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Nutrition disorder frequency in 5- to 9-year-old children from Colima, Mexico

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Abstract:

Background and Aims. The objectives were to determine nutrition disorder frequency, energy intake and type of nutrients in the diet of 5- to 9-year-old children from Colima, Mexico. **Material and Methods.** A populational survey was applied to 1992 children in the state of Colima, Mexico. The variables studied were weight, age, age-related weight, age-related height and body mass index (the last 3 expressed in percentiles). In a direct survey, parents provided information on all foods their children had eaten 24 hours before survey. The WM Boothby and J Berkson food nomogram and the Salvador Zubirán National Institute of Medical Science and Nutrition Mexican Food Composition Tables were used to determine child daily energy requirements. **Results.** In relation to body mass index, overweight and obesity was 28.5% in girls and 33.0% in boys. Malnutrition was present in 10.1 % of girls and 5.5 % of boys. Adequate energy intake was 31.3%. There was also 39.5%, 39.7%, and 32.5% adequate intake of proteins, carbohydrates, and lipids, respectively. **Conclusions.** In relation to body mass index in 5- to 9-year-old children from Colima, Mexico, nutrition disorder frequency was 38.6%, inadequate energy intake was 68.7%, and almost two-thirds of children had inadequate nutrient intake.

Keywords: Children; Malnutrition; Nutrition disorder; Obesity; Overweight

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Introduction

Currently, hundreds of millions of people suffer from diseases due to excessive or unbalanced diet [1]. Approximately 150 million children are victims of malnutrition worldwide and 200 million are physically under-developed [2]. In addition, obesity is the most widespread world metabolic disease. Its incidence has increased dramatically in the last two decades in developed as well as in undeveloped countries and represents the second cause of preventable death in the United States [3-5].

Mexico has experienced great social, political, and economic changes, all of which have caused profound socioeconomic inequality that is reflected in the dietary habits of the population. The groups most vulnerable to the worst effects of this situation are children, pregnant women, and the elderly [6].

In the 2006 National Health and Nutrition Survey applied to 5- to 11-year old Mexican children, the prevalence of low figures for age-

related height was 10% and the prevalence of obesity in this same group was 26%. In this survey, malnutrition, hyperlipidemia, high blood pressure, type 2 diabetes mellitus, as well as the quality of service and programs, and the policies and costs of medical attention in a Mexican were all determined [7]. Nutrient intake information was not included in this survey.

Malnutrition is an energy intake and loss imbalance. Its etiology has many causes and when present in children, will have repercussions in their adult lives. Therefore it is necessary to identify this phenomenon in order to begin corrective measures.

The objective of the present study was to determine nutrition disorder frequency and energy intake in 5- to 9-year-old children from Colima, Mexico.

Material and Methods

A populational survey in children from 5 to 9 years of age was carried out in the state of Colima, Mexico from August 2004 to November 2005. Children who did not wish to participate in the study, who were chronically ill, who had special needs, or who were recuperating from a recent illness were all excluded from the study.

Sample size was determined with the EPI-INFO 6-04b statistical package formula:

$$n = \frac{N z^2 p (1-p)}{d^2 (N-1) + z^2 (1-p)}$$

[p = 4.5% malnutrition prevalence; q = 1-p = 95.5%; d = 0.45% absolute precision 10% relative precision; n = 48, 783 (total number of 5- to 9-year-old children in state of Colima, obtained from INEGI, National Institute of Statistics, Geography and Informatics, Mexico); Z = 1.96 Design effect = 1]

The calculated statistical sample was 1730 children and taking into account a 15% loss, 1990 individuals were selected. Reference proportions for determining sample size were obtained from the National Health and Nutrition

Survey [7]. Malnutrition prevalence was used in order to obtain a larger sample size due to its being the lowest variable.

Sampling. Multi-staged random sampling was carried out. Municipalities were first randomly selected, followed by state primary school selection. Participating children were then selected from these. Parents were given detailed information about study objectives and were asked to sign letters of informed consent and to provide information on all foods their children had eaten during the 24 hours prior to the interview. The parents were interviewed directly and responded to each of the questions about the foods their children had eaten.

