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Nutritional status and dietary habits of the population of the Calchaqui Valleys of Tucuman, Argentina

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ABSTRACT

Objective: To assess the nutritional status and dietary habits of the adult population of the Calchaqui Valleys of Tucuman.
Methods: A cross-sectional nutritional survey that included one 24-h recall, a semiquantitative food-frequency questionnaire, and anthropometric measurements was conducted in a representative sample of 113 adult participants. Pregnant and lactating women were excluded. Overweight and obesity were assessed according to body mass index, and the percentage of individuals with cardiovascular risk according to waist circumference and waist-to-hip circumference ratio was determined. Dietary habits were described according to the mean nutrient and food intakes of men and women.
Results: Means ± standard deviations for total energy intake of men and women were 1856 ± 859 and 1589 ± 799 kcal/d, respectively. The average body mass indices of men and women were 26.8 and 26.7 kg/m^2, respectively. Thirty-seven percent of the population was overweight and 22.8% was obese, whereas 1.8% of the population was undernourished. Central adiposity was high (mean waist circumferences 99.8 and 87.3 cm in men and women, respectively).
Conclusions: Despite the low average energy intake, the population under study showed a high prevalence of overweight and obesity and a high risk of cardiovascular disease according to the central adiposity values. These findings could be explained by the introduction of new high-energy foods and a sedentary lifestyle or the possibility that the biological characteristics of these individuals make them more predisposed to a rapid increase in adiposity.

Introduction

The Calchaqui Valleys are in northwest Tucuman province, in Argentina, 1500 to 3500 m above sea level. The region of the Calchaqui Valleys includes the municipality of Tafi del Valle and the communes of El Mollar, Amaicha del Valle, Ampimpa, Colalao del Valle, and El Pichao. The Calchaqui Valleys is an arid region and the climate is dry and harsh, with daily thermal oscillations of 25°C [1]. The population numbered 13 883 according to the 2001 national population census [2]. Each commune operates an effective democratic system and has a political structure that derives from the *ayllu* community-based structure, with a chief who is an authority recognized by all. There are 15 primary educational establishments and one secondary school for all the Valleys. There are two fairly basic hospitals and primary care centers. The health care in this region is simple because it is a rural area with poor access to urban areas [3].

A nutritional transition is defined as changes in patterns of eating and lifestyle and their effect on indicators of health and nutrition and is a consequence of sociodemographic changes linked to urbanization, economic growth, and globalization [4]. In Latin America, where the nutritional transition process has occurred over a short period, dietary changes are characterized by an overall increase in energy intake, mostly from refined sugars and saturated fat, and a decrease in fiber intake, and this is known as the *Westernization* of the diet [5]. In addition to the Westernization of dietary patterns, a feature of the nutritional transition in Argentina is the wide heterogeneity in income and wealth distribution among different provinces and regions of the country [6,7]. In Argentina, there is evidence of food insecurity in certain population groups, and this is attributable to their limited

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access to foods, poverty, and increased levels of unemployment. This insecurity leads to a range of nutritional manifestations. As observed by Doak et al. [8], in a significant proportion of the population undergoing the nutritional transition, undernutrition may coexist with overweight and obesity at the population, household, or individual level, a situation called the *dual burden of malnutrition*.

In the Valleys region, there are many structural problems related to the food supply from a decrease in food production in the region and from the low level of knowledge about health and safety regulations; hence, nutritional assessment studies aimed at evaluating the situation in the region are necessary. The purpose of this study was to assess the nutritional status of the adult population of the Calchaqui Valleys of Tucuman based on the dietary habits and the prevalence of overweight and obesity.

Material and methods

The present study is a population-based cross-sectional nutritional survey carried out in the Calchaqui Valleys of Tucuman, Argentina. The survey was conducted from May through September 2008.

Population and sample

The selection of the sample was done using stratified, random, cluster-sampling procedures. The theoretical sample size was set at 86 families comprising 258 individuals, which was considered to be a sufficiently large sample to ensure an error level below 5% (type I error 0.05, type II error 0.10). To mitigate the effect of non-response, the theoretical sample was increased by 20% to 306 individuals. The visits were made by well-trained interviewers accompanied by a health worker.

