Fruit and vegetable intake in the Mexican population: Results from the Mexican National Health and Nutrition Survey 2006

Ivonne Ramírez-Silva, MSc,[1] Juan A Rivera, PhD,[1] Xochitl Ponce, MSc,[1]
Mauricio Hernández-Ávila, MD, PhD.[2]

Ramírez-Silva I, Rivera JA, Ponce X, Hernández-Ávila M. Fruit and vegetable intake in the Mexican population: Results from the Mexican National Health and Nutrition Survey 2006. Salud Publica Mex 2009;51 suppl 4:S574-S585.

Abstract

Objective. To quantify fruit and vegetable (FV) dietary intake in the Mexican population and compliance with international recommendations. **Material and Methods**. FV dietary intake (FV-DI) and compliance with international recommendations were obtained in a representative sample of a Mexican population ages 1-59 years old using dietary data from the Mexican National Health and Nutrition Survey 2006 (ENSANUT 2006). **Results**. Average FV-DI for different age groups range from 61 to 72 g for fruits and 26 to 56 g for vegetables. Average total FV intakes were 88.7 g in preschool-age, 103.1 g in school-aged children, 116.3 g in adolescents and 122.6 g in adults. The lowest intakes were observed in the northern region and among the population with the lowest wellbeing levels. **Conclusions**. Less than 30% of the Mexican population had adequate intakes of FV. Developing and implementing strategies aimed at increasing intake of these food groups is a national priority.

Key words: fruits; vegetables; children; adolescents; adults; Mexico

Ramírez-Silva I, Rivera JA, Ponce X, Hernández-Ávila M. Consumo de frutas y verduras en la población mexicana: resultados de la Encuesta Nacional de Salud y Nutrición 2006. Salud Publica Mex 2009;51 supl 4:S574-S585.

Resumen

Objetivo. Cuantificar la ingestión dietética de frutas y verduras y el apego a recomendaciones internacionales en la población mexicana. **Material y métodos**. La ingestión dietética de frutas y verduras y el apego a recomendaciones fueron obtenidas en una muestra representativa de la población mexicana de entre 1 a 59 años de edad, usando datos sobre dieta de la Encuesta Nacional de Salud y Nutrición 2006 (ENSANUT 2006). **Resultados**. Los promedios de ingestión dietética para los diversos grupos de edad fluctuaron entre 61 y 72 g en frutas y 26 y 56 g en verduras. Los promedios de ingestión dietética total de frutas y verduras fueron: 87.5 g en preescolares, 103.1 g en escolares, 116.3 g en adolescentes y 122.6 g en adultos. Los menores consumos se observaron en la región norte y en la población con los menores niveles de bienestar. **Conclusiones**. Menos de 30% de la población tuvo consumos adecuados. El desarrollo e implementación de estrategias y programas que contribuyan a aumentar el consumo de estos alimentos es de alta prioridad.

Palabras clave: frutas; verduras; niños; adolescentes; adultos; México

(1) Centro de Investigación en Nutrición y Salud. Instituto Nacional de Salud Pública, Cuernavaca Morelos. México.
(2) Secretaría de Salud. Mexico.

Received on: April 11, 2008 • **Accepted on:** April 28, 2009
Address reprint requests to: Dr. Juan A. Rivera Dommarco. Instituto Nacional de Salud Pública. Av. Universidad 655, col. Santa María Ahuacatitlán. 62100 Cuernavaca, Morelos, México.
E-mail: jrivera@correo.insp.mx

The World Health Organization (WHO) estimates that 2.7 million lives lost due to cardiovascular disease could be prevented if fruit and vegetable (FV) intake were adequate.[1] FV have beneficial effects on health and on body mass index (BMI) since they provide vitamins, minerals, fiber, and other dietary factors, such as photochemicals with different protective effects, stimulating the immune system and other physiological systems.[2,3] It has been largely documented that a high FV consumption is associated primarily or secondarily with less incidence of obesity,[4-6] cardiovascular disease,[7-10] diabetes mellitus type II,[10,11] and several types of cancer.[12] Several of these chronic diseases are currently of high prevalence among the Mexican population.[13,14] Obesity is a risk factor for the development of chronic diseases.[15] FV intake play an important role in preventing overweight and obesity due to their ability to produce satiety, their high fiber and water content, and their low energy density.[6] In addition, a low intake of FV has a detrimental effect on mineral and vitamin status, with negative consequences on health.[16,17] Based on food balance sheet data, availability of FV has increased worldwide; however, their consumption has decreased in some countries, particularly in low and middle income countries.[8,18] It has been documented that FV intake is far less than the recommended amounts.[19] A 30% decrease in FV purchases at the household level in Mexico has been documented.[20] However, there is no nationally representative information regarding FV dietary intake (DI) in Mexico.

Therefore, the objective of this study is to describe FV intake as well as compliance with international recommendations in the Mexican population aged 1 to 59 years old and in key relevant subpopulations. The information from this study can help identify research questions and develop actions, strategies and policies aimed at improving FV intake among the Mexican population.

Material and Methods

Population and study design

Data analyzed came from the Mexican National Health and Nutrition Survey 2006 (ENSANUT 2006) conducted between October 2005 to May 2006, which collected information from 48 304 households. A detailed description of sample procedures and methodology has been published elsewhere.[21] The probabilistic sample is representative at the national level and of rural and urban areas, the 31 states and Mexico City.

The aim of the ENSANUT 2006 was to collect information on the health and nutrition of the Mexican population. Analyses in this article include information from a random subsample of about 30% of the population for which dietary data were obtained. This subsample is representative of the Mexican population and provides adequate numbers for estimations for most of the categories studied.

Age groups considered for this study were: preschool-age children (1 to 4 years old), school-age children (5 to 11 years old), adolescents (12 to 18 years old) and adults (19 to 59 years old).

Data collection

Dietary data: Dietary data were obtained through a 7-day semi-quantitative Food Frequency Questionnaire (FFQ). The FFQ listed 101 foods including 13 fruits and 19 vegetables. A detailed description of the dietary data collection and processing can be found elsewhere.[22]
Anthropometric data: Weight and length (for children < 2 years) or height (for subjects 2 years of age or older) of each subject were obtained according to techniques described by Lohman (1981)[23] by trained and standardized personnel.[24] Weight (in kg) was obtained and recorded with a precision of 100 g using digital scales (Model 1583, Tanita, Tokyo, Japan) which were calibrated daily. Height was measured using a wall stadimeter with a 2 m capacity and a 1 mm precision (Model E-1, Dyna Top, Mexico City, Mexico) and length was measured using a locally made wooden board with 1 mm precision. Height, length and weight data were used to compute anthropometric indicators to classify individuals into overweight and obesity categories. Body mass index (weight/[height]^2) (kg/[m]^2) was computed for individuals from 5 to 59 years of age. For children from 1 to 4 years old, weight for height z-scores (WHZ) were obtained based on the new WHO growth standards published in 2006,[25] using the processing program provided by WHO.[26]
Sociodemographic data: Demographic data and housing characteristics were obtained using a household questionnaire. The information for the purpose of this analysis included: head of household schooling, age of the subjects studied, ethnic background (indigenous or non-indigenous), characteristics of the household and possession of goods.

Ethical considerations

Consent for participation was obtained. The project was approved by the Human Subjects Committee of the National Institute of Public Health (Instituto Nacional de Salud Pública, INSP).

Variables included in analyses

The variables for this study included FV dietary intake (g), adequacy of FV (% population consuming total or one-half of amounts recommended by the World Health Organization and the American Heart Association –AHA–), region of the country, area of residence (urban or rural), household wellbeing condition index (HWCI), ethnic background, age, sex and BMI categories.

