Anemia in Mexican women: Results of two national probabilistic surveys

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Abstract

Objective. To describe the prevalence of anemia in Mexican women and analyze its trends with information from the last two national nutrition surveys. **Material and methods**. The prevalence of anemia in women was analyzed. Anemia was adjusted by socioeconomic profile and by potentially explanatory variables. **Results**. The overall prevalence of anemia for pregnant women was 20.2% (95% *CI* 15.9, 26.2%) and 15.5% for non-pregnant women (95% *CI* 14.7, 16.4%). The prevalence of anemia in women decreased from 1999 to 2006 in all socioeconomic profiles. Adolescent women living in the northern and in the southern regions had a greater risk of anemia than those in Mexico City ($p= 0.05$). Significant risk was found among low socioeconomic level ($p< 0.06$). Greater parity was a significant risk factor ($p< 0.05$) for being anemic. **Conclusions**. Although anemia in reproductive age women in Mexico decreased, it continues to be a public health problem.

Keywords: anemia; women; surveys; prevalence; Mexico

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Resumen

Objetivo. Describir la prevalencia de anemia en mujeres y analizar su tendencia a través de las dos últimas encuestas nacionales de nutrición. **Material y métodos**. Se analizó la prevalencia de anemia en mujeres. La prevalencia de anemia se ajustó por perfil socioeconómico y por posibles variables que la expliquen. **Resultados**. La prevalencia global de anemia fue de 20.2% (*IC*95% 15.9, 26.2%) para mujeres embarazadas y de 15.5% (*IC*95% 14.7, 16.4%) para mujeres no embarazadas. La prevalencia de anemia en mujeres disminuyó de 1999 a 2006 en todos los niveles socioeconómicos. Las mujeres adolescentes que viven en las regiones norte y sur tuvieron mayor riesgo de anemia que las que viven en la Ciudad de México ($p= 0.05$). Se encontró un riesgo significativo asociado con el nivel socioeconómico bajo ($p< 0.06$). La mayor paridad resultó ser un factor de riesgo significativo ($p< 0.05$). **Conclusiones**. Aun cuando la presencia de anemia en mujeres en edad reproductiva en México ha disminuido, continúa siendo un problema de salud pública.

Palabras clave: anemia; mujeres; encuestas; prevalencia; México

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Anemia is a public health problem affecting millions of people; it has far-reaching consequences for human health and social and economic development.[1] The World Health Organization (WHO, 2001) estimated that a total of 2 000 million people worldwide were anemic, half of those being cases associated with iron deficiency.[2] Severe anemia in women is associated with a higher risk of perinatal morbidity and mortality; it is also associated with impaired cognitive and physical development in children as well as with low work productivity in adults.[3,4]

It has been estimated that the risk to develop anemia is 2 to 7 times greater in developing countries than in industrialized ones, particularly in rural areas.[5] Prevalence of anemia may be as high as 35% in women of reproductive age and 50% in pregnant women[5] living in economically depressed regions.[6-9]

Casanueva et al, reviewed 46 epidemiological and clinical studies published between 1939 and 2005, as well as Mexico-based governmental intervention programs. They found that the estimated prevalence of anemia in non-pregnant women of reproductive age has decreased from 39.6 to 15.5% (24.1 percentage points (pp) in the last 65 years), whereas in pregnant women it has only decreased 10 pp. Therefore, anemia in Mexican pregnant women is a more critical public health problem.[10]

The two most recent probabilistic national nutrition and health surveys reported a prevalence of 15.4 and 20.8% in non-pregnant and 18.2 and 26.7% in pregnant women.[11-12]

The objective of this investigation is to describe the prevalence and distribution of anemia in women 12 to 49 years of age in the latest Mexican National Nutrition and Health Survey 2006 (ENSANUT 2006) and to compare the changes related to the previous survey carried out in 1999 (ENN 99). Such analyses are intended to provide relevant information for developing appropriate national policies aimed at reducing and controlling the prevalence of anemia in Mexican women, as it is one of the most important national nutritional problems.

Material and methods

Population

Samples of women of reproductive age (12 to 49 years old) from two national nutrition surveys were collected. The ENN 99 with a sample size of 17 194 subjects and the ENSANUT 2006, with a sample size of 21 135 women.

Surveys' design

Both surveys were designed to be representative at the national level, in rural and urban areas, and in four geographic regions defined as: northern, central, Mexico City (included its metropolitan municipalities) and the southern region. The design of the surveys was stratified and by conglomerates. Further details about the methodology used for these two surveys have been described previously.[13,14] The methodological design, operative definitions and instruments used were purposely maintained as equal as possible for both surveys, allowing for fair comparisons among them.

