



Trabajo Original

Valoración nutricional

New Diet Quality Index for children and adolescents in Costa Rica *Nuevo Índice de Calidad de la Dieta de niños y adolescentes en Costa Rica*

Hilda Patricia Núñez-Rivas¹, Ileana Holst-Schumacher² and Natalia Campos-Saborío³

¹Instituto Costarricense de Investigación y Enseñanza en Nutrición y Salud. Tres Ríos, Costa Rica. ²Universidad de Costa Rica. San Pedro Montes de Oca, Costa Rica.

³Universidad Estatal a Distancia. Sabánilla, Costa Rica

Abstract

Introduction: there is an increasing interest in the study of total diet quality indicators through the study of food groups in certain dietary patterns.

Objective: to analyze the diet of students in Costa Rica with construction of a contextualized new diet quality index.

Material and methods: a cross-sectional study was performed in a population of 2,677 students from 64 educational centers. Data on habits and food intake frequency were collected through interviews and questionnaires. A new Diet Quality Index was constructed and applied, which assessed the adjustment of intake frequency for 22 food groups, corrected with five preventive dietary factors and five risk factors for chronic non-communicable diseases. Descriptive statistics were evaluated using the program SPSS, version 24.0. A p-value < 0.05 was considered significant.

Results: the population was made up of 1,259 (43 %) men and 1,418 women (57 %). According to the new Diet Quality Index-Costa Rica classification, 1.2 % (n = 33) of participants have a healthy diet; 9.0 % (n = 239) require dietary changes, and 89.8 % (n = 2 395) have an unhealthy diet because of excessive intake of processed foods (rich in sodium and fat) and a low consumption of fruits and vegetables. Significant differences were found in the averages of the Diet Quality Index-Costa Rica by sex, educational level, and socioeconomic status.

Conclusions: around 90 % of the studied population do not comply with the recommendations issued for a healthy diet. Nutritional education should be strengthened in Costa Rican education centers.

Keywords:

Diet. Students. Habits. Non-communicable diseases. Costa Rica.

Resumen

Introducción: existe un interés creciente en el estudio de los indicadores de la calidad de la dieta total a través del estudio de grupos de alimentos.

Objetivo: analizar la dieta de los estudiantes de Costa Rica con la construcción de un índice de calidad de la dieta contextualizado y nuevo.

Material y métodos: se realizó un estudio transversal con una población de 2677 estudiantes de 64 centros educativos. Los datos sobre hábitos y frecuencia de la ingesta de alimentos se recopilaron a través de entrevistas y cuestionarios. Se construyó y aplicó un nuevo Índice de Calidad de la Dieta, que evaluó el ajuste de la frecuencia de la ingesta de 22 grupos de alimentos corregidos con cinco factores dietéticos preventivos y cinco factores de riesgo para enfermedades crónicas no transmisibles. Se realizaron estadísticas descriptivas con el programa SPSS, versión 24.0. Se consideró significativo todo valor de p < 0,05.

Resultados: la población estaba compuesta por 1259 (43 %) hombres y 1418 mujeres (57 %). De acuerdo con la nueva clasificación del Índice de Calidad de la Dieta-Costa Rica, el 1,2 % (n = 33) de los participantes tienen una dieta saludable, el 9,0 % (n = 239) requieren cambios y el 89,8 % (n = 2 395) tienen una dieta poco saludable debido a la ingesta excesiva de alimentos procesados (ricos en sodio y grasas) y al bajo consumo de frutas y vegetales. Se encontraron diferencias significativas en los promedios del Índice de Calidad de la Dieta-Costa Rica por sexo, nivel educativo y clase socioeconómica.

Conclusiones: alrededor del 90 % de la población estudiada no cumple con las recomendaciones para llevar una dieta saludable. La educación nutricional debe fortalecerse en los centros educativos costarricenses.

Palabras clave:

Dieta. Estudiantes. Hábitos. Enfermedades crónicas no transmisibles. Costa Rica.

Received: 20/05/2019 • Accepted: 19/11/2019

Conflict of interest: the authors declare no conflict of interest.

Núñez-Rivas HP, Holst-Schumacher I, Campos-Saborío N. New Diet Quality Index for children and adolescents in Costa Rica. *Nutr Hosp* 2020;37(1):65-72

DOI: <http://dx.doi.org/10.20960/nh.02695>

Correspondence:

Ileana Holst-Schumacher. Universidad de Costa Rica.
San Pedro Montes de Oca, Costa Rica
e-mail: ileana.holst@ucr.ac.cr

INTRODUCTION

Food can be a heart protector or a risk factor for cardiovascular disease (CVD), different types of cancer (CA), type-2 diabetes mellitus (DM-II), and osteoporosis, among other pathologies (1,2). Certain dietary patterns are associated with health benefits, including the Mediterranean diet (3) and the dietetic proposals to mitigate hypertension (Dietary Approaches to Stop Hypertension, DASH) (4).

The most important challenge for public health is that the population adopt healthy lifestyles patterns despite being immersed in a social system with powerful commercial influences that promote unhealthy options and behaviors (5). It is important to simplify and lower the costs of diet monitoring in populations around the world.

Traditionally, different surveys have been used to analyze food, either as intake trend or 24-hour reminder. Consumption of each food, kind and nutrient group, and degree of adaptation to intake recommendations are evaluated (6,7). Although surveys are good tools to evaluate the deficient or excessive consumption of critical nutrients, they do not allow to establish a global diagnosis of food quality at the individual or population level. This is the reason why there is an increasing interest in the study of total diet quality indicators through the study of food groups in certain dietary patterns (8).