The anthropometric measuring process was thoroughly explained to each selected child before measurements were taken and was carried out in the following manner:

Weight. Following the recommendations of Habicht et al, weight was determined on a spring scale with a minimum reading of 100 g. To avoid error, the scales were gauged by adjusting a screw until the needle pointed to zero [8].

Height. Height was measured on a flat surface with the child standing barefoot, feet parallel, with heels, buttocks, shoulders and back of the head touching the back portion of the measuring scale. The head was comfortably held straight with eyes and ears at the same horizontal plane. Arms were maintained in a downward position at the sides of the body. The measuring scale had a wooden movable headpiece that was lowered to gently touch the top of the skull. The measuring scale reached 1.75 m with approximations of 0.1 cm.

The following three anthropomorphic indicators were used to determine nutrition degree: age-related weight, age-related height and BMI. Age-related weight was established according to the following percentiles: morbid obesity > 97, obesity 90-97, excess weight 75-89, normal 25-74, slight malnutrition 10-24, moderate

malnutrition 3-9, severe malnutrition < 3. Age-related height was determined based on the following percentiles: extremely high > 97, high 90-97, slightly high 75-89, normal 25-74, slightly low 10-24, low 3-9, extremely low < 3. Tables proposed by the World Health organization (WHO) that classify nutritional status by BMI through the following percentiles were used: malnutrition = < 3, overweight = > 85, obesity = > 95 [9].

The WM Boothby and J Berkson food nomogram was used to determine daily energy requirements for children [10].

Mexican Food Composition Tables (MFCT) from the Salvador Zubirán National Institute of Medical Science and Nutrition were used to evaluate energy content of food ingested by the children 24 hours prior to survey [11]. Ingested calories vs. required calories were then compared and if there was a difference between $\pm 10\%$, energy content was considered to be adequate. Figures higher or lower than 10% were considered to be energy excess or energy deficiency.

MFCT were also used to determine carbohydrate, protein, and lipid content in the food, and diet was considered adequate or balanced when nutrient percentages were 50-60%, 10-15%, and 30-35%, respectively [12].

Statistical analysis

Percentage, means, and standard deviation were used. Student's t test was used to compare calorie quantity and type of nutrients between groups.

Results

From the total of 5350 children invited to participate in the study, 2200 accepted. Finally a total of 1992 children (1032 boys and 960 girls) from 106 primary schools in the state of Colima, Mexico, were studied. Age distribution in the subjects and mean weight and height in boys and girls is shown in Table 1.

Table 1. Age distribution and mean weight and height in boys and girls in the state of Colima, Mexico.

Age (years)	Boys		Girls	
	Weight (Kg)	Height (cm)	Weight (Kg)	Height (cm)
5 (n=17)	21.3±4.2 (n=9)	120±0.5 (n=9)	17.9±1.1 (n=8)	110±0.2 (n=8)
6 (n=421)	24.0±6.1 (n=217)	121±0.6 (n=217)	22.1±4.6 (n=204)	119±0.5 (n=204)
7 (n=531)	27.4±7.4 (n=260)	125±0.7 (n=260)	26.1±6.8 (n=271)	124±0.6 (n=271)
8 (n=483)	30.5±8.2 (n=236)	130±0.6 (n=236)	30.5±9.2 (n=247)	129±0.7 (n=247)
9 (n=540)	35±10.2 (n=281)	136±0.7 (n=281)	35±10.1 (n=259)	134±0.4 (n=259)

Age-related weight. Overweight and obesity frequency in boys was 37.6% and in girls was 35.5%. Malnutrition was 31.3% in girls and 29.3% in boys (Figure 1).

Age-related height. Normal height was found in 49.6% of boys and 48.5% of girls while height under the norm was found in 27.2% of girls and 20.4% of boys (Figure 2).

In relation to BMI, the average of overweight and obesity frequency for both sexes was 31%, with 28.5% (278/960) in girls and 33.0% (340/1032) in boys. Malnutrition was found in 10.1% (97/960) of girls and 5.5% (57/1032) of boys (Figure 3).

