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# Total dietary fiber in urban and rural Costa Rican adolescents' diets

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**SUMMARY.** Dietary fiber has important health benefits in adolescence, especially in promoting normal laxation and reducing the future risk of some chronic diseases. The purpose of this survey was to examine the dietary fiber intake among Costa Rican adolescents. Prospective 3-d diet records were used for dietary fiber data collection. The "age + 5 rule" was used as criterion for adequate fiber intake. Mean daily reported fiber intake was 23.8 ± 12.6 grams. Mean fiber intake was higher in rural areas than in urban areas either for direct intake data or for values adjusted per 1,000 Kcal (13.6 ± 7.7 and 8.2 ± 2.9 respectively, $p < 0.001$). On the contrary, no differences were found among males and females when mean fiber intake was adjusted per 1,000 kcal. On average, only 45% of the total adolescents studied showed an adequate fiber intake. This percentage was higher in rural areas than urban areas. Adolescents who met the " age + 5 rule " have healthier diets than those with inadequate fiber intake. This study suggests that nutritionists working with adolescents should focus their efforts on promoting the consumption of fiber-rich foods, especially legumes, fruit and vegetables, in order to reduce the risk of diet-related chronic diseases during adulthood.
**Key words:** Dietary fiber, age + 5 rule, adolescents, Costa Rica.

**RESUMEN. Fibra dietética total en la dieta de adolescentes costarricenses del area urbana y rural.** La fibra dietética tiene importantes beneficios para la salud en la adolescencia, especialmente en la laxación normal y reducción del riesgo futuro de algunas enfermedades crónicas. Por tal razón este estudio se propuso estudiar el consumo de fibra en los adolescentes costarricenses. El consumo de fibra dietética se midió por medio del registro de alimentos de tres días. La regla "edad + 5" fue usada como criterio para definir el consumo adecuado de fibra. El consumo promedio de fibra fue 23.8 ± 12.6 gramos. Este consumo fue mayor en el área rural que en la urbana, aun cuando el consumo fue ajustado por 1000 Kcal (13.6 ± 7.7 y 8.2 ± 2.9 respectivamente, $p < 0.001$). Por el contrario, no se observaron diferencia por sexo cuando el consumo de fibra se ajustó por 1000 Kcal. Solamente 45% del total de adolescentes estudiados consumió una cantidad adecuada de fibra. Este porcentaje fue significativamente mayor en el área rural. Los adolescentes quienes alcanzaron la regla "edad +5" mostraron una dieta más saludable que aquellos con inadecuado consumo de fibra. Este estudio sugiere que los(as) nutricionistas que trabajan con adolescentes, deben enfocar sus esfuerzos a la promoción de alimentos ricos en fibra, especialmente leguminosas, frutas y vegetales, con el propósito de reducir el riesgo de enfermedades crónicas relacionadas con la dieta durante la edad adulta.
**Palabras clave:** Fibra dietética, regla "edad + 5", adolescentes, Costa Rica.

## INTRODUCTION

During the last 25 years the role of fiber in the diet has been recognized by numerous health organizations (1). The consumption of dietary fiber is associated with important heath benefits, especially with respect to promoting normal laxation (2). Dietary fiber also may help reduce the future risk of several chronic diseases, including some types of cancers (breast, colon, pancreas, ovary, endometrium, and prostate), cardiovascular disease, obesity, and diabetes mellitus, among others (3-6).

Because lifetime dietary patterns are established early in life, young children and adolescents should be encouraged to make nutritious high-fiber foods part of their daily diets to achieve optimum health (7). Therefore, primary prevention programs are required to encourage fiber intake from an early age. This appears to be quite important in countries such as Costa Rica where ischemic disease and stomach cancer are the leading causes of death among Costa Rican adults (8) and the prevalence of obesity and diabetes mellitus has shown a tendency to increase during the past years (8,9).

The ideal dietary fiber intake has not been defined, nor has a Recommended Dietary Allowance been established. Nevertheless, recently the American Health Foundation (10) recommended that a reasonable goal for minimal intake of dietary fiber for children and adolescents 3 to 20 years of age be the equivalent of the age of the child or adolescent plus 5 g of dietary fiber per day ("age + 5"). However, a safe range of dietary fiber for children and adolescents is suggested to be between age plus 5 and age plus 10-g/d (10). This range

of fiber intake is thought to be safe even for adolescents with marginal intake of some micronutrients (10,11).

