Energy and nutrient intake in preschool and school age Mexican children: National Nutrition Survey 1999

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Abstract

Objective. To estimate energy and nutrient intake and adequacy in preschool and school age Mexican children, using the National Nutrition Survey 1999 (NNS-1999). **Material and Methods**. Twenty four-h dietary recalls from pre-school (n=1 309) and school (n=2 611) children obtained from a representative sub-sample of the NNS-1999 were analyzed. Intakes and adequacies were estimated and compared across four regions, socio-economic strata, and between urban and rural areas, and indigenous *vs*. non-indigenous children. **Results**. Median energy intake in pre-school children was 949 kcal and in school children 1 377 kcal, with adequacies <70% for both groups. Protein adequacy was >150% in both age groups. The North and Mexico City regions had the highest fat intake and the lowest fiber intake. Children in the South region, indigenous children, and those in the lowest socio-economic stratum had higher fiber and carbohydrate intakes and the lowest fat intake. These children also showed the highest risks of inadequacies for vitamin A, vitamin C, folate, iron, zinc and calcium. **Conclusions**. Mexico is experiencing a nutrition transition with internal inequalities across regions and socio-economic strata. Food policy must account for these differences in order to optimize resources directed at social programs. The English version of this paper is available too at: http://www.insp.mx/salud/index.html

Key words: micronutrient deficiencies; diet; malnutrition; dietary reference intakes; nutrient adequacy; national nutrition survey; Mexico

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Resumen

Objetivo. Estimar el consumo de energía y nutrimentos y su adecuación en niños prescolares y escolares mexicanos, usando datos de la Encuesta Nacional de Nutrición 1999 (ENN-1999). **Material y métodos**. Se analizaron datos de recordatorio de dieta de 24 horas de 1 309 niños prescolares y 2 611 escolares en una sub-muestra representativa de la ENN-1999. Se calcularon la ingesta y la adecuación de energía y nutrimentos, y se hicieron comparaciones por región, área urbana y rural, estado socioeconómico e indigenismo. **Resultados**. La mediana de ingestión de energía fue de 949 kcal en prescolares y de 1 377 kcal en escolares, con adecuaciones <70% para ambos grupos de edad. La adecuación de proteína fue >150%. Las regiones norte y Ciudad de México tuvieron la mayor ingesta de grasa y la menor ingesta de fibra. Los niños de la región sur, los de familias indígenas y los del estrato socioeconómico más pobre tuvieron la mayor ingesta de carbohidratos y fibra y la menor ingesta de grasa. Estos mismos niños tuvieron los mayores riesgos de deficiencias de vitaminas A, C y folato, así como de hierro, cinc y calcio. **Conclusiones**. México está experimentando una transición nutricional con polarización interna entre regiones y estratos socioeconómicos. Las políticas alimentarias deben tomar estas diferencias en consideración para optimizar los recursos dirigidos a programas sociales. El texto completo en inglés de este artículo también está disponible en: http://www.insp.mx/salud/index.html

Palabras clave: deficiencias de micronutrientes; dieta; mala nutrición; ingestas dietéticas recomendadas; adecuación nutricional; encuesta nacional de nutrición; México

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Mexico is experiencing an epidemiological transition with important reductions in the prevalence of infections and undernourishment, as chronic diseases and overnourishment, increase dramatically.[1, 2] This profile, similar to the one observed in other countries of Latin America, has been called "delayed polarized model of transition", in which there is a lack of resolution of the transition process characterized by: a) a mixed morbi-mortality (i.e. malnutrition and infections still present, together with an increasing prevalence of obesity and chronic diseases), and b) polarization of the patterns of disease among geographical regions and socio-economic strata.[3]

This transition has been linked to changes in diet, physical activity and other environmental factors.[3-5] Estimate of child energy and nutrient intakes in national surveys are useful to analyze these trends and to identify public health problems and possible interventions.[6,7]

Using information obtained from two National Nutrition Surveys (NNS) carried out in 1988 [8] and in 1999,[9,10] it was possible to document a decrease in the prevalence of acute malnutrition in the last decade. However micronutrient deficiencies are still a major public health problem with direct consequences in child health status.[11] Micronutrient deficiencies during infancy have been strongly associated with growth retardation, diminished psychomotor development, decreased learning capacity[12,13] and with increased risk of morbidity and mortality.[14-16] In addition, early underourishment has been associated with the development of chronic diseases in adult hood.[17,18]

A previous analysis of the reported dietary intake from the NNS-1988[19,20] as well as work by other researchers[21] has identified low intakes of iron, zinc, vitamin A, folic acid, vitamin C, and calcium in the Mexican diet. The prevalence of anemia in school children from the NNS-1999 was 19.5%. It was also shown that at least 1 in five children from 5 to 11 years of age his overweight or obese. Thus, evidence of the delayed polarized model of transition is present and the analysis of child energy and nutrient intakes could be useful to understand this epidemiological profile and its determinants.

The objective of this paper is to analyze the estimated energy and nutrient intakes and adequacies in preschool age and school Mexican children, using data from the NNS-1999.

Material and methods

The National Nutrition Survey 1999

We analyzed data from the National Nutrition Survey 1999 (NNS-1999), a nation-wide, representative, probabilistic survey with sampling power great enough to disaggregate by region and urban-rural areas. A detailed description of the survey sampling procedures and methods has been published elsewhere.[22] This survey was designed to be comparable with the NNS-1988, carried out 11 years before.[8] The NNS-1999 was carried out between October 1998 and March 1999.