Definitions: Vegetables were defined as plants having edible parts such as: leaves (cabbage, lettuce, spinach, etc.), stems (celery, etc.), sprouts (asparagus, etc.), flowers (cauliflower, artichoke, etc.), pods (green beans, etc.), roots (carrots, beets, etc.), bulbs (onion, garlic, etc.), fruits culturally considered vegetables in Mexico (tomato, cucumber, avocado, etc.), and green seeds (peas, broad beans), except for mature seeds from spike or gramineae (corn, wheat, rice, oats, etc.) as well as pulses (beans, lentils, chickpeas, and soybeans). Fruits were botanically defined as fleshy edible parts from trees or fresh plants containing seeds.[1]

From this perspective, FV are considered foods characterized as low energy density and rich in vitamins, minerals, fiber and other bioactive components. Therefore, tubers were not considered in the vegetable group in this study, given their high starch content and low contribution of fiber and other micronutrients.[1] Fruit juices were excluded due to their high content of fructose and energy and low fiber content[1] and because of evidence suggesting negative effects on health.[27-29]

Fruit and vegetable of Dietary Intake (FV- DI). The estimation of intake was performed through calculation of grams of food intake per day based on the FFQ.[23]

Consumption was expressed in grams rather than in calories, since most recommendations use this unit. Adequacy intake of FV (AI-FV), was evaluated considering compliance with recommendations to prevent cardiovascular disease as defined by WHO and the AHA.[30,31]

Recommended intakes were 200g for 1 to 4 years-old children, 300 g for 5 to 8 years-old[30] and 400 g for subjects between 9 to 59 years.[31] Subjects were classified into three categories according to their intakes relative to age-specific recommendations: a) adequate intake: at or above recommended intake or adequacy of 100% or more; b) moderately inadequate intake (from 50% to 99% of recommended intake) and c) highly inadequate intake (less than 50% of recommended intake or adequacy less than 50%).

Regions: The country was divided into four regions: 1) north (including the status of Baja California, Baja California Sur, Coahuila, Chihuahua, Durango, Nuevo Leon, Sonora and Tamaulipas); 2) center (Aguascalientes, Colima, Guanajuato, Jalisco, State of Mexico, Michoacan, Morelos, Nayarit, Queretaro, San Luis Potosi, Sinaloa, Zacatecas); 3) Mexico City and 4) south (Campeche, Chiapas, Guerrero, Hidalgo, Oaxaca, Puebla, Quintana Roo, Tabasco, Tlaxcala, Veracruz and Yucatan).

Urban and rural areas: Were characterized according to the National Institute of Statistics, Geography and Informatics criteria, with urban areas as localities with ≥2500 inhabitants and rural areas as localities with < 2 500 inhabitants.

A Household Wellbeing Condition Index (HWCI): Was computed using household characteristics and possession of goods through principal components analysis (PCA). We used the first component of the PCA, which explained 46% of the variance. The variables in the model were floor material, ceiling material, total number of rooms in the household, possession of refrigerator, washing machine and stove as well as the number of electric appliances in the household (radio, TV, video player, telephone, and computer). The HWCI was divided into quintiles to categorize the wellbeing condition; thus, subjects in the low wellbeing quintile had the lowest wellbeing condition and those in the highest quintile (5) had the highest conditions.

Ethnic background: A household was classified as indigenous when at least one member of the household older than five years old spoke an indigenous language.

Body Mass Index categories: For the adult population, BMI cutoff points were those recommended by WHO: underweight <18.5 kg/m^2, overweight 25 to 29.9 kg/m^2 and obesity >30 kg/m^2.[15] For subjects between 5 to 18 years old, cutoff points used were those specific for underweight, overweight and obesity per age and sex, proposed by Cole *et al*.[32] For children younger than five years old, overweight and obese children were defined as weight-for-age z-scores (WAZ) higher than two standard deviations (SD) and underweight children were defined as below -2.0 SD, using the new WHO growth standards.[25,26]

Data analysis

Diet information was examined for validity. Data of individuals with dietary information considered invalid were excluded according to the following criteria: a) individuals with dietary intake adequacies above five standard deviations (SD) for energy and nutrients,

according to estimated average requirements by age and sex, considering physical activity, b) individuals having dietary adequacies lower than 25% of the total daily energy intake; and c) individuals with FV intake (in grams) higher than five standard deviations (intakes considered implausible). Pregnant and breastfeeding women were excluded from the analyses. Average FV-DI and proportion of the population who attained the recommendation were estimated for each age group according to sociodemographic and BMI categories characteristics.

FV-DI intakes were log-transformed to obtain a normal distribution.

Adjusted FV mean intakes and proportion of subjects who complied with recommended intakes AI-FV were estimated using multiple linear regressions and ordinal models, respectively. In both cases, models adjusted for potentially confounding variables (age, sex and HWCI). Statistical tests for the differences among categories of the variables studied were performed using these models. To adjust for the study design, the SVY module in STATA was employed. Statistical significance was stated at a $p< 0.05$.

Results

We analyzed a total of 3 224 children 1-4 years old, 8 294 children 5-11 years old, 7 722 adolescents 12 to 18 years old and 16 349 adults 19 to 59 years old, representing: 7 072 563, 14 802 442, 16 422 791, and 48 908 755 people for each age group, respectively (Table I and II). Table I also shows the sample sizes for all the categories of the variables for which information on intake is presented. For most categories large sample sizes are observed. The smaller samples are found, as expected, in children < 5 years of age. For most categories in this age group sample sizes are above 380. However, relatively small sample sizes (n < 150) are found in Mexico City (n= 149), and in the overweight (n= 128), obesity (n= 62) and underweight (n= 50) categories. For school-age children, the only category with sample size < 150 is the underweight category (n= 117). For adolescents, the only category with less than 150 cases is the underweight category (n= 87) and for adults, none of the categories had < 150 cases.

Fruit and vegetable intake and adequacy

Tables I and II describe daily FV dietary intake by age group, according to sociodemographic and BMI categories. In all age groups fruit intake was substantially higher compared to vegetable intake, with 61.3 g *vs*. 26.2 g for preschool children, 68.9 g *vs*. 34.2 g for school children, 72.9 g *vs*. 43.4 g for adolescents, and 65.8 g *vs*. 56.8 g for adults, respectively. The total amount of FV-DI for each age group is far below recommended intakes. The percentage of subjects with AI-FV was: 30.8% of preschool-age children, 17.0% of school-age children, 19.2% of adolescents and 24.2% of adults.

Results on FV-DI (g) as well as proportions of the AI-FV are presented below by age category.

Preschool-age children: Children from the northern region reported a significantly lower fruit intake compared to children from the south (50.5 *vs*. 65.2 g, respectively; $p< 0.05$). Urban children reported a significantly higher fruit intake compared to children living in rural settings (65.6 *vs*. 53.1 g; $p< 0.05$). Fruit intake had a progressive and significant increase from HWCI quintile 1 to 4 (49.2 g to 85.1 g; $p< 0.05$). Children aged 3 (70.5 g) and 4 (66.3g) years old reported a significantly higher fruit intake compared to children aged 1 year old (47.5 g; $p< 0.05$).

Preschool children living in Mexico City reported the highest vegetable intake (31.9 g) compared to the other regions of the country, while children from the north reported a significantly lower vegetable intake (21.3 g) compared to their counterparts from the other regions ($p< 0.05$). A progressive increase in vegetable intake was observed as HWCI improved ($p< 0.05$). A significantly higher vegetable intake was observed among children with adequate BMI (26.8 g)compared to obese children (17.3 g; p< 0.05). Older children reported a significantly higher vegetable intake compared to younger children (29.0 *vs*. 22.3 g, respectively; $p< 0.05$) (Table I).

