
N	1,170		941		1,422	
R-Squared	0.162		0.220		0.120	
Adj. R-Squared	0.149		0.201		0.112	
	B	SE	B	SE	B	SE
Constant	2.481	1.375	-1.892*	0.947	-1.567**	0.507
Age 12 to 23 months	-0.185***	0.052	-0.266***	0.061	-0.130**	0.042
Age 24 to 35 months	-0.274***	0.052	-0.132*	0.063	-0.048	0.042
Age 36 to 59 months	-0.182***	0.048	-0.119*	0.057	-0.047	0.039
Child is female	0.167***	0.029	0.090**	0.033	-0.002	0.024
Child is related to head of household, but not son/daughter	0.121**	0.046	0.021	0.055	-0.049	0.038
Child is not related to head of household	0.174	0.118	0.128	0.121	0.526***	0.096
Household head has some primary education	0.043	0.062	0.019	0.065	0.198***	0.047
Household head has completed primary education	-0.142	0.079	0.076	0.086	0.193**	0.063
Household head has some secondary education	-0.107	0.080	0.048	0.092	0.183**	0.064
Household head has completed secondary education	-0.028	0.088	0.016	0.108	0.297***	0.073
Household head has tertiary education	-0.437***	0.100	0.046	0.122	0.535***	0.083
Household head provided no education information	-0.073	0.070	0.052	0.074	0.263***	0.056
Highest number of years of education completed by an adult male in household	-0.080***	0.011	0.021	0.014	0.031**	0.010
Highest number of years of education completed by an adult male in household, squared	0.007***	0.001	-0.002	0.001	-0.003***	0.001
Highest number of years of education completed by an adult female in household	0.028*	0.013	0.002	0.014	-0.012	0.010
Highest number of years of education completed by an adult female in household, squared	0.000	0.001	0.002*	0.001	0.001	0.001
Female-headed household	-0.038	0.060	-0.367***	0.066	-0.224***	0.045
Household head is single	0.257	0.143	-0.187	0.143	-0.171	0.117
Household head is divorced or is not living together with partner/is separated	-0.059	0.064	0.289***	0.073	0.136*	0.053
Household head is widowed	0.047	0.081	0.392***	0.105	0.283***	0.067
Number of children under 5 years of age	-0.069**	0.025	0.020	0.030	-0.040*	0.020
Number of adult females	-0.085**	0.028	-0.060	0.036	0.015	0.022
Dependency ratio	-0.212	0.135	-0.734***	0.164	-0.581***	0.114
Air conditioner	0.230*	0.105	0.806**	0.234	0.010	0.097
Computer	0.152*	0.067	0.031	0.099	-0.024	0.058
Radio or Stereo	-0.057	0.034	-0.128**	0.039	0.130***	0.028
Refrigerator	-0.053	0.041	0.188***	0.044	0.083*	0.033
Stove	0.371***	0.069	0.125	0.086	-0.025	0.054
Television	0.098*	0.045	0.186***	0.048	-0.192***	0.036
Washing machine	0.097**	0.037	-0.112*	0.045	0.074*	0.030
Home has floor made from marble/tile	0.114	0.084	0.447**	0.144	0.053	0.113
Home has floor made from earth/dirt	-0.264**	0.092	-0.210**	0.070	0.002	0.056
Home has floor made of wood, other materials, or information was not provided	-0.263*	0.106	0.007	0.183	0.212*	0.106
Home has roof made from cement	0.157**	0.055	0.078	0.074	0.128**	0.037
Home has roof made from asbestos	-0.320	0.309	-	-	-0.572	0.315
Home has roof made from palm materials	0.030	0.148	-0.209*	0.087	-0.292**	0.092
Home has roof made from other materials or information was not provided	-0.206	0.170	-0.687**	0.223	-0.085	0.205

†: $p < 0.06$; *: $p < 0.05$; **: $p < 0.01$; ***: $p < 0.001$

^a Models may differ somewhat from zone to zone due to collinearity concerns and constant values.

