

# Energy and nutrient consumption in Mexican women 12-49 years of age: Analysis of the National Nutrition Survey 1999

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## Abstract

**Objective.** To describe the reported energy and nutrient intake and adequacies in Mexican women. **Material and Methods.** A 24-hour dietary recall was used to obtain nutrient intake in a representative sub-sample of 2 630 women from 12 to 49 years of age from the National Nutrition Survey 1999. Nutrient adequacies were estimated using the Dietary Reference Intakes and stratified according to region, area (urban or rural), socioeconomic status and obesity status (non-obese: BMI <30 kg/m<sup>2</sup>, obese: ≥30 kg/m<sup>2</sup>). Differences were analyzed using linear regression for complex surveys of log-transformed intake and adequacy, adjusting for multiple comparisons with the Bonferroni test. **Results.** The median national energy intake was 1 471 kcal. The Risk of Inadequacy (RI) (prevalence of adequacy <50%) was: vitamin A:38.3%, vitamin C: 45.5%, and folate: 34.3%. Carbohydrates, folate, iron and calcium intake was significantly higher in rural than in urban areas. The RI was higher in women of the lowest socioeconomic status tertile for all nutrients with the exception of carbohydrates and calcium. Macro-nutrient adequacies were significantly higher in non-obese women. **Conclusions.** Differences within the country among regions, rural and urban areas, and socioeconomic status tertile reflect an increasing availability of inexpensive calorie-dense foods in marginal groups. However, total energy, cholesterol, saturated and total fat were consumed in greater quantities by women from the higher socioeconomic status tertile and from urban areas. These patterns could be

## Resumen

**Objetivo.** Describir la ingesta reportada de energía y nutrientes en mujeres mexicanas. **Material y métodos.** Se utilizó un recordatorio de 24 horas para obtener la ingesta de energía en una submuestra representativa de 2 630 mujeres de 12 a 49 años de edad de la Encuesta Nacional de Nutrición 1999. Las adecuaciones nutrimentales se estimaron utilizando las Referencias de Ingesta Dietética y fueron estratificadas por región, área urbana o rural, nivel socioeconómico y presencia de obesidad (no-obesas: IMC <30 kg/m<sup>2</sup>, obesas: ≥30 kg/m<sup>2</sup>). Las diferencias se analizaron utilizando modelos de regresión lineal para encuestas complejas del logaritmo de la ingesta y la adecuación, ajustando para comparaciones múltiples con la prueba de Bonferroni. **Resultados.** La media nacional de ingesta de energía fue de 1 471 kcal. El riesgo de inadecuación (prevalencia de adecuación <50%) fue vitamina A: 38.3%, vitamina C: 45.5% y folato: 34.3%. La ingesta de carbohidratos, folato, hierro y calcio fue significativamente más alta en áreas rurales que en las urbanas. El riesgo de inadecuación fue mayor en mujeres del nivel socioeconómico más bajo para todos los nutrientes con excepción de carbohidratos y calcio. Las adecuaciones de macro-nutrientes fueron significativamente mayores en mujeres no-obesas. **Conclusiones.** Las diferencias entre las regiones, áreas del país y terciles de nivel socioeconómico reflejan una disponibilidad creciente de alimentos densamente calóricos de bajo costo en grupos marginales. Sin embargo, la energía total, colesterol y la

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a contributing factor to the rise of obesity and other non-communicable nutrition-related chronic diseases in Mexico. The English version of this paper is available at: <http://www.insp.mx/salud/index.html>

**Key words:** diet; nutritional transition; epidemiologic transition; obesity; dietary reference intake; probabilistic survey; Mexico

grasa saturada y total se consumieron en mayores cantidades por mujeres del tercil de nivel socioeconómico más alto y áreas urbanas. Estos patrones pueden estar contribuyendo al incremento de la obesidad y otras enfermedades no transmisibles en México. El texto completo en inglés de este artículo también está disponible en: <http://www.insp.mx/salud/index.html>

**Palabras clave:** dieta; transición nutricional; transición epidemiológica; obesidad; ingesta dietética de referencia; encuesta probabilística; México

**D**ietary studies are relevant for improving our understanding of the role of nutrition in preventing certain diseases, for identifying causes of public health problems and cost-effective interventions aimed at reducing potential health risks. Changes in food patterns and intake in countries such as Mexico experiencing an epidemiological transition must be carefully analyzed. The co-existence of non-communicable chronic diseases and nutrient deficiencies present a difficult challenge to health planners.<sup>1-5</sup> Diverse socioeconomic, environmental and demographic factors affect dietary consumption. In addition, cultural perceptions and traditions influence food intake.<sup>6,7</sup> Finally, the growing urbanization with increased access to energy-dense industrialized foods has an effect on dietary patterns with potential health consequences, in particular for marginal vulnerable populations.<sup>8-10</sup>

National consumption of energy and nutrients in the Mexican diet has been described using data collected 11 years previous to the present study.<sup>11,12</sup> The target group for this questionnaire were women between 12 and 49 years of age. This group has been considered a priority due to their fertility status, central role in the household food resource allocation and family health care.<sup>12-14</sup> Nutritional status of women of childbearing age affects not only their health but also contributes to the newborn's health, with a potential transgenerational impact.<sup>15-20</sup>

The objective of this analysis is to describe the reported energy and nutrient intake in women 12-49 years of age, obtained from the National Nutrition Survey (NNS) 1999.

## Material and Methods

### The National Nutrition Survey 1999

This analysis used data obtained from the NNS II (1999); a national probabilistic survey representative of the country with sampling power to disaggregate into urban (Pop $\geq$ 2 500) and rural (Pop $<$ 2 500) areas or

by four country regions: a) North (Baja California, Baja California Sur, Coahuila, Chihuahua, Durango, Nuevo León, Sonora, Tamaulipas); b) Center (Aguascalientes, Colima, Estado de México, Guanajuato, Jalisco, Michoacán, Morelos, Nayarit, Querétaro, San Luis Potosí, Sinaloa, Zacatecas); c) Mexico City, and d) South (Campeche, Chiapas, Guerrero, Hidalgo, Oaxaca, Puebla, Quintana Roo, Tabasco, Tlaxcala, Veracruz, Yucatán). The objective of this survey was to characterize the nutritional status as well as the food and nutrient patterns of pre-school and school-age children, and women of childbearing age in Mexico. A detailed description of the sampling procedures and survey methodology has been published elsewhere.<sup>21,22</sup> Approximately 4 200 women of childbearing age (12 to 49 years of age) from the selected households participated in this survey.

### Socioeconomic status index

The NNS 1999 collected socioeconomic information such as household conditions (flooring material, ceiling, walls, number of persons residing in the household), basic services infrastructure (i.e., water source and disposal) and possession of domestic appliances (i.e., radio, television and refrigerator). A principal component analysis was constructed following a methodology previously reported in the first National Nutrition Survey (1998).<sup>3</sup> With this information a main factor explaining 56.1% of the socioeconomic information variability was extracted. This factor had large loadings for household and community characteristics such as sewer system and indoor plumbing. It was divided into tertiles and used as a proxy for low, medium and high socioeconomic status.