Total AI-FV followed the same pattern as FV-DI. Children from the north reported lower AI-FV (28.7%) than children from Mexico City (32.2%; p< 0.05), although differences between center and south were not statistically significant. AI-FV was lower in the first two quintiles of HWCI relative to the upper quintiles ($p< 0.05$) and a trend of higher intake with higher HWCI was evident (Figure 1).

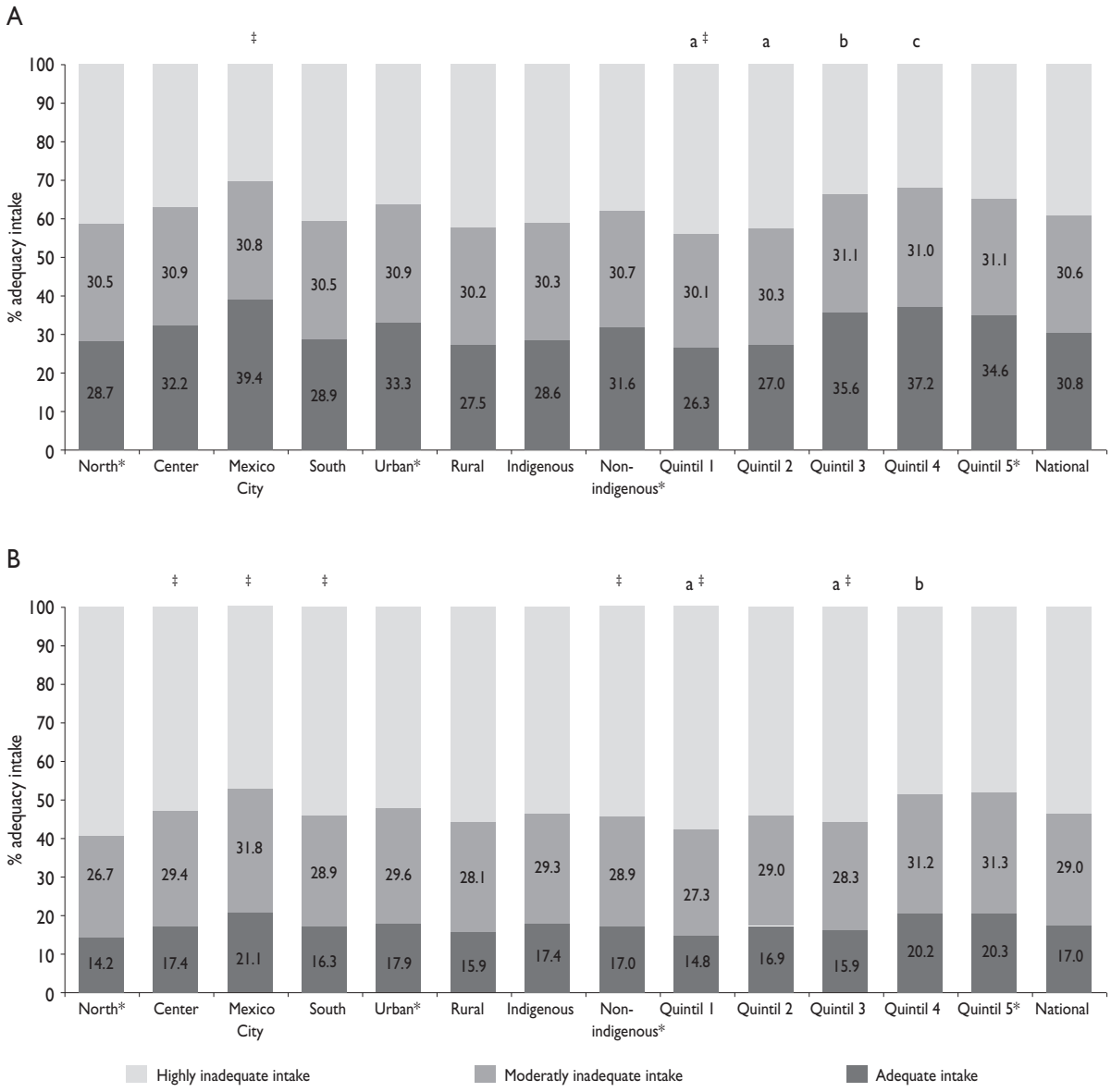
School-age children: Children aged 5 to 11 years living in the north present the lowest fruit intake (53.1 g) compared to children from the other regions ($p< 0.05$) and in particular to children from Mexico City, who presented the highest fruit intake (84. 7 g; $p< 0.05$). Fruit intake among children from the lowest HWCI was the lowest (57.2 g) compared to the better-off group (81.6 g) ($p< 0.001$) and to the intermediate quintiles ($p< 0.05$). Fruit intake in children aged 5 years old was the highest (75.9 g) compared to children aged 9 and 11 years old which reported the lowest fruit intake (62.9 g and 62.5 g, respectively, $p< 0.08$) (Table I).

Table I

FRUIT AND VEGETABLE OF DIETARY INTAKE AMONG PRE-SCHOOL AND SCHOOL CHILDREN BY SOCIODEMOGRAPHIC CHARACTERISTICS. ENSANUT 2006