Appendix 8 (continued): Regression Models^a for the Estimation of Weight-for-Age Z-scores

	Zone III Cibao Nordeste		Zone IV Cibao Noroeste		Zone V Valdesia	
N	1,170		941		1,422	
R-Squared	0.162		0.220		0.120	
Adj. R-Squared	0.149		0.201		0.112	
	B	SE	B	SE	B	SE
Home has walls made from shingles	-	-	-0.239	0.487	-0.145	0.102
Home has walls made from wood	0.148***	0.042	0.075	0.046	-0.032	0.033
Home has walls made from palm materials	0.065	0.053	0.101	0.066	-0.013	0.061
Home has walls made from other materials, including dung, or information was not provided	-0.003	0.101	0.389**	0.148	-0.073	0.066
Number of persons per room - crowding	-0.081**	0.025	-0.065**	0.025	-0.050**	0.016
Household has access to a latrine	-0.113*	0.047	0.064	0.051	0.033	0.034
Household has no access to sanitary facilities or information on facilities not provided	-0.061	0.074	-0.340***	0.095	0.134*	0.061
Source of household water – Well water	0.173**	0.051	0.069	0.130	-0.319***	0.088
Source of household water – Tanker truck water	-0.032	0.091	0.077	0.055	-0.054	0.050
Source of household water – Surface water, river	0.160**	0.058	-0.154†	0.079	-0.141	0.088
Source of household water – Rainwater	0.004	0.063	-0.499***	0.098	-0.003	0.089
Source of household water – Other sources, or information not provided	1.461***	0.246	-0.211	0.202	0.288	0.159
Household garbage burnt	-0.289***	0.054	-0.008	0.052	0.094*	0.043
Household garbage thrown in yard /near dwelling	-0.206**	0.062	-0.089	0.081	-0.047	0.049
Household garbage thrown outside homestead	-0.298**	0.092	0.250	0.221	-0.072	0.079
Household garbage information not provided	-0.972***	0.157	0.063	0.185	-0.387**	0.117
Household has electricity	-0.232**	0.079	-0.128	0.089	0.395***	0.091
Household has telephone service	0.180***	0.039	0.083	0.047	0.357***	0.034
Household uses charcoal for fuel	0.565***	0.157	0.134	0.130	-0.217**	0.081
Household uses firewood for fuel	-0.085	0.064	-0.229*	0.091	0.125*	0.057
Household uses no fuel because there is no cooking	1.094***	0.150	-0.030	0.118	-0.447**	0.165
Household uses other fuel sources (incl. Kerosene and electricity) or provided no information	0.320	0.351	-1.049***	0.212	-2.912***	0.362
Contamination near home: Stagnant water	-0.146**	0.043	0.200***	0.052	-0.051	0.033
Contamination near home: Garbage dump	-0.065	0.044	-0.156**	0.055	0.193***	0.033
Contamination near home: Stream/river with garbage	0.189***	0.049	0.083	0.059	-0.243***	0.038
Contamination near home: Traffic noise	-0.145***	0.033	-0.081*	0.038	-0.082**	0.027
Contamination near home: Pigsty/farm	0.100*	0.042	0.133**	0.050	0.136***	0.036
Contamination near home: Smoke and/or gas	-0.549***	0.157	-0.197	0.175	0.088	0.062
Contamination near home: Noise from factory	-0.252**	0.086	0.668***	0.130	0.342**	0.107
Contamination near home: Waste from factory	-0.070	0.216	-0.212	0.179	-0.234**	0.085
Contamination near home: Noise from plant	0.254***	0.069	-0.265**	0.092	-0.133*	0.059
Contamination near home: Gas/LP fill station	-0.497*	0.242	1.784***	0.268	0.296**	0.098
Contamination near home: Gasoline station	-0.043	0.182	-1.324**	0.430	-0.624***	0.162
Contamination near home: Music	0.232***	0.044	-0.112	0.066	-0.060	0.036
Contamination near home: No contamination	-0.071	0.077	0.120	0.076	-0.067	0.063
Urban residence	-0.026	0.132	-0.049	0.116	-0.051	0.069
Percentage of households receiving remittances	0.021***	0.005	0.041***	0.009	0.000	0.006
Percentage of households engaged in agriculture	-0.013*	0.006	0.009	0.006	0.014**	0.005
Percentage of population of Haitian extraction	0.368***	0.051	0.075***	0.017	0.013	0.013
Percentage of school-aged children matriculated	-0.025*	0.012	0.011	0.008	0.029***	0.007
Percentage of households that are female-headed	-0.013*	0.006	0.019**	0.007	-0.003	0.003

†: $p < 0.06$; *: $p < 0.05$; **: $p < 0.01$; ***: $p < 0.001$

^a Models may differ somewhat from zone to zone due to collinearity concerns and constant values.

