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ORIGINAL COMMUNICATION

High prevalence of folic acid and vitamin B_{12} deficiencies in infants, children, adolescents and pregnant women in Venezuela

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Background: There is increased worldwide concern about the consequences of folic acid and vitamin B_{12} deficiencies on health, which include megaloblastic anemia, neural tube defects and cardiovascular disease.
Objective: This study intended to determine the prevalence of folic acid and vitamin B_{12} deficiencies in vulnerable groups in labor and poor socioeconomic strata of the Venezuelan population.
Methods: A total of 5658 serum samples were processed to determine folic acid and vitamin B_{12} concentrations. The study involved three surveys performed during 2001–2002 and included infants, children, adolescents and pregnant women from labor and poor socioeconomic strata of the population. The method used was a radio immunoassay designed for the simultaneous measurement of serum folic acid and vitamin B_{12}.
Results: The prevalence of folic acid deficiency was higher than 30% for all groups studied, reaching 81.79% in adolescents. Vitamin B_{12} deficiency was 11.4% in samples collected nationwide, but there was also a similar prevalence of high serum levels. The prevalence of folic acid and vitamin B_{12} deficiencies in pregnant women reached 36.32 and 61.34%, respectively.
Conclusion: This work shows that there is a high prevalence of folic acid deficiency, especially in women of reproductive age, pregnant adolescents and in the whole population studied in Vargas state. This situation requires immediate intervention as supplementation or food fortification programs.
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Keywords: folic acid; vitamin B_{12}; children; pregnant women; Venezuela

Introduction

Folic acid is a water-soluble B vitamin involved in nucleic acid, blood cells and nervous tissue synthesis. It also has an important role in protein metabolism through methionine synthesis, which is used for polypeptide synthesis, but also as a precursor of *S*-adenosyl methionine, the universal methyl group donor for more than 100 organic reactions (Machlin & Hüni, 1994; ILSI-OPS, 1997). The consequences of folic acid deficiency include megaloblastic anemia with alterations in bone marrow and peripheral blood (Machlin & Hüni, 1994), an increased susceptibility to cancer incidence and severity (Giovanucci & Stampfer, 1993; Woon Choi & Mason, 2000; Woon Choi *et al*, 2003), neural tube defects (NTD), which include congenital malformations produced during the first stages of embryonic development when the open neural tube cannot be closed during the first month of pregnancy. It has been demonstrated that folic acid administration before pregnancy reduces the prevalence of neural tube defects (spina bifida and anencephaly) even in babies born of mothers who had at least one previous child with this defect (Medical Research Council, 1991; Czeizel, 1995; CDC-OPS, 2001). Another consequence of folic acid deficiency is its role in the development of cardiovascular disease. Folic acid

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deficiency produces an increase of serum homocysteine levels, which results in alterations on the vascular endothelium, platelets, coagulation system and vascular reactivity (Brattström & Wilcken, 2000; McKinley *et al*, 2001; Stipanuk, 2001).

Vitamin B_{12} includes a group of cobalt-containing compounds known as cobalamins. This vitamin is involved in myelin synthesis, fatty acid degradation and protein and DNA synthesis (Machlin & Hüni, 1994; Stipanuk, 2001). All the vitamin B_{12} in nature is produced by microorganisms and it is only found in foods of animal origin and vegetables contaminated with vitamin B_{12}-synthesizing bacteria. Vitamin B_{12} deficiency produces megaloblastic anemia characterized by big and immature erythrocytes and neurological manifestations. This deficiency is associated with the elderly due to Intrinsic Factor deficiency and is known as pernicious anemia (Herbert, 1994; Machlin & Hüni, 1994).

Folic acid deficiency is common in many parts of the world, and like anemia caused by iron or vitamin B_{12} deficiencies, it is part of a general problem of undernutrition and socioeconomic deficiencies. It can result from inadequate intake, reduced absorption, abnormal metabolism or increased requirement. Vitamin B_{12} deficiency is uncommon worldwide, probably due to low requirements, and relatively scarce reports are found in the literature regarding the prevalence of deficiency of this vitamin. Groups at risk of suffering folic acid and vitamin B_{12} deficiencies include populations where nutritional deficiencies are common, in economically underprivileged groups and individuals with gastric and intestinal affections, infection, cancer and renal damage. Also, people on special diets and the elderly are at risk of deficiency (Machlin & Hüni, 1994; ILSI-OPS, 1997; Rodríguez, 1998).

