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Changes in dietary intake and food sources of saturated and *cis* and *trans* unsaturated fatty acids in Costa Rican adolescents: 1996 versus 2006

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ABSTRACT

Objective: To identify how dietary intake and food sources of saturated (SFA) and *cis* (PUFA) and *trans* (TFA) unsaturated fatty acids in the diet of Costa Rican adolescents changed from 1996 to 2006—a period with several public health nutrition changes.
Methods: Cross-sectional comparisons used data from measured food records of 133 adolescents (ages 12–17 y) surveyed in 1996 and a similar group of adolescents surveyed in 2006. Values obtained in 1996 and 2006 were compared with the current World Health Organization guidelines for chronic disease prevention.
Results: Adolescents surveyed in 2006 reported a significantly higher mean daily energy intake from linoleic acid (LA) and alpha-linolenic acid (ALA) (0.9% and 7.8%, respectively) compared with the 1996 cohort, whereas SFA and TFA were significantly lower (9.5% and 1.3%, respectively). Food sources of fat also changed. In 2006, 2% of SFA in the diet came from palm shortening (compared with 34% in 1996); 39% of TFA came from ruminant-derived foods (in 1996, soybean oil was the main contributor of TFA, 34%), and bakery products (mainly pre-packaged cookies) provided 25% of the source of TFA, compared with only 11% in 1996. Dietary fatty intake of Costa Rican adolescents in 2006 is closer to WHO guidelines compared with 1996.
Conclusions: After public health initiatives that changed fatty acid profile of most foods, intakes of TFA, SFA, and food sources of fatty acids in adolescents' diets improved. Public health nutrition efforts should continue to strengthen diets that are low in SFA and TFA and higher in ALA content among Costa Rican adolescents.

Introduction

Coronary heart disease (CHD) is the leading cause of death in adults in Costa Rica [1]. Dietary intake of saturated fatty acids (SFA), industrial *trans* fatty acids (iTFA), and polyunsaturated fatty acids (PUFA) of *cis* configuration affect differently blood lipids, insulin sensitivity, thrombosis, and endothelial dysfunction, all predictors of CHD [2]. Results from epidemiological studies and controlled clinical trials have indicated that dietary SFA and iTFA increase the risk of CHD [3,4], whereas *cis* polyunsaturated fatty acids, both n-6 and n-3 classes, have beneficial effects on cardiovascular health [2,3].

During the period of 1996 to 2006, the public health sector in Costa Rica conducted a public health campaign that touted the health benefits of using vegetable oils, high in PUFA, for cooking instead of palm shortening. During this same period, the soybean oil industry voluntarily reduced the content of iTFA in their oils [5], and a strategic alliance between food industry, academia, and government led to virtual elimination of iTFA in other foodstuffs

Rafael Monge-Rojas conceived and designed the study, collected, analyzed, and interpreted the data, and drafted the manuscript. All authors contributed significantly to the interpretation and presentation of the data and revisions of the manuscript. Specifically, M. Catalina Aragón and Anne Chinnock contributed importantly to the analysis and interpretation of data. They also reviewed the draft, final, and revised manuscripts. Hannia Campos contributed significantly reviewing the draft and final manuscript. Uriyoán Colón-Ramos made central contributions in the interpretation of data; reviewed the draft, final, and revised manuscripts.

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[6]. Healthy eating guidelines and a public health campaign promoting a healthy lifestyle were also adopted at the time [7]. However, to date, we ignore the impact that these public health nutrition efforts may have had on the diet quality of Costa Ricans.

The availability of cross-sectional data of adolescent dietary intake from 1996 and from 2006 allows a unique opportunity to carefully examine adolescents' diet during a period that contained multisectorial public health interventions that aimed to change dietary behaviors and food composition [6,7]. The adolescent age period offers a remarkable opportunity to influence the dietary intakes of fatty acids before adulthood, as food preferences tend to change and get settled into adulthood during this period. This study is designed to identify how the dietary intake and food sources of saturated and *cis* and *trans* unsaturated fatty acids in Costa Rica adolescents have changed since 1996, after several public health nutrition efforts were carried out to improve the fatty acid profile of foodstuffs in Costa Rica. We compare dietary intake of adolescents surveyed in 1996 [8] to the intake from adolescents of similar age and socio-demographic background surveyed in 2006. In addition, we examine how these intakes fare in relation to current WHO guidelines for chronic disease prevention [9].

Materials and methods

Study population

The survey carried out in 2006 included adolescents ages 12 y to 17 y living in San José, Costa Rica. Adolescents were recruited from six urban and three rural public high schools. The schools were chosen from a list of all the public high schools in San José using a proportional-size probability formula. Both parents and students gave their written consent to participate in the study according to the rules provided by the Bioethics Committee of the Costa Rican Institute for Research and Education on Nutrition and Health (INCIENSA).

Dietary assessment

Dietary intake was determined using a three-d food record [10], including one weekend day and the next or previous two weekdays. The adolescents used a series of photographs of foods usually consumed in Costa Rica to estimate portion size while keeping the food record [11]. Food models and fresh foods were used to verify serving size. All dietary assessments were conducted by six trained nutritionists.

