The Costa Rican Experience: Reduction of Neural Tube Defects following Food Fortification Programs

Luis Tacsan Chen, M.D., DTPH, and Melany Ascencio Rivera, R.D., M.Sc.

Fortification of wheat flour in 1997 and corn flour in 1999 with folic acid among other micronutrients was implemented in Costa Rica by means of two decrees, resulting in an effective public health impact. A prevalence of 25% of folic acid serum levels deficiency detected in fertile women in 1996 decreased 87% in urban areas two years later, whereas in rural areas diminished by 63%. In addition, a significant reduction of neural tube defects at the national level has been reported, dropping from a rate of 9.7 per 1000 lb during the period 1996–1998 to 6.3 per 1000 lb in the period 1999–2000. Finally, there has been a reported 74% reduction in the number of Neural Tube Defects at Birth (NTB) at the National Children's Hospital, resulting in 105 cases treated in 1995 to 26 cases in 2001.

Key words: neural tube defects, Costa Rica, folate, fortification

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Introduction

Several observational epidemiologic studies conducted during the last two decades reported a favorable association between folic acid supplementation and fortification and the reduced recurrence of neural tube defects[1–5] This resulted in evaluation of folate and neural tube defects by the U.S. Food and Drug Administration (FDA) in 1990 as part of its response to the health claims section of the Nutrition Labeling and Education Act of 1990.[6]

Folic acid was suggested as a protective factor of neural tube defects by Hibbard,[7] and other studies proved the same association.[6] Based on these studies and other similar evidence,[8,9] folic acid fortification programs were initiated to increase serum folate concentrations among women of childbearing age. The Ministry of Health of Costa Rica began these programs in 1998.

In Costa Rica, the identification and characterization of congenital tube defects have been registered since 1987. Data flow of maternal and child health care comes from 24 public hospitals, which accounts for 90% coverage of total births in the country. Since 1996, records from private hospitals have been incorporated into national figures.

A registration system has been designed and implemented to identify all birth malformations presented by a single newborn. In this system, each presented malformation is described according to the established norms. In this respect, every live born or stillborn infant weighing 500 g or more is clinically examined to detect the presence of malformations. The results are documented in a record form designed specifically for this purpose.

In 1996, 25% of fertile women were found to have folic acid deficiency.[10] The incidence was highest in rural areas (31%), followed by urban areas (23%). The lowest incidence was found in metropolitan areas (19%). These findings may have been correlated to the low consumption of vegetables and viscera identified in the same national survey,[10] which indicated a deterioration of diet quality compared with a prior study conducted in 1992.

Due to these findings, the Costa Rican government began fortifying wheat flour with folic acid (1.5 mg/kg) in 1998. In 1999, this level was modified to 1.8 mg/kg; additionally, maize flour was fortified with folic acid (1.3 mg/kg) at this time. The following year, the fortification level of maize flour increased to 1.8 mg/kg. In 2001, the fortification of milk with folic acid at 0.4 mg/kg was initiated.

Coincidentally, a significant reduction in the number of NTB cases attended at the National Children's Hospital was documented, decreasing from 105 cases treated in 1995 to 26 in 2001, without any other intervention during the same period of time. Therefore, the purpose of this paper is to demonstrate the possible effect of food fortification with folic acid on the reduction of the incidence of neural tube defects during the period 1997–2001 in Costa Rica.

Dr. Tacsan and Ms. Ascencio are with the Ministry of Health, Costa Rica, Apto. 10123, San José, Costa Rica.

Table 1. Folate Serum Levels before and after Food Fortification

Setting/Indicator	Before Fortification (1996)	After Fortification (2000)
Metropolitan Area		
Serum folates (ng/mL)	10.1 (9.3–10.9)*	15.8 (14.7–16.9)
Folate deficiency (%)	19 (13.2–25.0)	2.5 ()
Rural Area		
Serum folate (ng/mL)	9.6 (8.6–10.6)	12.5 (10.4–14.6)
Folate deficiency (%)	31.4 (24.8–38.0)	11.6 (6.5–17.7)

* Confidence intervals.

Methodology

A comparison was made between serum folate levels of non-pregnant, non-lactating women between 15 to 44 years of age before and after wheat and maize flour fortification. Previous figures were obtained from the 1996 National Nutrition Survey for women in metropolitan areas (288 subjects) and rural areas (300 subjects). Data for the post-fortification period was obtained from the sentinel study of the urban district of Damas in San Jose (204 women) and the rural district of San Antonio in Nicoya (190 women). Both settings were representative of their equivalence at the metropolitan and rural areas of the 1996 national nutritional survey.