In Latin America, there have been some reports about the situation of folic acid deficiency in the regions that include Chile, Colombia, Costa Rica and Mexico. In Venezuela, the prevalence of folic acid and vitamin B_{12} deficiencies, as well as mean serum levels of both nutrients, is unknown. Because of the importance of both nutrients, the increased worldwide concern about the consequences of their deficiencies, the interrelationship between their metabolisms and the sustained deterioration of life quality of the Venezuelan population, the objective of this study was to determine the prevalence of folic acid and vitamin B_{12} deficiencies in infants, children, adolescents and pregnant women from labor and poor socioeconomic strata of the Venezuelan population.

Subjects and methods

A total of 5658 individuals from three surveys performed during the period 2001–2002 were interviewed and studied. These surveys collected information about social, economical, anthropometrical, nutritional and biochemical variables, which included serum folic acid and vitamin B_{12} determinations, as well as hemoglobin and ferritin concentrations. Individuals from the age groups and characteristics of interest, were randomly selected from schools and health centers of the regions studied and classified by socioeconomic stratum to define homogeneous groups. Social stratification was performed by the Graffar method modified by Mendez Castellano (Méndez-Castellano & Méndez, 1986). This method is based on four variables: profession of the head of the family, instruction level of the mother, main source of income and housing conditions.

Samples were taken in the morning after an overnight fast and interviews were performed by trained personnel from Fundacredesa (a National Institute created in 1976 to study the growth and development of the Venezuelan population). Individuals were randomly selected from the list of schools and Health Centers located in the main municipalities of the regions studied. Each individual was informed about the objectives of the study. The protocol was approved by the ethical committee of the Venezuelan Institute for Scientific Research.

The three surveys included (1) a national survey studying 1649 infants and children from 0 to 7 y. This survey analyzed samples from Caracas and 16 of the most important cities of the country; (2) Vargas state survey, which included 2720 samples from infants, children and adolescents from a state where living conditions were greatly deteriorated due to a natural disaster, occurred in 1999. The sample for this survey was taken from schools and health centers located in the 11 main municipalities of the state; and (3) a pregnancy survey of 1289 pregnant women from Gran Caracas, a region including the capital region and three semirural areas that surround Caracas: Guarenas, Guatire and Valles del Tuy.

Vargas state was studied in 2001, in order to evaluate the impact that a natural disaster that occurred in 1999 had on growth and health. During December of that year, continuous rains produced floods that resulted in between 12 000 and 15 000 deaths, great losses in infrastructure and economical losses calculated at more than 4 billion American dollars ($). The damage had a long-term impact on the population since tourism-related activities are the main sources of employment for Vargas state habitants, and the reconstruction of the state has not been completed yet. Blood was obtained by venous puncture of the arm after cleaning the area of extraction with isopropyl alcohol. Samples were placed in tubes without anticoagulant and serum was separated by centrifugation for other biochemical determinations, including folic acid and vitamin B_{12} concentrations. Blood samples obtained from the different locations planned in each study were transported refrigerated to obtain sera within 4 h of extraction. Serum samples were immediately frozen protected from light, transported to the laboratory and kept at -40°C until use.

The method used to determine folic acid and vitamin B_{12} concentrations was a radio immunoassay from DPC (Diagnostic Product Corporation, Los Angeles, CA, USA). This assay is designed for the simultaneous measurement of folic acid and vitamin B_{12} in blood, serum or plasma. Sample processing involves alkaline denaturalization of endogenous proteins, to release folic acid and vitamin B_{12} from carrier proteins and also to inactivate antibodies against intrinsic factor. In a second stage there occurs the competition of folic acid and vitamin B_{12} from samples, with radioactive tracers of both compounds for purified binders, which in the case of folic acid is folate-binding protein purified from milk and for vitamin B_{12} is intrinsic factor purified from hog. The last step of the process involves solid phase separation. Since the above-mentioned binders are immobilized to microcrystalline cellulose particles, isolation of bound fractions occurs by centrifugation and decanting. The amount of radioactivity in precipitates is inversely proportional to folic acid and vitamin B_{12} concentrations in the samples. The exact concentration of both compounds can be calculated from standard curves. The kit provides an internal control with known concentrations of folic acid and vitamin B_{12} in the deficient range (anemia control) that is included in each plate.

