# The High Prevalence of Overweight and Obesity in Mexican Children

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**Abstract**

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***Objective:*** To establish the prevalence of overweight and obesity in Mexican children 10 to 17 years of age according to the percentiles from both the Centers of Disease Control and Prevention (CDC) and the International Obesity Task Force (IOTF).

***Research Methods and Procedures:*** Heights and weights were measured in children from nationally representative, randomly chosen households in the Mexican National Health Survey 2000. The study population consisted of 7862 boys and 8947 girls, 10 to 17 years of age. Measurements used were the percentage of children in the corresponding BMI categories for overweight and obesity specified by the CDC and the IOTF BMI percentiles.

***Results:*** The children were short, with mean Z scores for height by age varying from – 0.62 ± 1.26 to –1.12 ± 1.06 in boys and from –0.45 ± 1.25 to –1.19 ± 1.12 in girls. CDC-based overweight prevalences varied by age from 10.8% to 16.1% in boys and 14.3% to 19.1% in girls, with obesity prevalences from 9.2% to 14.7% in boys and 6.8% to 10.6% in girls; these prevalences did not relate to stunting. IOTF-based excess weight prevalences were similar, with higher overweight rates (boys, 15.4% to 18.8%; girls, 18.4% to 22.3%) but lower obesity rates (boys, 6.1% to 9%; girls, 5.9% to 8.2%).

***Discussion:*** Mexican children have one-half the overweight/obesity prevalences of U.S. Mexican-American children; however, there are higher rates in Northern Mexico, which is closer to the U.S. These escalating rates of excess weight demand new prevention, as well as management, policies.

**Key words: BMI, CDC and IOTF percentiles, children, Mexico**

## Introduction

Children's obesity is a global nutritional issue with an increasing prevalence. In the U.S., prevalences of overweight have been increasing progressively from 4% to 11% in 6 to 11 year olds between 1960 to 1970 and 1988 to 1994, with similar increases in children 12 to 19 years of age (5% to 11%) (1,2). By the 1999 to 2000 National Health and Nutrition Survey (NHANES),[1] the prevalences were even higher: 2 to 5 year olds, 10.4%; 6 to 11 year olds, 15.3%; 12 to 19 year olds, 15.5%. In the previous decade, these increases were up to 0.5% per annum (1,2). In the recent trend analyses, overweight was defined as ≥95th percentile for the age- and sex-specific BMI values published in the U.S. Growth Chart 2000, which was developed by the

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[1] Nonstandard abbreviations: NHANES, National Health and Nutrition Survey; CDC, Centers for Disease Control and Prevention; WHO, World Health Organization; IOTF, International Obesity Task Force; ENSA 2000, National Health Survey 2000.

Centers for Disease Control and Prevention (CDC). This chart used five nationally representative data sets from previous surveys, with only data from children below 6 years of age being used from the 1988 to 1994 NHANES III. Therefore, the BMI percentiles were not skewed too much because of the emergence of obesity (3).

Other U.S. authors have arbitrarily recommended the 85th and 95th percentiles of BMI for age and sex, based on NHANES data, as cut-off points to identify overweight and obesity, respectively (4). These cut-off points may not apply to other populations and were not based on selecting the point on the population distribution curve of BMIs at which the health risk of obesity starts to rise steeply (5).

Definitions of childhood overweight and obesity to match adult criteria have not yet been agreed on by the World Health Organization (WHO) (6), but a consensus has emerged to use the BMI transformation of weight and height in both clinical practice and epidemiology (4,5). The BMI values in children are lower than in adults, and interpretation of these values depends on the child's sex and age because this index changes substantially during child development. In many countries, BMI national reference data are favored (7), and the BMI values for the 85th and 95th percentiles for overweight and obesity, respectively, have often been selected (5). More recently, new international definitions of overweight and obesity have been proposed by the International Obesity Task Force (IOTF) based on specifying the age- and sex-specific cut-off points corresponding to those percentiles, which by the age of 18, pass through the WHO adult cut-off points of 25 and 30 $kg/m^2$ (6). Cole et al. (5) obtained an international basis for this analysis by using data sets from six large nationally representative cross-sectional growth studies (Brazil, Great Britain, Hong Kong, The Netherlands, Singapore, and the United States). They adjusted and smoothed the BMI distributions to allow their expression as sex- and age-specific percentiles. The six national curves were averaged to provide age- and sex-specific BMI cut-off points from 2 to 18 years of age, corresponding to the defined percentiles at 18 years.

