Does Chile's nutritional situation constitute a double burden?[1–4]

Eduardo Atalah, Hugo Amigo, and Patricia Bustos

ABSTRACT

Background: Chile has probably experienced Latin America's fastest nutritional transition, as evidenced by very low rates of stunting, but the country shows a high prevalence of obesity in most population groups.

Objective: The aim was to assess the existence of a double burden of nutritional problems in Chile on the basis of available data.

Design: Secondary analyses were conducted on data collected by the Health Ministry (height and weight for children <6 y and for adults ≥65 y), the Education Ministry (height and weight in the first year of primary school and the first year of high school), the 2003 and 2009–2010 National Health Surveys [body mass index (BMI) and anemia prevalence], the 2010–2011 National Food Consumption Survey (ENCA; food consumption, height, and weight), and a Food Insecurity Survey of elderly adults (aged 65–74 y) in Santiago (height, weight, and food insecurity).

Results: In 2011 the prevalence of stunting (height-for-age < -2 z scores) was 1.9% for children <6 y old and 3.6% among children in the first year of primary school. This situation was in contrast with a high prevalence of obesity in children (22.1% of children in the first year of primary school; BMI ≥2 z scores) and among adults, especially women, increasing with age (44.8% of women 45–64 y old had a BMI ≥30 kg/m^2). The prevalence of anemia in women aged 15–64 y was low (5.1%). In the ENCA survey, women showed a high prevalence of below-average intakes of vitamin A, vitamin B-12, vitamin C, calcium, and zinc, irrespective of BMI. Elderly persons who were underweight and those who were obese had a significantly greater perception of food insecurity in relation to those with a normal weight (61%, 50%, and 33%, respectively).

Conclusions: The data showed high rates of obesity with very low frequency of stunting and, although more information is needed, the double burden of malnutrition probably does not exist in Chile, unlike in other countries in the region. Among specific groups there are low intakes of critical nutrients and food insecurity. Surveys that include anthropometric and biochemical measurements at the family level are needed to correctly evaluate the double burden of malnutrition in Chile. *Am J Clin Nutr* doi: 10.3945/ajcn.114.083790.

Keywords Chile, double burden, nutrition, obesity, stunting

INTRODUCTION

In recent decades, the nutritional situation of Latin American countries has undergone significant changes, leading governments to take action to combat nutritional deficits and more recently to tackle the problem of excess body weight. Excess body weight is becoming more prevalent in a majority of countries in the region, although to varying degrees, because they are in different stages of the epidemiologic transition (1).

Chile is an intermediate-developed country (2) that has experienced rapid economic growth and a decline in both poverty and extreme poverty since the early 1990s. Although the country's Human Development Index is 0.819, placing it 40th among all countries and first in Latin America (3), Chile's level of income inequality remains largely unchanged and is the highest among member countries of the Organization for Economic Co-operation and Development.

In the 1960s, Chile's health indicators were close to the average for Latin American countries (4). At the time, national programs provided broad health services coverage that ensured an adequate supply of primary care, including family planning and immunization programs, with special attention paid to the nutritional status of the population (5). Since then, food and nutrition policies in Chile have prioritized investment in maternal and child health programs, with comprehensive, stable coverage over time, adequate monitoring systems, and an emphasis on prevention, resulting in success in the rehabilitation of malnourished children (6). Furthermore, investments in health and nutrition as well as education and basic sanitation have reduced communicable diseases, and stunting has been practically eliminated.

Income growth has resulted in better access to food for the overall population, but there have also been increases in negative lifestyle changes, such as sedentarism and excessive intake of high-calorie foods, which could explain the progressive increase in obesity and chronic diseases (7–10). The latter indicates that the current situation is characterized by a rapid change toward a posttransition stage along with social protection policies that ensure an adequate food supply for the most vulnerable sector of the population.

The double burden concept consists of the presence of increased excess weight alongside a high prevalence of either stunting or some micronutrient deficiency. This implies the coexistence of both nutritional conditions in the population, within the same household (e.g., obese mothers and stunted children), or at the individual level (both conditions in the same individual) (11, 12). However, because Chile has reached minimal rates of

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[3] The study was based on a secondary analysis of databases and no specific funds were available for this purpose.

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child stunting, what is notable today is the steady increase in overweight and obesity beginning early in life (13, 14).

Chile's Health and Education Ministries periodically report information on the nutritional status of the population who attend public health centers and students who attend public schools. Although the lack of national information at the family level prevents a within-family evaluation of the nutritional double burden, as several authors have proposed (15–17), this phenomenon can be partially explored by using the data available for different age strata. Thus, the objective of this study was to assess, on the basis of the available data, if there is a double burden of nutritional problems in Chile and if so, if it is being addressed by national nutrition policies.

SUBJECTS AND METHODS

The information presented below is based on national surveys or administrative data that are generated periodically by governmental institutions. These databases do not include measurements of the various members of a family, making it impossible to estimate the nutritional double burden at this level.

Ministry of Health

The Ministry of Health annually collects anthropometric data (height and weight) on the population <6 y old, pregnant women, and persons ≥65 y who attend public health centers, encompassing 65% of the national population (18). The ministry reports annual data from the evaluation of ~1 million children <6 y old with the use of the 2006 WHO growth standards (19) for stunting (height-for-age < −2 SDs) and overweight and obesity (weight-for-height ≥2 SDs). Specific cutoffs are used for the elderly (n = 440,000) based on the following Ministry of Health standards (20): underweight, BMI (in kg/m^2) <23.0, and obesity, BMI >32.0.

Ministry of Education

Each year, the ministry evaluates the nutritional status of all children entering first grade (~6 y old) and those entering the first year of high school (~14 y old) in public schools and subsidized private schools (21); this population corresponds to 74% of all Chilean children of those ages. Private school students are not included in this data collection. The 2007 WHO standard is used as a reference (22) to determine stunting (height-for-age < −2 SDs) and obesity (BMI >2 SDs).

2009–2010 National Health Survey

This cross-sectional survey with random household sampling (stratified, multistage, conglomerate sample) provides national information that can be broken down by region and urban/rural area. The target population consists of subjects aged ≥15 y (3216 females and 2200 males) in which 42 health problems were studied, including nutritional status based on BMI. The prevalence of anemia was not analyzed in the latest survey, so for that variable the 2003 National Health Study, which had a similar methodology, was used (23).

2010–2011 National Food Consumption Survey

The 2010–2011 National Food Consumption Survey (ENCA) used a probability sample method (stratified and multistaged) and was representative of 5 zones in the country and by urban or rural area of residence. The sample size consisted of 4920 subjects aged ≥2 y. The information collected included socioeconomic, health, lifestyle, food consumption (a quantified food-frequency questionnaire and 24-h recall), and anthropometric (weight, height, and waist circumference) data. Although data on biochemical indicators were not collected, nutrient intake was estimated from 24-h recall. The information was obtained on the basis of the random selection of one person in each household. The data on female subjects were used to determine the prevalence of below-average consumption of requirements of critical nutrients (vitamins A, B-12, and C; iron; calcium; and zinc), on the basis of BMI (24).

Elderly Food Insecurity Survey

This was a cross-sectional study in 344 adults between 65 and 74 y of age in Santiago, Chile. The survey gathered information about socioeconomic situation, food characteristics, nutritional status, and food insecurity at home on the basis of the Household

TABLE 1
Prevalence of undernutrition and overweight/obesity in children <6 y old and schoolchildren in the first year of primary school and high school: 2011[1]

	n	Underweight, %	Stunting, %	Acute undernutrition, %	Obesity, %[2]
Public health system[3]					
0–23 mo	356,972	0.6	2.3	0.4	7.6
24–47 mo	346,367	0.5	1.9	0.3	9.4
48–71 mo	303,523	0.4	1.4	0.2	12.9
Schoolchildren[4]					
Primary school[5]	163,246	—	3.6	—	22.1
High school	164,508	—	3.2	—	8.2

[1]Underweight: weight-for-age index < −2 SDs; stunting: height-for-age < −2 SDs; acute undernutrition: weight-for-height < −2 SDs; obesity: weight-for-height ≥2 SDs.
[2]Percentages are given as BMI ≥2 Z for primary and high school children.
[3]Source: Ministry of Health, 2011 (18).
[4]Source: Ministry of Education, 2011 (21).
[5]First year only.

TABLE 2
Prevalence of underweight and obesity in female adolescents and adults and elderly women, by age

		BMI (in kg/m^2), %				
		Female adolescents and adults		Elderly women		
	n	<18.5	≥30.0	<23.0	≥32.0	Hemoglobin <12 g/dL, %[1]
National Health Survey[2]						
15–24 y	404	8.0	12.5	—	—	5.7
25–44 y	985	0.3	28.3	—	—	4.5
45–64 y	975	0.8	44.8	—	—	4.4
Public health system[3]						
65–69 y	118,000	—	—	5.7	33.0	—
70–79 y	204,000	—	—	8.3	27.0	—
≥80 y	119,000	—	—	15.9	17.7	—

[1]Source: National Health Survey, 2003.
[2]Source: National Health Survey, 2009–2010.
[3]Source: Ministry of Health, 2011 (18).

Food Insecurity Access Scale (HFIAS) (25). The survey included information about the perception of concern about food, not eating preferred foods, eating undesirable foods, reducing the frequency of eating and quantity of foods, going to bed hungry, and other variables. The relation between food insecurity and nutritional status among elderly adults was evaluated on the basis of BMI (26).

RESULTS

The prevalence of underweight and stunting was low among children <6 y of age in 2011 and was slightly higher among school-aged children (**Table 1**). An analysis by region or health services showed that the extreme values of stunting fluctuated between 1.4% and 2.7% among children <6 y old, regardless of the degree of rurality or level of development of the region (data not shown). Obesity, on the other hand, increased with age, reaching its highest value in primary school (22.1%) and decreasing during adolescence (8.2%).

The nutritional status of the adult population showed a high prevalence of obesity among women, with the highest figure (~45%) for those between 45 and 64 y of age, but a low prevalence of anemia among adult women (5.1%). On the other hand, obesity declined among elderly adults as age increased and the opposite occurred with the prevalence of underweight (**Table 2**).

The ENCA showed that, except for iron, >50% of women had insufficient intakes of several essential nutrients such as vitamins A, B-12, and C and calcium and zinc, regardless of their BMI (**Table 3**). Finally, the study in low-income elderly adults showed a high prevalence of food insecurity, which was significantly higher among people with underweight and obesity (**Table 4**).

DISCUSSION

Chile's current situation shows that the postnutritional transition stage is fully underway and, although more information is needed, the double burden of malnutrition probably does not exist. The evidence for this is that there are very low rates of childhood undernutrition and stunting and overweight constitutes a significant problem that affects almost all age groups and socioeconomic levels.

Chile's situation has evolved differently from that of other intermediate-developed countries. The practical elimination of stunting in Chile is related to the success of early interventions that involved the progressive expansion of coverage with a focus mainly on the most disadvantaged groups, both socially and biologically (27). Therefore, during cycles of social and political crisis, the most vulnerable sectors have been protected by public policies but also by the ability of these groups to defend their rights, as well as by the favorable evolution of the socioeconomic

TABLE 3
Prevalence (95% CI) of intake of vitamins and minerals below the Estimated Average Requirement in women by BMI[1]

	BMI (in kg/m^2), %			
Nutrient	18.5–24.9	25.0–29.9	≥30.0	*P*
Vitamin A	57.3 (52.7, 61.9)	62.0 (58.2, 65.8)	60.3 (56.6, 64.0)	0.306
Vitamin B-12	61.5 (57.0, 66.1)	64.0 (60.2, 67.8)	63.2 (59.6, 66.9)	0.704
Vitamin C	71.8 (67.6, 75.9)	73.4 (69.9, 76.8)	70.1 (66.6, 73.6)	0.423
Iron	38.2 (33.7, 42.7)	35.3 (31.6, 39.1)	31.1 (27.7, 34.7)	0.053
Calcium	84.9 (81.6, 88.2)	88.9 (86.4, 91.4)	88.3 (85.9, 90.7)	0.111
Zinc	58.0 (53.0, 62.5)	52.6 (48.7, 56.5)	53.0 (49.3, 56.8)	0.164

[1]Source: National Food Consumption Survey, 2010–11.

TABLE 4
Food insecurity among low-income men and women (65–74 y old) by nutritional status in Santiago, Chile[1]

Nutritional status	Food security (n = 204), %	Food insecurity (n = 138), %
Underweight	38.7	61.3
Normal	67.0	33.0
Overweight	60.5	39.5
Obesity	50.0	50.0
Total	59.6	40.4

[1] $\chi^2 = 13.99$, $P < 0.01$.

situation as reflected by reduced poverty and increased economic growth. As a result of these changes in nutritional status, government policies are now directed at preventing overweight, because almost 70% of the adult population is overweight and among schoolchildren the obesity figure is ~25%.

Chile's unique situation and how it compares with other countries may have multiple explanations, but it is undoubtedly related to the well-controlled effect of intervention policies focused on certain social groups. Today, this focus should be shifted toward preventing overweight, because globalization has brought unbalanced hypercaloric diets, and modern lifestyles and increased purchasing power have directly contributed to the rise in sedentarism (28).

From the point of view of the high prevalence of overweight, 2 elements stand out: *1*) women have the highest rates of overweight and *2*) the increase in abandonment and food insecurity, as well as an increase in undernutrition, among elderly adults. The latter element constitutes a significant challenge because the size of this population is expected to increase substantially in the coming years. This is a situation that has been observed in some developed countries and should be taken into account in future interventions.

All of this indicates that the reduction in nutritional deficiency in the maternal-child population is attributable to effective and large-scale interventions; for instance, Chile's supplementary nutrition programs continue their long-term focus on children and pregnant and lactating mothers. However, it now appears necessary to take a different approach to control overweight. This implies changing the goals, strategies, and focus of interventions; redefining target groups; and establishing partnerships for joint actions implemented by the state, civil society, and community groups. Such partnerships should include consumer groups and the substantial academic community studying this issue (29). The results presented with regard to children also indicate that actions to prevent overweight should start from a very early age.

From the point of view of nutrition, there is information that indicates that, nationally, food consumption is sufficient but not adequately varied, especially with regard to the intake of vegetables, fruit, fish, and milk, for which population nutrition guidelines are not being met (24). The more favorable situation with iron may be in part attributable to wheat flour fortification programs that have existed for >50 y. However, periodic national surveys of different age and population groups are needed to assess the biochemical indicators of critical nutrients.

Among the limitations of this study are the lack of information at the household level as well as only partial information about certain nutrients. In addition, the information is not sufficiently disaggregated, preventing the identification of those geographical areas where characteristics such as high prevalence of overweight are worse. For Chile and other countries, a breakdown by ethnic group, level of poverty, and other characteristics is essential, but unfortunately, the national data do not permit such disaggregation. Recently, the ENCA was carried out to assess intake and nutritional status, but only partial results have been released. An additional obstacle to comparing the nutritional situation of adults and elderly adults is that the studies use different cutoffs to classify excess weight for these 2 groups. A higher cutoff is used for elderly adults to take into account the loss of height that has occurred with age.

As for the strengths of this study, it should be noted that the information presented represents the country as a whole and is supported by long-term application of information collection standards by trained health professionals.

Chile's rapid transition should serve as an alert with regard to the need to formulate policies to protect vulnerable groups and focus in an ongoing manner on at-risk groups. The experience with eradicating undernutrition should now be directed toward preventing overweight.

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Nutrition transition and double burden of undernutrition and excess of weight in Brazil[1–4]

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ABSTRACT

Background: Brazil, a unique Latin American country recognized as 1 of the 8 major economies of the world, is experiencing a significant deterioration in health equality in the past decade, despite its universal and free-of-charge health service that is governed by its national constitution.

Objective: The objective was to describe the double burden at the national, household, and individual levels as well as its major trends across all demographic strata in the past 40 y.

Design: The data were collected from 6 Brazilian national surveys conducted in 1974–1975, 1989, 1996, 2002–2003, 2006, and 2008–2009. Anthropometric indicators were estimated for all age groups and anemia indicators for children <5 y and women >15 y according to WHO recommendations. The annual increment rate was calculated for all indicators to assess the different time points among surveys.

Results: In 2008–2009, 1 of every 7 citizens was obese. From 1974–1975 to 2008–2009, the annual obesity increment rate for men was 4.7% each year and was 2.5% each year for women. A large decrease in undernutrition in adults was observed from 1974–1975 to 1989. In children <5 y of age, no increase in the prevalence of overweight across the analyzed periods was observed, whereas a major decrease in the prevalence of undernutrition was detected from 1996 to 2006–2007. The prevalence of the obese mother–underweight child pair was low. No association between anemia and any other child anthropometric indicator was detected. Prevalence trends of adult obesity stratified by quintiles of per capita household income showed different trajectories for men and women across the surveys. In the last period, the poorest and richest adults showed positive incremental rates of obesity.

Conclusions: In Brazil, the current prevalence of excess weight is at least 3-fold higher than that of undernutrition. The lowest prevalence rate in the last period analyzed was observed in children <5 y of age. Inclusive social policies have succeeded in reducing poverty and in identifying new challenges related to obesity control or reduction. *Am J Clin Nutr* doi: 10.3945/ajcn.114.084764.

Keywords Brazil, epidemiology, nutrition transition, stunting, obesity, double burden, anemia

INTRODUCTION

Nutrition transition in Brazil has evolved across various relevant social contextual issues. Brazil, a unique Latin American country recognized as 1 of the 8 major economies of the world, is experiencing a significant deterioration in health equality in the past decade (1), despite its universal and free-of-charge health services that are governed by its national constitution.

The double burden of undernutrition and obesity in Brazil has been reviewed previously (2–4). Analysis highlighted the following points: *1*) the decrease in the prevalence of underweight and the increase in that of obesity are similar in adults and adolescents throughout the periods analyzed and *2*) double burden is mainly observed in the poorest members of society, particularly those with low height, which is a marker of nutrition during infancy and becoming obese during adulthood.

Data from a report generated by the Brazilian Institute of Geography and Statistics (Instituto Brasileiro de Geografia e Estatística) were used to generate figures showing the distribution of double burden in Brazil for the following subpopulations: the prevalence of underweight was 2.7%, whereas that of obesity was 14.8% of the population; among the poorest women, underweight was 5.7%, whereas obesity was 15.1%; among the poorest men, underweight was 2.7% and obesity was 5.5% (5).

Young-age transition, which is the change from adolescence to adulthood, seems to play a critical role in the maintenance of a healthy body weight. Considering the nutritional status at 20 y as the initial point, the incidence of obesity was 40.0% in both men and women, whereas the persistence of obesity was 65% in men and 47% in women (6).

The global spread of obesity has been propelled by the decrease in the relative gap among the prevalence rates of obesity in adults, adolescents, and children among countries (7). The relative gap is decreasing for undernutrition as well, in an inverse direction. These trends project critical figures for the prevalence of overweight and obesity in Brazil. It is estimated that by 2050, nearly 70% of Brazilian adults could be overweight if the present trends are sustained (8).

The Brazilian government has launched the Brazilian Strategic Action Plan to Combat Chronic Noncommunicable Diseases, which aims to achieve the following objectives by 2022: *1*) reduce the prevalence of obesity in children, adolescents, and adults; *2*) increase physical activity rates in the population; *3*) increase the consumption of fruit and vegetables; *4*) reduce alcohol consumption and tobacco use; *5*) reduce the use of dietary

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salt; *6*) improve early detection rates for cervical cancer; *7*) reduce mortality associated with noncommunicable diseases by 2% each year; and *8*) treat 100% of women diagnosed with cancerous lesions (9).

We learned that in 2010, Bolivia, and in 2013, Mexico, had launched national strategies against obesity, whereas other countries implemented minor policies to address these issues (10). Because these initiatives are relatively recent and thus have not been evaluated in terms of their success, the inclusion of these actions in an analysis of determinants of obesity is not feasible at this time. We therefore have no previous information regarding the implementation, population coverage, or the status quo of any policies either in Brazil or other countries in Latin America.

To our knowledge, there is no single study that describes nutrition transition for the entire Brazilian population and presents comparable indicators across surveys. This report presents and describes the double burden at the national, household, and individual levels, as well as its major trends across all demographic strata in the past 40 y.

METHODS

The data used in the present study were generated from 6 Brazilian national surveys. Two of these were the Demographic Health Surveys conducted in 1996 and 2006–2007, which assessed female adolescents and women aged 15–49 y and children of <5 y of age. The other 4 surveys were representative of total Brazilian populations: the National Study on Family Expenditures (Estudo Nacional da Despesa Familiar), conducted in 1974–1975 (11); the National Health and Nutrition Survey (Pesquisa Nacional sobre Saúde e Nutrição) performed in 1989 (12); and 2 Family Budget Surveys (Pesquisa de Orçamento Familiares), the first one conducted in 2002–2003 (13) and the second one in 2008–2009 (5). All 6 surveys were designed to sample household complexes that were representative of the Brazilian population. The 3 surveys conducted before the 2000s did not sample the scarcely populated rural census sectors in the northern region of Brazil, of which one was included in the 3 more recent surveys. All of the surveys include data representative of the Brazilian population and allow direct comparisons of various levels of the Brazil population at different time points. The sampling schemes, variables, and data collection procedures are described in the publication of each survey.

We describe the double burden of disease at 3 levels. The national level includes prevalence of stunting, underweight, and excessive weight. The household level includes the estimation of the mother's excessive weight and the children's stunting. The individual level includes the estimation of excessive weight, stunting, and anemia in mothers or children.

BMI was calculated as weight (in kg) divided by height squared (m^2). *z* Scores were calculated by comparing the height, weight, and BMI with the standard values of age and sex by using the 2006 WHO international growth reference (14). Stunting and wasting were defined as having *z* scores, which is a standardized measurement value, of -2 from the respective references. Obesity was defined by using the BMI-for-age reference with *z* scores ≥2. For children aged 5–19 y, anthropometric indicators were estimated by using the WHO 2007 reference (15). Children aged 5–19 y with *z* score values ≥1 from the BMI-for-age reference value were declared overweight.

The nutritional status of individuals aged ≥20 y was classified as underweight when their BMI (in kg/m^2) was <18.5 and as overweight when their BMI was ≥25 (16). Anemia was defined as having a hemoglobin concentration <110 g/L in children and <120 g/L in adolescent girls and women aged >15 y. The annual increment rate was calculated as an exponential series by dividing the second overweight prevalence by the first one, with the ratio raised to the power calculated as the inverse of the time span between surveys.

P values presented in the tables are functions of density generated from the Pearson chi-square test. All analyses were performed by taking into account sample strata, cluster, and weighing structure and were performed by using Stata version 12.1.

RESULTS

In Brazil, the prevalence of stunting decreased at an average rate of 0.5%/y. This performance was associated with a similar reduction that was observed among adults during the same period. Low weight for the same age range showed a stronger trend. A significant decrease in the prevalence of undernutrition in adults was observed from 1974–1975 to 1989, whereas in children <5 y of age, a marked decrease in prevalence was observed from 1996 to 2006–2007 (**Table 1**).

Among children <5 y of age, there was no increase in overweight across analyzed time periods. The next age group, 6–11 y, showed a significant increase in the prevalence of overweight in both males and females (Table 1). No valid data were available for that age strata in the 2002–2003 survey. However, the overweight trajectory was apparently similar to that observed for men and women.

In 2008–2009, 1 in every 2 Brazilian adults was overweight and 1 in every 6 men and 1 in every 8 women was obese. The incremental rate across periods varied between men and women. The mean annual increment for men was 4.7%/y and was 2.5%/y for women.

Evaluation of the nutritional status timeline of Brazil showed a unique trend for the prevalence of obesity in females. From 1974–1975 to 1989, obesity increased by at least 2-fold in males and females, with annual increments of 4.8% and 3.8%, respectively. From 1989 to 2002–2003, the incidence of obesity continued to increase in males, especially in some age groups; in females, the incidence reached a plateau or decreased. The annual rate of increase was 4.2% in males and was 0.4% in females. The trend was reversed from 2002–2003 to 2008–2009, with trends in females similar to those observed in males, although the annual rate was 5.8% for males and 4.5% for females.

The association between maternal and child weight based on anthropometric indicators showed a low prevalence obese mother–underweight child pairs (**Table 2**). Comparison of the status of overweight/obesity to stunting or anemia in children <5 y of age showed that the incidence of overweight/obesity was less than one-fifth of the incidence of stunted children relative to that observed among children of normal height. Stunting was not associated with anemia in children <5 y of age in the only survey that presented both anthropometric and biochemical data (Table 2). No association between anemia and any other child anthropometric indicator was observed.

