Energy and nutrient intake in Mexican adolescents: Analysis of the Mexican National Health and Nutrition Survey 2006

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Abstract
Objective. To describe energy and nutrient intake and adequacy percentages in Mexican adolescents included in the Mexican National Health and Nutrition Survey 2006 (ENSANUT 2006) as well as the proportion of population at risk of dietary inadequacy. **Material and Methods**. Data were analyzed from 7-day food-frequency questionnaires for 8 442 male and female adolescents 12-19 years old. Energy and nutrient adequacies as percentage of the Estimated Average Requirement were calculated and comparisons were done by region, residence area, and socioeconomic status (SES). **Results**. Energy intake was 1903 kcal [adequacy percentage (AP=75%)] in boys, and 1 571 kcal (AP=79.2%) in girls. Intake of most nutrients (zinc, iron, vitamin C and A) was lower in subjects of low SES, living in the southern region and in rural areas. **Conclusions**. The rural area, the southern region, and the lower socioeconomic status show the lowest intakes and percentages of nutrient adequacy for both male and female adolescents, in particular vitamin A, folates, heme iron, zinc, and calcium.

Key words: adolescents; energy and nutrient intake; nutrition surveys; Mexico

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Resumen
Objetivo. Describir la ingestión y porcentajes de adecuación de energía y nutrimentos en adolescentes mexicanos que participaron en la Encuesta Nacional de Salud y Nutrición 2006 (ENSANUT 2006). **Material y métodos**. Se analizó la información de frecuencia de consumo de alimentos de 7 días de 8 442 adolescentes de uno u otro sexo, de entre 12 a 19 años de edad. Se calculó la adecuación de energía y nutrimentos utilizando el requerimiento promedio estimado y se hicieron comparaciones por región, área de residencia y estrato socioeconómico. **Resultados**. La ingestión energética fue de 1 903 kcal [porcentaje de adecuación (PA=75%)] en adolescentes del sexo masculino y de 1 571 kcal (PA=79.2%) en las de sexo femenino. La ingestión de varios nutrimentos (zinc, hierro, vitaminas C y A) fue más baja en los adolescentes de estrato socioeconómico bajo, en la región sur y en áreas rurales. **Conclusiones**. Las y los adolescentes que viven en área rural, en la región sur y que son de estrato socieconómico bajo presentan las ingestiones y porcentajes de adecuación de nutrimentos más bajos, en particular de vitamina A, folatos, hierro heme, zinc y calcio.

Palabras clave: adolescentes; energía y consumo de nutrimentos; encuestas de nutrición; México

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Mexico is undergoing a nutritional and epidemiological transition mainly affecting the early stages of life.[1] The coexistence of nutrient deficiencies and chronic degenerative diseases constitutes a challenge for public health decision makers.[2] Thus, the reason for analyzing the role of diet as a determinant of nutrition problems is to develop strategies that may lead to changes in dietary behaviors, which may contribute to the prevention and control of those public health problems.[3] A relationship between low micronutrient intake and linear growth retardation and anemia, among other morbidities, has been documented in children, adolescents and women of childbearing age.[4-6] On the other hand, a positive energy balance related to low physical activity and an intake of an energy-dense diet rich in processed or fast foods, high in fat and refined carbohydrates, and low in fiber and micronutrients result in excess weight both in early life stages (infancy and adolescence) and in adult life, a great public health concern due to its health consequences.[7,8] In addition, this type of diet is not only a causal factor of overweight and obesity but also of other chronic degenerative diseases.[9-11] Several socioeconomic, environmental and demographic factors affect food intake and hence dietary quality.[12] For example, it has been documented that Mexican women 12 to 49 years old and children 1 to 11 years old from low socioeconomic status living in rural areas in the southern region have the lowest percentages of micronutrient adequacy.[13-15]

Adolescence is defined by the World Health Organization as the period of human life between 10 and 19 years of age.[16] Adolescents experience a lower prevalence of infectious diseases compared to younger population groups and lower chronic degenerative disease rates compared to populations of adults and older adults.[17] Consequently, little attention has been paid to this population group regarding the assessment of its nutrition status, even though adolescents are prone to nutrition deficiencies, as their rapid growth demands a higher intake of energy and important nutrients like iron, calcium, zinc, vitamin A, vitamin C, and folate, among others.[18]

Data from the Mexican National Health and Nutrition Survey 2006 (ENSANUT 2006) showed a stunting prevalence of 12.3% in female adolescents 12 to 17 years old (estimate made with 1977 NCHS/WHO references) and an anemia prevalence of 11.5% in male and female adolescents aged 12 to 19 years.[19] The survey also revealed that one of each three adolescents is overweight or obese (both boys and girls aged 12 to 19 years).[19] It is therefore necessary to identify the dietary characteristics in this population group to develop nutrition strategies according to its needs.

The objective of this analysis was to describe the energy and nutrient intake and adequacy percentages in Mexican adolescents 12 to 19 years old who participated in the ENSANUT 2006, and the proportion of the population at risk of dietary inadequacy. A second goal was to analyze differences in intake and adequacy, and in the risk of nutrient inadequacy by age group, area, geographic region and socioeconomic status.

Material and Methods

Data were analyzed from ENSANUT 2006, a cross-sectional, probabilistic, national and state representative survey conducted from October 2005 to May 2006. The survey aimed to characterize health and nutrition status from different age groups in the Mexican population. A detailed description of sampling procedures was published by Olaiz *et al*.[20] The study population for this analysis consisted of Mexican adolescent boys and girls 12 to 19 years old.