### Dietary information

To estimate food consumption of women and children in the first and second National Nutrition Surveys, a previously validated 24-hour dietary recall (24-h DR)

was used. Nutrient intake information in a sub-sample of 2 630 women from 12 to 49 years of age was obtained. This sub-sample was representative of the country and its regions. It included one of every 5 households in the sample and one woman per household. A detailed description of the sampling strategy has been published previously.<sup>21</sup> Standardized personnel applied the questionnaires and converted each reported preparation into grams or milliliters of individual foods. Nutrient intake was then estimated using a comprehensive nutrient composition database compiled from diverse references.<sup>23-28</sup>

Nutrient adequacies were estimated using as reference the following Dietary Reference Intakes (DRIs): Estimated Average Requirement (EAR) for vitamin A, vitamin C, folate, iron, zinc and calcium and Adequate Intakes (AI) for energy, protein, fat (using 30% of the total caloric intake as the cut-off point), carbohydrates and fiber.<sup>29-33</sup> Aberrant reported consumptions and adequacies were reviewed case by case and corrected when possible. If the value was not biologically plausible but information to correct it was not available, the case was eliminated. Adequacy was then estimated as the percentage of consumption relative to the requirement. Requirements for women with a Body Mass Index (BMI) <19 kg/m<sup>2</sup> (1.9%) or with missing anthropometric information (3.5%), were estimated based only on the corresponding adequacy for age. The requirements for pregnant (4.9%) or lactating (8.2%) women were considered. Only half of the energy DRI for lactating women was added when partial breast-feeding (breast milk plus formula or foods) was reported.<sup>34</sup> Due to missing or aberrant information 34 cases (1.29%) were excluded from this analysis.

### Data analysis

Once the nutrient intake database was cleaned of aberrant values, nutrient intakes were calculated for all women and stratified according to the following factors: region (North, Center, Mexico City, South), area (urban or rural), socioeconomic index tertiles and, for non-pregnant and non-lactating women >18 years of age, in body mass index group (non-obese: <30 kg/m<sup>2</sup> and obese: BMI ≥30 kg/m<sup>2</sup>).

Nutrient consumption was expressed as nutrient quantity and percentage of adequacy. Due to the skewed distribution of nutrient intake consumption, data were reported as medians with interquartile range instead of means to avoid overestimating consumption. Risk of inadequacy was evaluated calculating the prevalence below 50% of the estimated adequacy. To test for statistical differences across the factors of in-

terest in nutrient intakes and adequacies, we used generalized linear models for complex surveys with the log-transformed nutrient and adequacy as independent variable and the Bonferroni method to adjust for multiple comparisons, for the risk of inadequacy differences were established using logistic regression.<sup>35,36</sup> The median caloric consumption by age was analyzed comparing rural and urban cases and both non-obese and obese women >18 years old (BMI ≥30 kg/m<sup>2</sup>). All statistical calculations were done applying the expansion factors, using SPSS version 10 (SPSS Inc., Chicago IL, USA).<sup>36</sup> To adjust for the complex survey design effects, we used the "svy" command from STATA Statistical Software, Release 7.0 (Stata Corporation College Station, Texas, USA).<sup>37</sup>

## Results

The total valid sample of women ( $n=2\ 596$ ) represented 28 080 000 cases at the national level. From this sample, a total of 64.8% cases were between 20 and 39 years of age, 88% were non-pregnant and non-lactating and 75.8% lived in urban areas. Additional characteristics of the population and the diet sub-sample are shown in Table I. Energy and nutrient intake as well as adequacy relative to the DRIs is presented in Table II. Nutrient adequacies for all nutrients were <71% at the national level except for protein (98.9%), iron (101.2%) and zinc (82.8%). The median energy consumption at the national level was 1 471 calories and 23.1% of the women were at risk of energy inadequacy. The higher reported median energy adequacy by region was observed in the South (77.3%) and Center (72%) regions. Energy adequacy by area was slightly higher in rural than in urban and this difference was statistically significant. Fiber consumption at the national level was 17.3g with higher consumption in the South region and in rural areas. The same occurred for carbohydrates, folate, iron and calcium consumption. Fat intake was higher in urban areas and the risk of fat inadequacy was higher in the South and in the rural areas of the country. Protein was the nutrient with the lowest risk of inadequacy at the national level with a prevalence of only 10.8% (Table II). When intake and adequacy were compared by SES, fiber, carbohydrates, folate, iron and calcium consumption were higher in the lowest SES tertile. Energy and the remainder of the analyzed nutrients were higher in the highest SES tertile (Table III).

The estimated adequacy of energy and nutrients compared by BMI status (non-obese: <30, or obese: ≥30 kg/m<sup>2</sup>) was higher for all macronutrients (total energy, protein, fat and carbohydrates), and zinc in non-

Table I  
CHARACTERISTICS OF THE STUDY POPULATION.  
NATIONAL NUTRITION SURVEY  
AND DIET SUB-SAMPLE, MEXICO, 1999

	Diet sub-sample %*	NNS II sample %†
Age group		
12 to 19	17.8	28.9
20 to 29	35.3	30.7
30 to 39	29.5	23.5
40 to 49	17.4	16.9
Region		
North	18.7	18.5
Center	31.7	31.4
Mexico city	18.2	18.7
South	31.4	31.4
Area		
Rural	24.2	24.0
Urban	75.8	76.0
Physiological State		
Pregnant	4.7	3.8
Lactating	7.4	5.1
Non pregnant- non lactating	88.0	91.1
Schooling		
None	7.8	7.2
Primary School	41.6	37.7
Middle School	24.0	26.6
High school or more	26.3	28.0
Don't know/not specified	0.2	0.6

\* Sample size 2 596, weighted cases: 28 080 000

† Sample size 23 429, weighted cases: 28 748 192

obese women. Fiber, vitamin A, C, folate, iron, and calcium intakes showed no significant differences between groups. Reported total, saturated, monounsaturated and polyunsaturated fat intake were higher in non-obese women. However, only polyunsaturated fat was statistically significant. Zinc intake was significantly higher among non-obese women. Calcium intake was significantly higher among obese women (Table IV).

Analyzing reported energy intake by age groups and area, urban women between the ages of 20 and 36 years reported less energy intake; younger and older urban women reported higher intake than women

living in rural areas. Obese women reported intakes lower than or similar to non-obese women across most of the age groups (Figures 1a and 1b).

## Discussion

The stratification of the data shows interesting patterns related to the epidemiological and nutritional transition: the rural areas, the South region, and the lower Socio-Economic Status (SES) index tertile showed the highest fiber and carbohydrate intake and the lowest saturated fat intake.<sup>5,38</sup> Protein adequacy and intake were significantly higher in the South region; with the lowest saturated fat intake reflecting a relevant contribution of beans and cereals to this picture. Women from urban areas and from the higher socioeconomic status tertile had higher protein intakes.