TABLE 1
Anthropometric and biochemical indicators for Brazilian population according to sex and age group by survey year: 1974–1975 to 2008–2009[1]

Indicator by age and sex	1974–1975 (n = 264,767)	1989 (n = 62,420)	1996 (n = 4,818)	2002–2003 (n = 180,313)	2006–2007 (n = 20,395)	2008–2009 (n = 188,488)	Annual increment rate (last/first), %
Anthropometric indicators							
Age 0–5 y (both sexes)							
Weight-for-height ≤2 z	4.7 (4.3, 5.0)	2.0 (1.4, 2.6)	2.2 (1.6, 2.7)	—	1.4 (0.8, 2.1)	—	0.963
Height-for-age ≤2 z	36.8 (34.7, 40.2)	19.7 (17.7, 22.2)	13.6 (12.3, 15.20)	—	7.1 (5.8, 8.7)	—	0.950
Weight-for-age ≤2 z	15.1 (13.6, 16.6)	5.5 (4.6, 6.3)	4.6 (3.9, 5.4)	—	2.0 (1.4, 2.7)	—	0.939
BMI-for-age ≤2 z	11.1 (10.5, 11.6)	8.6 (7.4, 9.3)	7.4 (6.5, 8.3)	—	7.3 (6.0, 8.6)	—	0.987
Males							
Age 6–11 y							
BMI-for-age ≥1 z	8.3 (7.6, 9.1)	12.3 (10.7, 13.8)	—	—	—	33.8 (32.2, 35.5)	1.038
Age 12–19 y							
BMI-for-age ≤1 z	3.0 (2.6, 3.5)	6.9 (5.8, 8.0)	—	14.5 (13.4, 15.6)	—	19.3 (18.3, 20.4)	1.056
Age ≥20 y							
BMI (kg/m^2) <18.5	7.7 (7.1, 8.3)	4.3 (3.8, 4.8)	—	3.1 (2.8, 3.4)	—	1.8 (1.7, 1.9)	0.958
BMI ≥25	17.9 (16.3, 19.5)	29.0 (27.3, 30.6)	—	40.9 (40.0, 41.9)	—	50.1 (49.4, 50.8)	1.031
BMI ≥30	2.6 (2.3, 2.9)	5.1 (4.5, 5.7)	—	8.9 (8.3, 9.4)	—	12.5 (12.0, 13.0)	1.047
Females							
Age 6–11 y							
BMI-for-age ≥1 z	7.2 (6.4, 8.0)	11.0 (9.5, 12.4)	—	—	—	30.0 (28.4, 31.6)	1.039
Age 12–19 y							
BMI-for-age ≥1 z	8.1 (7.6, 8.7)	14.5 (13.0, 15.9)	—	14.0 (13.0, 15.0)	—	17.6 (16.6, 18.5)	1.023
Age ≥20 y							
BMI <18.5	11.6 (10.8, 12.5)	6.4 (5.8, 7.1)	—	5.7 (5.4, 6.1)	—	3.6 (3.3, 3.8)	0.966
BMI ≥25	26.9 (25.5, 28.2)	39.6 (30.1, 41.1)	—	39.6 (38.8, 40.4)	—	48.0 (47.3, 48.7)	1.017
BMI ≥30	7.2 (6.7, 7.7)	12.3 (11.4, 13.2)	—	13.0 (12.4, 13.5)	—	16.9 (16.4, 17.4)	1.025
Biomarker indicator							
Age 0–5 y (both sexes)							
Anemia (Hb <110 g/L)	—	—	—	—	21.8 (18.6, 24.9)	—	—
Females							
Age 15–19 y							
Anemia (Hb <120 g/L)	—	—	—	—	37.3 (31.3, 43.3)	—	—
Age ≥20 y							
Anemia (Hb <120 g/L)	—	—	—	—	30.6 (26.6, 34.6)	—	—

[1]Values are percentages (95% CIs) unless otherwise indicated. Hb, hemoglobin; z, z scores.

The incidence of anemia was 1 in every 3 Brazilian women of reproductive age, and the prevalence was higher in adolescent females. Among women of reproductive age, no association between anemia and overweight status was observed (Table 2). Separation of the 15- to 24- and 25- to 49-y age ranges also showed no association.

The prevalence rates of adult obesity stratified by quintiles of per capita household income differed between men and women across surveys (**Table 3**). Women, especially those in the middle- to high-income socioeconomic level, presented a stabilization in the incidence of obesity from 1989 to 2002–2003. From 2002–2003 to 2008–2009, the prevalence rates of obesity in men and women increased. From 2002–2003 to 2008–2009, a remarkable change was detected, wherein an inverse general correlation between the annual incidence rate of obesity and income quintiles was detected. This correlation was not observed in the last period, with the poorest and richest adults showing an increase in the incidence of obesity.

DISCUSSION

By examining all of the available Brazilian surveys nationwide, we have presented a large picture of the evolution of major opposite nutritional changes in the past 35 y across different age groups of the Brazilian population. The description highlights a number of issues: *1*) the incidence of stunting and underweight in children significantly decreased in Brazil, with the highest rate of decrease occurring in the past decade; *2*) the incidence of overweight in children <5 y of age is apparently constant, whereas an increase in incidence was observed in children aged 6–11 y; *3*) male adolescents showed the most significant increase in prevalence of overweight among all age groups; *4*) female adolescents and adults showed a changing trend for overweight and obesity incidence rates across the periods analyzed; *5*) in children <5 y of age, overweight was associated with stunting, whereas no relation was observed with anemia; *6*) among females of reproductive age, the incidence of overweight was not associated with anemia; and *7*) an inverse association between an increasing incidence of obesity and income quintiles in adults was not observed in last period investigated.

The positive evolution in nutritional status in Brazilian children <5 y of age was markedly influenced by several factors, including wide social changes, such as urbanization, female schooling, and access to health facilities, and contextual changes, such as the increase in per capita income and social

TABLE 2
Assessment of the double burden of undernutrition and overweight/obesity at the household and individual levels in Brazilian children and women[1]

	Stunting			Anemia		
	With	Without	Total	With	Without	Total
Household level						
Children aged <5 y						
Mother with OW/OB	2.6 (2.2, 3.2)[2]	40.0 (38.5, 41.5)	42.7 (41.2, 44.2)	—	—	—
Mother without OW/OB	4.7 (4.1, 5.3)	52.7 (51.2, 54.2)	57.3 (55.8, 58.8)	—	—	—
Total	7.4 (6.6, 8.2)	92.6 (91.9, 93.5)	100.0 (n = 4390)	—	—	—
P		0.005				
Individual level						
School-aged children (aged 5–11 y)						
With OW/OB	1.0 (0.6, 1.3)[3]	6.2 (5.4, 7.2)	7.2 (6.4, 8.2)	1.3 (0.8, 1.6)[4]	5.8 (4.9, 6.7)	34.1 (32.3, 35.9)
Without OW/OB	5.5 (4.7, 6.3)	87.3 (86.1, 88.5)	92.8 (91.9, 93.7)	17.7 (16.2, 19.2)	75.2 (73.6, 76.8)	65.9 (64.1, 67.7)
Total	6.4 (5.5, 7.3)	93.6 (92.7, 94.5)	100 (n = 4375)	18.9 (17.4, 20.4)	81.1 (79.6, 82.6)	100 (n = 3788)
P		0.001			0.821	
Females of reproductive age (12–49 y)						
With OW/OB	—	—	—	13.6 (12.0, 15.2)[5]	31.8 (29.7, 33.9)	45.4 (43.1, 47.7)
Without OW/OB	—	—	—	16.2 (14.5, 17.9)	38.4 (36.3, 40.7)	54.6 (52.4, 57.0)
Total	—	—	—	29.8 (27.7, 31.9)	70.2 (68.2, 72.4)	100 (n = 1955)
P		—			0.567	

[1]Values are percentages (95% CIs). All P values correspond to a chi-square test comparing expected prevalence with observed prevalence. OB, obesity; OW, overweight.
[2]3.1% expected.
[3]0.5% expected with height-for-age <2 SDs.
[4]1.3% expected.
[5]13.5% expected.

protection policies (17, 18). These factors have contributed, in an ordered and concatenated way, to the significant decrease in the incidence of stunting from 1996 to 2006 and in sustaining the incidence of overweight. The stabilization of overweight among Brazilian children <5 y of age has not yet been explained. A stronger hypothesis is that because the new child cohort shows an increase in height and weight, obesity has been blocked in that age group for a while.

The increase in the incidence of obesity in Brazil has followed the classical demographic spread from adults to adolescents, and finally to children (7). Annual incremental rates indicate a significant increase in the incidence of obesity among the poorest men and women in Brazil. Underweight is virtually controlled among adults.

A decrease in the incidence of obesity in women was observed from 1989 to 2003, whereas an increase was detected from 2003 to 2009. A change in socioeconomic status and obesity, including those in developing countries with low, middle, and high per capita gross national product, showed that as gross national product increased, females of low socioeconomic status have a higher risk of obesity (19). In Brazil, a decrease in the incidence of obesity in females was related to an increase in income or

TABLE 3
Frequencies and annual increment rates of obesity in Brazilian adults according to quintile of household per capita income in 4 surveys in Brazil: 1974–1975 to 2008–2009

	Year of survey, % (95% CI)				Annual increment rate, %		
Quintile of household per capita income	1974–1975 (n = 114,848)	1989 (n = 29,600)	2002–2003 (n = 96,454)	2008–2009 (n = 107,320)	1989/1975	2003/1989	2009/2003
Men							
1	0.5 (0.4, 0.7)	1.7 (1.1, 2.3)	4.1 (3.5, 4.7)	7.0 (6.4, 7.6)	1.088	1.067	1.093
2	1.4 (1.1, 1.6)	3.2 (2.2, 4.2)	8.1 (7.0, 9.0)	10.1 (9.1, 11.0)	1.059	1.071	1.037
3	2.2 (1.8, 2.5)	4.6 (3.4, 5.8)	8.7 (7.5, 9.8)	13.2 (12.1, 14.2)	1.052	1.048	1.072
4	3.7 (3.3, 4.1)	7.7 (6.4, 9.1)	10.6 (9.3, 11.8)	15.1 (14.0, 16.2)	1.052	1.024	1.061
5	5.5 (5.0, 6.0)	8.5 (7.2, 9.7)	12.8 (11.5, 14.1)	16.9 (15.7, 18.2)	1.030	1.031	1.047
Women							
1	2.5 (2.1, 2.9)	8.7 (7.3, 10.0)	11.1 (10.2, 12.0)	15.2 (14.4, 16.0)	1.090	1.018	1.054
2	5.6 (5.1, 6.1)	11.5 (9.8, 13.2)	13.5 (12.4, 14.6)	16.3 (15.4, 17.2)	1.051	1.012	1.032
3	8.6 (8.1, 9.2)	14.6 (12.4, 16.9)	13.4 (12.3, 14.6)	18.1 (17.1, 19.2)	1.037	0.994	1.051
4	10.9 (10.2, 11.6)	14.3 (12.1, 16.5)	14.1 (12.7, 15.4)	18.1 (16.9, 19.2)	1.019	0.999	1.043
5	8.5 (8.0, 9.1)	12.7 (10.0, 14.5)	12.7 (11.3, 13.9)	17.0 (15.8, 18.2)	1.028	1.000	1.050

educational achievement, particularly in the urban setting (20). The recent trend, as observed from 2002–2003 to 2008–2009, has not been explored in detail. Data from VIGITEL (Telephone-based Surveillance of Risk and Protective Factors for Chronic Diseases) indicate that 15% of Brazilian adults are physically active and 18% consume ≥5 portions of fruit and vegetables each day; both of these prevalence rates increased with schooling (21). Analysis of specific factors such as schooling and physical activity (data not shown) suggests the presence of protective effects that were inhibited by the effect of an increase in income in the past decade.

A statistical association between overweight in mothers and undernutrition (stunting) in children is also shown at the household level. This association has also been found in previous reports. An analysis of Demographic Health Surveys data from 54 countries indicated that the prevalence of stunted child/overweight mother pairs is not independent once their prevalence is associated with the prevalence of maternal overweight in the population (22). The stunted child/overweight mother pair is a typical match and probably reflects an increase in BMI, especially among countries undergoing nutritional transition (23). In these countries, women, many of whom present with low height, undergo a rapid weight gain from one generation to the next, whereas height gain is proportionally less intense throughout the next generations.

The association at the individual level between overweight and stunting in children <5 y in age probably reflects the nutritional transition process as well. There is no plausible hypothesis to support ≥2 different causes for these prevalence rates at same time in the same population.

Anemia is a multifactorial disease involving nutrition, infectious, and even genetic factors. No association between mother and child anemia was observed in the last Brazilian survey available. Deficiencies in iron can impair the developmental potential of children, who are considered to be the future of each country. Additional investigations identifying all causes that contribute to the high anemia prevalence in women (1 in every 3) and children (1 in every 4) and the effectiveness of public policies to address this issue in Brazil are thus warranted.

Our analyses indicate the extent and intensity of the nutritional transition in Brazil. The Brazilian government has launched a plan to reduce the mortality rate for noncommunicable diseases as well as their risk factors (9); however, these goals may be a huge challenge. In the past decade, 33 million Brazilians have risen above the poverty line due to the effects of a combination of market-oriented reforms and progressive social policies (23). Although this transformation was positive, it also accelerated the vectors of nutritional transition in the country and further intensified the double burden of disease.

Nutritional transition in Brazil has resulted in an increase in the prevalence of excessive weight by at least 3-fold compared with that of undernutrition. Only children <5 y of age were less affected by excessive weight increase in the last period analyzed. Anemia has become a public health issue, affecting 33% of females and 25% of children. A new public policy to reduce the risk factors and mortality rate from noncommunicable diseases has been launched. New national challenges have emerged because of the success of the social policies to reduce poverty in the past decade and a new social scenario has opened the gates to the spread of changes in food and behavioral patterns that have adverse effects on human health.

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The double burden of undernutrition and excess body weight in Ecuador[1–4]

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ABSTRACT

Background: Ecuador's current nutrition policies have not taken adequate notice of the double burden of malnutrition and continue to focus on stunting and to a lesser extent on overweight, without addressing the simultaneous presence of undernutrition, micronutrient deficiencies, and overweight or obesity (OW/OB).

Objective: The aim of this article was to describe the prevalence and distribution of undernutrition (stunting, anemia, and zinc deficiency), overweight, and obesity in Ecuador to explore the evolving double burden of malnutrition at the national, household, and individual levels and to discuss whether current public health policies are addressing the double burden.

Design: Data from the 2012 Ecuadorian National Health and Nutrition Survey (ENSANUT-ECU) was used to estimate the dual burden of malnutrition at the national, household, and individual levels in children <5 y old, school-aged children, and women of reproductive age.

Results: In 13.1% of households, mothers with excess body weight coexist with a stunted child <5 y old. Moreover, among households with overweight or obese mothers, 12.6% have an anemic child and 14% have a zinc-deficient child. At the individual levels, the coexistence of OW/OB and stunting, anemia, or zinc deficiency was found in 2.8%, 0.7%, and 8.4% of school-ages children, respectively. In addition, 8.9% and 32.6% of women aged 12–49 y have excess body weight and anemia or zinc deficiency, respectively.

Conclusions: This article shows the coexistence of high rates of undernutrition and OW/OB at the individual, household, and national levels in Ecuador. Although integrated approaches to address the emerging double burden are required, public health policies to date have not responded adequately. *Am J Clin Nutr* doi: 10.3945/ajcn.114.083766.

Keywords Ecuador, double burden, overweight, undernutrition, obesity, malnutrition, epidemiological transition

INTRODUCTION

Most underdeveloped countries have substantial experience in addressing undernutrition, which persists as an important public health issue. In addition, dramatic increases in rates of overweight and obesity have been noted in many countries (1). Because this is a relatively new phenomenon, the issue has not yet been adequately addressed or even fully recognized. The evolving double burden of undernutrition and overweight or obesity (OW/OB)[5] is expressed within the context of a complex web of social determinants (2, 3). It has been observed in many Latin American countries that, within the same household, stunting among children persists along with OW/OB in mothers, whereas household members also suffer from micronutrient deficiencies (4–6). The double burden is related to the epidemiologic transition, globalization, urbanization, shifts in occupational structures, and changing patterns of diet and physical activity (2, 7, 8). Although diets in developing countries still include large proportions of unprocessed foods, traditional diets have been replaced in whole or in part by energy-dense foods, particularly processed foods high in fat, sugar, and salt (9). In addition, traditional lifestyles have changed dramatically, particularly in terms of substantial reductions in physical activity (10).

Most underdeveloped countries either have not taken adequate notice of this looming problem or if they have, they lack the resources to address it adequately. Consequently, they continue to concentrate on undernutrition without addressing OW/OB. The current situation in Ecuador is not dramatically different from the trends and transitions that are currently unfolding on the world stage. Ecuador's population of ~15 million is >70% urban (11), although the rural and agricultural sectors remain important. Ecuador is geographically diverse and is home to important ethnic and racial minorities, including Afro-Ecuadorians, Montubios (mixed-race rural residents of the coastal region), and

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[5] Abbreviations used: ENSANUT-ECU, Ecuadorean National Health and Nutrition Survey; Hh An-OW/OBm, household level, child <5 y with anemia and overweight or obese mother; Hh St-OW/OBm, household level, stunted child <5 y and overweight or obese mother; Hh Zn-OW/OBm, household level, child <5 y with zinc deficiency and overweight or obese mother; Ii An-OW/OB, intraindividual level, school-aged children with anemia and overweight or obese; Ii An-OW/OBw, intraindividual level, anemic women of reproductive age with overweight or obese; Ii St-OW/OB, intraindividual level, school-aged children with stunting and overweight or obese; Ii Zn-OW/OB, intraindividual level, school-aged children with zinc deficiency and overweight or obese; Ii Zn-OW/OBw, intraindividual level, zinc-deficient women of reproductive age with overweight or obese; OW/OB, overweight or obesity.

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members of 14 indigenous groups. Although average incomes have increased in the past 2 decades, the country remains highly unequal, with a Gini coefficient that is still ~0.50 (12). Rapid social and economic development in the face of persistent poverty and inequality are factors that provide the context for the double burden of malnutrition.

The aim of this article is to describe the magnitude and distribution of the prevalence of both undernutrition (stunting, anemia, and zinc deficiency) and overweight and obesity in Ecuador to explore the double burden of malnutrition at the individual, household, and national levels and to discuss whether current public policies are addressing the double burden.

SUBJECTS AND METHODS

The data presented here come from the 2012 Ecuadorian National Health and Nutrition Survey (ENSANUT-ECU), which was based on a representative sample of Ecuadorians aged from 0 to 59 y (13). The probabilistic multistage sampling strategy is representative at the national and subregional levels: urban and rural Sierra (highlands), urban and rural coast, urban and rural Amazon (the tropical and semitropical region east of the highlands), Galápagos, and the cities of Quito and Guayaquil. The sample included 57,727 individuals and 19,803 households. A questionnaire collected information on sociodemographic characteristics and anthropometric measurements for all participants in different age groups: children <5 y (n = 8894), school-aged children 5–11 y (n = 11,534), adolescents aged 12–19 y (n = 8529), and adults aged 20–59 y (n = 28,740). From a subsample of subjects, venous blood and urine specimens were collected for micronutrient status determinations, including hemoglobin and zinc, in children aged 6–59 mo (n = 2047), 5–11 y (n = 4443), and 12–19 y (4039) and adults aged 20–59 y (n = 10,950).

Data collection and handling

Trained fieldworkers applied structured questionnaires to participants in the selected households with the use of standardized procedures, protocols, and equipment (14). Height was measured in subjects >2 y old by using portable stadiometers, whereas infantometers were used to measure length in children <2 y to the nearest 0.1 cm. Portable electronic scales were used to measure weight in children and adults to the nearest 0.1 kg. To ensure reliability, anthropometric data were collected for each variable twice, with an interval of 5 to 10 minutes. When there was a difference of ±0.5 kg in weight or ±0.5 cm in height, a third measure was made, and the mean value was calculated from the 2 closest values. In addition, supervisors remeasured participants in every tenth household, and interviewers were retrained after every 11 d of field work. Age was verified by observing each subject's national identity card. Venous blood and urine specimens for micronutrient status determinations were collected by using standardized procedures. Hemoglobin was measured by using sodium lauryl–hemoglobin method/spectrophotometry. Zinc was measured by using Flame atomic absorption spectrophotometry.

To assess nutritional status in preschool-aged children, school-aged children, and adolescents, z scores were calculated by using WHO 2006 and 2007 standards (15, 16). Preschool-aged children were classified as stunted if their length- or height-for-age z scores were < -2 SDs. Risk of overweight and overweight including obesity were defined as >1 SD and ≤2 SDs and >2 SDs of BMI-for-age z score, respectively. Stunting in school-aged children was defined as length- or height-for-age z scores < -2 SDs. For school-aged children and adolescents, overweight and obesity were determined by z scores between >1 SD and ≤2 SDs and >2 SDs in BMI-for-age, respectively. For individuals >19 y, BMI (in kg/m^2) was established according to WHO standards by using cutoffs of ≥25 and <30 for overweight and ≥30 for obesity (17). Weight and height outliers for individuals <19 y were defined by using the WHO SD boundaries, and for adults outliers were set at 5 SDs above or below the reference mean.

Anemia was defined by using WHO cutoffs (18). Hemoglobin values were adjusted for altitude by using the method proposed by Nestel (19) and adjusted by the CDC's Pediatric Nutrition Surveillance System. This method proposes an individual correction that uses a curvilinear equation of observed hemoglobin concentrations according to the altitude at which each subjects live (which in the case of the highlands is frequently >2500 m above sea level). The hemoglobin correction equation is as follows: adjusted hemoglobin = -0.32 (altitude in meters above sea level × 0.0033) + 0.22 (altitude in meters above sea level × 0.033)^2. Zinc deficiency was defined by using the International Zinc Nutrition Consultative Group and the WHO/UNICEF/International Atomic Energy Agency/International Zinc Nutrition Consultative Group cutoffs for >10 and <10 y, respectively (20, 21).

Double burden at the household level was defined as the coexistence of a stunted child <5 y and an overweight or obese mother, referred to hereafter as an Hh St-OW/OBm pair. The double burden at the household level was also defined as the coexistence of a child <5 y with anemia or zinc deficiency and an overweight or obese mother, referred to hereafter as an Hh An-OW/OBm pair and an Hh Zn-OW/OBm pair, respectively. Pregnant women and women with no children or with missing data for their <5-y-old child were excluded from the analysis. At the individual level, the prevalence of double burden in school-aged children (5–11 y) was defined as the coexistence in the same individual of OW/OB, stunting, anemia, or zinc deficiency, referred to hereafter as Ii St-OW/OB, Ii An-OW/OB, and Ii Zn-OW/OB, respectively. The double burden at the individual level was also defined for women of reproductive age (12–49 y) as the coexistence of OW/OB and anemia (referred to hereafter as Ii An-OW/OBw) and as the coexistence of OW/OB and zinc deficiency (referred to hereafter as Ii Zn-OW/OBw). School-aged children and women of reproductive age with missing data on weight, height, hemoglobin, or zinc were excluded from the analysis.

Before the initiation of field work, the study was approved by the Institutional Review Board of the San Francisco de Quito University. All participants signed informed consent forms, and all data were handled anonymously during data entry and analysis.

Statistical analysis

The normality of the distribution of variables was checked by Q-Q plot and histogram observation. The expected prevalence of

Hh St-OW/OBm, Hh An-OW/OBm, and Hh Zn-OW/OBm pairs was calculated by multiplying the prevalence of OW/OB in mothers by the prevalence of stunting, anemia, and zinc deficiency in children <5 y old divided by 100. The expected prevalence of Ii St-OW/OB, Ii An-OW/OB, Ii Zn-OW/OB, Ii An-OW/OBw, and Ii Zn-OW/OBw was calculated by multiplying the prevalence of OW/OB with the prevalence of stunting, anemia, or zinc deficiency divided by 100 in each case, assuming independence of the occurrence of the 2 conditions that encompass the double burden (22). The differences between the expected and the observed prevalence were compared by using a chi-square test. All statistical procedures were performed with Stata 12 (StataCorp) by using the SVY module for complex surveys (23).