According to the manufacturer, this is a high precision and high specificity kit. The detection limit is approximately 35 pg/ml for folic acid and 0.3 ng/ml for vitamin B_{12}. It is highly specific for both vitamins, with low cross reactivity and high spiking recoveries. Coefficients of variation, intra- or interassay, are lower than 10% for both folic acid and vitamin B_{12}. The cutoff points used for serum folic acid were <3 ng/ml for deficiency, 3–6 ng/ml for low levels and >6 ng/ml for normal. For vitamin B_{12}, deficiency was defined when serum concentration was below 200 pg/ml, normality range varied from 200 to 900 pg/ml and excess >900 pg/ml (ILSI-OPS, 1997; DPC, 1999).

Folic acid determinations by microbiological method

In 1980, a total of 4564 samples were tested for folic acid, as part of a national survey known as 'Venezuela Project'. This study included a general population of all ages and socioeconomic conditions and analyzed biochemical, social, economic and health variables to diagnose and improve health and nutrition in Venezuela. Samples were processed in our laboratory during that time, and the method used for this project was microbiological (Waters *et al*, 1961). Changes in turbidity of serum-containing media, produced by *L. casei* growth, was the indirect measurement of serum folic acid concentration, which was calculated from increases in turbidity in the presence of known concentrations of folic acid in a standard curve.

Statistical methods

The prevalence data for folic acid and vitamin B_{12} deficiency are presented as percentage. Serum concentrations of both nutrients are presented as ng/ml for folic acid and as pg/ml for vitamin B_{12}. Unpaired *t*-test was used to compare folic acid results from this study and the Venezuela Project.

Results

National survey for infants and children

Table 1 shows the results of folic acid deficiency for the whole group studied, with a global deficiency of 31.5% and a similar distribution between different age groups, although infants showed higher prevalences. When individuals were separated by socioeconomic strata (which classify individuals in four levels, strata IV and V being the poorest) and sex, there was no difference in prevalence: folic acid deficiency in children from the labor stratum (IV) was 32.2% and from the poor stratum (V) was 31.8%, while the prevalence was 33.7% for boys and 30.2% for girls. The sample was also analyzed as Caracas (capital region) and the rest of the country, showing no differences in prevalence by geographical distribution, sex or socioeconomic level, although in Caracas the prevalence of folic acid deficiency was lower as age increased, with a prevalence of 25.0% for children 5–7-y-old, 33.3% for children, 2–4-y-old and 37.3% for infants. There was no difference by sex, except for the 7-y-old group, in which the prevalence was considerably lower for girls than for boys, with 21.09 and 31.86%, respectively.

When groups with deficiency (<3 ng/ml) and low levels (3–6 ng/ml) of folic acid were added up, the prevalence resulted as high as 72.1%.

Data on the prevalence of vitamin B_{12} deficiency for this group are also shown in Table 1. Classification by age, sex, socioeconomic level and geographical distribution showed no difference between groups, except for the 7-y-old group,

Table 1 Prevalence of folic acid and vitamin B_{12} deficiencies in infants and children of Venezuela

		Folic acid			*Vitamin B_{12}*		
Age (y)	n	*Deficiency (<3 ng/ml) (%)*	*Low (3–6 ng/ml) (%)*	*Normal (>6 ng/ml) (%)*	*Deficiency (<200 pg/ml) (%)*	*Normal (200–900 pg/ml) (%)*	*High (>900 pg/ml) (%)*
0–1	351	31.11	36.51	32.38	15.87	74.29	9.84
2–4	718	35.05	38.34	26.60	9.70	74.02	16.28
5	251	30.38	43.46	26.16	8.86	78.48	12.66
7	472	27.51	44.98	27.51	12.01	74.67	13.32
Total	1792	31.53	40.57	27.89	11.40	74.89	13.71

in which, as for folic acid, girls showed a lower prevalence of deficiency than boys (7.41 and 18.14%, respectively).

Survey on Vargas state

Due to the natural disaster that occurred in 1999 in this region of Venezuela, data were processed separately because we suspected a more deteriorated nutritional situation than in the rest of the country. Age groups studied in this state included infants and children as in the national survey, but also adolescents of 11 and 15 y of age. Results from this survey are shown in Table 2. General prevalence of folic acid deficiency for the state was 53.53%, without differences by socioeconomic level or sex, except again for the 7-y-old group, in which the prevalence of folic acid deficiency was lower in girls (50.24%) than in boys (59.62%). There were important differences by age, showing a higher prevalence of folic acid deficiency in 11- and 15-y-old adolescents.