For the analysis of polarization in the NNS 1999, the following four regions were compared: *North* (Baja California, Baja California Sur, Coahuila, Chihuahua, Durango, Nuevo León, Sonora, Tamaulipas); *Center* (Aguascalientes, Colima, Estado de México, Guanajuato, Jalisco, Michoacán, Morelos, Nayarit, Querétaro, San Luis Potosí, Sinaloa, Zacatecas); *Mexico City*, and *South* (Campeche, Chiapas, Guerrero, Hidalgo, Oaxaca, Puebla, Quintana Roo, Tabasco, Tlaxcala, Veracruz, Yucatán). Locations with more than 2 499 inhabitants were classified as urban, and locations with less than 2 500 inhabitants as rural.

The NNS-1999 obtained socio-economic information such as household conditions, basic services infrastructure (i.e. water source and disposal) and possession of domestic appliances (i.e. radio, television and refrigerator). A principal components factor analysis was carried out using this information to extract a main factor which explained 56% of the socio-economic information variability.[23,24] This factor was divided into tertiles and used as a relative measure of Socio-Economic Status (SES). Children from households where a native language was spoken by at least one woman 14-49 years of age were considered to have an indigenous background.

A total of 8 011 preschool children (1 to 4 years of age) and 11 415 school children (5 to 11 years of age) from the selected households participated in the survey.

Dietary information

A previously validated 24-hour Dietary Recall (24HDR) was administered to the mothers to obtain dietary information of a randomly selected sub-sample of 1 309 preschool children and 2 611 school children. Some cases were excluded from the analysis due to missing information on age and/or diet. After data cleaning, the sample analyzed for this study included a total of 1 072 preschool children and 2 449 school children. Standardized personnel applied the questionnaires and converted each reported consumption into grams or milliliters of food items. Aberrant food consumptions were reviewed by hand and updated when a clear mistake was detected or eliminated if the value was not biologically plausible. Energy and nutrient intakes were then estimated for foods using a comprehensive nutrient composition database compiled from diverse sources.[25-30]

Data analysis

Energy and nutrient intakes were calculated for all children and stratified according to the following factors: age, sex, region (North, Center, Mexico City and South), area (urban or rural), SES tertile and indigenous background. Energy, carbohydrate, protein and fat intakes exceeding five standard deviations from their respective means were excluded from the analysis (less than 1% of the sample). Due the skewed distributions of nutrient intakes, data are presented as medians with interquartile ranges. Nutrient adequacies were calculated using as a reference the Estimated Average Requirements (EARs) from the Dietary Reference Intakes (DRIs).[31] Total energy, carbohydrate and fat adequacies were estimated relative to the Recommended Dietary Allowances (RDAs).[32] Iron, zinc, vitamin A, vitamin C, and folate adequacies were calculated using the Estimated Average Requirements (EARs).[31,33,34] For calcium, the Adequate Intake values (AIs) were used.[35] Protein adequacy was estimated using as a reference the RDA value minus 25%, to approximate the estimated average requirement.[32] To test for statistical differences in nutrient intakes and adequacies across the factors, we used an ANOVA of the log-transformed intake and adequacy of each nutrient of interest.[23,36] To evaluate the risk of inadequate intake, the proportion of children in this study who did not reach their correspondent EAR was calculated. In a normal population it is expected that 50% of the cases will be below the requirement, thus the percentage above this number reflects the excess prevalence at risk.[31] All calculations were weighted by expansion factors to adjust for sampling effects. Statistical analysis was carried-out using SPSS version 10.*

Table I
CHARACTERISTICS OF PRESCHOOL AND SCHOOL CHILDREN. NATIONAL NUTRITION SURVEY, MEXICO, 1999

		*Pre-school** %	*School*‡ %	*Total*
Age	1 to 3	70.7§		21.0
(years)	4	29.3		9.1
	5 to 6		28.0	19.4
	7 to 8		29.8	20.8
	9 to 11		42.2	29.5
Sex	Male	53.3	50.8	51.8
	Female	46.7	49.2	48.2
Regions	North	18.8	18.1	18.4
	Center	35.8	34.4	35.0
	Mexico City	12.7	13.9	13.4
	South	32.7	33.6	33.2
Area	Rural	30.4	32.1	31.4
	Urban	69.6	67.9	68.6
Indigenous	Yes	10.2#	9.3&	9.4
background	No	89.8	90.7	90.6
Socioeconomic	Low	39.8	36.3	37.7
index (tertile)	Medium	31.1	35.7	33.8
	High	29.1	28.0	28.5
Nutritional	Stunting (<- 2 HAZ)	17.1	15.9	16.4
status	Low weight (<-2 WAZ)	7.5	4.4	5.7
	Wasting (<-2 WHZ)	2.0	1.0	1.4
	Obesity (>+2 WHZ)	5.5	9.1	7.6
		Mean SD	Mean SD	
Z-scores	Height for age (HAZ)	-0.80 (1.2)	-0.76 (1.4)	
	Weight for age (WAZ)	-0.38 (1.1)	-0.28 (1.1)	
	Weight for height (WHZ)	0.23 (1.0)	0.45 (1.0)	

* *n*= 1 072, weighted cases: 10 582 157
‡ *n*= 2 449, weighted cases: 15 441 057
§ *n*= 1 068, weighted cases: 10 476 375
3 *n*= 995, weighted cases: 9 820 536
& *n*= 2 287, weighted cases: 14 184 312

Results

Data are presented for 1 072 pre-school children (ages 1 to 4 years) and 2 449 school children (ages 5 to 11 years). Socio-demographic and anthropometric characteristics of children are shown on Table I. The proportion of pre-school and school age males was 53.3% and 50.8%, respectively. Less than 33% were living in rural areas and the proportion of children with indigenous background was under 11 %. The mean height for age Z score (HAZ) was –0.8 (SD: 1.2) for pre-school children and -0.76 (SD: 1.4) in school children. Prevalences of stunting were 17% and 16% for pre-school and school children, respectively. Prevalences

* SPSS for Windows. Release 10.0.0. Chicago (IL): SPSS Inc, 1999.

of obesity were 5.5% and 9 % for preschool and school children, respectively.