Surveys

A questionnaire had been designed by the working group and applied previously in the Andean areas of the Northwest Argentine region [9,10]. It was divided in two parts. The first part was common to all individuals in the household and collected general information about the household, socioeconomic conditions, education of the household head, food security, and access to health. The second part included questions about individual educational level and employment, health status (presence of chronic diseases and/or infections), participation in government food programs, dietary habits, and physical activity patterns.

In the Calchaqui Valleys there is no well-defined geographic division. The urban sector was defined as areas with paved streets near a hospital, health centers, and schools; suburban areas included houses that were on the main road but several miles away from the population center; rural areas were defined as houses without paved streets, at a distance from other houses, and far from population centers.

Dietary questionnaire

Dietary data collection methods comprised a 24-h recall and a semi-quantitative food-frequency questionnaire. The nutrient intake of individuals was determined from the 24-h recall using a food composition table (FCT) with typical dishes from the region. The reference databases for the FCT were the Latin America FCT (LATINFOODS) [11] and the Argentina FCT (ARGENFOOD) [12] and data generated and compiled in different provinces in the north of the country (Salta, Jujuy, Santiago del Estero, and Tucuman).

Anthropometric measurements

Anthropometric measurements were performed according to the recommendations of Frisancho [13]. Height was determined using a mobile anthropometer (Kawe 44444, Kirchner & Wilhelm GmbH, Asperg, Germany). Subjects stood against a wall and remained standing barefoot looking straight ahead at the Frankfurt plane. Readings were taken in centimeters.

Body weight was determined using a digital scale (200-g precision; sc 2504, Tefal Charm, Rumilly, France). The subject was weighed in light clothing without shoes. Two measurements were taken and the average was computed.

The midupper arm circumference, waist circumference, and hip circumference were determined using a non-stretchable measuring tape (Kawe 43972).

The fat-free mass measurement was assessed using a hand-held impedance analyzer (model BF 306, Omron Body Fat Monitor, Omron Healthcare Co. Ltd., Japan). The Omron BF 306 body fat monitor consists of four electrodes, two for each hand. The manual indicates that the margin of fat that can be measured is 4% to 50%. For its calculation, the height, weight, age, and sex of the subject have to be indicated; measurements take about 7 s. Studies have shown that the Omron BF 306 monitor is a reliable tool for measuring body fat percentage in epidemiologic studies [14,15]. Blood pressure was measured using automated blood pressure machines (Omron RX3 Plus).

The nutritional status of adults was determined according to their body mass index (BMI) using the World Health Organization classification [16] (underweight defined as BMI <18.5 kg/m^2, normal weight as BMI 18.5–24.9kg/m^2, overweight as BMI 25–29.9 kg/m^2, obesity as BMI ≥ 30 kg/m^2). To assess central fat deposition, we also considered the cutoff points for men and women of waist circumference and waist-to-hip ratio, as described previously [17,18]. Hypertension was identified when the diastolic/systolic blood pressure was above 90/14 mmHg [19].

Sociodemographic characteristics

The sociodemographic variables included in the present study as possible determinants of nutritional status were sex, age, area (urban, suburban, and rural), socioeconomic status, security of food supply, and household characteristics.

The socioeconomic level was evaluated according to the following variables: occupational level of the head of the household (codified as low, medium, or high according to the methodology described by the National Institute of Statistics and Censuses); educational level of the head of the household classified as low (none or primary school), medium (primary school complete or secondary school incomplete), or high (secondary school complete or university degree); security of food supply was evaluated according to whether the subjects received government aid, produced or grew their own food (yes/no), and if they used preservation techniques. We also assessed the status of the household according to the conditions of hygiene and sanitation (floor type, number of rooms, electricity, bathrooms, waste pipe, kitchen, and drinking water).

Statistical analysis

Analysis was performed using SPSS 15.0 (SPSS, Inc., Chicago, IL, USA). Descriptive analysis relied on cross-tabulations, showing percentages within groups and group medians, means, and standard deviations. Significant differences in percentages between groups were calculated by chi-square test. Student's *t* test for independent samples was used to compare means. Differences were regarded as statistically significant at $P < 0.05$.