Vitamin B_{12} levels were normal in 73.24% of the cases studied, with a low prevalence of high serum levels and 20.99% of deficiency (Table 2). Prevalence was higher in adolescents and infants, without differences by socioeconomic level and sex. The prevalence of deficiency was higher for 7-y-old boys (16.90%) than for girls (10.43%).

The comparison of prevalences of folic acid and vitamin B_{12} deficiencies in the national and Vargas state surveys for the age groups that where included in both studies showed that prevalence for the groups studied in Vargas was higher (45.14%) than the prevalence for the rest of the country (31.53%). The situation for vitamin B_{12}, although better, also shows that the prevalence of deficiency is higher in samples from Vargas (17.21%) than in the rest of the country (11.40%).

Pregnancy survey

Prevalence of folic acid and vitamin B_{12} deficiencies by age, in the whole geographical region studied (Gran Caracas), are presented in Table 3, and show that almost 63% of the population studied had some degree of folic acid deficiency (considering deficiency + low levels), with a similar prevalence for vitamin B_{12} deficiency, without differences by age group. Distribution of data by regions showed that Caracas presented the lowest prevalence of deficiency for both nutrients (Table 4). Distribution of data by trimester of pregnancy and age showed a higher prevalence of folic acid deficiency for adolescents during the first trimester of pregnancy. Vitamin B_{12} deficiency increased as pregnancy advanced, independent of the age of the mother (Table 5). There was a higher prevalence of deficiency of folic acid, but not of vitamin B_{12}, in the poorer segments of the population. Prevalence of deficiency of folic acid and vitamin B_{12} for the whole region studied was 31.06 and 60.49% for stratum IV and 42.35 and 62.75% for stratum V, respectively.

Table 2 Prevalence of folic acid and vitamin B_{12} deficiencies in infants, children and adolescents of Vargas state

		Folic acid			*Vitamin B_{12}*		
Age (y)	n	*Deficiency (<3 ng/ml) (%)*	*Low (3–6 ng/ml) (%)*	*Normal (>6 ng/ml) (%)*	*Deficiency (<200 pg/ml) (%)*	*Normal (200–900 pg/ml) (%)*	*High (>900 pg/ml) (%)*
0–1	432	46.29	28.70	25.00	26.62	68.52	4.86
2–4	753	39.58	35.46	24.97	15.14	74.63	10.23
5	325	43.69	36.62	19.69	14.15	79.69	6.15
7	424	54.95	30.89	14.15	13.68	81.84	4.48
11	440	68.18	24.09	7.73	25.00	72.05	2.95
15	346	81.79	15.03	3.18	36.99	60.98	2.02
Total	2720	53.53	29.38	17.09	20.99	73.24	5.77

Table 3 Prevalence of folic acid and vitamin B_{12} deficiencies in pregnant women of Gran Caracas by age

		Folic acid			*Vitamin B_{12}*		
Age (y)	n	*Deficiency (<3 ng/ml) (%)*	*Low (3–6 ng/ml) (%)*	*Normal (>6 ng/ml) (%)*	*Deficiency (<200 pg/ml) (%)*	*Normal (200–900 pg/ml) (%)*	*High (>900 pg/ml) (%)*
14–18	263	38.02	22.81	39.16	63.88	34.98	1.14
19–25	571	39.23	28.37	32.39	60.42	38.53	1.05
26 +	449	31.63	24.72	43.65	61.02	37.19	1.78
Total	1283	36.32	25.95	37.72	61.34	37.33	1.33

Table 4 Prevalence of folic acid and vitamin B_{12} deficiencies in pregnant women of Gran Caracas by region studied (Caracas, Guarenas + Guatire and Vales Del Tuy)

		Folic acid			*Vitamin B_{12}*		
Region[a]	n	*Deficiency (< 3 ng/ml) (%)*	*Low (3–6 ng/ml) (%)*	*Normal (> 6 ng/ml) (%)*	*Deficiency (< 200 pg/ml) (%)*	*Normal (200–900 pg/ml) (%)*	*High (> 900 pg/ml) (%)*
CCS	491	28.92	27.90	43.18	56.82	42.57	0.61
G + G	392	44.89	26.02	29.08	64.03	34.69	1.28
VT	400	37.25	23.25	39.50	64.25	33.50	2.25
Total	1283	36.32	25.95	37.72	61.34	37.33	1.33

[a]CCS Caracas, G + G Guarenas + Guatire, VT Valles del Tuy.