				Dietary intake*							
				Fruits				Vegetables			
Variables	Categories	N	n	Mean	95% CI		p	Mean	95% CI		p
Pre-school children		7 072 563	3 224	61.3	56.1	67.1		26.2	24.4	28.0	
Region‡	North	1 383 296	523	50.5	41.2	61.9	-	21.3	17.9	25.2	-
	Center	2 187 817	1 244	60.0	50.8	70.9	0.18	27.5	24.4	31.1	<0.01
	Mexico city	1 132 571	149	69.2	50.6	94.7	0.10	31.9	25.7	39.5	<0.01
	South	2 368 879	1 308	65.2	58.4	72.9	0.03	25.6	23.2	28.3	<0.01
Area‡	Urban	5 134 308	1 828	65.6	59.1	72.9	-	27.3	25.0	29.9	
	Rural	1 938 255	1 396	53.1	44.8	62.9	0.04	23.7	20.9	26.9	<0.01
Ethnic background‡	Indigenous	792 714	481	67.3	52.1	87.0	-	28.4	24.2	33.4	
	Non-indigenous	6 279 849	2 743	60.3	54.8	66.5	0.45	25.7	23.8	27.8	0.3
Wellbeing condition§	Quintile 1	1 432 769	863	49.2 [a]	41.1	59.0	0.19	22.8 [a]	20.2	25.7	<0.01
	Quintile 2	1 452 140	767	54 [a]	44.0	66.4	0.44	24.1 [b]	20.6	28.3	<0.01
	Quintile 3	1 479 413	699	73.8 [b]	62.8	86.6	0.26	25.2	21.4	29.7	<0.01
	Quintile 4	1 333 704	506	85.1 [b]	73.4	98.7	0.04	30.7	26.4	35.8	<0.01
	Quintile 5	1 374 537	389	61.5	47.1	80.4	-	35.0	29.6	41.4	
BMI categories‡	Normal	6 629 201	2 984	61.4	56.0	67.3	-	26.8	25.0	28.7	
	Overweight	234 693	128	61.2	43.6	86.1	0.99	19.2	11.6	31.8	0.2
	Obesity	126 892	62	68.0	37.7	122.5	0.74	17.3	8.7	34.2	0.04
	Underweight	81 777	50	42.8	22.7	80.7	0.26	16.1	10.4	25.0	0.2
Sex#	Male	3 562 563	1 661	60.3	53.2	68.3	-	26.2	23.8	28.9	
	Female	3 510 000	1 563	62.3	55.0	70.6	0.73	26.0	23.6	28.6	0.9
Age *(years)*&	1	1 478 344	614	47.5	40.1	56.2	-	22.3	19.0	26.2	
	2	1 644 199	774	57.4	47.6	69.3	0.15	26.4	22.8	30.4	0.12
	3	2 041 914	881	70.5	59.6	83.4	0.00	25.9	22.5	29.8	0.16
	4	1 908 106	955	66.3	55.4	79.4	0.01	29.0	26.0	32.4	0.01
School-age children		14 802 442	8 294	68.9	64.3	74.0		34.2	32.4	36.2	
Region‡	North	2 677 706	1 298	53.1	44.3	63.7	-	28.6	25.7	31.9	-
	Center	4 691 854	3 175	67.9[a]	61.3	75.2	0.02	32.8[a]	30.1	35.7	0.05
	Mexico City	2 303 233	321	84.7[b]	69.9	102.5	<0.01	49.3[b]	42.3	57.5	<0.01
	South	5 129 649	3 500	72.7[a]	65.4	80.7	<0.01	33.8[ab]	31.19	36.6	0.01
Area‡	Urban	10 410 184	4 473	69.1	63.3	75.5	-	35.6	33.3	29.3	-
	Rural	4 392 258	3 821	68.7	60.8	77.5	0.93	31.9	29.3	34.7	0.04
Ethnic background‡	Indigenous	1 832 577	1 306	72.0	59.2	87.6	-	31.9	26.9	37.9	-
	Non-indigenous	12 969 865	6 988	68.4	63.3	73.8	0.64	34.7	32.9	36.7	0.34
Wellbeing condition§	Quintile 1	3 007 939	2 151	57.2[a]	48.5	67.5	<0.01	27.0[a]	23.8	30.6	<0.01
	Quintile 2	2 969 880	2 128	70.2[b]	61.8	79.8	0.09	34.0[b]	30.6	37.8	<0.01
	Quintile 3	3 074 397	1 776	72.1[b]	63.0	82.5	0.19	35.1[bc]	32.2	38.3	<0.01
	Quintile 4	2 831 089	1 246	79.2[b]	68.5	91.6	0.77	40.0[d]	35.9	44.6	0.07
	Quintile 5	2 919 137	993	81.6	71.5	93.1	-	46.5	40.8	53.1	-
BMI categories§	Normal	10 815 549	6 175	68.8	63.8	74.3	-	34.3	32.3	36.4	-
	Overweight	2 438 715	1 358	67.1	57.4	78.4	0.75	35.2	31.3	39.6	0.68
	Obesity	1 335 308	644	70.7	57.0	87.7	0.81	31.5	26.9	36.9	0.29
	Underweight	212 870	117	85.5	62.8	116.3	0.17	39.3	30.6	50.4	0.29
Sex#	Male	7 328 030	4 110	66.9	61.2	73.1	-	33.2	30.9	35.6	-
	Female	7 474 412	4 184	71.0	64.9	77.8	0.28	35.3	32.9	37.9	0.17
Age *(years)*&	5	1 769 808	903	75.9	65.2	88.6	-	33.7	29.6	38.2	-
	6	1 871 805	1 029	73.9	63.2	86.6	0.80	31.7	27.9	36.0	0.51
	7	1 854 811	1 064	77.9[a]	65.1	93.0	0.82	32.4	27.9	37.7	0.71
	8	2 087 778	1 159	65.1	56.2	75.5	0.14	35.1	31.0	39.6	0.64
	9	2 559 947	1 387	62.9[b]	53.9	73.5	0.07	33.6	30.1	37.4	0.97
	10	2 325 086	1 371	71.2	62.7	80.9	0.53	34.2	31.16	37.6	0.82
	11	2 333 207	1 381	62.5	53.4	73.1	0.08	38.3	34.6	42.5	0.10

* Fruits and vegetables dietary intake of in grams
‡ Mean FV of dietary intake adjusted by wellbeing condition, sex, age and effect of study design
§ Mean FV of dietary intake adjusted by sex, age and effect of study design
# Mean FV of dietary intake adjusted by age wellbeing condition and effect of study design
& Mean FV of dietary intake adjusted by sex, wellbeing condition and effect of study design
[a, b, c] Means with different letter are significantly different among them



* Reference variable
‡ $p < 0.05$: Significant difference compared to reference variable
a, b, c: Proportions with different letters are significantly different among them

FIGURE 1. PRE-SCHOOL (A) AND SCHOOL CHILDREN (B) DISTRIBUTIONS OF ADEQUATE PERCENTAGE ACCORDING TO RECOMMENDATIONS. ENSANUT 2006

Vegetable intake was significantly lower in children living in the north (28.6 g) relative to the other three regions ($p < 0.05$). Children living in Mexico City had higher intakes (49.3 g) than those living in the north (28.6 g) and the center (32.8 g; $p < 0.05$). Urban school-age children reported a significantly higher vegetable intake than rural children (35.6 g *vs*. 31.9 g; $p < 0.05$). A significant and progressive increase in vegetable intake was observed as HWCI improved (27.0 g for quintile 1 *vs* 46.5 g for quintile 5; $p < 0.05$) (Table I).

The lowest adequacy of FV intake was reported among children living in the north (14.2%) relative

to the center, Mexico City and the south ($p< 0.05$). Indigenous children had a significantly slightly higher AI-FV compared to non-indigenous children, and the difference was statistically significant (17.4% *vs*. 17.0%, respectively; $p< 0.05$). Better-off children (quintile 5) reported higher adequacy intake than worst-off children (quintiles 1 and 3; $p< 0.05$) and a trend of higher intake with higher HWCI was evident (Figure 1).

Adolescents: Fruit intake was substantially lower in the north (48.7 g) compared to the other regions of the country (center, 77.2 g; Mexico City, 75.2 g; and south, 81.9g; $p< 0.05$). Surprisingly, indigenous adolescents, a group that lives in poverty, reported a significantly higher fruit intake (87.3 g) than non-indigenous adolescents (70.6 g; $p< 0.05$). Eighteen year-old adolescents had significantly lower intakes than adolescents from other age groups ($p< 0.05$).

Vegetable intake in the north (35.7 g) was significantly lower than intake in the center (44.7 g), Mexico City (50.2 g) and the south (43.1 g; $p< 0.05$). A significant and progressive increase in vegetable intake was documented from quintile 1 (36.1 g) to quintile 4 (52.5 g; $p< 0.05$) (Table II).

Adolescents from the north of the country reported lower adequacy of FV intake (15.9%; $p< 0.05$) compared to adolescents from the other regions (center, 19.0%; Mexico City, 22.2%; and the south, 20.2%). Adolescents from quintile 1 (16.6%) reported lower AI-FV relative to adolescents from quintile 4 (22.6%) and 5 (21.1%; $p< 0.05$) (Figure 2).

Adults: Fruit intake was significantly lower in subjects living in the north (45.7 g) compared to the other regions of the country ($p <$center, 67.3 g; Mexico City, 68.2 g; and south, 75.9 g; $p< 0.05$). Fruit intake significantly and progressively increased from quintile 1 (55.4 g) to 5 (101.9 g). All differences with the highest quintile were statistically significant ($p< 0.05$). Overweight subjects consumed a significantly higher fruit intake than obese adults (74.1 g *vs*. 61.9 g, respectively; $p< 0.05$). A significantly higher intake of fruit was observed among women (75.5 g) compared to men (52.3 g; $p< 0.05$). Fruit intake significantly and progressively increased with age (19 to 29 years old, 53.4 g; 30 to 39 years old, 69 g; 40 to 59 years old, 74.1 g). Differences between the youngest and all other groups were statistically significant ($p< 0.05$) (Table II).