Since the SES index was built using household and family characteristics, the extracted factor could reflect access to certain conditions such as sanitation (water quality and disposal) and information (radio and TV) rather than a precise socio-economic status. Thus, our indicator must be interpreted with caution as a rough estimate. However, a previous analysis showed a significant association between the lowest tertile of a similar index and poor nutritional status indicators.<sup>3</sup>

The 24-h DR has been recognized as a useful method for quantifying consumption in large surveys since it is inexpensive and relatively easy to apply. Furthermore, it is known to have good compliance.<sup>39</sup> Nevertheless, it has been described that some frequently reported foods in the Mexican diet (such as tortillas, sugar and oil) tend to be underestimated.<sup>40</sup> In addition, a previous analysis with this information identified an almost twofold under-reporting in obese (36%) vs. non-obese women (20%), controlling for confounders. This underreporting was higher in the North and Mexico City regions compared to the Center and South regions, but without urban-rural differences.<sup>41</sup> These results are in the same direction as other recent nutrition surveys in developed and developing countries.<sup>42</sup> Therefore, although the median energy intake was below the RDA, an important percentage of energy consumption is not detected with this instrument.

Energy, protein, carbohydrate and lipid intakes reported in this survey were slightly lower than those reported in the First NNS (1988). Energy consumption decreased from a median of 1 586 to 1 470. The only exception was total fat, increasing from 41.2 g to 48.6 g.<sup>12</sup> However, these differences must be considered with caution since obesity and overweight have increased substantially from the first to the second national nutrition survey. Thus, a higher under-reporting in the latter

Table II  
**NUTRIENT INTAKE, ADEQUACY AND PERCENT OF ADEQUACY < 50% AT THE NATIONAL LEVEL, BY REGION AND AREA.\***  
**NATIONAL NUTRITION SURVEY, MEXICO, 1999**

