Research Article

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Journal of Clinical Nutrition & Dietetics
ISSN 2472-1921

2017
Vol. 3 No. 4:24

DOI: 10.4172/2472-1921.100059

Food and Nutritional Assessment in Schoolchildren from Mountainous Areas of Argentinean Northwest

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Citation: De Piero AJ, Rossi MC, Bassett MN Sammán NC (2017) Food and Nutritional Assessment in Schoolchildren from Mountainous Areas of Argentinean Northwest. J Clin Nutr Diet Vol. 3 No. 4:24

Abstract

Background: Previous studies in Argentinean northwest found nutritional problems that could affect especially children, in process of growth and development.

Objective: To assess nutritional status and food consumption frequency adequacy in relation to dietary guidelines in schoolchildren of high-altitude regions from northwest of Argentina.

Methods: The study involved a sample of schoolchildren. Anthropometric and biochemical data were collected. The metabolic syndrome risk factors were defined following cook criterion. A nutritional questionnaire containing the main food groups was used. Economic and educational levels of household were analyzed.

Results: The sample consisted of 242 children, being the mean age 8.8 ± 2.0. Undernourished (2.2%), low weight (12.7%), overweight (12.7%) and obese (7.4%) children were observed. Stunting and obesity coexist. Dietary patterns showed high intake of simple carbohydrates, sugar products and do not comply with the recommendations of the Argentinean food guidelines. Household income observation showed low economic level. An elevated proportion of children presented metabolic syndrome (18.2%). Taking into account ionic calcium calculation, 35.6% of them showed deficiency of this mineral.

Conclusions: Problems of malnutrition due to excess or deficient intake of nutrients were found. The existence of inadequate dietary patterns combined with physical inactivity increases the risk of chronic disease.

Keywords: Schoolchildren; Dietary patterns; Nutritional status; Food consumption; Northwest of Argentina

Received: November 27, 2017; **Accepted:** December 05, 2017; **Published:** December 12, 2017

Introduction

The Andean population, from Humahuaca and Puna in Jujuy to the high valleys in Tucuman and Salta, inhabits areas between 1500 masl and 4500 masl which border to other provinces of the Argentinean Northwest (NOA) [1]. A large part of its inhabitants are descendants of indigenous people from various ethnic groups living in NOA and Bolivia, as Diaguitas, Cochinhucas, Omaguacas, Atacamas, Quechuas and Aymaras, belonging to a region which has been a crossroads for economic, social and cultural communication [2]. In the high valleys of NOA, primary education establishments are single or double shift and some of them have shelters for students. Previous studies carried out in NOA observed a nutritional transition so it is important to see how current changes in lifestyles and eating habits of this population are some of the causes of the increasing overweight and obesity globally [3]. Obesity in children is a growing health problem in the world and is a risk factor for several chronic non-communicable diseases such as type 2 diabetes, metabolic syndrome and heart disease in adults [4].

In Latin America and particularly in the region of the Northwest of Argentina, dietary problems related to food consumption, could cause health problems such as wasting, stunting, overweight and obesity. Often, the coexistence of child malnutrition with adult obesity is observed in the same families and even more so in the lower socioeconomic levels compared to middle and upper socioeconomic levels [4-7].

School age children are a vulnerable segment of the population for geographical, socioeconomic and physiological reasons; in Argentina, there are not enough studies on this age group showing the nutritional status of children attending primary schools. It is especially important considering that children are through a growth process and a state of malnutrition could damage school performance significantly [8].

Given this situation, the objective of this study was to evaluate the nutritional status and adequacy of food frequency consumption in relation to the food guidelines of schoolchildren in the high mountainous region of Northwestern Argentina.