Adults living in the north (49.9 g) reported a significantly lower vegetable intake compared to those living in the center (59.8 g), Mexico City (61.5 g) and the south (56.2 g; $p< 0.05$). There was a significant and progressive increase in vegetable intake form quintile 1 (43.2 g) to quintile 5 (87.2 g; $p< 0.05$). Overweight adults reported a significantly higher vegetable intake (60.5 g) than underweight adults (37.8 g; $p< 0.05$). Women's vegetable intake (61.2g) was significantly higher than men's 50.2 g; $p< 0.05$). Adults aged 19 to 29 years old reported a significantly lower vegetable intake (47.1 g) compared to older adults ($p< 0.05$) and adults between 40 to 49 years old reported a significantly higher vegetable intake compared to their counterparts (63.2 g; $p< 0.05$) (Table II).

Subjects with the lowest percentages of AI-FV were found in the north (20.4%) and in the low HWCI (19.6%); compared to their counterparts ($p< 0.05$). A clear trend of higher intake with higher HWCI was observed (Figure 2).

In summary, the overall results show consistent FV intake patterns across age categories for regions and wellbeing conditions. Residents from the northern region of the country had the lowest average intake of both fruits and vegetables compared with all other regions, for all age groups. In general, amounts of both fruits and vegetables consumed among those in the poor (lower HWCI) quintiles were inferior to those in the high HWCI quintiles. An exception was fruit intake in adolescents, where no differences among HWCI quintiles were observed.

Differences in intakes among categories of other variables were not consistent across age groups. Intakes in rural areas were lower than in urban areas in children less than five years old (of both fruits and vegetables) and in school-age children (only of vegetables). In contrast, fruit intake in adolescents was lower in urban relative to rural areas. Intakes of both fruits and vegetables were lower at younger ages in children less than 5 years old (≤ 2 years *vs*. ≥ 3 years) and adults (< 29 years *vs*. ≥ 30 years) and vegetable intake was also lower in younger adolescents (12 years *vs*. 13 and 14 years). In contrast, for adolescents, older subjects had lower fruit intakes than younger subjects (18 years *vs*. 12, 16 and 17 years). Female adults had higher FV-DI but not female children. Intakes were similar in indigenous and non-indigenous populations, with the only exception being fruit intake, which was lower in non-indigenous adolescents. Patterns were not consistent for BMI categories.

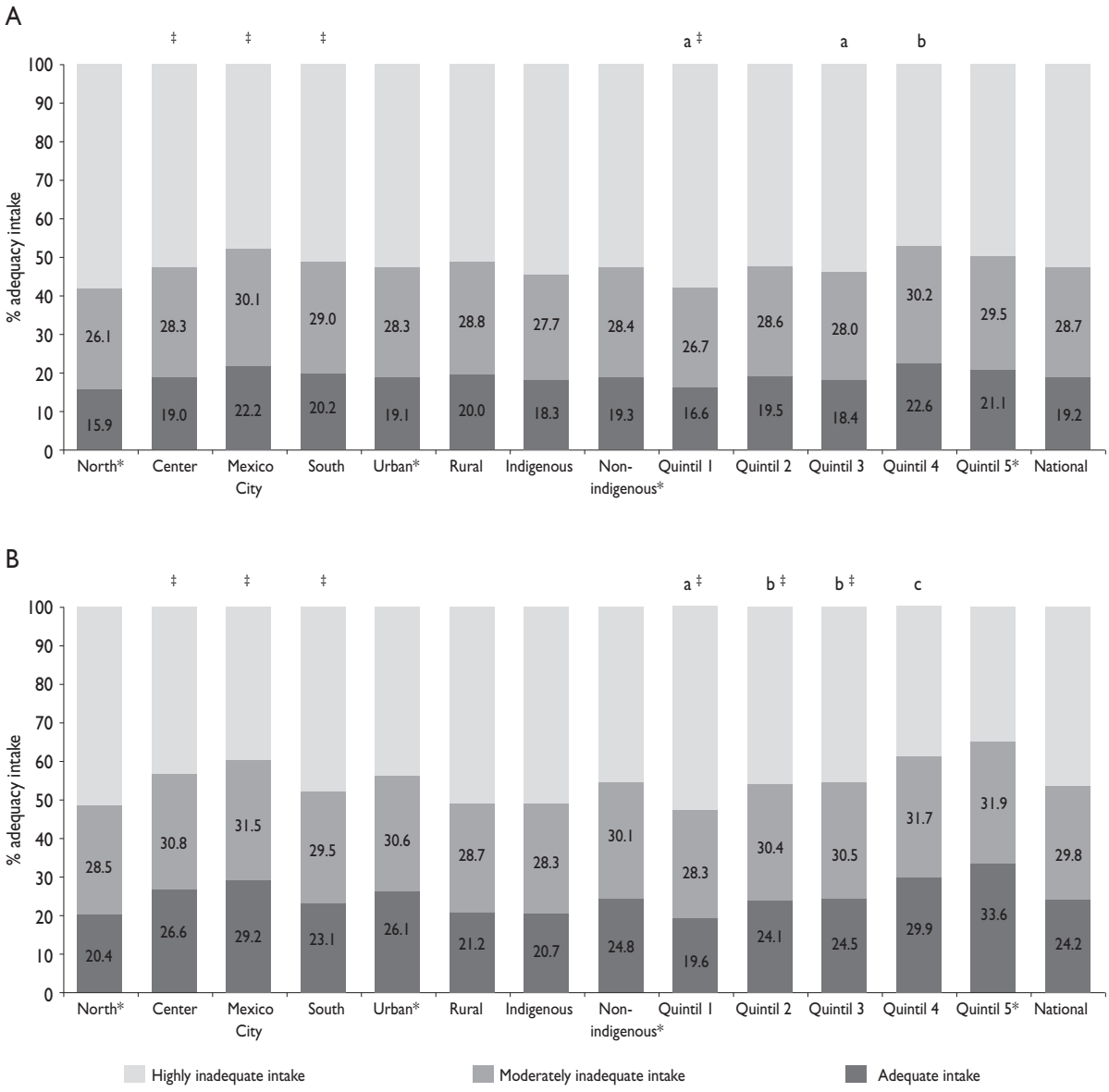
Large percentages of subjects with highly inadequate intakes of FV (less than 50% of the recommended intake) were observed in all age groups. The proportions with highly inadequate intakes were about 40% in preschool-age children, between 50 and 60% in school-age children and adolescents, and between 40 and 50% in adults.