Defining national prevalences of overweight and obesity in children is of obvious importance because it has been reported that more than 60% of obese children have one or more cardiovascular risk factors such as hyperinsulinemia, glucose intolerance, dyslipidemia, or hypertension. There is also a clustering of these risk factors with increases in BMI and body fat (8,9). Overweight children are known to have higher fasting glucose levels (10), and they produce more insulin after a glucose challenge (11). The impact of excess weight gain could be particularly important in Hispanic and African Americans, because healthy children from these ethnic groups are already reported to have lower insulin sensitivity than white children (12). The newly emerging and increasing incidence of type 2 diabetes in children and adolescents has also been ascribed to the high prevalence of obesity (10,11,13–15). Furthermore, if a child is obese at 6 years of age, the chances of becoming an obese adult are >50% (15), and if an adolescent is obese, their probability of becoming an obese adult rises to 70% (13). The dual effects of pre-existing morbidities and the probability of the excess weight persisting into adulthood markedly increase the risk of disease and premature death.

Given the emergence of a remarkably high prevalence of obesity in adult Mexicans (16,17), it becomes important to establish whether the same epidemic is affecting children. The Ministry of Health (Secretaría de Salud) in Mexico, therefore, decided to undertake a nationally representative survey in the year 2000 of children 10 to 17 years of age to assess their weight and health status. The results of this survey are presented here.

## Research Methods and Procedures

The National Health Survey 2000 (ENSA 2000) was based on a random sample of basic geographic statistical units obtained in each of the Mexican states and in the Federal District (Mexico City) from a database updated periodically by the Instituto Nacional de Geografía y Estadística (National Institute of Geography and Statistics). The issues to be included in the ENSA 2000, as well as the survey instruments, were defined based on the public health information requirements and the analysis of previous surveys.

The analysis unit was the household and its inhabitants. Subjects from 10 to 19 years of age in these households were randomly selected and interviewed. The probabilistic sampling in the ENSA 2000 survey required a survey that was stepped (i.e., involving the survey being conducted at different times in some states) and stratified (to take account of all states, the population urban–rural distribution, the inclusion of a minimum number of municipalities within a state, and all previously defined geographic areas). The procedures involved the identification of household clusters of an appropriate sample size to allow for a nonresponder rate of 30%, a minimum (prevalence) for any estimate of 5% for hypertension or diabetes, and a maximum relative error (i.e., error of precision in measurement) of 3%. Given these constraints, there was a selection of households on a proportional basis between urban and rural communities, with each Mexican state being part of the sampling scheme and with 14 municipal areas being selected within each state. Five geographic areas were identified within each municipality so that they had equivalent numbers of households. Then, three blocks per area were identified before selecting seven households per block. The number of households within each sampling area was always proportional to the distribution of household numbers.

The survey involved a specially trained nursing staff who were trained for 30 days in the selection and measurement procedures before undertaking a 5-day pilot study, which allowed further training and adjustment of procedures and techniques based on the pilot study. In all, 100 working teams were involved, with 20 teams per state evaluating, on average, four households per day over a total survey time of 5 months. Supervisors checked all data and questionnaires.

A total of 47,360 households, with 123,136 individuals, were identified. From these households, 21,390 adolescents (9929 boys and 11,461 girls) 10 to 17 years of age were studied. In practice, 17.4% of the total potential national sample was identified (compared with a value of 17.3% for the corresponding age group for the total Mexican population as defined by the 2000 census). However, in keeping with the expected issues in adolescent monitoring, 21.4% of the data had to be rejected as incomplete in relation to height or weight, with the occasional rejection of extraordinary values. In all, 7862 boys and 8947 girls had all the relevant data for analysis. All of the procedures were undertaken in accordance with the ethical standards of the Helsinki Declaration of 1975, as revised in 1983.