Children with dietary information did not differ from children without dietary information regarding sex, region, area, indigenous background, SES index and anthropometric Z scores. However, children with dietary data were on average three months older than children without it.

Energy and macronutrients

Nutritional intakes and percent adequacy of energy and nutrients are shown in Table II for pre-school children and in Table III for school children, by region and area of residency. The estimated median energy intake in pre-school children was 949 kcal (percent adequacy (PA)=67.4). Protein intake was 32.4 g (PA=180.5) and carbohydrate intake was 120.4 g (PA= 63.6). The median fat intake was 34.5 g (PA=74.9), and the fiber intake was 8.2 g . The highest energy and protein adequacies were reported in Mexico City and the highest fat intake was reported in the North region. Carbohydrate intake was higher in the Center and South regions. The lowest energy, protein and fat intakes were observed in the South region. Energy, protein, carbohydrate, and fat intakes were higher in the urban compared to rural areas. Only fiber intake in grams was higher in rural areas.

In school children, the median energy intake was 1377 kcal (PA=69.4). The median protein intake was 44.7 g (PA=155.5). Carbohydrate intake was 187.2 g (PA=68.6), and this was the only macronutrient in which the estimated adequacy was higher in school children compared to pre-school children. The median fat intake was 47.9 g (PA=72.8), and the fiber intake was 13.8 g. By region, the highest energy and fat adequacies were reported in the North, while protein adequacy was higher in Mexico City. The highest carbohydrate intake, and the lowest protein and fat intakes were observed in the South.

Micronutrients

Micronutrient intake and adequacy are shown in Table II for pre-school and Table III for school children. In pre-school children, the estimated national median intakes were: 265.1 mcgRE for vitamin A (PA=61.9), 22.3 mg for vitamin C (PA=135.0), 131.8 mcg for folate (PA=81.1) and 571.5 mg (PA=94.2) for calcium. Median iron intake was 4.5mg (PA=45.2) and zinc intake was 3.8mg (PA=129.2). The highest vitamin A and calcium intakes were reported in Mexico City. Vitamin C, folate, iron and zinc intakes were higher in the North compared to other regions. The lowest vitamin A, vitamin C, zinc and calcium intakes were observed in the South and in rural areas. Intakes for energy and all nutrients studied were higher in urban compared to rural areas. Total fiber intake was higher in rural areas.

In school children, the estimated national median intakes were: 303.5 mcgRE for vitamin A (PA=46.7), 29 mg for vitamin C (PA=95), 200.2 mcg for folate (PA=83.9), 7.1 mg for iron (PA=69.4), 5.4 mg for zinc (PA=52.2) and 677.8 mg for calcium (PA=67.7). By region, the highest adequacies of vitamin A and C, calcium and zinc and the lowest adequacies of iron were reported in Mexico City. The lowest folate intake was observed in Mexico City. The highest iron and folate intakes were observed in the North region. The lowest vitamin A and vitamin C intakes were reported in the South. Energy and nutrient adequacies were higher in urban compared to rural areas. Total fiber intake was higher in rural compared to urban areas.

Evaluation of risk for inadequate energy and nutrient intake

The prevalence of cases below the requirement for energy and each particular nutrient in pre-school and school children are presented in Table IV by age, sex, region, area, indigenous background, and socio-economic status. For energy and most nutrients, the proportion of cases at risk of inadequacy in pre-school children was substantially higher in rural areas (except for iron which was almost equal), and in children from indigenous backgrounds and low socio-economic status. By region, the highest proportion of inadequacy was observed in the South with the exception of folate and iron, which had a higher risk of inadequacy in Mexico City.

School children had a higher proportion of risk of inadequacy compared to pre-school children for energy and all nutrients but folate and iron. Similar to preschool children, a higher proportion of cases at risk of inadequacy was observed in school age children with an indigenous background, the lowest socio-economic status, and in the South Region. The exceptions were folate (higher in Mexico City) and iron (higher in the Center). In addition, a higher proportion of female pre-school and school children at risk for inadequacy of iron and zinc was observed, in comparison to male children.

Macronutrient composition

The macronutrient composition of diet, in terms of percent contribution to total energy intake, is shown

Table II

ENERGY AND NUTRIENT INTAKES AND PERCENT ADEQUACIES AMONG PREESCHOOL CHILDREN BY REGION AND AREA. NATIONAL NUTRITION SURVEY, MEXICO, 1999