Appendix 8 (continued): Regression Models^a for the Estimation of Weight-for-Age Z-scores

	Zone III Cibao Nordeste		Zone IV Cibao Noroeste		Zone V Valdesia	
N	1,170		941		1,422	
R-Squared	0.162		0.220		0.120	
Adj. R-Squared	0.149		0.201		0.112	
	B	SE	B	SE	B	SE
Percentage of household heads who have completed only primary school	0.021	0.012	0.026*	0.013	0.002	0.014
Percentage of household heads who have completed through secondary school	-0.020	0.013	-0.060**	0.021	0.017	0.013
Percentage of household heads who have at least some tertiary education	0.061***	0.010	-0.008	0.013	0.023*	0.009
Percentage of households that have dwellings with floors made of cement	0.006	0.006	-0.019***	0.005	-0.010**	0.003
Percentage of households that have dwellings with roofs made of cement	0.000	0.004	-0.002	0.006	-0.011***	0.003
Percentage of households that have dwellings with walls made of cement	-0.004	0.003	-0.009*	0.004	-0.008***	0.002
Percentage of households with access to a toilet	-0.006	0.004	0.003	0.004	0.009**	0.003
Percentage of households with access to piped water	0.003**	0.001	0.012***	0.001	-0.001	0.001
Percentage of households with garbage collection	-0.003	0.003	-0.002	0.002	-0.001	0.001
Percentage of households that have electricity	0.000	0.003	0.003	0.004	-0.005*	0.002
Percentage of households that use natural gas or propane for fuel	-0.009*	0.004	0.009	0.008	0.011***	0.003
Percentage of area within 5 km of a major road	0.008***	0.002	-0.004	0.003	0.001	0.001
Distance in kilometers to nearest major urban center	-0.006	0.003	-0.001	0.003	-0.013*	0.005
Distance in kilometers to nearest hospital	0.020	0.012	0.047***	0.011	0.001	0.007
Number of health care facilities per 1000 persons	-1.481***	0.336	-0.033	0.296	-0.313	0.259
Population density	-0.001	0.000	0.001*	0.000	0.000***	0.000
Mean elevation in meters	0.000	0.000	0.000	0.001	0.000	0.000
Elevation range – slope	0.000	0.000	0.000*	0.000	0.000	0.000
Land type: Percentage of area that is arid	-	-	-0.005	0.004	0.000	0.002
Land type: Percentage of area that is humid	-	-	-	-	0.008***	0.002
Land type: Percentage of area that is semi-arid	-	-	-0.006	0.004	0.000	0.002
Land type: Percentage of area that is semi-humid	0.006***	0.002	-0.022	0.013	-0.014***	0.002
Land type: Percentage of area that is island	-	-	-	-	-	-
Number of droughts from 1996-2000	-	-	-	-	0.179	0.143
Number of floods from 1996-2000	-0.085*	0.033	0.073*	0.033	0.245***	0.067
Province on the <i>frontera</i> with Haiti	-	-	0.337	0.203	-	-

[†]: $p < 0.06$; *: $p < 0.05$; **: $p < 0.01$; ***: $p < 0.001$

^a Models may differ somewhat from zone to zone due to collinearity concerns and constant values.