Demographic data were documented, and all children had their height (Estadimeter; SECA Productos, ADEX S.A. de C.V., Mexico) and weight (Solar Scale; Tanita Corp., Arlington Heights, IL) measured to the nearest 5 mm and 0.1 kg, respectively, with the child in light clothing and without shoes. BMI was calculated as the weight (kilograms) divided by the square of the height (meters squared).

Statistical analyses were performed using the SPSS 9.0 (SPSS Inc., Chicago, IL). All results are expressed as mean ± SD or as a percentage where appropriate. The IOTF percentiles were obtained from Cole et al. (5), with each measured value being compared with the corresponding integrated year-based value. Percentiles from CDC were obtained from the following website: www.cdc.gov/nchs/about/major/nhanes/growthcharts/bmiage.txt. All the fractional values of BMI for the range of BMIs in a complete year were averaged to obtain a mean value for all the children with that age in complete years. Flegal has recommended this standardization of data to compensate for the possible errors involved in taking mean values and complete years (18). The percentage of children in the overweight category in both IOTF and CDC methods were those with BMI values between the upper percentile limit for normal BMI and the percentile cut-off point for obesity.

In addition, the percentiles corresponding to BMIs of 25 and 30 kg/m$^2$ at 18 years in boys and girls were determined in a way similar to that used by Cole et al. (5).

## Results

Tables 1 and 2 show the number, mean weight, and mean height for each age group by sex, as well as the corresponding BMI percentiles for each age group.

Tables 3 and 4 show the prevalence of overweight and obesity in children specified according to the 85th and 95th percentile from CDC and in relation to the IOTF criteria, respectively. Using the CDC percentiles, overweight prevalences in the different age groups varied from 10.8% to 16.1% in boys and from 14.3% to 19.1% in girls, whereas obesity prevalences were from 9.2% to 14.7% in boys and from 6.8% to 10.6% in girls. Using the IOTF definitions, overweight prevalences in the different age groups varied from 15.4% to 18.8% in boys and from 18.4% to 22.3% in girls, whereas obesity prevalences were from 6.1% to 9% in boys and from 5.9% to 8.2% in girls. Thus, the IOTF criteria produced slightly higher prevalences of overweight and lower prevalences of obesity compared with the CDC 85th and 95th percentiles approach.

With the IOTF approach, the Mexican percentiles corresponding to a BMI of 25 kg/m$^2$ at 18 years of age were 71.5th for men and 70.5th for women compared with the six country IOTF estimates of the 90th percentile for men (national range, 81.9th to 95.3th) and the 89th (range, 89th to 94th) in women. Corresponding percentiles for a BMI of 30 kg/m$^2$ at 18 years in Mexico were 93.8th in men compared with the IOTF 98th percentile (national range, 97th to 99.9th) and 92.1th in Mexican women (IOTF; mean, 98th; range, 96th to 99.7th).

The mean Z scores for height were from −0.62 ± 1.26 to −1.12 ± 1.06 in boys and from −0.45 ± 1.25 to −1.19 ± 1.12 in girls. Because the prevalence of stunting may affect the prevalence of overweight and obesity, the percentage prevalences of stunting (defined as $Z < -2$ according to the current CDC stature for age growth charts) were assessed and ranged from 9.7% to 22.2% in the different age and sex groups. The older groups (14 to 17 years) had the higher prevalences. When those classified as stunted were assessed for their overweight and obesity, those in the younger age groups (10 to 13 years) had lower prevalences (i.e., of 9.8% to 16.6% overweight and 7.2% to 14.2% obesity rates), but in the older ages, the prevalences in the stunted children tended to be similar to those of normal height (data not shown).