Table 5 Prevalence of folic acid (< 3 ng/ml) and vitamin B_{12} (< 200 pg/ml) deficiencies in pregnant women from Gran Caracas

	Folic acid				*Vitamin B_{12}*			
	Trimester of pregnancy							
Age (y)	*First (%)*	*Second (%)*	*Third (%)*	*Total (%)*	*First (%)*	*Second (%)*	*Third (%)*	*Total (%)*
14–18	61.76 (34)[a]	34.35 (131)	33.67 (98)	37.64 (263)	50.00 (34)	58.78 (131)	72.45 (98)	62.74 (263)
19–25	39.53 (86)	41.15 (243)	35.47 (234)	38.54 (563)	44.19 (86)	58.85 (243)	69.23 (234)	60.92 (563)
26– +	44.19 (43)	29.41 (187)	30.88 (204)	31.57 (434)	41.86 (43)	58.29 (187)	68.14 (204)	61.29 (434)
Total	45.40 (163)	35.65 (561)	33.39 (536)	35.95 (1260)	44.79 (163)	58.65 (561)	69.40 (536)	61.42 (1260)

[a]Numbers in parenthesis = *n*.

Comparison of recent data from national survey with folic acid determinations by microbiological method

Samples from the 'Venezuela Project' were analyzed using the same cutoff points to define deficiency, low and normal levels of serum folic acid, and the prevalence was 12.82, 43.82 and 43.36%, respectively. Although the 'Venezuela Project' also included other age groups, it can be observed that the prevalence of folic acid deficiency has increased over the years, showing that today, only 28% of the population presented normal values while during the 1980s, 43% of the population has adequate levels of serum folic acid. Regarding folic acid serum concentrations, data from the 'Venezuela Project' resulted in a significantly different ($P < 0.0001$) mean value of 6.82 ng/ml, compared to 5.29 ng/ml for the 2001 national survey. The mean serum level obtained from the different sources of data presented in this study includes 5.29 ng/ml in the national Survey, 4.04 ng/ml in the Vargas survey and 8.42 ng/ml in the pregnancy survey.

Discussion

Folic acid deficiency is an important health problem in many countries worldwide although the prevalence of deficiency shows a high variability. Prevalence of folic acid deficiency in preschoolers and women of reproductive age from Costa Rica was 11.4 and 24.7%, respectively (Blanco *et al*, 2001; Cunningham *et al*, 2001), while in the 1999 National Nutrition Survey in Mexico, the prevalence of folic acid deficiency was 8.8% in infants, 2.3% in adolescents and only 5% in women of reproductive age (SSA/INSP/INEGI, 1999). However, a recent study in Mexico in 117 women of reproductive age reported a deficiency of erythrocyte folate and vitamin B_{12} of 28 and 20%, respectively (Casanueva *et al*, 2000). Chile deserves special mention with a successful wheat flour fortification program that has been evaluated recently and resulted in an important decrease of folic acid deficiency (Bunout *et al*, 1998; Hertrampf *et al*, 2003). Other countries such as Spain, Cuba and Poland, with important socioeconomic differences, are affected by a high prevalence of folic acid and vitamin B_{12} deficiencies (OPS, 1999; Wartanowicz *et al*, 2001; Planeéis *et al*, 2003).

In Venezuela, there is a high prevalence of folic acid deficiency for all groups analyzed, although vitamin B_{12} levels also require immediate action not only due to megaloblastic anemia problems but also the fact that this deficiency is considered an independent risk factor for neural tube defects, due to a reduced cellular uptake of folates in the presence of vitamin B_{12} deficiency (Allen, 1994). Prevalence of deficiencies is higher in Vargas state, showing a greater deterioration in living conditions, which is evidenced not only with regard to folic acid and vitamin B_{12} but also to iron deficiency and other parameters of growth and development. The deteriorated conditions found in Vargas state require immediate attention and action not only as a whole region but also especially for certain age groups such as 11- and 15-y-old adolescents and infants, where the prevalence of any degree of folic acid deficiency is higher than 75%, with an alarming 96.8% for 15-y-old adolescents.