Information on dietary fiber intake in the Costa Rican population is very limited and available only for adults. In 1990 alone the consumption of dietary fiber in a group of adolescents 13-16 years of age was evaluated. Although the sample was very small (n=40) and specific, for two urban studies the study warned of the tendency of this population to have a low consumption of fiber (12).

For more than a decade, the consumption of fiber in adolescents was not the object of study; however, recently it has been considered that current information on the subject could constitute input material for the formulation of an action plan directed at promoting healthy eating habits in adolescents.

This survey was designed to examine the dietary fiber intake among urban and rural Costa Rican adolescents based on the " age + 5 rule ".

## METHODS

A sample of 275 adolescents, 13-18 year-olds, 48% from urban areas and 52% from rural areas, were selected from 10 public high schools. The high schools were chosen from the province of San José, Costa Rica. In each high school, adolescents were selected at random. Written parental and adolescent consent were required to participate in the study.

Dietary fiber intake was determined with three-day food records (13). The three days of dietary intake included one weekend day and the previous or next two days (Sunday, Monday and Tuesday or Thursday, Friday and Saturday). A series of six photographs of food usually consumed in Costa Rica were used to estimate portion size while keeping the food record.

Food records were verified by trained nutritionists who reviewed them in detail with each youngster. Foods and three-dimensional food models were used to verify the size of some portions reported by the adolescents. The Food Processor® for Windows version 6.0 (Esha Research, Salem-Oregon) was used to perform fiber calculation from dietary data. The nutrient information in the ESHA database is a compilation of the latest USDA data and of over a thousand additional scientific sources (14). The nutritional value, including fiber content, of approximately 60 food preparations commonly consumed in Costa Rica was incorporated into this database. The School of Nutrition at the University of Costa Rica provided the information.

To evaluate fiber intake, it was compared with the minimum recommended fiber consumption per day for each adolescent. The minimum recommended consumption was determined using the "age + 5 rule" (11), i.e., adding 5 g of dietary fiber to the age of each of the young participants in the study. Following this rule, the minimum fiber consumption for an adolescent 14 years old was 19 grams, as an example.

Fiber consumption less than that determined using the "age + 5 rule" was considered inadequate. Based on this information, two groups of adolescents were made up; one with an adequate consumption of fiber and another with an inadequate consumption. The average consumption of various nutrients was determined for each group, as well as the percentage energy derived from total fat, saturated fat, protein, carbohydrates, and sucrose. Thus 9 was multiplied by the amount of fat consumed and then the result was multiplied by 100 and divided by the total calories consumed by the adolescent ((grams x 9) x 100)/ Kcal. In the case of the other macronutrients and sucrose, a similar procedure was used, but multiplying the grams consumed by 4: (grams x 4) x 100)/ Kcal.

Food groups were created to identify dietary sources of fiber. The contribution of total dietary fiber by each food group was determined using the following formula: (total grams of dietary fiber from all foods in a group)÷(total grams of dietary fiber from all foods). Given the importance of legumes in the Costa Rican diet, their contribution to the total consumption of fiber was analyzed outside the group of vegetables. Likewise, considering the seasonal consumption of the peach palm *Bactris gasepaes*), its contribution to fiber was analyzed separately from the group of fruits.

Analysis of variance tests was used to determine significant differences in energy intake and energy-adjusted macro and micronutrient intakes between those adolescents who consumed adequate dietary fiber according to the " age + 5 rule " and those who did not. A level of $p < 0.05$ was considered significant.

## RESULTS

The sample consisted of 131 urban and 144 rural adolescents; 52% were males and 48% females for each area. All adolescents were from the same ethnic background (mestizo). The adolescents' mean age was 15 ± 1.6 years-old with no differences between urban and rural areas. The proportion of adolescents in each age group was similar for both areas.

Mean daily reported fiber intake was 23.8 ± 12.6 grams (Table 1). Mean intake was higher in rural areas than in urban areas (29.0 ± 11.4 and 18.5 ± 8.2 respectively, $p< 0.0001$). This pattern was similar even when fiber intake was adjusted per 1,000 Kcal (13.6 ± 7.7 and 8.2 ± 2.9 respectively, $p< 0.0001$). Mean daily fiber intake was higher in males than in females (26.8 ± 11.6 and 20.8 ± 9.8 respectively, $p<0.05$). Nevertheless when mean fiber intake was adjusted per 1,000 kcal no differences were found ($p>0.05$). Although total energy intake was higher in males than in females ($p< 0.0001$) the fiber density of the diet was similar.