Because the timing and stage of puberty may also influence the prevalence of overweight and obesity, analysis of pubertal status was warranted. Unfortunately, as in most large population studies, the children's pubertal stage was not determined, but the girls were asked whether they had begun to menstruate. Those girls of comparable age who had experienced menarche were taller, with higher BMIs; e.g., in those 10, 11, and 12 years of age who were already menstruating, their heights were greater, i.e., 142.6 ± 9.5, 148.2 ± 7.3, and 151.7 ± 7.0 cm compared with 142.6 ± 9.5, 148.2 ± 7.3, and 151.7 ± 7.0 cm, respectively, for those girls who had not menstruated ($p < 0.001$). The comparable greater BMI values were 19.3 ± 3.5, 20.9 ± 4.1, and 21.5 ± 4.2 kg/m$^2$ in the menstruating girls compared with 18.4 ± 3.6, 19.1 ± 4.1, and 19.0 ± 3.5 kg/m$^2$ in those had not had their menarche ($p < 0.01$). This agrees

**Table 1.** BMI percentiles in Mexican boys from 10 to 17 years of age

| | Age group (years) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | **10** | **11** | **12** | **13** | **14** | **15** | **16** | **17** |
| *n* | 1240 | 1153 | 1086 | 1042 | 927 | 924 | 729 | 761 |
| Mean ± SD weight | 35.8 ± 10.0 | 39.1 ± 10.7 | 43.4 ± 11.5 | 49.0 ± 12.7 | 55.0 ± 14.2 | 58.4 ± 13.0 | 61.8 ± 13.6 | 64.8 ± 13.8 |
| Mean ± SD height | 137.1 ± 8.1 | 141.8 ± 8.5 | 147.4 ± 9.3 | 154.3 ± 9.9 | 160.2 ± 9.5 | 164.3 ± 8.9 | 165.8 ± 8.5 | 168.1 ± 8.0 |
| Percentiles | | | | | | | | |
| 5 | 14.4 | 14.9 | 15.2 | 15.9 | 16.4 | 17.2 | 17.6 | 17.5 |
| 10 | 15.1 | 15.5 | 15.9 | 16.5 | 17.0 | 17.7 | 18.3 | 18.5 |
| 15 | 15.5 | 15.9 | 16.4 | 16.9 | 17.5 | 18.2 | 18.9 | 19.2 |
| 20 | 15.9 | 16.2 | 16.8 | 17.4 | 17.9 | 18.5 | 19.2 | 19.7 |
| 30 | 16.5 | 16.8 | 17.4 | 18.1 | 18.7 | 19.3 | 19.9 | 20.4 |
| 40 | 17.0 | 17.5 | 18.0 | 18.7 | 19.4 | 19.9 | 20.5 | 21.2 |
| 50 | 17.7 | 18.1 | 18.8 | 19.4 | 20.1 | 20.5 | 21.4 | 22.0 |
| 60 | 18.5 | 19.0 | 19.6 | 20.3 | 21.1 | 21.3 | 22.2 | 22.8 |
| 70 | 19.9 | 20.2 | 20.9 | 21.4 | 22.2 | 22.4 | 23.2 | 24.0 |
| 80 | 21.7 | 21.8 | 22.5 | 23.0 | 23.9 | 24.0 | 24.7 | 25.8 |
| 85 | 22.6 | 23.5 | 23.5 | 24.3 | 25.3 | 25.5 | 26.1 | 26.8 |
| 90 | 24.0 | 25.0 | 24.9 | 25.8 | 27.0 | 27.1 | 28.1 | 28.6 |
| 95 | 26.2 | 27.5 | 27.8 | 28.0 | 30.0 | 29.2 | 31.9 | 31.5 |
| 97.5 | 28.5 | 29.3 | 29.5 | 30.4 | 33.2 | 31.4 | 34.7 | 34.1 |

with previous reports that girls with greater early BMI gains in childhood have an earlier onset of puberty, with an earlier menarche. Such an early gain also tends to reduce their final height and is linked to higher risks of overweight (19).

The regional distribution of overweight and obesity in the different Mexican states is given in Table 5. Noteworthy is the fact that, when excess weight prevalences, i.e., including both overweight and obesity, are assessed with either CDC or IOTF criteria, children in the Metropolitan area of Mexico City and the Northern State, areas closest to the U.S., have the highest rates, whereas the Southern and Central states (with the higher rates of stunting in all age groups) have the lowest prevalences of excess weights. However, there were no differences in the estimated ages of menarche across Mexico; therefore, pubertal age does not seem to have confounded the geographic differences in the excess weights.