	National <sup>†</sup>		North <sup>§,a</sup>		Center <sup>§,b</sup>		Mexico City <sup>§,c</sup>		South <sup>§,d</sup>		Rural <sup>§</sup>		Urban <sup>§</sup>			
	Median	(P 25, P 75)	Median	(P 25, P 75)	Median	(P 25, P 75)	Median	(P 25, P 75)	Median	(P 25, P 75)	Median	(P 25, P 75)	Median	(P 25, P 75)		
<b>Intake</b>																
Energy (kcal)	1 471	(1 095, 1 924)	1 402	(991, 1 797)	1 500.0	(1 105, 1 987)	1 362	(1 013, 1 771)	1 560	(1 142, 2 004)	1 492	(1 093, 1 912)	1 465 <sup>o</sup>	(1 096, 1 928)		
Fiber (g)	17.3	(11.7, 25.8)	14.3 <sup>ab</sup>	(9.2, 21.4)	19.3 <sup>ac</sup>	(13.4, 26.8)	14.5 <sup>ab</sup>	(9.4, 19.7)	20.7 <sup>ac</sup>	(13.0, 30.5)	23.6	(15.7, 34.2)	15.5 <sup>o</sup>	(10.7, 22.6)		
Protein (g)	47.7	(34.2, 64.9)	46.0 <sup>d</sup>	(32.9, 63.1)	48.1	(34.3, 65.7)	46.3 <sup>d</sup>	(32.6, 60.5)	48.8 <sup>ac</sup>	(36.8, 67.8)	45.4	(32.2, 61.7)	48.4 <sup>o</sup>	(35.3, 65.8)		
Fat (g)	48.6	(29.5, 72.7)	50.9 <sup>bd</sup>	(31.3, 76.7)	51.9 <sup>b</sup>	(31.3, 73.5)	49.8 <sup>d</sup>	(34.4, 71.6)	45.3 <sup>ab</sup>	(25.5, 69.9)	37.4	(20.9, 62.2)	52.0 <sup>o</sup>	(33.7, 75.9)		
Cholesterol (mg)	124.1	(55.2, 252.7)	144.9 <sup>b</sup>	(64.6, 277.5)	117.3 <sup>bd</sup>	(48.6, 222.3)	119.5 <sup>b</sup>	(71.9, 256.3)	129.2 <sup>b</sup>	(47.7, 279.8)	96.9	(20.8, 223.9)	131.5 <sup>o</sup>	(67.4, 263.3)		
Saturated fat (g)	14.9	(7.3, 23.6)	16.0 <sup>d</sup>	(9.1, 23.5)	16.0 <sup>d</sup>	(8.4, 26.5)	15.5 <sup>d</sup>	(8.5, 24.3)	11.8 <sup>abc</sup>	(5.4, 21.1)	8.9	(3.8, 17.0)	16.4 <sup>o</sup>	(9.2, 25.3)		
Monounsaturated fat (g)	13.3	(8.0, 21.6)	15.0 <sup>cd</sup>	(8.4, 23.0)	13.6	(8.4, 22.2)	12.9	(8.7, 19.8)	12.1 <sup>a</sup>	(6.5, 21.2)	10.0	(4.8, 18.1)	14.6 <sup>o</sup>	(9.0, 22.7)		
Polysaturated fat (g)	8.6	(3.9, 16.1)	9.3 <sup>d</sup>	(4.0, 16.9)	8.6	(4.6, 16.1)	8.8 <sup>d</sup>	(5.0, 17.9)	7.8 <sup>ca</sup>	(2.9, 15.2)	6.3	(2.2, 13.8)	9.4 <sup>o</sup>	(4.6, 16.8)		
Carbohydrates (g)	205.5	(148.5, 271.8)	173.8 <sup>bd</sup>	(131.7, 236.8)	211.6 <sup>cd</sup>	(156.2, 276.0)	190.6 <sup>bd</sup>	(136.3, 246.5)	229.9 <sup>abc</sup>	(163.0, 299.0)	233.4	(169.8, 299.0)	198.1 <sup>o</sup>	(143.8, 259.5)		
Vitamin A (mcg ER)	360.3	(175.8, 686.9)	326.6 <sup>c</sup>	(169.6, 645.7)	343.0 <sup>c</sup>	(171.4, 632.1)	468.8 <sup>ab</sup>	(220.8, 863.1)	341.8	(171.9, 647.5)	244.3	(134.4, 486.7)	403.0 <sup>o</sup>	(195.1, 741.6)		
Vitamin C (mg)	35.8	(14.7, 88.7)	33.7 <sup>c</sup>	(12.3, 70.0)	31.3 <sup>c</sup>	(14.9, 82.1)	47.5 <sup>abd</sup>	(23.5, 121.4)	32.6 <sup>c</sup>	(12.5, 86.9)	21.9	(8.1, 62.3)	41.2 <sup>o</sup>	(18.2, 93.6)		
Folate (mcg)	220.9	(133.7, 339.0)	215.1 <sup>bd</sup>	(124.5, 338.5)	229.9 <sup>acd</sup>	(149.8, 355.9)	187.7 <sup>bd</sup>	(112.1, 270.1)	238.2 <sup>abc</sup>	(141.8, 357.9)	250.3	(141.8, 386.0)	213.4 <sup>o</sup>	(129.9, 325.1)		
Iron (mg)	8.3	(5.9, 11.7)	8.5 <sup>c</sup>	(6.0, 12.2)	8.4 <sup>c</sup>	(6.1, 11.2)	6.8 <sup>abd</sup>	(5.1, 9.6)	9.2 <sup>c</sup>	(6.5, 12.5)	9.4	(6.8, 12.6)	7.9 <sup>o</sup>	(5.8, 11.1)		
Zinc (mg)	6.0	(4.2, 8.4)	5.7 <sup>bd</sup>	(3.9, 8.0)	6.0 <sup>bc</sup>	(4.4, 8.4)	5.6 <sup>bd</sup>	(3.7, 7.7)	6.3 <sup>ac</sup>	(4.6, 8.8)	6.0	(4.2, 8.2)	6.0	(4.2, 8.4)		
Calcium (mg)	673.2	(444.9, 966.2)	513 <sup>bd</sup>	(360.5, 776.4)	714.1 <sup>ac</sup>	(492.0, 1049.6)	665.9 <sup>bd</sup>	(417.6, 901.9)	733 <sup>ac</sup>	(497.5, 1005.6)	729.6	(497.5, 978.5)	652.9 <sup>o</sup>	(434.1, 958.9)		
<b>Adequacy (%)</b>																
Energy	70.7	52.0	94.4	64.2 <sup>bd</sup>	44.5	83.7	72.0 <sup>cd</sup>	(53.1, 97.6)	65.7 <sup>d</sup>	(49.4, 88.9)	77.3 <sup>abc</sup>	(58.0, 101.0)	74.7	(55.9, 97.5)	69.8 <sup>o</sup>	(51.0, 93.4)
Fiber	67.6	(45.9, 100.0)	54.8 <sup>bd</sup>	(36.1, 84.6)	74.3 <sup>bc</sup>	(52.3, 105.0)	57.1 <sup>bd</sup>	(36.8, 77.8)	80.0 <sup>bc</sup>	(50.8, 118.2)	92.7	(60.7, 133.3)	60.9 <sup>o</sup>	(42.0, 89.3)		
Protein	98.9	(72.9, 136.0)	94.1 <sup>d</sup>	(67.8, 129.5)	100.1	(72.2, 136.3)	93.0 <sup>d</sup>	(70.0, 129.7)	105.7 <sup>ac</sup>	(77.5, 145.8)	95.9	(69.3, 131.3)	99.9	(73.7, 137.4)		
Fat	69.9	(43.2, 105.4)	69.4	(42.1, 105.4)	72.9	(45.5, 103.6)	72.4	(48.9, 105.2)	66.4	(38.4, 106.2)	56.3	(34.2, 92.7)	73.2 <sup>o</sup>	(47.8, 109.1)		
Carbohydrates	66.7	(47.3, 88.6)	53.6 <sup>bd</sup>	(39.5, 74.1)	67.9 <sup>acd</sup>	(50.5, 89.8)	60.6 <sup>bd</sup>	(43.1, 80.7)	76.9 <sup>abc</sup>	(54.5, 100.7)	78.5	(58.0, 101.7)	63.1 <sup>o</sup>	(45.3, 83.9)		
Vitamin A	68.7	(34.1, 135.6)	61.4	(30.3, 127.3)	64.9	(33.5, 124.0)	92.7	(42.4, 172.6)	62.9	(31.7, 125.1)	47.2	(25.2, 95.1)	76.7 <sup>o</sup>	(38.1, 148.3)		
Vitamin C	59.3	(23.5, 145.6)	56.2 <sup>c</sup>	(20.6, 112.3)	52.7	(24.9, 137.6)	82.1 <sup>a</sup>	(40.0, 204.2)	51.1	(19.4, 142.9)	35.8	(12.7, 103.9)	65.8 <sup>o</sup>	(28.5, 154.4)		
Folate	67.0	(39.0, 102.0)	64.5 <sup>c</sup>	(35.3, 101.0)	70.4 <sup>c</sup>	(45.0, 104.2)	58.0 <sup>abd</sup>	(32.4, 84.2)	71.4 <sup>c</sup>	(41.6, 108.7)	73.8	(41.9, 115.1)	64.5 <sup>o</sup>	(38.0, 98.3)		
Iron	101.2	(71.2, 146.0)	99.2 <sup>c</sup>	(66.5, 148.5)	103.2 <sup>cd</sup>	(73.7, 140.6)	83.3 <sup>abd</sup>	(61.9, 121.1)	112.5 <sup>bc</sup>	(76.2, 158.4)	116.1	(79.3, 161.4)	96.8 <sup>o</sup>	(69.5, 140.5)		
Zinc	82.8	(57.6, 117.2)	77.6	(52.5, 112.7)	83.4 <sup>c</sup>	(61.5, 119.1)	77.5 <sup>bd</sup>	(52.0, 111.7)	87.2 <sup>c</sup>	(62.2, 121.3)	82.6	(57.5, 111.0)	83.1	(57.6, 118.3)		
Calcium	64.5	(42.7, 92.0)	50.0 <sup>bcd</sup>	(34.1, 75.2)	68.8 <sup>acd</sup>	(47.3, 100.3)	64.9 <sup>abd</sup>	(41.5, 88.2)	69.0 <sup>bc</sup>	(46.7, 96.7)	68.4	(47.6, 95.3)	63.3 <sup>o</sup>	(41.5, 90.3)		

(Continued)

Table II  
(CONTINUED)

	National <sup>†</sup>		North <sup>§,a</sup>		Center <sup>#,b</sup>		Mexico City <sup>&amp;,c</sup>		South <sup>*,d</sup>		Rural <sup>∞</sup>		Urban <sup>o</sup>	
	Median	(P 25, P 75) %	Median	(P 25, P 75) %	Median	(P 25, P 75) %	Median	(P 25, P 75) %	Median	(P 25, P 75) %	Median	(P 25, P 75) %	Median	(P 25, P 75) %
Prevalence of adequacy < 50%														
Energy	23.1		31.8 <sup>b,d</sup>		22.4 <sup>a</sup>		26.1 <sup>d</sup>		16.6 <sup>c,c</sup>		19.6		24.1 <sup>o</sup>	
Fiber	29.9		41.6 <sup>b,d</sup>		22.4 <sup>a,c</sup>		40.5 <sup>b,d</sup>		24.3 <sup>c,c</sup>		16.5		34.1 <sup>o</sup>	
Protein	10.8		15.6 <sup>d</sup>		10.3		11.7		7.9 <sup>a</sup>		9.8		11.1	
Fat	31.0		32.7		28.9		25.2 <sup>d</sup>		35.5 <sup>c</sup>		48.2		28.7 <sup>o</sup>	
Carbohydrates	29.3		43.4 <sup>b,d</sup>		24.0 <sup>c</sup>		37.3 <sup>b,d</sup>		21.3 <sup>c</sup>		18.1		32.9 <sup>o</sup>	
Vitamin A	38.3		39.6 <sup>c</sup>		39.9 <sup>c</sup>		29.4 <sup>abd</sup>		41.2 <sup>c</sup>		51.8		34.1 <sup>o</sup>	
Vitamin C	45.4		47.9 <sup>c</sup>		48.3 <sup>c</sup>		31.7 <sup>abd</sup>		48.8 <sup>c</sup>		58.4		41.2 <sup>o</sup>	
Folate	34.7		38.6 <sup>b</sup>		29.7 <sup>a</sup>		42.6 <sup>b,d</sup>		32.8 <sup>c</sup>		32.6		35.4	
Iron	11.2		12.6		8.7 <sup>c</sup>		17.9 <sup>b,d</sup>		9.1 <sup>c</sup>		8.8		12.0 <sup>o</sup>	
Zinc	19.2		23.8 <sup>d</sup>		17.0		23.8		16.1 <sup>a</sup>		19.4		19.1	
Calcium	33.8		50.2 <sup>bcd</sup>		24.2 <sup>a</sup>		35.2 <sup>a</sup>		28.7 <sup>a</sup>		28.7		35.4 <sup>o</sup>	