Materials and Methods

Subjects

The sample consisted of schoolchildren aged from 6 yrs to 12 yrs old belonging to the mountainous region of Argentinean Northwest: Tucumán (*Tafi del Valle* and *Amaicha del Valle*) and Jujuy (*León* and *Barranca*). Difficulties in accessibility and very specific dietary patterns were the reasons for studying mountainous regions. They attend local primary schools both single or double shift and even some of them are boarding schools. The sample size was determined by taking into account data from the target populations of the national census conducted in 2010 [9]. The sample was composed of 241 schoolchildren from four locations, two per province and represented 1.6% of the scholar population, which was considered to be a representative sample and 0.5% of the school population is taken into consideration in order to reach a number similar to that of the National Survey of Nutrition and Health. A cross-sectional descriptive study was conducted and the selection of schools was made at random.

Then, a convenience subsample was chosen, taking 45 schoolchildren from *Amaicha del Valle* from the participants in the initial study for the obtention of biochemical data and the design of further intervention.

Inclusion criteria were: belonging to the selected primary schools and having a signed permission from parents and/or legal guardians.

Ethical clearance for the study was obtained from responsible academic of the respective educational institution. Protocols work with children was properly approved by the scientific committee of CONICET Tucumán.

Methods

A trained staff administered a validated questionnaire applied previously in other population of this age. Younger children (6 yrs to 9 yrs old) were requested to have a tutor or parent presence for carrying out the survey for reliable information. The questionnaire in the study addressing different aspects:

Dietary questionnaire: A semi-quantitative food frequency questionnaire that included 22 foods within 12 groups was administered. High validity and precision has been reported for the method used [10]. Questions about their perception of healthy foods were asked. Food consumed was transformed in terms of energy and nutrients with SARA® program of the Ministry of Health of the Nation (www.msal.gov.ar/promin/archivos/htm/descarga-sara.htm).

Socio-sanitary characteristics: A questionnaire that included information about the following items was administered to parents and/or legal guardians:

- Economic level: household income was classified according to the estimated total food basic basket (CBA) of Tucuman and Jujuy values into three categories: homelessness, poverty and above poverty.
- Parents educational level: classified into three categories, low: without primary school studies; medium: with incomplete high school studies; and high: with tertiary or university studies.

Besides, the questionnaire included questions on household characteristics, health status and maternal perception of the child's body weight.

In addition, different measurements were made to obtain the following data:

Anthropometric measurements: The weight and height were determined with an electronic balance (TEFAL CHARM, SC 2504 Rumilly, France, accuracy 200 g) and a mobile rod (KAWE, 44444, Kirchner & Whilhelm GmbH, Asperg, Germany), respectively. For these measurements, subjects were in light clothing and without shoes. All data were recorded following the rules of Frisancho [11] and WHO [12]. The measures were made by research personnel who were specifically trained.

The nutritional status was evaluated using z-scores and percentiles of weight for age (WA), height for age (HA) z-score and body mass index for age (BMI-A) z-score and compared with reference standards (5 yrs to 19 yrs) proposed by WHO (2009) [13]. To assess the nutritional status, the following reference was used: BMI-A z-score P5-85, normal; BMI-A z-score ≥ 85, overweight; BMI-A z-score ≥ P95, obesity and HA z-score ≤ 2SD, stunting; HA z-score>2SD, high.

Blood pressure measurements: The blood pressure measurements were performed following the instructions of WHO (1987) [14]. The blood pressure were measured twice, taken at an interval of five minutes, with the subject resting for at least half an hour before the first measurement, using a digital sphygmomanometer Boso Compact 2 (Bosch+Sohn GMBH U. CO. Jungingen Germany), in a quiet and calm environment. The measurement was made by previously trained staff with the child seated and the right arm placed in a semi-flexed position at heart level. To assess systolic and diastolic blood pressure, respectively (SBP) (DBP), the following reference values of normal blood pressure were used: SBP and DBP ≤ P90; Pre-hypertension: SBP or DBP ≥ P90 and ≤ P95; hypertension: SBP or DBP ≥ P95 taking into account age, gender and height [15].

Biochemical characteristics: Blood samples from schoolchildren with a 12-hour fasting were obtained early in the morning from children of School No. 10 "Claudia Cano" in *Amaicha del Valle* (Tucuman). CONICET protocols approved by the Bioethics Committee were followed.