The Healthy Eating Index (HEI) (9), the Diet Quality Index (DQI) (10), the Healthy Diet Indicator (HDI) (11), and the Mediterranean Diet Score (MDS) (12) are the four original indices that have been referenced, adapted to the recommendations of different countries, and validated more extensively, followed by others that also consider the degree of adherence to Mediterranean lifestyle habits (13).

The last National Nutrition Survey in Costa Rica (CR) (14) and the apparent consumption of food surveys that were incorporated into the Multiple Purpose Household Survey (from 1989, 1991 and 2001) (15) have shown a trend towards a high proportion of the population having a low intake of fruits, vegetables, dairy products, fish and legumes, and an excessive consumption of unhealthy foods, characterized by high-energy contents including fat, sugar and sodium, and deficient calcium and fiber (16). These databases are of great value for CR because they include variables of food intake frequency and may facilitate the assessment of quality in the Costa Rican diet and a definition of intervention strategies by public policy makers. However, the aforementioned data have not yet been exploited.

The multiple recommendations and guidelines regarding food intake for CR and other countries have been ineffective strategies for reducing the pandemics of non-communicable diseases (NCDs) from an early age (19). National and international studies with children and adolescent populations have shown a consumption pattern involving foods high in fat, refined carbohydrates and sodium (both by the extra addition of salt or by the contribution of processed foods) (17). These high-energy meals are accompanied by a low intake of fruits and vegetables, linked in part to the fact that home cooking is not being regularly practiced anymore (17). The acquisition of good eating habits during childhood and adolescence promotes wellbeing, health, and the foundations

for a healthy diet in the future, preventing NCD development at younger ages.

The objective of this study was to analyze the usual diet of a representative sample of students from CR schools and high schools by constructing a contextualized, new Diet Quality Index (DQI-CR), and to compare it with the demographic and socioeconomic characteristics of the study population.

MATERIALS AND METHODS

A cross-sectional study was performed in a population of 2,677 students from 24 elementary-middle schools and 40 high schools with daytime schedule. The proportion estimation formula was used with a 95 % confidence interval and a standard error of 3 %. In each educational center a total of 40 children and adolescents were randomly selected using age (7 to 18 years) as the only inclusion criterion. Exclusion criteria included: incomplete participant information, inability to read and write, history of eating disorders, celiac disease or diabetes mellitus, and alcohol or illicit drug dependence.

A food frequency survey was designed and applied to study the food and beverage consumption habits of the participants. Some demographic and socioeconomic variables were also explored in this questionnaire.

The food frequency questionnaire was elaborated based on the American Healthy Eating Index (9), considering the dietary recommendations for children and adolescents issued by the World Health Organization (1) and the Dietary Guidelines for Americans (18); the parameters of the DASH diet (4); the Mediterranean diet (3); and the general guidelines included in the Dietary Guidelines for CR (19).

Different foods and beverages were included and classified into 22 groups, which are detailed in table I. The 22 groups are varied with the purpose of evaluating the variety and consumption quality registered by each of the students, who were oriented to include the intake frequency of any other food not found in the list. The result was a list of 120 foods including homemade and industrial products that are part of the Costa Rican diet and the global habits of children and adolescents, known as the "youth" culture (20). For example, the intake of carbonated drinks, fast food, hidden and added sodium dietary sources, visible fat, and fried foods was investigated.

The validated questionnaire to assess the intake frequency of foods was applied individually with the supervision of two nutritionists. Children who attended first, second and third year of school were interviewed.

Five positive and five negative criteria were included in the study based on the dietary recommendations detailed in table II.

The new DQI-CR is the result of carrying out four steps:

Step 1: assessment of the adequacy of consumption frequency for the 22 groups of foods, products and beverages. Each of these variables was divided into four categories according to intake frequency: a) 5 to 7 times/week; b) 2 to 4 times/week; c) 1 time/week, and d) never or < 1 time/month (Table III). Based on this information,

Table I. List of foods, beverages and preparations whose frequency was investigated by the survey

Cereals	Non-whole and whole grains: rice, barley, oats, breakfast cereals, tortilla, and breads, among others
Starchy vegetables	Potato, yucca, sweet potato, tiquizque, ñampi, among others
Meats, eggs	No visible fat: beef, pork, chicken, fish, tuna, “scrambled” (not fried) chicken egg
Fruits	Papaya, melon, watermelon, banana, guava, soursop, orange, tangerine, among others
Legumes	Beans of any color, lentils, chickpeas, peas
Milk and derivatives rich in calcium	Skimmed or semi-skimmed milk, yogurt and fresh white cheese (not ripe or creamy); whole milk
Processed meats / sausages	Sausage, mortadella, chopped
Meats with visible or fried fat	Pork rinds, beef or pork ribs with bacon
Sauces	Soy, spices (Lizano®), tomato, among others
Fast foods	Pizza, hot dog, taco, hamburger, nachos, among others
Fried prepared pastries and sandwiches	Puff pastry, empanadas, churros, among others
Snacks in small packages	Roasted potatoes, fried plantains, among others
Cookies	Any salty or stuffed cookie
Salted seeds and popcorn	Peanuts, almonds, walnuts, cashew nuts, popcorn of any kind, with salt
Sweets and creamy ice cream	Sweets, chocolates, creamy ice cream of any kind
Soups	Ready-made soups (instant) ready to heat and consume
Unsalted seeds	Almonds, nuts, among others, with no salt
Dressings	Mayonnaise, cream cheese, pink sauce, among others
Mature or creamy cheeses	Yellow cheese of any kind; ripe (not white or fresh), for melting or frying
Non-starchy vegetables	Vanilla, carrot, cabbage, tomato, tender squash, lettuce, cucumber, among others
Drinks with alcohol	Beer, white or red wine or sparkling wine, whiskey, vodka, rum, among others
Other drinks	Soda cola, soda citrus flavor, other carbonated drinks, concentrated juices powdered or packed with added sugar, flavored water, flavored milk, sports drinks, energy drinks, among others. Drinks with no sugar added. Water