Analysis was carried out to evaluate calorie quantity and type of nutrient consumed by children with overweight and obesity (n = 618) in relation to BMI, compared with the normal group. Comparison results of calorie quantity and type of nutrients showed an excess of calories (66%, $p=0.0001$), 1687 ± 90.5 Kcal (normal group) vs $2,800\pm150$ Kcal (overweight and obesity); an excess of proteins (27.1%, $p=0.003$), $14.0\pm0.5\%$ (normal group) vs $17.8\pm1.2\%$ (overweight and obesity); an excess of lipids (50%, $p=0.0002$) $30.3\pm1.5\%$ (normal

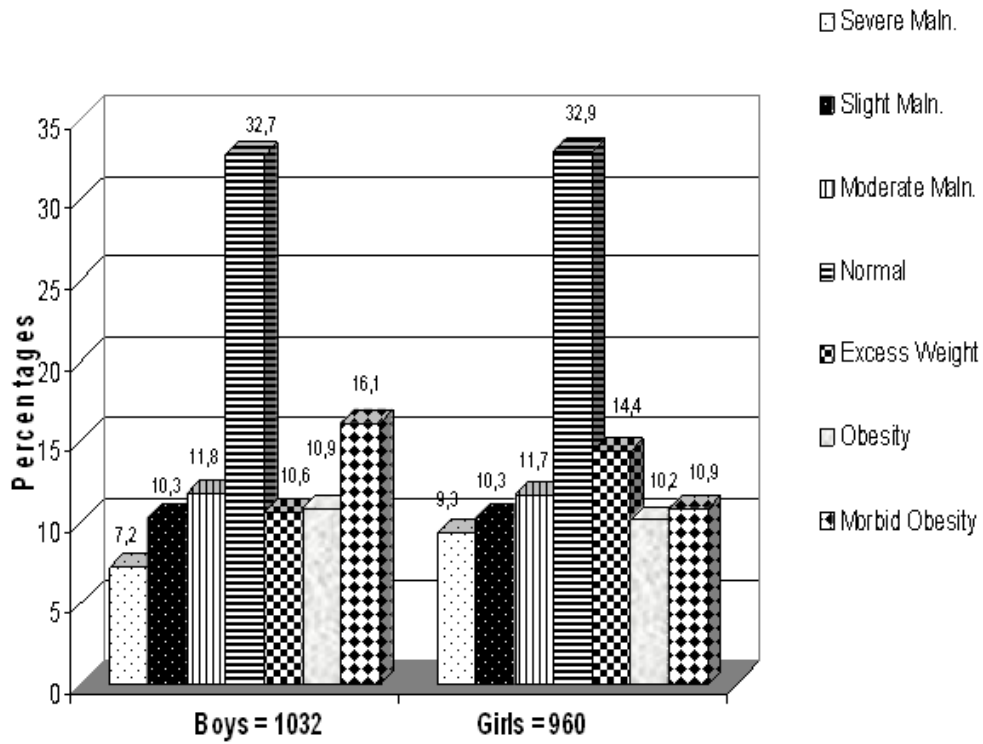


Figure 1. Age-related weight indicator for 5- to 9-year-old boys and girls in the state of Colima, Mexico. The respective percentages of each category are shown. (MALN.= malnutrition).

