Situation of Severe Growth Retardation in First-grade Schoolchildren in Countries of Central America Around 2000

Introduction

The nutritional status of schoolchildren is a relevant aspect of health situation analyses. This status can be seen, on the one hand, as a reflection of life conditions, human development, food safety, and the health of children and, on the other, as an indicator of the risk (vulnerability) to develop acute/severe episodes of malnutrition and other health impairments. Chronic malnutrition, which is reflected in growth retardation among school-age children, is the most frequent form of malnutrition of the Region of the Americas.

According to data published by the Pan American Health Organization (PAHO), the Central American countries have long presented levels of malnutrition in their children population, in many cases serious malnutrition. For example, in Honduras the prevalence of malnutrition in children under 5 increased from 48.6% in 1987 to 52.5% in 1991, and 2.1% of deaths in children were associated to malnutrition. Moreover, in Guatemala, there were 45 deaths per 100,000 population due to malnutrition in 1994, while the Survey of Sentinel Schools showed 64% of girls and 75% of boys under 6 had a height-for-age deficit. Meanwhile in El Salvador, the 1993 National Family Health Survey determined that the prevalence of low height for age in children under 5 was 22.8%.

The measurement of height-for-age of schoolchildren represents a simple method for the evaluation of the average nutritional status of a population. In turn, the evaluation of growth retardation through periodic height censuses allows monitoring the nutritional status of a population and confirming changes on it. This and other information allows the analysis with various regional risk factors. The objectives of this first paper were: 1) to define the magnitude and distribution of the prevalence of Severe Growth Retardation (SGR) in schoolchildren in countries of Central America; and, 2) to evaluate the relationship between nutritional status and selected environmental risk factors.

Materials and methods

The area of study covers three contiguous countries of Central America: El Salvador, Guatemala, and Honduras. Estimates for the year 2000 indicate that, together, these countries had an approximate total population of 24.1 million, living in about 900 municipalities.

The population under study involved first grade schoolchildren of both sexes, ages 6 to 9 years. The data come from the National Schoolchildren Height Censuses of El Salvador in 2000, Guatemala in 2001, and Honduras in 1997.

The nutritional status was assessed through height-for-age measurements, through an anthropometric methodology and previously validated standard instruments. Children’s SGR was defined as three or more standardized normal deviations (z-scores) of individual height with respect to the standard reference for age and sex, according to the World Health Organization. The individual data were summarized in tables, histograms and boxplots utilizing the statistical package SPSS.

The analysis of the nutritional status was also done at the population level, with municipalities as unit of analysis. To this end, the individual database was consolidated in accordance with the scores, and the proportion of SGR was calculated in children studied in each municipality.

The geographic data of the national and first subnational levels were obtained from the World Digital Atlas and reviewed by PAHO. This electronic database is to the 1:100,000,000 scale. The geographical databases for the second subnational level were provided by the Ministry of Agriculture and Livestock of Guatemala, by the Honduras and El Salvador Ministries of Health and the Digital Atlas of Central America, prepared by several institutions in response to Hurricane Mitch, compiled by PAHO. Given the fact that at the time of this evaluation, there is not information on food availability and production at municipal level for the study area and given the recognized influence of the environmental factors on food production, the environmental information is analyzed using proxy indicators such as terrain access conditions and land use. Access problems are positively related with topography. For this study topography was obtained and calculated from the Digital Elevation Model (DEM) based on data from the United States Geological Survey. Two tiles were employed, W140N40 and W100N40 for the construction of the Irregular Triangular Network (TIN) and slope features calculated each 250 meters above sea level for the set of the three countries. The land use is commonly associated to the distribution of major natural ecosystems and land exploitation patterns for agriculture, livestock, forest, or urban settings. Land use is evidence of the man’s action over geographical environment. Its alterations are direct outcomes of the development of economic activities. The influence of environmental factors on food vulnerability is linked to its aptitude for agriculture activities, where soil quality is essential, but varies in relation to drainage, elevation gradients, erosion, temperatures, and rains. Among countries with low tech agriculture activities, distribution of agricultural land use has a decisive impact on food availability.
For geographical analysis, the geographic information systems package SIGEpi20 was used, developed by PAHO20. In order to link the geographical layers with data on the prevalence of SGR, the municipal codes of each country were used as reference keys. Thematic rank choropleth maps were prepared with the variables of interest, using the quantile method for the classification of units. Furthermore, various area spatial queries were used to determine the geographical relation of critical areas of SGR to the selected risk factors.

**Results**

Based on the height censuses, information on 782,905 children was included, 21.7% from El Salvador, 48.6% from Guatemala, and 29.7% from Honduras (Table 1). Among the total of surveyed schoolchildren, 48.3% were female, where the proportion was similar in all countries. With respect to the ages, the children from Honduras were, on average, 6 and 8 months younger than those from El Salvador and Guatemala, respectively.