Table II. Positive and negative quality criteria used for the Diet Quality Index of Costa Rica

Positive quality criteria (add 5 points each)
Has breakfast, lunch and dinner every day
Eats two or more fruits every day
Eats non-starchy vegetables (salad or hash) twice a day, every day
Drinks three or more glasses of water a day, every day
Eats white meats (chicken, fish, tuna) once a day, five or more times a week
Negative quality criteria (subtract 5 points each)
Drinks alcoholic beverages at any frequency
Drinks carbonated beverages at any frequency
Takes energy or hydrating drinks at any frequency
Adds salt to food or the served dish at any frequency
Eats sausages or processed meats at any frequency

being the maximum and 0 being the minimum score (Table III). The DQI-CR allows a maximum score of 141.

Step 2: identification of the presence of positive quality criteria (Table II), which are added to the score obtained in step 1. Maximum sum: 25 points (5 points for each criterion identified).

Step 3: identification of the presence of negative quality criteria (Table II), which are subtracted from the score obtained in step 2. Maximum subtraction: 25 points (5 points for each criterion identified).

Step 4: categorization of the DQI-CR. The index classifies the habitual diet into three categories: a) healthy: > 119 points; b) requires changes: from 100 to 119 points; and c) unhealthy: < 100 points. In order to establish the cut-off points of the new index and to interpret and define the concepts of “healthy”, “requires changes” and “unhealthy”, international study cut-off points (21,22) were reviewed. The researchers decided to use the cut-off points of those studies in order to be able to compare the results obtained in this work. To corroborate this decision, extreme and intermediate scores were calculated according to patterns of healthy and unhealthy intake. Additionally, twelve focus groups of respondents were assessed using interviews and validated ques-

scores were assigned according to the dietary recommendation for each of the foods, products and beverages consumed, with 7 points

Table III. Scores according to intake frequency of different food groups in schoolchildren and adolescents in Costa Rica

Evaluated aspects / 1 time a day	Score according to intake frequency			
	7 points	5.25 points	3.50 points	0 points
Cereals (whole and not-whole grains)	5 to 7 times/week 3.5 points	2 to 4 times/week 2.6 points	1 time/week 1.75 points	Never or < 1 time/month
Starchy vegetables	5 to 7 times/week 3.5 points	2 to 4 times/week 2.6 points	1 time/week 1.75 points	Never or < 1 time/month
Meats, eggs	1 time a day, 5 to 7 times a week	2 times a day, 5 to 7 times/week or 2 to 4 times/week	3 times/day, 5 to 7 times/week or 1 time/week	3 or more times/day, 5 to 7 times/week or < 1 time/month
Fruits	5 to 7 times/week	2 to 4 times/week	1 time/week	Never or < 1 time/week
Legumes	5 to 7 times/week	2 to 4 times/week	1 time/week	Never or < 1 time/month
Milk, yogurt, white cheese	5 to 7 times/week	2 to 4 times/week	1 time/week	Never or < 1 time/month
Processed meats / sausages	Never or < 1 time/month	1 time/week	2 to 4 times/week	5 to 7 times/week
Meats with visible or fried fat	Never or < 1 time/month	1 time/week	2 to 4 times/week	5 to 7 times/week
Sauces: soy, spices (Lizano®), tomato, among other similar ones	Never or < 1 time/month	1 time/week	2 to 4 times/week	5 to 7 times/week
Fast foods (hot dogs, tacos, hamburgers)	Never or < 1 time/month	1 time/week	2 to 4 times/week	5 to 7 times/week
Puff pastry confectionery, fried prepared sandwiches (empanada, churro)	Never or < 1 time/month	1 time/week	2 to 4 times/week	5 to 7 times/week
Snacks in packets (toasted potatoes, among others)	Never or < 1 time/month	1 time/week	2 to 4 times/week	5 to 7 times/week
Salted cookies	Never or < 1 time/month	1 time/week	2 to 4 times/week	5 to 7 times/week
Salted seeds and popcorn	Never or < 1 time/month	1 time/week	2 to 4 times/week	5 to 7 times/week
Sweet drinks, treats and creamy ice cream	Never or < 1 time/month	1 time/week	2 to 4 times/week	5 to 7 times/week
Instant soups	Never or < 1 time/month	1 time/week	2 to 4 times/week	5 to 7 times/week
Unsalted seeds (almonds)	5 to 7 times/week	2 to 4 times/week	1 time/week	Never or < 1 time/week
Dressings (mayonnaise, cream cheese, among others)	Never or < 1 time/month	1 time/week	2 to 4 times/week	5 to 7 times/week
Mature or creamy cheeses	Never or < 1 time/month	1 time/week	2 to 4 times/week	5 to 7 times/week
Have breakfast	5 to 7 times/week	2 to 4 times/week	1 time/week	Never or < 1 time/month
Have lunch	5 to 7 times/week	2 to 4 times/week	1 time/week	Never or < 1 time/month
Have dinner	5 to 7 times/week	2 to 4 times/week	1 time/week	Never or < 1 time/month
Non-starchy vegetables (salad, hash) at lunch	5 to 7 times/week	2 to 4 times/week	1 time/week	Never or < 1 time/month
Non-starchy vegetables (salad, hash) at dinner	5 to 7 times/week	2 to 4 times/week	1 time/week	Never or < 1 time/month