RESULTS

Sociodemographic characteristics are described in **Table 1**. These data are comparable to the results of the 2010 national population census (11). Note that only 18.5% of mothers have more than a secondary school education. With regard to anthropometric measurements, 1 of 10 mothers is <145 cm tall, whereas nearly 6 in 10 are either overweight or obese. The national prevalence of stunting and OW/OB in children <5 y, as well as of anemia and zinc deficiency in preschool-aged children, school-aged children, adolescents, and women of reproductive age, is shown in **Figure 1**. As shown in Figure 1A, the traditional problem of stunting persists, affecting 1 in 4 preschool-aged children (25.3%) and nearly 1 in 3 children between 12 and 23 mo of age (32.6%). Although the prevalence

TABLE 1
Characteristics of children <5 y old and their mothers, school-aged children, and women of reproductive age in the ENSANUT-ECU, 2012[1]

Characteristics	Children <5 y old (0–59 mo)	School-aged children (5–11 y)	Women of reproductive age (12–49 y)
n	8894	11,534	18,909
Sex, % male	51.0 (49.5, 52.5)[2]	51.1 (49.7, 52.5)	—
Age, y	2.0 ± 1.4[3]	8.0 ± 2.0	28.5 ± 10.8
Area, %			
Urban	65.0 (62.5, 67.3)	63.7 (61.3, 66.0)	69.0 (66.9, 71.1)
Rural[4]	35.0 (32.7, 37.5)	36.3 (34.0, 38.7)	31.0 (28.9, 33.1)
Economic status index,[5] %			
Q1	27.0 (24.9, 29.1)	23.4 (21.7, 25.3)	20.4 (18.9, 22.1)
Q2	22.5 (21.0, 24.1)	23.4 (21.9, 25.1)	21.1 (19.9, 22.5)
Q3	20.1 (18.6, 21.7)	19.5 (18.1, 20.9)	20.0 (18.8, 21.2)
Q4	16.9 (15.4, 18.5)	18.6 (17.0, 20.3)	19.6 (18.2, 21.1)
Q5	13.6 (11.9, 15.4)	15.1 (13.5, 16.8)	18.9 (17.2, 20.6)
Ethnicity, %			
Indigenous	8.4 (7.1, 9.8)	7.6 (6.5, 8.9)	6.3 (5.5, 7.3)
Afro-Ecuadorian	4.5 (3.7, 5.4)	4.4 (3.6, 5.4)	4.6 (4.0, 5.4)
Montubio	5.1 (4.1, 6.4)	5.5 (4.5, 6.6)	5.5 (4.7, 6.5)
Mestizo, white, and others	82.0 (80.2, 83.7)	82.5 (80.8, 84.0)	83.5 (82.2, 84.8)
Region, %			
Highlands	46.4 (42.8, 50.0)	45.9 (42.4, 49.4)	45.6 (42.1, 49.0)
Coast	46.3 (42.6, 50.1)	47.6 (44.1, 51.2)	49.5 (46.0, 53.1)
Amazon	7.3 (6.4, 8.3)	6.5 (5.7, 7.4)	4.9 (4.3, 5.5)
Maternal characteristics (*n* = 7470)			
Height, %			
<145 cm	—	—	9.8 (8.8, 11.0)
145–149 cm	—	—	23.8 (22.3, 25.4)
≥150 cm	—	—	66.4 (64.5, 68.2)
Age, y	—	—	28.5 ± 6.8
Level of education, %			
No schooling/incomplete primary school	—	—	2.0 (1.6, 2.6)
Primary school/incomplete secondary school	—	—	54.0 (51.9, 55.9)
Secondary school	—	—	25.4 (23.8, 27.1)
Greater than secondary school	—	—	18.5 (17.1, 20.3)
BMI,[6] %			
Underweight (<18.5 kg/m^2)	—	—	1.4 (1.1, 1.8)
Normal (18.5–24.9 kg/m^2)	—	—	40.4 (38.7, 42.0)
Overweight (25.0–29.9 kg/m^2)	—	—	37.8 (36.1, 39.6)
Obese (≥30.0)	—	—	20.4 (19.0, 22.0)

[1]ENSANUT-ECU, Ecuadorian National Health and Nutrition Survey; Q, quintile.
[2]Prevalence (%); 95% CI in parentheses (all such values).
[3]Mean ± SD (all such values).
[4]Rural subjects lived in a locality with <2500 residents; urban subjects lived in a locality with ≥2500 residents.
[5]Q1 = poorest and Q5 = wealthiest.
[6]BMI-for-age *z* scores were used for mothers <19 y old.

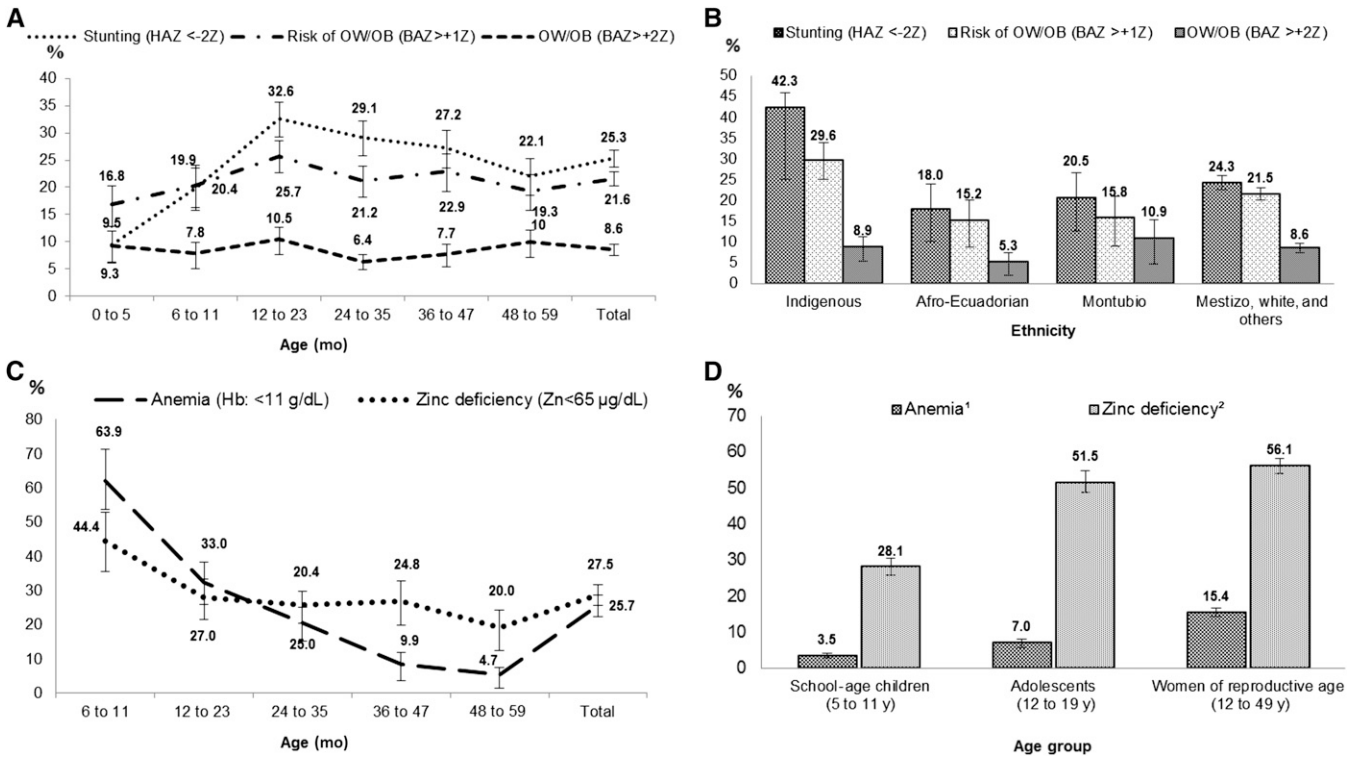

FIGURE 1 Prevalence of stunting, risk of OW/OB, and OW/OB in children <5 y old by age (A) and ethnicity (B). Prevalence of anemia and zinc deficiency in children <5 y old by age (C). Prevalence of zinc deficiency and anemia in school-aged children, adolescents, and women of reproductive age (D). [1]Cutoffs for anemia: school-aged children (Hb <11.5 g/dL) and adolescents and nonpregnant women of reproductive age (Hb <12 g/dL). [2]Cutoffs for zinc deficiency: males (Zn <74 μg/dL) and females (Zn <70 μg/dL). BAZ, BMI-for-age z score; HAZ, length- or height-for-age z score; Hb, hemoglobin; OW/OB, overweight or obesity.

of OW/OB is lower, affecting 8.6% of children <5 y, the risk of OW/OB is considerably higher and affects 21.6% of children <5 y. With regard to ethnicity, Figure 1B shows that historically high levels of stunting persist in the indigenous population (42.3%). Moreover, the risk of OW/OB in indigenous children <5 y old is double that of children in the other ethnic groups. As shown in Figure 1C anemia and zinc deficiency affect 25.7% and 27.5% of preschool-aged children, respectively. The prevalence of both deficiencies is very high, especially in infants between 6 and 11 mo of age. Anemia is more prevalent than zinc deficiency in the first year of life, but by the second year zinc deficiency is more prevalent. As shown in Figure 1D, 1 in 4 school-aged children continue to be affected by zinc deficiency and more than half of adolescents from 12 to 19 y of age are affected by this problem. Moreover, nearly 6 in 10 women of reproductive age suffer from zinc deficiency and 1 in 10 from anemia. As shown in **Figure 2**, the prevalence of OW/OB among school-aged children is higher in boys (32.5%) than in girls (27.1%), but in both sexes it affects >1 in 4 children. Among adolescents, in contrast, overweight is more prevalent in girls (21.9%) than in boys (16.2%), whereas the rates of obesity are similar, affecting ~7% of subjects in this age range. By the time adulthood is reached, however, overweight is more prevalent in men (44.3%) than in women (38.3%) who nevertheless suffer from obesity in higher proportions.

Data that show the double burden of undernutrition and excess body weight at the household and individual levels are presented in **Table 2**. At the household level, 57.6% of mothers were either overweight or obese, and 24.8% of children <5 y were stunted. In 13.1% of households, mothers with OW/OB coexist with a stunted child <5 y old. This proportion was lower than expected ($P < 0.05$) assuming independence of the occurrence of each condition. Moreover, the coexistence of an overweight or obese mother with an anemic or zinc-deficient child <5 y old was observed in 12.6% and 14.0% of households, respectively. Both values were lower than expected, although not significant assuming burdens were independent ($P > 0.05$). At the individual level, the double burden of OW/OB and stunting, anemia, or zinc deficiency was found in 2.8%, 0.7%, and 8.4%

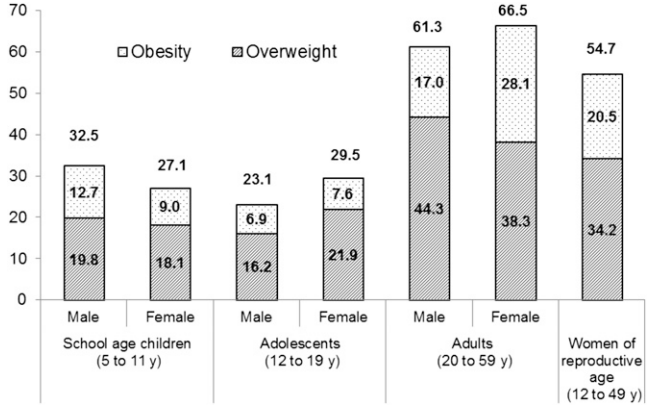

FIGURE 2 Prevalence of overweight and obesity in school-aged children, adolescents, adults, and women of reproductive age.

TABLE 2
Assessment of the double burden of undernutrition and OW/OB at household and individual levels in Ecuadorian children and women: ENSANUT-ECU, 2012[1]

	Stunting, %			Anemia, %			Zinc deficiency, %		
	With	Without	Total[2]	With	Without	Total[2]	With	Without	Total[2]
Household level									
Children <5 y old									
Nonpregnant mother with OW/OB	13.1[3] (12.0, 14.4)	44.5 (42.7, 46.3)	57.6 (55.8, 59.4)	12.6[4] (10.6, 14.9)	40.9 (37.6, 44.2)	53.5 (49.9, 57.0)	14.0[5] (11.9, 16.5)	39.4 (36.1, 42.8)	53.4 (49.9, 56.9)
Nonpregnant mother without OW/OB	11.7 (10.6, 12.9)	30.7 (29.0, 32.4)	42.4 (40.6, 44.2)	13.8 (11.4, 16.6)	32.8 (29.7, 36.1)	46.5 (43.0, 50.1)	13.5 (11.2, 16.2)	33.0 (29.8, 36.5)	46.6 (43.1, 50.1)
Total	24.8 (23.3, 26.5)	75.2 (73.5, 76.8)	100.0 [8078]	26.4 (23.4, 29.5)	73.6 (70.5, 76.6)	100.0 [1893]	27.5 (24.5, 30.8)	72.4 (69.2, 75.5)	100.0 [1893]
P			0.002			0.057			0.378
Individual level									
School-aged children (5–11 y)									
With OW/OB	2.8[6] (2.4, 3.2)	26.7 (25.3, 28.2)	29.5 (28.0, 31.0)	0.7[7] (0.4, 1.3)	28.3 (26.1, 30.6)	29.0 (26.8, 31.4)	8.4[8] (7.0, 10.0)	20.6 (18.8, 22.6)	29.0 (26.8, 31.4)
Without OW/OB	12.2 (11.3, 13.2)	58.3 (56.8, 59.9)	70.5 (69.0, 72.0)	2.7 (2.1, 3.4)	68.3 (66.0, 70.6)	71.0 (68.7, 73.2)	19.5 (17.6, 21.6)	51.5 (48.9, 54.0)	71.0 (68.7, 73.2)
Total	15.0 (13.9, 16.1)	85.0 (83.9, 86.1)	100.0 [11,379]	3.4 (2.7, 4.2)	96.6 (95.8, 97.3)	100.0 [4396]	27.9 (25.6, 30.3)	72.1 (69.7, 74.4)	100.0 [4395]
P			0.001			0.133			0.582
Women of reproductive age (12–49 y)									
With OW/OB	—	—	—	8.9[9] (7.9, 9.9)	49.1 (47.3, 50.9)	58.0 (56.3, 59.7)	32.6[10] (30.7, 34.5)	24.9 (23.2, 26.8)	57.5 (54.0, 58.4)
Without OW/OB	—	—	—	6.2 (5.4, 7.1)	35.8 (34.1, 37.5)	42.0 (40.3, 43.8)	23.6 (22.0, 25.4)	18.8 (17.4, 20.4)	42.5 (41.6, 46.0)
Total	—	—	—	15.1 (13.9, 16.4)	84.9 (83.6, 86.1)	100.0 [8014]	56.2 (55.7, 59.3)	43.8 (40.7, 44.3)	100.0 [7205]
P			—			0.664			0.606

[1]Values are prevalences (%); 95% CIs in parentheses. All *P* values are for comparisons between the percentage with double burden and the percentage expected if the burdens were independent. Differences between the expected and the observed prevalence were compared by using a chi-square test. ENSANUT-ECU, Ecuadorian National Health and Nutrition Survey; OW/OB, overweight or obesity.

[2]*n* in brackets.

[3–10]Expected values = [3]14.3%, [4]14.1%, [5]14.7%, [6]4.4%, [7]1.0%, [8]8.1%, [9]8.8%, and [10]32.3%.

of school-aged children, respectively. The observed prevalences of Ii An-OW/OB and Ii Zn-OW/OB corresponded to the expected value because they were not significant. At the individual level, the coexistence of OW/OB and anemia was found in 8.9% of women of reproductive age. Moreover, 32.6% of overweight or obese women aged 12–49 y also suffer from zinc deficiency. In both cases, the prevalence corresponded to expected values because they were not significant. In synthesis, the data show that micronutrient deficiencies are present in women of reproductive age, independent of their BMI. Moreover, the data confirm findings presented earlier that show that anemia is less prevalent than zinc deficiency but that both persist as important nutritional problems.

DISCUSSION

Although stunting and micronutrient deficiencies have been observed in Ecuador for at least 2 decades (24), the emerging phenomenon of OW/OB is still not widely recognized, even though other recent studies also found high rates of overweight and obesity in women of reproductive age as well as in older adults (25, 26). In this highly dynamic scenario, rates of undernutrition in the form of stunting, anemia, and zinc deficiency persist, particularly in vulnerable segments of the population. At the same time, rates of overweight and obesity have increased dramatically in all points of the life cycle (13).

A study conducted by the World Bank (27) that estimated the prevalence of undernutrition in children <5 y old in Ecuador is the only previous work that shows simultaneous high levels of undernutrition and OW/OB in mothers, thereby suggesting the presence of the double burden. Nevertheless, as far as we are aware, the data presented in this article are the first collected from a national, representative sample that conclusively show the coexistence of high rates of undernutrition and OW/OB in Ecuador at the individual, household, and national levels. Specifically, in >13.1% of the households, a stunted child <5 y old coexists with an overweight or obese mother. The dual burden was also observed at the individual level; 8.4% of school-aged children are both zinc-deficient and either overweight or obese whereas 32.6% of women of reproductive age are also zinc-deficient and suffer from OW/OB.

Most of the prevalence values observed with regard to the double burden at the individual and household levels fall within the range of expected values, although the prevalance of Hh St-OW/OBm and Ii St-OW/OBs was lower than expected and was significant. Therefore, the analysis of the double burden in different population segments shows that the presence of each condition (stunting, OW/OB, anemia, and zinc deficiency) in the same household or at the individual level is the product of the magnitude of the individual prevalence rates in the population. Nevertheless, the independence of each condition does not change the fact that both conditions coexist and therefore the underlying determinants of undernutrition and OW/OB should be simultaneously addressed by appropriate public health policies.

The coexistence of nutritional problems of deficit and excess in the same individuals and households can be explained by several factors, which are hardly unique to Ecuador. In this sense, the present case is particularly relevant because, although Ecuador is a middle-income country, the United Nations places it in the high-development category in the 89th place of 186 countries (12).

First, the increase in the rate of overweight and obesity in the Ecuadorian population is greater than the decrease in undernutrition. Second, the double burden is related to changing patterns of diet and physical activity. The ENSANUT-ECU study suggests that emerging food consumption patterns in Ecuador might be substantially contributing to the double burden. On one hand, 30% of the population has an excessive intake of carbohydrates based in large part on the consumption of rice, which is the most important staple in that it also contributes significantly to the daily intake of protein, iron, and zinc, even though it provides low nutrient bioavailability (13). In contrast, Ecuadorians consume, on average, very small quantities of fresh fruit and vegetables; although the recommendation is 400 g/d, mean consumption is only 183 g. Hence, the prevailing pattern of food consumption incorporates an inadequate consumption of micronutrients but at the same time might promote overweight and obesity. In addition, levels of physical activity are low in all age groups. Among school-aged children and adolescents, 21% and 26%, respectively, spend an average of ≥2 h/d watching television or playing electronic games, whereas 45% of adults have a low level of physical activity or are inactive (13). Third, recent studies have shown that overweight and obese individuals have a greater probability of suffering from iron and zinc deficiency than do those who are not overweight or obese (28–30). Fourth, these patterns have evolved within the context of structural changes observed in Ecuador and throughout the world to one degree or another. Specifically, nutritional status has been irrevocably altered by the globalization of agricultural production and food consumption fueled in part by transnational markets, the diffusion of technological innovations (particularly the near-universalization of television and digital communications), accelerated rates of urbanization, dramatic shifts in occupational structure, improved educational status, and changing sex roles (31, 32).

Although the double burden of undernutrition and OW/OB should be part of public discourse and should also frame health policy in Ecuador, decision makers have yet to recognize the implications of the high prevalence of overweight and obesity or to fully understand that the presence of this problem in children and adolescents presages an unhealthy future. In short, there is little appreciation or sufficient understanding of the double burden of undernutrition and OW/OB in different segments of the population.

The Ecuadorian government has allocated unprecedented proportions of the budget to investments in health and nutrition. Among the priorities is a reduction in the persistently high rates of undernutrition in children <5 y, for whom substantial resources have been dedicated, according to an action plan that was based on scientific evidence (33). Nevertheless, the prevalence of stunting remains at very high levels and is much higher than levels found in other countries in the region, including Brazil, Mexico, and Colombia (34–36).

The government has implemented a set of interrelated actions, including a package of health services for mothers and children called "Desnutrición Cero" (Zero Undernutrition), a school lunch program called "Programa de Alimentación Escolar" (School Lunch Program), and the promotion of physical activity. In addition, the government is presently considering various alternatives for regulating the advertising and sale of processed foods. Nevertheless, at the implementation level, these actions

are poorly articulated and fail to address the looming double burden of malnutrition. Moreover, these programs have not been evaluated to determine whether or not they have had any impact.

To be able to define an integrated strategy that simultaneously addresses the double burden, it is essential that there be broad consensus on the causes and determinants of this evolving public health problem. In that context, it is expected the ENSANUT-ECU study will contribute to a shared understanding of the evolving epidemiologic and nutritional profile of the diverse Ecuadorian population and to the development of an integrated strategy that considers both undernutrition and overweight and obesity.

The principal lesson to be learned from the Ecuadorian experience is that although program implementation in some places may suffer from inadequate resources, this is not always the case. Rather, the ability to successfully address this complex and emerging problem may be limited by other factors, including gaps between knowing what should be done and being able to implement effective solutions, in part because of political realities and because qualified professionals are often not in a position to take the lead in implementing innovative solutions. Even at the local level, public health teams, which generally include physicians, nurses, and nutritionists, are often unable to include nutrition components within a package of primary health services. Given these limitations, it is essential that a broad range of actors be incorporated into interdisciplinary and integrated efforts at all levels of decision making and implementation to address the double burden discussed in this article.

The authors' responsibilities were as follows—WBF: designed and supervised the research, prepared the first draft of the manuscript, and had major responsibility for the final content; KMS-J, MJR-L, and WFW: analyzed data and wrote the final manuscript; and PB: provided statistical expertise. All of the authors contributed to the interpretation of the data, read the manuscript, participated in the preparation and editing of the manuscript, and read and approved the final version. None of the authors had any personal or financial conflict of interest related to this article.

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The double burden of undernutrition and excess body weight in Mexico[1–4]

Maria F Kroker-Lobos, Andrea Pedroza-Tobías, Lilia S Pedraza and Juan A Rivera

ABSTRACT

Background: In Mexico, stunting and anemia have declined but are still high in some regions and subpopulations, whereas overweight and obesity have increased at alarming rates in all age and socioeconomic groups.

Objective: The objective was to describe the coexistence of stunting, anemia, and overweight and obesity at the national, household, and individual levels.

Design: We estimated national prevalences of and trends for stunting, anemia, and overweight and obesity in children <5 y and in school-aged children (5–11 y) and anemia and overweight and obesity in women aged 20–49 y by using the National Health and Nutrition Surveys conducted in 1988, 1999, 2006, and 2012. With the use of the most recent data (2012), the double burden of malnutrition at the household level was estimated and defined as the coexistence of stunting in children <5 y and overweight or obesity in the mother. At the individual level, double burden was defined as concurrent stunting and overweight and obesity in children aged 5–11 y and concurrent anemia and overweight or obesity in children aged 5–11 y and in women. We also tested if the coexistence of the conditions corresponded to expected values, under the assumption of independent distributions of each condition.

Results: At the household level, the prevalence of concurrent stunting in children <5 y and overweight and obesity in mothers was 8.4%; at the individual level, prevalences were 1% for stunting and overweight or obesity and 2.9% for anemia and overweight or obesity in children aged 5–11 y and 7.6% for anemia and overweight or obesity in women. At the household and individual levels in children aged 5–11 y, prevalences of double burden were significantly lower than expected, whereas anemia and the prevalence of overweight or obesity in women were not different from that expected.

Conclusions: Although some prevalences of double burden were lower than expected, assuming independent distributions of the 2 conditions, the coexistence of stunting, overweight or obesity, and anemia at the national, household, and intraindividual levels in Mexico calls for policies and programs to prevent the 3 conditions.

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Keywords Mexico, double burden, overweight and obesity, undernutrition, children, women nutrition policy

INTRODUCTION

Undernutrition has declined, whereas excess body weight is increasing globally. Stunting in children aged <5 y has decreased by 35% globally, and wasting has declined by 11% during the past 2 decades (1). The obesity epidemic, which started in most high-income countries in the 1970s and 1980s, has extended to many lower-middle-income countries. By 2008, an estimated 1.96 billion adults and 170 million children aged <18 y globally were overweight or obese (2). In high-income countries, undernutrition is no longer a public health problem and thus obesity is the major concern. However, in several lower-middle–income countries, including most Latin American countries, relatively high prevalences of undernutrition and excess body weight coexist and thus the double burden of undernutrition and obesity are of public health concern (3).

Mexico has experienced a nutrition transition characterized by a decrease in the prevalence of different forms of undernutrition (4) and anemia (5) in children aged <5 y, whereas excess body weight (overweight/obesity) has increased in all age groups (6, 7). Despite the decline of stunting and anemia in the past 25 y, both conditions are still high in some regions and subpopulations, whereas obesity is widespread; therefore, undernutrition and obesity coexist in the Mexican population. Although deficiencies and conditions of excess comprising the double burden of malnutrition might seem opposite to one another, they share environmental conditions and behaviors and can co-occur at the household and individual level (8).

National programs and policies such as the Human Development Program "Oportunidades" (9), a subsidized milk distribution program (Liconsa) (10), and recently, the National Crusade against Hunger (11) have or are attempting to address undernutrition and food insecurity. On the other hand, other strategies such as the National Agreement for Obesity Prevention [Acuerdo Nacional para la Salud Alimentaria (ANSA)] (12, 13) statutory regulations designed to secure the availability and accessibility of healthy foods and safe water and to reduce access to unhealthy foods such as sugar-sweetened beverages (SSBs) in Mexican schools; the National Strategy to Prevent and

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Control Overweight, Obesity, and Diabetes; and taxation of SSBs and unhealthy foods have been implemented or will be applied to tackle the obesity epidemic (14–16). However, it is not clear to what extent these programs integrate actions to tackle the double burden. This article presents an overview of the coexistence of undernutrition (stunting and anemia) and excess body weight (overweight or obesity) at the national, household, and intraindividual levels in Mexico over a 24-y period to ascertain the degree to which nutrition programs and policies in Mexico include the double burden as part of their scope and objectives.

SUBJECTS AND METHODS

Subjects

We analyzed anthropometric and hemoglobin data in preschool-aged children (<5 y), school-aged children (5–11 y), and females of reproductive age (12–49 y) from 1988, 1999, 2006, and 2012 nationally representative nutrition surveys. The sample size of the surveys ranged from 13,000 to 49,000 households. A detailed description of the sampling and the data collection methods are presented elsewhere (17–22).

A multistage, random, cluster-sampling procedure was used to draw the sample from each survey. All surveys were representative at the national and regional level; the 1999 survey was also representative for rural and urban areas, whereas the 2006 and 2012 surveys were, in addition, representative at the state level. Weight and height outliers were defined for children at 5 SDs above or below the reference mean. No further data cleaning was conducted on BMI in children. For mothers, BMIs (in kg/m^2) <10 or >58 were used as the lower and upper limits to consider the data valid. At the household level, we excluded mothers with missing BMI data, those who were pregnant or breastfeeding, and women who had no children or no data on their <5-y-old child. At the individual level, we included school-aged children and woman with complete weight, height, and hemoglobin data.