Complete blood count determinations were performed following standard clinical laboratory techniques: hematocrit, hemoglobin, red blood cells (RBCs), mean corpuscular volume, mean corpuscular hemoglobin, mean corpuscular hemoglobin concentration, white blood cells (WBCs), RBCs neutrophils, RBCs eosinophils, RBCs lymphocytes, RBCs monocytes and platelets; glucose, insulin, triglycerides, total cholesterol, HDL cholesterol, LDL cholesterol, phosphatemia, serum creatinine, serum iron, serum albumin, total protein and parathyroid hormone (PTH).

Calculation of ionic calcium was performed taking into account values of serum calcium, serum albumin and total protein and determined as normal reference point (4.9 mg/dL-5.5 mg/dL) [16]. Measurement of serum free (ionized) calcium reflects true calcium status of the body in health and disease and is considered internally valid [17]. It was decided to evaluate the serum calcium, because it would be difficult in a school group to collect urine for 24 hours and performing bone density tests would be an expensive technique.

Factors associated to metabolic syndrome: To define the metabolic syndrome (MS), cook criteria were applied. These criteria were adapted to Argentinian reference values and establish the presence of MS when at least three of the following five criteria are met: glucose ≥ 100 mg/dL, waist circumference ≥ P90 [18], triglycerides>P90 [19], HDL ≤ P10 [19], SBP or DBP>P90 [15].

Statistical analysis: Personal and anthropometric data, household socioeconomic conditions, educational level of parents and/or guardians and eating patterns according to the locality were considered. Mean values, standard deviation (SD) and percentage (%) were determined for each one of the parameters studied. To evaluate the differences observed between two proportions Chi-square test was used.

The observed mean comparisons between the towns were made with one-way ANOVA test.

A logistic regression analysis has been conducted to analyze the risk of overweight and obesity associated with socioeconomic status and maternal education. The sample size was determinated using a confidence level of 95% to select the number of the sample by means of statistical equation. Statistical analysis was performed with the (IBM Software Group, Chicago, IL, USA) package SPSS Advanced Statistics 20.0. p>0.05 was selected to denote statistical significance.

Results

The sample consisted of 242 students of which 123 were boys and 119 girls. **Table 1** shows that the mean age was 8.8 ± 2.0, significant differences were observed for weight, height and BMI.

Overall, schoolchildren presented 2.2% of undernourishment, 12.7% of underweight, 12.7% of overweight and 7.4% of obesity. When analyzing the weight situation depending on the locality (**Table 1**), more cases of undernourishment and obesity were found in *Amaicha del Valle*, while *León* showed a higher number of cases of underweight and overweight, analyzing both percentiles and z-score of BMI-A. According to HAZ scores, both *Tafi del Valle* and *León* had high rates of stunting 10.7 and 9.8% respectively, showing significant differences with the other localities.

The household income showed that 18.4%, 10.3% and 71.3% of households were living in extreme poverty, poverty and above the poverty line respectively. The analysis of the economic level associated with the weight status of schoolchildren is shown in **Figure 1**. Most children with deficient intakes were concentrated in households living in poverty and children with malnutrition due to excess (BMI-A z-score P ≥ 95) concentrated in households above the poverty line. The existence of double burden of malnutrition (deficit or excess) in households below the poverty line is highlighted.

The basic food basket is a National Indicator, which has been determined taking into account the essential kilocaloric and protein normative requirements for and adult male, between 30 yrs and 60 yrs of moderate activity, to cover for a month those needs. Food and quantities were selected according to the consumption habits of the population based on the information provided by the Household Income and Expenditure Survey.

When performing a logistic regression analysis, it was observed that households with an income that makes it possible for them to access the total food basic basket were positively associated with increased likelihood that their members in school age are overweight and obese [OR=0.323 (0.092 to 1.128), p<0.01].