To determine the contribution of the different foods to the total selected fatty acids intake, individual foods were grouped together into food groups according to their nutritional value. Energy intake, total fat, and dietary fatty acids intake were calculated using the Valor Nut software, based on the Central America Food Composition Database and modified to include the Costa Rican Fatty Acid Database [12], which includes detailed fatty acid content information from 220 foods habitually consumed in Costa Rica.

To evaluate adolescents' compliance with WHO's fatty acid intake recommendation [9], we compared the proportion of adolescents in the two cohorts (1996 [8] and 2006) who complied. Finally, a comparison was made to determine changes in the food sources of the different fatty acids in the adolescents' diet. Fatty acid data from 1996 [8] was estimated using an unpublished food composition database, provided by the principal investigator (H. Campos) of the Costa Rican Heart Disease Study [8]. For 2006, data was estimated from an updated version of the food composition database of 1996 [12].

Statistical data

Variables were checked for outliers and normality, and transformed using natural logarithm when necessary. Fatty acid intakes were adjusted for total energy intake using the regression method [13]. Statistical analyses were performed using independent samples *t* test, χ^2 test and ANOVA procedures available in the Statistical Package for Social Sciences (SPSS Inc., version 12.0 for Windows, Chicago, IL, USA).

Results

Of the 150 selected adolescents, we excluded those adolescents who did not wish to participate or whose parents did not provide written consent to participate in the study (n = 17). The final sample of 133 adolescents consisted of 64 boys and 69 girls (no significant differences between genders in selected socio-demographic characteristics were observed). Table 1 shows the socio-demographic and dietary behavior characteristics for the groups surveyed in 1996 and in 2006. Adolescents surveyed in 2006 reported higher mean daily energy intake from carbohydrate, total fat, and unsaturated fat, particularly linoleic acid (LA) and alpha-linolenic acid (ALA), and lower intake of SFA and iTFA, than the 1996 group. No other significant differences in socio-demographic and dietary characteristics were observed between the groups. Table 2 depicts energy-adjusted intake of individual saturated and *cis* and *trans* unsaturated fatty acids for the two cohorts. In general, the 2006 cohort reported lower intakes of SFA (all) and iTFA (C18:1 and C18:2), and higher intake of n-3 (ALA and DHA) and of n-6 (LA, gamma-linoleic, and arachidonic).

The percentage of Costa Rican adolescents meeting the WHO recommended levels of fat and fatty acids intake is presented in Table 3. The percentage of Costa Rican adolescents who exceeded the WHO recommendation on total fat intake (<30% of total energy) was higher for 2006 than for 1996 (54% compared with only 27% in 1996); however, because the types of fats consumed in 2006 were different from those consumed in 1996, a higher proportion of adolescents in 2006 met the WHO recommendation for SFA intake (62% in 2006 compared with 11% in 1996), PUFA (48.2% in 2006 compared with 28.4% in 1996) LA and ALA (41% and 4.5% for LA and ALA, respectively, for 2006, compared with 4% and 0% in 1996, respectively). Sixty-eight percent of adolescents in 2006 exceeded the upper limit on TFA intake (>1% TE), with intake ranging mostly around 1% to 2% and 2% to 3% of total energy; however, this is an improvement from 1996, when 100% of teenagers reported TFA intakes above 1% of total energy, mostly hovering around >4% of total energy.

In comparison with 1996, the major food contributors to fatty acid intake have drastically shifted in these past 10 y (Fig. 1). In 1996, 34% of SFA in the adolescent diet came from palm shortening, while in 2006 most of the SFA came from dairy; palm shortening provided only 2% of SFA in the diet in 2006. Soybean

Table 1
Sociodemographic and dietary characteristics of Costa Rican adolescents, 1996 and 2006

Characteristics	1996 (n = 276) [8]	2006 (n = 133)	*P* value*
Age (y)	15.9 ± 1.6	16.1 ± 0.8	0.227
Female (%)	47.7	48.2	0.632
Rural (%)	41.7	40.1	0.873
BMI (kg/m2)	21.1 ± 2.1	21.8 ± 3.0	0.410
Energy intake (Kcal)	2185.1 ± 138.2	2251.6 ± 132.1	0.699
Carbohydrate (% Energy)	63.5 ± 7.8	56.4 ± 7.6	0.042
Protein (% Energy)	11.9 ± 3.3	12.7 ± 2.1	0.816
Total fat (% Energy)	25.6 ± 6.9	31.1 ± 7.4	0.022
Saturated (SFA) (% Energy)	12.1 ± 2.8	9.5 ± 2.7	0.031
Monounsaturated (% Energy)	8.2 ± 2.5	10.6 ± 3.3	0.005
Polyunsaturated (% Energy)	5.5 ± 3.0	7.5 ± 3.3	0.043
Linoleic acid (LA) (% Energy)	0.4 ± 0.1	0.9 ± 0.2	0.025
∝-Linolenic acid (ALA) (% Energy)	4.1 ± 1.2	7.8. ± 3.8	0.002
Eicosapentaenoic acid (EPA) (mg)	60 ± 15	32 ± 45	0.078
Docosahexaenoic acid (DHA) (mg)	60 ± 30	50 ± 85	0.083
Trans (TFA) (% Energy)	2.1 ± 0.9	1.3 ± 0.5	0.005

Values are mean ± SD.
* *P* values of the independent samples t *test*.