\* Data was adjusted for the survey design (see methods)

† Sample size: 2 596, weighted cases: 28 080 000

‡ Sample size: 776, weighted cases: 5 238 500

# Sample size: 738, weighted cases: 8 913 300

& Sample size: 283, weighted cases: 5 123 900

\* Sample size: 799, weighted cases: 8 804 300

∞ Sample size: 909, weighted cases: 6 785 200

o Sample size: 1 687, weighted cases: 21 294 800

o Statistically different from rural

ab,c,d: Different superindices represent statistically significant differences among regions

Table III  
**NUTRIENT INTAKE, ADEQUACY AND PERCENT OF ADEQUACY <50% BY TERTILE OF SOCIO-ECONOMIC STATUS.\***  
**NATIONAL NUTRITION SURVEY, MEXICO, 1999**

	Low <sup>†,a</sup>		Medium <sup>‡,b</sup>		High <sup>§,c</sup>	
	Median	(P 25, P 75)	Median	(P 25, P 75)	Median	(P 25, P 75)
<b>Intake</b>						
Energy (kcal)	1456 <sup>c</sup>	(1056, 1928)	1433 <sup>c</sup>	(1035, 1851)	1511 <sup>ab</sup>	(1140, 1963)
Fiber (g)	22.6 <sup>bc</sup>	(14.8, 33.6)	16.4 <sup>ac</sup>	(11.3, 24.5)	14.8 <sup>ab</sup>	(10.0, 21.3)
Protein (g)	45.0 <sup>c</sup>	(31.4, 61.2)	46.5 <sup>c</sup>	(32.5, 61.3)	50.3 <sup>ab</sup>	(38.9, 70.0)
Fat (g)	37.0 <sup>bc</sup>	(19.9, 61.7)	49.1 <sup>ac</sup>	(29.6, 72.7)	56.4 <sup>ab</sup>	(39.1, 80.3)
Cholesterol (mg)	93.5 <sup>c</sup>	(17.1, 227.5)	121.3 <sup>c</sup>	(54.6, 247.2)	139.1 <sup>ab</sup>	(85.3, 283.2)
Saturated fat (g)	8.3 <sup>bc</sup>	(3.5, 16.5)	14.2 <sup>ac</sup>	(8.1, 22.5)	20.0 <sup>ab</sup>	(12.8, 28.0)
Monounsaturated fat (g)	9.7 <sup>bc</sup>	(5.0, 17.6)	13.0 <sup>ac</sup>	(8.0, 21.3)	15.9 <sup>ab</sup>	(10.6, 24.4)
Polyunsaturated fat (g)	6.7 <sup>bc</sup>	(2.1, 13.7)	9.0 <sup>a</sup>	(4.2, 18.2)	10.1 <sup>a</sup>	(5.1, 16.3)
Carbohydrates (g)	228.3 <sup>bc</sup>	(165.9, 301.8)	198.5 <sup>a</sup>	(142.4, 256.8)	198.6 <sup>a</sup>	(144.0, 258.3)
Vitamin A (mcg ER)	235.1 <sup>bc</sup>	(132.6, 447.1)	312.4 <sup>ac</sup>	(154.3, 652.7)	484.0 <sup>ab</sup>	(272.4, 863.1)
Vitamin C (mg)	19.3 <sup>bc</sup>	(7.1, 47.6)	34.3 <sup>ac</sup>	(15.0, 80.5)	57.3 <sup>ab</sup>	(24.9, 132.9)
Folate (mcg)	229.9	(133.8, 369.5)	223.8	(126.6, 342.6)	206.2	(138.3, 314.8)
Iron (mg)	9.2 <sup>b</sup>	(6.3, 12.3)	7.7 <sup>ac</sup>	(5.5, 10.8)	8.1 <sup>b</sup>	(6.0, 11.4)
Zinc (mg)	5.9 <sup>c</sup>	(4.1, 7.9)	5.6 <sup>c</sup>	(3.8, 7.6)	6.4 <sup>ab</sup>	(4.5, 8.9)
Calcium (mg)	726.2 <sup>b</sup>	(476.4, 984.9)	622.0 <sup>ac</sup>	(418.2, 891.1)	675.9 <sup>b</sup>	(448.4, 987.8)
<b>Adequacy (%)</b>						
Energy	74.4 <sup>b</sup>	(55.3, 99.4)	68.4 <sup>a</sup>	(49.2, 89.0)	70.9	(52.9, 94.1)
Fiber	87.8 <sup>bc</sup>	(57.6, 131.5)	64.5 <sup>ac</sup>	(44.9, 95.6)	59.0 <sup>ab</sup>	(40.0, 84.0)
Protein	96.4 <sup>c</sup>	(66.6, 129.7)	95.3 <sup>c</sup>	(67.9, 129.7)	104.4 <sup>ab</sup>	(80.3, 147.7)
Fat	56.9 <sup>bc</sup>	(33.1, 95.5)	70.2 <sup>ac</sup>	(43.2, 102.1)	78.4 <sup>ab</sup>	(54.2, 113.7)
Carbohydrates	78.1 <sup>bc</sup>	(56.8, 104.4)	61.9 <sup>a</sup>	(44.5, 82.3)	63.1 <sup>a</sup>	(44.8, 81.1)
Vitamin A	45.9 <sup>c</sup>	(24.2, 88.4)	60.1	(30.5, 130.6)	95.5 <sup>a</sup>	(53.8, 174.4)
Vitamin C	31.7 <sup>c</sup>	(11.7, 75.7)	56.1 <sup>c</sup>	(24.5, 135.6)	95.0 <sup>ab</sup>	(40.7, 222.6)
Folate	68.6 <sup>c</sup>	(39.4, 108.7)	67.9	(37.0, 104.5)	63.0 <sup>a</sup>	(39.9, 96.3)
Iron	109.2 <sup>b</sup>	(73.4, 156.0)	98.7 <sup>a</sup>	(67.7, 141.0)	96.2	(71.8, 142.3)
Zinc	79.2 <sup>c</sup>	(55.8, 107.8)	78.8	(53.4, 111.3)	87.9 <sup>a</sup>	(65.6, 127.6)
Calcium	67.0 <sup>b</sup>	(45.1, 94.2)	59.2 <sup>ac</sup>	(40.6, 85.0)	66.0 <sup>b</sup>	(43.1, 95.0)
<b>Prevalence of adequacy &lt; 50%</b>						
	%		%		%	
Energy	20.7 <sup>b</sup>		27.9 <sup>ac</sup>		20.5 <sup>b</sup>	
Fiber	19.7 <sup>bc</sup>		30.7 <sup>a</sup>		36.9 <sup>a</sup>	
Protein	12.8 <sup>c</sup>		13.2 <sup>c</sup>		7.2 <sup>ab</sup>	
Fat	43.6 <sup>bc</sup>		31.7 <sup>ac</sup>		20.8 <sup>ab</sup>	
Carbohydrates	19.1 <sup>bc</sup>		33.9 <sup>a</sup>		33.0 <sup>a</sup>	
Vitamin A	53.8 <sup>bc</sup>		42.2 <sup>ac</sup>		23.2 <sup>ab</sup>	
Vitamin C	64.7 <sup>bc</sup>		45.2 <sup>ac</sup>		30.7 <sup>ab</sup>	
Folate	35.7		33.8		34.8	
Iron	10.1		13.8		9.9	
Zinc	21.4 <sup>c</sup>		22.0 <sup>c</sup>		15.1 <sup>ab</sup>	
Calcium	31.7		37.3		32.2	