Dietary information: A modified 7-day food-frequency questionnaire was used to estimate intake in adolescents. This questionnaire was already validated previously in other studies.[21] In this case, the amount of portions of consumed food was included to increase its precision. Data for consumed foods (those that represented 95% of the total consumption) from the 24-hour recall questionnaire were identified from the National Nutrition Survey 1999 (ENN-99),[22] obtaining a final list of 101 foods. Each adolescent was interviewed by personnel trained and standardized in data collection. Details about personnel training are found in the Procedure Handbook for Nutrition Projects developed by the National Institute of Public Health (INSP).[23] For each food, study participants were asked number of days of intake per week, times-a-day, portion size (very small, small, medium, large, and very large), and number of portions consumed. Conversion of daily food quantities into energy and nutrient units was done using a food composition table compiled by the INSP, which was used in ENN-99.* Intake of energy, carbohydrates, proteins, iron (total and heme), zinc, vitamin C, vitamin A, folates, calcium and fiber were analyzed. Adequacy percentage of the above dietary components was calculated as well. Reference data from the Estimated Average Requirement (EAR) recommended by the United

* Safdie M, Barquera S, Porcayo M, Rodríguez S, Ramírez C, Rivera J, et al. Bases de datos del valor nutritivo de los alimentos. Compilación del Instituto Nacional de Salud Pública. México, 2004 (Unpublished document).

States Institute of Medicine were used to calculate the adequacy percentages of proteins, total iron, zinc, vitamin C, vitamin A, folate, and calcium.[24-30] Values of 50 and 30% of energy intake from carbohydrates and fat, respectively, were used as suitable proportions of the total energy intake. For energy adequacy, reference data from the Estimated Energy Requirement (EER) recommended by the same institute was used.[31] For using the EER estimation equations a physical activity factor had to be included. Briefly, 326 observations (3.7%) were eliminated because the adequacy percentage of energy and/or adequacy percentages of some nutrients were above 5 SDs, or adequacy percentage of energy was lower than 25%. The data processing to obtain nutrients was done in Access (Microsoft Office, 2003) using the Visual Basic code and SQL queries. Data cleaning was performed with Stata version 9.2 (Stata Corporation, TX, USA), and SPSS version 15.0 (SPSS Inc., Chicago, IL, USA). More details about the processing of dietary information are available in the paper on methodological analysis of dietary data.[2]

Geographic region: The country was divided into four geographic regions: north, center, Mexico City (including its metropolitan area) and south.

Residence Area: For the analysis by type of residence area, urban locations were considered as those with ≥2500 inhabitants, and rural locations otherwise.

Socioeconomic status: An indicator of socioeconomic status (SES), or well-being was constructed through a principal components analysis.[32] It included variables related to housing conditions (such as flooring and roofing materials), ownership of home appliances (refrigerator, stove, washing machine, TV set, radio, videoplayer, telephone, and computer), and number of rooms (other than bathroom, kitchen, and corridors). The first component accounted for 46% of the total variance. The standardized factor obtained was divided into tertiles to present three SES categories: low, middle, and high.

Information on physiologic status of the adolescent girls was also obtained, which was categorized into nonpregnant, pregnant, breastfeeding, and pregnant-breastfeeding.

Informed consent was obtained from each subject or subject's parent or guardian for their participation in the study. The survey protocol was approved by the Ethics Committee of the National Institute of Public Health, Mexico.

Data analysis: Descriptive statistics of medians, 25 and 75 percentiles of intake, and adequacy of nutrients of interest were obtained. The prevalence of population at risk of dietary inadequacy was estimated. Those subjects whose intake was below 100% of the recommended were considered at risk of deficiency for that particular nutrient.

Differences among geographic regions, residence areas, and SES categories were analyzed and *p* value was adjusted by multiple comparisons (Bonferroni adjustment).[33] Continuous dietary variables do not have normal distributions and logarithmic transformations were performed. Differences between categories were conducted with *t* tests. In addition, differences in the prevalence of populations at risk of inadequate intake (adequate intake<100%) among residence areas, regions, and socioeconomic status were analyzed through χ^2 test.

Analyses were conducted using the Stata 9.0 program *SVY* module for survey data to adjust for the expansion factor and the design effect.

Results

Data from 8 442 Mexican adolescents (4 130 boys and 4 312 girls) aged 12 to 19 years old were analyzed, representing 18 276 531 individuals nationwide, by applying the expansion factor.

Mean age was 15.16 ± 2.2 years. Roughly 74% belonged to urban areas; about 30% lived in the center of the country and another 30% in the south (Table I). Most female adolescents were not pregnant (98.4%), only 1.6% was pregnant or pregnant and breastfeeding.

With regard to dietary information, 11.6% of energy intake was derived from protein, 27.7% from fat, and 62.4% from carbohydrate intake in both male and female adolescents.

Table II shows intake and energy and nutrient adequacy percentages by sex and residence area. Median energy intake in boys was higher in urban than in rural areas (1 943 kcal *vs*. 1 776 kcal ($p< 0.05$)). Fiber intake varied from 20 g in the urban to 22.8 g in the rural areas, with statistically significant difference between areas ($p< 0.05$). Protein and fat intakes were higher in the urban than in the rural areas; the same pattern was observed for the micronutrients analyzed (vitamins A and C, folates, iron, zinc, and calcium). Heme iron intake was higher in the urban (0.33 mg) than in the rural areas (0.18 mg) ($p< 0.05$), corresponding to 2.8% and 1.5% of total iron, respectively.