TABLE 1

Mean (± standard deviation) daily intake of total fiber by Costa Rican adolescents

| Population | n | Energy, Kcal | Total fiber, g | Fiber/1,000 Kcal, g |
|---|---|---|---|---|
| **Urban adolescents** | | | | |
| Males | 69 | 2445 ± 723 | 19.6 ± 9.8 | 7.9 ± 2.9 |
| Females | 62 | 2078 ± 516 | 17.3 ± 5.6 | 8.5 ± 2.8 |
| *p* value | | 0.001 | 0.096 | 0.270 |
| **Rural adolescents** | | | | |
| Males | 75 | 2329 ± 673 | 33.9 ± 19.8 | 14.2 ± 9.2 |
| Females | 69 | 1918 ± 644 | 24.2 ± 11.5 | 12.8 ± 5.4 |
| *p* value | | 0.000 | 0.006 | 0.299 |
| **Total** | | | | |
| Urban | 131 | 2261 ± 657 | 18.5 ± 8.2 | 8.2 ± 2.9 |
| Rural | 144 | 2123 ± 688 | 29.0 ± 11.4 | 13.6 ± 7.7 |
| *p* value | | 0.088 | 0.000 | 0.000 |
| Males | 144 | 2387 ± 697 | 26.8 ± 11.6 | 11.3 ± 7.7 |
| Females | 131 | 1998 ± 590 | 20.7 ± 9.8 | 10.8 ± 4.9 |
| *p* value | | 0.000 | 0.003 | 0.000 |
| **Total population** | 275 | 2192 ± 672 | 23.8 ± 12.6 | 11.2 ± 5.3 |

Among the urban adolescents, 70% did not meet the " age + 5 rule". In comparison, the proportion of rural adolescents who did not meet the " age + 5 rule" was significantly lower (40%, $p < 0.001$) than the proportion of urban youngsters. On average, only 45% of the total adolescents studied consumed adequate fiber levels according to the " age + 5 rule".

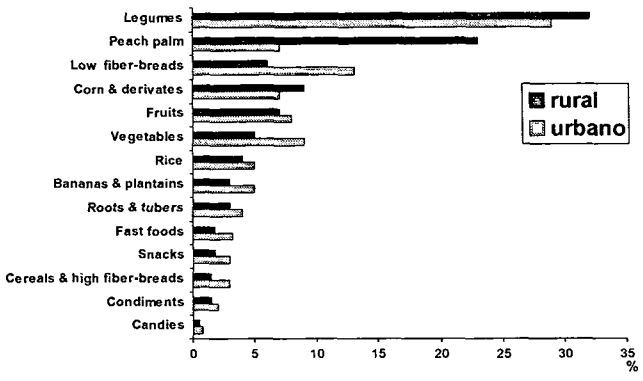
In urban areas, only 33% of males and 26% of females met the " age + 5 rule". On the contrary, a significantly higher percentage ($p < 0.0001$) of rural males and females met the aforementioned rule (54% and 60% respectively). In both areas, 31% of adolescents aged 13-14 years, 23% of 15 year olds and 46% of youngsters aged 16 to 18 years have inadequate fiber consumption.

For urban adolescents legumes and low fiber breads were the two major groups contributing dietary fiber (Figure 1). Legumes provided 29% and low fiber breads 13% of the total dietary fiber eaten. Other notable sources of dietary fiber in the urban adolescents' diet included vegetables (9%), fruits (8%), and corn and derivates (7%). Rice and bananas and plantains each contributed 5%, and roots and tubers provided 4% of total dietary fiber.

For rural youngsters, legumes provided 32% of total dietary fiber, whereas peach palm (*Bactris gasepaes*) contributed 23% of the total fiber intake. Peach palm contribution reflects the widespread availability of this food during the harvest season. Additional sources of dietary fiber in the rural adolescents' diet were corn and derivates (9%), fruits (7%), low fiber breads (6%) and vegetables (5%). Together rice, bananas and plantains and the root and tuber group contributed about 10% to fiber intake. Paradoxically in both groups of adolescents, the contribution of fruits and vegetables to total dietary fiber intake is very low, even though there is a wide variety and availability of these foods throughout the year in Costa Rica.

FIGURE 1

Food sources of total fiber in Costa Rican adolescents' diet




Other food groups such as fast foods, snacks, condiments, candies, cereals and high fiber breads each contributed between 0.5% - 3% of the total fiber intake of urban and rural youngsters. These food groups contributed more fiber to urban adolescents' diet ($p < 0.001$).