\* Data was adjusted for the survey design (see methods)

<sup>†</sup> Sample size: 877, Weighted cases: 8 159 500

<sup>‡</sup> Sample size: 905, Weighted cases: 9 278 200

<sup>§</sup> Sample size: 814, Weighted cases: 10 641 900

(a,b,c): Different superindices represent statistically significant differences among socio-economic index tertiles

Table IV  
**NUTRIENT INTAKE, ADEQUACY AND PREVALENCE OF ADEQUACY <50% IN OBESE AND NON OBESE WOMEN OLDER THAN 18 YEARS OF AGE. \* NATIONAL NUTRITION SURVEY, MEXICO, 1999**

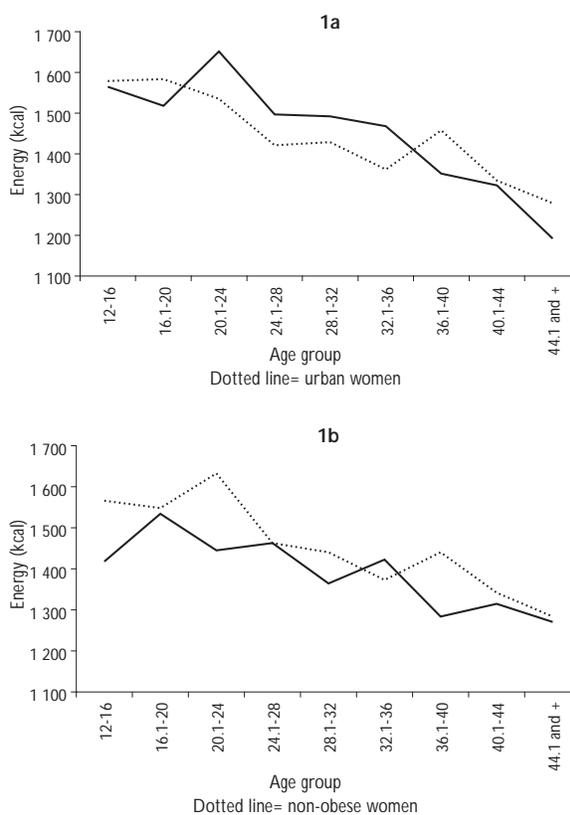
	Non obese <sup>‡</sup>		Obese <sup>§</sup>	
	Median	(P 25, P 75)	Median	(P 25, P 75)
<b>Intake</b>				
Energy (kcal)	1445	(1102, 1870)	1368 <sup>#</sup>	(997, 1743)
Fiber (g)	16.6	(11.6, 24.8)	16.6	(10.7, 24.7)
Protein (g)	47.1	(34.7, 63.7)	44.0 <sup>#</sup>	(31.9, 59.5)
Fat (g)	48.6	(30.3, 71.6)	45.3	(26.6, 69.2)
Cholesterol (mg)	123.6	(61.4, 251.7)	111	(43.4, 255.8)
Saturated fat (g)	15.1	(7.8, 23.7)	12.7	(6.9, 20.7)
Monounsaturated fat (g)	13.4	(8.2, 21.6)	12.2	(7.0, 20.2)
Polyunsaturated fat (g)	8.9	(4.4, 16.3)	7.8 <sup>#</sup>	(2.9, 15.8)
Carbohydrates (g)	202.7	(146.2, 264.1)	192.7	(138.0, 251.1)
Vitamin A (mcg ER)	373.9	(185.3, 711.1)	291.4	(145.8, 611.2)
Vitamin C (mg)	37.6	(15.0, 91.5)	35.1	(14.3, 73.5)
Folate (mcg)	212.7	(129.9, 326.2)	226.9	(126.3, 344.1)
Iron (mg)	8.1	(5.8, 11.5)	8.0	(5.7, 11.0)
Zinc (mg)	6.0	(4.2, 8.2)	5.5 <sup>#</sup>	(3.7, 7.6)
Calcium (mg)	670	(441.4, 939.0)	851.3 <sup>#</sup>	(414.0, 851.3)
<b>Adequacy (%)</b>				
Energy	71.4	(52.8, 93.9)	59.8 <sup>#</sup>	(42.6, 75.7)
Fiber	66.6	(46.1, 99.4)	66.5	(42.9, 98.7)
Protein	101	(75.1, 139.3)	89.6 <sup>#</sup>	(64.6, 119.0)
Fat	70.6	(45.5, 107.1)	57.3 <sup>#</sup>	(35.2, 88.6)
Carbohydrates	66.2	(47.3, 88.6)	55.9 <sup>#</sup>	(40.5, 73.0)
Vitamin A	75.7	(37.57, 147.8)	58.7	(30.0, 126.2)
Vitamin C	63.1	(25.4, 153.7)	58.5	(24.0, 122.5)
Folate	66.5	(40.6, 102.0)	70.9	(39.5, 107.6)
Iron	100.5	(72.3, 142.8)	99.4	(70.6, 136.9)
Zinc	88.4	(62.6, 122.3)	81.1 <sup>#</sup>	(55.2, 112.5)
Calcium	66.8	(44.1, 91.6)	58.1	(40.5, 85.1)
<b>Prevalence of adequacy &lt;50%</b>				
Energy		21.5		37.9 <sup>#</sup>
Fiber		29.6		30.5
Protein		9.5		14.2
Fat		28.3		43.9 <sup>#</sup>
Carbohydrates		29.1		42.5 <sup>#</sup>
Vitamin A		34.6		43.3
Vitamin C		43.4		45.4
Folate		33.2		33.7
Iron		8.7		11.1
Zinc		16.6		21.8
Calcium		32.0		38.3