Cases of malnutrition/underweight of schoolchildren were observed in households with mothers of all educational levels, while the higher prevalence of overweight and obesity of schoolchildren was found in homes with high levels of maternal education (**Figure 2**).

Furthermore, 69.2% of mothers of children with undernourishment and underweight considered their children had a healthy weight and only 22% of mothers of children with overweight and obesity considered their children were overweight. When performing a logistic regression analysis, it was found that high maternal education was positively associated with a greater likelihood that their school-age members are overweight and obese [OR=0.556 (0.204 to 1.512), p<0.01].

The dietary pattern of the population under study is described in **Table 2**. It was observed that consumption of fruits, vegetables, dairy, fish and lentils were below the recommendations, while meat consumption complies with the recommendations of the guidelines. Certain food groups that require moderation in consumption (sausages, fats and oils, sugar products, bakery products, processed products and high in sodium products) showed significant differences between regions and exceeded the recommendation in all localities under study.

Biochemical data of the subsample is described in **Table 3**. Considering the cut-offs, it was observed that 24.4% have high levels of cholesterol, 4.4% higher triglyceride levels, 64.4% decreased HDL cholesterol values and 24.4% elevated LDL cholesterol. Taking into account ionic calcium calculation, 35.6% showed deficiency; no significant differences were found. In relation to iron, 8.9% of schoolchildren had low hemoglobin (cut-offs corrected by age and geographical altitude). It was found that 18.2% presented MS while 24.2% is at risk of MS (presence of two of the five criteria for the diagnosis) central obesity and blood pressure was observed.