Data Collection

Anemia

The hemoglobin concentrations in ENN 99 and ENSANUT 2006 were measured in capillary blood using a portable photometer Hemocue (Hemocue Inc., Angelholm, Sweden). Anemia was defined as the concentration of hemoglobin below 12.0 g/dL at sea level for non-pregnant women and below 11.0 g/dL for pregnant women, in accordance with WHO recommendations.[15] Hemoglobin concentrations were adjusted for altitude using the equation published by Cohen and Hass.[16] Hemoglobin values under 5.0 g/dL and above 18.5 g/dL were considered spurious and excluded from the analysis according to criteria published previously.[17,18]

Socioeconomic characteristics

Information on socioeconomic characteristics in both Surveys was based on housing characteristics (flooring material, sewage system, water piping) and family assets (ownership of a car, refrigerator, radio, television and telephone and being beneficiary of a food distribution program). Parity was stratified into three categories: women with less than three children, with three to five children, and with more than five children.

Anthropometry

Weight and height were measured using standard anthropometric methodology.[19,20] Weight was measured using an electronic scale with 10g of precision (Tanita, model 1583, Tokyo, Japan). Height was measured using an anthropometer with a maximum capacity of 2m and

a precision of 1mm (Dyna-Top, model E-1, Mexico). In both surveys, communities with a population of less than 2 500 were considered as rural and those over 2 500 as urban. A family was categorized as indigenous when at least the mother spoke an indigenous language.

Statistical analysis

Descriptive results are presented as proportions, means, 95% confidence intervals and standard deviations for pregnant and non-pregnant women. In order to calculate the probabilities of anemia adjusted by mean socioeconomic profile, a logistic regression model was constructed. Secondary logistic models were used in order to assess the association between the prevalence of anemia with potentially explanatory variables in adolescent and adult women, separately. Because the sample size for pregnant women was small they were not included in this set of analysis.

The first model included several variables such as age, body mass index (BMI) and the following household characteristics and assets: cement floor, piped water, sewage system, possession of car, refrigerator, radio or television sets and telephone. Availability of any of those characteristics or assets was graded as 1; otherwise the grading was 0. As a central reference for the data of all women, three socioeconomic profiles were defined for women with mean age of 27 years and BMI of 25 kg/m^2. The high profile was defined when all household characteristics and assets were graded as 1; profile medium when the number of household characteristics and assets graded as 1 corresponded to the mode; and low when all characteristics and assets were graded as 0. In a second step, the probability of being anemic was calculated for the three socioeconomic profiles for each one of the surveys (ENN 99 and ENSANUT 2006). Comparisons of the adjusted prevalence of anemia between surveys were then performed at national, regional and urban/rural levels.

The OR and 95% confidence intervals (95% *CI*) were derived in a second step from separate logistic models for adolescent and adult women having as covariables some potentially explanatory variables. The covariables introduced to the adolescents' model were age at menarche, height, indigenous ethnicity, household characteristics and assets, and being beneficiary of a food distribution program. For adult women, the model included the same variables plus body mass index (BMI) and parity; age at menarche was excluded.

All analyses were adjusted by the sampling design. Statistical significance was set with a p value <0.05. The data analysis was performed using the statistical software SAS v9.1 (SAS Institute. Proprietary Software Release 9.1 TS Level 1M3. Cary, NC: SAS, 2002-2003) and Stata 9.2 (College Station, Texas, Stata Corp. 2006).

Results

The overall prevalence of anemia in ENSANUT 2006 for pregnant women was 20.2% (95% *CI* 15.9, 26.2%) and 15.5% for non-pregnant women (95% *CI*; 14.7, 16.4%). A reduction of 4.9 pp in the prevalence of anemia in non-pregnant women and of 4.5 pp in pregnant women from 1999 to 2006 was observed.

The prevalence of anemia for each survey in non-pregnant women is shown in Table I. In both surveys (ENN 99, and ENSANUT 2006), the prevalence of anemia increased with age and it was higher in pregnant than in non-pregnant women. The prevalence of anemia was 12 pp higher in women with a larger parity (> 5 children) than those with parity 0 (Table I). The prevalence of anemia increased as BMI increased in ENSANUT 2006 but not in ENN 99. Women living in the northern and southern regions and of indigenous ethnicity were the most affected by anemia in both surveys; reductions of about 5 pp were observed in these categories from 1999 to 2006.