Study design

By using the 1988, 1999, 2006, and 2012 nationally representative nutrition surveys, we estimated the magnitude of and trends for stunting, anemia, and excess body weight in preschool-aged (<5 y), school-aged children (5–11 y), and women (20–49 y). To estimate the double burden of malnutrition at the household and intraindividual levels, we used data from the 2012 National Health and Nutrition Survey [Encuesta Nacional de Salud y Nutrición (ENSANUT) 2012] only. At the household level, we estimated the prevalence of double burden, defined as the coexistence of a stunted child (<5 y) and an overweight or obese mother. At the individual level, the concurrent prevalences of stunting and excess body weight within individuals were assessed in school-aged children ("intraindividual concurrent stunting and excess weight"), and the concurrent prevalences of anemia and excess body weight ("intraindividual concurrent anemia and excess weight") were estimated in school-aged children and girls and women of reproductive age.

We defined stunting, wasting, and underweight by using <2 z scores as the cutoff for each indicator: length- or height-for-age, weight-for-length or -height, and weight-for-age, respectively, for each age (mo) and sex in children aged <5 y (23). BMI, calculated by dividing the weight (kg) by the square of height (m^2), was used as the indicator for excess body weight (overweight/obesity) and was defined according to WHO 2006 and 2007 references (23) by using weight-for-height z score (>2 SDs ≤3) for overweight and (>3 SDs) for obesity in children aged <5 y, BMI-for-age z score (>1 SD ≤2) for overweight and (>2 SDs) for obesity for children and adolescents aged 5–19 y, and BMI (>25 and < 30) for overweight and (≥30) for obesity in adults aged >20 y. Anemia was defined with the use of the sex and age WHO cutoffs, adjusting for altitude over sea level, by using the Cohen and Haas equation (24).

Statistical analysis

At the national level, we estimated prevalences and 95% CIs for stunting (in children <5 y), anemia (in school-aged children and women), and excess body weight for children (birth to age 11 y) by sex and for females of reproductive age (12–49 y). Trends were evaluated statistically by using chi-square tests for trend.

At the household level, we calculated the expected prevalence of stunting in <5-y-old children and overweight or obesity in their mothers by multiplying the prevalence of overweight or obese mothers by the prevalence of stunted preschool-aged children and dividing the product by 100.

We then estimated the expected prevalence of stunting and excess body weight in school-aged children and of anemia and excess body weight in both school-aged children and reproductive-age females. Expected prevalences were also estimated as explained previously for the household-level double burden.

We compared the expected prevalence with the observed prevalence of double burden conditions at the household and individual levels to determine whether the coexistence of undernutrition and obesity is larger than what would be expected solely on the basis of the prevalences of each separate condition in the population (25). Prevalences and 95% CIs were estimated and compared by using a chi-square test from which P values were obtained. All analyses were adjusted for the complex sample design by using the "SVY" module of Stata 12 (StataCorp).

RESULTS

The sample sizes for the analysis of trends at the national level are provided in the legend for **Figure 1**. For national prevalences in 2012, the sample sizes were as follows: 10,658 preschool-aged children, 16,351 school-aged children, 13,992 adolescents, and 37,580 adults aged ≥20 y. For the household-level analysis of double burden, we included 4777 households in which anthropometric data were available for both mothers and children aged <5 y.

For the analysis of double burden at the intraindividual level, a total of 11,638 children and adolescents (<20 y), 12,734 women aged 20–49 y, and 12,758 adults >60 y had plausible hemoglobin data. Of these, 13,679 children aged 5–11 y and 17,925 girls and women aged 12–49 y had anthropometric and anemia data. The sample sizes for the actual analysis were as follows—school-aged children: the coexistence of stunting and excess body weight, n = 16,351, and the coexistence of anemia and excess body weight, n = 13,679; women: the coexistence of anemia and overweight or obesity, n = 17,925.

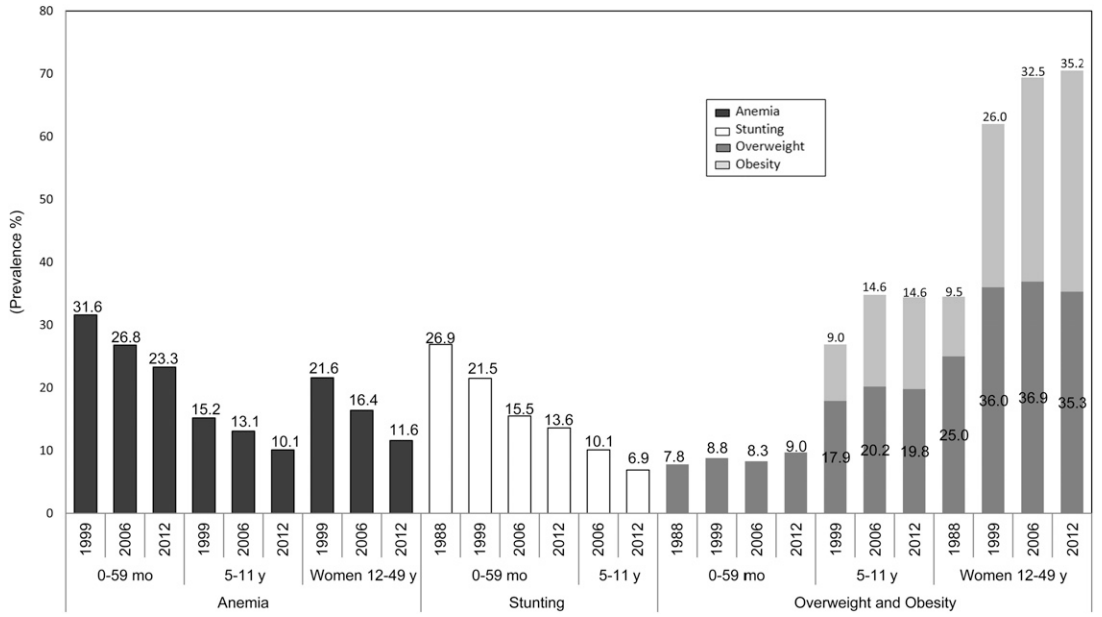

FIGURE 1. Prevalences of and trends for anemia, stunting, and overweight/obesity in children <5 y and in school-aged children and for anemia and overweight/obesity in women aged 20–49 y from 1988 to 2012. Sample sizes were as follows—children <5 y: anemia (1999, n = 5201; 2006, n = 6618; 2012, n = 7570), stunting and overweight (1988, n = 6937; 1999, n = 7590; 2006, n = 7707; 2012, n = 10,658); school-aged children: anemia (1999, n = 10,218; 2006, n = 14,666; 2012, n = 13,866), stunting (2006, n = 15,111; 2012, n = 16,351), overweight (1999, n = 11,338; 2006, n = 15,111; 2012, n = 16,351); females aged 12–49 y: anemia (1999, n = 16,497; 2006, n = 20,610; 2012, n = 18,118); women aged 20–49 y: overweight (1988, n = 16,864; 1999, n = 12,798; 2006, n = 14,556; 2012, n = 14,570). All P-trend < 0.01 (chi-square test).

A steady and significant decline in the prevalence of stunting, underweight, and anemia in the past 25 y accompanied by a consistent increase in the prevalence of overweight and obesity in all studied age groups are shown in Figure 1. In preschool-aged children, decreases of 49.4% from 1988 to 2012 and 26.3% from 1999 to 2012 were observed in the prevalences of stunting and anemia, respectively, which amounted to a 2%/y decline in both conditions. In contrast, an increase of 47.5% from 1988 to 2012 in the combined prevalence of overweight and obesity was found. Similar trends were found in school-aged children for stunting, anemia, and overweight or obesity. In women (20–49 y), the increase in overweight and obesity from 1988 to 2012 was 104% (4.3%/y), obesity increased by 270% (11%/y) in the same period of time, whereas the prevalence of anemia in females aged 12–49 y decreased by 46% from 2006 to 2012 (3.6%/y). All trends were significant (P-trend < 0.01).

Prevalences using the ENSANUT 2012 data were 13.6% for stunting, 23.3% for anemia, and 9.0% for overweight in children aged <5 y. Prevalences in school-aged children were 6.9%, 10.1%, and 34.4% for stunting, anemia, and overweight or obesity, respectively, and 10.1% and 34.9% for anemia and overweight or obesity in adolescents. Sex differences in the prevalences of children and adolescents were small.

In adults aged ≥20 y, high prevalences of overweight and obesity were observed, with large differences between age categories, as follows: 64.4%, 81.5%, and 70.2% for those aged 20–39 y, 40–59 y, and ≥60 y, respectively. Females had higher prevalences of obesity, whereas males had higher prevalences of overweight across age groups. We also found anemia in 11.9% and 16.2% of the 20–49-y and the 40–59-y groups, respectively, and in 16.5% of adults (both sexes) aged ≥60 y **(Table 1)**. Less than 2.0% of adolescents and women were thin (data not shown).

At the household level, we found that in 64% of the households mothers were overweight or obese, and in 14.2% of the households children <5 y were stunted. In 8.4% of the households we found the coexistence of an overweight or obese mother with a stunted child <5 y. This proportion of households with the double burden is lower than expected (9.1%; P = 0.039), assuming independence of the proportions of households with overweight or obese mothers and with stunted children (**Table 2**). Stratified analysis at the regional level showed that in the urban south region of the country, the coexistence of stunting in children <5 y and excess body weight in their mothers was observed in 13.4% of households (data not shown). This proportion was lower than expected (15.5%), assuming independence of the occurrence of each condition.

At the individual level, in school-aged children, we found that 34.4% were overweight or obese and 7.0% were stunted. The double burden of overweight/obesity and stunting was found in 1.0% of these children, which was lower than expected (2.3%; P < 0.001), assuming independence in the prevalences of each condition. Also in school-aged children, prevalences of 34.1% for overweight/obesity and 9.9% for anemia were found. The prevalence of the double burden was 2.9%, which was also lower than expected assuming independence in the prevalences of each condition (3.4%; P < 0.001). At the individual level in females aged 12–49 y we found that 61.7% were overweight or obese and 11.6% were anemic. The double burden of anemia and overweight or obesity was present in 7.6%, higher than expected assuming independent distributions of each condition (7.2%; P = 0.03). We analyzed separately the double burden of obesity and anemia (Table 2). The coexistence of both conditions was 3.4%, which was not different (P = 0.893) than the expected value assuming independent distributions of each condition (3.3%).

TABLE 1
Prevalences of underweight, overweight, obesity, and anemia by age group and sex in a Mexican population (ENSANUT 2012)[1]

		Undernutrition[2], % (95% CI)			Weight-for-age, BMI-for-age, or BMI, % (95% CI)		Anemia[3]	
Age group and sex	*n*	Wasting/thinness BMI-for-age or BMI	Stunting	Underweight	Overweight[4]	Obesity[5]	*n*	% (95% CI)
<5 y								
Total	10,658	1.6 (1.3, 2.0)	13.6 (12.6, 14.7)	2.8 (2.4, 3.3)	7.1 (6.3, 7.8)	1.9 (1.4, 2.3)	7570	23.3 (21.8, 24.8)
Male	5314	1.8 (1.3, 2.5)	15.1 (13.8, 16.6)	2.8 (2.2, 3.6)	7.2 (6.1, 8.4)	1.8 (1.2, 2.3)	3819	24.4 (22.4, 26.6)
Female	5344	1.4 (1.0, 1.9)	12.1 (10.8, 13.5)	2.8 (2.2, 3.4)	7.0 (6.0, 8.0)	2.0 (1.4, 2.6)	3751	22.1 (19.9, 24.5)
5–11 y								
Total	16,351	1.5 (1.2, 1.8)	6.9 (6.2, 7.6)	1.5 (1.2, 1.8)	19.8 (18.8, 20.9)	14.6 (13.7, 15.6)	13,866	10.1 (9.3, 10.9)
Male	8195	1.3 (0.9, 1.7)	6.6 (5.8, 7.4)	1.3 (0.9, 1.7)	19.5 (18.1, 21.0)	17.4 (16.0, 18.8)	6938	10 (9.0, 11.2)
Female	8156	1.7 (1.3, 2.1)	7.2 (6.3, 8.2)	1.7 (1.3, 2.1)	20.2 (18.8, 21.6)	11.8 (10.8, 12.8)	6928	10.1 (9.1, 11.3)
12–19 y								
Total	13,992	1.9 (1.6, 2.3)	—	—	21.6 (20.5, 22.8)	13.3 (12.5, 14.2)	11,638	5.6 (4.9, 6.4)
Male	7041	2.4 (1.9, 3.1)	—	—	19.6 (18.2, 21.1)	14.5 (13.3, 15.8)	5792	3.6 (3.0, 4.4)
Female	6951	1.4 (1.1, 1.8)	—	—	23.7 (22.1, 25.5)	12.1 (10.9, 13.4)	5846	7.7 (6.6, 9.0)
20–39 y								
Total	16,762	1.7 (1.4, 2.0)	—	—	36.3 (35.2, 37.4)	28.1 (27.0, 29.2)	—	—
Male	6896	1.3 (0.9, 1.9)	—	—	38.3 (36.6, 40.0)	25.2 (23.6, 26.9)	—	—
Female	9866	2 (1.6, 2.6)	—	—	34.4 (33.0, 35.9)	30.7 (29.3, 32.2)	8774	11.9 (10.9, 13.0)
40–59 y								
Total	13,641	0.4 (0.3, 0.6)	—	—	41.8 (40.4, 43.2)	39.7 (38.3, 41.1)	—	—
Male	5739	0.4 (0.2, 0.7)	—	—	46.8 (44.8, 48.8)	31.9 (30.0, 33.8)	—	—
Female	7902	0.4 (0.3, 0.6)	—	—	37.3 (35.4, 39.1)	46.8 (45.0, 48.7)	3960	16.2 (14.3, 18.2)[6]
≥60 y								
Total	7177	1.5 (1.1, 2.0)	—	—	40.2 (38.4, 42.1)	30 (28.2, 31.8)	6379	16.5 (15.1, 18.1)
Male	3327	1.6 (1.1, 2.2)	—	—	46.4 (43.5, 49.3)	20.7 (18.6, 23.1)	2927	17.8 (15.8, 20.1)
Female	3850	1.4 (0.9, 2.2)	—	—	34.9 (32.5, 37.3)	38.1 (35.6, 40.6)	3452	15.4 (13.5, 17.5)

[1]ENSANUT, Encuesta Nacional de Salud y Nutrición (National Health and Nutrition Survey) (22).
[2]Undernutrition: weight-for-height, weight-for-age, and height-for-age *z* scores < -2 SDs are used for children <5 y; BMI-for-age *z* scores < -2 SDs are used for children 5–19 y; and BMI (in kg/m^2) <18.5 for was used for those aged ≥20 y (23).
[3]Anemia: WHO cutoffs for sex and age group, adjusted by using the Cohen and Haas equation (24).
[4]Overweight: Weight-for-height *z* score >2 SDs for children <5 y, BMI-for-age *z* score >1 SD for children aged 5–19 y, and BMI ≥25 and <30 in adults aged ≥20 y.
[5]Obesity: weight-for-height *z* score >3 SDs for children <5 y, BMI-for-age *z* score >2 SDs for children aged 5–19 y, and BMI ≥30 for adults aged ≥20 y.
[6]This prevalence corresponds to women 40–49 y of age.

DISCUSSION

We documented a nutritional transition in Mexico during the past quarter of a century, characterized by the decline in undernutrition and anemia and the increase in excess body weight in all studied age groups. As shown in the latest national survey (2012), Mexico faces the double burden of high prevalences of overweight/obesity (33–82% across age groups) with the persistence of moderate to low prevalences of anemia (12–23%) and stunting (~14%). In >8% of the households a stunted child coexists with her overweight or obese mother. We also documented the double burden in the same individual: >7% of women are both anemic and overweight or obese. The coexistence of the double burden in school-aged children is much lower: 1% and 2.9% for overweight/obesity with stunting or with anemia, respectively.

The prevalences of the double burden at the household level and at the intraindividual level in school-aged children were lower than expected, whereas those in women were larger than what would be expected assuming independence of the distributions of each nutrition condition. Although all differences were significant, their relative magnitude was too small in most cases (<15% of the expected prevalence) in terms of public health relevance. In other words, the occurrence of each separate condition (overweight/obesity, stunting, anemia) at the household or individual level does not seem to influence the occurrence of the other conditions, and therefore the coexistence of both malnutrition conditions in the same household or individual appears to be solely the result of the magnitude of the separate prevalences in the population. The only exception was the coexistence of anemia and stunting in school-aged children in whom the difference between the expected and actual prevalence amounted to almost 60% of the expected prevalence. However, contrary to expectations, the expected prevalence was larger than the actual prevalence.

The hypothesis of a larger than expected prevalence of the coexistence of stunting and excess body weight at the household and individual levels arises from evidence that indicates that children who are stunted during the first 2 y of life are more likely to be overweight or obese later in life (26–29). On the other hand, the assumption of larger than expected prevalences of anemia and excess body weight is based on findings that low-income groups in Mexico purchase foods of lower cost per calorie than do those from higher income levels and that those low-cost-per-calorie foods are also of low nutritional quality, particularly in

TABLE 2
Assessment of the double burden of undernutrition or micronutrient deficiency and overweight/obesity at the household and individual level in Mexican children and women (ENSANUT 2012)[1]

	Stunting, % (95% CI)			Anemia, % (95% CI)		
	With	Without	Total	With	Without	Total
Household level						
Children aged <5 y						
Mother with overweight/obesity	8.4 (7.4, 9.6)[2]	55.6 (53.6, 57.5)	64.0 (62.1, 65.9)	—	—	—
Mother without overweight/obesity	5.8 (5.0, 6.8)	30.2 (28.4, 32.0)	36.0 (34.1, 38.0)	—	—	—
Total	14.2 (13.0, 15.6)	85.8 (84.3, 57.5)	100.0 (n = 4777)	—	—	—
P		0.039				
Individual level						
School-aged children (5–11 y)						
With overweight/obesity	1.0 (0.76, 1.2)[3]	33.5 (32.3, 34.7)	34.4 (33.3, 35.6)	2.9 (2.5, 3.4)[4]	31.2 (30.1, 32.4)	34.1 (32.9, 35.4)
Without overweight/obesity	5.9 (5.3, 6.6)	59.6 (58.4, 60.8)	65.6 (64.4, 66.7)	7.0 (6.4 ,7.7)	58.9 (57.7, 60.0)	65.9 (64.6, 67.1)
Total	6.9 (6.2, 7.6)	93.1 (92.4, 93.8)	100 (n = 16,351)	9.9 (9.2, 10.7)	90.1 (89.3, 90.9)	100 (n = 13,679)
P		0.001			0.001	
Women of reproductive age (12–49 y)						
With overweight/obesity	—	—	—	7.6 (7.0, 8.2)[5]	54.1 (52.9, 55.3)	61.7 (60.6, 62.9)
Without overweight/obesity	—	—	—	4.1 (3.6, 4.5)	34.2 (33.1, 35.3)	38.3 (37.1, 39.5)
Total	—	—	—	11.7 (10.9, 12.4)	88.3 (87.6, 89.1)	100 (n = 17,924)
P	—	—	—		0.0367	
With obesity	—	—	—	3.4 (3.0, 3.9)[6]	25.8 (24.8, 26.9)	29.3 (28.2, 30.4)
Without obesity	—	—	—	8.2 (7.6, 8.9)	62.5 (61.4, 63.6)	70.7 (69.6, 71.8)
Total	—	—	—	11.6 (10.9, 12.4)	88.3 (87.6, 89.1)	100 (n = 17,924)
P	—	—	—		0.893	

[1]All P values correspond to a chi-square test comparing expected prevalence with observed prevalence. ENSANUT, Encuesta Nacional de Salud y Nutrición (National Health and Nutrition Survey) (22).
[2–6]Expected values: [2]9.1%, [3]2.3%, [4]3.4%, [5]7.2%, [6]3.3%.

terms of protein and micronutrient contents (30). This would result in individuals from low-income households being overweight or obese as a result of the high intakes of cheap calories but also anemic or deficient in micronutrients given the low micronutrient quality of the food.

However, our results suggest that the conditions considered (undernutrition, including anemia and excess body weight) are virtually independent, and in one case the actual prevalence was lower than expected. Therefore, our results do not support the hypothesis that the coexistence of undernutrition and excess body weight would be higher than expected under the assumption of independent distribution of the 2 conditions. These results are probably driven by the high prevalence of excess body weight in all age groups studied in comparison with the prevalences of anemia and stunting and by the high prevalences of excess body weight in all socioeconomic groups in Mexico (31). The exception to this latter statement is the lower prevalence of excess body weight in school-aged children, which probably explains the lower than expected coexistence of excess body weight and stunting (typically occurring in the lower socioeconomic group).

Despite the apparent independence of the occurrence of the conditions that characterize a double burden, the fact that undernutrition (including anemia) coexists with overweight and obesity at the national, household, and intraindividual levels should be recognized and public policies must be designed to address both conditions. Although the coexistence of undernutrition and excess body weight in households and within individuals at the national level was relatively low (1–8.4%), in the southern region the occurrence of both conditions was much higher (13.4%; data not shown), stressing the need to consider the double burden when designing nutrition policies and programs. The southern region is the poorest in the country and has the highest concentration of indigenous and rural areas. This shows the heterogeneity of the double burden, which, in turn, shows the diversity in the prevalences of undernutrition and excess body weight among different regions, urban/rural settings, indigenous and nonindigenous populations, and socioeconomic groups.

The apparent paradox of the coexistence in the same household or even within the same individual of stunting and overweight or obesity may be the result of the confluence of certain factors that participate in the natural history of these conditions. Growth stunting occurs during gestation and the first 2 y of life. Several factors, not necessarily related to food insecurity, play a role in the etiology of stunting, including the high demand for energy and nutrients for rapid growth; small gastric capacity, which necessitates frequent feeding; immaturity of the gastrointestinal system, which poses limitations to types and consistencies of complementary foods from 6 mo on; strong influences of culture and tradition on foods considered "adequate" for young children; and an immature immune system, which leads to infections in unclean environments. All of these factors could produce stunting even in food-secure households in which the intake of unhealthy, high-energy diets may result in excess weight gain in other family members and even in the same child later in life (31).

In Mexico, a large proportion of poor households have access to enough food to meet their energy requirements, although often their diets are of low quality, such as high-energy-dense foods and SSBs, which are low in micronutrients and fiber. These diets promote weight gain and can be deficient in key micronutrients. In these poor households, a stunted child can coexist with an overweight or obese

mother, who can also be anemic as a result of a high-energy, low-quality diet. A stunted and anemic child may start to gain weight after 2 y of age and can become an overweight and short-for-age school-aged child (with a history of stunting) who also may be anemic.

The coexistence of anemia and overweight/obesity may be explained by factors other than high-energy, low-micronutrient (particularly iron) diets, including increased iron requirements or impaired iron absorption in overweight or obese individuals. Inflammation in overweight or obese individuals may play a role through its regulation of hepcidin, which is higher in obese individuals and linked to subclinical inflammation, which may reduce iron absorption (32). In addition, inflammation may result in iron sequestration from reticuloendothelial macrophages due to the inhibition of the expression of ferroportin (32).

Cepeda-Lopez et al (33) examined the association between iron status and BMI in women of reproductive age in Mexico. In this cross-sectional study, obese women were more likely to have iron deficiency after adjustment for age, rural or urban residence, geographic region, parity, and iron intake (OR: 1.92; 95% CI: 1.23, 3.01); and serum iron concentrations had a significant inverse correlation with BMI ($r = -0.09$, $P = 0.003$). These results are consistent with our findings of a higher than expected prevalence of coexisting overweight/obesity and anemia in adult woman, assuming independence of the 2 conditions, and were significant. However, the difference between the predicted and actual prevalence of double burden was too small to be considered of public health significance. Moreover, the coexistence of anemia with obesity (BMI >30) in women was not different from the predicted value, assuming independent distributions of the 2 conditions, which is not consistent with the findings from Cepeda-Lopez et al (33).

The low prevalences of the double burden at the household and intraindividual levels, particularly the coexistence of overweight/obesity with anemia and stunting, respectively, in school-aged children, may be explained by the advanced stage of the nutrition transition in Mexico. As mentioned before, the prevalences of stunting and anemia have decreased substantially in the past decades and overweight/obesity has increased in this age group, although not as much as in adults; therefore, the expected prevalence of the double burden has decreased.

The presence of the double burden at the national level, and to a lesser extent at household and individual levels, calls for policies and programs to address this double burden. There is evidence that maternal age, formal education, and number of siblings are associated with the concurrent presence of stunting in children <5 y and overweight/obesity in mothers (34). On the other hand, in a study conducted in 2003 in rural areas of Mexico, maternal age, maternal height, maternal schooling, perceived social status, number of individuals in the household, and a poor sewage disposal system were associated with greater odds of stunting and the coexistence of stunting and excess weight in preschool-aged children (35). These results suggest that the double burden at household and individual levels has poverty as a common denominator. Programs and policies aimed at improving height and formal education may have a strong effect in the prevention of the double burden in the long term.