tionnaires, which allowed some adjustments before establishing the definitive version.

Sociodemographic variables (personal, familial, and social information) were collected through a validated self-administered questionnaire. Socioeconomic class was determined according to Madrigal's methodology (23).

RESEARCH ETHICS

All participants gave their written informed consent or assentment to be included in the study. These documents were approved

by the Scientific Ethics Committees of the institutions involved in the study, and all the procedures performed were in accordance with the Helsinki Declaration and its ethical standards.

STATISTICAL ANALYSIS

Based on the DQI-CR a descriptive analysis of frequencies, means and percentages was carried out and stratified by sex, educational level, and socioeconomic class. To study the differences in means according to sex and educational level, the Mann-Whitney test was used for two independent samples. For the study of the

differences between means according to socioeconomic class, a nonparametric Kruskal-Wallis test was performed for several independent samples. For the categorical variables, an independence analysis was carried out using a Chi-square test.

The analysis and processing of the data was done with the statistical package SPSS, version 24.0. A value of $p < 0.05$ was considered to be significant.

RESULTS

Only 1.2 % ($n = 33$) of students have a healthy diet; 9.0 % ($n = 239$) require changes, and 89.8 % ($n = 2,395$) have an unhealthy diet resulting from excessive intake of processed foods (high in sodium and fat) and low consumption of fruits and vegetables. Table III shows the mean scores of the DQI-CR for each of the study variables, and the percentages of students in each of the three categories for this indicator.

The average DQI-CR score for the male population (70.06 ± 22.26) is significantly lower than the average DQI-CR score for the female population (72.94 ± 22.47) ($p = 0.001$). The percentage of the population of both genders that requires changes in their diet exceeds 85 %. Significant differences were also found in the DQI-CR averages according to educational level: school: 72.91 ± 22.03 vs. high school: 70.28 ± 22.88 , ($p = 0.003$); socioeconomic class: low: 66.0 ± 21.84 ; medium: 72.01 ± 23.58 , and high: 73.91 ± 21.96 ($p = 0.001$) (Table IV).

Regarding the dichotomous analysis of sex and educational variables versus the three categories in the DQI-CR, no statistically significant differences were found. As regards socioeconomic level, the proportion of students of low socioeconomic class who

have an unhealthy diet (95.2 %) is significantly higher than the proportion of students of medium socioeconomic class with the same issue (87.9 %) ($p = 0.001$). Likewise, the proportion of students of low socioeconomic class who have a healthy diet (0.3 %) is significantly lower than the proportion of students of medium socioeconomic class with a healthy diet (1.4 %) ($p = 0.010$).

More than 85 % of the population have an excessive intake of processed meats, fast foods, fat-based dressings and carbonated drinks.

DISCUSSION

The DQI's purpose is to evaluate the diet in a general manner and to categorize individuals according to the adequacy of their behaviors considered as healthy. In CR there are no national studies that assess total dietary quality; therefore, the newly proposed index considers key food groups (3), such as those presented in the MDS, fish, high-carbohydrate fruits and vegetables, and even alcohol drinking.

The Costa Rican index and almost all DQIs, except those that consider only nutrients, include fruits, vegetables and cereals. However, the HEI, MDS and HDI tools do not distinguish between whole and refined grains, as opposed to the DQI-CR. In addition, the Costa Rican index contains an additional attribute as it includes the item "legumes", rich in non-heme iron and dietary fiber.

In the DQI-CR meat is included in the low-frequency and moderate-amount group since a high intake of red meats and other processed and ultraprocessed (UP) products is associated with an increased prevalence of some NCDs (DAEUA Report, 2010) (5). UP products are formulations developed from substances extracted from foods (fats, starches and sugars) (24), and include a wide range of energy-dense snacks, sweetened breakfast cereals, cookies and cakes, sweet drinks, and "fast foods", as well as reconstituted animal products and ready-to-heat meals. Also included in the DQI-CR are the following: meats with visible or fried fat; mature and creamy cheeses (not fresh); dressings (mayonnaise, cream cheese, among others); fast foods (hot dogs, tacos, hamburgers); puff pastry confectionery; prepared fried sandwiches (empanada, churro), and snacks in small packs (toasted potatoes, among others) because a frequent intake of these products leads to a high consumption of saturated fatty acids, cholesterol, and energy density, which brings about obesity, among other chronic diseases.