Results

The final sample consisted of 230 individuals (72 men and 158 women, age range 0–96 y) from 93 families (response rate 90%). Non-participants included subjects declining to be interviewed and involuntary non-participation because of census errors caused by address changes, empty houses, or unavoidable impediments to survey participation. Only data from adults ($n = 113$, >18 y old) were considered in this study; pregnant and lactating women were excluded.

Table 1 lists the sociodemographic characteristics of the households in the Calchaqui Valleys. The socioeconomic status was low, with most household incomes ranging from 150 to 400 pesos (46.6%), and 63.3% of the population received government aid.

The occupational level of the household head was low (53.6%). Most household heads were men. The average ages of the household heads were 49 $\pm$ 15.6 and 56 $\pm$ 20.6 y for men and women, respectively. Most (75%) had a medium educational level. Only a few inhabitants in the Valleys produced and preserved foods (21.3%). Virtually all households (99%) had electricity

Table 2 lists mean values of anthropometric measurements by sex. There were significant differences between men and women in weight, height, midupper arm and waist circumferences, and fat percentages. The prevalences of overweight and obesity in the sample were 37.7% and 22.8%, respectively, with no difference between the sexes (Table 3).

The mean waist circumferences were 99.8 and 87.3 cm for men and women, respectively. According to these results, 44% of

Table 1
Characteristics of households in the Calchaqui Valleys

Variables	
Area or sector	
Urban	33%
Suburban	30%
Rural	37%
Housing type	
Home	92%
Box	8%
Number of rooms	
1	8%
2–3	52%
>3	40%
Type of floor	
Soil	23%
Cement	77%
Electricity	
Yes	99%
No	1%
Drinking water	
Yes	24%
No	76%
Bathroom	
Latrine	22%
Yes	77%
No	1%
Waste pipe	
Septic tank	92%
Cesspit	6%
Others	1%
None	1%
Separated kitchen	
Yes	96%
No	4%
Sex of household head	
Men	85%
Women	15%
Occupation of household head	
High level	2.1%
Medium level	44.3%
Low level	53.6%
Monthly income of household	
<150 pesos	9.1%
150–400 pesos	46.6%
400–800 pesos	28.4%
>800 pesos	15.9%
Educational level of household head	
High	23%
Medium	75%
Low	2%
Receive food aid from government	
Yes	63.3%
No	36.7%
Produce food in household	
Yes	21.3%
No	78.7%
Preservation techniques	
Drying	15.3%
None	8.2%
Refrigerator	76.5%
Health coverage/insurance	
Yes	48%
No	52%
Medical assistance	
Hospital	51.5%
Health center	41.4%
Others	6.3%

the population was at risk of cardiovascular disease. Almost half of the total population (48.3%) had hypertension.

Table 4 lists the energy, macronutrient, fiber, and cholesterol contents of the adult population diet. No differences between the sexes were observed in these intakes.

Table 2
Anthropometric measurements and nutritional status of adult population (≥18 y) by sex*

Anthropometric values	Total ($n = 113$)	Men ($n = 33$)	Women ($n = 80$)	P
Age (y)	46.3 ± 17.3	53.4 ± 20.2	43.4 ± 15.2	‖
Weight (kg)	69.1 ± 14.1	77.0 ± 12.8	65.8 ± 13.3	‖
Height (cm)	160.6 ± 9.2	169.3 ± 7.0	157.1 ± 7.5	‖
MUAC (cm)	27.9 ± 4.2	29.7 ± 3.4	27.2 ± 4.2	‖
WC (cm)	91.0 ± 15.2	99.8 ± 18.9	87.3 ± 11.6	‖
HC (cm)	103.8 ± 10.9	104.4 ± 7.4	103.5 ± 12.1	
Fat mass (%)	32.6 ± 7.9	26.3 ± 7.5	35.2 ± 6.6	‖
BMI (kg/m^2)	26.8 ± 4.4	26.8 ± 3.7	26.7 ± 4.7	
Minimum BP (mmHg)	79.0 ± 14.4	81.2 ± 12.2	78.2 ± 15.2	
Maximum BP (mmHg)	131.3 ± 24	137.1 ± 21.1	129 ± 24.8	
WC†	44.0	32.4	48.8	
WHR‡	23.9	30.3	21.3	
Hypertension§	48.3	58.8	44.0	