Since 1997, when the Oportunidades program (formerly Progresa) was created, Mexico has developed evidence-based policies for the prevention of undernutrition. Oportunidades is targeted to low-income families, children <2 y of age, and pregnant and lactating women and provides conditional cash transfers and micronutrient-fortified foods or supplements to all children aged 6–23 mo, to underweight children aged 2–4 y, and to pregnant and lactating women. Evaluations of the nutritional impact of the program have shown a positive effect on growth and a reduction in anemia (9). In recent years, the program has modified the food supplements distributed to reduce the amounts of calories while maintaining their micronutrient composition to avoid undesirable effects on weight gain. Moreover, the program is in the process of scaling up a strategy based on individual counseling that promotes breastfeeding and healthy complementary feeding and emphasizes the importance of promoting linear growth and avoiding excessive weight gain in preschool-aged children. Other programs such as a fortified milk distribution program (10) and a nutrition program targeted to isolated communities without health and education services have shown positive effects on the nutritional status of children (36). In addition to the programs aimed at preventing undernutrition, in 2010 the Mexican government implemented a multifaceted and multi-institutional national obesity prevention strategy in the form of an agreement with participation from several stakeholders, including government, civil society, academia, the media, and the food industry. The agreement (12) proposed 10 main action lines based on international recommendations (15). One of the main results of the agreement were statutory regulations designed to secure the availability and accessibility of healthy foods and safe water and to reduce access to unhealthy foods, including the banning of SSBs in Mexican schools (15). These statutory regulations are in the process of being evaluated.

An initiative of the Mexican legislative branch to tax sodas and high-energy-dense foods was approved and its implementation began in 2014. Estimations of price elasticities show that the demand for soft drinks is responsive to price changes in Mexico: a 10% increase in the price of soft drinks is associated with a decrease in consumption of 10–13%, depending on the data sources used, indicating that taxing soft drinks is likely to reduce their intake (14). The Mexican federal government has launched a program called "Crusade against Hunger," with major emphasis on a reduction in food insecurity, including plans to strengthen the nutrition component of the program Oportunidades (11). When it was launched, the program did not take into account the fact that 7 of every 10 adults and 1 of every 3 children are overweight or obese in Mexico, including the low-income population who is the target of this program. Nonetheless, the program has been slowly including overweight/obesity as a concern. In addition, the president presented the National Strategy to Prevent and Control overweight, obesity, and type 2 diabetes, developed by the Ministry of Health, which will continue to regulate food and beverages in schools and will implement regulations for marketing food to children and for food labels. It remains to be seen whether the current government continues with policies and programs that address the double burden of malnutrition in Mexico. Despite all the advances, there is still the need to integrate nutrition programs around the notion of "healthy eating" and to include the promotion of physical activity during the different phases of the life course.

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made contributions to the manuscript; and JAR: designed the research, wrote the manuscript, and has primary responsibility for final content. All of the authors read and approved the final manuscript. None of the authors declared a conflict of interest.

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The double burden of malnutrition in indigenous and nonindigenous Guatemalan populations[1–4]

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ABSTRACT

Background: As the prevalence of obesity increases in developing countries, the double burden of malnutrition (DBM) has become a public health problem, particularly in countries such as Guatemala with a high concentration of indigenous communities where the prevalence of stunting remains high.

Objective: The aim was to describe and analyze the prevalence of DBM over time (1998–2008) in indigenous and nonindigenous Guatemalan populations.

Design: We used 3 National Maternal and Child Health Surveys conducted in Guatemala between 1998 and 2008 that include anthropometric data from children aged 0–60 mo and women of reproductive age (15–49 y). We assessed the prevalence of childhood stunting and both child and adult female overweight and obesity between 1998 and 2008. For the year 2008, we assessed the prevalence of DBM at the household (a stunted child and an overweight mother) and individual (stunting/short stature and overweight or anemia and overweight in the same individual) levels and compared the expected and observed prevalence rates to test if the coexistence of the DBM conditions corresponded to expected values.

Results: Between 1998 and 2008, the prevalence of childhood stunting decreased in both indigenous and nonindigenous populations, whereas overweight and obesity in women increased faster in indigenous populations than in nonindigenous populations (0.91% compared with 0.38%/y; P-trend < 0.01). In 2008, the prevalence of stunted children was 28.8 percentage points higher and of overweight women 4.6 percentage points lower in indigenous compared with nonindigenous populations (63.7% compared with 34.9% and 46.7% compared with 51.3%, respectively). DBM at the household and individual levels was higher in indigenous populations and was higher in geographic areas in which most of the population was indigenous, where there was also a greater prevalence of stunting and DBM at the individual level, both in women and children.

Conclusions: In Guatemala, DBM is more prevalent in indigenous than in nonindigenous populations at the household and individual levels. To enhance effectiveness, current strategies of national policies and programs should consider DBM and focus on indigenous populations. *Am J Clin Nutr* doi: 10.3945/ajcn.114.083857.

Keywords double burden, Guatemala, malnutrition, indigenous, obesity, stunting, anemia

INTRODUCTION

Approximately half (42%) of the Guatemalan population is self-identified as indigenous, and >75% of indigenous individuals live in poverty (1). The double burden of malnutrition (DBM)[5], which refers to the coexistence of under- and overnutrition, is increasing as the nutrition transition occurs in many developing countries (2, 3). Currently, Guatemala has the second highest prevalence of stunting in the world among children <5 y of age and the highest in Latin America (49%) (4). The prevalence of stunting in Guatemala has decreased by only 5.1% in the past 20 y (1). Stunting is related to a nutrient-poor diet, a high incidence and recurrence of infectious diseases during childhood, inadequate wastewater disposal (<25% coverage in 2006), and overcrowded conditions (1, 5). The prevalence of anemia is also a public health problem in Guatemala that affects 21.4% of nonpregnant women and 47.7% of children aged 6–59 mo (6). Globally, the burden of anemia in indigenous populations is higher than in the nonindigenous population (7). Moreover, the combination of maternal short stature and anemia accounts for at least 20% of maternal mortality and greater infant morbidity and mortality (1).

As in most developing countries, the prevalence of overweight and obesity in Guatemala has increased rapidly, particularly in the past 2 decades. Approximately 50% of women of reproductive age (WRA) are overweight or obese (4). The increase in overweight and obesity in Guatemala is related to drastic changes in dietary and physical activity patterns, particularly associated with an obesogenic environment.

Previous studies conducted with the use of data from the year 2000 found that Guatemalan households had the highest prevalence of DBM in the world, with a prevalence of 16–18% [stunted child–overweight mother (SCOM) pairs] (8, 9). Guatemalan households with SCOM pairs were more likely to self-identify as

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[3] The authors reported no funding received for this study.

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[5] Abbreviations used: DBM, double burden of malnutrition; ENSMI, Encuesta Nacional de Salud Materno Infantil (National Maternal and Child Health Survey); SCOM, stunted child overweight mother; WRA, women of reproductive age.

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indigenous, be of lower socioeconomic status, have a mother of short stature and higher parity, and include women currently working (9). However, there is no information about the prevalence of DBM at the individual level (stunting/short stature and overweight or anemia and overweight in the same individual) or that quantifies the differences in DBM prevalence between indigenous and nonindigenous populations in Guatemala. Therefore, the purpose of our study was to further assess the trend of stunting/short stature and overweight/obesity in Guatemalan children <5 y of age and WRA between 1998 and 2008 and the prevalence of DBM at the household and individual levels in 2008. In addition, we aimed to describe differences in the prevalence of DBM between indigenous and nonindigenous populations.

SUBJECTS AND METHODS

We used the 1998, 2002, and 2008 Encuesta Nacional de Salud Materno Infantil (National Maternal and Child Health Surveys; ENSMI), which are nationally representative of the 22 departments (geopolitical divisions) in Guatemala. For each ENSMI, a multistage, random, stratified cluster-sampling procedure was used to select a nationally representative sample. The surveys were composed of 5587 (1998), 16,162 (2002), and 22,990 (2008) households; 6201, 7913, and 16,819 WRA (15–49 y); and 4545, 7525, and 10,775 offspring aged 0–59 mo. A detailed description of the sampling and data collection methods are described elsewhere (10–12).

We estimated the national prevalence of underweight, stunting/short stature, anemia, overweight, and obesity in children (0–59 mo) and in WRA and stratified by ethnicity for each case. Ethnicity was defined as indigenous when respondents self-declared as being indigenous and if the WRA spoke an indigenous language (10–12). We also estimated the combined prevalence of these indicators to determine the DBM at the household and individual levels in the total population as well as by ethnicity.

We defined underweight as weight-for-height z score < -2 SDs, stunting as height-for-age z score < -2 SDs, overweight as weight-for-height z score >2 SDs and ≤3 SDs, and obesity as weight-for-height z score >3 SDs for children 0–59 mo by using WHO 2006 and 2007 references (13). BMI was calculated by dividing body weight (kg) by height squared (m^2) and was used as the indicator for underweight (in kg/m^2; <18.5), overweight (≥25 and <30), and obesity (≥30) for all women. Short stature was defined as height <145 cm. Anemia was defined by using the sex and age WHO cutoffs and adjusted for Ruiz-Argüelles equation for altitudes >1000 m (14, 15). Weight-for-height outliers were defined as < -5 SDs and height-for-age outliers as < -6 SDs.

By using data from all 3 surveys, at the national level we estimated the prevalence and CIs for underweight, stunting, overweight, and obesity in children 0–59 mo and underweight, anemia, short stature, overweight, and obesity in WRA. We also analyzed data in 2 age groups for WRA (15–34 and 35–49 y). Anemia in children was calculated only among those aged 6–59 mo following the WHO hemoglobin cutoffs (16). For all other analyses described below, we used the most current survey data available (2008).

At the household level, we estimated the prevalence of SCOM pairs, defined as those with a stunted child (< -2 SDs of height-for-age) and an overweight or obese mother (BMI >25.0), for the whole population and stratified by ethnicity. To estimate SCOM pairs at the household level, we excluded mothers with missing BMI data, those who were pregnant or breastfeeding, and women who had no children or no data on their 0- to 59-mo-old child. In households with twin siblings, one twin was selected at random for this analysis. In the case of ≥2 children aged 0–59 mo within the same household, we performed the analysis with the oldest children. We calculated the expected prevalence of SCOM pairs by multiplying the prevalence of overweight/obese mothers by the prevalence of stunted children.

At the individual level, we estimated the concurrent prevalence of stunting and overweight/obesity as well as of anemia and overweight/obesity in children, both in the general population and by ethnicity. In WRA, the concurrent prevalence of short stature and excess body weight and anemia and excess body weight were estimated. We included children and woman with complete weight, height, and hemoglobin data. We then estimated the expected prevalence of stunted/overweight children, anemic/overweight children, anemic/overweight women, and short-stature/overweight women. We calculated the expected prevalence by multiplying the prevalence of overweight/obesity by the prevalence of stunting and anemia in children and short stature and anemia in WRA.

At the department level, we estimated the same prevalence rates described above for the whole population and stratifying by ethnicity. We performed a Student's t test to assess the differences between indigenous and nonindigenous populations within the ENSMI 2008, and P values were obtained. We also compared the expected prevalence with the observed prevalence at the household and individual levels, stratifying by ethnicity, by using the chi-square test from which P values were obtained (17). A chi-square test was also conducted to obtain trends in stunting, overweight, and obesity in children and for short stature, overweight, and obesity in WRA from 1998 to 2008, stratifying by ethnicity. All analyses were adjusted for the complex survey sampling design by using STATA version 12.0 (StataCorp).

RESULTS

Childhood stunting significantly decreased ($P < 0.01$), whereas overweight and obesity in WRA significantly increased between 1998 and 2008. There was a significant reduction in stunting in both indigenous (0.8%/y) and nonindigenous (0.6%/y) children and a reduction in short stature in indigenous WRA (0.6%/y) (**Figure 1**). There was also a significant reduction in overweight and obesity in indigenous children but not in nonindigenous children. Overweight/obesity increased by 1.0 percentage point/y in indigenous WRA compared with only a 0.4 percentage point/y increase in nonindigenous WRA. This increase is evident by the overall greater increase in the prevalence of obesity in WRA between 1998 and 2008, which more than doubled in indigenous WRA (6.1% to 13.5%).

In 2008, the national prevalence of stunted children was 28.8 percentage points higher and of overweight WRA 4.6 percentage points lower in indigenous populations than in nonindigenous populations (63.7% compared with 34.9% and 46.7 compared

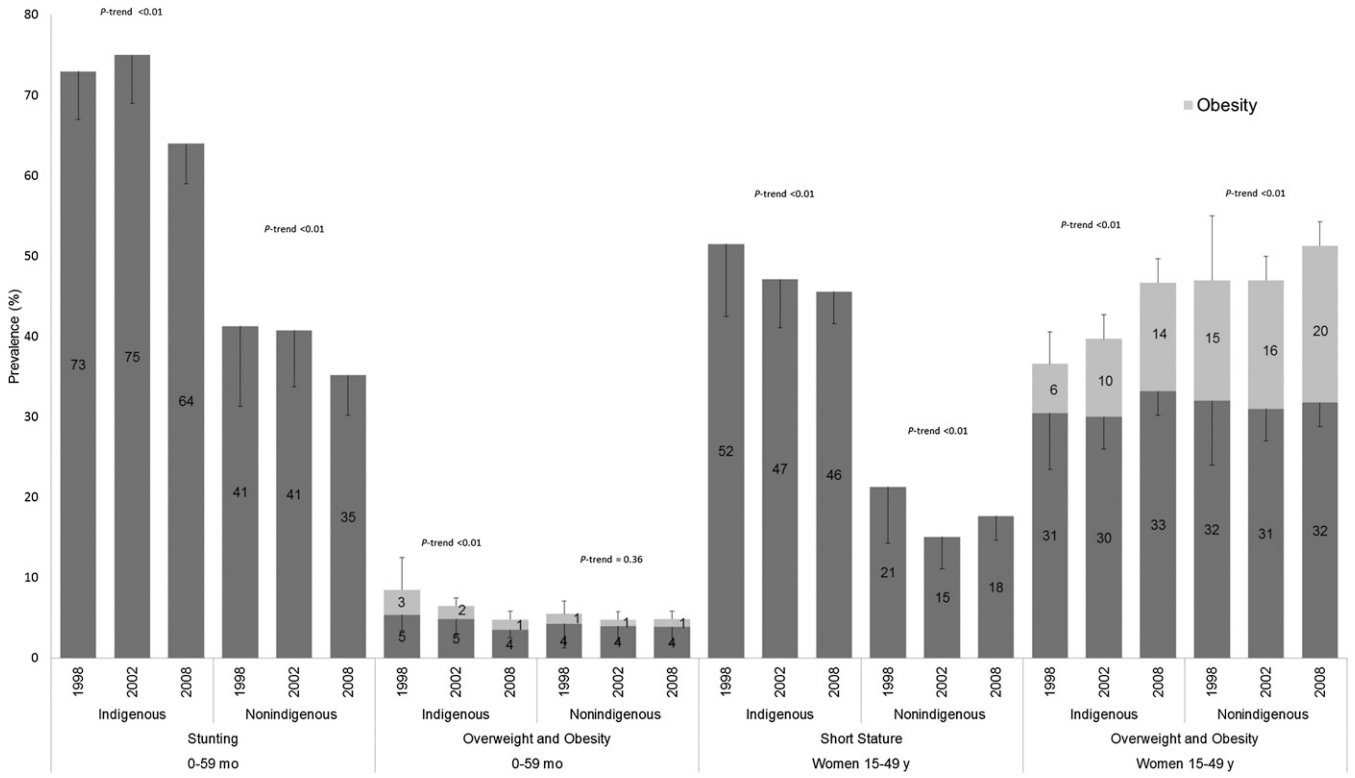

FIGURE 1 Trends in prevalences of stunting and overweight/obesity in children aged 0–59 mo and short stature and overweight/obesity in women of reproductive age (15–49 y) from 1998 to 2008. Weighted *n*—children aged 0–59 mo: 1998 = 3620, 2002 = 4610, and 2008 = 10,330; women of reproductive age (15–49 y): 1998 = 2300, 2002 = 7360, and 2008 = 15,333. Stunting = height-for-age *z* score < -2 SDs; overweight in children = weight-for-height *z* score >2 SDs and ≤ 3 SDs; obesity in children = weight-for-height *z* score >3 SDs; short stature = height <145 cm; overweight in women = BMI (in kg/m^2) ≥ 25 and <30; obesity in women = BMI ≥ 30. Error bars indicate SEs. Trends were assessed by using a chi-square test for each condition.

with 51.3%, respectively) (**Table 1**). There was no significant difference in the prevalence of overweight/obesity and anemia between indigenous and nonindigenous children. The proportion of indigenous WRA with short stature was >2.5 times that for nonindigenous WRA (45.6% compared with 17.7%; $P < 0.05$), and this difference was also significant and of the same magnitude in both age groups (Table 1). The prevalence of anemia was significantly higher in indigenous WRA compared with nonindigenous WRA, overall and in both age groups. Furthermore, anemia was 7.5% percentage points higher in the 35- to 49-y group than in the 15- to 34-y group in indigenous WRA (33.6% compared with 26.5%); this difference in nonindigenous WRA was only 3.2% percentage points (26.1% compared with 23.3%). The prevalence of overweight/obese WRA increased considerably with age (40.6% in the 15- to 34-y group compared with 70.0% in the 35- to 49-y group). Nonindigenous WRA had a greater prevalence of obesity than did indigenous WRA, overall and in both age groups. Among both children and WRA, the prevalence of underweight prevalence in Guatemala is low (Table 1).

At the household level, child stunting and maternal overweight (SCOM) was identified in 20.0% of all households (**Table 2**). Indigenous households had twice the prevalence of SCOM pairs than did nonindigenous households (28.2% compared with 14.4%). The observed prevalences of households with SCOM pairs were significantly lower than the expected prevalences.

At the individual level, the DBM when defined by the prevalence of both anemia and overweight/obesity was similar among indigenous and nonindigenous WRA (Table 2), and all of the observed prevalences were significantly lower than expected. However, the DBM when defined by the coexistence of short stature and overweight/obesity was 2.5 times greater in indigenous WRA compared with nonindigenous WRA (22.0% compared with 8.7%).

Among children, the DBM at the individual level was similar to that observed in WRA (Table 2). The prevalence of DBM when reported by the coexistence of overweight/obesity and stunting was 2.7% in indigenous children compared with 1.1% in nonindigenous children. When DBM was reported by anemia and stunting, the prevalence of DBM was 1.1% and 1.7% in indigenous and nonindigenous children, respectively. Among children, all observed prevalences of DBM were lower than the expected prevalences, except for those for anemia and stunting.

At the department level, the prevalence of overweight and obesity in WRA varied between 41% and 57%, and the prevalence of stunting varied between 24% and 80%. The 5 departments with the highest prevalence of SCOM pairs or DBM at the household level (>28%; **Figure 2**) had both a high prevalence of stunting (>58%) and a high proportion of indigenous population (68–95%). These departments were also within the top 5 with the highest prevalence of individual DBM (short stature and overweight/obesity) in WRA (19–28%), within the top 9 departments with the highest prevalence of overweight and obesity in children (5.5–6.8%), and within the top 8 departments with the highest prevalence of individual DBM (stunting and overweight/obesity) in children (2.3–4.0%).

TABLE 1
National prevalence of underweight, overweight, obesity, and anemia by ethnicity in children (0–59 mo) and by ethnicity and age group in WRA (15–49 y): ENSMI 2008[1]

		Undernutrition, % (95% CI)		Overnutrition, % (95% CI)			Anemia[2]	
	Total *n*	Underweight	Stunting/short stature	Overweight	Obesity	Overweight/ obesity	*n*	% (95% CI)
Children aged 0–59 mo								
All	10,178	1.0 (0.8, 1.3)	48.0 (45.8, 50.2)	3.9 (3.2, 4.2)	1.1 (0.9, 1.4)	4.9 (4.3, 5.4)	8892	49.2 (47.1, 51.3)
Indigenous	5735	0.8 (0.6, 1.3)	63.7 (61.1, 66.2)*	3.5 (2.8, 4.2)	1.4 (1.0, 1.9)[3]	4.9 (4.1, 5.8)	3861	49.6 (46.4, 52.8)
Nonindigenous	4443	1.1 (0.8, 1.5)	34.9 (32.4, 37.4)	3.9 (3.2, 4.5)	0.9 (0.6, 1.2)	4.8 (4.1, 5.5)	5031	48.8 (46.2, 51.4)
All WRA								
All	15,119	2.6 (2.1, 3.0)	28.3 (26.8, 29.7)	32.2 (31.3, 33.2)	17.2 (16.3, 18.2)	49.5 (48.3, 50.8)	16,137	25.9 (24.3, 27.5)
Indigenous	5527	1.2 (0.8, 1.6)*	45.6 (43.6, 47.7)*	33.2 (31.7, 34.7)	13.5 (12.3, 14.8)*	46.7 (45.0, 48.6)*	5883	28.7 (26.0, 31.4)*
Nonindigenous	9743	3.3 (2.8, 4.0)	17.7 (16.3, 19.2)	31.7 (30.5, 32.3)	19.5 (18.4, 20.7)	51.3 (49.7, 52.8)	3078	24.2 (22.3, 26.0)
WRA aged 15–34 y								
All	10,576	3.2 (2.7, 3.8)	27.6 (26.1, 29.1)	29.0 (27.8, 30.1)	11.7 (10.8, 12.5)	40.6 (39.3, 42.0)	11,381	24.5 (22.7, 26.3)
Indigenous	3819	1.6 (1.0, 2.1)*	45.0 (42.6, 47.4)*	30.4 (26.7, 29.4)*	8.4 (7.4, 9.5)*	39.0 (37.0, 40.8)*	4151	26.5 (23.5, 29.6)*
Nonindigenous	6757	4.3 (3.5, 5.1)	17.0 (15.4, 18.4)	28.0 (26.7, 29.4)	13.6 (12.5, 14.8)	41.7 (40.0, 43.4)	7230	23.3 (21.3, 25.3)
WRA aged 35–49 y								
All	4694	0.9 (0.6, 1.2)	30.0 (27.8, 32.1)	39.8 (38.0, 41.6)	30.0 (28.2, 32.0)	70.0 (68.1, 71.7)	4756	29.0 (26.9, 31.0)
Indigenous	1708	0.4 (0.1, 0.8)*	47.0 (44.0, 50.0)*	39.5 (36.6, 42.4)	25.2 (22.4, 28.1)*	64.8 (62.0, 67.8)*	1732	33.6 (30.2, 37.1)*
Nonindigenous	2986	1.2 (0.8, 1.7)	19.6 (17.2, 22.1)	40.0 (37.7, 42.4)	33.0 (30.6, 35.3)	73.0 (71.0, 75.1)	3024	26.1 (23.7, 28.5)

[1]Data from reference 12. Underweight was defined as weight/height < -2 SDs in children and BMI (in kg/m^2) <18.5 in WRA. Stunting was defined as height/age < -2 SDs in children, and short stature in WRA was defined as <145 cm. Overweight was defined as weight/height >2 SDs to ≤ 3 SDs in children and BMI ≥ 25 to <30 in WRA. Obesity was defined as weight/height >3 SDs in children and BMI ≥ 30 in WRA. *Significantly different from nonindigenous group, $P < 0.05$ (Student's t test). ENSMI, Encuesta Nacional de Salud Materno Infantil (National Maternal and Child Health Survey); WRA, women of reproductive age.

[2]WHO cutoffs for sex and age group and adjusted for Ruiz-Argüelles equation. Anemia in children was calculated only for those between 6 and 59 mo of age.

DISCUSSION

In Guatemala, which has one of the highest rates of prevalence of DBM reported previously in the world, we sought to enrich the understanding of DBM at the household and individual levels. We found that the indigenous population in Guatemala was the most vulnerable to DBM, in which more than a quarter of households had SCOM pairs and more than one-fifth of WRA had an individual DBM. We also identified the region in Guatemala (Western Highlands) where DBM is highest, which is mainly inhabited by indigenous populations.

DBM can be understood within the nutritional transition context. The greater prevalence of DBM found in indigenous Guatemalans at both the household and individual levels (except for anemic-overweight/obese children) suggests that the DBM has sociodemographic determinants, especially those associated with poverty. These findings are consistent with other studies that found that the presence of SCOM pairs was associated with myriad sociodemographic and socioeconomic indicators. One study found that the presence of SCOM pairs was associated with maternal age, formal education, and number of siblings (18). Other studies identified that DBM in children (stunting and overweight in preschoolers) was associated with maternal age, maternal height, maternal schooling, perceived social status, self-identified as indigenous, number of individuals in the household, poor drainage system, lower socioeconomic status, and women currently working (9, 19).

The relation between anemia and overweight is less understood. One hypothesis is that because of higher concentrations of hepcidin present in overweight individuals, which may reduce iron absorption, obesity-related inflammation mechanisms might result in iron sequestration (20, 21). Furthermore, pediatric adiposity was found to predict iron deficiency as well as a reduced response to iron fortification (22).