	National*		North[‡]		Center[§]		Mexico City[#]		South[&]		Rural[≠]		Urban[∞]	
	Median	C (25, 75)	Median	C (25, 75)	Median	C (25, 75)	Median	C (25, 75)	Median	C (25 75)	Median	C (25, 75)	Median	C (25, 75)
Intake														
Energy (kcal)	949	(676, 1 251)	1 009	(711, 1291)	967	(682, 1 249)	988	(820, 1 272)	887	(640, 1 176)	820	(583, 1 129)	1 011	(734, 1 287)[ø]
Fiber (g)	8.2	(4.7, 13.1)	7.1[d]	(3.5, 11.4)	8.2[d]	(4.8 , 13.1)	6.1[d]	(4.2, 11.0)	10.0[abc]	(6.1, 14.9)	10.1	(6.0, 15.7)	7.4	(4.2, 12.0)[ø]
Protein (g)	32.4	(22.3, 44.6)	35.4	(23.1, 51.0)	32.3	(23.7, 42.5)	39.4[d]	(29.1, 47.6)	30.2[c]	(18.4 ,41.0)	26.4	(17.5, 37.6)	35.5	(24.6, 45.9)[ø]
Carbohydrates (g)	120.4	(86.3, 169.2)	110.2	(77.7, 159.9)	123.3	(82.0, 172.1)	119.5	(93.7, 156)	123.4	(92.8, 180.3)	119.1	(84.5, 163.6)	123.2	(88.5, 170.5)
Fat (g)	34.5	(22.3, 48.7)	42.1[d]	(26.8, 58.9)	33.4[d]	(23.0, 47.1)	39.2[d]	(29.5, 51.8)	28.6[abc]	(17.7, 42.4)	27.4	(15.3, 40.5)	37.9	(25.3, 53.8)[ø]
Vitamin A (mcg RE)	265.1	(132.4, 472.9)	260.7[c]	(132.4, 430.4)	250.4[c]	(103.7, 467.3)	544.0[abd]	(253.6, 944.1)	228.1[c]	(134, 409)	185.5	(93.6, 329.3)	313.2	(146.2, 573.1)[ø]
Vitamin C (mg)	22.3	(10.0, 58.1)	32.7	(11.6, 65.0)	20.8[c]	(9.5, 57.2)	26.9[bd]	(20.0, 63.4)	20.5[c]	(7.6, 48.1)	14.5	(4.8, 43.9)	26.0	(12.9, 63.6)[ø]
Folate (mcg)	131.8	(76.9, 213)	157.2	(84.3, 244.7)	132.4	(71.2, 218.6)	121.0	(79.4, 159.4)	129.6	(81.0, 190.0)	117.7	(71.9, 189.2)	140.9	(79.6, 218.6)[ø]
Iron (mg)	4.5	(2.9, 7.4)	5.9[d]	(3.1, 10.4)	4.2	(2.7, 6.8)	4.9	(2.9, 7.4)	4.3[a]	(2.9, 6.4)	4.4	(2.8, 6.5)	4.8	(2.9, 7.4)
Zinc (mg)	3.8	(2.5, 5.2)	4.3	(2.7, 5.7)	3.7	(2.5, 5.1)	4.1	(3.1, 5.5)	3.3	(82.3, 4.8)	2.9	(2.0, 4.3)	4.1	(2.8, 5.5)[ø]
Calcium (mg)	571.5	(337.4 792.7)	539.7	(337.4, 796.9)	597.2[d]	(381.1, 824.7)	609.7[d]	(459.1, 874.4)	488.1[bc]	(290.7, 713)	420.0	(259, 657.5)	609.7	(405.3, 836.9)[ø]
Percent Adecuacy														
Energy	67.4	(50.1, 88.6)	70.3	(51.7, 95.4)	65.7	(50.6, 88.9)	70.9	(56.6, 85.4)	66.4	(47.2, 86.6)	61.3	(43.1, 83.9)	69.8	(53.5, 91.4)[ø]
Protein	180.5	(118.3, 245.8)	187.4[d]	(130.0, 283.8)	173.7	(120.6, 244.9)	239.3[d]	(167.6, 279.4)	155.9[ac]	(104.6, 213.3)	145.4	(99.9, 218.0)	191.0	(133.2, 260.2)[ø]
Carbohydrates	63.6	(45.6, 86.4)	58.4[d]	(43.5, 79.6)	64.3	(42.3, 85.4)	59.5	(49.2, 85.6)	68.1[a]	(51.6, 92.5)	64.3	(46.3, 88.4)	63.6	(45.5, 86.2)[ø]
Fat	74.9	(48.3, 104.2)	88.1[d]	(57.5, 125.7)	74.8[d]	(50.0, 104.0)	81.6[d]	(62.0, 102.1)	62.1[abc]	(36.3 93.9)	59.5	(33.7, 88.9)	78.7	(56.1, 115.6)[ø]
Vitamin A	61.9	(30.3, 114.6)	62.9[cd]	(31.6, 107.6)	58.5[c]	(24.7, 107.6)	117.4[abd]	(50.7, 236.0)	52.9[d]	(30.4 99.8)	42.3	(21.4, 75.9)	72.1	(36.2, 124.8)[ø]
Vitamin C	135.0	(53.7, 325.4)	179.4	(72.7, 415.1)	116.4	(50.4, 275.7)	150.2	(92.6, 366.7)	115.7	(39.2, 293.4)	80.7	(26.4, 257.9)	147.5	(76.0, 374.5)[ø]
Folate	81.1	(50.4, 126.0)	97.7[d]	(53.1, 156.1)	83.5	(45.1, 126.1)	69.4	(53.0, 105.8)	77.7[a]	(51.0, 115.0)	71.6	(45.9, 114.1)	84.8	(51.4, 127.1)[ø]
Iron	45.2	(29.3, 74.5)	58.7[bd]	(31.2, 104.6)	41.9[a]	(27.7, 68.2)	48.6	(29.7, 74.5)	43.7[a]	(29.9, 64.6)	43.7	(28.4, 65.4)	47.5	(29.5, 74.7)
Zinc	129.2	(88.1, 185.0)	149.2	(92.9, 201.2)	124.2	(88.1, 181.3)	154.2	(102.0, 213.6)	116.8	(83.5, 161.2)	104.4	(73.8, 147.6)	139.5	(97.3, 196.6)[ø]
Calcium	94.2	(59.2, 134.2)	86.2	(61.9, 133.8)	103.4[d]	(61.2, 140.1)	109.7d	(82.4, 158.7)	84.0[bc]	(53.1, 124.6)	70.9	(43.4, 112.9)	104.2	(71.5, 143.1)[ø]

* Sample size: 1 072, weight:10 582 150
‡ Sample size: 280, weight: 1 984 620
§ Sample size: 362, weight: 3 790 880
# Sample size: 73, weight: 1 344 080
& Sample size: 357, weight: 3 462 550
≠ Sample size: 425, weight: 3 211 880
∞ Sample size: 647, weight: 7 370 270
ø Statistically different from rural intake and adequacy

a,b,c,d: Superindices represent statistically significant differences among regions using Bonferroni contrast. a=North, b=Center, c=Mexico City, d=South