The average height of the entire population studied was 115.7 cm (standard deviation of 6.86); this average was 4 and 6 cm greater in El Salvador (119.2 cm), than in Guatemala (115.7 cm) and in Honduras (113.2 cm), respectively. The average subregional values for men and women were 116.1 and 115.3 cm; this difference of 1 cm between sexes was similar in the 3 countries. The distribution of height values per country is presented in Figure 1, showing a displacement to the left of the curve and height average in Honduras compared to Guatemala, and Guatemala compared to El Salvador.

The Z score was used to consider the effects of age and sex on the population height comparisons. The average subregional Z-score for height with regard to the standard population was of -1.72 (Table 1), which indicates that, on average, children of the subregion are smaller than the reference children. The lower value was observed in Guatemala (-1.94) and the highest in El Salvador (-1.12), while the value in Honduras was in a situation closer to that of Guatemala (-1.79). Even though the height averages were

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**Table 1: Distribution studied population for each country, sex and average values and standard deviation by age, height and Z score, around 2000.**

<table>
<thead>
<tr>
<th>Subregion</th>
<th>Number (%)</th>
<th>Average age in months (S.D.)*</th>
<th>Average height in cm (S.D.)</th>
<th>Average Z score (S.D.)</th>
<th>Severe retardation (%) **</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>782,905</td>
<td>93.0 (11.1)</td>
<td>115.7 (6.9)</td>
<td>-1.72 (1.13)</td>
<td>95.965 (12.3)</td>
</tr>
<tr>
<td>Males</td>
<td>404,834 (51.7)</td>
<td>93.3 (11.1)</td>
<td>116.1 (6.8)</td>
<td>-1.82 (1.16)</td>
<td>60.475 (14.9)</td>
</tr>
<tr>
<td>Females</td>
<td>378,071 (48.3)</td>
<td>92.7 (11.1)</td>
<td>115.3 (6.9)</td>
<td>-1.61 (1.08)</td>
<td>35.490 (9.4)</td>
</tr>
</tbody>
</table>

El Salvador

| Total     | 169,719    | 93.6 (10.2)                    | 119.2 (6.3)                 | -1.12 (1.04)           | 5.702 (3.1)               |
| Males     | 87,492 (51.6) | 94.0 (10.3)                 | 119.6 (6.2)                 | -1.19 (1.08)           | 3.554 (4.1)               |
| Females   | 82,227 (48.4) | 93.1 (10.2)                 | 118.7 (6.3)                 | -1.04 (1.00)           | 1.648 (2.0)               |

Guatemala

| Total     | 380,578    | 95.8 (10.5)                    | 115.7 (6.5)                 | -1.94 (1.03)           | 55.370 (14.5)             |
| Males     | 197,426 (51.9) | 96.0 (10.5)                 | 116.1 (6.4)                 | -2.03 (1.05)           | 34.988 (17.7)             |
| Females   | 183,152 (48.1) | 95.7 (10.6)                 | 115.3 (6.5)                 | -1.84 (0.99)           | 20.382 (11.1)             |

Honduras

| Total     | 232,608    | 88.0 (10.9)                    | 113.2 (6.8)                 | -1.79 (1.18)           | 35.393 (15.2)             |
| Males     | 119,916 (51.6) | 88.4 (11.0)                 | 113.5 (6.2)                 | -1.92 (1.21)           | 21.933 (18.3)             |
| Females   | 112,692 (48.4) | 87.6 (10.8)                 | 112.8 (6.8)                 | -1.67 (1.14)           | 13.460 (11.9)             |

**Graph 1: Distribution of height in first-grade children in El Salvador, Guatemala, and Honduras from National Censuses around 2000**

For geographical analysis, the geographic information systems package SIGEpi20 was used, developed by PAHO20. In order to link the geographical layers with data on the prevalence of SGR, the municipal codes of each country were used as reference keys. Thematic rank choropleth maps were prepared with the variables of interest, using the quantile method for the classification of units. Furthermore, various area spatial queries were used to determine the geographical relation of critical areas of SGR to the selected risk factors.

**Graph 2: Distribution of Z scores of height with respect to the reference in first-grade children, by country, around 2000**
greater among boys than girls, the Z-scores average of—1.82 and -1.61 indicated a less favorable situation among men than in women compared to the standard. The differences between men and women are maintained at the country level. The distribution of the Z-scores at the country level indicates that a segment of the populations of each of them is at important disadvantage with regard to the standard (Figure 2), although in Guatemala and Honduras nearly half are two or more deviations away from the reference, in contrast with El Salvador where less than 25% are in that position. Furthermore, in Honduras a greater dispersion is observed with more extreme Z values, also suggesting important inequalities.

A total of 12.3% of the studied schoolchildren at the subregional level showed a SGR (Table 1). In the different countries, SGR was 3.1% for El Salvador, 14.5% for Guatemala, and 15.2% for Honduras; an excess risk of SGR being noted among boys compared to girls, from 53 to 100%, independently of the level of retardation in the countries. At the subregional level, a sustained increase in the frequency of SGR with age was also noted, from 8.8% at 6 years of age up to 12.3% at 9 years, but the levels are significantly lower in El Salvador (Figure 3). According to sex, the rising trend, and the excess among boys remains relatively constant, regardless of the level of the country. A higher prevalence is observed among boys in Honduras, which increases as age does, like the slope of the curve shows. In view of this trend and considering that the average age of schoolchildren in the Honduran Census was younger than in El Salvador and Guatemala (which is also reflected in a smaller average height in Honduras), it is expected that, if the growth retardation frequency with age were maintained and older children were included, the prevalence of SGR would also be higher in Honduras.