Table II shows the mean concentrations of hemoglobin (g/dL) of women studied in both nutrition surveys, categorized by pregnant or non-pregnant status, geographical region and urban or rural dwelling. The hemoglobin concentration of non-pregnant women was more than 1 g/dL higher than that of pregnant women but no significant differences were observed between the overall and category-specific means of hemoglobin in 1999 and 2006.

Figure 1 shows the overall prevalence of anemia in non-pregnant women adjusted by socioeconomic profile for each survey. Although the prevalence of anemia was not different among surveys it tended to be lower in 2006 than in 1999 in the medium and low socioeconomic profiles. Comparisons within surveys showed a lower prevalence in the higher socioeconomic profile compared to the low in 1999. Such a difference vanished in 2006.

The prevalence of anemia by region adjusted by socioeconomic profile according to the year of the survey is presented in figure 2. In 2006, there was a reduction in the prevalence of anemia in all three profiles; however, it was not statistically significant.

Adjusted OR for adolescent women living in the northern and southern regions was higher than that of those living in Mexico City (p=0.05). Another risk factor was belonging to low socioeconomic level (p<0.06). For adult women, parity greater than three was a significant risk (p<0.05). Having indigenous ethnicity or being

Table I

PREVALENCE (%) OF ANEMIA* IN 12 TO 49 YEAR-OLD NON-PREGNANT WOMEN ACCORDING TO DIFFERENT CHARACTERISTICS. MEXICO, ENN 1999; ENSANUT 2006

	ENN 99				ENSANUT 2006			
	Sample (n)	N (Thousands)	Expansion %	CI95%	Sample (n)	N (Thousands) %	Expansion %	CI95%
Age (y)								
12 to 18	4 314	4 929.2	16.9	(15.5 , 18.4)	6 388	951.4	11.5	(10.4 , 12.8)
19 to 35	8 786	9 352.5	21.3	(20.1 , 22.5)	8 181	2 348.8	16.7	(15.3 , 18.2)
36 to 49	4 390	5 244.3	23.6	(22.1 , 25.2)	6 041	2 075.8	19.5	(17.8 , 21.3)
Parity (Num. children)								
0	6 378	7 606.5	16.3	(15.1 , 17.5)	9 423	1 812.3	12.5	(11.4 , 13.7)
1 to 2	4 291	5 315.5	22.7	(21.1 , 24.3)	4 219	1 376.8	17.5	(15.5 , 19.6)
3 toa 5	4 373	5 044.5	23.3	(21.7 , 25.0)	5 701	1 783.3	20.3	(18.7 , 22.1)
> 5	1 449	1 559.5	28.2	(25.5 , 31.1)	1 267	403.6	22.2	(19.0 , 25.8)
BMI (body/height^2)								
<18	238	178.9	18.8	(13.4 , 25.9)	877	109.4	8.8	(6.7 , 11.4)
18.0 to 24.9	6 451	6 153.9	22.3	(20.9 , 23.8)	8231	1 906.9	14.8	(13.6 , 16.1)
25 to 29.9	4 158	5 811.5	18.7	(17.3 , 20.3)	6266	1 860.1	18.0	(16.3 , 19.9)
>=30	3 041	4 579.9	20.6	(19.0 , 22.2)	5133	1 465.4	17.5	(15.8 , 19.3)
Area								
Urban	10 282	14 369.3	20.2	(19.1 , 21.2)	14 500	4 140.6	16.2	(15.2 , 17.3)
Rural	6 209	5 156.7	22.6	(21.0 , 24.2)	6110	1 235.4	16.6	(15.2 , 18.2)
Region								
Northern	5 059	3 838.2	20.9	(19.2 , 22.7)	4309	1 055.6	16.7	(15.1 , 18.4)
Center	4 644	6 013.5	20.6	(19.1 , 22.2)	7813	1 700.9	16.5	(15.1 , 18.1)
Mexico City	1 539	3 186.0	16.4	(14.1 , 18.9)	835	820.9	13.6	(10.9 , 16.8)
Southern	5 249	6 488.3	23.1	(21.6 , 24.7)	7653	1 798.4	17.4	(16.1 , 18.7)
Indigenous								
Non indigenous	15 010	17 831.1	20.4	(19.5 , 21.3)	19 066	4 994.6	16.2	(15.3 , 17.2)
Indigenous	1 480	1 694.9	24.8	(22.2 , 27.5)	1536	381.4	17.6	(15.1 , 20.3)

* Pregnant women <11 g/dL. Non-pregnant women <12 g/dL (sea level)

beneficiary of food distribution programs was not associated with anemia (Table III).