Table III

ENERGY AND NUTRIENT INTAKES AND PERCENT ADEQUACIES AMONG SCHOOL CHILDREN BY REGION AND AREA. NATIONAL NUTRITION SURVEY, MEXICO, 1999

	National*		North‡		Center§		Mexico City#		South&		Rural≠		Urban∞	
	Median	C (25, 75)	Median	C (25, 75)	Median	C (25, 75)	Median	C (25, 75)	Median	C (25 75)	Median	C (25, 75)	Median	C (25, 75)
Intake														
Energy (kcal)	1377	(994, 1818)	1422d	(1050, 1798)	1371d	(982, 1811)	1369[d]	(1030, 1820)	1368c	(970, 1840)	1214	(864, 1693)	1445	(1086, 1872)[ø]
Fiber (g)	13.8	(9.1, 21.2)	11.3[bd]	(8.2, 15.8)	14.8[a]	(9.1, 21.8)	12.2[d]	(9.1, 16.9)	16.5[ac]	(10.3, 24.7)	17.0	(10.7, 25.9)	12.6	(8.8, 19.0)[ø]
Protein (g)	44.7	(31.1, 59.8)	44.2	(30.6, 61.0)	45.1	(30.6, 62.8)	46.3	(33.2, 58.7)	43.2	(31.1, 57.2)	38.2	(26.9, 51.7)	47.0	(33.5, 64.1)[ø]
Carbohydrates (g)	187.2	(138.0, 250.6)	179.3[d]	(134.0, 234.6)	187.1	(138.0, 246.4)	181.9	(140.7, 243.4)	199.3[a]	(140.1, 275.5)	184.2	(127.1, 249.2)	188.0	(141.1, 250.6)
Fat (g)	47.9	(29.2, 70.4)	53.1[bd]	(34.8, 78.8)	48.7[a]	(29.0, 69.3)	51.6[d]	(35.2, 68.4)	41.0[ac]	(24.0, 63.6)	35.5	(20.3, 54.9)	53.0	(35.1, 75.4)[ø]
Vitamin A (mcg RE)	303.5	(159.4, 585.4)	345.5	(178.8, 596.8)	279.7	(151.1, 570.6)	430.5	(221.0, 690.9)	271.0	(156.0, 489.8)	215.1	(119.3, 416.0)	356.4	(190.3, 653.9)[ø]
Vitamin C (mg)	29	(10.5, 77.2)	33.9[cd]	(12.9, 74.6)	25.5[c]	(10.4, 61.7)	66.8[abd]	(25.3, 113.8)	24.0[ac]	(7.0, 73.7)	16.3	(5.5, 52.2)	37.5	(15.6, 85.6)[ø]
Folate (mcg)	200.2	(125.0, 306.9)	211.0[bcd]	(134.9, 340.4)	206.9[a]	(123.6, 306.3)	189.8[a]	(141.1, 270.2)	190.4	(113.1, 313.4)	187.7	(112.2, 323.3)	206.0	(131.9, 304.5)
Iron (mg)	7.1	(4.9, 10.7)	8.7[bcd]	(5.5, 12.9)	7.0[a]	(4.8, 10.2)	6.3[a]	(4.6, 10.2)	7.4[a]	(4.9, 10.3)	7.0	(4.7, 10.2)	7.3	(4.9, 10.9)[ø]
Zinc (mg)	5.4	(3.8, 7.4)	5.5	(3.7, 7.5)	5.3	(3.6, 7.8)	5.6	(4.1, 7.5)	5.3	(3.8, 7.2)	4.6	(3.4, 6.6)	5.6	(4.0, 7.9)[ø]
Calcium (mg)	677.8	(446.4, 946.5)	585.5[bc]	(381.4, 882.4)	691.2[a]	(464.8, 967.4)	793.2[ad]	(561.3, 970.6)	646.6[c]	(426.1, 934.4)	604.1	(402.8, 854.9)	701.0	(467.7, 970.2)[ø]
Percent Adecuacy														
Energy	69.4	(50.9, 91.6)	71.8	(53.1, 91.7)	68.5	(50.6 90.7)	69.8	(53.4, 93.8)	69.3	(50.0, 92.5)	62.0	(43.9, 83.8)	72.6	(55.4, 95.2)[ø]
Protein	155.5	(108.5, 212.4)	149.8	(107.4, 217.0)	159.2	(107.1, 219.1)	165.4	(113.7, 224.1)	148.1	(107.6, 204.4)	135.0	(95.1, 186.6)	165.4	(117.2, 227.6)[ø]
Carbohidrates	68.6	(51.1, 92.0)	65.6[a]	(49.5, 85.3)	68.6	(50.2, 89.2)	67.3	(51.2, 90.9)	72.0[a]	(53.0, 100.0)	67.6	(47.9, 90.4)	69.1	(52.1, 93.0)
Fat	72.8	(44.7, 107.4)	82.6[bd]	(52.3, 119.4)	73.6[a]	(44.1, 103.8)	78.9	(53.8, 112.5)	62.7[a]	(36.0, 95.8)	53.5	(31.1, 85.0)	80.3	(53.4, 115.5)[ø]
Vitamin A	46.7	(23.9, 90.9)	52.7	(26.3, 92.9)	42.0	(22.2. 89.8)	65.9	(30.0, 120.5)	41.5	(22.5, 75.9)	32.7	(17.7, 64.6)	54.7	(29.0, 101.8)[ø]
Vitamin C	95.0	(32.9, 246.1)	101.7[c]	(42.3, 240.1)	82.3	(32.0, 199.6)	173.9[a]	(80.4, 355.8)	75.3	(21.5, 226.2)	50.7	(16.1, 177.9)	116.6	(48.8, 272.5)[ø]
Folate	83.9	(51.9, 131.5)	89.9[c]	(55.2, 141.3)	85.5	(54.3, 132.9)	83.8[a]	(53.4, 115.4)	79.0	(46.0, 131.5)	80.2	(46.4, 139.3)	85.8	(53.2, 129.5)
Iron	69.4	(46.8, 104.6)	83.8[bc]	(52.9, 121.8)	67.8[a]	(45.3, 100.0)	63.0[a]	(42.8, 101.4)	70.0	(47.5, 100.4)	67.5	(44.5, 98.1)	70.4	(47.7, 107.4)[ø]
Zinc	52.2	(36.1, 72.2)	52.9	(36.2, 72.8)	51.5	(34.3, 74.6)	54.7	(39.6, 74.3)	50.8	(36.3, 69.1)	44.8	(32.5, 63.5)	55.0	(39.3, 76.0)
Calcium	67.7	(42.7, 95.9)	61.5[c]	(38.9, 88.7)	69.4	(45.1, 96.8)	83.9[ad]	(55.2, 112.5)	62.3[c]	(41.1, 91.0)	61.1	(41.1, 87.6)	71.0	(43.5, 100.4)[ø]