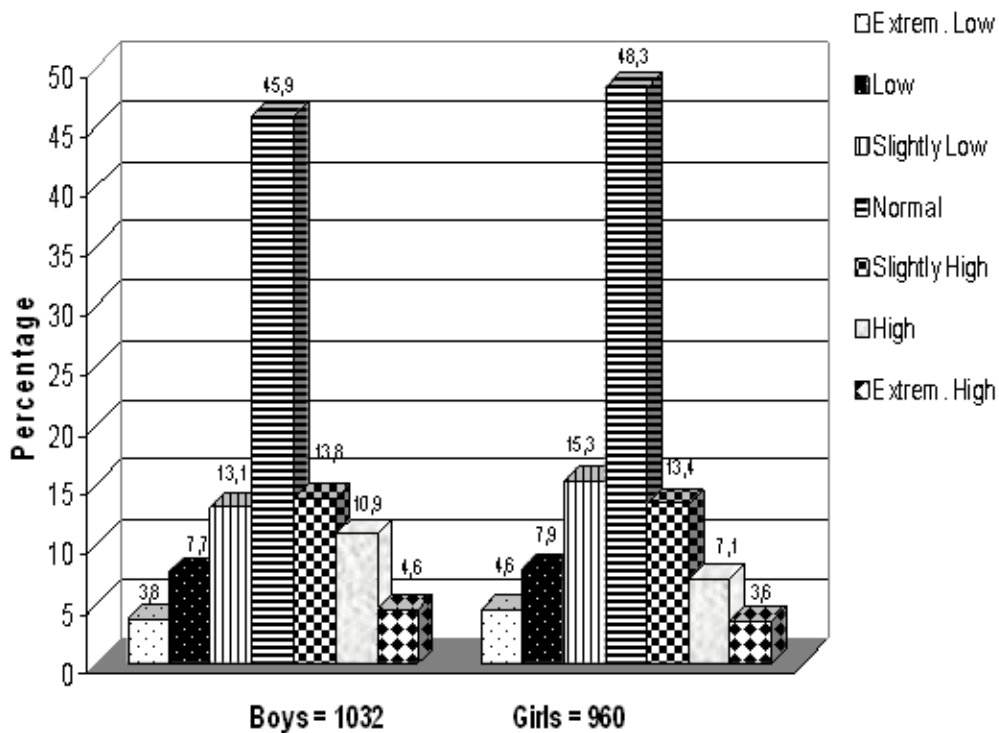


Figure 2. Age-related height indicator for 5- to 9-year-old boys and girls in the state of Colima, Mexico. The respective percentages of each category are shown. (EXTREM.= extremely)

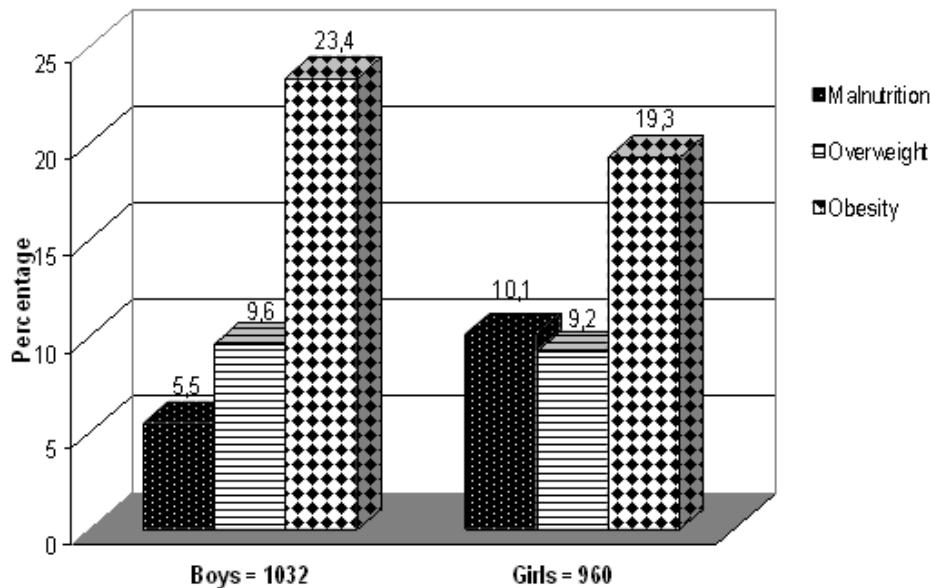


Figure 3. Body mass index of 5- to 9-year old boys and girls in the state of Colima, Mexico. The respective percentages of each category are shown.