Appendix 8 (continued): Regression Models^a for the Estimation of Weight-for-Age Z-scores

	Zone VI El Valle		Zone VII Enriquillo		Zone VIII Yuma	
N	635		1,391		964	
R-Squared	0.263		0.245		0.204	
Adj. R-Squared	0.241		0.227		0.192	
	B	SE	B	SE	B	SE
Constant	-0.906	0.964	-0.624	0.861	-1.950	2.175
Age 12 to 23 months	-0.431***	0.068	-0.549***	0.061	-0.223***	0.055
Age 24 to 35 months	-0.812***	0.065	-0.623***	0.059	-0.259***	0.055
Age 36 to 59 months	-0.661***	0.061	-0.471***	0.055	-0.278***	0.052
Child is female	0.037	0.039	0.101**	0.035	0.103***	0.029
Child is related to head of household, but not son/daughter	0.316***	0.058	-0.033	0.051	0.083	0.046
Child is not related to head of household	0.700**	0.202	0.098	0.175	-0.251**	0.092
Household head has some primary education	0.119	0.068	-0.319***	0.056	0.002	0.063
Household head has completed primary education	0.082	0.111	-0.463***	0.093	-0.210**	0.079
Household head has some secondary education	-0.175	0.112	-0.271**	0.090	-0.049	0.082
Household head has completed secondary education	-0.043	0.127	-0.560***	0.109	-0.036	0.096
Household head has tertiary education	0.779***	0.150	-0.532***	0.129	-0.579***	0.114
Household head provided no education information	0.134 [†]	0.070	-0.320***	0.062	0.163*	0.067
Highest number of years of education completed by an adult male in household	0.018	0.018	0.035*	0.014	-0.051***	0.013
Highest number of years of education completed by an adult male in household, squared	-0.001	0.001	-0.001	0.001	0.005***	0.001
Highest number of years of education completed by an adult female in household	-0.026	0.014	-0.016	0.013	0.018	0.012
Highest number of years of education completed by an adult female in household, squared	0.002 [†]	0.001	0.002**	0.001	0.000	0.001
Female-headed household	-0.072	0.097	0.169**	0.065	-0.059	0.056
Household head is single	0.919***	0.241	-0.081	0.158	0.269*	0.109
Household head is divorced or is not living together with partner/is separated	-0.189	0.105	-0.141	0.076	0.060	0.064
Household head is widowed	-0.126	0.121	-0.083	0.096	0.248**	0.095
Number of children under 5 years of age	0.053*	0.027	0.015	0.025	-0.063**	0.024
Number of adult females	-0.148***	0.039	-0.081**	0.028	-0.147***	0.028
Dependency ratio	-0.252	0.189	0.427**	0.163	-0.576***	0.137
Air conditioner	-1.247**	0.378	0.960***	0.186	-0.072	0.095
Computer	-	-	0.401**	0.145	-0.135 [†]	0.071
Radio or Stereo	0.047	0.044	-0.060	0.038	0.035	0.034
Refrigerator	0.009	0.065	0.254***	0.046	0.172***	0.041
Stove	0.200**	0.068	0.243**	0.079	-0.160*	0.074
Television	0.015	0.053	0.010	0.047	0.018	0.042
Washing machine	-0.296***	0.061	0.051	0.047	0.195***	0.040
Home has floor made from marble/tile	-2.111***	0.387	-0.025	0.182	0.578***	0.104
Home has floor made from earth/dirt	-0.195***	0.054	-0.020	0.058	0.079	0.074
Home has floor made of wood, other materials, or information was not provided	0.458**	0.140	-0.402*	0.160	0.103	0.141
Home has roof made from cement	0.259*	0.105	-0.079	0.076	-0.009	0.046
Home has roof made from asbestos	-	-	0.032	0.116	1.147**	0.343
Home has roof made from palm materials	-0.446***	0.122	-0.043	0.082	0.017	0.164
Home has roof made from other materials or information was not provided	0.286	0.173	0.898***	0.202	-0.011	0.165

[†]: $p < 0.06$; *: $p < 0.05$; **: $p < 0.01$; ***: $p < 0.001$

^a Models may differ somewhat from zone to zone due to collinearity concerns and constant values.