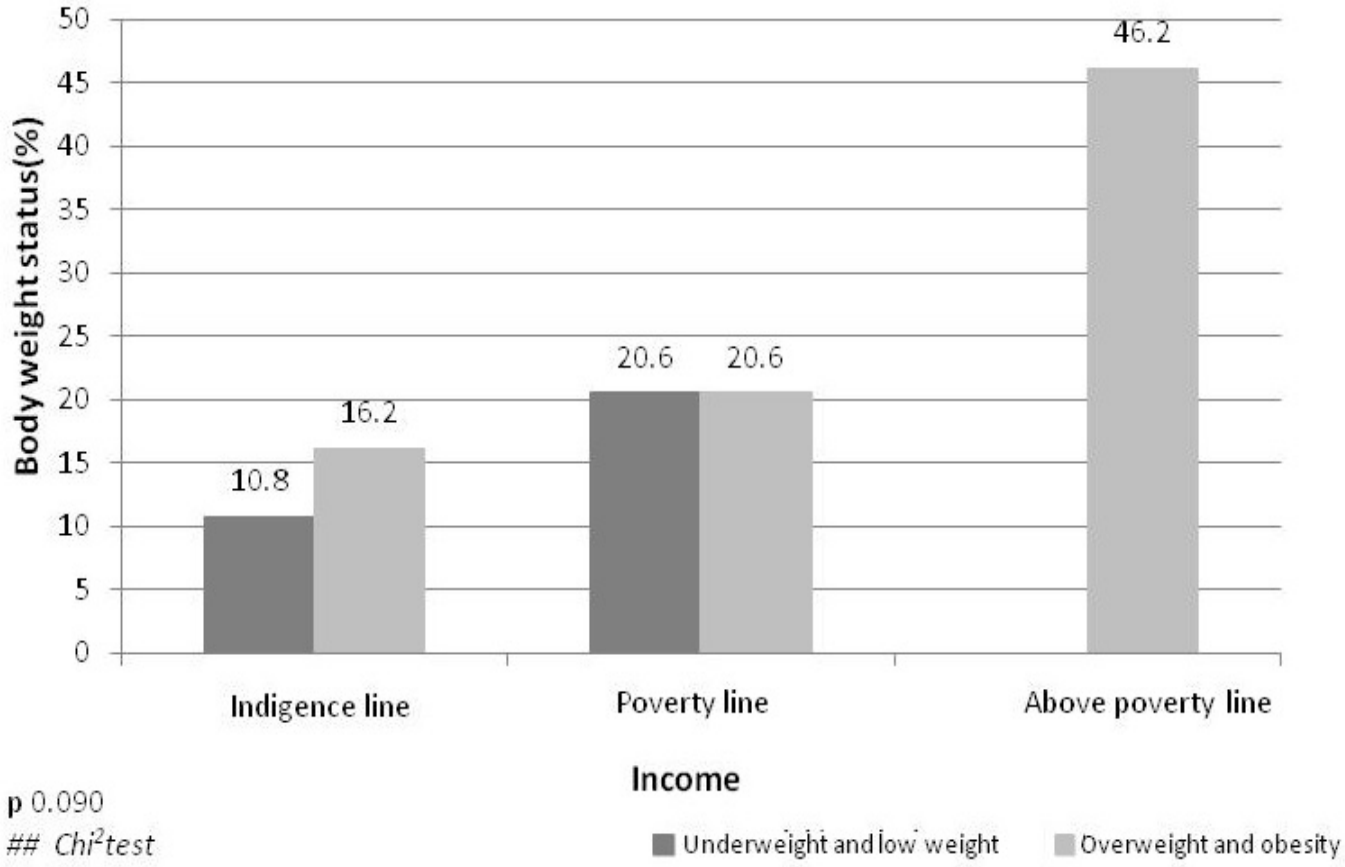

Figure 1 Income and body weight status of schoolchildren.

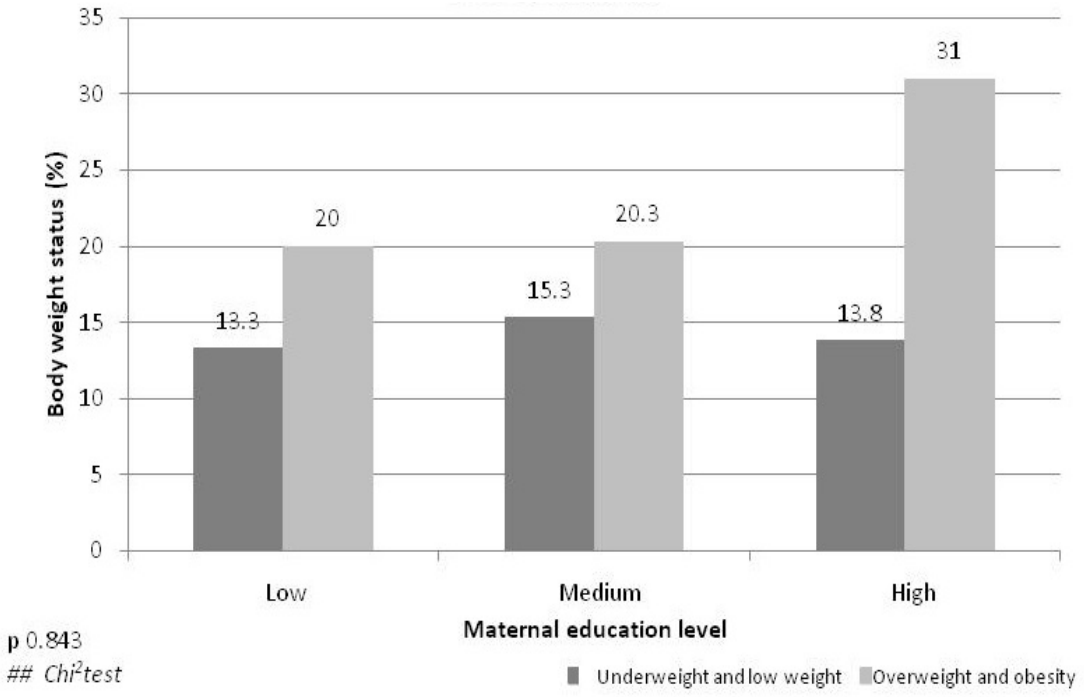

Figure 2 Maternal educational level and body weight status of schoolchildren.