Energy intake was 1 571 kcal for female adolescents, and it was higher in urban than in rural areas (1 613 kcal *vs*. 1 470 kcal, respectively ($p< 0.05$)). Fiber intake ranged from 16 g in urban to 18.7 g in rural areas ($p< 0.05$). Protein (47 g) and total fat (51.5 g) intakes were higher in urban than in rural areas (protein 41.8 g, and

Table I
GENERAL CHARACTERISTICS OF MEXICAN ADOLESCENTS BY SEX

	National‡	Males§	Females#
Age (years)*	15.16±2.2	15.05±2.2	15.27±2.2
Geographic region (%)			
North	18.6	18.8	18.4
Center	32.6	31.7	33.6
Mexico City	15.8	15.8	15.8
South	33.0	33.7	32.3
Residence area (%)			
Urban	73.7	74.4	73.1
Rural	26.3	25.6	26.9
Socioeconomic status (%)&			
Low	36.0	36.2	35.8
Middle	34.2	33.5	34.8
High	29.8	30.3	29.4
Physiologic status (%) ≠			
Nonpregnant	-	-	98.4
Pregnant	-	-	1.4
Breastfeeding	-	-	0
Pregnant and breastfeeding	-	-	0.2

* Mean± SD
‡ Sample size:8 442, expansion factor: 18 276 531
§ Sample size:4 130, expansion factor: 9 125 173
# Sample size:4 312, expansion factor: 9 151 358
& 28 observations without available information
≠ 39 observations without available information

total fat 39.5 g, $p< 0.05$). In general, the urban area had a higher micronutrient intake than the rural area. For example, heme iron intake was 0.28 mg in urban and 0.15 mg in rural areas ($p< 0.05$).

Table III shows intake and adequacy percentages by geographic region and sex. In male adolescents, the highest energy intake and adequacy was observed in the north (2 002 kcal), followed by those in the center (1 917 kcal) and Mexico City (1 914 kcal), and the lowest was registered in the south (1 816 kcal). Fiber intake was higher in the center and in the south. The highest vitamin A intake was in Mexico City and the highest vitamin C intake was in the center. Folate intake was higher in the northern and central regions. Total iron and zinc intakes were higher in the northern region; the same occurred with heme iron.

In female adolescents, the highest energy intake was observed in Mexico City (1 648 kcal), followed by the northern and central regions (1 645 kcal and 1 549 kcal, respectively), and the lowest intake occurred in the southern region (1 495 kcal). Fiber intake was higher in the central and southern regions. Vitamin A intake was higher in the Mexico City region and vitamin C intake was higher in the central region. Folates, total iron, and zinc intakes were higher in the northern region. Calcium intake was higher in the Mexico City region than in the other regions.

Intake and nutrient adequacy by sex and by SES categories is presented in Table IV. For male adolescents, the lowest energy intake was reported in the low compared with the middle and high SES groups ($p< 0.016$). The lowest quantity of fiber was reported in the high SES ($p< 0.016$, compared with the other two groups). Intakes of protein and fat were higher in the high SES ($p< 0.016$). Intakes of vitamins A and C were also higher in the high than in the middle and low SES groups ($p< 0.016$). Intake of folates was higher in the middle than in the low SES group ($p< 0.016$). Intakes of heme iron, as an indicator of meat intake, was higher in the high SES than in the middle and low SES groups ($p< 0.016$). The same pattern was observed for zinc intake, which was higher in the high SES than in the other two strata.

In both female and male adolescents, the lowest energy intake and the greatest fiber intake were reported in the lower SES, with a statistically significant difference compared with the middle and high SES categories ($p< 0.016$). Intakes of protein and total fat were higher in the high than in the middle and low SES groups ($p< 0.016$); the same happened with intakes of vitamins A and C ($p<0.016$). Folate intake was lower in the low SES ($p< 0.016$). Intake of heme iron was higher in the high SES than in the middle and low SES groups ($p< 0.016$). The same pattern was observed for zinc, its intake being higher in the high than in the other two categories of SES ($p< 0.016$). Calcium quantity was lower in the low and middle than in the high SES groups ($p< 0.016$).

Table V shows the prevalence of population at risk of dietary inadequacy by different characteristics. For male adolescents in rural areas, a higher risk was found of inadequate intake of vitamin A, folates and zinc as compared with boys in urban areas ($p< 0.05$). For female adolescents in rural areas, there was also a higher prevalence of risk of inadequate intakes of energy, protein, vitamin A, vitamin C, folates, and zinc compared with girls in urban areas ($p< 0.05$). In general, the southern region presented the highest prevalences of population at risk of dietary inadequacy in both male and female adolescents. By socioeconomic status, the lowest category presented the highest prevalences of

Table II

Intake and energy and nutrient adequacy by sex and residence area in Mexican adolescents. Mexico, ENSANUT 2006