Discussion

Anemia in women of reproductive age continues to be a public health problem in Mexico, although of medium importance according to the WHO grading of the prevalence of anemia in non-pregnant (medium= 5 - 19.9%) and pregnant women (>20).[21] In this period (1999-2006), there was a 5.6 pp decrease for non-pregnant and 4.5 pp for pregnant women. If the changes between 1999 and 2006 continue at the same pace, 8.4 and 9.6 years would be needed to reduce the prevalence of anemia of non-pregnant and pregnant women, respectively, to acceptable rates (<5.0%).[22]

When adjusting the information from both surveys according to socioeconomic profile, we found that the southern region shows a severe anemia prevalence regardless of the period observed. This fact must be kept in sight since this region concentrates a high proportion of indigenous population with the least economic

Table II
MEAN AND 95% CONFIDENCE INTERVAL OF HEMOGLOBIN (G/DL) IN WOMEN 12 TO 49 YEARS OLD ACCORDING TO PHYSIOLOGICAL CONDITION BY REGION AND NATIONALLY. MEXICO, ENN 1999; ENSANUT 2006

Region	ENN 99				ENSANUT 06			
	Sample Number	Expansion			Sample Number	Expansion		
		Number (Thousands)	Mean	CI95%		Number (Thousands)	Mean	CI95%
Pregnant								
Northern	207	157.2	11.9	11.6 a 12.1	114	197.8	12.2	11.9 a 12.5
Center	210	277.4	12.4	12.2 a 12.7	199	251.2	12.5	12.3 a 12.8
Mexico City	58	134.8	12.6	12.1 a 13.1	19	131.4	12.7	11.9 a 13.9
Southern	219	271.2	12.0	11.8 a 12.2	193	278.4	12.3	12.0 a 12.6
Rural	300	253.3	12.2	12.0 a 12.4	166	203.7	12.4	12.1 a 12.7
Urban	394	587.3	12.2	12.0 a 12.4	359	655.2	12.4	12.2 a 12.6
National	694	840.6	12.2	12.1 a 12.3	525	858.8	12.4	12.2 a 12.6
Non -pregnant								
Northern	5050	3819.6	13.1	13.0 a 13.1	4307	6307.3	13.3	13.3 a 13.4
Center	4635	6048.3	13.6	15.5 a 13.6	7793	10271.4	13.9	13.8 a 14.0
Mexico City	1535	3160.8	14.0	13.9 a 14.1	825	5995.2	14.6	14.4 a 14.8
Southern	5234	6497.9	13.2	13.1 a 13.2	7641	10323.1	13.6	13.5 a 13.7
Rural	6202	5155.9	13.3	13.2 a 13.3	6090	7415.7	13.8	13.7 a 14.0
Urban	10252	14370.8	13.4	13.4 a 13.5	14469	25479.7	13.8	13.8 a 13.9
National	16454	19526.7	13.4	13.37 a 13.4	20566	32897.0	13.8	13.8 a 13.9

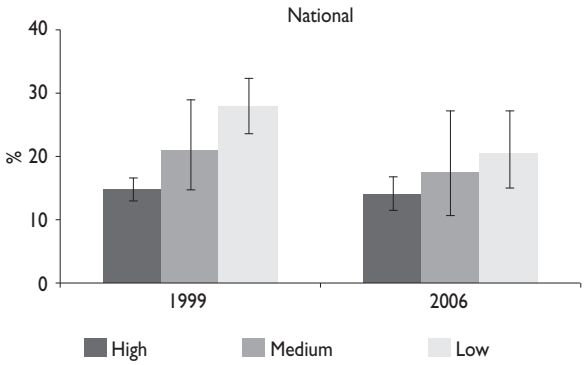

FIGURE 1. NATIONAL PREVALENCE OF ANEMIA IN WOMEN BY SOCIOECONOMIC PROFILE AND YEAR OF SURVEY

opportunities and the worst life standards.[23] Also to be noticed are the consistently high prevalences of anemia in women in the northern region where the population with the highest socioeconomic profile concentrates (Figure 2). This can be a result of such variables as age, sex, kind of diet, frequency and intensity of acute recurrent infections, the existence of chronic inflammatory processes[20] or other nutritional deficiencies such as folate or vitamin A or B12.[24] Similar prevalences can be found among women in small towns in the northern region as is the case in the Tarahumara area where anemia prevalence was 16.1% (mean of hemoglobin concentration 140±16 g/l) and 25.7% (129±12 g/l) for non-pregnant and pregnant women, respectively.[25]

It has been documented that demographic indicators such as age, number of children, parity and education were associated with iron deficiency or anemia[26] and there was an association between education and increasing meat intake.[27] This suggests better-educated women can afford, or make it a priority to include meat in their diet.[28]

It is also possible to suppose that factors other than socioeconomic profile contribute importantly to the presence of anemia (Figure 1).