\* Data was adjusted for the survey design (see methods)

<sup>‡</sup> BMI >18.5 and <30kg/m<sup>2</sup>, Sample size: 1390, weighted cases: 15 426 500

<sup>§</sup> BMI ≥30kg/m<sup>2</sup>, Sample size: 471, weighted cases: 4 931 900

<sup>#</sup> Statistically significant differences between non-obese and obese women



**FIGURE 1. (A). MEDIAN ENERGY CONSUMPTION (KCAL) IN RURAL AND URBAN WOMEN BY AGE GROUP. (B). MEDIAN ENERGY CONSUMPTION (KCAL) IN OBESE AND NON-OBESE WOMEN BY AGE GROUP. NATIONAL NUTRITION SURVEY, MEXICO, 1999**

could be suspected, partially explaining lower median consumptions and adequacies.<sup>1</sup> As other studies have shown, under-reporting of energy intake is associated with bias in estimates of macronutrient intake (low energy intake reporters tend to report a higher percentage of energy from protein and a lower percentage of energy from fat while energy from total carbohydrate is variable).<sup>43</sup> In addition, we applied an updated nutrient composition database with more precise information but different from the one used to analyze the previous survey. Therefore, comparisons between both are limited and must be done carefully.

Our data suggest that protein intake quantity in women is adequate; however, an analysis of the protein quality must be done since there must be clear differences among regions. Consumption of nutrients in this descriptive analysis is not adjusted for energy; therefore, adequacies could reflect in some cases a high-

er net intake rather than better diet quality when comparing factors.<sup>44</sup> Fiber consumption had a prevalence of inadequacy of 29.9% at the national level. By region the Center and South (less developed) had a clearly lower risk of inadequacy than the North and Mexico City regions (22.4 and 24.3 vs. 41.6 and 40.5% respectively). This is due mainly to the fiber content of tortillas, beans and other cereals, since fruit and vegetable intake is low, as suggested from the low micronutrient adequacies and consumption (in particular vitamins A, C and folate). Folate and iron consumption were higher in rural areas, lowest socioeconomic index tertile and the South region of the country. This could be explained by the contribution of beans to the diet, an iron and folate-rich food. However, even though beans contain folate and iron, their phytic acid content decreases the absorption and bio-availability, and the cooking process affects folate dramatically. Fortified foods such as corn and wheat flour, the national vitamin A supplementation program and the National Health, Nutrition and Education programs could be contributing to improve the micronutrient intake in marginal areas.<sup>45</sup> The impact of these policies is currently under evaluation.

Energy consumption decreased with age, reaching the maximum median consumption approximately at 20 years of age and decreasing steadily. This is consistent with results obtained from the U.S. Nutrition Surveys in the American population.<sup>46</sup> Rural women reported higher caloric consumption than urban women from 20 to 36 years of age; this could be explained by a higher energy demand due to higher physical activity and less under-reporting of the 24-h DR questionnaire. Obese women reported less energy consumption than non-obese women across most of the age groups (Figure 1).

Differences within the country among regions, rural and urban areas, and socioeconomic tertiles could indicate that inexpensive calorie-dense foods are becoming more available explaining the higher carbohydrate consumption for marginal groups. On the other hand, cholesterol and saturated and total fat were more frequently consumed by women in the higher SES and urban areas. Micronutrient adequacies were low reflecting a poor consumption of fruits and vegetables throughout the country. These patterns have been associated with increased non-communicable chronic disease morbidity and mortality in a number of studies<sup>47-52</sup> and could be associated with the rising prevalence of obesity and other non-communicable chronic diseases currently reported in Mexico.

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## References

- González-Cossío T, Rivera J, Shamah T, Barquera S, Hernández B, Sepúlveda J. Obesity in Mexico: A growing national epidemic. *Ann Nutr Metabol* 2001;45:405.
- Romieu I, Hernández-Avila M, Rivera JA, Ruel MT, Parra S. Dietary studies in countries experiencing a health transition: Mexico and Central America. *Am J Clin Nutr* 1997;65:1159s-1165s.
- Hernández-Díaz S, Peterson K, Dixit S, Hernández B, Parra S, Barquera S et al. Association of maternal short stature with stunting in Mexican children: common genes vs common environment. *Eur J Clin Nutr* 1999;53:938-945.
- Hernández B, Peterson K, Sobol A, Rivera J, Sepúlveda J, Lezana MA. Overweight in 12-49 year-old women and children under 5 years of age in Mexico. *Salud Publica Mex* 1996;38:178-188.
- Drewnowski A, Popkin BM. The nutrition transition: New trends in the global diet. *Nutr Rev* 1997;55:31-43.
- Murphy S, Rose D, Hudes M, Viteri F. Demographic and economic factors associated with dietary quality for adults in the 1987\_88 nationwide food consumption survey. *J Am Diet Assoc* 1992;92:1352-1357.
- Zeitlin M, Ghassemi H, Mansour M. Positive deviance in child nutrition with emphasis on psychosocial and behavioural aspects and implications for development. Tokyo: The United Nations University, 1990. Vol. Food and Nutrition Bulletin Supplement 141:153.
- Loslier L. Ambiocontrol as a primary factor of health. *Soc Sci Med* 1993;37:735-743.
- Duhl LJ. Urbanization, poverty, and health. *Bull New York Acad Med* 1966;42:369-379.
- Harpham T, Stephens C. Urbanization and health in developing countries. *World Health Statistics Quarterly Report Trimestriel de Statistiques Sanitaires Mondiales* 1991;44:62-69.
- Sepúlveda-Amor J, Angel Lezana M, Tapia-Conyer R, Valdespino J, Madrigal H, Kumate J. Nutritional status of pre-school children and women in Mexico: Results of a probabilistic national survey. *Gaceta Med Mex* 1990;126:207-224.
- Flores M, Melgar H, Cortés C, Rivera M, Rivera J, Sepúlveda J. Energy and nutrient consumption in Mexican women in reproductive age. *Salud Publica Mex* 1998;40:161-171.
- Secretaría de Salud. Programa Nacional de Salud 2001-2006. México DF: SA, 2000:205.
- Zeitlin MF, Ahmed NU, Beiser AS, Zeitlin JA, Super CM, Guldan GS. Developmental, behavioural, and environmental risk factors for diarrhoea among rural Bangladesh children of less than two years. *J Diarrhoeal Dis Res* 1995;13:99-105.
- Barker DJ. Fetal growth and adult disease. *Br J Obstet Gynaecol* 1992;99:275-276.