## Discussion

Childhood obesity has become a global health problem, so it is important to assess the problem as accurately as possible. Recently Flegal (18) highlighted the difficulties of standardizing the percentiles for children according to the different age groupings and advocated the use of values for groups comprising a whole year of age. In this study, therefore, we used data relating to complete years, e.g., with the age group of 7 corresponding to a range that goes from 7.0 to 7 years, 11 months, and 30 days.

### *Validity of Different Cut-off Points*

There is some debate about how to use the different criteria for defining overweight and obesity in children (7). In this study, IOTF definitions produce higher levels of overweight and lower levels of obesity than the CDC criteria, but when the total number of overweight and obese are considered together, the values are very similar, implying that it is the higher BMI cut-off point for obesity in the IOTF model compared with the CDC values that explains the difference. Understandably, authors wishing to emphasize the importance of this problem tend to favor systems that give higher values for the more extreme condition. Recently, Kain et al. (20) and Abrantes et al. (21), in Chile and Brazil, respectively, compared the prevalences of overweight and obesity using the same two criteria. When Kain related weight to height with WHO reference data and then compared CDC and IOTF criteria in children with a 6-year age range, the prevalences of those with excess weight were almost identical, but the IOTF criteria gave higher overweight but lower obese prevalences than the CDC values.

**Table 2.** BMI percentiles in Mexican girls from 10 to 17 years of age

| | Age group (years) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 |
| *n* | 1275 | 1182 | 1203 | 1207 | 1035 | 1011 | 953 | 1081 |
| Mean ± SD weight | 35.5 ± 9.3 | 41.0 ± 11.1 | 45.7 ± 11.4 | 49.6 ± 11.5 | 53.2 ± 11.5 | 55.0 ± 11.5 | 56.0 ± 11.0 | 56.7 ± 11.5 |
| Mean ± SD height | 137.7 ± 8.6 | 144.0 ± 8.3 | 148.9 ± 8.2 | 152.4 ± 7.3 | 154.3 ± 7.1 | 154.8 ± 7.6 | 155.2 ± 7.2 | 155.3 ± 7.3 |
| Percentiles | | | | | | | | |
| 5 | 14.3 | 14.7 | 15.4 | 15.9 | 17.1 | 17.8 | 18.1 | 18.0 |
| 10 | 14.9 | 15.4 | 16.2 | 17.0 | 17.9 | 18.6 | 19.0 | 19.3 |
| 15 | 15.4 | 16.0 | 16.8 | 17.6 | 18.5 | 19.2 | 19.5 | 19.8 |
| 20 | 15.8 | 16.3 | 17.3 | 18.1 | 19.1 | 19.7 | 19.9 | 20.4 |
| 30 | 16.4 | 17.2 | 18.0 | 18.9 | 19.9 | 20.6 | 20.9 | 21.1 |
| 40 | 17.0 | 18.0 | 18.8 | 19.7 | 20.8 | 21.5 | 21.7 | 22.1 |
| 50 | 17.6 | 18.7 | 19.7 | 20.5 | 21.6 | 22.2 | 22.5 | 22.9 |
| 60 | 18.4 | 19.7 | 20.5 | 21.5 | 22.4 | 23.0 | 23.4 | 23.7 |
| 70 | 19.6 | 20.8 | 21.8 | 22.5 | 23.6 | 24.1 | 24.5 | 24.7 |
| 80 | 21.1 | 22.2 | 23.2 | 24.0 | 24.9 | 25.4 | 26.1 | 25.9 |
| 85 | 22.2 | 23.4 | 24.1 | 25.2 | 26.1 | 26.6 | 27.1 | 27.2 |
| 90 | 23.3 | 24.9 | 25.8 | 27.0 | 27.8 | 28.2 | 28.9 | 28.7 |
| 95 | 25.2 | 27.1 | 28.0 | 29.2 | 30.2 | 30.9 | 31.1 | 31.1 |
| 97.5 | 27.5 | 30.2 | 30.1 | 31.6 | 33.1 | 33.6 | 33.8 | 34.3 |

Similarly, Abrantes et al., with data for 2- to 10-year-old Brazilian children, found lower rates of obesity using IOTF criteria, but the overall sensitivity for detecting the total number with excess body weights was similar with IOTF and CDC methodologies (22,23).