Therefore, the inclusion of dairy products in the proposed DQI-CR was a complex issue because some of these products (creams, butter, mature and creamy cheeses) are rich in saturated fatty acids (SFA) (1), and skimmed, semi-skimmed and fermented products are rich in calcium and have been associated with protection factors for NCDs. Thus, calcium intake during childhood and adolescence is an important factor to reach maximum bone mass, skeletal mineralization, and protection against fractures and osteoporosis (1,2).

The drinking of alcoholic beverages in Costa Rican children and adolescents was also included in the DQI-CR because this

Table IV. Averages (\pm SD) in the DQI-CR according to sex, socioeconomic class, and educational level

Variables	DQI-CR			p-value
	n	Mean	\pm SD	
<i>Sex</i>				
Male	1,259	70.06	22.26	0.001*
Female	1,418	72.94	22.47	
<i>Socioeconomic class</i>				
Low	752	66.00	21.84	0.001†
Middle	1,500	72.01	23.58	
High	425	73.91	21.96	
<i>Educational level</i>				
School	1,571	72.91	22.03	0.003*
High School	1,106	70.28	22.88	

n: number of subjects; \pm SD: standard deviation; DQI-CR: Diet Quality Diet Index of Costa Rica; *p*-value significant if < 0.05 . *Mann-Whitney test for two independent samples. †Kruskal-Wallis test for several independent samples.

is the main drug used by the Costa Rican younger population, and is a high-risk factor for impairment of physical and emotional well-being for them, their families, and society as a whole (25).

The DQI-CR considers the habit of adding salt to foods and eating processed food, sandwiches and chips or similar snacks, as was considered by Lucini et al. in building the Simple Index of Healthy Lifestyle based on the Web (26). The health consequences of this excessive intake of sodium and insufficient potassium are important since they are associated with high blood pressure, cardiovascular health issues, DM-II, heart disease, and stroke (26). Other trace elements and vitamins also play an essential role in health; however, the DQI-CR, like other DQIs, does not include them specifically because it is assumed that a varied intake of food groups would result in an acceptable ingestion of these essential components (27). However, considering only the variety of diet as a guide has become controversial because the evidence suggests that consuming a greater variety of foods may be related to excessive energy intake and adiposity (28).

In general, the greatest utility of the DQI-CR lies in its estimation of diet quality in children and adolescents in a qualitative manner; also, it offers necessary and interesting information for planning food and nutritional national policies. However, Alkerwi (29) has reviewed the concept of diet quality and has discussed some key points of the multiple DQIs and the complexity of defining and quantifying this concept. Therefore, DQIs must be used and interpreted carefully. In the future, new proposals, in either short or large versions, could be put forward to improve its predictive capacity in relation to chronic diseases, and the tool could be used to help make dietary guidelines clearer and more actionable regarding the benefits of dietary variety, in combination with ease of use and a low cost for these tools (proposals) meant to assess diet quality (30).

Harris et al. found that social classes with a higher income and population groups with a high level of education have a healthier diet (31). Similarities have also been found in the stratification by age and sex, where women and the older population groups are the ones with a healthier diet (31). The results of our study agree in terms of sex and socioeconomic class but not of age. The average DQI-CR score stratified by sex showed a significantly higher score for women as compared to men, whereas the group of school students scored significantly higher than the group of high school students. In relation to socioeconomic class, the average DQI-CR score was significantly lower in low-class children and adolescents as compared to their middle-class peers. Similarly, the average DQI-CR score was significantly higher in high-class children and adolescents when compared to their middle-class peers. Only 0.3 % ($n = 2$) of low-class students achieved a score within the "healthy eating" category; the proportion of children and adolescents in this class who were classified with an unhealthy diet is significantly higher in comparison with the proportion of children and adolescents with medium socioeconomic status.

This demographic, sociocultural and economic information is important to consider in focused health interventions in terms of sex (in this case, male), level of education (in this case, high school) and lower socioeconomic classes, since it is possible to

direct the intervention to these sectors of the young population to get to move the entire student population towards a healthier diet.

Although the construction of the DQI-CR indicator has limitations associated with consumption data, because it does not provide exact amounts of food or energy, it gives information about intake frequency by food groups. Importantly, the results of our study are like those of others (22,32) when comparing the population percentages with unhealthy diets or diets that require changes. Probably, this fact can be explained because the diet of children and adolescents is becoming globalized (33). The proposed index is consistent with most of the studies regarding critical foods, low intake frequency of fruits, vegetables, dairy products, and whole grains, and high intake frequency of processed and UP foods, with a high content of fats, sugars and sodium (20-22,24,33,34).

Regarding the age variable, this study shows that diet quality is more deficient or regrettable in adolescents in high school than in elementary or middle school. This suggests a possible relationship with the lifestyle of adolescents, with a broad day of activities including study or work, greater exposure and access to an unhealthy food supply (20,33), and with socioeconomic limiting or marginal factors (35). The latter influence not only the diet of young people but also of people of all ages, as evidenced in this study and in others (36).

This study proposes that a DQI has the advantage of being an easily administered instrument that can be adapted to the recommendations of each country. The results of the study reinforce the importance of encouraging activities to promote a healthy diet throughout the life cycle. It is expected that the regulation No. 36910-MEP-S of the Ministry of Public Education, applied since 2012 (37) for the operation and administration of the soda service in public schools, will reduce the intake of UP products and industrial unhealthy foods, and improve the national DQI-CR score.