The consequences of DBM, particularly individual DBM, remain largely unknown and understudied. Almost 3 decades ago, Barker (23) proposed the fetal origins hypothesis, which laid the foundation for the Developmental Origins of Health and Disease (DOHaD) research concept to explain how early-life exposures affect diseases in adulthood, particularly chronic diseases, through programming mechanisms including cellular signaling pathways, metabolic and hormonal responses, and epigenetic modifications (3, 24). The mismatch between early and later environment may explain the earlier onset and higher severity of chronic diseases in low- and middle-income countries, where premature deaths by those diseases is much higher than in high-income countries (25, 26). Stunted growth and repeated gut infections, both common in early life in Guatemala, increase the risk of developing obesity and its associated comorbidities in both adolescence and adulthood (27).

There are 370 million indigenous people worldwide (28). The basic causes of morbidity are similar in indigenous and nonindigenous individuals, but the burden of disease, disability, and death is consistently greater in indigenous populations (29). The greater prevalence of DBM found in the Mayan indigenous population in Guatemala might be related to a combination of environmental and genetic predisposition. In general, the morbidity observed in indigenous populations is related to poverty, poor hygiene, recurrent infections, overcrowding, and inadequate clinical care and health promotion, all of which are common in

TABLE 2
Assessment of the double burden of stunting or anemia and OW/OB at the household and individual levels in Guatemalan children (0–59 mo) and WRA (15–49 y), overall and by ethnicity: ENSMI 2008[1]

	Stunting, % (95% CI)			Anemia, % (95% CI)		
	With	Without	Total[2]	With	Without	Total[2]
Household level						
Children aged 0–59 mo						
Whole population						
Mother with OW/OB	20.0 (18.7, 21.4)[3]	31.5 (29.5, 33.4)	51.5 (49.8, 53.1)	—	—	—
Mother without OW/OB	24.2 (22.5, 26.0)	24.3 (22.9, 25.6)	48.5 (46.8, 50.1)	—	—	—
Total	44.2 (41.9, 46.7)	55.8 (53.3, 58.1)	100 [9320]	—	—	—
P			<0.001		—	
Indigenous						
Mother with OW/OB	28.2 (26.3, 30.1)[4]	19.4 (17.3, 21.2)	47.5 (45.1, 50.0)	—	—	—
Mother without OW/OB	35.4 (33.0, 38.0)	17.0 (15.3, 18.9)	52.4 (50.0, 55.0)	—	—	—
Total	63.6 (60.7, 66.4)	36.4 (33.6, 39.3)	100 [2566]	—	—	—
P			<0.001		—	
Nonindigenous						
Mother with OW/OB	14.4 (13.0, 16.0)[5]	39.8 (37.6, 42.0)	54.2 (52.1, 56.2)	—	—	—
Mother without OW/OB	16.5 (14.9, 18.3)	29.3 (27.6, 31.0)	45.8 (43.7. 47.8)	—	—	—
Total	30.9 (28.5, 33.5)	69.0 (66.5. 71.5)	100 [3822]	—	—	—
P			<0.001		—	
Individual level						
Children aged 0–59 mo						
Whole population						
With OW/OB	1.9 (1.6, 2.3)[6]	3.1 (2.7, 3.5)	5.0 (4.5, 5.5)	1.4 (1.2, 1.8)[7]	2.1 (1.7, 2.5)	3.5 (3.1, 4.0)
Without OW/OB	46.4 (44.3, 48.6)	48.6 (46.5,50.7)	95.0 (94.5, 95.5)	47.5 (45.5, 49.5)	49.0 (47.0, 51.0)	96.5 (96.0, 97.0)
Total	48.3 (46.1, 50.5)	51.7 (49.5, 53.8)	100 [10,163]	49.0 (46.9, 51.0)	51.1 (49.1, 53.1)	100 [8891]
P			<0.001			0.011
Indigenous						
With OW/OB	2.8 (2.2, 3.4)[8]	2.2 (1.8, 2.7)	5.0 (4.2, 5.7)	1.1 (0.81, 1.5)[9]	1.5 (1.1, 2.0)	2.6 (2.0, 3.3)
Without OW/OB	61.7 (59.3, 64.0)	33.3 (31.0, 35.8)	95.0 (94.2, 95.8)	48.5 (45.5, 51.3)	48.9 (45.9, 52.0)	97.4 (96.7, 98.0)
Total	64.5 (62.0, 66.9)	35.5 (33.1, 37.8)	100 [4430]	49.6 (46.6, 0.53)	50.4 (47.3, 53.4)	100 [3860]
P			0.021			0.188
Nonindigenous						
With OW/OB	1.2 (0.9, 1.6)[10]	3.8 (3.2, 4.4)	5.0 (4.4, 5.7)	1.7 (1.3, 2.2)[11]	2.5 (2.1, 3.1)	4.2 (3.6, 4.5)
Without OW/OB	34.0 (31.7, 36.4)	61.0 (58.6, 63.4)	95.0 (94.3, 95.7)	46.6 (44.2, 49.0)	49.1 (46.7, 51.5)	95.7 (95.0, 96.4)
Total	35.2 (32.8, 37.7)	64.8 (62.3, 67.2)	100 [5733]	48.3 (45.8, 50.8)	51.7 (49.2, 54.1)	100 [5031]
P			<0.001			0.030
WRA (15–49 y)						
Whole population						
With OW/OB	13.7 (12.9, 14.6)[12]	35.9 (34.5, 37.2)	49.6 (48.3, 50.8)	11.7 (11.0,12.7)[13]	38.0 (36.6, 39.2)	49.7 (48.4, 51.0)
Without OW/OB	14.6 (13.6, 15.7)	35.8 (34.6, 37.0)	50.4 (49.1, 51.7)	14.1 (13.1, 15.2)	36.2 (34.9, 37.5)	50.3 (49.1, 51.6)
Total	28.3 (27.0, 29.8)	71.6 (70.2, 73.1)	100 [15,270]	25.9 (24.3, 27.6)	74.1 (72.4, 75.7)	100 [15,049]
P			0.189			<0.001
Indigenous						
With OW/OB	22.0 (20.6, 23.2)[14]	24.9 (23.3, 26.5)	46.9 (45.0, 48.6)	12.7 (11.2, 14.2)[15]	34.1 (32.2. 36.1)	46.8 (44.9. 48.7)
Without OW/OB	23.8 (22.0, 25.6)	29.4 (27.8, 31.2)	53.2 (51.4, 55.1)	16.0 (14.3, 17.8)	37.1 (35.0, 39.3)	53.2 (51.3, 55.0)
Total	45.7 (43.6, 47.7)	54.3 (52.2, 56.3)	100 [5527]	28.7 (26.0, 31.6)	71.3 (68.4, 74.0)	100 [5430]
P			0.199			0.034
Nonindigenous						
With OW/OB	8.8 (7.9, 9.7)[16]	42.5 (41.0, 44.2)	51.3 (49.8, 52.9)	11.2 (10.2, 12.3)[17]	40.2 (38.6, 41.9)	51.4 (49.8, 53.0)
Without OW/OB	9.0 (8.0, 10.1)	39.7 (38.2, 41.1)	48.7 (47.1, 50.2)	13.0 (11.8, 14.2)	35.6 (34.0, 37.1)	48.6 (47.0, 50.2)
Total	17.8 (16.4, 19.3)	82.2 (80.7, 83.6)	100 [9743]	24.2 (22.4, 26.1)	75.8 (74.0, 77.6)	100 [9619]
P			0.194			<0.001

[1]Data from reference 12. All *P* values correspond to a chi-square test comparing observed prevalence of the double burden with expected prevalence if the burdens were independent. ENSMI, Encuesta Nacional de Salud Materno Infantil (National Maternal and Child Health Surveys); OW/OB, overweight or obesity; WRA, women of reproductive age.

[2]*n* in brackets.

[3–17]Expected = [3]22.9%, [4]30.2%, [5]16.7%, [6]2.3%, [7]1.6%, [8]3.1%, [9]1.2%, [10]1.7%, [11]2.0%, [12]14.1%, [13]12.7%, [14]20.7%, [15]13.3%, [16]9.1%, [17]12.3%.

indigenous areas in Guatemala (28). At the same time, greater genetic susceptibility might amplify the relation between social and environmental disadvantages and morbidity in indigenous populations. For example, the disproportionate prevalence of diabetes found in several indigenous populations in the world suggests such a genetic susceptibility (30, 31). These results

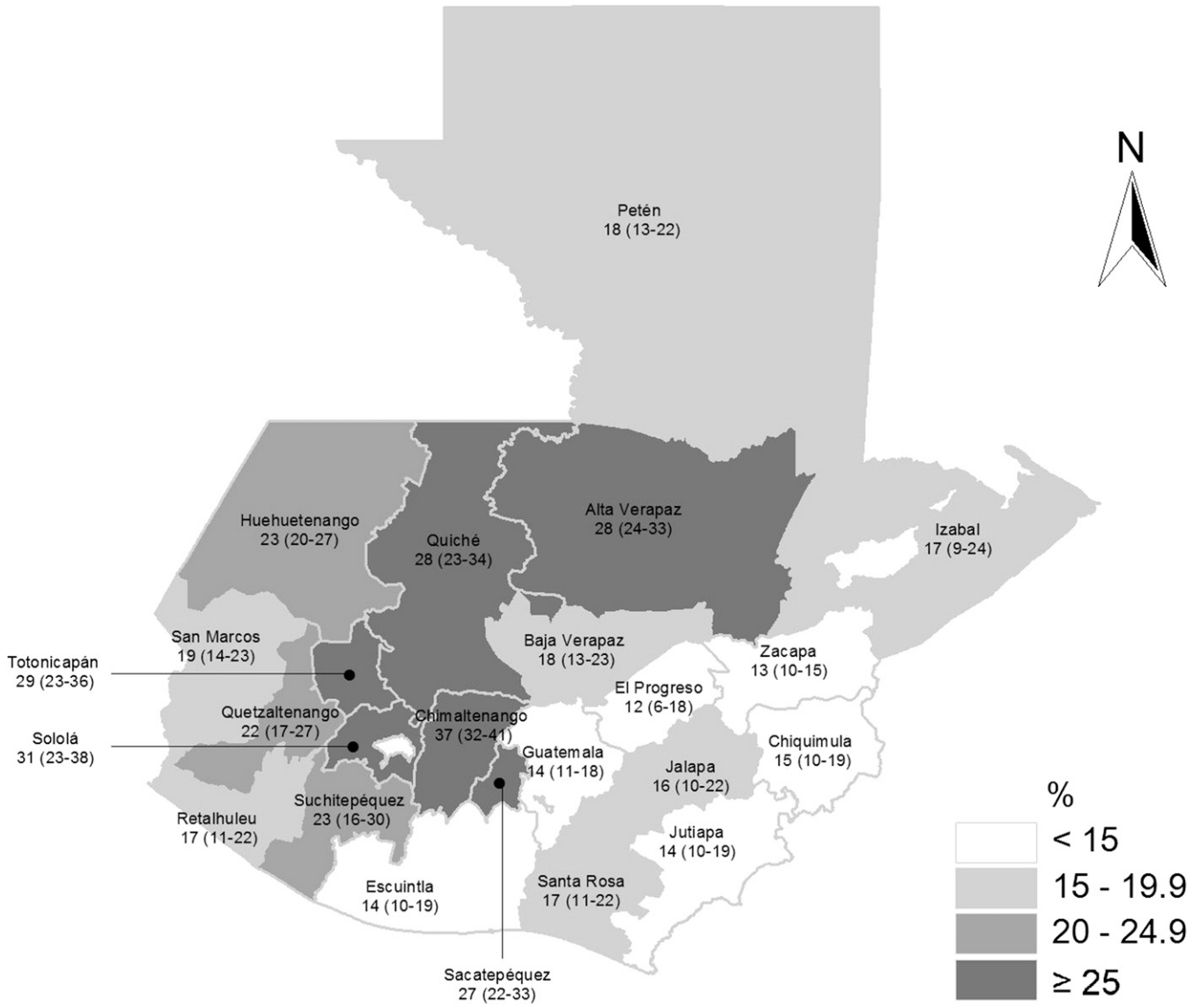

FIGURE 2 Prevalence (95% CI) of the coexistence of a stunted child and an overweight mother in the same household by department in 2008. Weighted n = 7747. Stunting = height-for-age z score < -2 SDs; overweight = BMI (in kg/m^2) $\geq$25.

should encourage further investigation to disentangle the causes related to the greater DBM prevalence in Guatemalan indigenous populations, as well as the validity and consistency of these findings in indigenous populations in other Latin American countries.

The occurrence of DBM at the household and individual levels in children and WRA was lower than expected (17). Therefore, DBM in the same household or individual appears to be solely the result of the magnitude of the separate prevalence rates of the individual conditions (stunting, anemia, overweight/obesity) in the population. Nevertheless, prevalence rates of DBM at the household level are of such a magnitude in Guatemala that they deserve greater attention and urgent public health interventions.

Health systems should be adjusted to meet the challenges of the DBM, and previous studies support that a multidimensional approach is needed, ranging from education, sex and income equity, public-private partnerships, economic development, environmental improvement, and targeted community-based interventions (2, 32–34). Interventions in low- and middle-income countries to increase birth weight and linear growth during the first 2 y of life are likely to result in substantial gains in height and give some protection from adult chronic disease risk factors, with few adverse trade-offs (35). Furthermore, the geographical distribution of DBM prevalence at the department level will be key to target plans and programs to tackle this nutritional problem.

Even though a few current policies and plans related to nutrition and food security in Guatemala mention DBM, their implementation strategies do not include this phenomenon. There is only one national and one regional policy, respectively, that consider DBM with an implementation strategy. The Food Security and Nutrition Policy of Central America and Dominican Republic was approved by the Council of Ministries of Health from Central America and Dominican Republic (COMISCA), the Central American Agricultural Council (CAC), and the Central American Social Integration Council (CIS) between June 2012

and April 2013, for a 20-y execution period. This policy was promoted as a way to better coordinate, integrate, and strengthen regional efforts and effectiveness to address malnutrition deficiencies and excesses. One of the measures that this policy mentions is the development of guidelines to strengthen national plans, programs, and projects for the prevention and control of DBM. However, so far, no action has been taken.

The National Policy of Food Security and Nutrition (PFSN) has the main goal of providing a strategic framework between the public sector, civil society, and international cooperation agencies to ensure sound food security and proper nutrition. This policy was approved in 2008. One of the specific objectives of this policy is to develop and strengthen mechanisms for the prevention and treatment of nutritional problems of shortage or excess, prioritizing high-risk groups. However, most actions taken in Guatemala have addressed only problems related to undernutrition. For example, as a response to the PFSN, the current government developed and approved the Plan for Zero Hunger Pact. Yet, the Zero Hunger Pact mentions only acute and chronic undernutrition as the 2 main nutritional problems that should be addressed in the country. A case in which the DBM approach is applied in Guatemala at the policy level is within the National Healthy Schools Strategy. Through this strategy, teachers are trained in health and nutrition, which includes information on the prevention of both undernutrition as well as noncommunicable diseases.

In conclusion, the DBM affects the indigenous population in Guatemala in a greater proportion in comparison with the nonindigenous population, at both the household and individual levels. These results deserve further research on the causes of the greater DBM found in this population. Implementation strategies of current and new national policies and plans should include DBM and establish early and timely preventive actions with a particular focus on indigenous populations, primarily those living in the Western Highlands, to be more effective.

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Introduction to the double burden of undernutrition and excess weight in Latin America[1–3]

Juan A Rivera, Lilia S Pedraza, Reynaldo Martorell, and Angel Gil

The satellite symposium entitled "The Double Burden of Undernutrition and Obesity in Latin America: Where Do We Stand and Where Do We Go? was presented at the International Union of Nutritional Science (IUNS) 20th International Congress of Nutrition, "Joining Cultures through Nutrition," held in Granada, Spain, 15–20 September 2013, and hosted by the Spanish Society of Nutrition (SEN).

The symposium, chaired by Juan Rivera [National Institute of Public Health, Mexico (INSP)] and Eduardo Atalah (University of Chile, Santiago, Chile), aimed at documenting the coexistence of undernutrition and obesity at the individual, household, and country levels and the degree to which nutrition programs and policies take into account the double burden within their scope and objectives in 11 Latin American countries.

The participants presented results from Argentina, Brazil, Chile, Colombia, Cuba, Ecuador, Guatemala, Mexico, Peru, Uruguay, and Venezuela; 9 of them completed a final manuscript describing their country's situation (1–7). The participation of the investigators was cosponsored by DSM Nutritional Products, the IUNS 20th International Congress of Nutrition, and the authors' own institutions. The publication of the articles was funded by the Division of Social Protection and Health of the Inter-American Development Bank, Washington, DC.

The prevalence of stunting and of overweight and obesity (OW/OB) in children <5 y as well as the prevalence of OW/OB in women are shown in **Table 1**. Chile has the lowest prevalence of stunting (~1.9%), lower in fact than in the WHO standards (2.3%), whereas Guatemala has the highest prevalence (48%) followed by Ecuador (25.3%). Colombia, Mexico, and Uruguay have prevalences ranging between 10% and 14%, and Brazil has a prevalence of ~7%. Prevalences of excess body weight >7% in children <5 y are found in Chile, Uruguay, Mexico, Ecuador, and Brazil, whereas prevalences in Guatemala and Colombia are lower. The prevalence of OW/OB in women for different age subgroups ranged between 40.6% and 84.1%. The highest prevalences were found in Mexico and the lowest in Colombia and Guatemala. Statistics are not provided for Chile, but other publications report a high prevalence of OW/OB in women (8, 9).

The double burden of malnutrition was estimated by each country following a common framework (10) provided by the symposium coordinators. The percentage of households with a stunted child and an overweight or obese mother, referred to as the prevalence of the double burden at household level, is shown in **Table 2**. Prevalence estimates ranged from 20% in Guatemala to 13.1% in Ecuador, 8.4% in Mexico, 6.3% in Uruguay, 5.1% in Colombia and 2.7% in Brazil. To assess if the coexistence or joint prevalence of the 2 conditions was solely the result of the independent occurrence of each one of them, we compared the observed prevalence of the double burden with the expected prevalence under the assumption that the 2 conditions are uncorrelated. In 5 of 6 countries (Brazil, Colombia, Ecuador, Guatemala, and Mexico), the observed double burden prevalence was significantly lower than the expected value, indicating lower risk of stunting in children <5 y or of overweight or obesity in women in households in which the other condition was present. In Uruguay, the observed and expected values were not significantly different. In all cases, differences between observed and expected prevalences were small.

The prevalence of the double burden of overweight and anemia (or zinc deficiency in Ecuador) at the individual level in preschool- or school-aged children ranged from as low as 1.2% in Brazil to 8.4% in Ecuadorian children <5 y (Table 2). In 3 of 5 countries with available information, prevalences were lower than expected ($P < 0.05$) under the assumption of independent occurrence of the 2 conditions; in Brazil, the observed and expected values were not significantly different ($P > 0.05$), whereas in Ecuador the observed prevalence was higher than expected ($P < 0.05$). However, as was the case at the household level, all differences were small.

The prevalence of the double burden of overweight and anemia at the individual level in women ranged from 3.4% to 13.6% (Table 2). Brazil presented the highest prevalence (13.6%) followed by Guatemala (11.7%). Other countries had prevalences between 3.4% and 8.9%. In 2 of 5 countries, observed prevalence rates were lower than expected ($P < 0.05$); in one (Mexico) the observed prevalence was higher than expected ($P < 0.05$); and in 2, observed and expected prevalence rates were not signifi-

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TABLE 1
Prevalences of stunting, OW/OB, and anemia in children <5 y and women in Latin America[1]

	Children								Women									
	Stunting and OW/OB					Anemia			OW/OB						Anemia			
Country	Year of data collection	Age, y	*n*	Stunting,[2] %	OW/OB, %	Age	*n*	Anemia,[3] %	Year of data collection	Age, y	*n*	OW,[4] %	OB,[5] %	OW/OB, %	Year of data collection	Age, y	*n*	Anemia,[6] %
Brazil	2006–2007	<5	20,395	7.1	7.3[7]	<5 y	20,395	21.8	2008–2009	≥20	188,488	48.0	16.9	64.9	2006–2007	≥20	20,395	30.6
Chile	2011	<1	356,972	2.3	7.6[8]	NA	NA	NA	NA	15–24	NA	NA	12.5	NA	2011	15–24	404	5.7
Chile	2011	1 to <4	346,367	1.9	9.4[8]	NA	NA	NA	NA	25–44	NA	NA	28.3	NA	2011	25–44	985	4.5
Chile	2011	4 to <6	303,523	1.4	12.9[8]	NA	NA	NA	NA	45–64	NA	NA	44.8	NA	2011	45–64	975	4.4
Colombia	2010	<5	17,696	13.2	5.2[7]	6–59 mo	7725	27.5	2010	18–64	50,823	NA	NA	55.2	2010	18–29	9314	6.6
Colombia	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2010	30–49	9314	10.3
Ecuador	2012	<5	8894	25.3	8.6[7]	<5 y	2047	25.7	2012	≥20	18,909	38.3	28.1	66.5	2012	20–40	8014	15.4
Guatemala	2008	<5	10,178	48.0	4.9[8]	<5 y	8892	49.2	2008	15–34	10,576	29.0	11.7	40.6	2008	15–34	11,381	24.5
Guatemala	—	—	—	—	—	—	—	—	2008	35–49	4694	39.8	30.0	69.8	2008	35–49	4756	29.0
Mexico	2012	<5	10, 658	13.6	9.0[8]	<5 y	7570	23.3	2012	20–39	9866	34.4	30.7	65.1	2012	20–39	8774	11.9
Mexico	—	—	—	—	—	—	—	—	2012	40–59	7902	37.3	46.8	84.1	2012	40–59	3960	16.2
Uruguay	2011	<2	2994	10.9	9.5[7]	<2 y	756	31.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

[1]NA, no available data; OB, obesity; OW, overweight; OW/OB, overweight and obesity.
[2]Height-for-age *z* score < 2.
[3]Hemoglobin <11 g/dL.
[4]BMI (in kg/m^2) ≥25.
[5]BMI ≥30.
[6]Hemoglobin <12 g/dL.
[7]BMI-for-age >2 *z* scores.
[8]Weight-for-height >2 *z* scores.

TABLE 2
Prevalences of the double burden of malnutrition at the household (child <5 y with stunting and mother with OW/OB) and individual (children with OW and micronutrient deficiency or women with OW/OB and micronutrient deficiency) levels in Latin America[1]

	Household level			Individual level							
				Children				Women			
Country	Year of data collection	*n*	Observed prevalence of double burden, % (expected prevalence)	Age	*n*	Type of double burden	Observed prevalence of double burden, % (expected prevalence)	Age, y	*n*	Type of double burden	Observed prevalence of double burden, % (expected prevalence)
Brazil	2006–2007	4390	2.7 (3.1)[2]	<5 y	3012	OW + anemia	1.2 (1.3)[3]	15–49	1955	OW/OB + anemia	13.6 (13.5)[3]
Colombia	2010	10,317	5.1 (6.9)[2]	5–12 y	7178	OW + anemia	1.4 (1.5)[2]	13–49	6604	OW/OB + anemia	3.4 (3.5)[2]
Ecuador	2012	8078	13.1 (14.3)[2]	5–11 y	4395	OW + zinc deficiency	8.4 (8.1)[4]	12–49	8014	OW/OB + anemia	8.9 (8.8)[3]
Guatemala	2008	9320	20.0 (22.9)[2]	6–59 mo	8891	OW + anemia	1.4 (1.6)[2]	15–49	15,049	OW/OB + anemia	11.7 (12.7)[2]
Mexico	2012	4777	8.4 (9.1)[2]	5–11 y	13,679	OW + anemia	2.9 (3.4)[2]	15–49	17,924	OW/OB + anemia	7.46 (7.2)[4]
Uruguay[5]	2004	1532	6.3 (7.0)[3]	NA	NA	NA	NA	NA	NA	NA	NA

[1] Differences between observed and expected prevalences were obtained by chi-square test by the authors of each article. NA, no available data; OB, obesity; OW, overweight.
[2] Observed vs. expected prevalences significantly lower, $P < 0.05$.
[3] Observed vs. expected prevalences not significantly different, $P > 0.05$.
[4] Observed vs. expected prevalences significantly higher, $P < 0.05$.
[5] In the Uruguay data, the double burden pair at the household level considers children <6 y.

cantly different ($P > 0.05$). Again, the differences were small and probably of little practical importance.

In summary, in only 2 of 16 comparisons, observed prevalence rates were higher than expected, whereas 10 were lower than expected and 4 were not significantly different. Moreover, in the 2 cases in which the observed prevalence of double burden was higher than expected, the absolute differences were very small (0.4 and 0.3 percentage points). Also, in most of the cases in which the observed prevalence estimates were lower than expected (8 of 10), differences were <1.5 percentage points and therefore were not considered important in public health terms. This indicates that, contrary to expectations, the double burden is either lower or equal to expected values (with only 2 exceptions in which differences were very small). We conclude that our expectation of an association between the risks of undernutrition and excess body weight did not hold. On the other hand, despite the high number of comparisons in which observed values were lower than expected, in most cases differences were too small to be considered of practical significance and therefore we cannot conclude that the risks of undernutrition and excess body weight are negatively related.