group) vs $45.5 \pm 2.2\%$ (overweight and obesity) and an excess of carbohydrates (59.1% , $p=0.00007$), $47.0 \pm 3.1\%$ (normal group) vs $74.8 \pm 1.6\%$ (overweight and obesity). In relation to children with malnutrition ($n=151$) comparison results of calorie quantity and type of nutrients with the normal group showed a lack of calories (32.7% , $p=0.003$), 1687 ± 90.5 Kcal (normal group) vs $1,135 \pm 170$ Kcal (malnutrition); a lack of proteins (52.1% , $p=0.001$), $14.0 \pm 0.5\%$ (normal group) vs $6.7 \pm 1.7\%$ (malnutrition); a lack of lipids (29.7% , $p=0.002$), $30.3 \pm 1.5\%$ (normal group) vs $21.3 \pm 2.3\%$ (malnutrition) and a lack of carbohydrates (19.1% , $p=0.008$), $47.0 \pm 3.1\%$ (normal group) vs $38.0 \pm 2.5\%$ (malnutrition).

In the overall analysis, a total of 31.3% ($n=624$) of children had a hypocaloric diet and anthropometric indicators were expressed as follows: age-related weight: 43.1% ($n=268$) were underweight, 29.6% ($n=185$) were normal weight and 28.3% ($n=170$) were overweight; age-related height: 20.8% ($n=130$) were under the norm, 48.6% ($n=303$) were normal height and 30.6% were above the norm ($n=191$); BMI: 23.8% ($n=149$) were underweight, 52.2% ($n=325$) were normal weight and 24% ($n=150$)

were overweight and obesity. Dietary nutritional content was as follows: proteins: low or deficient 43.6% ($n=272$), adequate in 33% ($n=206$) and excessive in 23.4% ($n=146$); lipids: deficient in 52.9% ($n=330$), normal in 23.4% ($n=146$) and excessive in 23.7% ($n=148$); carbohydrates: deficient in 30.7% ($n=49.2\%$), normal in 38.3% ($n=239$) and excessive in 12.5% ($n=78$). As can be observed, children with hypocaloric diets had the highest deficiency percentages of the 3 nutrients.

A total of 37.6% of children (359 boys and 390 girls) had elevated energy intake and anthropometric indicators were as follows: age-related weight: 20.7% ($n=155$) were underweight, 29.5% ($n=221$) were normal weight and 49.2% ($n=373$) were overweight; age-related height: 33% ($n=248$) were under the norm, 46.5% ($n=348$) were normal height and 21.3% ($n=153$) were above the norm; BMI: 6% ($n=45$) were underweight, 52.7% ($n=397$) were normal weight and 41.3% ($n=307$) were overweight and obesity; nutritional content for proteins: 35.1% ($n=263$) had low or deficient content, 40.1% ($n=300$) had adequate content and 24.8% ($n=186$) had excessive content; lipids: 7.7% ($n=50$) had low content, 18.2% ($n=136$) had normal content

and 74.1% (n=555) had excessive content; carbohydrates: 9.2% (n=69) had low content, 44.3% (n=250) had normal content 57.4% (n=430) had excessive content. As can be seen, children with hypercaloric diets had the highest percentages of excess lipids and carbohydrates.

Children with overweight and obesity principally had excess intake of carbohydrates and lipids. Basically, carbohydrates included refined sugars (cookies, pastries, desserts, and candies) as well as artificial juices. Lipids included an excess of saturated fats (fried foods and eggs) (Table 2).

Table 2. Descriptive statistics of absolute energy and macronutrient intake.

	Obesity	Malnutrition
Energy (Kcal)	2,800±150	1,135±170
Macronutrients		
Carbohydrates	74.8 %	38 %
Lipids	45.5 %	21.3 %
Proteins	17.8 %	6.7 %

Discussion

To the best of our knowledge, this study presents the first estimates of nutrition disorder prevalence, energy intake, and food type in children from 5 to 9 years of age in Colima, Mexico.

The results of the present study show that in the entire state of Colima, Mexico, approximately 2 out of every 6 children suffer from overweight or obesity and 1 out of every 10 suffer from malnutrition. The prevalence of malnutrition was greater in girls, while overweight and obesity was slightly higher in boys. A complex overview can be observed due to the fact that obesity as well as malnutrition now coexist in our community. Therefore it is necessary to revise management means for both alterations and for the corresponding decision makers in the areas of Health and Education to modify existing guidelines.