In CR, from 1966 to 1982, the population's diet was evaluated using the previous day reminder method. In 1996 and 2008 the Apparent Consumption Method (ACM) was used (38). Also, in 1991, 1999 and 2001 intake surveys were carried out that were incorporated as modules in household surveys with multiple purposes (15). The ACM is easier and cheaper than the traditional registration methods with weights and previous day reminders, but has bigger limitations to measure the real intake, since it is done by measuring the amount of food used in a reference week. This method does not consider the food that is consumed by other people who are not family members (guests), or the intrafamilial distribution of food, or the amounts of food lost due to deterioration, or the products used for feeding domestic animals.

The National Nutrition Surveys of the Ministry of Health and the National Institute of Statistics and Census (INEC) (14) have shown that there is a significant increase in the intake of vegetables and fruits in the CR population. According to Novygrodt (16), the average intake of fruits per person is 55.2 grams, while that of vegetables is 141.2 grams. Both add up to 196.4 grams (50 % of what is recommended) and, in addition, a deficient intake of calcium, vitamin D and selenium is documented, which has contributed to a greater presence of diseases such as osteoporosis. Therefore, it is necessary to increase the consumption of fruits and vegetables,

since it is a determinant of deficiencies in micronutrients among the population and a risk factor for NCDs. Milk has also shown a tendency towards decreased intake, which deserves attention because it is one of the main foods that protect against calcium deficiency. In the same way, the per capita intake of beans (legumes), a part of the traditional basic diet of the Costa Rican population, has been reduced, which may alter the protein-energy balance and the intake of dietary fiber.

In fact, in CR the “Food Circle” is used, led by the Inter-sectorial Food Guidance Commission (CIGA) (19), to promote a higher intake of cereals, legumes and mealy vegetables, followed by the group of vegetables and fruits, and a smaller proportion of products of animal origin or in the group of fats and sugars, which must be consumed in very small quantities.

The information collected in CR through the ACM that identifies changes in consumer trends, and the promotion of healthy eating, which has been done through the use of the “Circle of food” (19), have served to support the definition of public policies and guide the development of plans and programs (38). However, both tools do not allow us to examine the frequency of food intake with bioactive components in the Costa Rican population’s diet. Monitoring the DQI-CR would be useful because it allows to categorize the population according to the diet’s quality, and distinguish between traditional and industrialized-modern feeding patterns.

Traditional kitchens have evolved as an important part of personal autonomy, identity and culture, and the loss of knowledge about food and culinary skills creates a serious vulnerability in societies, rural economies, and agricultural biodiversity. If traditional healthy foods (for example, rice and beans) are compared to those frozen or prepared with UP products, the latter contain more sugar, saturated fats and sodium, and less dietary fiber, minerals and vitamins. They also have a higher energy density (24). In addition, they are ubiquitous, heavily publicized, highly palatable, and result in habit-forming practices from early ages (24).

International initiatives, plans, programs and projects on human nutrition and regulations should be monitored periodically to promote healthy lifestyles, but not only for establishing prevalence statistics (for example, for obesity) but also for using intermediate indicators, for which the new DQI-CR could be an interesting option. The regulation of the food industry should cover the labeling, promotion and advertising of UP products (24,39); such measures are proposed in the Action Plan for the Prevention of Obesity in Children and Adolescents (39), but it is required that they should be implemented and monitored in a scientific-ethical manner.

In conclusion, CR children and adolescents are not complying with the recommendations issued to have a healthy diet. It is necessary to strengthen the educational processes on healthy eating in the elementary, middle and high schools of CR, and to face NCDs. In this process, families should be considered, mainly those with low socioeconomic level (40). It is essential to reconfigure the traditional diet in families, and turn it into the axis of formal educational activities to make learning significant, which implies that the Ministry of Public Education be consistent with maintaining a healthy food availability within educational centers. Young people must surround themselves with native and healthy

environments, both in their homes and in their elementary, middle and high schools, complements that are essential for the construction of healthy lifestyles.

STRENGTHS OF THE STUDY

This is the first study to analyze the diet of elementary, middle and high school students from Costa Rica with the construction of a contextualized, new diet quality index. Further, the sample of this study is large and representative of the whole country, confidentiality was guaranteed to participants, and only validated, anonymous instruments were used.

LIMITATIONS OF THE STUDY

The design of this study is cross-sectional, so it only allows to make inferences about associations but not about causality. Socioeconomic and consumption data were based on self-recordings, which may be influenced by social convenience and memory bias.