Table II

FRUIT AND VEGETABLES OF DIETARY INTAKES AMONG ADOLESCENTS AND ADULTS BY SOCIODEMOGRAPHIC CHARACTERISTICS. ENSANUT 2006

				*Dietary intake**							
				Fruits				*Vegetables*			
Variables	*Categories*	*N*	*n*	*Mean*	*95% CI*		*p*	*Mean*	*95% CI*		*p*
Adolescents		16 422 791	7 722	72.9	67.4	78.71		43.4	41.1	45.7	
Region‡	North	3 026 615	1 280	48.7	41.3	57.6	-	35.7	31.9	40.1	-
	Center	5 365 719	3 012	77.2	67.9	87.8	< 0.01	44.7	40.4	49.6	< 0.01
	Mexico City	2 548 316	292	75.2	58.3	96.8	< 0.01	50.2	42.9	58.7	< 0.01
	South	5 482 141	3 138	81.9	72.5	92.6	< 0.01	43.1	40.1	46.4	< 0.01
Area‡	Urban	11 907 018	4 294	69.1	62.7	76.0	-	43.1	40.3	46.1	-
	Rural	4 515 773	3 428	81.1	71.5	92.0	0.05	43.2	39.3	47.5	0.96
Ethnic background‡	Indigenous	1 884 836	1 170	87.3	73.4	103.7		43.8	38.4	50.1	-
	Non-indigenous	14 537 955	6 552	70.6	64.9	76.9	0.04	43.0	40.7	45.5	0.78
Wellbeing condition§	Quintile 1	3 286 293	2 018	64.2	54.1	75.1	0.32	36.1[a]	32.9	39.6	< 0.01
	Quintile 2	3 338 429	2 047	76.2	65.6	88.6	0.7	43.1[b]	39.2	47.4	< 0.01
	Quintile 3	3 250 024	1 480	76.6	67.5	86.6	0.66	42.9[b]	37.9	48.6	< 0.01
	Quintile 4	3 319 402	1 249	81.2	67.2	98.1	0.41	52.5[bc]	48.3	57.1	0.5
	Quintile 5	3 228 643	928	72.7	60.0	88.2	-	49.7	42.7	57.9	-
BMI categories‡	Normal weight	10 487 617	4 949	74.8	68.0	82.2	-	44.8	42.2	47.4	-
	Overweight	3 431 411	1 568	69.4	59.7	80.7	0.4	40.8	35.7	46.7	0.2
	Obesity	1 314 969	654	67.1	52.9	85.2	0.4	41.9	35.4	49.5	0.5
	Underweight	188 969	87	63.1	35.4	112.3	0.6	27.4	18.6	40.3	< 0.01
Sex#	Male	8 268 589	3 905	70.8	63.2	79.2	-	41.5	38.2	44.2	-
	Female	8 154 202	3 817	74.9	67.4	83.1	0.5	45.3	42.2	48.6	0.05
Age *(years)*&	12	2 360 098	1 239	81.1	68.3	95.7	-	38.8	34.5	43.8	-
	13	3 083 748	1 407	74.6	64.4	86.4	0.5	45.4	40.5	50.9	0.05
	14	2 507 994	1 232	73.2	59.3	90.5	0.5	45.5	41.1	50.3	0.05
	15	2 571 901	1 113	75.7	63.1	90.9	0.6	41.1	36.5	46.3	0.50
	16	2 027 100	990	80.0[a]	67.2	95.3	0.9	43.4	35.6	52.9	0.34
	17	1 802 118	880	71.9[a]	59.5	86.9	0.4	45.2	39.8	51.6	0.08
	18	2 069 832	861	52.9[b]	39.8	70.2	0.01	42.9	37.2	49.6	0.28
Adults		48 908 755	16 349	65.8	61.4	70.5		56.8	54.3	59.4	
Region‡	North	9 760 146	3 045	45.7	40.0	52.2	-	49.9	45.6	54.5	-
	Center	14 599 263	6 178	67.3	59.0	76.7	< 0.01	59.8	55.5	64.3	< 0.01
	Mexico City	9 933 681	702	68.2	56.3	82.7	< 0.01	61.5	53.9	70.2	< 0.01
	South	14 615 665	6 424	75.9	69.3	83.1	< 0.01	56.2	52.4	60.3	< 0.01
Area‡	Urban	39 427 895	9 647	64.6	59.6	70.0	-	58.1	55.0	61.3	-
	Rural	9 480 860	6 702	68.9	59.6	79.6	0.45	53.6	49.5	58.0	0.10
Ethnic background‡	Indigenous	4 305 338	2 345	69.9	56.7	86.2	-	58.4	51.9	65.7	-
	Non-indigenous	44 603 417	14 004	65.2	60.6	70.1	0.53	56.5	53.9	59.4	0.62
Wellbeing condition§	Quintile 1	9 807 378	5 591	55.4[a]	48.5	63.1	< 0.01	43.2[a]	39.9	46.8	< 0.01
	Quintile 2	9 811 916	4 053	65.8[b]	57.8	74.9	< 0.01	58.5[b]	53.7	63.7	< 0.01
	Quintile 3	9 747 321	2 968	68.9[b]	61.0	77.9	< 0.01	61.3[bc]	55.8	67.4	< 0.01
	Quintile 4	10 107 607	2 237	75.3[b]	63.9	88.7	< 0.01	78.1[d]	70.9	85.9	0.13
	Quintile 5	9 434 533	1 500	101.9	87.6	118.5	-	87.2	78.9	96.4	-
BMI categories‡	Normal weight	13 076 438	4 459	64.2	56.3	73.1	-	54.8	50.6	59.4	-
	Overweight	17 944 666	5 910	74.1[a]	66.9	82.2	0.06	60.5[a]	56.6	64.7	0.05
	Obesity	14 209 020	4 684	61.9[b]	55.6	69.0	0.67	56.5[ab]	52.6	60.6	0.57
	Underweight	654 815	175	31.9[ab]	12.5	81.4	0.15	37.8[b]	24.5	58.2	0.10
Sex#	Male	19 756 232	6 169	52.3	47.4	57.8	-	50.2	46.7	54.1	-
	Female	29 152 523	10 180	75.5	69.3	82.3	< 0.01	61.2	58.2	64.3	< 0.01
Age *(years)*&	19-29	14 290 585	4 513	53.4	47.3	60.2	-	47.1	43.7	50.8	-
	30-39	14 190 517	5 304	69.0	61.8	77.1	< 0.01	62.0	57.9	66.4	< 0.01
	40-49	11 850 981	4 015	74.1	64.9	84.5	< 0.01	63.2	59.1	67.6	< 0.01
	50-59	8 576 672	2 517	74.1	63.6	86.3	< 0.01	58.1	51.4	65.7	< 0.01

* Fruits and vegetables of dietary intake in grams
‡ Mean FV of dietary intake adjusted by wellbeing condition, sex, age and effect of study design
§ Mean FV of dietary intake adjusted by sex, age and effect of study design
# Mean FV of dietary intake adjusted by age wellbeing condition and effect of study design
& Mean FV of dietary intake adjusted by sex, wellbeing condition and effect of study design
[a, b, c] Means with different letter are significantly different among them



* Reference variable
‡ $p < 0.05$: Significant difference compared to reference variable
a, b, c: Proportions with different letters are significantly different among them

FIGURE 2. ADOLESCENTS (A) AND ADULTS (B) DISTRIBUTIONS OF ADEQUATE PERCENTAGE ACCORDING TO RECOMMENDATIONS. ENSANUT 2006

Discussion

This study documents a low dietary intake of FV among the Mexican population relative to international recommendations. Low intakes were observed both in fruits and vegetables and in all age groups, regions, ethnic groups, wellbeing categories, urban and rural populations and both sexes. Only 30.8% of preschool children, 17.0% of school children, 19.2% of adolescents, and 24.2% of the adult population fulfilled the recommended intakes.

The consistent lower intake in low wellbeing quintiles for all subgroups studied suggests barriers to the FV-DI among the poor. Although data does not allow

identification of the specific reasons for the lower intakes among the poor, the possible reasons include lower demand due to, for example, higher prices of fruits and vegetables per calorie relative to energy-dense low-price foods, and/or to social and cultural factors linked to poverty. Another set of potential reasons may be due to lower FV supply in areas where poor populations live or problems of access to markets due to limitations in transportation systems.