16. Barker DJ, Hales CN, Fall CH, Osmond C, Phipps K, Clark PM. Type 2 (non-insulin-dependent) diabetes mellitus, hypertension and hyperlipidaemia (syndrome X): Relation to reduced fetal growth. *Diabetologia* 1993;36:62-67.
17. Hales CN. Metabolic consequences of intrauterine growth retardation. *Acta Paediatr* 1997;423(Suppl):184-187.
18. Barker DJ, Osmond C, Simmonds SJ, Wield GA. The relation of small head circumference and thinness at birth to death from cardiovascular disease in adult life. *BMJ* 1993;306:422-426.
19. Hales CN, Barker DJ. Type 2 (non-insulin-dependent) diabetes mellitus: The thrifty phenotype hypothesis. *Diabetologia* 1992;35:595-601.
20. Barker DJ. Maternal nutrition, fetal nutrition, and disease in later life. *J Nutr* 1997;13:807-813.
21. Resano-Pérez E, Vicencio-Acevedo C, Landeros-Díaz A, Shamah-Levy T, Rivera-Dommarco J. Metodología. En: Rivera-Dommarco J, Shamah-Levy T, Villalpando-Hernández S, González-Cossio T, Hernández-Prado B, Sepúlveda-Amor J, ed. Encuesta Nacional de Nutrición II: Estado nutricional de niños y mujeres en México. Cuernavaca, Morelos: Instituto Nacional de Salud Pública, 2000:21-28.
22. Rivera-Dommarco J, Shamah-Levy T, Villalpando-Hernández S, González-Cossio T, Hernández-Prado B, Sepúlveda-Amor J, ed. Encuesta Nacional de Nutrición II: Estado Nutricional de Niños y Mujeres en México. Cuernavaca, Morelos: Instituto Nacional de Salud Pública, 2000.
23. US Department of Agriculture, Agricultural Research Service. USDA Nutrient Database for Standard Reference, Release 13. Nutrient Data Laboratory, 1999.
24. Food composition database. Davis (CA): University of California-Davis, 1998.
25. Instituto de Nutrición de Centroamérica y Panamá. Tabla de composición de alimentos para uso en América Latina. Guatemala: Panamerican Health Organization-Instituto de Nutrición de Centroamérica y Panamá, 1961-98.
26. Morales J, Babinsky V, Bourges H, Camacho M. Tablas de composición de alimentos mexicanos del Instituto Nacional de Ciencias Médicas y Nutrición Salvador Zubirán. Mexico DF: Instituto Nacional de Nutrición, 1999.
27. Muñoz M, Chávez A, Pérez-Gil F, Roldán JA, Ledesma JA, Hernández-Cordero SL. Tablas de valor nutritivo de los alimentos de mayor consumo en México. Mexico, DF: Editorial Pax, 1996:330.
28. Souci S, Fachmann W, Kraut H. Food composition and nutrition tables. En: Sener HSuF, Ed. Stuttgart: Medpharm Scientific Publications/CRC Press, 2000.
29. Institute of Medicine Dietary reference intakes for: Calcium, phosphorus, magnesium, vitamin D and fluoride. Washington, DC: Institute of Medicine, National Academy Press, 2000:432.
30. Institute of Medicine Dietary reference intakes for: Vitamin C, vitamin E, selenium and carotenoids. Washington, DC: Institute of Medicine, National Academy Press, 2000:506.
31. Institute of Medicine Dietary reference intakes for: Thiamin, riboflavin, niacin, vitamin B6, folate, vitamin B12, pantothenic acid, biotin, and choline. Washington, DC: Institute of Medicine, National Academy Press, 2000:564.
32. Institute of Medicine Dietary reference intakes for: Vitamin A, vitamin K, arsenic, boron, chromium, copper, iodine, iron, manganese, molybdenum, nickel, silicon, vanadium, and zinc. Washington, DC: Institute of Medicine, National Academy Press, 2001:650.
33. Institute of Medicine Dietary reference intakes for energy, carbohydrate, fiber, fat, fatty acids, cholesterol, protein, and amino acids (macronutrients). Washington, DC: Institute of Medicine, National Academy Press, 2002: 207-608.
34. National Research Council. Recommended dietary allowances. Washington, DC: National Academy Press, 1989.
35. Millns H, Woodward M, Bolton-Smith C. Is it necessary to transform nutrient variables prior to statistical analyses? *Am J Epidemiol* 1995;141:251-262.
36. SPSS for Windows. Release 10.0. Chicago (IL): SPSS Inc., 1999.
37. Stata Corp. Stata Reference Manual Release 7. Texas: Stata Press, 2001:Vol. 1-4.
38. Popkin BM. The nutrition transition in low-income countries: An emerging crisis. *Nutr Rev* 1994;52:285-298.
39. Gibson R. Principles of nutritional assessment. Nueva York (NY): Oxford University Press, 1990:691.
40. Madrigal H, Martínez H. Manual de encuestas de dieta. Cuernavaca, Morelos: Instituto Nacional de Salud Pública, 1996: Perspectiva en Salud Pública 23.
41. Campirano F, Barquera S, Rivera J, Hernández-Prado B, Flores M, Monterrubio E. Estimation of energy under-reporting in obese and non-obese Mexican women using different equations: Analysis of the Mexican Nutrition Survey. *Ann Nutr Metabol* 2001;45:146.
42. Briefel R, Sempos C, McDowell M, Chien S, Alaimo K. Dietary methods research in the third National Health and Nutrition Examination Surveys: Underreporting of energy intake. *Ame J Clin Nutr* 1997;65:1203S-1209S.
43. Livingstone B, Black A. Markers of the validity of reported energy intake. *J Nutr* 2003 Mar; 133 (Suppl 3):895S-920S.
44. Willett W. Implications of total energy intake for epidemiologic analyses. *Nutritional Epidemiology*. Nueva York (NY): Oxford University Press, 1990:396.
45. Barquera S, Rivera J, Gasca-García A. Políticas y programas de alimentación y nutrición en México [Food and nutrition policy and programs in Mexico]. *Salud Publica Mex* 2001;43:1-14.
46. Bray G. Etiology and pathogenesis of obesity. *Clin Cornerstone* 1999;2:1-15.
47. Hu FB, Manson JE, Stampfer MJ, Colditz G, Liu S, Solomon CG *et al*. Diet, lifestyle, and the risk of type 2 diabetes mellitus in women. *N Engl J Med* 2001;345:790-797.
48. Hu FB, Willett WC. Diet and coronary heart disease: Findings from the Nurses' Health Study and Health Professionals' Follow-up Study. *J Nutr Health Aging* 2001;5:132-138.
49. Liu S, Manson JE, Lee IM, Cole SR, Hennekens CH, Willett WC *et al*. Fruit and vegetable intake and risk of cardiovascular disease: The Women's Health Study. *Am J Clin Nutr* 2000;72:922-928.
50. Liu S, Buring JE, Sesso HD, Rimm EB, Willett WC, Manson JE. A prospective study of dietary fiber intake and risk of cardiovascular disease among women. *J Am Coll Cardiol* 2002;39:49-56.
51. Fung TT, Willett WC, Stampfer MJ, Manson JE, Hu FB. Dietary patterns and the risk of coronary heart disease in women. *Arch Intern Med* 2001;161:1857-1862.
52. Tucker K, Selhub J, Wilson P, Rosenberg I. Dietary intake pattern relates to plasma folate and homocysteine concentrations in the Framingham Heart Study. *J Nutr* 1996;126:3025-3031.