REFERENCES

- Méndez L, Dasilva G, Taltavull N, Romeu M, Medina I. Marine Lipids on Cardiovascular Diseases and Other Chronic Diseases Induced by Diet: An Insight Provided by Proteomics and Lipidomics. *Mar Drugs* 2017;18;15(8). DOI: 10.3390/md15080258
- Saha SK, Lee SB, Won J, Choi HY, Kim K, Yang GM, et al. Correlation between Oxidative Stress, Nutrition, and Cancer Initiation. *Int J Mol Sci* 2017;18(7). DOI: 10.3390/ijms18071544
- Del Bo C, Marino M, Martini D, Tucci M, Ciappellano S, Riso P, Porrini M. Overview of Human Intervention Studies Evaluating the Impact of the Mediterranean Diet on Markers of DNA Damage. *Nutrients* 2019;11(2). DOI: 10.3390/nu11020391
- Schwingshackl L, Bogensberger B, Hoffmann G. Diet Quality as Assessed by the Healthy Eating Index, Alternate Healthy Eating Index, Dietary Approaches to Stop Hypertension Score, and Health Outcomes: An Updated Systematic Review and Meta-Analysis of Cohort Studies. *J Acad Nutr Diet* 2018;118(1):74-100. DOI: 10.1016/j.jand.2017.08.024
- Sonntag D, Schneider S, Mdege N, Ali S, Schmidt B. Beyond Food Promotion: A Systematic Review on the Influence of the Food Industry on Obesity-Related Dietary Behaviour among Children. *Nutrients* 2015;7(10):8565-76. DOI: 10.3390/nu7105414
- Heuer T, Krems C, Moon K, Brombach C, Hoffmann I. Food consumption of adults in Germany: results of the German National Nutrition Survey II based on diet history interviews. *Br J Nutr* 2015;113(10):1603-14. DOI: 10.1017/S0007114515000744
- Freire WB, Belmont P, López-Cevallos DF, Waters WF. Ecuador’s National Health and Nutrition Survey: objectives, design, and methods. *Ann Epidemiol* 2015;25(11):877-8. DOI: 10.1016/j.annepidem.2015.08.009
- Castro MA, Baltar VT, Marchioni DM, Fisberg RM. Examining associations between dietary patterns and metabolic CVD risk factors: a novel use of structural equation modelling. *Br J Nutr* 2016;115(9):1586-97. DOI: 10.1017/S0007114516000556
- Krebs-Smith SM, Pannucci TE, Subar AF, Kirkpatrick SI, Lerman JL, Tooze JA, et al. Update of the Healthy Eating Index: HEI-2015. *J Acad Nutr Diet* 2018;118(9):1591-602. DOI: 10.1016/j.jand.2018.05.021
- Chen LW, Fung SM, Fok D, Leong LP, Toh JY, Lim HX, et al. The Development and Evaluation of a Diet Quality Index for Asian Toddlers and Its Perinatal Correlates: The GUSTO Cohort Study. *Nutrients* 2019;11(3). DOI: 10.3390/nu11030535