* Sample size: 2 449, weight: 15 441 050
‡ Sample size: 730, weight: 2 793 960
§ Sample size: 778, weight: 5 317 000
\# Sample size: 174, weight: 2 141 640
& Sample size: 767, weight: 5 188 440
≠ Sample size: 1 044, weight: 4 955 420
∞ Sample size: 1 405, weight: 10 485 620
ø Statistically different from rural intake and adequacy

a, b, c, d: Superindices represent statistically significant differences among regions using Bonferroni contrast. a=North, b=Center, c=Mexico City, d=South

Table IV
PERCENT AT RISK FOR DIETARY INADEQUACY AMONG PRE-SCHOOL AND SCHOOL CHILDREN. NATIONAL NUTRITION SURVEY, MEXICO, 1999

	Energy	Vitamin A	Vitamin C	Folate	Iron	Zinc	Calcium
Pre-school children*							
Age (years)‡							
1 to 3	84.5	47.7	35.3	49.4	32.4	22.0	50.7
4	91.6	52.0	46.7	47.7	27.7	45.8	73.2
Sex							
Male	85.3	42.3	36.8	49.8	28.7	25.9	48.9
Female	88.2	44.3	35.2	48.0	31.6	30.2	57.7
Region							
North	83.2	40.7	31.8	42.4	26.5	24.7	55.1
Center	88.1	46.5	37.3	46.4	32.9	27.3	47.8
Mexico City	76.7	25.6	19.8	57.4	30.4	17.3	39.4
South	89.8	48.1	43.6	52.5	28.7	34.4	62.6
Area							
Rural	91.7	57.6	50.3	56.7	29.8	39.2	68.6
Urban	83.3	37.2	30.0	45.8	30.1	23.0	46.2
Indigenous Yes	97.2	63.5	62.3§	56.5	26.6	43.8	71.4
background‡ No	86.0	41.1	33.4	48.3	30.4	26.2	51.0
Socioeconomic index (tertile)							
High	79.6	33.4	26.5	47.5	28.2	18.0	42.8
Medium	87.9	50.3	36.3	49.2	32.8	28.2	57.3
Low	92.8	64.4	54.6	50.0	32.0	42.2	73.7
Total	86.6	43.2	36.1	49.0	30.0	27.8	52.9
School children§							
Age (years)							
5 to 6	84.3	44.2	39.7	42.7	22.8	35.4	69.6
7 to 8	82.1	45.4	40.3	36.1	17.2	28.1	62.7
9 to 11	82.6	64.2	56.4	59.1	27.1	65.9	92.7
Sex							
Male	81.3	50.5	47.4	45.3	18.7	42.9	76.2
Female	84.7	55.8	46.5	50.1	27.5	49.6	78.5
Region							
North	84.4	47.9	42.7	44.8	17.7	44.2	81.5
Center	83.2	55.6	52.4	46.1	26.8	45.6	75.5
Mexico City	81.0	38.3	26.1	47.0	25.3	39.2	64.2
South	81.7	59.2	52.4	51.0	20.8	50.5	82.2
Area							
Rural	79.4	67.2	62.2	50.3	24.0	54.8	82.6
Urban	87.6	46.3	39.9	46.4	22.4	42.0	74.8
Indigenous Yes	89.3	66.6#	68&	49.7	21.3	52.8	80.9
background No	82.2	51.7	44.9	47.4	23.1	45.4	76.9
Socioeconomic index (tertile)							
High	76.7	38.4	32.8	43.2	22.3	37.1	73.3
Medium	84.7	54.4	45.6	49.9	22.0	46.8	75.3
Low	87.7	70.2	67.5	50.4	24.9	56.9	85.1
Total	82.9	53.0	46.9	47.6	22.9	46.1	77.3

Differences among the factors are statistically significant
* *n*= 1 072, weight: 10 582 157
‡ *n*=1 068, weight: 10 476 375
§ *n*=1 069, weight: 10 516 675
\# *n*= 2 449, weight: 15 441 057
& *n*= 2 446, weight: 15 415 184
≠ *n*= 2 421, weight: 15 264 432

on Table V. In preschool children, carbohydrates accounted for 53% of energy intake, protein contributed with 13.8%, and fat provided 34.1%. The proportion of energy from carbohydrate was higher in the South compared to other regions, and highest in rural areas compared to urban. Proportion of energy from protein and fat was lower in the South and in rural areas. Indigenous children had the higher proportion of energy from carbohydrate and the lowest proportion of energy from other macronutrients. The same trends were observed in school children. In school children, carbohydrates accounted for 56.1% of total energy intake, while protein provided 12.8%, and fat accounted for 32.4%.