Another consistent finding across all subgroups studied was lower intake of FV in the north, adjusting for wellbeing conditions, age and sex. This finding indicates that there are barriers to the consumption of FV in the north, which are more likely to be in the demand rather than the supply side, given the relative higher development and wellbeing in the north and the fact that the differences persist after adjusting for wellbeing conditions; they may have to do with cultural factors or with changes in food patterns as a result of the food and nutrition transition due to modernization. An alternative cause of lower DI-FV in the north may be that the north faces climate conditions that are less favorable for FV production relative to other regions. Studies should be conducted to identify the reasons for the lower FV-DI in the north.

The fact that the indigenous population's intake is generally similar to the non-indigenous population, after adjusting for wellbeing conditions, suggest that FV supply in Indigenous communities, which are usually more isolated than non-indigenous communities, is not the main problem. It is possible that the more restricted markets in isolated indigenous villages are compensated with local production. This finding reinforces the hypothesis that lower intakes in certain groups are probably more related to demand than supply.

A peculiar finding was the fact that rural and indigenous adolescents intake more fruits than urban and non-indigenous adolescents. Again, it is unlikely that this lower intake could be explained by limitations in supply. It is more likely that it has to do with demand issues, such as changes in eating patterns related to modern and urban life; for example, eating more fast food and outside the home.

Adult women and older adults (≥ 30 years old) consumed more FV than men and than younger adults (19 to 29 years old). This higher intake may reflect a greater interest of women and older adults in health and healthy lifestyles or eating more frequently at home as opposed to eating fast food or away from home.

There was not a consistent pattern of differences in intake among BMI categories. Although there is evidence in the literature that low energy density diets are associated with lower risk of obesity,[3,4] the cross-sectional nature of the data in this study is not adequate to study causal associations. In addition, several other dietary factors and physical activity may explain energy balance. However, despite the lack of a consistent pattern, there were two age groups –children less than five years old (for vegetables) and adults (for fruits)– in which lower BMIs were associated with higher intakes.

The discussion so far has focused on the differences among categories of the variables studied; however, the most important finding is the strikingly low intake of fruits and the even lower intake of vegetables in the population as a whole. The remarkably low intakes are more evident when the percentages of highly inadequate intakes (less than 50% of recommended intakes) are examined. These percentages range from approximately 40 to 60% for the different age groups.

FV-DI in the preschool Mexican population (87.5 g) is comparable to low income Southeast Asian countries such as Bangladesh, India and Nepal (94 g/person/day).[33] In the adolescent and adult population, average consumption (116.3 g and 122.6 g, respectively) would be similar to those of countries such as Estonia, Kazakhstan, Letonia, Lithuania, and the Russian Federation (approximately 195g/person/day). The low consumption in school-age children (103.1 g) is a special case, in which no country was found to be comparable.

Ruel *et al*. and Rojas *et al*. report higher average FV intake in urban than rural areas in developing countries (Burundi, Kenya and Costa Rica).[34,35] Our findings were similar only for children. Although rural areas could have greater access to FV in theory, given that most of the production occurs in these areas, however consumption is usually low probably because most of the production goes to the market and that availability of a variety of FV is more sustainable throughout the year in urban areas.[36,37]

Another identified factor associated with DI-FV in the Mexican population was wellbeing conditions. Studies by Fouéré *et al*.[38] and Arimond and Ruel[39] found that decreasing economic income was associated with lower DI-FV in Africa, Cambodia, Nepal, Colombia, Peru and Haiti. Hatloy[40] reported that when economic income increases in Mali, food diversity also increases, and as a consequence, intake of FV is higher.

It was also found that adult women presented higher DI-FV relative to adult men, consistent with what has been observed in African populations.[34] A possible explanation that has been given is that women give FV intake a higher priority than men in order to improve diet quality.[41]

One of the possible limitations of the present analysis is the considerable number of subjects who were lost

as a result of data cleaning and missing data (18.6% pre-school children and 11.6% school children), which could have biased the sample. Analyses were made to determine differences between excluded and non-excluded subjects in the following variables: region, rural/urban area, ethnic background, wellbeing condition quintiles, BMI category, sex, and age. In general, no statistically significant differences were observed in the variables compared ($p > 0.05$), except for certain particular ages in pre-school children, ethnic background, urban/rural residence and BMI categories in school-age children. A higher proportion of excluded subjects were found at 1 and 2 years of age. Also, a greater proportion of excluded subjects were found in the urban area, non-indigenous and school-age children with adequate BMI. For adults and adolescents, the proportions not included in the analysis (3.4% and 4.2%, respectively) were lower than for children.

There were no estimations of FV intake at the national level before this study. The data analyzed comes from the ENSANUT 2006, which was designed to be representative at national, regional and state levels and by urban and rural areas. Since we excluded foods with high starch content like tubers or pulses, which are high in energy density and protein, our results do not overestimate FV intake as could be the case of other studies[43,44] where pulses, potatoes and potato chips were considered as vegetables.

In order to evaluate AI-FV in the pre-school and school population, recommendations from the AHA were adopted. One limitation of this recommendation is that they were made for children from the United States and not for Mexican children. The adult recommendations may be more appropriate since they were made by WHO considering a more international scope.

One limitation of the data is that it does not provide information as to the form in which FV were prepared for consumption. Identifying if FV were fried, boiled or dressed or raw would be important in different studies, as healthy FV could be fried or consumed along with high energy density foods like butter, mayonnaise, and other dressings.

In conclusion, FV intake in the Mexican population was much lower than recommended intakes in all age groups and, particularly, in the school-age and adolescent population. Vegetable intake was much lower than fruit intake. Fruit intake was 2 to 5 times higher than vegetable intake in the different groups, with the highest differences in school-age children and adolescents. In general, the population living in the northern region and lowest HWCI were the subgroups having the lowest intakes and the lowest compliances with recommended intakes of FV. Some subgroups had higher FV-DI, such as the population living in Mexico City and those classified in the highest HWCI; unfortunately this consumption did not reach average recommended intakes and even in these subgroups the percentages of individuals who complied with recommendations were in all cases less than 35%.

Research is needed to better understand the reasons for the general low intakes and in certain subgroups. Using the results of this research, the development and implementation of programs, strategies and policies aimed at improving FV intake in the different population groups is recommended. This could be done through: a) information and communication strategies aimed at improving food preferences towards a higher intake of FV in all age groups, and b) improving the availability and lowering the prices of these foods for lower income households as needed. Particular programs should be developed in schools to increase the availability and intake of fruits and to create a new culture of FV consumption in the new generations.