Of the total fiber consumed by both groups of adolescents studied, 14% to 17% came from breakfast, 25% to 32% from lunch, 22% from dinner, and 31% to 35% from snacks.

When urban and rural adolescents were stratified based on satisfaction of the " age + 5 rule" (Table 2), significant differences were noted in the dietary composition of the total daily intake of selected nutrients between those adolescents who met the "age + 5 rule" and those who did not meet it. The energy intake of adolescents who met the " age + 5 rule" was about 640 kcal greater ($p<0.001$) than the energy intake of the adolescents who consumed low-fiber diets. Likewise, mean 1,000 kcal-adjusted intakes of folate, iron and magnesium were significantly ($p<0.001$) greater among those with an adequate fiber intake. In contrast, energy-adjusted intakes of total fat and saturated fat were significantly ($p<0.001$) higher among the adolescents with fiber-poor diets; furthermore, urban adolescents who consumed inadequate fiber had significantly higher ($p<0.05$) energy-adjusted intake of sodium. Cholesterol and sucrose intakes were lower, but not significantly among those adolescents who met the " age + 5 rule". The opposite was true for protein and vitamin A intake.

TABLE 2

Mean (± standard deviation) daily intake of nutrients by urban and rural adolescents who consumed inadequate and adequate amounts of total fiber [a]

| Nutrient | Urban adolescents | | | Rural adolescents | | |
|---|---|---|---|---|---|---|
| | Inadequate intake (n=92) | Adequate intake (n=39) | *p value* | Inadequate intake (n=58) | Adequate intake (n=86) | *p value* |
| Energy (Kcal) | 2080 ± 536 | 2721 ± 703 | 0.000 | 1744 ± 533 | 2393 ± 649 | 0.000 |
| Dietary fiber (g) [b] | 7.2 ± 2.0 | 10.7 ± 3.3 | 0.000 | 9.3 ± 2.6 | 16.4 ± 8.7 | 0.000 |
| Protein (g) [b] | 30.8 ± 6.0 | 32.4 ± 5.8 | 0.161 | 27.8 ± 6.2 | 28.2 ± 4.4 | 0.651 |
| Total fat (g) [b] | 35.1 ± 5.9 | 30.5 ± 6.4 | 0.000 | 28.9 ± 9.5 | 24.2 ± 6.9 | 0.000 |
| Saturated fat (g) [b] | 12.7 ± 3.1 | 9.6 ± 2.2 | 0.000 | 11.8 ± 3.2 | 8.2 ± 2.4 | 0.000 |
| Carbohydrates (g) [b] | 137.9 ± 16.2 | 145.3 ± 16.7 | 0.019 | 140.9 ± 22.7 | 153.6 ± 16.7 | 0.000 |
| Sucrose (g) [b] | 52 .3 ± 16.1 | 49.2 ± 18.7 | 0.388 | 46.3 ± 15.3 | 46.1 ± 12.5 | 0.931 |
| Cholesterol (g) [b] | 111.2 ± 5.3 | 105.4 ± 44.8 | 0.238 | 113.8 ± 70.2 | 98.9 ± 52.8 | 0.148 |
| Vitamin A (RE) [b] | 399.5 ± 289 | 486.4 ± 290 | 0.119 | 339.9 ± 271 | 381.2 ± 255 | 0.355 |
| Vitamin E (mg α TE) [b] | 9.3 ± 7.1 | 8.7 ± 5.9 | 0.643 | 16.0 ± 13.8 | 14.2 ± 9.9 | 0.364 |
| Folate (μg) [b] | 101.7 ± 33.2 | 156 ± 53.4 | 0.000 | 122.9 ± 36.3 | 156.8 ± 50.4 | 0.000 |
| Iron (mg) [b] | 4.6 ± 2.0 | 5.0 ± 2.1 | 0.000 | 4.2 ± 2.1 | 5.0 ± 2.0 | 0.022 |
| Magnesium (mg) [b] | 102.3 ± 20 | 125.4 ± 22.8 | 0.000 | 116.7 ± 24.8 | 130.7 ± 27.0 | 0.003 |
| Sodium (mg) [b] | 820 ± 220 | 716 ± 299 | 0.029 | 560 ± 280 | 522 ± 235 | 0.221 |
| **Energy from:** | | | | | | |
| Total fat (%) | 33.1 ± 5.4 | 30.2 ± 5.8 | 0.009 | 33.2 ± 8.6 | 29.0 ± 6.3 | 0.000 |
| Saturated fat (%) | 14.0 ± 3.1 | 9.8 ± 2.5 | 0.000 | 12.3 ± 3.2 | 8.9 ± 2.6 | 0.000 |
| Protein (%) | 12.3 ± 2.4 | 12.9 ± 2.3 | 0.188 | 11.5 ± 2.5 | 11.2 ± 1.8 | 0.404 |
| Carbohydrate (%) | 55.2 ± 6.4 | 57.1 ± 6.7 | 0.021 | 56.4 ± 9.1 | 61.4 ± 6.7 | 0.000 |
| Sucrose (%) | 20.9 ± 6.4 | 19.7 ± 7.5 | 0.353 | 18.5 ± 5.0 | 18.4 ± 5.0 | 0.914 |