These results suggest that priority should be given to cure anemia in pregnant women since 1 out of 5 women suffer from it, not only because of its deleteri-

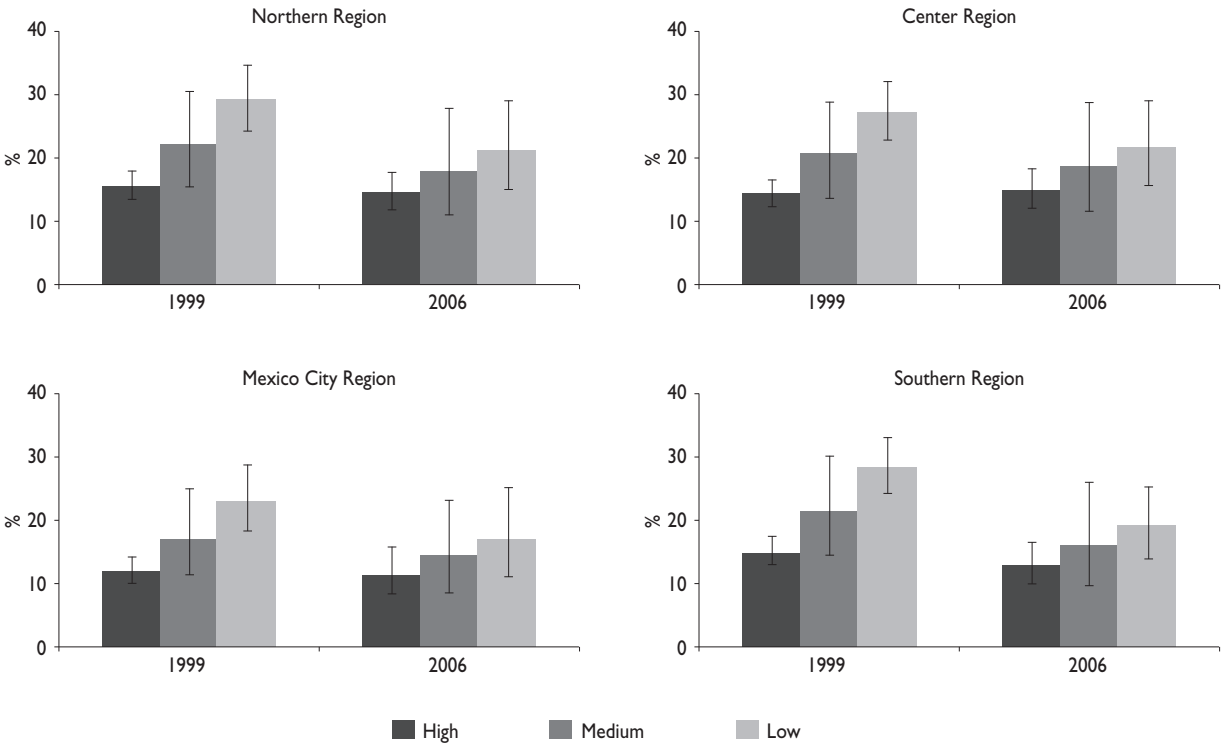

FIGURE 2. PREVALENCE OF ANEMIA IN WOMEN BY SOCIOECONOMIC PROFILE, REGION AND YEAR OF SURVEY. MEXICO, ENN 1999; ENSANUT 2006

ous effects on the maternal body but also because of the grave repercussions for their neonates.[29-30]

In several countries worldwide, various iron supplementation programs have been enacted to reduce anemia in pregnant and breastfeeding women. However, most of these programs have not been successful due in many instances to late intervention during pregnancy.[31,32] In addition, one of the main problems is low compliance with iron supplementation.[33,34] In the case of small children, an age when iron deficiency anemia is also highly prevalent, few countries have large scale programs to reduce and control anemia. As a result of the latter two situations an unchanged worldwide prevalence of anemia has been maintained for the past 15 years.[35]