Reilly et al. (24), when assessing the validity of the cut-off point in relation to defined body fat percentages in 10-year-old children using independent measures of body fat, concluded that the IOTF overweight cut-off point had a sensitivity of 90% in boys and 97% in girls, with a speci-

**Table 3.** Prevalence (%) and 95% confidence intervals (CIs) of overweight in Mexican boys and girls according to both the CDC and the IOTF criteria

| | Boys | | | | Girls | | | |
|---|---|---|---|---|---|---|---|---|
| | CDC | | IOTF | | CDC | | IOTF | |
| Age (years) | % | 95% CI | % | 95% CI | % | 95% CI | % | 95% CI |
| 10 | 16.1 | (14.1 to 18.2) | 18.8 | (16.6 to 21.0) | 14.3 | (12.4 to 16.2) | 18.4 | (16.3 to 20.6) |
| 11 | 13.6 | (11.6 to 15.6) | 16.3 | (14.2 to 18.4) | 16.2 | (14.1 to 18.3) | 20.7 | (18.4 to 23.0) |
| 12 | 14.9 | (12.8 to 17.0) | 17.8 | (15.5 to 20.0) | 16.6 | (14.5 to 18.7) | 20.9 | (18.6 to 23.2) |
| 13 | 13.1 | (11.0 to 15.1) | 17.4 | (15.1 to 19.7) | 16.2 | (14.1 to 18.2) | 18.5 | (16.3 to 20.7) |
| 14 | 12.5 | (10.4 to 14.6) | 16.9 | (14.5 to 19.4) | 18.3 | (15.9 to 20.6) | 22.3 | (19.8 to 24.9) |
| 15 | 11.6 | (9.5 to 13.6) | 15.7 | (13.3 to 18.0) | 19.1 | (16.7 to 21.5) | 22.0 | (19.4 to 24.5) |
| 16 | 10.8 | (8.6 to 13.1) | 15.4 | (12.7 to 18.0) | 17.9 | (15.5 to 20.4) | 21.2 | (18.6 to 23.8) |
| 17 | 12.2 | (9.9 to 14.5) | 17.9 | (15.1 to 20.6) | 16.5 | (14.3 to 18.7) | 21.2 | (18.7 to 23.6) |

**Table 4.** Prevalence (%) and 95% confidence intervals (CIs) of obesity in Mexican boys and girls according to both the CDC and the IOTF criteria

| | Boys | | | | Girls | | | |
|---|---|---|---|---|---|---|---|---|
| | CDC | | IOTF | | CDC | | IOTF | |
| Age (years) | % | 95% CI | % | 95% CI | % | 95% CI | % | 95% CI |
| 10 | 14.7 | (12.7 to 16.6) | 9 | (7.4 to 10.5) | 9.4 | (7.8 to 11.0) | 6.1 | (4.8 to 7.4) |
| 11 | 14.4 | (12.4 to 16.4) | 8.9 | (7.3 to 10.6) | 10.4 | (8.7 to 12.1) | 6.4 | (5.0 to 7.8) |
| 12 | 11.2 | (9.4 to 13.1) | 7.3 | (5.7 to 8.8) | 10.1 | (8.4 to 11.8) | 5.9 | (4.6 to 7.2) |
| 13 | 11.1 | (9.2 to 13.0) | 6.6 | (5.1 to 8.1) | 10.6 | (8.9 to 12.3) | 7.9 | (6.4 to 9.4) |
| 14 | 11.8 | (9.7 to 13.8) | 8.2 | (6.4 to 10.0) | 10.4 | (8.6 to 12.3) | 6.5 | (5.0 to 8.0) |
| 15 | 9.2 | (7.3 to 11.1) | 6.1 | (4.5 to 7.6) | 9.1 | (7.3 to 10.9) | 7.4 | (5.8 to 9.0) |
| 16 | 10.2 | (8.0 to 12.3) | 8.2 | (6.2 to 10.2) | 8.9 | (7.1 to 10.7) | 8.2 | (6.4 to 9.9) |
| 17 | 9.9 | (7.7 to 12.0) | 7.6 | (5.7 to 9.5) | 6.8 | (5.3 to 8.4) | 7.1 | (5.6 to 8.7) |