[a] Adequacy was judged based on the age +5 rule, [b] Adjusted per 1,000 kcal

## DISCUSSION

According to the "age + 5 rule", this study made clear that most of the adolescents included in the sample reported inadequate dietary fiber intake. These results deserve prompt attention since consumption less than the "age + 5 rule" represents a consumption less than the recommended minimum. A healthy intake of dietary fiber should range from "age plus 5" to "age plus 10" g/d (11).

Low fiber intake is noteworthy in Costa Rican adolescents, particularly considering that their diet is rich in saturated fat (> 11% Kcal) and low in polyunsaturated fat (< 5% Kcal), folic acid and calcium (15,16). This suggests that the adolescents' diet have several characteristics related to chronic

disease development. Therefore, primary prevention programs are required to improve the food habits. This appears to be quite important in developing countries, such as Costa Rica, which have a delayed epidemiological model where chronic and infectious diseases coexist (17,18).

The life expectancy in developing countries has increased; however, the possibility of improving it will depend not only on a decrease in the infant mortality, but also on a decrease in chronic non-transmissible disease associated with premature mortality. An increase in the dietary fiber consumption from early life could contribute toward achieving this goal. As has been widely demonstrated, it is possible to reduce the proportion of deaths due to chronic disease and even more so, prevent the occurrence of new cases by applying strategies directed to the modification of lifestyle risk factors (i.e., dietary intake) (19-21).

This study confirms that youngsters with high fiber intake have healthier diets. Even after controlling for total energy intake, adolescents who met the age + 5 rule still consumed significantly more energy-adjusted amounts of folate, magnesium and iron and less saturated fat and sodium. This evidence suggests that adolescents who met the " age + 5 rule " made better food choices that those who did not meet the rule.

Nutritionists working with adolescents should focus their efforts on promoting the consumption of fiber-rich foods, especially, fruits and vegetables. The consumption of these foods among Costa Rican adolescents is well below the recommended 5 servings per day. Current intake averages around 1.5 servings and only 2% of adolescents consume at least 5 servings of vegetables and fruits daily (22).

Several studies show that social norms and eating patterns at home may contribute substantially to an individual's eating habits (23,24). In addition, barriers to healthy eating posed by family preferences for fruits and vegetables have been found to be associated with individual consumption of fruits and vegetables (23). Therefore, family interventions appear to be a promising strategy for increasing fiber-rich food consumption among adolescents.

Since it was frequently consumed, low-fiber bread was a considerable source of dietary fiber for all of the adolescents in this study, especially urban youngsters. It may be assumed that substituting high-fiber breads would go a long way toward improving adolescents' dietary fiber intakes and, with the wide variety available, should be relatively easy to accomplish. However this represents a difficult change in the Costa Rican food pattern, because high-fiber breads are not popularly consumed in the country. The promotion of legume and plantain consumption (high-fiber foods) could be a better strategy because of their marked influence on the youngsters' diets.

In that sense, the need to promote the consumption of beans in the young Costa Rican population stands out, since in the past years there has been evidence of a reduction in their consumption at the family level (25). On the other hand, it is necessary to consider that although the peach palm (*Bactris gasepaes*) represented the second source of dietary fiber for the rural youths, this finding is solely a direct effect of the seasonal availability of this food. Therefore, in order to maintain adequate fiber consumption in the adolescent population, it is necessary to promote the consumption of fiber-rich foods, such as fruits, vegetables, and legumes, whose availability is constant throughout the year.

A modification in the menus offered at high school cafeterias could be another strategy for providing a larger selection of fiber-rich foods. In addition, the availability of fruits in high school cafeterias could contribute to increasing the consumption of these foods.

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