

# Impact of food fortification on dietary folate intake and adequacy in a representative sample of Costa Rican population: results from the Latin American Study of Nutrition and Health (ELANS)



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## ABSTRACT

**Object:** The study aimed to evaluate the impact of mandatory and voluntary fortification on folate intake adequacy in the Costa Rican urban population. **Methods:** ELANS is a multicenter, cross-sectional study including a representative sample of urban population from eight Latin American countries (Argentina, Brazil, Chile, Colombia, Costa Rica, Ecuador, Peru and Venezuela). In Costa Rica, 798 participants (15-65 years old) provided two 24-h dietary recalls. Nutritional data was entered in Nutrition Data System for Research (NDS-R) after a harmonization process between local foods and NDS-R database, and adjusting for mandatory folic acid fortification of rice, milk, wheat flour and corn flour. Total folate intakes were expressed as dietary folate equivalents (DFE) =  $\mu\text{g}$  food folate + ( $\mu\text{g}$  dietary folic acid  $\times 1.7$ ). The prevalence of inadequate folate intake was calculated using Estimated Average Requirement of 330  $\mu\text{g}$  DFE/day for adolescents and 320  $\mu\text{g}$  DFE/day for men and women. The Mann-Whitney test was used to analyze the differences between age groups and gender, and Chi-square tests to analyze differences of folate inadequacy between groups considering  $p < 0.05$  as statistically significant. **Results:** The sample comprised of 49.4% men and 50.6% women and included 15%, 38%, 28% and 19% in the age groups 15-19y, 20-34y, 35-49y and 50-65y, respectively. Usual median DFE intake was 566  $\mu\text{g}/\text{d}$ , higher in men (639  $\mu\text{g}/\text{d}$ ) than in women (486  $\mu\text{g}/\text{d}$ ) ( $p < 0.05$ ). The older group (50-65y) showed the lowest intakes of DFE (497  $\mu\text{g}/\text{d}$ ) ( $p < 0.05$ ). The overall prevalence of DFE inadequacy was 13.9% in the urban Costa Rican population, and higher in women than in men in all age groups ( $p < 0.05$ ). Women aged 15-19y and 50-65y showed the highest prevalence of inadequacy (11% and 10% respectively). Synthetic folate from fortified foods (mainly from bread, other wheat flour products and rice) contributed 43.1% of total folate intakes. In this study, DFE intake exceeding the Tolerable Upper Intake Level (1000  $\mu\text{g}$  DFE/d) from food only was observed in 1.6% of the population ( $n=13$ ). **Conclusion:** The probability of folate intake being inadequate in urban Costa Rican population is higher among women in the youngest and oldest age groups. This data should be taken into account to evaluate future decisions regarding food fortification and public health programs to educate about better food choices in order to increase folate intake. This research was funded by the Coca Cola Company and the International Life Sciences Institute- Mesoamérica.

1. Fisberg et al. BMC Public Health. 16:933 (2016)

## METHODOLOGY

**ELANS** a multicenter, cross-sectional nutritional and health surveillance study of nationally representative sample ( $n=9218$ ) of urban populations from eight Latin American countries (Argentina, Brazil, Chile, Colombia, Ecuador, Peru, Venezuela and Costa Rica). ELANS study aims to provide up-to-date reliable and comparable data of dietary intake, physical activity and its association with anthropometric profile.



Costa Rica (total population in 2014: approx 4,8 millions)

- Data was collected between November 2014 and May 2015.
- Urban population, sample size: 798 participants (15-65 years old).
- Two non-consecutive 24-h dietary recalls per person.
- The database was created using Nutrition Data System for Research (NDS-R) program, after harmonization process between local foods and NDS-R database for mandatory folic acid fortification of rice, milk, wheat flour and corn flour.

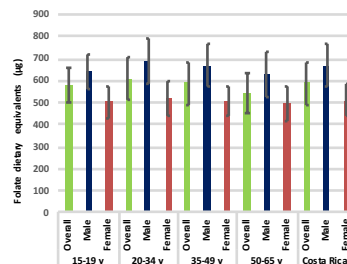
- Total folate intakes were expressed as **dietary folate equivalents (DFE)**, where:  
**DFE =  $\mu\text{g}$  food folate + ( $\mu\text{g}$  dietary folic acid  $\times 1.7$ ).**
- Usual intake was estimated by the Multiple Source Method (MSM), based on both 24HR.
- Inadequacy intake was estimated using the Estimated Average Requirement (EAR) method as cut off points:
  - Adolescents (from both genders): 330  $\mu\text{g}$  DFE/day\*
  - Adults/Elderly (from both genders) 320  $\mu\text{g}$  DFE/day\*
- \*Food and Nutrition Board, Institute of Medicine and National Academy
- The Mann-Whitney test was used to analyze differences between age groups and gender, and Chi-square tests to analyze differences of folate inadequacy between groups ( $p < 0.05$  as statistically significant).
- Dietary sources: foods were grouped according to their nutritional characteristics. A list of more than 1309 foods and preparations, was clustered in 63 principal groups.
- Statistical analysis was performed using StataCorp. 2015. *Stata Statistical Software: Release 14*.