BMI, body mass index; BP, blood pressure; HC, hip circumference; MUAC, mid-upper arm circumference; WC, waist circumference; WHR, waist-to-hip ratio
* Values are presented as mean ± SD or percentage.
† Cutoff limits were >102 cm in men and >88 cm in women [19,20].
‡ Cutoff limits were >1.00 in men and >0.90 in women [19,20].
§ Defined as diastolic BP >90 mmHg and systolic >140 mmHg [21].
‖ Significant differences between the sexes by t test at $P < 0.05$.

In general, the energy intake was low (mean intakes 1856 ± 859 and 1589 ± 799 kcal/d for men and women, respectively). The macronutrient composition as a percentage of total energy was 16.5%, 57.1%, and 26.4% from proteins, carbohydrates, and lipids, respectively.

Protein intake came from animal and vegetable sources (53.2% and 46.2%, respectively). The data showed that the fiber intake was low (11.4 g/d); the mean intake of saturated fat was less than 10% of total energy and mean cholesterol intake was less than 100 mg/1000 kcal [20]. There was a considerable contribution of simple sugars to the total energy intake (18.2%).

Table 5 presents the mean consumption of food groups; generally speaking, the daily food pattern consisted of two to three servings of cereals (including breads), approximately one serving of potatoes, fruits, vegetables, and meat (50 g), and one to two servings of fat and/or oils. Dairy products, eggs, and legumes were consumed four times, two times, and one time per week, respectively. Sugars were consumed two or more times per day. Alcoholic beverages were consumed once a week. Most people did not eat fresh or canned fish.

Discussion

This nutritional study included a representative sample of the adult population of the Calchaqui Valleys. Most of the population was indigenous, and their socioeconomic and educational statuses were low. Most people of the Valleys of Tucuman do not produce their own food and about two-thirds of the sample received some aid or participated in a government food program.

Table 3
Distribution of adult population (>18 y old) based on BMI*

BMI (kg/m^2)	Total ($n = 113$)	Women ($n = 80$)	Men ($n = 33$)
<18.5 (underweight)	1.8	1.3	3.0
18.5–24.9 (normal)	37.7	38.8	33.3
25–29.9 (overweight)	37.7	36.3	42.4
>30 (obese)	22.8	23.8	21.2

BMI, bod mass index
* Values are presented as percentage. No statistical differences between the sexes were detected.

Table 4
Energy, macronutrient, fiber, and cholesterol contents in the diet of individuals of Calchaqui Valleys*

	Total ($n = 113$)	Men ($n = 33$)	Women ($n = 80$)
Energy (kcal/d)	1656 ± 819	1856 ± 859	1589 ± 799
Energy (kcal/kg per day)	25 ± 13	24 ± 11	25 ± 14
Energy (kJ/kg per day)	105 ± 55	103 ± 45	106 ± 58
Proteins (g/kg per day)	1.0 ± 1.2	0.9 ± 0.4	1.1 ± 1.3
Protein (g/d)	69.0 ± 70.0	71.6 ± 34.1	68.1 ± 78.8
Energy from protein (%)	16.5 ± 9.8	16.8 ± 8.4	16.4 ± 10.3
Energy from vegetal protein sources (%)	46.2 ± 26.2	45.5 ± 27.3	46.5 ± 26.0
Energy from vegetal animal sources (%)	53.2 ± 26.2	54.5 ± 27.2	52.7 ± 26.0
Energy from carbohydrates (%)	57.1 ± 15.4	55.7 ± 14.6	57.6 ± 15.7
Energy from simple carbohydrates (%)	18.2 ± 10.4	17.4 ± 8.7	18.4 ± 10.9
Energy from complex carbohydrates (%)	39.1 ± 14.5	38.4 ± 15.6	39.3 ± 14.2
Energy from lipids (%)	26.4 ± 11.1	25.9 ± 10.3	26.6 ± 11.3
Energy from saturated fat (%)	8.9 ± 4.2	8.8 ± 4.3	8.9 ± 4.2
Energy from monounsaturated fat (%)	10.4 ± 5.1	10.3 ± 4.8	10.4 ± 5.2
Energy from polyunsaturated fat (%)	4.3 ± 3.2	4.1 ± 3.1	4.4 ± 3.2
Fiber (g/d)	11.4 ± 7.8	12.3 ± 8.1	11.1 ± 7.7
Fiber (g)/energy (MJ)	1.7 ± 0.9	1.6 ± 1.0	1.8 ± 0.9
Cholesterol (mg/d)	253.1 ± 237.0	220.8 ± 154.6	263.8 ± 258.5
Cholesterol (mg/MJ)	35.2 ± 28.9	30.6 ± 21.7	36.8 ± 30.8