		Residence area	
	National‡	*Urban*	*Rural*
Males§			
Intake	Median (25, 75)	Median (25, 75)	Median (25, 75)
Energy (kcal)*	1 903 (1484, 2540)	1 943 (1484, 2605)	1 776 (1268, 2462)
Fiber (g)*	20.6 (14.8, 29.2)	20.09 (14.3, 27.7)	22.8 (16.7, 31.8)
Protein (g)*	55.3 (40.9, 75.8)	57.0 (42.6, 76.9)	50.1 (35.9, 68.2)
Total fat (g)*	57.5 (38.5, 82.1)	62.6 (42.0, 85.6)	45.2 (30.3, 65.5)
Carbohydrates (g)	292.7 (215.7, 392.1)	292.8 (218.9, 390.9)	291.6 (207.3, 392.1)
Vitamin A (μg ER)*	430.4 (249.5, 710.9)	458.1 (268.8, 748.7)	351.1 (187.4, 605.7)
Vitamin C (mg)*	70.6 (35.3, 127.4)	73 (37.1, 128.7)	62.8 (31.4, 120.7)
Folates (μg)*	232.1 (163.1, 319.6)	240.9 (172.9, 326.7)	208.2 (148.2, 299.9)
Total iron (mg)	12.4 (8.8, 16.5)	12.5 (8.9, 16.4)	12.1 (8.3, 16.8)
Heme iron (mg)*	0.29 (0.13, 0.54)	0.33 (0.17, 0.60)	0.18 (0.07, 0.35)
Zinc (mg)*	7.8 (5.7, 10.8)	8.0 (5.9, 10.9)	7.1 (4.9, 9.9)
Calcium (mg)	887.2 (612.8, 1284)	891.4 (624.4, 1297.7)	867.9 (597.5, 1231.5)
Adequacy percentage (%)			
Energy	75.0 (55.6, 100.6)	75.7 (56.6, 100.4)	73.0 (51.8, 101.5)
Protein*	142.5 (99.8, 201.7)	147.4 (99.9, 203.7)	130.5 (94.6, 193.0)
Total fat*	67.5 (45.5, 94.9)	71.4 (49.5, 99.4)	55.7 (37.5, 84.0)
Carbohydrates*	91.5 (67.1, 125.4)	90.1 (66.9, 121.7)	94.7 (68.6, 134.0)
Vitamin A *	75.4 (42.5, 131.0)	79.3 (45.8, 135.9)	62.9 (33.7 113.2)
Vitamin C	124.4 (63.5, 245.3)	125.5 (64.5, 247.9)	117.5 (57.4, 235.7)
Folates *	77.2 (54.5,107.0)	78.6 (55.9, 107.9)	72.5 (47.8, 101.2)
Total iron	177.7 (124.3, 240.3)	178.7 (125.5, 237.7)	175.3 (119.3, 253.0)
Zinc *	95.3 (70.0, 132.9)	97.6 (71.8, 134.6)	87.7 (63.5, 125.9)
Calcium	70.2 (47.9, 100.8)	70.7 (48.7, 102.3)	67.7 (46.3, 96.1)
Females#			
Intake			
Energy (kcal)*	1 571 (1 171, 2090)	1 613 (1 212.7, 2 143)	1 470 (1 086, 1 954)
Fiber (g)*	16.9 (12.1, 23.1)	16 (11.6, 22.3)	18.7 (13.9, 25.9)
Protein (g)*	45.6 (33.2, 62.1)	47.0 (34.6, 63.7)	41.8 (30.5, 56.6)
Total fat (g)*	48.3 (31.6, 67.3)	51.5 (34.8, 70.2)	39.5 (25.4, 56.5)
Carbohydrates (g)	239.0 (180.5, 320.3)	237.1 (181.6, 320.8)	242.5 (175.5, 317.8)
Vitamin A (μg ER)*	410.3 (224.9, 653.9)	441.3 (247.6, 691.9)	325.9 (176.1, 545.6)
Vitamin C (mg)*	68.7 (33.4, 119.5)	70.6 (34.7, 123.7)	60.2 (29.9, 111.4)
Folates (μg)*	190.6 (133.3, 260.8)	197.5 (137.8, 266.6)	176.3 (122.2, 245.5)
Total iron (mg)	9.9 (7.2, 13.8)	9.9 (7.2, 13.8)	9.9 (7.2, 13.6)
Heme iron (mg)*	0.24 (0.11, 0.44)	0.28 (0.14, 0.47)	0.15 (0.06, 0.32)
Zinc (mg)*	6.4 (4.7, 8.6)	6.6 (4.8, 8.7)	5.9 (4.3, 7.8)
Calcium (mg)*	739.6 (511.9, 1067.9)	749.1 (519.7, 1090.3)	718.5 (480, 988.9)
Adequacy percentage (%)			
Energy*	79.2 (58.5, 106.0)	80.1 (59.6, 107.6)	77.6 (56.8, 101.0)
Protein*	129.9 (92.3, 181.4)	132.8 (95.8, 186.3)	121.9 (85.9, 172.1)
Total fat*	72.8 (48.2, 138.1)	77.9 (52.8, 107.5)	61.1 (39.5, 87.3)
Carbohydrates	97.1 (72.5, 130.8)	95.5 (72.5, 129.7)	99.6 (72.5, 133.6)
Vitamin A*	87.5 (48.7, 139.1)	93.0 (53.1, 148.3)	70.2 (40.1, 118.8)
Vitamin C*	131.7 (65.5, 238.7)	136.7 (68.1, 243.5)	119.4 (58.0, 225.9)
Folates*	62.3 (43.0, 87.4)	63.3 (44.3, 88.9)	57.7 (40.2, 83.4)
Total iron	136.1 (97.5, 193. 6)	135.3 (95.9, 193.0)	136.9 (99.1, 195.2)
Zinc*	89.5 (65.6, 121.5)	92.2 (67.1, 124.2)	81.8 (59.0, 109.9)
Calcium*	58.4 (40.1, 84.3)	59.1 (41.3, 86.1)	55.8 (37.3, 77.7)

* Statistically significant differences ($p < 0.05$) between rural and urban area
‡ Sample size: 8 442, expansion factor: 18 276 531
§ Sample size: 4 130, expansion factor: 9 125 173
\# Sample size: 4 312, expansion factor: 9 151 358