It is important to mention that in reference to age-related weight and age-related height indicators, malnutrition frequency was higher than that reported in previous national surveys. The majority of reports (such as the recent Mexican National Health and Nutrition Survey) determine abnormality to be from 95% and 5% (Z scores ± 2), respectively. The cut-off point moves away from the median or mean of the normal curve and the reject zone is small in all of the tails [7]. The current survey used similar definitions for BMI. Therefore the present study complements these data, since the National Health and Nutrition Survey reported 26% of obesity and this paper shows 31%. An important difference is that no dietary data were collected in the National Health and Nutrition Survey.

In relation to BMI, nutrition disorder frequency of 38.6% (769/1992) was found; 31% (n=618) with overweight and obesity and 7.6% (n=151) with deterioration. These figures are higher than those recently reported in Mexico, as mentioned previously, and they are also much higher than in international reports [7]. In the present report nutritional status is defined by two methods: age-related weight and BMI. Different frequency values were found in each one. The difference in frequency of overweight and obesity from age-related weight and BMI could be explained by the fact that age-related weight has high sensitivity and low specificity. In other words, it tends to overestimate malnutrition prevalence and to classify children who are not malnourished as having malnutrition. It is useful at the community level because it helps detect cases of both marked deficit malnutrition and those children with mild deficit that are at risk for malnutrition. In addition, BMI integrally relates weight and height, which aids in rapid detection of possible malnutrition cases, particularly obesity cases. Because of this integral report of weight and height, BMI is the better tool for estimating nutritional status and it is also the most widely used parameter worldwide.

Furthermore, there are periods during growth and development, as is the case with school-age children, in which the risk of developing overweight and obesity is higher, due not only to biological stage but also to eating habits, such as diets with high energy content [13]. Diet macronutrient distribution appears to play a key role in weight regulation and body composition. The mechanisms by which the organism achieves homeostatic regulation of metabolic substrates and controls adiposity have not yet been fully established. However, the interrelation among the metabolism of lipids, carbohydrates, and proteins and their respective dietary intake has been well-defined [14]. In the present study, the percentage of ingested macronutrients in a child's diet in 24 hours was calculated and the results showed a deficiency in proteins, even though amounts were adequate for the majority of children. These results are significant because children between the ages of 5 and 9 are growing and a protein deficient diet can cause a reduction in lineal growth [15]. Dietary data from only one day was used. Due to day-to-day variation in nutrient intake a much wider spread of intakes is obtained than if intake is estimated over a longer period of days. This means that the number of children found in excessive and inadequate nutrient intake categories is likely to be considerably overestimated. This is a limitation of the dietary assessment method used in the present study.

One of the current theories on obesity is the excess of chronic fat ingestion, that when added to its poor satisfying power, leads to excessive energy intake ending in overweight and obesity [16]. An excess of high energy dietary intake, a diet rich in fat over long periods of time [17] serves as a depository for storing the body's extra calories and filling adipose cells (adipose tissue reserves) [18] and this excess leads to weight gain, overweight and obesity. Finally, it should be taken into account that a low-fat diet rich in carbohydrates is not exempt from weight gain [19]. Carbohydrate intake was observed to be adequate in the majority of children. However, excessive carbohydrate intake is significant since carbohydrate sugars regulate

body fat accumulation leading to the overweight and obesity seen in the study results [20].

The increase in overweight and obesity is related to geographical region. Overweight and obesity prevalence is greater in North America than in South America. For example in the United States and Mexico, overweight prevalence in children is 54% and 48.7%, respectively, and in South America prevalence is from 13-27.5% [21-24]. Better socioeconomic conditions may be an explanation for this higher prevalence in northern countries. Prevalence is lower in Europe, which may be due to the type of diet that children eat [25]. However, more studies are necessary to corroborate this.

In conclusion, in relation to body mass index in 5- to 9-year-old children from Colima, Mexico, nutrition disorder frequency was 38.6%, inadequate energy intake was 68.7%, and almost two-thirds of children had inadequate nutrient intake.

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