* Values are presented as mean ± SD. Significant differences between the sexes were assessed by Student's *t* test. No statistical differences between the sexes were detected.

They have occupations that do not require physical effort, they do not walk long distances, and they do not exercise or participate in sports activities regularly, and therefore they tended to have a sedentary lifestyle.

A study of the adequacy of the diet showed that the average energy intake of the population was below the requirements [21]. This value is not compatible with adequate long-term health. There are many possible reasons to explain the low energy consumption in this population. First, the instruments used to measure the diet are subject to biases caused by "underreporting," i.e., the tendency of individuals to declare a lower energy intake, especially those that are overweight or obese. Second, the low energy intake could be related to the low energy expenditure as a result of the sedentary lifestyle in this population [10]. Third, some investigators have suggested that the equations of basal metabolic rate from Food and Agriculture Organization/World Health Organization/United Nations University 1985 [22] may overestimate daily energy needs [23,24].

The average protein intake was within the acceptable range, even above requirements [22], and was equally distributed between animal and vegetable proteins.

The mean intake of total fat in the diet was low but within the acceptable range as recommended [20]. However, a considerable percentage of the population (18.4%) reported a total fat intake below 15% of total energy intake, namely the minimum necessary to ensure the supply of essential fatty acids; conversely, 23.5% of

Table 5
Dietary patterns of adult population by sex*

Food groups (servings per day and per week)	Types of food	Serving sizes (g)†	Total ($n = 113$)	Men ($n = 33$)	Women ($n = 80$)
Sum of complex carbohydrates			2.4 ± 1.2	2.2 ± 1.0	2.5 ± 1.2
Cereals and grains	rice, pasta, flours *polenta*	50	1.1 ± 0.9	0.8 ± 0.7	1.1 ± 1.0
Bakery products	*casero* bread, tortillas, white bread	40	0.8 ± 0.6	0.9 ± 0.6	0.7 ± 0.6
Tubers	potatoes, yams	150	0.6 ± 0.4	0.5 ± 0.4	0.6 ± 0.5
Pulses‡	lentils, soy bean, beans, chickpeas, peas	60	0.7 ± 1.7	1.0 ± 2.0	0.5 ± 1.0
Sum of meats and meat products			0.9 ± 0.6	0.8 ± 0.5	0.9 ± 0.7
Poultry	chicken, lamb	50	0.3 ± 0.3	0.2 ± 0.1	0.3 ± 0.4
Meat	beef, goat, pork	60	0.6 ± 0.5	0.6 ± 0.5	0.6 ± 0.5
Processed cold meat	processed cold meats, entrails	20	0.1 ± 0.1	0.1 ± 0.1	0.1 ± 0.1
Eggs‡	hen eggs	60	2.4 ± 2.6	2.3 ± 2.1	2.5 ± 2.8
Fish	fresh and canned	80	0.0 ± 0.1	0.0 ± 0.1	0.0 ± 0.0
Milk and diary products‡	cow's milk	200	4.6 ± 5.4	4.9 ± 6.7	4.5 ± 5.0
	yogurt	125			
	cheeses	50			
Sum of fruits and vegetables			1.6 ± 0.7	1.5 ± 0.6	1.6 ± 0.7
Fruits	fresh fruits	150	0.7 ± 0.5	0.6 ± 0.4	0.7 ± 0.5
Vegetables	fresh and cooked vegetables	150	0.9 ± 0.4	0.9 ± 0.4	0.9 ± 0.4
Sum of fat and oils‡			8.3 ± 4.4	8.8 ± 5.0	8.1 ± 4.2
Added oils‡	mixed vegetable oils, olive oil, etc.	15	6.9 ± 2.7	7.3 ± 3.1	6.8 ± 2.5
Animal fat for cooking‡	butter, animal fat	10	1.4 ± 2.9	1.5 ± 3.2	1.3 ± 2.8
Sum of sugary products‡			14.4 ± 8.6	15.2 ± 10.4	14.2 ± 8.0
Sugary drinks‡	powered juices, sodas	250	6.2 ± 5.2	6.7 ± 7.0	6.0 ± 4.5
Sweet‡	jam, sugar, *dulce de leche*	15	6.7 ± 6.4	6.8 ± 7.8	6.6 ± 5.9
Desserts‡	flan, gelatin, *mazamorra*	100	1.6 ± 2.2	1.7 ± 2.2	1.6 ± 2.2
Alcoholic drinks	wine, beer, etc.	250	0.1 ± 0.4	0.2 ± 0.4	0.1 ± 0.4