An important proportion of the cases with anemia is not exclusively due to iron deficiency; deficiencies of other hemopoietic micronutrients such as folate, vitamin B12 and vitamin A are associated with anemia. If the actual goal of public health programs is to control anemia, then the problem can not be tackled simply aiming to reduce iron deficiency. In a randomized controlled study carried out in rural Nepal; women were treated with either: a) folic acid, b) folic acid with iron, c) folic acid with iron, zinc and other 11 micronutrients or vitamin A. Women receiving folic acid and iron had the highest hemoglobin concentration at the end of the trial.[36]

The association of higher prevalence of anemia with parity suggests a progressive depletion of iron stores during successive pregnancies without an adequate recovery, thus multiparous women had a greater risk for anemia than primiparous women.[37,38]

It has been documented that iron deficiency anemia is a serious public health problem, especially for women and small children, causing negative consequences on human capital for a country. Based on that evidence, goals to fight anemia have been established at international, national and local levels. Such strategies include actions aimed to increase, for the whole population, the supply, access and intake of quality foods, along with programs to supplement and fortify food with iron.[39]

Consistent and updated information have been produced in Mexico to quantify the prevalence and distribution of anemia in women of reproductive age. Nearly three-fourths of the research published are of descriptive nature; more recently, a handful of clinical trials

Table III

LOGISTIC REGRESSION MODEL FOR ANEMIA,§ CONSIDERING COMPLEX SAMPLING VARIANCE AMONG ADOLESCENT AND ADULT NON-PREGNANT WOMEN IN A NATIONAL PROBABILISTIC SAMPLE. MEXICO, ENN 1999; ENSANUT 2006

	Adolescent women		*Adult women*	
	OR	*[CI 95%]*	*OR*	*[CI 95%]*
Parity				
<3 children	-	-	1.3	0.9 to 1.6
3 to 5 children	-	-	1.5*	1.2 to 1.9
> 5 children	-	-	1.6*	1.2 to 2.2
BMI (kg/m^2)	-	-	0.9	0.9 to 1.0
Age at menarche	1.0	0.9 to 1.1	-	-
Height	0.9	0.9 to 1.0	-	-
Socioeconomic level				
Low	1.4‡	1.1 to 1.9	1.1	0.9 to 1.4
Medium	1.2	0.9 to 1.6	1.2	0.9 to 1.4
Region				
Northern	1.3*	1.1 to 1.8	0.9	0.8 to 1.1
Center	1.0	0.6 to 1.7	0.7	0.5 to 1.0
Southern	1.7*	1.3 to 2.3	0.9	0.7 to 1.0
Urban	1.2	0.9 to 1.5	1.1	0.9 to 1.3
Indigenous	0.7	0.5 to 1.2	1.0	0.8 to 1.3
Beneficiary programs				
Oportunidades	0.9	0.7 to 1.4	1.0	0.8 to 1.3
Liconsa	0.5	0.2 to 1.5	1.2	0.7 to 2.2
Other Food Programs	1.2	0.9 to 1.6	0.9	0.8 to 1.2

* $p < 0.05$
‡ $p = 0.06$
§ < 12 g/dL (sea level)

have evaluated the efficacy and effectiveness of public nutrition programs, demonstrating variable success of the interventions.[10] However, the reduction of 0.7 pp in the prevalence of anemia from 1999 to 2006 suggests a positive impact of massive nutritional supplementation programs directed to highly vulnerable populations living in extreme poverty. This is the case of *Oportunidades* which provides 21.2% of pregnant women with anemia with a fortified beverage (ENSANUT 2006)[40] and *Arranque Parejo en la Vida* which distributes a multi-mineral and vitamin supplement; their impact, however, has not yet been documented.

In Mexico, economic indicators have not changed with respect to the percentage of people who live in nutritional poverty, according to GINI's index of indicators of nutrition status.* Also, the use of the contraceptive methods for the prevention of the pregnancy does not show variation over the past decades, specifically in the use of intrauterine devices (≈ 20%) that could generate bleeding in women.[41,42]

Regardless of the progress achieved in reducing anemia in women of reproductive age, the problem is far from being resolved. Process evaluation research of programs is needed to improve their effectiveness. Moreover, it is necessary to study and evaluate new strategies for the supplementation and fortification of food with micronutrients to fight anemia in women. Targeted screening and interventions to improve and strengthen effectiveness of interventions such as diet and compliance with iron supplementation are warranted for this at-risk group and developing stronger political commitments on the part of national and international agencies to enhance coverage of effective interventions is urged. Furthermore, it is essential to consider a strong educational strategy among the population that receives food and benefits from nutrition programs.