Table III

INTAKE AND ENERGY AND NUTRIENT ADEQUACY BY SEX AND GEOGRAPHIC REGION IN MEXICAN ADOLESCENTS. MEXICO, ENSANUT 2006

	Geographic region			
	North[∞]	*Center*[ø]	*Mexico City*[◊]	*South*[€]
Males				
Intake	Median (25, 75%)	Median (25, 75%)	Median (25, 75%)	Median (25, 75%)
Energy (kcal)[§]	2 002 (1 487, 2 698)	1 917 (1 458, 2 567)	1 914 (1 484, 2 398)	1 816 (1 339, 2459)
Fiber (g)[*,§,#]	19.7 (13.2, 27.4)	22.2 (16.3, 30.5)	17.6 (13.1, 24.7)	21.2 (15.5, 30.3)
Protein (g)[§]	59.6 (43.3, 81.3)	56.6 (40.4, 74.8)	54.9 (44.1, 75.1)	51.7 (38.1, 72.0)
Total fat (g)[*,§,&,≠]	68.3 (47.92, 93.18)	57.3 (38.1, 82.1)	64.1 (43.1, 81.6)	49.4 (32.0, 73.5)
Carbohydrates (g)	290.5 (211.4, 394.3)	295.8 (219.2, 391.8)	284.7 (205.4, 369.6)	295.0 (215.8, 400.1)
Vitamin A (µg ER)[‡,#,≠]	384.4 (226.7, 643.3)	419.3 (232.7, 700.3)	601.6 (335.8, 856.6)	422.9 (237.9, 684.9)
Vitamin C (mg)	65.4 (31.9, 114.0)	73.9 (34.5, 137.8)	72.2 (40.8, 145.2)	69.8 (34.6, 120.6)
Folates (µg)[*,§,&]	266.2 (187.2, 369.8)	240.9 (170.4, 325.9)	221.6 (159.7, 289.1)	212.2 (151.7, 296.7)
Total iron (mg)[‡]	13.0 (9.5, 17.38)	12.1 (9.0, 16.9)	12.3 (8.5, 14.8)	12.2 (8.5, 16.4)
Heme iron (mg)[*,§,&,≠]	0.43 (0.22, 0.75)	0.28 (0.13, 0.56)	0.34 (0.16, 0.58)	0.29 (0.10, 0.43)
Zinc (mg)[§,&]	8.5 (6.1, 11.4)	8.1 (5.7, 10.9)	7.6 (5.9, 10.5)	7.7 (5.7, 10.8)
Calcium (mg)[*]	809.4 (575.6, 1216.8)	905.5 (638.8, 1274.5)	947.4 (665.5, 1297.7)	887.1 (612.8, 1284.0)
Adequacy percentage (%)				
Energy	75.8 (58.1, 101.6)	75.7 (56.8, 102.6)	73.2 (55.1, 95.3)	73.6 (54.0, 99.2)
Protein[§]	155.6 (103.7, 203.2)	147.2 (100.1, 206.6)	136.0(99.8, 207.1)	134.1 (96.2, 194.6)
Total fat[*,§,&,≠]	76.9 (54.7, 108.5)	66.9 (44.3, 96.1)	69.4 (50.0, 101.3)	59.4 (39.2, 87.5)
Carbohydrates[§]	88.3 (66.1, 120.5)	92.8 (67.4, 128.3)	85.1 (66.8, 116.1)	95.2 (69.3, 128.4)
Vitamin A[‡,#,≠]	66.0 (39.7, 115.7)	73.6 (42.7, 130.6)	105.5 (53.3, 157.3)	73.5 (39.6, 121.7)
Vitamin C	116.6 (55.7, 203.8)	126.1 (60.7, 252.5)	136.7 (64.9, 283.8)	124.8 (65.4, 227.3)
Folates[§,&]	88.0 (60.0, 121.6)	78.7 (58.3, 107.4)	70.3 (52.6, 100.4)	71.3 (48.8, 102.0)
Total iron	184.5 (134.9, 254.4)	179.5 (127.0, 248.2)	170.7 (117.6, 225.8)	175.4 (121.4, 236.8)
Zinc[§,&]	105.0 (74.2, 141.7)	97.0 (70.2, 134.3)	95.4 (71.4, 130.9)	91.7 (65.9, 125.9)
Calcium	63.6 (44.2, 96.6)	71.0 (49.6, 102.0)	73.6 (52.0, 100.8)	69.8 (46.8, 101.4)
Females				
Intake				
Energy (kcal)[§]	1 645 (1 183, 2 236)	1 549 (1 198, 2 074)	1 648 (1 213, 2 263)	1 495 (1 111, 1 991)
Fiber (g)[*,#,≠]	15.9 (11.7, 22.2)	17.9 (13.0, 24.1)	15.1 (9.9, 21.5)	17.3 (12.1, 24.0)
Protein (g)[§]	48.3 (33.8, 66.8)	45.1 (32.9, 59.8)	47.3 (35.9, 64.6)	43.4 (31.4, 59.5)
Total fat (g)[*,§,&,≠]	55.7 (38.6, 80.0)	47.0 (32.7, 64.0)	55.9 (35.3, 75.6)	41.9 (26.5, 60.0)
Carbohydrates (g)	237.6 (169.8, 323.7)	238.4 (187.0, 320.8)	237.0 (178.9, 318.3)	241.1 (180.3, 317.6)
Vitamin A (µg ER)[‡,#,≠]	383.2 (219.7, 576.7)	397.6 (223.6, 650.7)	497.1 (295.2, 736.7)	395.1 (206.3, 654.2)
Vitamin C (mg)[*,&]	59.8 (30.4, 104.7)	72.6 (38.0, 132.7)	72.9 (34.5, 128.8)	61.2 (30.5, 116.3)
Folates (µg)[*,‡,§,&]	214.5 (151.1, 293.0)	194.9 (144.1, 266.5)	189.8 (127.4, 257.1)	175.7 (116.6, 247.5)
Total iron (mg)[*,‡,§]	10.8 (8.0, 15.4)	10.0 (7.4,13.5)	9.2 (6.6, 13.3)	9.8 (6.9, 13.3)
Heme iron (mg)[*,§,≠]	0.33 (0.17, 0.55)	0.23 (0.10, 0.44)	0.28 (0.18, 0.42)	0.20 (0.09, 0.38)
Zinc (mg)[§,&]	6.8 (4.8, 9.6)	6.4 (4.7, 8.5)	6.5 (4.7, 8.5)	6.0 (4.4, 8.3)
Calcium (mg)[*,‡,&,≠]	686.9 (486.0, 968.4)	774.3 (546.6, 1072.7)	811.6 (568.2, 1163.7)	708.4 (474.0, 1044.3)
Adequacy percentage (%)				
Energy	80.7 (60.0, 109.8)	78.7 (58.5, 104.1)	82.6 (59.6, 106.9)	77.9 (57.5, 105.5)
Protein[§]	133.4 (96.6, 191.3)	128.3 (92.6, 176.3)	136.8 (95.6, 186.2)	126.3(87.7, 176.1)
Total fat[*,§,&,≠]	82.4 (57.1, 117.1)	71.5 (49.3, 95.5)	83.2 (53.6, 110.2)	65.5 (41.5, 92.8)
Carbohydrates	94.3 (68.8, 127.3)	96.7 (73.5, 128.5)	95.0 (74.0, 132.0)	100.0 (73.8, 135.3)
Vitamin A[‡,$,≠]	82.1 (45.8, 121.6)	85.2 (46.6, 135.4)	104.4 (64.9, 152.4)	86.8 (46.5, 139.1)
Vitamin C[*,&]	119.7 (61.9, 209.0)	152.3 (74.9, 265.1)	139.3 (68.1, 244.5)	123.1 (59.9, 230.9)
Folates[‡,§,&]	69.1 (47.9, 98.8)	63.0 (47.9, 90.2)	60.1 (38.6, 80.9)	58.4 (38.3, 82.0)
Total iron[‡,§]	153.8 (104.4, 206.5)	138.0 (101.5, 190.2)	120.6 (88.5, 184.3)	133.2 (93.6, 192.0)
Zinc[§,&]	95.1 (67.1, 137.0)	90.7 (67.5, 118.8)	89.9 (66.7, 122.8)	83.8 (61.2, 116.2)
Calcium[*,‡,&,≠]	54.4 (38.3, 75.7)	61.5 (43.4, 83.5)	64.7 (45.4, 95.6)	55.8 (36.8, 81.0)