* Values are presented as mean ± SD. No significance differences in dietary patterns were found between the sexes by *t* test at $P < 0.05$.
† Serving sizes were estimated according to the observed common amount of food consumed by the present population.
‡ Servings per week; the rest are servings per day.

the population reported a high intake of total fat (>35% of total energy). About 38.2% of the sample reported a consumption of saturated fatty acids above 10% [20]. The mean fiber intake was lower than the recommendations for this population [25]. The percentage of energy from carbohydrates (57.1%) was within the acceptable recommended range; however, the average consumption of simple sugars was high, above the recommendation of 10% of total energy [26].

Usually the typical composition of the main food dish of this population has a base of rice, pasta, flour or corn, accompanied by tubers or eggs, or a few vegetables and beef, normally fried. This dish varies little from one day to another, constituting a monotonous diet with a high intake of fried foods, refined grains, and little quantity and variety of vegetables and fruits. A new and undesirable element in the dietary pattern of the adult population of the Calchaqui Valleys is the sugary and carbonated drink, cola type, with larger portion sizes reaching 120 kcal/100 g.

A similar situation in dietary patterns was observed in an adult population sample from Colombia. The Colombian sample reported low intakes of vegetables, legumes, and fruits compared with the recommendations [27]. They also had a low dairy intake [28]. Schjtman [29] compared the dietary pattern of the Colombian sample with the average diet of Latin America and concluded that it fit into the model corresponding to the Andean countries, i.e., dominated by the consumption of tubers and cereals.

The changes in diet and physical activity patterns are usually related to the economic conditions of a country. Popkin [30–32] described the middle-income countries as being in a state of nutritional transition, showing shifts in consumption patterns from a high-carbohydrate and whole-grain diet based on cereals, fruits, and vegetables toward increased consumption of refined grains, higher-fat food, sugary products, and ready-made foods, or food prepared away from home. A similar situation was observed in the population of the Calchaqui Valleys: low intake of fiber and high intake of simple sugars, probably as a result of the low fruit and vegetable consumption, together with high consumption of refined grains, sugar, and cola drinks.

According to the anthropometric measurements, the average height of this population was short and similar to the height of other Andean populations (Peruvian Quechua 158 cm, Bolivian Aymara 161 cm, Chilean Aymara 163 cm) but taller than the average height observed in the Andean population in Jujuy, a province in northwestern Argentina [9,33].

Despite the low energy intake reported in this sample, the mean BMI indicates a high prevalence of overweight and obesity, with no significant differences between the sexes. The recent Chilean National Survey conducted in 2003, carried out for a representative population sample of the country, showed a prevalence of overweight of 38%, obesity of 22%, and morbid obesity of 1.3% (BMI >40 kg/m^2), figures similar to those found in the present study [34].