Blood samples were obtained from each subject; the corresponding analysis was undertaken at the specialized Ministry of Health laboratories (INCIENSA) using the radioimmunology essay test (solid phase, DPC, 1995). Average and percentage of cases with deficiency levels of folate was determined for those women with folate

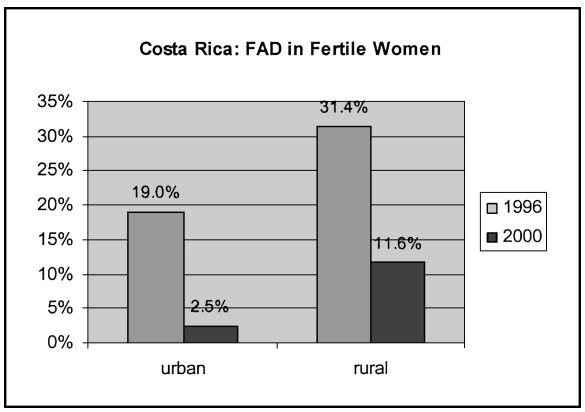

Figure 1. Costa Rica. Folic acid deficiency in fertile women. Source: Ministry of Health, Costa Rica: Nutritional Survey, 1996, and Sentinel Sites 2000. FAD = folic acid deficiency.

Table 2. Current Food Fortification in Costa Rica

Food	Consumption (g/day)	Fortification (mg/kg)	Folic Acid (μg/day)	DDR (%)
Wheat flour	60	1.8	108	27
Corn flour	20	1.8	36	9
Milk	220	0.4	88	22
Rice	114	1.8	205	51
Total			437	109

From the Ministry of Health, Costa Rica, 2003. DDR = daily dietary recommendations.

levels under 6 ng/ml according to WHO recommendation.

Results

Table 1 presents the serum folate levels found in study subjects before and after flour fortification:

Results indicated a reduction of 87% of folic acid deficiency (FAD) in urban areas and a 63% reduction in rural areas, measuring folate plasmatic levels in women (Figure 1). At that time both fortified flours met 29% of folic acid daily dietary recommendation level (DDR).

Today, other basic foods have been fortified—by law, and according to executive decrees—with folic acid and iron, with the expectation of reaching the DDR (Table 2). Fortification of whole, semi-skimmed, skimmed, and powdered milk began on January 1, 2002, and reached 39% of DDR. Rice fortification is scheduled to begin during January 2003. If successful, these fortifications altogether should provide 437 μg/day and 109% of the DDR. Clinicians still advocate for supplementation, although the high cost and coverage difficulties due to logistical constraints must be considered.

The same positive effect of decreased incidence of neural tube defects was obtained from a mean rate of 9.7 per 1000 lb in the period 1996–1998, to 6.3 per 1000 lb in the period 1999–2000.* All provinces except one presented decrease of the problem (Table 3). Diminished incidence was reported in both sexes, although the reduction was significant only in females.

The National Children's Hospital, functioning as a national reference center, has also reported a 74% reduction of the incidence of myelomeningocele. This incidence expressed in number of cases dropped from 105 in 1997, to 26 in 2001† (Figure 2). In addition to reducing

* INCIENSA. Centro de Registro de Enfermedades congénitas (CREC). Prevalencia de enfermedades congénitas por provincias y cantones. Costa Rica 1987–2000.

† Ministerio de Salud, Memoria Anual 2002, San José, 2002.

Table 3. Neural Tube Defects Rates per Provinces, Costa Rica 1996–2000

Provinces	1996–1998	1999–2000
San José	12.6	5.3
Alajuela	7.3	6.5
Cartago	9.3	8.6
Heredia	7.7	3.8
Guanacaste	10.5	6.6
Puntarenas	8.3	5.6
Limón	5.9	9.4
COSTA RICA	9.7	6.3

From INCIENSA, Centro de Registro de Enfermedades Congénitas, 2002.

NTD rates, fortification has also been found to prevent more severe cases, as shown in Figure 3.

Conclusion

It is most likely that folic acid fortification has been the major cause for prevention of NTB in Costa Rica. In addition, folic acid fortification may also help prevent more severe cases of NTB. However, the challenge of determining if folic acid food fortification should necessarily be accompanied by supplementation still remains. Another main line of development is to improve the rice fortification technology.