Appendix 8 (continued): Regression Models^a for the Estimation of Weight-for-Age Z-scores

	Zone VI El Valle		Zone VII Enriquillo		Zone VIII Yuma	
N	635		1,391		964	
R-Squared	0.263		0.245		0.204	
Adj. R-Squared	0.241		0.227		0.192	
	B	SE	B	SE	B	SE
Home has walls made from shingles	0.612***	0.098	-0.080	0.131	-	-
Home has walls made from wood	-0.256***	0.054	0.073	0.049	-0.164***	0.042
Home has walls made from palm materials	0.102	0.080	0.192**	0.063	-0.239**	0.071
Home has walls made from other materials, including dung, or information was not provided	-0.189	0.129	0.185	0.121	0.012	0.062
Number of persons per room - crowding	-0.095***	0.023	-0.070***	0.016	-0.031	0.016
Household has access to a latrine	-0.209**	0.075	-0.146*	0.059	-0.189***	0.043
Household has no access to sanitary facilities or information on facilities not provided	-0.101	0.089	-0.062	0.081	-0.237**	0.069
Source of household water – Well water	0.141	0.125	0.028	0.079	-0.099	0.053
Source of household water – Tanker truck water	0.088	0.375	-0.040	0.087	0.229***	0.052
Source of household water – Surface water, river	0.178*	0.081	0.023	0.089	-0.368**	0.108
Source of household water – Rainwater	-	-	0.339*	0.154	0.260*	0.104
Source of household water – Other sources, or information not provided	0.417*	0.175	1.679***	0.262	-0.637	0.610
Household garbage burnt	0.034	0.081	0.015	0.057	0.071	0.049
Household garbage thrown in yard /near dwelling	0.014	0.095	-0.192**	0.065	-0.047	0.055
Household garbage thrown outside homestead	-0.525***	0.106	-0.155	0.102	0.542***	0.114
Household garbage information not provided	-0.555*	0.221	-0.207	0.166	-0.176	0.121
Household has electricity	0.321***	0.084	-0.045	0.100	0.366***	0.085
Household has telephone service	-0.169*	0.085	0.051	0.056	-0.008	0.041
Household uses charcoal for fuel	-0.142	0.113	0.095	0.091	-0.113	0.093
Household uses firewood for fuel	-0.100	0.082	-0.235**	0.082	0.191*	0.081
Household uses no fuel because there is no cooking	-0.497	0.397	0.134	0.190	-0.428*	0.167
Household uses other fuel sources (incl. Kerosene and electricity) or provided no information	0.001	0.404	0.340	0.606	2.046***	0.466
Contamination near home: Stagnant water	0.321***	0.078	-0.056	0.055	-0.107**	0.040
Contamination near home: Garbage dump	-0.291***	0.069	0.285***	0.049	-0.029	0.040
Contamination near home: Stream/river with garbage	-0.029	0.073	0.011	0.060	-0.046	0.054
Contamination near home: Traffic noise	0.086 [†]	0.044	0.050	0.040	0.075*	0.034
Contamination near home: Pigsty/farm	0.219**	0.079	0.027	0.056	0.067	0.053
Contamination near home: Smoke and/or gas	-1.018***	0.217	0.081	0.110	-0.347***	0.087
Contamination near home: Noise from factory	0.092	0.157	0.168	0.131	-0.226**	0.083
Contamination near home: Waste from factory	0.033	0.228	0.461**	0.136	1.264***	0.118
Contamination near home: Noise from plant	0.157	0.126	0.374*	0.174	0.200**	0.064
Contamination near home: Gas/LP fill station	-0.359	0.504	-0.657**	0.202	0.077	0.276
Contamination near home: Gasoline station	-0.726*	0.298	-0.037	0.174	0.190	0.174
Contamination near home: Music	0.117	0.063	0.088	0.057	-0.254***	0.048
Contamination near home: No contamination	0.151	0.089	-0.048	0.131	-0.228**	0.075
Urban residence	0.545*	0.240	-0.073	0.135	-0.089	0.337
Percentage of households receiving remittances	-0.020	0.028	-0.016**	0.005	-0.009	0.027
Percentage of households engaged in agriculture	0.005	0.006	-0.006	0.006	0.013	0.012
Percentage of population of Haitian extraction	-0.052**	0.016	0.005	0.008	0.010	0.008
Percentage of school-aged children matriculated	0.004	0.007	0.002	0.006	0.020	0.015
Percentage of households that are female-headed	0.018	0.012	-0.001	0.005	0.022*	0.011

[†]: $p < 0.06$; *: $p < 0.05$; **: $p < 0.01$; ***: $p < 0.001$

^a Models may differ somewhat from zone to zone due to collinearity concerns and constant values.