Table 1 Anthropometric characteristics of children. Differences according to the town.

	Total (n=242)	Tafí del Valle (n=59)	Amaicha del Valle (n=110)	León (n=42)	Barranca (n=31)	p#
Age (y)	8.8 ± 2.0	8.3 ± 2.0	8.5 ± 1.9	10.0 ± 2.1	9.2 ± 1.9	**0.000**
Weight (kg)	31.2 ± 9.5	29.5 ± 10.2	32.0 ± 9.7	33.9 ± 9.5	28.3 ± 6.4	**0.034**
Height (cm)	133.6 ± 13.1	129.4 ± 13.8	135.6 ± 12.8	136.7 ± 12.2	130.6 ± 12.1	**0.008**
BMI-Age percentile (kg/m²)	53.7 ± 30.3	56.5 ± 29.9	52.7 ± 32.9	57.6 ± 29.0	46.9 ± 22.2	0.441
Energy intake (kcal/d)	1547 ± 478	1531 ± 370	1527 ± 579	1365 ± 261	1916 ± 313	**0.000**
BMR (kcal/d)	1145 ± 172	1102 ± 162	1159 ± 180	1200 ± 186	1103 ± 114	**0.016**
TEE (kcal/d)	1667 ± 264	1577 ± 273	1678 ± 257	1749 ± 284	1743 ± 174	**0.013**
PAL	1.4 ± 0.09	1.4 ± 0.08	1.4 ± 0.07	1.4 ± 0.06	1.5 ± 0.11	**0.000**
BMI-Age (%)						**0.043##**
Underweight	2.2	0.0	4.8	0.0	0.0	
Low weight	12.7	10.9	11.5	17.1	13.8	
Overweight	12.7	10.9	13.5	22.0	0.0	
Obesity	7.4	9.1	10.6	2.4	0.0	
Height-Age z score (%)						**0.002##**
<-2 SD (stunting)	4.8	10.7	0.0	9.8	3.4	
>2 SD	3.5	0.0	7.6	0.0	0.0	
BMI-Age z score (%)						**0.153##**
<-2 SD (underweight)	2.2	0.0	4.8	0.0	0.0	
-2 a-1 SD (low weight)	13.0	10.9	12.4	17.1	13.8	
1 a 2 SD (overweight)	17.0	14.5	20.0	22.0	3.4	
>2 SD (obesity)	4.8	5.5	6.7	2.4	0.0	

One-way ANOVA
Chi² test
BMI: Body Mass Index;
BMR: Basal Metabolic Rate (kcal/d);
TEE: Total Energetic Expenditure (kcal/d);
PAL: Physical Activity Level;
SD: Standard Deviation

Discussion

Main nutritional problems found in schoolchildren in this study were the presence of overweight/obesity and stunting. This situation resembles to that reported in previous studies in the heights of northwestern Argentina and other countries with similar social, ethnic and geographic characteristics [20-23].

The type of diet, sedentary lifestyles, socioeconomic conditions and food availability are factors that determine the obesogenic environment in the population. Associated with industrialization, in this study, a dietary pattern characterized by consumption of simple carbohydrates, saturated fat, high-sodium products and sugar products was observed; instead of an eating pattern consisting in products such as corn, potatoes, peppers and Andean cereals belonging to the region of northwestern Argentina.

It is noteworthy that fish consumption is not common in this population due to eating habits and geographic availability. Consumption of foods high in calories and poor in micronutrient content is common since they provide greater satiating power, high energy intake and lower prices. Some authors observed eating patterns in schoolchildren [24-26] similar to those found in this work.

The situation of nutritional risk observed in the localities under study is the result of several factors including lack of physical activity, difficulties in access to food in certain sectors of the population and little, if any, knowledge about healthy eating of those responsible for providing the foods. The low consumption of foods rich in priority nutrients confirms that far from an improvement in the nutritional status of the population there is deterioration in the quality of food consumption which results in overweight/obesity coexistence with micronutrient deficiency. This food vulnerability could be attributed to limited access and selection of food included in those provided by food programs school menus, especially when taking into account the economic crises that took place in Argentina in the last thirty years [27].