Although undernutrition and excess body weight risks seem to be largely unrelated at the individual and household levels, the fact remains that both types of conditions are very common in Latin American countries: overweight and obesity coexist with undernutrition (either stunting, anemia, or zinc deficiency) at the national level. The prevalence of obesity in women is high in all countries, the prevalence of anemia in children and women is also high in most countries, and the prevalence of stunting is medium to very high in the majority of the countries studied. The coexistence of the double burden at the household and individual levels was also documented in most countries. As a result of the high prevalences of the 2 conditions, the joint prevalence or co-occurrence of the double burden is common. It is therefore clear that the double burden does exist in Latin American countries.

These findings evidently indicate the need of policies and programs to tackle both conditions simultaneously in a coordinated fashion. The articles in this supplement issue show that all countries have in place programs aimed at preventing undernutriton and that most countries are in the process of implementing obesity prevention as part of the policy agenda. There is evidence in the literature that cash transfers or food distribution programs may result in increased energy intake at the household level (11). This has led to concerns about the possible contribution of these programs to obesity in populations who are not energy deficient and supports the need to include obesity prevention strategies as an essential component of cash or food transfer programs in countries with the double burden of malnutrition. Only one country (Mexico) reported that its main undernutrition prevention program "Oportunidades" is in the process of scaling up a strategy based on individual counseling, which promotes breastfeeding and healthy complementary feeding and emphasizes the importance of promoting linear growth and avoiding excessive weight gain in preschool-aged children. Oportunidades also includes obesity and noncommunicable disease prevention in adults. However, given the importance of obesity-promoting environments as determinants of obesity (12), in addition to including obesity prevention strategies as part of the cash or food transfer programs, governments should implement regulations and policies aimed at

promoting healthy food environments and physical activity (13). Moreover, the program has modified the food supplements distributed, reducing energy to avoid weight gain in subgroups at risk of obesity. However, undernutrition and obesity prevention strategies are not integrated in the region. The coexistence of the conditions indicates the need to reformulate policies and programs around the notion of "healthy eating" and "healthy lifestyles," including the promotion of physical activity during the different phases of the life course, in a region in which most countries are still not tackling both conditions simultaneously.

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The dual burden of malnutrition in Colombia[1–4]

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ABSTRACT

Background: Almost all nutrition policies in Colombia currently focus on either undernutrition or obesity, with the predominant emphasis on undernutrition. It is crucial to assess the prevalence of the dual burden of malnutrition in Colombia to better target programs and policies.

Objective: The aim was to estimate the national prevalence of the dual burden of malnutrition in Colombia at the individual and household levels in children <5 y, school-age children, adolescents, and adults.

Design: This was a cross-sectional analysis from the 2010 Colombian Demographic and Health Survey and the National Nutritional Survey that included 17,696 children <5 y, 25,508 school-aged children, 28,328 adolescents, 89,164 adults, and 10,487 households with mothers and children <5 y. The dual burden of malnutrition was defined as the coexistence of overweight and stunting or anemia in the same person or household.

Results: In Colombia, low to high prevalences of overweight and obesity (3.4–51.2%) coexist with moderate to high prevalences of anemia (8.1–27.5%) and stunting (13.2%). The observed prevalence of the dual burden was lower than expected. Approximately 5% of households had at least one stunted child <5 y and an overweight mother compared with an expected prevalence of 6.9% ($P < 0.001$). Among school-aged children, 0.1% were classified as stunted and obese and 1.4% were both anemic and overweight compared with expected prevalences of 0.5% ($P < 0.001$) and 1.5% ($P = 0.037$), respectively. Among 13- to 49 y-old women, 3.4% had anemia and were overweight compared with an expected prevalence of 3.5% ($P = 0.038$).

Conclusions: National estimates of the dual burden of malnutrition in Colombia are lower than expected. Despite the independence of the occurrence of these conditions, the fact that the dual burden coexists at the national, household, and intraindividual levels suggests that public policies should address both conditions through multiple strategies. It is imperative to evaluate the current nutrition policies to inform malnutrition prevention efforts in Colombia and to share lessons with other countries at a similar stage of nutritional transition. *Am J Clin Nutr* doi: 10.3945/ajcn.114.083816.

Keywords anemia, children, malnutrition, obesity, stunting

INTRODUCTION

Middle-income countries such as Colombia are experiencing rapid urbanization and integration to global markets, which lead to changes in diet and physical activity and, with these changes, large effects on body composition (1). These changes in body composition are contributing to a global increase in the prevalence of noncommunicable diseases (1). In the midst of this transition from communicable to noncommunicable diseases, conditions of over- and undernutrition may coexist; this phenomenon is also known as the dual burden of malnutrition (2, 3).

In Colombia, the dual burden has been assessed among households (4) and pregnant women (5). Preliminary research showed a national prevalence of within-household dual burden (a stunted child of 0–5 y of age and an overweight or obese mother) of 5% in 1995 (6). Another study exploring the dual burden of malnutrition specifically in Antioquia found a prevalence of 12% (7). In addition, a study in pregnant women in Colombia showed that pregnant adolescents are more likely to be underweight and that adult pregnant women are more likely to be overweight (5). A recent study found that overweight and obese women of reproductive age are less likely to be anemic than are normal-weight women (8). Findings from these studies highlight the importance of considering the coexistence of undernutrition and overweight when implementing prevention and treatment programs (9). Nonetheless, there are no evaluations to assess if the coexistence of nutrition problems is greater than would be expected by chance at the individual and household levels among children <5 y, school-age children, adolescents, and adults from Colombia.

A number of policies to prevent undernutrition or overweight have been implemented in Colombia. However, none of them explicitly addresses the dual burden of malnutrition. Instead,

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current policies focus separately on undernutrition or obesity. Even though overweight and obesity are growing concerns for the population, the predominant emphasis of these policies continues to be undernutrition. Efforts to address undernutrition in Colombia include food fortification and micronutrient supplementation programs, conditional cash transfer (CCT)[5] programs with nutritional education, promotion of breastfeeding with individual and group counseling, and food assistance programs (e.g., a school breakfast program) (10). All of these are embedded in the National Policy of Food and Nutrition Security (NPFNS) of 2008 (10). Through this document, the Intersectoral Committee on Food and Nutrition Security was created with the objective of designing a plan to meet the NPFNS goals. More recently, the National Plan of Food and Nutrition Security 2012–2019 was enacted to reinforce and coordinate all efforts to control undernutrition, which is the main focus of the document (11).

Probably the most important effort to prevent overweight and obesity in Colombia is law 1355 passed by the congress of this country in 2009. Also known as the obesity law, it outlines regulations, policies, and practices for the prevention and control of obesity in Colombia (12). One of the main aspects of the law is its intersectoral approach for the prevention, treatment, and control of obesity. Unfortunately, this law has not been fully implemented by the Colombian government. The aim of this study was to estimate the national prevalence of the dual burden of malnutrition in Colombia at the individual and household levels among children <5 y, school-aged children, adolescents, and adults.

METHODS

Sampling design and study populations

Our analysis used cross-sectional data from the 2010 Colombian Demographic and Health Survey [Encuesta Nacional de Demografía y Salud (ENDS)] (13) and the National Nutritional Survey [Encuesta Nacional de la Situación Nutricional en Colombia (ENSIN)] (14). These surveys applied a multistage, population-based sampling design stratified by clusters (household segments) that included 50,670 households.

The sample for this analysis comprised 17,696 children <5 y, 25,508 school-aged children (5–11 y), 28,328 adolescents (12–19 y), and 89,164 adults (18–64 y) with available information on anthropometric measurements. The subsample of individuals for whom hemoglobin concentrations were analyzed included 7725 children 6–59 mo old, 7906 school-aged children (5–12 y), 7861 adolescents (13–17 y), and 9314 women (13–49 y).

The subsample for households included mothers aged 18–49 y and children <5 y. The range of children under the age of 5 y per mother in our sample was 1–4 children. The average number of children per mother was 2. Cases in which there was more than one eligible mother with children <5 y at the household level were excluded. A total of 945 households were excluded, corresponding to 8.6% of the original sample. The composition of multifamily households is very different from extended and nuclear families and can have very different determinants of nutritional status. In addition, we could not select a mother-child pair, because our analysis allowed for the inclusion of all children in the household who were <5 y of age. This approach allows the inclusion of all children <5 y in the household, under the assumption that a triple burden of malnutrition could exist (i.e., both overweight and undernourished children in the household). No significant differences were found between the sociodemographic characteristics of excluded and included households. The final sample included 10,487 households.

Questionnaires including information about individuals and households were administered in the home by female interviewers equipped with computer-assisted personal interview technology. The Profamilia Institutional Review Board on Research involving Human Subjects and the Colombian National Institutes of Health granted local ethical approval.

Measures

Malnutrition measures

Nutritional status among children <5 y was assessed by using the following variables: *1*) acute underweight, *2*) stunting, *3*) low weight for age, *4*) overweight/obesity, and *5*) anemia. According to the WHO Growth Standards (15), we defined underweight as a weight-for-height z score < -2 SDs, stunting as a height-for-age z score < -2 SDs, low weight for age as a weight-for-age z score < -2 SDs, and overweight/obesity as a BMI z score ≥ 2 SDs (16). Among school-aged children and adolescents, we defined obesity as a BMI z score ≥ 2 SDs from the mean of the WHO reference population for children ’5 y of age (17). For adults, we assessed overweight/obesity and thinness by using BMI. Overweight/obesity was defined as BMI (in kg/m^2) ≥ 25 and thinness was defined as BMI <18.5.

Hemoglobin was measured by the Hemocue method (HemoCue AB) and adjusted by altitude as recommended by the International Nutritional Anemia Consultative Group (18). Among children 6–59 mo, anemia was defined as hemoglobin <11 g/dL. For children 5–12 y old and female adolescents, anemia was defined as hemoglobin <12 g/dL. For male adolescents, anemia was defined as hemoglobin <13 g/dL, for adult women as hemoglobin <12 g/dL, and for pregnant women as hemoglobin <11 g/dL.

To assess the dual burden at the household level we created the following categories: *1*) mother with normal BMI and all children without stunting, *2*) mother with normal BMI and at least one child who was stunted (the remaining children <5 y could be normal or stunted), *3*) overweight/obese mother and at least one child who was stunted (the remaining children <5 y could be either normal or stunted), and *4*) overweight mother and all children who were normal (no stunting or normal BMI).

Sociodemographic factors

The sociodemographic characteristics included sex, age category [children <5 y (6–59 mo), school-aged children (6–11y), adolescents (12–19 y), and adults (20–49 y)]; and socioeconomic status (SES) was assessed by using the Sistema de Identificación de Potenciales Beneficiarios de Programas

[5]Abbreviations used: CCT, conditional cash transfer; NPFNS, National Policy of Food and Nutrition Security; SES, socioeconomic status; SISBEN, Sistema de Identificación de Potenciales Beneficiarios de Programas Sociales (System to identify families that could benefit from social programs).

Sociales (SISBEN). The SISBEN (19) is a system designed by the Colombian National Government to identify families who could benefit from social programs. It takes into account sociodemographic characteristics (family composition, employment status, family income, and educational level), living conditions (construction type and materials), and access to public utilities (sewer, electricity, potable water, and garbage collection). Households are classified into 6 levels with 1 being the poorest and 6 being the wealthiest. For this study we classified SISBEN scores into 4 categories (1, 2, 3, and ≥4).

Statistical analysis

We estimated the prevalences and 95% CIs of indicators of nutrition status at the individual and household levels. Prevalences of malnutrition were stratified by sociodemographic characteristics. Prevalences of the 2-way combinations of overweight and stunting at the household level, overweight and stunting among school-aged children, and overweight and anemia among school-aged children and women were computed from contingency tables (20, 21). A chi-square test was conducted to compare our estimated prevalence to the expected value. Analyses were conducted by using the statistical software packages SAS version 9.3 (SAS Institute) and STATA version 11 (StataCorp LP) with appropriate weighting and adjustment for the sampling design.

RESULTS

Children <5 y

For undernutrition, the highest prevalence was stunting (13.2%), followed by low weight for age (3.4%), and acute underweight (0.9%). According to hemoglobin concentration, 27.5% of children <5 y had anemia. The prevalence of stunting varied by sex: boys were more likely to be stunted than were girls (14.2% compared with 12.1%; $P = 0.003$) (**Table 1**).

TABLE 1
Prevalence of undernutrition, overweight, and anemia in children, adolescents, and adults from Colombia: the National Nutritional Survey (ENSIN) and the Colombian Demographic and Health Survey (ENDS) 2010[1]

	Overall, %	Females, %	Males, %	P[2]
Population				
Children <5 y				
< −2 WHZ (acute undernutrition)	0.9 (0.7, 1.1)	0.9 (0.7, 1.1)	0.9 (0.7, 1.1)	0.939
< −2 HAZ (stunting)	13.2 (12.5, 13.9)	12.1 (11.2, 13.1)	14.2 (13.2, 15.2)	0.003
< −2 WAZ (global undernutrition)	3.4 (3.1, 3.8)	3.3 (2.9, 3.9)	3.5 (3.1, 4.0)	0.515
> +2 BMIZ (obesity)	5.2 (4.8, 5.7)	4.7 (4.2, 5.4)	5.7 (5.1, 6.3)	0.017
School-aged children, 5–11 y				
> +2 BMIZ	4.6 (4.0, 5.3)	3.5 (3.0, 4.0)	5.7 (4.8, 6.6)	<0.001
Adolescents, 12–19 y				
> +2 BMIZ (obesity)	3.4 (2.9, 3.7)	3.4 (2.9, 3.9)	3.3 (2.8, 3.8)	0.798
Adults, 18–64 y				
BMI				
<18.5 kg/m^2	2.8 (2.7, 2.9)	3.0 (2.8, 3.2)	2.5 (2.3, 2.7)	0.001
≥25 kg/m^2	51.2 (50.7, 51.7)	55.2 (54.6, 55.8)	45.6 (44.9, 46.4)	<0.001
Anemia				
Children, 6–59 mo				
Hemoglobin <11 g/dL	27.5 (26.1, 28.9)	26.3 (24.4, 28.2)	28.6 (26.8, 30.4)	0.098
School-aged children, 5–12 y				
Hemoglobin <12 g/dL	8.1 (7.3, 9.0)	8.6 (7.4, 10.0)	7.6 (6.6, 8.7)	0.240
Adolescents, 13–17 y				
Hemoglobin <12 g/dL[3]	10.6 (9.7, 11.6)	5.5 (4.6, 6.5)	NA	
Hemoglobin <13 g/dL[4]	NA	NA	15.6 (14.2, 17.1)	<0.001
Women				
Age 18–29 y				
Hemoglobin <12 g/dL	NA	6.6 (5.6, 7.9)	NA	
Age 30–49 y				<0.001
Hemoglobin <12 g/dL	NA	10.3 (9.1, 11.5)	NA	
Pregnant women				
Age 13–17 y				0.658
Hemoglobin <11 g/dL	NA	19.3 (13.5, 26.7)	NA	
Age 18–29 y				
Hemoglobin <11 g/dL	NA	18.3 (15.8, 21.0)	NA	
Age 30–49 y				
Hemoglobin <11 g/dL	NA	16.0 (12.0, 20.9)	NA	

[1]Values are prevalences; 95% CIs in parentheses. BMIZ, BMI z score; ENDS, Encuesta Nacional de Demografía y Salud; ENSIN, Encuesta Nacional de la Situación Nutricional en Colombia; HAZ, height-for-age z score; NA, data not available; WAZ, weight-for-age z score; WHZ, weight-for-height z score.

[2]All P values are for comparisons between prevalences of females compared with males.

[3]Cutoff for anemia in females.

[4]Cutoff for anemia in males.

Likewise, there was a higher prevalence of undernutrition among the population with the lowest SES compared with the population with a high SES (**Table 2**).

The overall prevalence of obesity was 5.2%. Boys were more likely to be obese than were girls (5.7% compared with 4.7%; $P = 0.017$) (Table 1). In contrast with undernutrition, the dose response relation of obesity with SES indicated a lower prevalence among the population with the lowest SES compared with the population with a high SES (Table 2).

At the household level, 5.1% of the households had at least one stunted child under the age of 5 y, with the remaining children <5 y either stunted or normal, and an overweight/obese mother. The observed prevalence for dual burden at the household level was lower than the expected prevalence (5.1% compared with 6.9%; $P < 0.001$) (**Table 3**).

School-aged children (5–11 y) and adolescents (12–19 y)

For undernutrition, 8.1% of school-aged children and 10.6% of adolescents had anemia, with male adolescents more likely to have anemia than female adolescents (15.6% compared with 5.5%; $P < 0.001$) (Table 1). Socioeconomic inequalities in the prevalence of anemia among adolescents indicated a higher prevalence among the population with the lowest SES compared with the population with a high SES (Table 2).

With regard to obesity, the overall prevalence among school-aged children was 4.6%. Boys were more likely to be obese than were girls (5.7% compared with 3.5%; $P < 0.001$) (Table 1). Among adolescents, the overall prevalence of obesity was 3.4%. In contrast with undernutrition, among school-aged children obesity was less prevalent among the population with the lowest SES compared with the population with a highest SES (Table 2).

Among school-aged children, the observed prevalence of the co-occurrence of obesity and stunting was 0.1%, which was lower than the expected co-occurrence of 0.5% ($P < 0.001$). Similarly, the co-occurrence of anemia and overweight among school-aged children was 1.4%, which was slightly lower than the expected co-occurrence of 1.5% ($P = 0.037$) (Table 3).

TABLE 2
Prevalence of undernutrition, overweight, and anemia in children, adolescents, and adults from Colombia, by SISBEN level: the National Nutritional Survey (ENSIN) and the Colombian Demographic and Health Survey (ENDS) 2010[1]

	SISBEN level, %				
	1	2	3	≥4	P^2
Population					
Children <5 y					
< −2 WHZ (acute undernutrition)	1.2 (0.9, 1.5)	0.2 (0.1, 0.6)	0.8 (0.4, 1.5)	0.6 (0.4, 1.0)	<0.001
< −2 HAZ (stunting)	16.8 (15.7, 18.0)	10.5 (8.8, 12.5)	8.3 (6.7, 10.2)	9.1 (8.0, 10.4)	<0.001
< −2 WAZ (global undernutrition)	4.7 (4.2, 5.3)	2.2 (1.4, 3.4)	1.6 (1.0, 2.5)	2.2 (1.7, 2.8)	<0.001
> +2 BMIZ (obesity)	4.3 (3.8, 4.9)	5.4 (4.3, 6.7)	7.0 (5.5, 8.7)	6.3 (5.4, 7.3)	<0.001
School-aged children, 5–11 y					
> +2 BMIZ	3.0 (1.9, 4.1)	6.3 (4.0, 8.6)	8.9 (4.8, 13.0)	8.2 (6.2, 10.2)	0.002
Adolescents, 12–19 y					
> +2 BMIZ	2.6 (1.8, 3.4)	2.8 (1.5, 4.0)	4.1 (2.3, 5.9)	3.7 (2.9, 4.5)	0.355
Adults, 18–64 y					
BMI					
<18.5 kg/m^2	3.5 (3.2, 3.7)	2.6 (2.3, 3.1)	2.7 (2.4, 3.2)	2.3 (2.1, 2.6)	<0.001
≥25 kg/m^2	47.1 (46.3, 47.8)	51.7 (50.5, 52.9)	53.9 (52.6, 55.2)	53.5 (52.7, 54.2)	<0.001
Anemia					
Children					
Age 6–59 mo					
Hemoglobin <11 g/dL	30.8 (28.9, 32.7)	23.2 (20.0, 26.8)	24.1 (20.3, 28.3)	24.0 (21.4, 26.8)	<0.001
Age 5–12 y					
Hemoglobin <12 g/dL	8.7 (7.7, 10.0)	7.3 (5.4, 9.8)	6.8 (4.6, 9.9)	7.8 (6.2, 9.8)	0.470
Adolescents, 13–17 y					
Hemoglobin <12 g/dL[3]	12.0 (10.7, 13.3)	9.8 (7.6, 12.6)	9.1 (6.8, 12.1)	9.0 (7.4, 10.9)	0.037
Hemoglobin <13 g/dL[4]					
Females, 13–49 y					
Hemoglobin <12 g/dL	8.2 (7.7, 9.8)	7.3 (5.8, 9.3)	6.6 (5.0, 8.6)	6.8 (5.8, 7.9)	0.078
Pregnant women, 13–49 y					
Hemoglobin <11 g/dL	22.6 (19.4, 26.1)	14.3 (9.2, 21.7)	12.1 (7.2, 19.6)	13.3 (10.3, 17.0)	0.001

[1]All values are prevalences; 95% CIs in parentheses. SISBEN level is a life standard measure in Colombia used to assess socioeconomic status. BMIZ, BMI *z* score; ENDS, Encuesta Nacional de Demografía y Salud; ENSIN, Encuesta Nacional de la Situación Nutricional en Colombia; HAZ, height-for-age *z* score; SISBEN, Sistema de Identificación de Potenciales Beneficiarios de Programas Sociales; WAZ, weight-for-age *z* score; WHZ, weight-for-height *z* score.

[2]*P* values are for comparisons between prevalences stratified by SISBEN level.

[3]Cutoff for anemia in females.

[4]Cutoff for anemia in males.

TABLE 3
Dual burden at the household and individual levels in Colombia: the National Nutritional Survey (ENSIN) and the Colombian Demographic and Health Survey (ENDS) 2010[1]

	Stunting, %			Anemia, %		
	With	Without	Total	With	Without	Total
Household level						
Child <5 y old						
Mother with overweight/obesity[2]	5.1[3]	39.0	44.1	—	—	—
Mother without overweight/obesity[4]	6.6	39.0	45.6	—	—	—
Total	11.7	78	89.7 (n = 10,317)	—	—	—
P			<0.001			
Individual level						
School-aged children, 5–12 y						
With overweight/obesity	0.1[5]	5.3	5.4	1.4[6]	17.5	18.9
Without overweight/obesity	8.5[7]	86.1[7]	94.6	6.7[8]	74.4[8]	81.0
Total	8.6	91.4	100 (n = 22,091)	8.0	92.9	100 (n = 7761)
P			<0.001			0.037
Women,[9] 13–49 y						
With overweight/obesity	—	—	—	3.4[10]	47.1	50.5
Without overweight/obesity[4]	—	—	—	3.5	46.1	49.6
Total	—	—	—	6.9	93.2	100 (n = 7178)
P						0.038

[1] n values in parentheses. All chi-square test P values are for comparisons between the percentage with dual burden and the percentage expected if the burdens were independent. ENDS, Encuesta Nacional de Demografía y Salud; ENSIN, Encuesta Nacional de la Situación Nutricional en Colombia.

[2] Overweight/obesity: BMI (in kg/m^2) ≥25.

[3] Expected percentage in the overweight/obese mother with at least one stunted child cell = 6.9%.

[4] Without overweight/obesity: BMI (in kg/m^2) between 18.5 and 24.9.

[5] Expected percentage in the obese and stunting cell = 0.5%. Obesity: BMI > +2 SDs.

[6] Expected percentage in the overweight/obese and anemia cell = 1.5%. Overweight/obesity: BMI > +1 SD.

[7] Without obesity: BMI < +2 SDs.

[8] Without overweight/obesity: BMI < +1 SD.

[9] Nonpregnant women

[10] Expected percentage in the overweight/obese and anemia cell = 3.5%. Overweight/obesity: BMI (in kg/m^2) ≥25.

Adults and pregnant women

The prevalence of thinness among adults was 2.8%. Women were more likely to be thin than were men (3% compared with 2.5%; P = 0.001). The prevalence of anemia among women differed by age. Women between 30 and 49 y old were more likely to have anemia than were women aged 18–29 y (10.3% compared with 6.6%; $P < 0.001$). Among pregnant women, the prevalence of anemia ranged from 16% to 19.3% (Table 1). The highest prevalence of thinness was found among those with the lowest SES (Table 2).

The overall prevalence of overweight was 51.2% (BMI ≥25). Women were more likely to be overweight than were men (55.2% compared with 45.6%; $P < 0.001$) (Table 1). In contrast with undernutrition, the lowest prevalence was found among the population with the lowest SES (Table 2). The overall prevalence of obesity (BMI ≥30) was 16.5%. Women were more likely to be obese than were men (20.1% compared with 11.5%; $P < 0.001$). Among women between 13 and 49 y of age, the observed prevalence of the co-occurrence of anemia and overweight was 3.4%, which was slightly lower than the expected co-occurrence of 3.5% (P = 0.038) (Table 3).

DISCUSSION

In Colombia, the dual burden of under- and overnutrition coexists at the national, household, and individual levels. Low to high prevalences of overweight and obesity (3.4–51.2%) coexist with moderate to high prevalences of anemia (8.1–27.5%) and stunting (13.2%). The coexistence of overweight/obesity of mothers with a stunted child was 5.1%, which was higher than the coexistence of obesity with stunting among school-aged children (0.1%) and the coexistence of overweight/obesity with anemia among school-aged children (1.4%) and among women (3.4%). Nonetheless, these observed estimates were lower than expected estimates of the dual burden at the household and individual levels. Despite the independence of the occurrence of these conditions, the fact that the dual burden coexists at the national, household, and intraindividual levels suggests that public policies should address both conditions through multiple strategies.

Results from this analysis should be placed in context of the Colombian current policies that address these conditions of malnutrition. In Colombia, action plans, programs, and indicators for addressing and monitoring malnutrition use as a framework the NPFNS, which prioritizes the poorest and most vulnerable populations. The main components of NPFNS are *1*) the economic means dimension, *2*) the quality of life and well-being dimension, and *3*) the intersectoral actions for food quality and safety.