References

1. Agudo A. Measuring intake of fruit and vegetables. Geneva: WHO, 2005.
2. World Cancer Research Fund/American Institute for Cancer Research. Fruit and vegetables. Handbook of cancer prevention. London: WCRF, Washington DC: AICR, 2003: 8.
3. World Health Organization. Fruit, Vegetables and NCD disease prevention. Global, strategy on diet, physical activity and health. Geneva: WHO, 2002.
4. Biing-Hwan L, Mentzer-Morrison R. Higher fruit consumption linked with lower body mass index. Food Rev 2003;25(3):28-32.
5. Lahti-Koski M, Pietinen P, Heliövaara M, Vartiainen E. Associations of body mass index and obesity with physical activity, food choices, alcohol intake, and smoking in the 1982-1997 FINRISK Studies. Am J Clin Nutr 2002;75:809-817.
6. Carlton-Tohill B. Dietary intake of fruit and vegetables and management of body weight. Geneva: WHO, 2005.
7. Hu FB. Plant-based foods and prevention of cardiovascular disease: an overview. Am J Clin Nutr 2003;78:544S-551S.
8. World Health Organization. Globalization, Diets and Noncommunicable Diseases. Dietary Transition in Developing Countries: Challenges for Chronic Disease Prevention. Geneva: WHO, 2002.
9. Joshipura KJ, Ascherio A, Manson JE, Stampfer MJ, Rimm EB, Speizer FE, *et al*. Fruit and vegetable intake in relation to risk of ischemic stroke. JAMA 1999;282:1233-1239.
10. Bazzano L. Dietary intake of fruit and vegetables and risk of diabetes mellitus and cardiovascular diseases. Geneva: WHO, 2005.
11. Giacco R, Parillo M, Rivellese A, Lasorella G, Gliacco A, D'episcopo L, *et al*. Long-term dietary treatment with increased amounts of fiber-rich low-glycemic index natural foods improves blood glucose control and reduces the number of hypoglycemic events in type 1 diabetic patients. Diabetes Care 2000;23(10):1461-1466.
12. World Cancer Research Fund / American Institute for Cancer Research. Food, nutrition, physical activity, and the prevention of cancer: a global perpective. Washington, DC: AICR, 2007.

13. Barquera S. Prevención de la diabetes mellitus: un problema mundial. Salud Publica Mex 2003;45:413-414.
14. Olaiz G, Rojas R, Barquera S, Shamah T, Aguilar C, Cravioto P, *et al.* Encuesta Nacional de Salud 2000. Cuernavaca, Morelos, México: Instituto Nacional de Salud Pública, 2000.
15. World Health Organization. Obesity: Preventing and Managing the Global Epidemic. Geneva: WHO, 2000.
16. Bermudez OI, Tucker KL. Trends in dietary patterns of Latin American populations. Cad Saude Publica 2003; suppl 1:S87-S99.
17. Torheim LE, Ouattara F, Diarra MM, Thiam FD, Barikmo I, Hatloy A, *et al.* Nutrient adequacy and dietary diversity in rural Mali: association and determinants. Eur J Clin Nutr 2004;58:594-604.
18. Pollack SL. Consumer Demand for Fruit and Vegetables: The U.S. Example. Washington, DC: Economic Research Service/USDA, Changing Structure of Global Food Consumption and Trade, 2001: 49-54.
19. Rasmussen M, Krølner R, Klepp K, Lytle L. Determinants of fruit and vegetable consumption among children and adolescents: a review of the literature. Part I: quantitative studies. Int J Behav Nutr Phys Act 2006;3:22.
20. Barquera S, Bernier R, Bouchard C, Bush M, Drewnowsky A, Lee J, *et al.* Understanding and overcoming obesity: The need for action. Cuernavaca, Mexico: Instituto Nacional de Salud Pública, 2005.
21. Shamah-Levy T, Villalpando-Hernández S, Rivera-Dommarco JA. Resultados de Nutrición de la ENSANUT 2006. Cuernavaca, Mexico: Instituto Nacional de Salud Pública, 2007.
22. Rodríguez- Ramírez S, Mundo- Rosas V, Jiménez- Aguilar A, Shamah-Levy T. Methodology for the analysis of dietary data from the National Health and Nutrition Survey 2006. Salud Publica Mex 2009;51.
23. Lohman T, Roche AF, Martorell R. Anthropometric Standardization Reference Manual. Champaign(IL): Human Kinetics Books, 1991.
24. Habicht JP. Standardization of quantitative epidemiological methods in the field. Bol Oficina Sanit Panam 1974;76(5):375-384.
25. World Health Organization. Child Growth Standards based on length/height, weight and age. Acta Paediatr 2006;450 Suppl:S76-S85.
26. World Health Organization. WHO Anthro 2005 software and macros. Geneva: WHO, 2006. [Consulted on 2007 Dec 10]. Available at: http://www.who.int/childgrowth/software/en/.
27. Tam CS, Garnett SP, Cowell CT, Campbell K, Cabrera G, Baur LA. Soft drink consumption and excess weight gain in Australian school students: Results from the Nepean study. Int J Obes 2006;30(7):1091-1093.
28. Sanigorski AM, Bell AC. Association of key foods and beverages with obesity in Australian schoolchildren. Public Health Nutr 2007;10(2): 152-157.
29. Bazzano LA, Tricia YL, Joshipura KJ, Hu FB. Fruit and vegetable intake and risk of diabetes in women. Boston: Harvard University Department of Nutrition, 2007.
30. Gidding SS, Dennison BA, Birch LL, Daniels SR, Gillman MW, Lichtenstein AH, et al. American Heart Association. Dietary recommendations for children and adolescents: a guide for practitioners. Pediatrics 2006;117(2):544-559.
31. World Health Organization/Food and Agriculture Organization. Dieta, nutrición y prevención de enfermedades crónicas. Geneva: WHO/FAO, 2003. Serie de informes técnicos 916.
32. Cole TJ, Bellizzi MC, Flegal KM, Dietz WH. Establishing a standard definition for child overweight and obesity worldwide: International survey. BMJ 2000;320:1240-1243.
33. Lock K, Pomerleau J, Causer L, Altmenn D, Mckee M. The global burden of disease attributable to low consumption of fruit and vegetables: implications for the global strategy on diet. Bull World Health Organ 2005;83(2):100-108.
34. Ruel MT, Minot N, Smith L. Paterns and determinants of fruit and vegetable consumption in sub-Saharian Africa: a multi-country comparison. Geneva: WHO, 2005.
35. Rojas R. Fruits and vegetables consumption among Costa Rican adolescents. Arch Latinoam Nutr 2001;51:81-85.
36. Solomons N, Gross R. Urban nutrition in developing countries. Nutr Rev 1995;53:90-95.
37. Delisle H. Patterns of urban food consumption in developing countries: perspective from the 1980's, In: Food Policy and Nutrition Division, FAO, ed. Rome: Food and Agricultural Organization, 1990.
38. Fouéré T, Maire B, Delpeuch F, Martin-Prével Y, Tchibindat F, Adoua-Oyila G. Dietary changes in African urban households in response to currency devaluation: foreseeable risks for health and nutrition. Public Health Nutr 2000;3:293-301.
39. Arimond M, Ruel TM. Dietary Diversity, Dietary Quality and Child BMI categories: Evidence from Eleven Demographic and Health Surveys. Washington, DC: Food and Nutritional Technical Assistance Project (FANTA), 2004.
40. Hatloy A, Hallund J, Diarra MM, Oshaug A. Food variety, socioeconomic status and BMI categories in urban and rural areas in Koutiala (Mali). Public Health Nutr 2000;3:57-65.
41. Smith L. The importance of women's status for child nutrition in developing countries. Washington, DC: International Food Policy Research Institute, 2003.
42. Bazzano L. Dietary intake of fruit and vegetables and risk of diabetes mellitus and cardiovascular diseases. Geneva: WHO, 2005.
43. Gillman MW, Cupples LA, Gagnon D, Posner BM, Ellison RC, Castelli WP, *et al.* Protective effect of fruits and vegetables on development of stroke in men. JAMA 1995;273:1113-1117.
44. Steffen LM, Jacobs DR Jr, Stevens J, Shahar E, Carithers T, Folsom AR. Associations of whole-grain, refined-grain, and fruit and vegetable consumption with risks of all-cause mortality and incident coronary artery disease and ischemic stroke: the Atherosclerosis Risk in Communities (ARIC) Study. Am J Clin Nutr 2003;78:383-390.