Furthermore, in this study the maternal education level was related with the weight status of the schoolchildren. In all maternal education levels it was observed that there are problems of malnutrition both excess and deficit. Other authors observed that the educational level of parents is associated with the level of knowledge about health issues and accessibility to food they give their children [28,29]. Studies show that mothers who underestimate or overestimate the body weight of children could be a risk factor that increases the prevalence of malnutrition [30,31] similar to that situation observed in this work.

In the nutritional assessment of schoolchildren, biochemical data are important, especially when states of malnutrition are presented. The prevalence of metabolic syndrome in school was similar to that value observed by Gotthelf [32]. While the

Table 2 Food frequency intake of the school population.

Food	Types of food	Median consumption*							
		Serving sizes (g)▲	Tafi (n=56)	Amaicha (n=88)	León (n=26)	Barranca (n=31)	Total (n=201)	P value	Recommendation guidesº
Cereals and grains	Bread, tortilla, rice, pasta, polenta (p/d)	50	1.0	2.7	1.1	1.9	1.9	0.000	2 p/d
Tubers	Potatoes, yams/sweet potatoes (p/d)	50	0.51	0.75	0.79	1.0	0.74	0.002	2 p/d
Pulses	Lentils, chickpeas, beans, peas (p/w)	60	0.98	1.10	1.30	0.80	1.04	n.s	3 p/w
Total of meat and meat products			7.1	4.6	6.1	9.5	6.3	0.000	
Meat and entrails	Caprines, ovines, bovines, pork, kidney, liver (p/w)	120	4.7	2.4	4.3	9.2	4.3	0.000	2-3 p/w
Poultry	Chicken, hen, turkey (p/w)	120	2.4	2.2	1.7	0.26	1.9	0.000	2-3 p/w
Processed cold cuts	Chorizo, salami, mortadela, sausage (p/w)	50	0.61	2.4	0.50	0.14	1.3	0.000	1 p/w
Eggs	Hen's eggs (p/w)	60	2.5	1.7	1.1	3.6	2.1	0.001	3-4 p/w
Fish	Tinned and fresh fish (p/w)	60	0.20	0.77	0.55	0.07	0.48	0.030	2-3 p/w
Milk and dairy products	Cow's milk, yoghurt, cheese (p/d)	150	6.8	8.7	3.1	4.8	6.9	0.000	2 p/d
Total of fruit and vegetables			1.7	1.6	1.6	1.6	1.7	n.s	
Fruit	Cooked and fresh fruit (p/d)	150	0.85	0.90	0.83	0.72	0.85	n.s	2 p/d
Vegetables	Cooked and fresh vegetables (p/d)	150	0.91	0.77	0.81	0.96	0.84	n.s	2 p/d
Total of fats and oils			9.5	5.0	5.4	9.7	7.0	0.000	
Animal fat used for cooking	Animal fats, butter (p/w)	10	1.8	2.2	1.0	2.9	2.0	n.s	1-2 p/w
Vegetable oils	Vegetable oil, sunflower oil (p/w)	15	7.7	2.7	4.3	6.8	4.9	0.000	7 p/w
Total of sugary products			26.2	35.5	12.1	6.6	25.4	0.000	
Sweet	Sugar, table sugar, jam, *dulce de leche* (p/w)	15	15.4	16.7	5.3	1.8	12.5	0.000	6 p/w
Desserts	Pudding, jelly, *arroz con leche* (p/w)	100	3.5	3.0	2.5	1.8	2.9	n.s	1 p/w
Sugary drinks	Powered instant juice, soft drinks (p/w)	250	7.2	15.7	4.2	3.0	9.9	0.000	1 p/w
Bakery products	Croissants, bollo, tortilla (p/w)	60	6.1	6.5	6.7	16.4	8.0	0.002	2 p/w
Processed foods	Pizzas, empanadas, locro, cooked dishes (p/w)	150	4.3	6.3	2.0	1.1	4.3	0.000	1 p/w
Salt, sauces, soups	Salt, red sauce, white sauce, soups (p/w)	50	5.7	9.2	2.6	2.8	6.4	0.000	<1 p/w
Snacks	Potato crips, salted peanuts, cheese puffs (p/w)	30	0.94	0.92	0.56	0.55	0.74	0.032	<1 p/w