The National Plan of Food and Nutrition Security 2012–2019 establishes the main lines of action for each of the components of the NPFNS. Actions in the economic dimension focus on the

availability and access to essential food groups that ensure a minimum supply of nutrients in the case of contingencies that affect food production. It is important to note that processed products are not part of the priority food.

The quality of life and well-being dimension has 4 lines of action. The first line of action includes nutrition education strategies that promote healthy eating and the reduction of sugar consumption and contributes to the reduction in morbidity and mortality associated with inadequate diets. The second line of action includes integrated efforts intended to prevent and reduce undernutrition and micronutrient deficiencies (nutritional anemia, mainly in children <5 y). Specific strategies within this line of action include the following: *1*) nutrition education for parents and caregivers; *2*) promotion of healthy lifestyles with a life cycle approach; *3*) delayed umbilical cord clamping as an intervention to increase hemoglobin concentrations in newborns and to reduce the risk of anemia; *4*) promotion and support of breastfeeding; *5*) promotion and support of adequate complementary feeding according to WHO guidelines; *6*) nutritional assessment for pregnant women, nursing mothers, and children <5 y; *7*) growth and development monitoring and control; *8*) supplementation with vitamins and minerals for pregnant women and children <5 y; and *9*) fortified complementary food supply and home fortification of food with powdered micronutrients for children between 6 and 23 mo. The third line of action is the improvement of breastfeeding practices to increase exclusive and total breastfeeding through the implementation of the Ten Year Plan of Breastfeeding 2010–2020 (22). The fourth line of action is the promotion of healthy lifestyles through actions focused on individuals and their environments. Strategies are recommended at schools, universities, and work sites. This line of action also includes the development of a national strategy to promote fruit and vegetable consumption.

In the third dimension, the intersectoral actions for food quality and safety and nutrition security, the plan emphasizes current regulations for improving and monitoring water and food quality and safety. Furthermore, it stresses the need to articulate current programs that can contribute to food and nutrition security, even though food and nutrition security is not its main target. The national plan also recommends maintaining the ENSIN as one of the main surveys to monitor nutrition indicators.

On the other side, law 1355 of 2009, also known as the obesity law, is currently the guide to establish intersectorial actions to prevent, treat, and control obesity and noncommunicable diseases. The law also describes strategies to promote healthy eating, such as *1*) ensuring fruit and vegetable availability in schools; *2*) implementation of food education programs in schools; *3*) regulation of highly caloric food and beverage intake in schools; *4*) encouraging consumption, production, and marketing of fruit and vegetables; and *5*) regulation of fat content of food, mainly *trans* and saturated fats. The law also promotes physical activity through strategies such as increasing physical education time in schools, promoting active breaks at work sites, and supporting active transportation. It emphasizes actions such as increasing cyclist and pedestrian road safety and the number and frequency of public spaces used for leisure activities, such as Ciclovía (a mass recreational program in which streets are closed temporarily to motorized transport, allowing access only to walkers, runners, rollerbladers, and cyclists) (23).

Some of the strategies and actions established in the NPFNS and the obesity law are realized through programs such as the School Feeding Program (Programa de Alimentación Escolar), which provides meals to children and adolescents enrolled in public schools. These meals cover a minimum of 20% of children's recommended energy and nutrients intake (24). In addition to alleviating short-term hunger, this program aims to improve academic performance. Another initiative, Childhood Breakfasts with Love (Desayunos Infantiles con Amor), provides breakfasts fortified with iron, folic acid, and zinc to children between 6 mo and 5 y from vulnerable populations (25). Prosperous Cities for Children and Adolescents (Ciudades Prósperas de los Niños, Niñas y Adolescentes) is an initiative that aims to improve children's and adolescents' quality of life through the creation of environments that allow for the development of healthy lifestyles (26).

Parallel to these policies, Colombia's government has implemented nutrition-sensitive strategies such as the UNIDOS Network and De Cero a Siempre (From zero to always). The UNIDOS Network is a CCT strategy that aims to overcome extreme poverty and to develop human capital. UNIDOS also comprises actions to prevent hunger and child undernutrition (27). De Cero a Siempre is the national strategy for comprehensive care in early childhood. It encompasses all of the plans, programs, and actions developed by the government to ensure the adequate development of children <5 y. It includes health and nutrition interventions in its main lines of action (28).

In summary, important strengths of the current policies to prevent undernutrition or overweight in Colombia seem to be their intersectorial nature, their focus on well-being and quality of life as a whole and not on individual aspects of health or nutritional status, and the emphasis on prevention through lifestyle and built-environment interventions. Conversely, limitations of Colombian policies thus far include the lack of impact evaluations that encompass impact on both under- and overnutrition outcomes, inadequate implementation of the policies, and coordination of entities working on both sides of the problem to optimize resources and ensure that specific policies are not contributing to worsen any other health problem. For example, a recent study reported that beneficiaries from CCT programs in Colombia were more likely to be obese compared with nonbeneficiaries (29). This was hypothesized to be attributable to dietary changes made by beneficiaries of CCT programs, who tend to consume more high-energy-dense foods that are deficient in micronutrients (30) and who are less likely to report physical activity during leisure time. Adding a physical activity and healthy eating component to CCT programs could help prevent a potential increase in the dual burden of malnutrition in Colombia.

Other recommendations to prevent the dual burden of malnutrition in Colombia could be the implementation of selective and tailored nutrition programs based on anthropometric measures and nutritional status, as measured by micronutrients (31), and interventions to reduce stunting during the first 2 y of life (32). Furthermore, maternal obesity is a known risk factor for preterm birth and has been found to be associated with low birth weight. Moreover, higher parity and shorter interpregnancy intervals are associated with higher likelihood of obesity (33–37). As a consequence, interventions that monitor and control weight gain during pregnancy, family planning policies, and

information on the negative effects of shorter birth spacing should be encouraged among reproductive-aged women. Finally, improving dietary quality with food-based and comprehensive diet approaches should be encouraged.

It is important to note that many countries in Latin America are at a stage of the nutrition transition similar to Colombia (38). Consequently, lessons learned from the Colombian case through analyses of available surveillance data, as well as from future process and impact evaluation of policies and programs, have the potential to inform malnutrition prevention efforts in other settings.

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Double burden of undernutrition and obesity in Uruguay[1–4]

Cecilia Severi and Ximena Moratorio

ABSTRACT

Background: Uruguay is at an advanced stage of the epidemiologic transition; like other Latin American countries, it bears a nutritional double burden composed of undernutrition and overweight or obesity.

Objectives: The aim was to estimate whether a double burden of nutritional problems exists in Uruguay and to identify if governmental programs and policies for nutrition take this double burden into account.

Design: Existing studies were reviewed, and other data were processed specifically for the purpose of this article. Several data sources were used to include a broad, comprehensive population range.

Results: The prevalence of stunting in children aged <2 y is 10.9%. There is a high frequency of obesity, which increases with age (9.5% in children <2 y old, 18.8% in those aged 6 y, 20.4% in those aged 11 y, 26.6% in those aged 13–15 y, and 35.3% in adults). In addition, 13.8% of women start pregnancy underweight and the rate of obesity increases during pregnancy from 36.7% at the beginning to 46.5% at the end. Anemia is very frequent in the selected population we examined, as follows: 31% of children <2 y old and 20.9% of pregnant women in their third trimester. An obese mother with a stunted child are present in 6.3% of households; 1.9% of stunted children are obese at age 6 y and 3.1% are obese at the age of 11. Multiple logistic analysis applied to children <2 y showed an association between stunting and obesity (OR: 2.0; 95% CI: 1.2, 3.6).

Conclusions: The data suggest that there is a nutritional double burden in Uruguay. This nutritional burden is similar to that of other countries in the region. This important public issue should be tackled, and it should be addressed in early infancy. *Am J Clin Nutr* doi: 10.3945/ajcn.114.083808.

Keywords double burden, overweight/obesity, programs review, undernutrition

INTRODUCTION

In most developed countries, obesity is a major public nutritional problem. In several Latin American countries, undernutrition is still prevalent but now coexists with excess body weight, which makes the situation much more complex. The coexistence of, for example, undernutrition with stunting or anemia or both stunting and anemia with overweight or obesity is called the double burden of malnutrition. The double burden phenomenon can take place in a same family (in the case of stunted child–overweight mother pairs) or simply coexist in one individual (in the case of an obese child with stunting) (1, 2).

Uruguay is at an advanced stage of the epidemiologic transition, and although in the past 12 y stunting rates decreased from 14.6% to 10.9% in children <2 y old, stunting still remains a public health problem, especially in lower socioeconomic sectors. In addition, Uruguay has an elevated prevalence of obesity at all ages, similar to high-income countries (3).

Some programs have been implemented in Uruguay throughout the past decades, but they seem to be focused on either one or the other side of the problem—undernutrition or overweight—and more particularly on undernutrition; for obesity, it was only recently that some initiatives to tackle the problem were undertaken. It is not clear to what extent the current programs integrate actions to manage the double burden simultaneously.

The objective of this article, therefore, was to assess the existence of a double burden of nutritional problems by age group at the household and intraindividual levels in Uruguay and to determine whether the nutrition programs and policies in the country have incorporated the double burden as part of their approach.

METHODS

A review of existing studies and the processing of other available data were conducted for the specific purpose of this article. Several data sources were used to include a broad range of population:

1) A 2011 national survey on nutritional state, eating habits, and anemia in children <2 y old (*Encuesta nacional sobre estado nutricional, prácticas de alimentación y anemia en niños menores de dos años*), which included a representative sample of 2994 cases <2 y old. The 2006 WHO growth standards were used to classify anthropometric measures: stunting (height-for-age <2 SDs), wasting (weight-for-lage <2 SDs), and overweight and obesity (weight-for-height <1 SD and <2 SDs, respectively) (4). The anemia cutoff used was that suggested by the WHO: hemoglobin <11 g/dL (5). Risk factors for stunting were analyzed by logistic regression analysis. A detailed description of the sampling and the data collection methods is presented elsewhere (6).

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2) "The nutritional state of children and food policies" (*El estado nutricional de los niños/as y las políticas alimentarias*), a 2004–2011 cohort study in a nationally representative sample obtained at schools and that included 4254 children aged 6 y who were followed up until they were 11 y old and for which the 2006 WHO reference was used as well as the same criteria applied in the study in children <2 y (7). The sample was obtained following probabilistic, random, and representative methods, which included the children's mothers' years of schooling, whether they attended full-time schools, their school's social context, whether their schools had common dining areas, and what meals were provided in their schools (breakfast, lunch, or both). Details and a description of the sampling, data collection, and analysis are presented elsewhere (8).

3) The Second Global Survey on Adolescent Health (*II encuesta mundial de salud adolescente*), with a representative sample of 3524 cases (13–15 y old) from state and private schools. Children were measured by specialists in the period June–July 2012, and the WHO BMI cutoffs of >1 SD and >2 SDs for overweight and obesity, respectively, were used (9).

4) The 2006 First National Survey on Risk Factors associated with Chronic, Noncommunicable Diseases (*Primera Encuesta Nacional de los factores de riesgo de Enfermedades Crónicas no trasmisibles)*, which included a nationally representative sample of 2010 cases (25–64 y old). The BMI (in kg/m^2) cutoffs used were <18.5 (underweight), 25–30 (overweight), and >30 (obesity). Details of the sampling method and data collection are presented elsewhere (10).

5) Other data processed specifically for this article included the following:

- Data from a 2012 database of 36,693 women registered in the Informatics Perinatal System for whom BMI by gestational age and anemia were processed. BMI was classified by using Atalah et al.'s reference (11); for anemia in the third trimester of pregnancy, the cutoff used for hemoglobin was <11 g/dL.
- Data from the 2004–2011 cohort study database with which cases of obese mothers with a stunted child at household were studied as well as the coexistence of children with stunting and obesity at 6 y old; the same calculations were then made when the same children were 11 y old. Results were compared with predicted results by applying a chi-square test. A review of other ongoing programs was also conducted with the use of official information.

RESULTS

The national prevalence of weight-for-height <2 *z* scores in children <2 y old is 1%, height-for-age <2 *z* scores is 10.9%, and anemia values are high, as shown in **Table 1**. The frequency of overweight/obesity is high in all ages and increases with age, as shown in **Table 2**, reaching almost 58% of the adult population (BMI ≥25). In pregnant women, 13.8% are underweight and 36.7% are obese at the beginning of gestation. At the third trimester, the prevalence of obesity is higher (46.5%) and that of anemia is 20.9% (data not shown).

In 6.3% of households there is an obese mother and a stunted child. This percentage of households with a double burden is not different from what was expected, assuming independence of burdens, and the difference was not significant ($P = 0.146$) (**Table 3**).

With regard to the double burden existing within the same person, 1.9% of school-aged children had a double burden of overweight/obesity and stunting at 6 y old and 3.1% experienced this double burden at 11 y old. These proportions of double burden are different from what was expected assuming independence of the burdens, and the difference was significant ($P < 0.001$ for both calculations; Table 3). A multivariate analysis applied to children <2 y old showed an association between stunting and obesity (OR: 2.2; 95% CI: 1.5, 3.6) (**Table 4**).

DISCUSSION

The strength of this review is that it is based on studies with large representative samples in all age groups; its main limitation is that the data used were collected in different years and with different methodologies.

Uruguay, like some other developed and even developing countries around the world, faces a double burden of malnutrition that includes both undernutrition and overweight. Wasting is almost absent in all age groups, but there exists a moderate prevalence of stunting and a high prevalence of overweight/obesity. Results also show the existence of individuals with the double burden of malnutrition.

The data presented suggest a link between stunting and obesity, through the prevalence of stunted and obese schoolchildren and the association shown between stunting and overweight in <2-y-old children. A plausible explanation for this was shown in studies by Barker et al (12, 13) and Jackson (14), which found that to suffer undernutrition in the early stages of life entails a higher probability of being overweight and obese in the short and long term, which may also come along with chronic diseases.

Some programs have been initiated in Uruguay throughout the past decades, but they seem to be focused on undernutrition in the framework of overcoming poverty, such as the program *Comedores* (feeding centers), a school meals program, "baskets for nutritional risk," "fortified milk supply," and cash transfer programs, among others (15, 16).

The Health System Reform played an important role in infant nutrition by including "a payment for health goals." One of these

TABLE 1
Prevalence of undernutrition and overweight/obesity in children <2 y old[1]

Indicator	Total, %
Undernutrition	
<2 *z* scores weight-for-height	1.0
<2 *z* scores height-for-age	10.9
<2 *z* scores weight-for-age	4.0
Anemia[2]	31.5[3]
Obesity	
BMI >2 *z* scores	9.5

[1] $n = 2994$ unless noted otherwise. Source: reference 6.
[2] Hemoglobin <11 g/dL.
[3] $n = 756$.

TABLE 2
Prevalence of malnutrition (obesity and thinness) in school-aged children, adolescents, and adults[1]

	Prevalence, %		
	Boys	Girls	Total
Children aged 6 y (BMI-for-age)			
BMI >2 *z* scores	9.2 (7.08, 11.3)	6.6 (4.9, 8.5)	8.1 (6.4, 9.5)
Children aged 11 y (BMI-for-age)			
BMI >2 *z* scores	10.6 (7.1, 12.9)	7.2 (5.19, 9.4)	9.4 (7.7, 11.0)
Adolescents aged 13–15 y (BMI-for-age)			
BMI >2 *z* scores	8.1 (6.9, 9.5)	6.0 (4.7, 7.6)	7.9 (6.0, 8.1)
Adults aged 25–64 y			
BMI of 25–30 kg/m^2	—	—	35.3 (31.9, 44.4)[2]
BMI >30 kg/m^2	—	—	21.8 (19.0, 24.6)[2]
Thinness in women (>20 y old)			
BMI <18.5 kg/m^2 (%)	—	6.5	—

[1]Values are prevalences (95% CIs) unless otherwise indicated. Sources—school-aged children (6–11 y): 2004–2011 cohort study (n = 4254) (8); adolescents (13–15 y): the *II Encuesta mundial de salud adolescente*, 2012 (n = 3524) (9); and adults (25–64 y): First National Survey of Risk Factors Associated with Chronic Noncommunicable Diseases, 2006 (n = 2010) (10). For "Thinness in women," the authors' processed data from the Perinatal Informatics System, 2012 (n = 36,693), were used.
[2] Differences by sex were not provided and cannot be calculated with the available data.

goals was the accreditation of health centers in good nutrition practices. This is reflected in the increase in exclusive breastfeeding rates at 6 mo of age, reaching 65.2% in 2011 (6).

Recently, certain initiatives were undertaken to respond to the obesity problem, such as the "Interagency Commitment for an appropriate diet in the Uruguayan population" and a recently approved law for healthy eating at schools (17).

The aims and interventions proposed in the different programs seem to be focused on one or the other side of the problem, undernutrition or overweight, and especially on undernutrition. It is not clear to what extent the current programs integrate actions to manage the double burden simultaneously.

The problem to be tackled is more complex and difficult to solve. The double burden of malnutrition calls for a new nutritional and welfare policy based on a life-course approach. This demands a radical shift from a food delivery policy aimed at encouraging people to eat more into a policy that facilitates the appropriate conditions and guides people as to how to eat better in terms of quality. This challenge requires a huge effort from different participants and sectors of society; it is easier for a policy to provide assistance than to produce changes in individuals' and families' personal practices to lead to a new way of eating and a more active lifestyle (18, 19). Thus, a strong political leadership is imperative to respond to this double burden of malnutrition.

TABLE 3
Assessment of the double burden of stunting and overweight/obesity at the household and individual levels in Uruguayan children and women (2004–2011 school-aged cohort study)[1]

	Stunting, %		
	With	Without	Total
Household level			
Children aged 6 y (n = 1532)			
Mother with overweight/obesity	6.3[2] (5.2, 7.7)	31.0 (26.7, 33.3)	37.3 (34.9, 39.7)
Mother without overweight/obesity	12.5 (11.0, 14.3)	50.2 (47.7, 33.3)	62.7 (60.3, 65.1)
Total	18.8 (17.0, 20.9)	81.2 (79.1, 83.0)	100.0
P			0.146
Individual level			
Children aged 6 y (n = 1901)			
With overweight/obesity	1.9[3] (1.4, 2,7)	21.7 (19.9, 23.6)	23.6 (21.7, 25.6)
Without overweight/obesity	18.5 (16.8, 20.3)	57.9 (55.7, 60.1)	76.4 (74.4, 78.2)
Total	20.4 (18.7, 22.28)	79.6 (77.7, 81.3)	100.0
P			0.001
Children aged 11 y (n = 1664)			
With overweight/obesity	3.1[4] (2.4, 4.1)	26.9 (24.8, 29.0)	30.0 (27.8, 32.2)
Without overweight/obesity	15.4 (13.8, 17.3)	54.6 (52.2, 56.9)	70.0 (67.8, 72.2)
Total	18.6 (16.8, 20.5)	81.4 (79.5, 83.2)	100.0
P			0.001

[1]Values are prevalences (95% CIs). *P* values are for comparisons between percentage with double burden and percentage expected if the burdens were independent.
[2–4]Expected = [2]7.02%, [3]4.81%, [4]5.57%.

TABLE 4
Risk factors associated with stunting in children <2 y old[1]

	β	SE	P	OR (95% CI)
Low birth weight	2.39	0.23	0.00	11.0 (6.9, 17.2)
Maternal height <1.52 m (10th percentile)	1.02	0.23	0.00	2.8 (1.8, 4.3)
Maternal BMI <18.5 kg/m^2 pregestation	0.86	0.26	0.00	2.4 (1.4, 3.9)
<6 mo old	0.78	0.18	0.00	2.2 (1.5, 3.29)
Obese child	0.71	0.29	0.01	2.0 (1.2, 3.6)
Maternal education <9 y	0.68	0.20	0.00	2.0 (1.3, 2.9)
State health care centers	0.39	0.20	0.05	1.5 (1.01, 2.2)
Male sex	0.40	0.18	0.03	1.5 (1.1, 2.1)

[1]n = 2994. Source: reference 6.

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Optimal child growth and the double burden of malnutrition: research and programmatic implications[1–3]

Cesar G Victora and Juan A Rivera

Latin American children are getting taller, but they are also becoming fatter. These 2 simultaneous shifts have been widely documented: both the distributions of height (length) for age and of weight relative to height (length) are moving to the right side (1–3). These changes are not restricted to Latin America. With the possible exception of sub-Saharan Africa, the prevalence of stunting is rapidly decreasing. Child overweight is increasing in all regions, including Africa (3), at a faster rate than adult overweight (4). Whereas only a few years ago the major concern was with undernutrition, in particular with its impact on morbidity, mortality, and child development, the nutrition transition has shifted the focus to the risk of adult noncommunicable diseases (NCDs) related to early growth patterns. In fact, nutrition-related factors still contribute to almost half of all deaths of children <5 y of age (3), so that the global burden of undernutrition is still immense.

In recent years, we have learned much about how growth in different age ranges during childhood affects long-term outcomes. It has been confirmed globally that growth faltering is particularly concentrated in the first 1000 d from conception to the second birthday (5).

Cohort analyses from low- and middle-income countries (LMICs) initially focused on weight gain, which includes linear growth but also increases in relative adiposity, or greater weight for length or height. These analyses showed that rapid weight gain during the 1000-d window is associated with greater human capital, expressed in terms of intelligence, productivity, adult height, or next-generation reproductive outcomes (6). Contrary to what may have been expected, rapid gains in this period showed variable associations with NCD markers measured in young adults, which somewhat increased risks for some markers and no associations or protection against others (6). Rapid weight gains after the first couple of years, however, were consistently associated with higher concentrations of markers for NCDs, and did not contribute to improving human capital.

These analyses were further elaborated by using conditional growth analyses to disentangle linear growth from relative weight gain, above and beyond what would be predicted from a child's linear growth (7). The data from LMIC cohorts suggest that higher birth weight and fast linear growth—particularly in the first 2 y—had important positive effects on human capital and few adverse trade-offs in terms of NCD markers. Gaining weight faster than expected in terms of linear growth, on the other hand, not only did not contribute to future human capital but markedly increased the risk of NCD markers, particularly if this occurred after the age of 2 y. These conclusions are well in line with earlier results from the only randomized nutrition supplementation trial that followed up its participants until adulthood, the Guatemala Instituto de Nutrición de Centro America y Panama (INCAP) study (8).

Two main conclusions arise from these results. First, it does matter when rapid growth occurs. Second, looking solely at weight gain fails to separate 2 types of growth with different prognostic implications: linear growth and relative weight gains.

Do these findings apply to children from high-income countries? We don't know yet. Children in the LMIC cohorts suffered from a high prevalence of intrauterine growth retardation and stunting, which is not the case in present-day populations in high-income settings and in some middle-income countries as well. However, the nutritional situation of the cohort children is quite typical of what is happening currently in low-income countries where most of the world's children are born.

These findings have programmatic implications. Programs aimed at promoting weight gains in children >2 y—except of course in populations in whom wasting is prevalent—may do more harm than good.

Typically, as is the case for school feeding programs (9), such interventions lead to faster weight gain than is the case for linear growth, at an age range in which long-term risk of NCDs may be affected. The WHO is currently undertaking a review of the nutrition programs it promotes to assess whether these may be having such undesirable side effects.

The findings also have important research implications. Can we further improve nutrition programs so that these lead primarily to improving linear growth rather than increase weight for height? Which interventions—breastfeeding promotion, zinc supplementation, high quality proteins, etc.—are most likely to lead to fast linear growth?

Implications for monitoring and evaluation are important. Incorporating measurement of length or height in health services is not an easy task, but one should not rely solely on weight for

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monitoring the status of children and populations, nor for evaluating the impact of specific interventions.

Last, the days for carrying out nutritional studies with a single outcome are over. Recent research shows that in addition to considering the short-term effects of growth and nutritional status, it is important to measure outcomes later in childhood (e.g., psychomotor development) as well as long-term impact on human capital and risk of NCDs. As shown above, results may vary according to the indicator used. For example, being taller is systematically associated with increased blood pressure and the risk of some cancers (6), but tallness also relates positively to human capital (6) and is associated with lower overall mortality (10). Any study that makes recommendations on the basis of a single outcome will likely miss the full picture.

The topic of how shifts in the double burden of malnutrition will affect the long-term health and human capital of children from LMICs is a complex one. In particular, the age ranges in which the shift is most pronounced, and the characteristics of the shift, will define whether we can look forward to a healthier and more productive future generation or to one at higher risk of NCDs.

This supplement issue presents evidence of the coexistence of stunting and excess body weight at country and household levels and within the same individual in 8 of 9 Latin American countries for which information on the double burden is presented. The articles also inform that in most countries interventions and programs aimed at the prevention of stunting and other forms of undernutrition are in place. A few countries are also implementing policies to curb the obesity epidemic, but the strategies to prevent stunting and excess weight gain are unconnected in most countries. Only one country (Mexico) is slowly moving to integrated interventions during gestation and the first years of life that are aimed at promoting healthy growth, namely fostering linear growth without excessive weight for length gain, including monitoring both length and weight-for-length gains.

How can countries move to cohesive interventions to curb the double burden of malnutrition? On the one hand, research is needed to identify efficacious interventions for promoting healthy growth to inform programs and policies. On the other hand, programs that have already incorporated or will incorporate healthy growth promotion as an objective should be evaluated to identify their effectiveness in terms of multiple outcomes.

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