11. Kanauchi M, Kanauchi K. The World Health Organization's Healthy Diet Indicator and its associated factors: A cross-sectional study in central Kinki, Japan. *Prev Med Rep* 2018;24(12):198-202. DOI: 10.1016/j.pmedr.2018.09.011
12. Sofi F, Dinu M, Pagliai G, Marcucci R, Casini. Validation of a literature-based adherence score to Mediterranean diet: the MEDI-LITE score. *Int J Food Sci Nutr* 2017;68(6):757-62. DOI: 10.1080/09637486.2017.1287884
13. García S, Herrera N, Rodríguez C, Nissensohn M, Román-Viñas B, Serra-Majem L, et al. Kidmed test; prevalence of low adherence to the mediterranean diet in children and young; a systematic review. *Nutr Hosp* 2015;32(6):2390-9.
14. Ministerio de Salud. Encuesta Nacional de Nutrición 2008-2009. 2012. Available from: https://www.paho.org/cor/index.php?option=com_docman&view=document&category_slug=alimentacion-y-nutricion&alias=67-encuesta-nacional-de-nutricion-costa-rica-2008-2009&Itemid=222.
15. Instituto Nacional de Estadística y Censos de Costa Rica. Encuesta de Hogares de Propósitos Múltiples julio 2019. San José, C.R.: INEC; 2009. Available from: <http://www.inec.go.cr/sites/default/files/documentos/empleo/publicaciones/reehpm2009-01.pdf>.
16. Novygrodt R. Logros y retos sobre nutrición en Costa Rica. San José, Costa Rica: Ministerio de Salud; 2015.
17. Corvalán C, Garmendia ML, Jones-Smith J, Lutter CK, Miranda JJ, Pedraza LS, et al. Nutrition status of children in Latin America. *Obes Rev* 2017;18:7-18. DOI: 10.1111/obr.12571
18. U.S. Department of Health and Human Services and U.S. Department of Agriculture. 2015–2020. Dietary Guidelines for Americans, 8th Ed.; December 2015. Available from: <http://health.gov/dietaryguidelines/2015/guidelines/>. Accessed September, 2018.
19. Ministerio de Salud. Comisión Intersectorial de Guías Alimentarias para Costa Rica Guías Alimentarias para Costa Rica. San José, C.R.: CI GA; 2010. ISBN 978-9977-62-086-2. Available from: https://www.ministeriodesalud.go.cr/gestores_en_salud/guiasalimentarias/guia_alimentarias_2011_completo.pdf.
20. Soares L, Cruz B, Pereira V, Vieira FS, Kluczynik C. Causes of infantile-juvenile obesity: reflexions based on the theory of Hannah Arendt. *Text Context Nursing* 2015;24(3):891-7.
21. Ratner R, Hernández P, Martel J, Atalah E. Propuesta de un nuevo índice de calidad global de la alimentación. *Rev Chil Nutr* 2017;44(1):33-8. DOI: 10.4067/S0717-75182017000100005
22. Cúneo F, Maidana TE. Propuesta y aplicación de un índice de calidad y protección de alimentación en adolescentes urbanos. *Diaeta (B. Aires)* 2014;32(149):14-22. Available from: <http://www.scielo.org.ar/img/revistas/diaeta/v32n149/html/v32n149a03.htm>.
23. Madrigal J. La construcción de índices. San José, Costa Rica: Editorial UCR; 1997.
24. D'Ávila HF, Kirsten VR. Energy intake from ultra-processed foods among adolescents. *Rev Paul Pediatr* 2017;35(1):54-60.
25. Instituto sobre Alcoholismo y Farmacodependencia. IV Encuesta Nacional sobre Consumo de Drogas en Población de Educación Secundaria. Costa Rica 2015. San José, CR.: IAFA; 2016. Available from: <https://www.iafa.go.cr/images/descargables/conocimiento/Consumo%20de%20drogas%20en%20la%20juventud%20escolarizada%202015%20Costa%20Rica,%202017.pdf>
26. Lucini D, Zanuso S, Blair S, Pagani M. A simple healthy lifestyle index as a proxy of wellness: a proof of concept. *Acta Diabetol* 2015;52(1):81-9. DOI: 10.1007/s00592-014-0605-z
27. de Oliveira Otto MC, Anderson CAM, Dearborn JL, Ferranti EP, Mozaffarian D, Rao G, et al. American Heart Association Behavioral Change for Improving Health Factors Committee of the Council on Lifestyle and Cardiometabolic Health and Council on Epidemiology and Prevention; Council on Cardiovascular and Stroke Nursing; Council on Clinical Cardiology; and Stroke Council. Dietary Diversity: Implications for Obesity Prevention in Adult Populations: A Science Advisory From the American Heart Association. *Circulation* 2018;119(11):e160-8. DOI: 10.1161/CIR.0000000000000595
28. Vadiello M, Sacks FM, Champagne CM, Bray GA, Mattei J. Greater Healthful Dietary Variety Is Associated with Greater 2-Year Changes in Weight and Adiposity in the Preventing Overweight Using Novel Dietary Strategies (POUNDS Lost) Trial. *J Nutr* 2016;146(8):1552-9. DOI: 10.3945/jn.115.224683
29. Alkerwi A. Diet quality concept. *Nutrition* 2014;30(6):613-8. DOI: 10.1016/j.nut.2013.10.001
30. Johnston CS, Bliss C, Knurick JR, Scholtz C. Rapid Eating Assessment for Participants [shortened version] scores are associated with Healthy Eating Index-2010 scores and other indices of diet quality in healthy adult omnivores and vegetarians. *Nutr J* 2018;28;17(1):89. DOI: 10.1186/s12937-018-0399-x
31. Harris C, Flexeder C, Thiering E, Buyken A, Berdel D, Koletzko S, et al. Changes in dietary intake during puberty and their determinants: results from the GINIplus birth cohort study. *BMC Public Health* 2015;15:841. DOI: 10.1186/s12889-015-2189-0
32. González-Rosendo G, Puga-Díaz R, Quintero-Gutiérrez A. Índice de alimentación saludable en mujeres adolescentes de Morelos, México. *Rev Esp Nutr Comunitaria* 2012;18(1):12-18. Available from: http://www.renc.es/images/auxiliar/files/Nutr_1-2012_art%202.pdf.
33. Belay H, Kumera N, Tefera B. Evolution of human diet and effect of globalization on regional diet with emphasis to the Mediterranean diet. *Nutrition & Food Science* 2017;47(6):869-83. DOI: 10.1108/NFS-02-2017-0017
34. Gasser CE, Mensah FK, Kerr JA, Wake M. Early life socioeconomic determinants of dietary score and pattern trajectories across six waves of the Longitudinal Study of Australian Children. *J Epidemiol Community Health* 2017;71(12):1152-60. DOI: 10.1136/jech-2017-209641
35. Lassi ZS, Mansoor T, Salam RA, Bhutta SZ, Das JK, Bhutta ZA. Review of nutrition guidelines relevant for adolescents in low- and middle-income countries. *Ann N Y Acad Sci* 2017;1393(1):51-60. DOI: 10.1111/nyas.13332
36. Rehm CD, Monsivais P, Drewnowski A. Relation between diet cost and Healthy Eating Index 2010 scores among adults in the United States 2007-2010. *Prev Med* 2015;73:70-5. DOI: 10.1016/j.ypmed.2015.01.019
37. Ministerio de Educación Pública de Costa Rica. Reglamento para el Funcionamiento de sodas escolares en centros educativos públicos. (Decreto N° 36910-MEP-S); 2015. Available from: <https://www.mep.go.cr/sites/default/files/page/adjuntos/reglamento-vigente-2013.pdf>.
38. Meza N, Rodríguez N. II Encuesta Nacional sobre consumo aparente de alimentos 1991. Análisis de las tendencias en el consumo de alimentos. Programa de Seguridad alimentaria del istmo centroamericano. San José, Costa Rica: CADESCA/CEE; 2007.
39. Organización Mundial de la Salud/Organización Panamericana de la Salud. Plan de acción para la prevención de la obesidad en la niñez y la adolescencia. Consejo directivo, Comité Regional de la OMS para las Américas. Washington, D.C.: EUA; 2014. Available from: <https://www.paho.org/hq/dmdocuments/2015/Obesity-Plan-Of-Action-Child-Spa-2015.pdf>.
40. Pullar J, Allen L, Townsend N, Williams J, Foster C, Roberts N, et al. The impact of poverty reduction and development interventions on non-communicable diseases and their behavioural risk factors in low and lower-middle income countries: A systematic review. *PLoS One* 2018;13(2). DOI: 10.1371/journal.pone.0193378