According to the Costa Rican experience, the following steps could be suggested in order to implement a

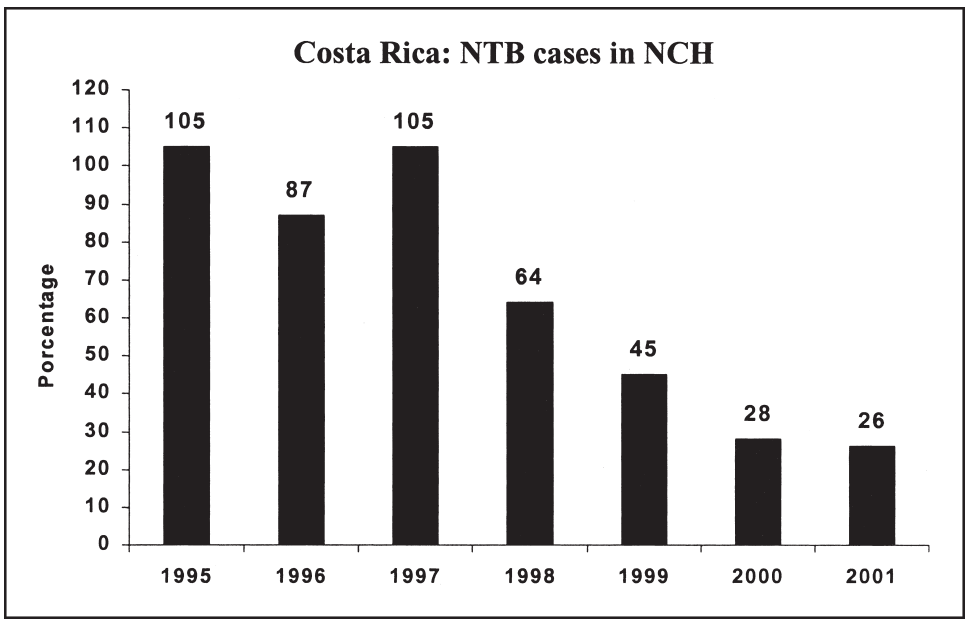

Figure 2. Costa Rica. Neural tube defects cases at National Children's Hospital.

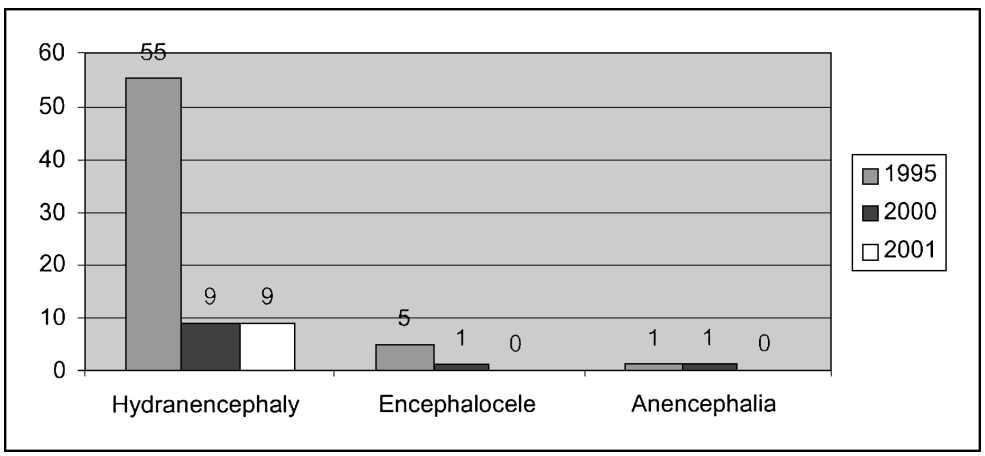

Figure 3. Other types of neural tube defects at National Children's Hospital.

food fortification program with folic acid addressed to reduce the NTB incidence:

1. A solid, well-based registration system with reliable data and extensive coverage is required. This system will need to be tested and proven for several years to attain quality and actualization of data so it can guarantee early detection of changes in the prevalence and incidence of NTB.
2. The availability of updated national nutritional surveys with data on serum levels of folic acid of women in reproductive age, as well as information on food consumption, (specifically food sources of folates) will also be required. Data should be available at segregated levels such as urban/rural, and incorporate other factors, such as socioeconomic level, in order to determinate future changes.
3. The establishment of strong strategic alliances with private industry for the most appropriate technological adoption for food fortification is essential. This action should be accompanied by a strong and well-developed control system by health authorities for the surveillance of products at market and home level.
4. Finally, the country should have available funds for the monitoring and impact evaluation, which will need to be periodically undertaken for adjustment measures.

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