ficity of 92% and 84%, respectively, but the obesity cut-off point was a poorer predictor of a substantial excess of body fat. This does not help discriminate the relative benefits of the IOTF or CDC measures but does question the robustness of the BMI index in children of high weight for heights for their age as a measure of fatness. Therefore, until more discerning weight-for-height criteria or other simple criteria based on health risks as well as body fat and its distribution can be developed, it would seem reasonable to focus on the total proportion of a population with weights in excess of the BMI overweight cut-off point (which gives comparable data by either CDC or IOTF methods) rather than emphasizing the distinction between overweight and obesity.

Clearly the choice of cut-off points relates essentially to their predictive value of a risk to health and well-being. Therefore, there is no intrinsic merit in having national reference growth curves; these were discarded by WHO when it was concerned about the differing national prevalences of childhood protein–energy malnutrition and stunting. It was soon recognized that these were not signifying

**Table 5.** Regional distribution of overweight and obesity (%) according to both the CDC and the IOTF criteria in children 10 to 17 years of age in the different Mexican regions*

| | Boys | | | Girls | | |
|---|---|---|---|---|---|---|
| | Total percent with excess weight | Overweight (%) | Obesity (%) | Total percent with excess weight | Overweight (%) | Obesity (%) |
| CDC criteria (3) | | | | | | |
| North | 29.6 | 14.9 | 14.7 | 30.2 | 17.2 | 13.0 |
| Central | 24.8 | 13.7 | 11.1 | 25.2 | 15.8 | 9.4 |
| Metropolitan | 28.6 | 16.1 | 12.5 | 30.1 | 19.4 | 10.7 |
| South | 19.7 | 10.7 | 9.0 | 23.7 | 17.4 | 6.3 |
| Total | 24.8 | 13.2 | 11.6 | 26.4 | 16.9 | 9.5 |
| IOTF Criteria | | | | | | |
| North | 29.4 | 19.0 | 10.4 | 31.1 | 21.6 | 9.5 |
| Central | 25.9 | 17.5 | 7.4 | 26.5 | 19.5 | 7.0 |
| Metropolitan | 28.5 | 20.3 | 8.2 | 31.6 | 23.8 | 7.8 |
| South | 20.0 | 14.4 | 5.6 | 24.9 | 20.5 | 4.4 |
| Total | 24.7 | 17.0 | 7.7 | 27.5 | 20.6 | 6.9 |

* The corresponding populations were adjusted to the age structure of the National Mexican Census 2000.

different genetically determined growth curves in different populations of children (25). Therefore, internationally based reference cut-off points for excess weight seem preferable for Mexico, and the IOTF method has the advantage of conceptual coherence with internationally accepted adult cut-off BMI values (26).

### *International Comparisons*

There are, however, advantages in the present context in also using the CDC reference base so that the major differences in prevalence between Mexican children in Mexico and their counterparts in the U.S. can be assessed. In the recent NHANES 1999 to 2000, the corresponding obesity prevalences in U.S. 12- to 19-year-old Mexican Americans were far higher (27.5% in boys and 19.4% in girls) than the national U.S. average of 15.5% (1) and greatly exceeded the prevalences in Mexico (9.2% to 11.8% in 12- to 17-year-old boys and 6.8% to 10.6% in 10- to 17-year-old girls). Thus, Mexican children in their own national environment have about one-half the prevalences of ethnically similar children in a U.S. setting.