Appendix 8 (continued): Regression Models^a for the Estimation of Weight-for-Age Z-scores

	Zone VI El Valle		Zone VII Enriquillo		Zone VIII Yuma	
N	635		1,391		964	
R-Squared	0.263		0.245		0.204	
Adj. R-Squared	0.241		0.227		0.192	
	B	SE	B	SE	B	SE
Percentage of household heads who have completed only primary school	-0.009	0.032	-0.001	0.010	-0.044	0.026
Percentage of household heads who have completed through secondary school	-0.011	0.039	0.043**	0.015	-0.192*	0.078
Percentage of household heads who have at least some tertiary education	0.034	0.029	-0.038*	0.016	0.010	0.035
Percentage of households that have dwellings with floors made of cement	-0.017*	0.008	0.007*	0.003	0.015	0.010
Percentage of households that have dwellings with roofs made of cement	0.018*	0.008	0.009	0.005	0.021*	0.009
Percentage of households that have dwellings with walls made of cement	-0.006	0.004	0.005	0.003	-0.006	0.007
Percentage of households with access to a toilet	-0.020*	0.009	-0.001	0.005	0.045***	0.012
Percentage of households with access to piped water	0.005**	0.002	-0.003*	0.001	0.009*	0.004
Percentage of households with garbage collection	0.004	0.003	-0.004	0.002	-0.010*	0.005
Percentage of households that have electricity	-0.003	0.003	-0.007**	0.003	0.027***	0.007
Percentage of households that use natural gas or propane for fuel	0.004	0.005	0.010*	0.004	-0.033**	0.011
Percentage of area within 5 km of a major road	0.004	0.003	0.006**	0.002	-0.017***	0.004
Distance in kilometers to nearest major urban center	0.008	0.007	-0.011*	0.004	0.000	0.011
Distance in kilometers to nearest hospital	0.017	0.013	0.017	0.013	0.059	0.036
Number of health care facilities per 1000 persons	0.933*	0.440	0.532*	0.253	-	-
Population density	0.000	0.003	0.000	0.000	-0.002**	0.001
Mean elevation in meters	0.000	0.000	0.001 [†]	0.000	-0.006	0.004
Elevation range – slope	0.000	0.000	0.000	0.000	-0.001***	0.000
Land type: Percentage of area that is arid	0.124 [†]	0.066	0.004 [†]	0.002	-	-
Land type: Percentage of area that is humid	-	-	0.027***	0.006	-	-
Land type: Percentage of area that is semi-arid	-0.009**	0.003	0.006**	0.002	-	-
Land type: Percentage of area that is semi-humid	0.001	0.002	0.002	0.003	-0.010	0.007
Land type: Percentage of area that is island	-	-	-0.111	0.067	-	-
Number of droughts from 1996-2000	-	-	0.042	0.154	-	-
Number of floods from 1996-2000	0.182**	0.055	-	-	0.494***	0.117
Province on the <i>frontera</i> with Haiti	-	-	0.007	0.130	-	-

[†]: $p < 0.06$; *: $p < 0.05$; **: $p < 0.01$; ***: $p < 0.001$

^a Models may differ somewhat from zone to zone due to collinearity concerns and constant values.

Appendix 8 (continued): Regression Models^a for the Estimation of Weight-for-Age Z-scores