Previous studies [8] have suggested that the BMI might not be a good index of obesity in ethnic communities living in Andean regions. However, when we used the waist circumference as a proxy measurement of central adiposity, which has also been linked to a higher cardiovascular risk, we observed that the proportion of those with central adiposity was also high, similar to what we observed with BMI.

Some methodologic limitations of the present study should be acknowledged. First, the sample was small; however, this was thought to be representative of the study population given the low population density in this area. Second, nutrient intake was assessed with only one 24-h recall. In the developing world, high intraindividual variability in nutrient intake has been found, possibly caused by low food security, high day-to-day fluctuations in food supply, and seasonal variation in food production [35]. Nevertheless, to overcome possible day-to-day and seasonal variations in food intake, the questionnaires were administered daily from Monday to Sunday and the fieldwork was carried out in two waves to collect data in the postharvest and preharvest seasons.

Conclusions

We found a high prevalence of obesity and overweight in the adult population of the Calchaqui Valleys. These results suggest that this population may be in the early stages of nutritional transition as reflected by the high intake of refined grains and sugars and the trend toward decreased physical activity caused by the sedentary nature of work. These results could be used in this population to encourage healthy eating habits and physical activity.

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References

[1] Turismo Tucuman; 2007. Available at: http://www.tucumanturismo.gov.ar. Accessed August 2008.
[2] Censo 2001 e indicadores demograficos; 2001. Available at: http://estadistica.tucuman.gov.ar. Accessed August 2008.
[3] González Cainzo MJ, Arenas P, Guyot E, editors. Resumen: Análisis participativo del proceso de transformación productiva e institucional en el Valle de "Tafí–Tucumán." In: Taller de validación del análisis participativo de los procesos productivos e institucionales en el Valle de Tafí. Tucumán; 2005. Available at: http://www.rimisp.org/FCKeditor/UserFiles/File/documentos/docs/pdf/territoriales_informe_9.pdf. Accessed July 2007.
[4] Britos S, O'Donnell A, Ugalde V, Clacheo R. Transición nutricional, obesidad y desafios de las politicas públicas y los agronegocios. Centro de Estudios sobre Nutricion Infantil; 2008. Available at: http://www.nutrinfo.com/pagina/info/papersaludyagronegocios2008.pdf. Accessed August 2008.
[5] Duran P. Transición epidemiologica nutricional o el "efecto mariposa." Arch Argent Pediatr 2005;103:195–7.
[6] A.A.D.Y.N.D. La situación nutricional en la Argentina. Buenos Aires Asociación Argentina de Dietistas y Nutricionistas Dietistas; 2009. Available at: http://www.aadynd.org.ar/detalle_info.php?id = 27. Accessed July 2009.
[7] World Health Organization. Obesity: preventing and managing the global epidemic. Report of a WHO consultation. Report 0512–3054. Geneva: World Health Organization; 2000.
[8] Doak CM, Adair LS, Monteiro C, Popkin BM. Overweight and underweight coexist within households in Brazil, China and Russia. J Nutr 2000;130:2965–71.
[9] Romaguera D, Samman N, Farfan N, Lobo M, Pons A, Tur JA. Nutritional status of the Andean population of Puna and Quebrada of Humahuaca, Jujuy, Argentina. Public Health Nutr 2008;11:606–15.
[10] Romaguera D, Samman N, Rossi A, Miranda C, Pons A, Tur JA. Dietary patterns of the Andean population of Puna and Quebrada of Humahuaca, Jujuy, Argentina. Br J Nutr 2008;99:390–7.
[11] Food and Agriculture Organization, LATINFOODS. Tablas de composicion de alimentos de América Latina; 2002. Available at: http://www.rlc.fao.org/es/bases/alimento. Accessed October 2007.
[12] ARGENFOODS. Tablas de composición de alimentos. Available at: http://www.unlu.edu.ar/~argenfood/Tablas/Tabla. Accessed November 2008.
[13] Frisancho A. Anthropometric standards for the assessment of growth and nutritional status. Clin Nutr 1991;10:131–2.
[14] Deurenberg P, Andreoli A, Borg P, Kukkonen-Harjula K, de Lorenzo A, van Marken Lichtenbelt WD, et al. The validity of predicted body fat percentage from body mass index and from impedance in samples of five European populations. Eur J Clin Nutr 2001;55:973–9.
[15] Lintsi M, Kaarma H, Kull I. Comparison of hand-to-hand bioimpedance and anthropometry equations versus dual-energy X-ray absorptiometry for the assessment of body fat percentage in 17–18-year-old conscripts. Clin Physiol Funct Imaging 2004;24:85–90.