Discussion

This is the first time in 10 years that dietary information is obtained from pre-school children, and the first time ever that this information is collected from school age children in Mexico by a nationally representative survey.

Children in the South region, indigenous children, and those in the lowest socio-economic stratum, had higher fiber and carbohydrate intake with lower fat intake. These children also showed the higher risks of inadequacies for vitamins A, C and folate, and for iron, zinc and calcium. Deficiencies were more marked in rural areas, compared to urban. Energy and carbohydrate adequacies were below 70% for both preschool and school children.

The 24-hour dietary recall is the most widely used method to assess dietary intake and has been extensively used in national and population-based surveys.[37] However, it should be noted that the 24-hour dietary recall tends to under-report energy and nutrient intake.[37,38] One could confirm –and roughly quantify the magnitude of this under-report by looking at the median percent adequacy of energy in children in the higher socio-economic group, which was 75% for preschool and 80% for school children. Since in this socio-economic stratum one could expect that the percent adequacy of energy would be at least 100%, the magnitude of energy and nutrient under-reporting would be at least around 20 to 25%. As a consequence, the proportion of children at risk of nutrient inadequacies could be overestimated in the present study. Moreover, we do not know if this dietary under-reporting differs by SES status, maternal schooling or literacy, or the child's nutritional status in the present study. Thus, caution is advised, and more studies are needed to clarify this issue.

Clearly, the energy and macronutrient consumption follows a geographical pattern associated with

Table V
PROPORTION OF ENERGY FROM MACRONUTRIENTS (%) FOR PRE-SCHOOL AND SCHOOL CHILDREN. NATIONAL NUTRITION SURVEY, MEXICO, 1999

		Carbohydrates		Protein		Fat		Saturated fat	
Pre-school children*									
Age (years)‡		Median	C (25 , 75)	Median	C (25 , 75)	Median	C (25 , 75)	Median	C (25 , 75)
1 to 3		52.1	(43.4, 62.4)	13.9	(11.5, 16.7)§	34.8	(26.4, 42.1)	13.7	(8.1, 18.7)
4		55.4	(45.8, 65.0)	13.4	(11.3, 15.5)	32.7	(23.8, 40.3)	12.9	(6.5, 16.5)
Sex§									
Male		53.3	(44.9, 63.5)	13.9	(11.4, 16.3)	34.4	(25.0, 40.0)	13.5	(7.7, 18.6)
Female		52.6	(43.6, 63.8)	13.6	(11.4, 16.5)	33.2	(25.9, 42.0)	13.0	(7.5, 17.7)
Region									
North		48.9	(39.5, 56.8)	14.2	(12.2, 17.2)	37.2	(30.4, 44.4)	15.4	(10.4, 20.1)
Center		51.5	(43.7, 61.7)	13.9	(11.4, 16.4)	35.9	(26.4, 42.3)	14.5	(9.0, 20.1)
Mexico City		51.8	(44.2, 57.1)	14.7	(13.2, 17.0)	35.1	(30.0, 40.3)	17.0	(13.5, 18.4)
South		60.7	(49.7, 70.3)	12.8	(10.8, 15.1)	28.8	(20.1, 37.2)	8.7	(4.2, 13.8)
Area									
Rural		59.9	(49.0, 69.8)	12.8	(10.9, 14.8)	28.9	(20.1, 38.1)	7.9	(3.6, 13.6)
Urban		51.0	(42.9, 60.5)	14.2	(11.9, 16.7)	36.0	(27.8, 42.3)	15.2	(10.0, 19.8)
Indigenous	Yes	61.2	(53.7, 73.4)	11.8	(9.9, 14.3)	26.5	(14.0, 32.7)	5.4	(1.7, 11.5)
background‡	No	52.3	(43.7, 62.6)	13.9	(11.6, 16.5)	35.2	(26.2, 41.7)	14.0	(8.6, 18.7)
Socioeconomic index (tertile)									
High		47.7	(43.4, 57.1)	14.5	(12.7, 17.2)	37.6	(30.6, 42.1)	16.0	(11.9, 20.1)
Medium		52.9	(42.2, 61.2)	13.8	(11.7, 16.4)	35.1	(27.1, 42.3)	14.2	(9.2, 19.2)
Low		62.8	(51.3, 73.3)	12.3	(10.5, 14.6)	25.9	(17.5, 35.8)	6.1	(2.9, 11.8)
Total		53.0	(44.0, 63.5)	13.8	(11.4, 16.4)	34.1	(25.5, 41.3)	13.5	(7.7, 18.3)
School children#									
Age (years)									
5 to 6		54.9	(47.8, 63.4)	12.8	(10.7, 14.6)	33.1	(25.8, 40.1)	–	
7 to 8		55.6	(47.6, 65.5)	12.8	(11.0, 15.3)	32.8	(24.5, 39.7)		
9 to 11		57.4	(48.8, 67.2)	12.8	(11.1, 15.1)	31.3	(22.5, 38.1)	–	
Sex§									
Male		56.3	(48.2, 65.8)	12.8	(11.1, 14.9)	32.1	(23.5, 38.8)	–	
Female		55.8	(48.1, 64.7)	12.7	(10.7, 15.1)	32.7	(24.6, 39.1)	–	
Region									
North		52.2	(45.4, 59.8)	12.6	(10.7, 14.7)	35.4	(29.0, 42.2)	–	
Center		55.7	(47.9, 65.4)	13.1	(10.9, 15.2)	32.9	(23.9, 39.2)	–	
Mexico City		55.3	(48.7, 62.2)	12.9	(11.5, 15.8)	33.1	(26.7, 39.7)	–	
South		59.8	(50.3, 69.9)	12.7	(10.9, 14.6)	29.3	(19.6, 36.7)	–	
Area									
Urban		54.1	(47.1, 62.2)	12.9	(11.1, 15.2)	33.8	(27.1, 40.1)	–	
Rural		62.3	(51.4, 71.8)	12.4	(10.7, 14.5)	27.1	(18.5, 36.3)	–	
Indigenous	Yes	67.3	(54.4, 77.4)	12.3	(10.6, 13.8)	22.9	(14.9, 31.8)	–	
background	No	55.5	(47.9, 64.1)	12.8	(11.1, 15.1)	33.1	(25.1, 39.5)	–	
Socioeconomic index (tertile)									
High		51.8	(45.4, 59.8)	13.1	(10.7, 15.5)	35.9	(30.6, 41.8)	–	
Medium		55.6	(48.4, 64.1)	12.9	(11.2, 15.1)	32.2	(25.1, 38.4)	–	
Low		51.8	(45.4, 59.8)	13.1	(10.7, 15.5)	35.9	(30.6, 41.8)	–	
Total		56.1	(48.1, 65.5)	12.8	(10.9, 14.9)	32.4	(24.1, 39.1)	–	