Regarding vitamin B_{12}, although 75% of the children studied nationwide present normal levels, there is 11% deficiency and 14% excess of this nutrient, which implies that fortification strategies should be planned very carefully, since excess and deficit had the same incidence. On the other hand, in Vargas state, the increase in the prevalence of deficiency seems to be a consequence of the diminution of cases with high levels of vitamin B_{12}, since the proportion of normal individuals is similar to nationwide values, which is between 73 and 75% in both surveys. For the same vitamin, the high prevalence of deficiency in pregnant women is probably due, at least during the second and third trimesters of pregnancy, to a blood dilution effect. However, when data are analyzed by trimester of pregnancy, it can be observed that during the first trimester there is a 44.79% deficiency, which is not explainable by a dilution effect, but also is too high to be only due to a nutritional deficiency. Trying to explain the high prevalence of vitamin B_{12} deficiency during pregnancy besides the dilution effect, some authors have proposed changes in nutrient transference to the fetus, increased requirement and impaired absorption, especially in underdeveloped countries (Zamorano *et al*, 1985; Knight *et al*, 1994; Allen *et al*, 1995; Mc Grath *et al*, 1995; O'Connor 1995; Casterline *et al*, 1997).

Although the prevalence of folic acid deficiency in pregnant women is high, when data are disaggregated by regions, deficiency is considerably lower in Caracas than in the other regions studied, indicating that although Guarenas, Guatire and Valles del Tuy are satellite cities of Caracas and less than 1 h away from each other by ground transportation, socioeconomic conditions, access to health and food acquisition are better in the capital region, which could explain the relatively better situation there. Distribution of cases by trimester of pregnancy shows a higher prevalence of folic acid deficiency during the first trimester, and also for teenagers. The implications of 61.76% prevalence of folic acid deficiency in teenagers during the first trimester of pregnancy are very important, since this indicates a nutritional deficit before pregnancy that could affect the proper closure of the neural tube, resulting in NTD for the fetus, as well as the consequences for both mother and child, such as cardiovascular damage and anemia.

There are some interesting studies during pregnancy that indicate a high incidence of these two deficiencies in many countries, not necessarily associated with a low socioeconomic level. Prevalence of vitamin B_{12} deficiency studied in 130 Turkish pregnant women was 48.8% at 13–17 weeks of pregnancy, 80.9% at 28–32 weeks and 60% 13–17 weeks after delivery. Folic acid deficiency for the same periods was 59.7, 76.4 and 73.3%, respectively (Ackurt *et al*, 1995). There are also developed countries with high prevalences of deficiency. A study performed in 2000 in Canada showed that prevalences of erythrocyte folic acid and vitamin B_{12} deficiencies in pregnant women were 27 and 43.6%, respectively, a high prevalence for folic acid considering that determinations were performed in erythrocytes (Houe *et al*, 2000).

It is possible that the main cause for the high prevalences of folic acid deficiency found in these three studies, which included 5658 individuals, is due to inadequate or insufficient intake. Life conditions in Venezuela have continued deteriorating since 1985 when an important socioeconomic crisis started. The cost of a basic diet per month for a family of five (father, mother and three children) was reported in 2000 (García-Casal & Layrisse, 2002). This diet contains only locally produced foods and the main food constituents are corn flour, rice, plantain, potatoes, milk, fruit, meats, vegetables and eggs. The average macronutrient contents are as follows: 9257 kJ energy, 65 g protein, 343 g carbohydrate and 66 g fat. In 1994, the monthly cost of this diet was 989 Bolívares (Bs.), equivalent to 7$. In 1998, the diet cost increased to 142.000 Bs, equivalent to 209 $. During this period, 10% of the middle class, 20% of the labor class and 30% of the low socioeconomic class were unable to cover their nutritional requirement through this base diet (Méndez-Castellano & Méndez, 1986; Méndez-Castellano, 1995). As a consequence, there has been a progressive reduction of the quality and quantity of food consumption, characterized by a lower intake of meat, vegetables and fruits as well as cereals, grains and tubers.

This work shows that there is a high prevalence of folic acid deficiency. According to the sample analyzed, the situation is alarming for women of reproductive age, teenagers during their first trimester of pregnancy and the age groups studied in Vargas state. It is important to highlight that according to cutoff points for folic acid deficiency, the population analyzed (except for pregnant women) is considered to have low levels of serum folic acid (cutoff: 3–6 ng/ml). This situation requires immediate intervention as supplementation or food fortification programs.

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