[16] Bailey KV, Ferro-Luzzi A. Use of body mass index of adults in assessing individual and community nutritional status. Bull World Health Organ 1995;73:673–80.
[17] Han TS, van Leer EM, Seidell JC, Lean ME. Waist circumference action levels in the identification of cardiovascular risk factors: prevalence study in a random sample. BMJ 1995;311:1401–5.
[18] Bray GA. Classification and evaluation of the obesities. Med Clin North Am 1989;73:161–84.
[19] Joint National Committee on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults. The fifth report of the Joint National Committee on Detection, Evaluation, and Treatment of High Blood Pressure (JNC V). Arch Intern Med 1993;148:1023–38.
[20] World Health Organization. WHO and FAO joint consultation: fats and oils in human nutrition. Nutr Rev 1995;53:202–5.
[21] FAO/WHO. Human energy requirements. Report of a joint FAO/WHO/UNU expert consultation. Report 1. Geneva: World Health Organization; 2004.
[22] FAO/WHO. Energy and protein requirements. Report of a joint FAO/WHO/UNU expert consultation. World Health Organ Tech Rep Ser 1985;724:1–206.
[23] Gutierrez-Fisac JL, Banegas Banegas JR, Artalejo FR, Regidor E. Increasing prevalence of overweight and obesity among Spanish adults, 1987–1997. Int J Obes Relat Metab Disord 2000;24:1677–82.
[24] Norman A, Bellocco R, Vaida F, Wolk A. Total physical activity in relation to age, body mass, health and other factors in a cohort of Swedish men. Int J Obes Relat Metab Disord 2002;26:670–5.
[25] World Health Organization. Diet, nutrition, and the prevention of chronic diseases. Report of a WHO study group. World Health Organ Tech Rep Ser 1990;797:1–204.
[26] FAO/WHO. Carbohydrates in human nutrition. Report of a joint FAO/WHO expert consultation. FAO Food Nutr Pap 1998;66:1–140.
[27] Instituto Colombiano de Bienestar F. Guias alimentarias para la población colombiana mayor de dos anos: bases tecnicas. Santafe de Bogota, DC: Instituto Colombiano de Bienestar F; 2000.
[28] Herrán OF, Bautista LE. Calidad de la dieta de la población adulta en Bucaramanga y su patrón alimentario. Colombia Med 2005;36:94–102.
[29] Schjtman A. Economia politica de los sistemas alimentarios en América Latina. Santiago: División Agrícola Conjunta FAO/CEPAL; 1994.
[30] Popkin BM. The nutrition transition and obesity in the developing world. J Nutr 2001;131:871S–3S.
[31] Popkin BM. The nutrition transition: an overview of world patterns of change. Nutr Rev 2004;62:S140–3.
[32] Popkin BM, Doak CM. The obesity epidemic is a worldwide phenomenon. Nutr Rev 1998;56(4 pt 1):106–14.
[33] Toselli S, Tarazona-Santos E, Pettener D. Body size, composition, and blood pressure of high-altitude Quechua from the Peruvian Central Andes (Huancavelica, 3,680 m). Am J Hum Biol 2001;13:539–47.
[34] Atalah E, Urteaga C, Rebolledo A. Self perception of nutritional status among adults in Santiago. Rev Med Chil 2004;132:1383–8.
[35] Berti PR, Leonard WR. Demographic and socioeconomic determinants of variation in food and nutrient intake in an Andean community. Am J Phys Anthropol 1998;105:407–17.