* *n*= 1072, weight: 10 582 157
‡ *n*=1068, weight: 10 476 375
§ Differences were statistically significant between categories except where marked by this symbol
\# *n*=2 449, weight: 15 441 057

morbidity and mortality, explaining some characteristics of the epidemiologic and nutrition transition. The North region, which has the highest prevalence of obesity at the national level, has higher energy and fat percent adequacies. Likewise, urban areas, higher socio-economic status and children without indigenous background showed higher levels of energy and fat consumption with a lower consumption of fiber and carbohydrates. These patterns were observed previously by our group analyzing the Mexican National Household Income and Expenditure Surveys from 1984 to 1998.[1] This suggests that Mexico is still in a different stage of the epidemiological and nutrition transition, as compared to more developed countries in which the more educated groups adopt healthier lifestyles.[39,40]

On the other hand, micronutrient information suggests important risks for deficiencies in preschool and school children. Children with higher risks of inadequacies were those living in rural areas, in the South region of the country and those with an indigenous background. These results agree with previous reviews on micronutrient deficiencies in Mexico and Latin America, related to the importance of inadequacy risks for calcium, vitamin A, vitamin C, zinc and iron in disadvantaged populations.[21,41]

The EAR is the median usual intake value that is estimated to meet the requirement of half the healthy individuals in a life stage and gender group.[31] At this level of intake, the other half of the individuals would not have met their needs. However, due to the methodological procedures involved in the estimation of intake it is necessary to consider with caution this information due to the following considerations:

In the case of calcium, an EAR has not been established. Therefore we used the AI as a reference. The AI reflects the mean intake of a healthy population within a specific gender and age group; thus, the proportion of children under the AI does not necessarily reflect inadequate intakes.

The 24-hour dietary recall questionnaire did not considered the vitamin A mega-dose supplementation program, a nation-wide strategy carried out by the Ministry of Health in order to prevent vitamin A deficiency in children. Thus, reported vitamin A intakes could be underestimated. This would lead to an overestimation of the risk of vitamin A inadequacy. The risk of inadequacy for iron did not consider dietary sources of the element, neither its biochemical form (heme vs. non-heme). This is important, since the Mexican diet contains high quantities of fiber, phytates, phosphates and tannins which are among the most powerful depressants of iron bio-availability. Therefore, the risk of iron deficiency could be higher than that reported in this study if the non-heme form of iron is an important source of the mineral. Our results are consistent with other studies that have identified zinc deficiency as a major nutritional problem in Mexican children.[11] Moreover, similar to iron, zinc faces bio-availability problems related to the presence of dietary inhibitors such as fiber, phytates and so on. Thus, interventions aimed at improving zinc intake in children should be encouraged. Vitamin C risk of inadequacy was higher than could be expected considering that Mexico produces large quantities of citrus and tropical fruits, which are excellent sources of the vitamin. Thus, consumption of these foods by children should be encouraged to improve their vitamin C intake. Folate intakes were lower in the urban areas and in the North and Mexico City regions, compared to the South and rural areas. This suggests different dietary patterns among strata, particularly in relation to the consumption of green leafy vegetables.

The data showed important risks of inadequacies for various micronutrients, which are essential for normal child health and development. This can pose a risk for their health and nutrition status, and actions are needed to address this problem. Micronutrient supplementation has proved to be a very effective, low-cost strategy to control nutrient deficiencies in developing countries, and thus, it should be encouraged.[15,16]

However, while some interventions, such as multiple micronutrient supplementation in young children are useful for resolving micronutrient deficiencies in the short term, it is worthwhile to consider long term interventions such as food fortification and diet diversification. This would have particular importance in school-age children, because dietary habits are acquired during this period of life. Moreover, diverse studies have shown that people who consume a diversity of foods (i.e. fruits, vegetables and fiber) have a reduced risk of obesity and chronic diseases.[42-47] The prevalence of overweight or obesity has been reported to be between 13 and 26% for school-age children in this survey.[10] Thus, together with micronutrient deficiencies, a call for major actions aimed to prevent these health problems starting at early ages is necessary.[48-52] There is increasing evidence that the risk of cardiovascular diseases, which represent the first cause of mortality in the country, begins in childhood.[53] A careful exploration of nutrition education in children must be carried out, aiming to improve the quality of their diet and increase physical activity to reduce the prevalence of coronary heart disease and other non-communicable chronic diseases in later life.[39,49,54,55] Finally, it is important for health planners to review the country is food and nutrition program targeting, and to evaluate the impact of nutrition interventions, in order to optimize resources and to guarantee the effectiveness of these actions.

Our data showed important differences in nutrient intakes and inadequacies between rural and urban areas, children from indigenous and non-indigenous backgrounds and national regions. Policy should direct resources to the most vulnerable groups in order to improve the nutritional status of children.

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