References

1. Trowbridge F, Martorell R. Summary and recommendations. Supplement: Forging Effective Strategies to Combat Iron Deficiency. J Nutr 2002;132:875S-879S.
2. WHO/UNICEF/UNU. Iron deficiency anaemia: assessment, prevention, and control. Geneva: World Health Organization, 2001 (WHO/NHD/01.3).
3. Stoltzfus RJ. Iron-deficiency anemia: reexamining the nature and magnitude of the public health problem. Summary: implications for research and programs. J Nutr 2001;131:697S-701S.
4. Haas JD, Brownlie IVT. Iron deficiency and reduced work capacity: a critical review of the research to determine a causal relationship. J Nutr 2001;131:676S-690S.
5. Stoltzfus RJ. Defining iron deficiency anemia in public health terms: a time for reflection. J Nutr 2001;131:565S-567S.
6. Brabin BJ, Hakimi M, Pelletier D. An analysis of anemia and pregnancy-related maternal mortality. J Nutr 2001;131:604S-615S.
7. Brabin BJ, Premji Z, Verhoeff F. An analysis of anemia and child mortality. J Nutr 2001;131:636S-648S.
8. International Nutritional Anemia Consultative Group (INACG). Anemia Prevention and Control: What works? Part I. Program Guidance. Washington, DC: USAID, The World Bank, UNICEF, PAHO, FAO, The Micronutrient Initiative, 2003.
9. International Nutritional Anemia Consultative Group (INACG). Anemia Prevention and Control: What works? Part II. Tools and Resources. Washington, DC: USAID, The World Bank, UNICEF, PAHO, FAO, The Micronutrient Initiative, 2003.

* CONEVAL. http://www.coneval.gob.mx.