	Zone IX Higüamo		Zone X Ozama	
N	892		729	
R-Squared	0.269		0.194	
Adj. R-Squared	0.258		0.192	
	B	SE	B	SE
Constant	-1.717	1.050	50.644***	6.351
Age 12 to 23 months	-0.459***	0.050	-0.399***	0.031
Age 24 to 35 months	-0.354***	0.050	-0.095**	0.031
Age 36 to 59 months	-0.271***	0.046	0.197***	0.029
Child is female	-0.014	0.029	0.171***	0.015
Child is related to head of household, but not son/daughter	-0.105*	0.049	-0.219***	0.025
Child is not related to head of household	0.597***	0.105	-0.229***	0.065
Household head has some primary education	0.150*	0.068	0.257***	0.043
Household head has completed primary education	0.293**	0.085	0.349***	0.046
Household head has some secondary education	0.233**	0.085	0.079	0.047
Household head has completed secondary education	0.020	0.093	0.345***	0.049
Household head has tertiary education	-0.231	0.123	0.184**	0.056
Household head provided no education information	0.401***	0.076	0.412***	0.047
Highest number of years of education completed by an adult male in household	-0.026 [†]	0.013	-0.010	0.006
Highest number of years of education completed by an adult male in household, squared	0.005***	0.001	0.000	0.000
Highest number of years of education completed by an adult female in household	-0.009	0.013	-0.076***	0.006
Highest number of years of education completed by an adult female in household, squared	0.005***	0.001	0.006***	0.000
Female-headed household	0.114	0.061	-0.164***	0.029
Household head is single	0.048	0.127	0.239***	0.061
Household head is divorced or is not living together with partner/is separated	-0.377***	0.068	0.074*	0.032
Household head is widowed	0.049	0.093	-0.088 [†]	0.045
Number of children under 5 years of age	-0.070**	0.023	0.089***	0.014
Number of adult females	-0.009	0.031	-0.055***	0.013
Dependency ratio	-0.151	0.147	-1.281***	0.071
Air conditioner	0.314*	0.125	-0.451***	0.033
Computer	-0.119	0.104	0.204***	0.025
Radio or Stereo	0.123***	0.034	0.162***	0.019
Refrigerator	0.108**	0.036	0.051*	0.023
Stove	0.138*	0.069	-0.402***	0.068
Television	0.081 [†]	0.043	0.000	0.027
Washing machine	-0.063	0.037	0.244***	0.022
Home has floor made from marble/tile	0.079	0.125	-0.180***	0.030
Home has floor made from earth/dirt	-0.017	0.065	0.063	0.050
Home has floor made of wood, other materials, or information was not provided	0.423*	0.177	0.081	0.093
Home has roof made from cement	0.241***	0.053	0.142***	0.021
Home has roof made from asbestos	-	-	-	-
Home has roof made from palm materials	1.063***	0.217	-	-
Home has roof made from other materials or information was not provided	-0.682*	0.315	-1.243***	0.122

[†]: $p < 0.06$; *: $p < 0.05$; **: $p < 0.01$; ***: $p < 0.001$

^a Models may differ somewhat from zone to zone due to collinearity concerns and constant values.

Appendix 8 (continued): Regression Models^a for the Estimation of Weight-for-Age Z-scores

	Zone IX Higüamo		Zone X Ozama	
N	892		729	
R-Squared	0.269		0.194	
Adj. R-Squared	0.258		0.192	
	B	SE	B	SE
Home has walls made from shingles	-	-	-	-
Home has walls made from wood	0.000	0.039	0.201***	0.024
Home has walls made from palm materials	0.143*	0.063	-0.645**	0.187
Home has walls made from other materials, including dung, or information was not provided	-0.023	0.067	-0.094 [†]	0.049
Number of persons per room - crowding	-0.065***	0.018	0.021	0.011
Household has access to a latrine	0.038	0.044	-0.116***	0.024
Household has no access to sanitary facilities or information on facilities not provided	0.194**	0.062	0.002	0.046
Source of household water – Well water	-0.028	0.050	0.622***	0.062
Source of household water – Tanker truck water	0.213**	0.082	-0.246***	0.041
Source of household water – Surface water, river	0.094	0.083	-	-
Source of household water – Rainwater	0.301**	0.096	-0.449***	0.103
Source of household water – Other sources, or information not provided	0.408**	0.140	-0.229*	0.090
Household garbage burnt	-0.215***	0.048	-0.056	0.066
Household garbage thrown in yard /near dwelling	-0.322***	0.055	-0.225***	0.038
Household garbage thrown outside homestead	0.157	0.130	0.000	0.037
Household garbage information not provided	0.531***	0.134	-0.025	0.047
Household has electricity	0.124	0.075	1.600***	0.148
Household has telephone service	-0.016	0.043	0.067**	0.020
Household uses charcoal for fuel	-0.156	0.098	1.064***	0.204
Household uses firewood for fuel	-0.081	0.074	0.274	0.212
Household uses no fuel because there is no cooking	1.067***	0.226	-0.445***	0.097
Household uses other fuel sources (incl. Kerosene and electricity) or provided no information	0.560	0.610	-	-
Contamination near home: Stagnant water	0.051	0.035	0.044*	0.021
Contamination near home: Garbage dump	-0.128**	0.043	-0.188***	0.022
Contamination near home: Stream/river with garbage	-0.127**	0.048	0.008	0.025
Contamination near home: Traffic noise	0.023	0.035	0.046*	0.018
Contamination near home: Pigsty/farm	-0.004	0.045	-0.092	0.052
Contamination near home: Smoke and/or gas	-0.215*	0.109	-0.024	0.039
Contamination near home: Noise from factory	0.669***	0.087	-0.023	0.032
Contamination near home: Waste from factory	0.083	0.099	-0.076	0.043
Contamination near home: Noise from plant	0.532***	0.095	0.090**	0.034
Contamination near home: Gas/LP fill station	0.083	0.112	-0.018	0.050
Contamination near home: Gasoline station	1.506***	0.212	0.652***	0.082
Contamination near home: Music	-0.166**	0.050	-0.068**	0.020
Contamination near home: No contamination	0.069	0.065	0.010	0.036
Urban residence	0.159	0.150	0.282***	0.080
Percentage of households receiving remittances	-0.005	0.012	-	-
Percentage of households engaged in agriculture	-0.018**	0.006	-0.175**	0.055
Percentage of population of Haitian extraction	0.021***	0.005	0.094*	0.036
Percentage of school-aged children matriculated	0.007	0.013	-0.137**	0.044
Percentage of households that are female-headed	0.009	0.009	0.043**	0.015