▲The portion size was estimated according to the Technical Regulations Mercosur Specific [36]
* Average consumption of food groups in portions are expressed in daily rations (p/d) or weekly (p/w) according to the group
º Argentina Food Guide [37]
Difference between groups by ANOVA one-way P values not shown are greater than 0.05 and the difference is not statistically significant

prevalence observed in this study was higher than the one described by Cardenas-Villarreal [33] in schoolchildren of Mexico.

Calcium deficiency noted from dietary patterns is confirmed with abnormal biochemical levels. Noteworthy is the low consumption of calcium food sources in this school population under study. In another work carried out in children with similar situation to that observed in the present study [34] this is described. Given this situation, a dietary intervention providing snack fortified with calcium salts has been proposed and is currently being carried out.

Although the levels of iron intake are adequate, the presence of anemia in children aged 6 yrs to 9 yrs (detected by hemoglobin) was observed by biochemical analyzes. This might be due to the consumption of foods with iron absorption inhibitors (caffeinated teas, phytates, etc.), low intake of foods rich in substances facilitating absorption of iron (sources of vitamin C) and the endemic area of parasites [35].

The fact that the nutritional assessment of this age group from this particular region was achieved can be considered a strength

Table 3 Biochemical data of the population depending on the sex (X ± SD).

	Total (n=45) %	6-9 yrs old (n=40) %	10-12 yrs old (n=5) %	p##
Hemoglobin (g/dl)*				
Normal	91.1	80	0	0.357
Low	8.9	20	100	0.357
Cholesterol (mg/dL)*				
Normal	75.6	72.5	100	0.228
High	24.4	27.5	0	0.228
Triglyceride (mg/dL)*				
Normal	95.6	97.5	80	0.212
High	4.4	2.5	20	0.212
HDL cholesterol (mg/dL)*				
Normal	35.6	35	40	0.592
Low	64.4	65	60	0.592
LDL cholesterol (mg/dL)*				
Normal	75.6	75	80	0.645
High	24.4	25	20	0.645
Ionic calcium (mg/dL)*				
Normal	64.4	62.5	80	0.408
Low	35.6	37.5	20	0.408

Chi^2 test
Hemoglobin cut-off (low<13.4g/dl; normal>13.4 g/dl)
Cholesterol cut-off (normal<170 mg/dL; high>170 mg/dL)
Triglyceride cut-off (normal<150 mg/dL; high>150 mg/dL)
HDL cholesterol cut-off (low<60 mg/dL; normal>60 mg/dL)
LDL cholesterol cut-off (normal<100 mg/dL; high>100 mg/dL)
Ionic calcium cut-off (low<4.9 mg/dL; normal>4.9 mg/dL

of this study since it is of great importance due to their ethnic and geographic peculiarities.

The main limitation in this work is that the technique of the 24-hour recall depends on memory, both for the identification of the foods consumed and for the quantification of the portions. However, trained professionals can minimize the difficulties of interviewees when recalling.

Conclusion

Problems of malnutrition due to excess or deficient intake of nutrients were found. An elevated proportion of children presented metabolic syndrome. Dietary patterns do not comply with the recommendations of the Argentinean food guidelines.

Food problems are still in force and involve a progressive increase in obesity. The existence of inadequate dietary patterns combined with physical inactivity increases the risk of chronic disease and it is possible to improve qualitative changes in the diet and lifestyle, restructuring food programs for school menus, processing workshops and programs for health professionals aimed at those responsible for food.

Conflicts of Interest

The authors have no conflicts of interest to disclose.

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