10. Casanueva E, De Regil LM, Flores-Campuzano MF. Anemia por deficiencia de hierro en mujeres mexicanas en edad reproductiva. Historia de un problema no resuelto. Salud Publica Mex 2006;48:166-175.
11. Martínez H, González-Cossío T, Flores M, Rivera-Domarco J, Lezana MA, Sepúlveda-Amor J. Anemia en mujeres de edad reproductiva. Resultados de una encuesta probabilística nacional. Salud Publica Mex 1995;37:108-119.
12. Shamah-Levy T, Villalpando S, Rivera JA, Mejia-Rodriguez F, Camacho-Cisneros M, Monterrubio EA. Anemia en mujeres mexicanas. Un problema de salud pública. Salud Publica Mex 2003;45 suppl 4:S499-S507.
13. Resano-Pérez E, Méndez-Ramírez I, Shamah-Levy T, Rivera JA, Sepúlveda-Amor J. Methods of the Nacional Nutrition Survey 1999. Salud Publica Mex 2003;45 Suppl 4:S558-S564.
14. Palma O, Shamah T, Franco A, Olaiz G, Méndez I. Metodología. In: Encuesta Nacional de Salud y Nutrición (ENSANUT-2006). Cuernavaca, Mexico: Instituto Nacional de Salud Pública, 2006:19-33.
15. World Health Organization. The prevalence of anemia in women: a tabulation of available information. 2nd edition. Ginebra: WHO, 1992.
16. Cohen JH, Hass JD. Hemoglobin correction factors for estimating the prevalence of iron deficiency anemia in pregnant women residing at high altitudes in Bolivia. Pan Am J Public Health 1999;6(6):392-399.
17. Rush D. Nutrition and maternal mortality in developing world. Am J Clin Nutr 2000;72 Suppl:212S-240S.
18. Yip R. Significance of an abnormally low or high hemoglobin concentration during pregnancy: special consideration of iron nutrition. Am J Clin Nutr 2000;72 Suppl:272S-279S.
19. Lohman T, Roche A, Martorell R. Anthropometric standarization reference manual. Champlaign (IL): Human Kinetics, 1988.
20. Habicht JP. Estandarización de métodos epidemiológicos cuantitativos sobre el terreno (Standardization of anthropometric methods in the field). PAHO Bull 1974;76:375-384.
21. World Health Organization and Food and Agriculture Organization of the United Nations. Guidelines on food fortification with micronutrients. France: WHO/FAO, 2006: 47.
22. Olaiz-Fernández G, Rivera-Dommarco J, Shamah-Levy T, Rojas R, Villalpando-Hernández S, Hernández-Avila M, *et al*. Encuesta Nacional de Salud y Nutrición 2006. Cuernavaca, México: Instituto Nacional de Salud Pública, 2006.
23. Consejo Nacional de Evaluación de la Política de Desarrollo Social. CONEVAL. Los Mapas de Pobreza en México. México, julio 2007.
24. Suharno D, West CE, Muhilal, Karyadi D, Hautvast JG. Supplementation with vitamin A and iron for nutritional anaemia in pregnant women in West Java, Indonesia. Lancet 1993;342:1325-1328.
25. Monárrez-Espino J, Martínez H, Greiner T. Iron deficiency anemia in reproductive-age Tarahumara women of Northern Mexico. Salud Publica Mex 2001;43:392-401.
26. Iannotti LL, O'Brien KO, Chang SCh, Mancini J, Schulman-Nathanson M, Liu Sh, *et al*. Iron Deficiency Anemia and Depleted Body Iron Reserves Are Prevalent among Pregnant African-American Adolescents. J Nutr 2005;135:2572-2577.
27. Pasricha Sant-Rayn, Caruana SR, Phuc TQ, Casey GJ, Jolley D, Kingsland S, *et al*. Anemia, Iron Deficiency, Meat Consumption, and Hookworm Infection in Women of Reproductive Age in Northwest Vietnam. Am J Trop Med Hyg 2008;78(3):375-381.
28. Nguyen PH, Nguyen KC, Le Mai B, Nguyen TV, Ha KH, Bern C, *et al*. Risk factors for anemia in Vietnam. Southeast Asian J Trop Med Public Health 2006;37:1213-1223.
29. Sanghvi T, RossJ, Heymann H. Why is reducing vitamin and mineral deficiencies critical for development? The links between VMDs and survival, health, education, and productivity. Food Nut Bull 2007;28(1) Suppl:S167- S173.
30. Stoltzfus RM, Mullany L, Black RE. Iron deficiency anaemia. In: Comparative Quantification of Health Risks: The Global and Regional Burden of Disease due to 25 Selected Major Risk Factors. Cambridge (MA): World Health Organization/Harvard University Press, 2004.
31. Scanlon K, Yip R, Schieve L, Cogswell M. High and Low Hemoglobin Levels During Pregnancy: Differential Risks for Preterm Birth and Small for Gestational Age. Obstet Gynecol 2000;96:741-748.
32. Scholl T. Iron status during pregnancy: setting the stage for mother and infant. Am J Clin Nutr 2005;81:1218S-1222S.
33. Schultink W, Ree M, Matulessi P, Gross R. Low compliance with an iron-supplementation program: a study among pregnant women in Jakarta, Indonesia. Am J Clin Nutr 1993;57:135-139.
34. Allen LH. Nutritional supplementation for the pregnant woman. Clin Obstet Gynecol 1994;37:587-595.
35. Mason J, Rivers J, Helwig C. Recent Trends in Malnutrition in Developing Regions: Vitamin A deficiency, anemia, iodine deficiency, and child underweight. Food Nutr Bull 2005;26:28-34.
36. International Nutritional Anemia Consultative Group. INACG Symposium. Why iron is important and what to do about it: a new perspective. Washington, DC: International Life Sciences Institute Research Foundation, Human Nutrition Institute, INACG, 2002 Mar. 50 p.
37. Christian P, Shrestha J, LeClerq SC, Khatry SK, Jiang T, Wagner T, *et al*. Supplementation with Micronutrients in Addition to Iron and Folic Acid Does Not Further Improve the Hematologic Status of Pregnant Women in Rural Nepal. J Nutr 2003;133:3492-3498.
38. Diallo MS, Diallo TS, Diallo FB, Diallo Y, Camara AY, Onivogui G, *et al*. Anemia and pregnancy: epidemiologic, clinical and prognostic study at the university clinic of the Ignace Deen Hospital, Conakry (Guinée). Rev Fr Gynecol Obstet 1995;90:138-141.
39. Brunvand L, Henriksen C, Larsson M, Sandberg. AS. Iron deficiency among pregnant Pakistanis in Norway and the content of phyticacid in their diet. Acta obstet Gynecol Scand 1995;74:520-525.
40. Rivera-Dommarco J, Shamah-Levy T, Villalpando-Hernández S. Versión final del segundo documento técnico de resultados. Comparación en beneficiarios y no beneficiarios del programa Oportunidades. Cuernavaca, Morelos: Instituto Nacional de Salud Pública, 2006:67-68.
41. Last updated 2001, Mexico. OPS, OMS. [Consulted October 7, 2008]. Available at: http://www.paho.org/Spanish/SHA/prflMEX.htm.
42. Velasco-Murillo V, Padilla I, de la Cruz L, Acosta-Cazares B. Salud Reproductiva, 2003. Rev Med Inst Mex Seguro Soc 2006;44 suppl 1: S87-S95.