[†]: $p < 0.06$; *: $p < 0.05$; **: $p < 0.01$; ***: $p < 0.001$

^a Models may differ somewhat from zone to zone due to collinearity concerns and constant values.

Appendix 8 (continued): Regression Models^a for the Estimation of Weight-for-Age Z-scores

	Zone IX Higüamo		Zone X Ozama	
N	892		729	
R-Squared	0.269		0.194	
Adj. R-Squared	0.258		0.192	
	B	SE	B	SE
Percentage of household heads who have completed only primary school	0.140***	0.019	-	-
Percentage of household heads who have completed through secondary school	0.100***	0.023	0.094***	0.022
Percentage of household heads who have at least some tertiary education	-0.042**	0.014	-	-
Percentage of households that have dwellings with floors made of cement	-0.004	0.011	-	-
Percentage of households that have dwellings with roofs made of cement	-0.021**	0.007	-0.018***	0.002
Percentage of households that have dwellings with walls made of cement	0.016**	0.005	-	-
Percentage of households with access to a toilet	0.001	0.007	-	-
Percentage of households with access to piped water	-0.003	0.002	-0.021***	0.004
Percentage of households with garbage collection	-0.006	0.003	0.035***	0.006
Percentage of households that have electricity	0.011*	0.004	-0.414***	0.040
Percentage of households that use natural gas or propane for fuel	-0.035***	0.006	-	-
Percentage of area within 5 km of a major road	0.001	0.002	-	-
Distance in kilometers to nearest major urban center	-0.001	0.005	-	-
Distance in kilometers to nearest hospital	-0.005	0.012	-	-
Number of health care facilities per 1000 persons	1.451***	0.329	-3.354***	0.292
Population density	0.000	0.000	0.000	0.000
Mean elevation in meters	0.001	0.001	-0.016***	0.003
Elevation range – slope	0.000	0.000	-	-
Land type: Percentage of area that is arid	-	-	-	-
Land type: Percentage of area that is humid	0.004	0.004	-	-
Land type: Percentage of area that is semi-arid	-	-	-	-
Land type: Percentage of area that is semi-humid	0.006*	0.002	-0.001	0.002
Land type: Percentage of area that is island	-	-	-	-
Number of droughts from 1996-2000	-	-	-	-
Number of floods from 1996-2000	-	-	-	-
Province on the <i>frontera</i> with Haiti	-	-	-	-

[†]: $p < 0.06$; *: $p < 0.05$; **: $p < 0.01$; ***: $p < 0.001$

^a Models may differ somewhat from zone to zone due to collinearity concerns and constant values.