[*] Statistically significant differences ($p < 0.012$) between northern and central region
[‡] Statistically significant differences ($p < 0.012$) between northern region and Mexico City
[§] Statistically significant differences ($p < 0.012$) between northern and southern region
[#] Statistically significant differences ($p < 0.012$) between central region and Mexico City
[&] Statistically significant differences ($p < 0.012$) between central and southern region
[≠] Statistically significant differences ($p < 0.012$) between Mexico City and southern region
[∞] Sample size: 1 415, expansion factor: 3 396 442
[ø] Sample size: 3 270, expansion factor: 5 962 969
[◊] Sample size: 335, expansion factor: 2 883 903
[€] Sample size: 3 422, expansion factor: 6 033 217

Table IV
Intake and energy and nutrient adequacy by sex and socioeconomic status categories in Mexican adolescents. Mexico, ENSANUT 2006

	Socioeconomic status[∞]		
	Low[#]	*Middle*[&]	*High*[≠]
Males			
Intake	Median (25, 75%)	Median (25, 75%)	Median (25, 75%)
Energy (kcal)*,‡	1 775 (1 240, 2 428)	1 920 (1 458, 2 605)	2 013 (1 598, 2 627)
Fiber (g)‡,§	21.5 (15.3, 31,3)	21.5 (15.5, 29.4)	19.0 (13.2, 25.9)
Protein (g)*,‡,§	50.1 (34.7, 68.7)	55.8 (40.9, 78.7)	60.7 (45.2, 79.0)
Total fat (g)*,‡,§	45.5 (31.1, 70.9)	59.6 (38.7, 84.2)	68.6 (50.6, 90.1)
Carbohydrates (g)	290.3 (201.2, 397.4)	302.6 (218.5, 398.6)	286.1 (222.2, 383.4)
Vitamin A (µg ER)*,‡,§	340.8 (189.8, 594.5)	454.9 (251.9, 733.2)	499.3 (326.8, 806.7)
Vitamin C (mg)‡,§	57.1 (29.4, 116.9)	72.0 (35.8, 124.4)	84.3 (42.9, 145.3)
Folates (µg)*,‡	212.7 (144.7, 296.9)	245.5 (187, 333.9)	240.6 (173.9, 325.3)
Total iron (mg)	11.9 (8.2, 16.6)	12.4 (8.8, 16.6)	12.8 (9.5, 16)
Heme iron (mg)*,‡,§	0.18 (0.07, 0.39)	0.29 (0.15, 0.56)	0.43 (0.24, 0.74)
Zinc (mg)*,‡	7.1 (4.9, 9.9)	7.9 (5.8, 11)	8.4 (6.5, 11.1)
Calcium (mg)	855.2 (565.2, 1227.4)	886.5 (624.4, 1222)	942 (680.6, 1375.7)
Adequacy percentage (%)			
Energy	73.6 (51.3, 100.0)	73.5 (56.1, 102.9)	76.9 (59.0, 99.9)
Protein*,‡	129.5 (92.1, 183.3)	146.3 (100.3, 203.2)	156.1 (103.1, 212.4)
Total fat*,‡,§	56.8 (38.1, 86.6)	70.5 (46.2, 95.2)	76.3 (55.5, 102.7)
Carbohydrates	93.8 (66.5, 132.8)	93.3 (67.8, 123.6)	86.9 (66.8, 115.8)
Vitamin A*,‡	62.1 (33.4, 109.6)	80.4 (44.1, 138.9)	87.1 (52.8, 145.2)
Vitamin C‡	108.2 (54.5, 220.3)	125.5 (64.1, 237.2)	143.1 (75.4, 264.3)
Folates*,‡	70.3 (47.2, 103.9)	82.3 (60.5, 112.2)	77.3 (54.8, 106.9)
Total iron	173.0 (118.4, 233.5)	177.1 (126.7, 244.4)	180.8 (130.3, 238.2)
Zinc*,‡	90.3 (62.2, 123.7)	96.4 (71.4, 133.5)	102.4 (78.9, 141.6)
Calcium‡	66.4 (43.9, 95.7)	69.8 (48.7, 98.1)	75.8 (53.1, 107.8)
Females			
Intake			
Energy (kcal)‡	1 479 (1 096, 2 036)	1 573 (1 190, 2 030)	1 712.9 (1 233.4, 2200)
Fiber (g)*,‡	18.4 (13.5, 26.5)	16.9 (12.0, 22.4)	15.4 (11.3, 21.5)
Protein (g)‡,§	42.6 (30.9, 58.9)	45.4 (33.1, 60.8)	49.6 (37.7, 68.5)
Total fat (g)*,‡,§	39.6 (26.1, 57.5)	49.2 (33.7, 67.3)	56.4 (40.5, 76)
Carbohydrates (g)	242.2 (179.7, 332.5)	237.1 (182.9, 311.3)	239.7 (180.9, 320.3)