In Map 1, geographical distribution of SGR prevalence is presented at the municipal level for the three countries. When classified by quintiles, the prevalence of SGR was found to be lower than 3.6% in 178 (20%) of the 888 municipalities with 134,872 schoolchildren, 2,808 of which presented SGR. In contrast, another fifth of the municipalities, with 100,329 schoolchildren, shows levels higher than 22%; however, among these some units had prevalence figures up to 72.7%. The municipalities that belong to this superior quintile can be defined as the most critical areas, where 31,679 of the schoolchildren, i.e. nearly 30% have SGR. Municipal clusters can be identified where the prevalence of severe deficit is higher than 21% for the west of Honduras and Guatemala, but not for El Salvador, which suggests the existence of some factors that increase risk in such areas.

The environmental factors under study integrate some elements that could influence the production, availability or access to food supplies. Under abrupt topographic conditions, areas that would have greater access difficulties cover Western Guatemala mountain areas, which continue towards the South East, along the border between Honduras and El Salvador (Map 2). This ecosystem is known as the Central American pine-oak forest, typified by mixed needle and broad leaves mountainous woodland (Map 3). Information about natural or man’s modified ecosystems’ distribution was integrated and measured, taking into account the proportion of agricultural landuse with respect to the municipal total surface (Map 4). Landuse patterns corroborate that more intensive agricultural activities predominate alongside the South East coasts, as well as over the piedmonts surrounding the pine-oak forest ecosystem.

With geo-processing and digital maps overlapping, the spatial allocation of the critical areas of SGR was analyzed simultaneously with different environmental factors. Critical areas of SGR concur geographically with the ecosystem pine-oak forest, on top of areas of abrupt topography and the additional factor of being located over low agricultural occupation lands. This, besides their adversity for farming activity are also characterized by their low access and coverage of basic services. In turn, critical areas of SGR are apart from terrain agricultural vocation (Map 5).

Conclusions

The situation analysis of nutritional status based on height censuses in countries of Central America indicates that SGR is a very frequent public health problem, that deserves special attention in some areas of El Salvador, Guatemala and Honduras. Although SGR is an indicator of chronic malnutrition, it is important to note that vulnerability or risk of developing acute malnutrition episodes of increases with the frequency and severity of observed growth
retardation among populations. Distribution of heights and Z-scores by country shows that growth retardation is particularly precarious in Honduras; however, high levels of SGR prevalence of (>22%) also affects groups of municipalities in Guatemala, which means that any intervention should consider both countries.

The present study shows that geographical conditions linked to topography, type of soil and other socioeconomic status are associated with the levels of SGR. Unlike the results presented in graphs, map modelling allows the identification of spatial aggregation patterns such as the ones described for Honduras and Guatemala (Martínez et al.,22) and the relation with other factors that have different distributions to the political-administrative division, such as land use, and topography. The measurement of environmental factors associated with the risk of SGR, suggests that the identification and monitoring of high-risk populations through such indicators is feasible. However, it is necessary to consider that there exist other social, economic and health factors that have an impact on the nutritional status and growth retardation.

For instance, Nájera-Aguilar et al.23. have found in Honduras, that there is a high spatial correlation between municipalities with SGR clusters and elevated proportion of indigenous population, as well as low services availability (i.e. roads, health, municipal services as water and drainage). But this is happening just aver abrupt topography areas. The latter indicates the existence of multiple variables that must be analyzed, in order to establish their relative importance in the other countries.
The present study shows an ecological analysis, where the information collected from different sources of information is taken advantage of, both, health conditions at municipal level, and the continuous surfaces that correspond to environmental characteristics - satellite images-, accordingly there are some limitations on the inferences interpretation.

In the results explanation, it is also important to take into account that schoolchildren included in the censuses do not necessarily represent all children between 6 to 9 years old, a situation associated with the access to schools, besides customs of incorporating them early, to productive activities inside and outside the home, as occurs particularly in rural areas. This could mean an underestimation of SGR prevalence if the children not included are from the lowest socioeconomical levels living in mountainous areas. However, in order to evaluate the representativeness of these censuses, it is worthy to indicate, that in Guatemala it was an estimated coverage nearby 97% of the public schools4, validating that the estimates of prevalence of SGR are an expression of the country’s situation.

In short, the high frequency of SGR in countries of the Central American subregion points out to the need for establishing programs and policies aimed at diminishing its occurrence and impact. The Millennium Development Goals contemplate the reduction of poverty, hunger, and malnutrition24; the present situation analysis reflects a first step for the process of monitoring and orientation of plans and policies to address such a situation. Moreover, the use of the information on height censuses allows evaluating the magnitude and distribution of SGR, identifying areas or epidemiological strata having similar risk determinants where specific health interventions may be directed.

Map 5: Critical areas or SGR prevalence over agriculture zones and abrupt topography.