## RESULTS

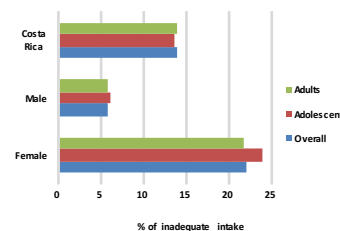
Sample distribution by age and sex, ELANS-Costa Rica, 2014-2015

Age group	Sample distribution (%)		
	Overall	Male	Female
15-19	18.05	21.51	14.61
20-34	36.84	37.36	36.33
35-49	25.56	26.04	25.09
50-65	19.55	15.09	23.97

The sample comprised of 49.4% men and 50.6% women.



Usual median intake of DFE by age and sex, ELANS- Costa Rica, 2014- 2015



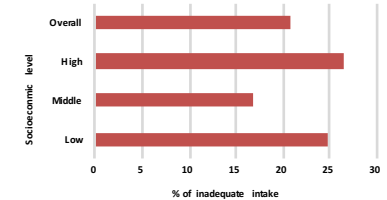
Prevalence of inadequate intake of DFE by age and gender, ELANS-Costa Rica, 2014-2015

Usual median DFE intake was 566  $\mu\text{g}/\text{d}$ , higher in men (639  $\mu\text{g}/\text{d}$ ) than in women (486  $\mu\text{g}/\text{d}$ ) ( $p < 0.05$ ). The older group showed the lowest intakes of DFE (497  $\mu\text{g}/\text{d}$ ) ( $p < 0.05$ ).

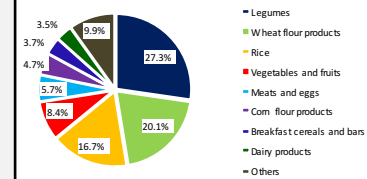
The overall prevalence of DFE inadequacy was 13.9% in the urban Costa Rican population, and higher in women than in men in all age groups ( $p < 0.05$ ).

Women aged 15-19y and 50-65y showed the highest prevalence of inadequacy: 11% and 10% respectively ( $p < 0.05$ ).

## RESULTS

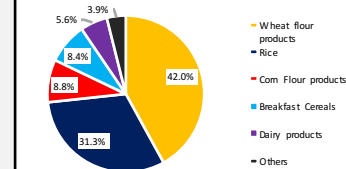


Prevalence of inadequate intake of DFE in women in childbearing age, based on socioeconomic level ELANS-Costa Rica, 2014- 2015



Main food sources of DFE (natural folate + folic acid), Costa Rica- ELANS, 2014-2015

- The main source of natural folate were legumes, such as beans, chickpeas, and lentils, followed by fruits, meats and non starchy vegetables.



Main food sources of folic acid, Costa Rica- ELANS, 2014-2015

- Natural sources of folate vs synthetic folic acid: 43.1% of DFE comes from fortified foods.
- Folic acid intake exceeding the Tolerable Upper Intake Level (1000  $\mu\text{g}$  DFE/d) from food only was observed in 1.6% of the population ( $n=13$ ).

## CONCLUSIONS

- The prevalence of inadequacy intake of folate in urban Costa Rican population is higher among women, oldest and youngest age groups, which raises concerns because the latter includes women of childbearing age.
- Although only 1.6% of the sample had folic acid intake above the Tolerable Upper Intake Level, it must be taken into account that there could be populations vulnerable to excessive amounts.
- Approximately 40% of the DFE of the participants' intake comes from fortified foods, which reflects the impact of the mandatory fortification program for the prevention of folate deficiency.
- This data could be valuable as a tool for evaluating future policy regarding food fortification and public health programs, as well to educate about better food choices to increase folate intake.

## INTRODUCTION

Costa Rica has an obligatory Fortification Program that includes several products of usual consumption

In 1996, the National Nutrition Survey found low folate blood levels in 25% of women in childbearing age.

To address this issue, with the main purpose of reducing the risk of neural tube diseases (NTD) on newborns and the associated morbidity and mortality, and to prevent folate deficiency in the general population.

National Program for the Fortification with Folic Acid

- Wheat flour (1997)
- Corn flour (1999)
- Cow Milk (2001)
- Rice (2002)

Positive impact: prevalence of NTD fell by 51% in relation to the prefortification phase.

The infant mortality rate associated with NTD decreased from 0,64 (before 1997) to 0,17 per 1000 live births in 2009.

## PURPOSE

This study aimed to evaluate the impact of mandatory and voluntary fortification of the folate intake and its adequacy in the Costa Rican urban population and while characterizing the intake of folate and folic acid.