Vitamin A (µg ER)*,‡,§	330.9 (176.1, 584.7)	410.5, 236.4, 631.8)	478.8 (304.9, 736.8)
Vitamin C (mg)*,‡	57.2 (27.5, 103.9)	72.1 (35.4, 136.6)	77.9 (39.3, 129.9)
Folates (µg)*,‡	178.7 (122.1, 253.9)	198.2 (133.7, 267)	199.8 (150.2, 260.8)
Total iron (mg)	10.0 (7.1, 14.0)	9.5 (7.1, 13.7)	10.2 (7.6, 13.7)
Heme iron (mg)*,‡,§	0.16 (0.07, 0.33)	0.24 (0.12, 0.42)	0.36 (0.21, 0.57)
Zinc (mg)‡,§	6 (4.7, 8.6)	6.2 (4.7, 8.6)	7 (5.2, 9.4)
Calcium (mg)‡,§	727.9 (479.1, 1029.1)	726.1 (503.6, 1040.3)	789.8 (554.3, 1121.8)
Adequacy percentage (%)			
Energy‡	77.9 (57.0, 106.0)	78.1 (59.6, 102.4)	83.9 (60.6, 113.6)
Protein‡,§	124.9 (84.6, 174.5)	127.2 (90.9, 176.3)	138.9 (103.4, 192.3)
Total fat*,‡,§	62.4 (41.3, 89.3)	73.7 (51.1, 101.9)	85.9 (60.3, 114.9)
Carbohydrates	100.0 (73.9, 138.2)	94.6 (72.4, 127.6)	97.4 (70.3, 127.1)
Vitamin A*,‡,§	73.4 (39.1, 127.7)	87.8 (48.9, 135.4)	98.6 (64.5, 154.9)
Vitamin C*,‡	113.3 (54.0, 210.2)	141.6 (69.8, 258.3)	149.6 (73.6, 254.2)
Folates‡	57.7 (39.8, 85.1)	64.0 (41.8, 89.6)	63.4 (48.3, 87.0)
Total iron	137.4 (97.7, 195.7)	133.1 (92.9, 189.9)	134.7 (100.1, 193.8)
Zinc‡,§	84.4 (59.1, 113.0)	87.1 (63.8, 119.7)	96.6 (71.9, 129.3)
Calcium‡,§	57.5 (37.8, 81.5)	56.9 (39.3, 81.2)	63.1 (43.7, 87.9)

* Statistically significant differences (p <0.016) between low and middle socioeconomic strata
‡ Statistically significant differences (p <0.016) between low and high socioeconomic strata
§ Statistically significant differences (p <0.016) between middle and high socioeconomic strata
# Sample size: 4 087, expansion factor: 6 538 931
& Sample size: 2 758, expansion factor: 6 208 047
≠ Sample size: 1 569, expansion factor: 5 425 516
∞ 28 observations without available information

Table V

PREVALENCE OF DIETARY INADEQUACY BY SEX IN MEXICAN ADOLESCENTS. MEXICO, ENSANUT 2006

Characteristics		*Energy*	*Protein*	*Vitamin A*	*Vitamin C*	*Folates*	*Total iron*	*Zinc*	*Calcium*
Males									
National		74.5	25.9	62.9	39.9	69.7	12.9	53.6	74.1
Area§,&,∞	Urban	74.6	25.1	60.5	39.1	68.2	12.0	51.5	73.0
	Rural	74.0	28.2	69.9	42.1	74.1	15.4	59.4	77.4
Region§,&,∞	North	72.8	21.8	68.2	42.7	60.5	11.7	47.6	75.9
	Center	72.4	24.9	65	39.3	68.9	11.9	51.9	73.6
	Mex city	78.3	29.5	46.7	36.2	74.1	14.3	55.5	73.9
	South	75.5	27.6	65.5	40.6	73.6	13.8	57.6	73.8
SES§,#,≠,∞,ø	Low	75.0	30.2	70.9	45.8	72.7	15.9	60.5	77.1
	Middle	73.1	23.9	60.0	40.0	67.5	10.0	52.0	76.4
	High	75.2	23.5	57.1	33.0	69.3	12.5	47.5	68.8
Females									
National		69.9	29.9	57.6	38.4	82.8	26.7	60.5	84.9
Area*,‡,§,&,∞	Urban	68.5	27.4	54.3	37.6	81.5	27.1	57.8	84.2
	Rural	73.8	36.7	66.6	40.6	86.3	25.5	67.8	87.1
Region§,#,&,∞	North	66.4	27.6	60.9	44.6	75.7	22.4	53.3	89.9
	Center	71.8	29.3	60.6	34.0	81.9	24.0	61.7	83.8
	Mex city	66.5	27.4	46.3	34.7	87.6	32.3	58.2	81.0
	South	71.6	33.0	58.0	41.2	85.4	29.3	64.5	85.2
SES*,‡,§,∞	Low	71.6	34.5	63.7	43.6	83.9	26.4	65.0	84.4
	Middle	73.0	31.0	57.3	35.7	81.6	28.6	62.9	87.6
	High	63.8	22.7	50.3	35.6	82.4	24.3	52.2	82.4