### *Possible Confounders of Stunting and Pubertal Age*

Stunting may, by virtue of the shorter legs and longer trunk, tend to give higher BMI values in children as well as adults, but care is also needed because the Benn index of 2 is an arbitrary extension of the BMI measure from adults to children, and if the index were based on a nonheight relationship with weight, it would vary with age, particularly from 6 years of age onward (27). Because, however, the same index and percentile (but not BMI) cut-offs are used in practice at all ages with no discernible systematic amplification of excess weight prevalences at particular ages in Western populations, it seems reasonable to report these prevalences until more discerning criteria, e.g., of body fat, are available on a population basis. Clearly, in this study, the higher prevalences of stunting in the Central and Southern states are in keeping with malnutrition promoting circumstances, and the lower rates of excess weight reflect either the theoretical inappropriateness of the Benn index of 2 in shorter children or, more likely, that these children also live in a less excess weight–promoting environment. However, if these children grow to the heights of their short parents, their absolute requirement for energy will continue to be less than taller individuals of equivalent activity, and they may, therefore, become more prone to excess weight gain. The fact that older stunted children had similar overweight and obesity prevalences as their nonstunted colleagues emphasizes that the immediate environmental promoters of excess energy, and therefore weight gain, in adolescence are different from the longer-term promoters of height growth, e.g., animal protein intake and hygienic environments.

Because excess weight gain in 6 to 10 year olds is known to precipitate the early onset of puberty, we wanted to assess this phenomenon in our study population. In practice, the average age of menarche in girls in Mexico was 13.3 years in the years 1998 to 1999 (28), i.e., later than the age of 12.5 years seen in the U.S. in 1988 to 1994 (29). This difference should reduce not only the observed heights but also the BMIs of young adolescents in Mexico compared with the U.S. Clearly the amplification of excess weight in Mexican adolescents cannot be ascribed to an earlier onset of puberty in Mexico, but there is little information on the secular rate of change in the age of menarche. The failure to induce earlier menarche in overweight Mexican girls also shows that other environmental factors, e.g., including maternal nutritional signals affecting fetal programming, are also probably involved.

### *Secular Changes in Mexican Rates of Childhood Excess Weight*

Mexican prevalences of excess weight in children have almost certainly increased markedly recently, because for decades, the major pediatric concern in Mexico was the rate of malnutrition rather than obesity. Thus, the National Nutrition Surveys in 1988 focused only on protein–energy malnutrition (PEM) in preschool children (30). In 1996, however, a study of four poor Mexican rural communities was now showing that 17% of boys and 19% of girls aged $<$18 years were already classified as exceeding the same IOTF overweight cut-offs as used in this national survey (31), and by 1999, there was a limited National Nutrition Survey that included children 5 to 11 years of age. Using Must et al.'s definition of overweight derived from the 85th BMI percentile found in NHANES I, overweight prevalences averaged 25.7% (24.3% to 27.0% CI) in boys and 28.6% (27.3% to 29.9% CI) in girls. If we take only the children 10 and 11 years of age from this 1999 survey, the overweight prevalences for boys 10 and 11 years of age were 20.4% (17.3% to 23.5% CI) and 19.3% (16.5% to 22.2%), respectively, and for girls were 22.6% (18.7% to 26.5%) and 21.0% (17.1% to 24.9%). These values are not statistically different from our survey ($p > 0.05$), despite the different CDC reference criteria used in the two analyses.

The basis for this escalating problem of obesity has to be recognized, but detailed analyses of the factors involved on a national basis in Mexico are lacking. The current data on higher prevalences in the Metropolitan area and Northern State are in keeping with the impact of North American and other international foods and cultural interests promoting the use of energy-dense products in Mexico. The prevailing national perception of parents and their children seems to be that the availability of soft drinks and high-fat foods is a manifestation of improved circumstances and affluence, and there is little recognition of the hazards of overweight in either children or adults. Given the national decades-long concern to obtain enough food and to feed children adequately, it is little wonder that food consumption patterns have changed markedly over the last 10 years, with substantial increases in fat and sugar intakes (32), accompanied by an almost universal aspiration to own an automobile not only for convenience but as a manifestation of financial progress. Television ownership and television watching have also grown remarkably.

Given these cultural perceptions, the prevention and management of obesity in Mexico is going to be a major challenge. New initiatives are particularly important in Mexico because of the size of this adolescent population group. Adolescent numbers have doubled proportionately in the last 30 years from 11.4% of the total national population in the 1970s to 21.3%, i.e., 10.5 million adolescents (33). The future adult health burden in Mexico, therefore, looks grim, given the likelihood of overweight adolescents remaining overweight as they enter adulthood, with markedly increased risks of cardiovascular disease and type 2 diabetes.

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