* Statistically significant differences ($p < 0.05$ for area, $p < 0.012$ for region, $p < 0.016$ for socioeconomic level) in energy intake between categories
‡ Statistically significant differences (($p < 0.05$ for area, $p < 0.012$ for region, $p < 0.016$ for socioeconomic level) in protein intake between categories
§ Statistically significant differences ($p < 0.05$ for area, $p < 0.012$ for region, $p < 0.016$ for socioeconomic level) in vitamin A intake between categories
\# Statistically significant differences ($p < 0.05$ for area, $p < 0.012$ for region, $p < 0.016$ for socioeconomic level) in vitamin C intake between categories
& Statistically significant differences ($p < 0.05$ for area, $p < 0.012$ for region, $p < 0.016$ for socioeconomic level) in folates intake between categories
≠ Statistically significant differences ($p < 0.05$ for area, $p < 0.012$ for region, $p < 0.016$ for socioeconomic level) in total iron intake between categories
∞ Statistically significant differences ($p < 0.05$ for area, $p < 0.012$ for region, $p < 0.016$ for socioeconomic level) in zinc intake between categories
ø Statistically significant differences ($p < 0.05$ for area, $p < 0.012$ for region, $p < 0.016$ for socioeconomic level) in calcium intake between categories

SES: socioeconomic status

population at risk of dietary inadequacy in both male and female adolescents.

Discussion

This is the first study that includes male adolescents in the analysis of food intake, energy and nutrient adequacy percentages in a nationwide representative sample in Mexico.

Data analysis by residence area, geographic region, and SES show important trends related to the nutrition and epidemiological transition that Mexico is experiencing. The rural area, the southern region, and the lower SES have the lowest intakes and percentages of nutrient adequacy, in particular, vitamin A, folates, heme iron, zinc, and calcium, for both boys and girls. This information agrees with the prevalences of nutrient deficiencies (through biochemical indicators), stunting, and anemia observed in Mexico in these populations.[19,34] Overall, these results suggest an increase in the energy and nutrient intake compared with those reported in the ENN-99. For example, for female adolescents the energy adequacy percentage below 100% (between 75 and 79%) is somewhat higher than that reported in the ENN-99 for females aged 12 to 49 years (70.7%) and females aged 12 to 19 years (76.3%).[14,35] These results are congruent with the observed increase in the prevalence of overweight (1.7 percentual points (pp)) and obesity (2.3 pp) from 1999 to 2006.[19] Although dietary data collection methods are not comparable between these two Mexican surveys since the 24-hour recall method was used in the ENN-99, these comparisons offer a general idea of changes in consumption patterns. For fiber, we found the same differences by residence area as in the ENN-99 a higher intake in the rural than in the urban areas.

Results from this survey and from other studies in adolescents are similar regarding differences between urban and rural areas; urban adolescents consume a higher intake of refined cereals, sugars, and animal products than rural ones. Consequently, there is a higher intake of energy, total and saturated fat, and proteins from animal sources in urban settings, which results in a higher risk of overweight and obesity.[36] Another example is the health and nutrition survey carried out in China in 1993,[37] which showed a higher protein intake in the urban (74.3 g) than in the rural areas (72.1 g) in adolescents 14 to 18 years old, similar to that found in the Mexican population.

Special attention must be placed on bioavailable iron, since its deficiency represents an important problem in the Mexican population. The problem is not total iron intake, which is high (boys consume 12.4 mg/d and girls 9.9 mg/d and total iron adequacy is 178% in boys and 136% in girls) not corresponding to anemia (11.5% in both male and female adolescents)[19] and iron deficiency (40.5% in girls aged 12 to 19 years)[34] prevalences found in the Mexican population. The data presented in this survey refer to total iron intake, mostly consisting of nonheme iron, whose bioavailability is very low.[38] Moreover, the percentage of heme iron included in the total iron intake of Mexican adolescents is very low compared with that of other populations (2.5% for both Mexican males and females *vs*. 10% to 15.5% for populations in countries like the United States).[39,40] In addition, we must consider that the reference used for the estimated average requirement (based on the diet of the United States population) takes into account a bioavailability of 18%, which is higher than the bioavailability in Mexico.[27,41]

Though cohort analyses were not performed, these data suggest an increase of energy and macronutrient intakes in the female population, which is a determinant for the development of chronic degenerative diseases,[8] but not of commonly deficient micronutrients. We expect that micronutrient deficiency persists in this population.[42] Such persistent deficiencies complicate the public health nutrition profile because chronic degenerative diseases and micronutrient deficiencies contribute to the global burden of disease and generate high costs for public health.[43,44]

There are some limitations in this study. We should stress that the instrument used for the collection of dietary data for this survey (food frequency questionnaire) determines not only the within-subject variability, but also that between subjects, as the data collection period spans an entire week. The seasonal effect could be a limitant, since we do not have data for the whole year to determine intake variability. Fortunately, the survey was conducted during a relatively long time period (from October 2005 to May 2006), so data on intake variability is available at the group level. Also, it was the same period as the data collection for the ENN-99.[22]

Finally, it is worth noting that our results indicate important differences in intake and adequacy among residence area, geographic region, and socioeconomic status. These types of studies are needed to better understand the role of nutrition in the prevention of certain diseases; its objective is to identify risk factors that may cause health problems in a population. More attention should be paid to nutrition in adolescence, taking into account the data collected in this survey, in order to help develop adequate strategies to control and prevent the nutrition problems of this population, improving diet quality and increasing their nutritional status looking toward adult life.

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