Low prevalence of iron deficiency anemia between 1981 and 2010 in Chilean women of childbearing age

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Abstract

Objective. To determine the prevalence of anemia and iron status among Chilean women of childbearing age between 1981 and 2010. **Materials and methods**. Calculation of the prevalence of anemia and iron status was based on multiple cross-sectional iron absorption studies performed in 888 women during this period of time. All studies included measurements of hemoglobin, mean corpuscular volume, zinc protoporphyrin, percentage of transferrin saturation and serum ferritin. Data were grouped by decade (1981-1990, 1991-2000, and 2001-2010). **Results.** Prevalence of anemia for these decades was 9, 6 and 10%, respectively (p=NS). Iron deficiency anemia was the main cause of anemia in all periods (55, 85 and 75%, respectively; p=NS). A high prevalence of women with normal iron status was observed for all periods (64, 69, and 67, respectively; p=NS). Prevalence of iron deficiency without anemia in 1981-1990, 1991-2000 and 2001-2010 was 7, 20 and 12%, respectively (p<0.05). Finally, prevalence of iron depleted stores was 20, 6 and 10%, respectively (p<0.05). **Conclusions.** Prevalence of iron deficiency anemia in Chilean women of childbearing age was mild between 1981 and 2010. More than 60% of childbearing age women presented normal iron status in all periods. However, prevalence of iron depleted stores was moderate during 1981-1990, and was mild during 1991-2000 and 2001-2010.

Key words: Prevalence; anemia; iron; iron deficiency; Chile

Ríos-Castillo I, Brito A, Olivares M, López-de Romaña D, Pizarro F. Baja prevalencia de anemia por deficiencia de hierro entre 1981 y 2010 en mujeres chilenas en edad fértil. Salud Publica Mex 2013;55:478-483.

Resumen

Objetivo. Determinar la prevalencia de anemia y el estado de nutrición de hierro entre 1981 y 2010 en mujeres chilenas en edad fértil. **Material y métodos**. La prevalencia de anemia y el estado de nutrición de hierro fueron calculados con base en múltiples estudios transversales de absorción de hierro realizados en 888 mujeres. Estos estudios incluían medición de hemoglobina, volumen corpuscular medio, zinc protoporfirina, porcentaje de saturación de transferrina y ferritina sérica. Los datos fueron agrupados por décadas (1981-1990, 1991-2000, y 2001-2010). **Resultados**. La prevalencia de anemia para estas décadas fue de 9, 6 y 10%, respectivamente (p=NS). La anemia por deficiencia de hierro fue la principal causa de anemia en los periodos evaluados (55, 85 y 75%, respectivamente; p=NS). Una alta prevalencia de mujeres con estado de nutrición normal de hierro fue observado en todos los periodos (64, 69, y 67%, respectivamente; p=NS). La prevalencia de deficiencia de hierro sin anemia fue de 7, 20 y 12%, respectivamente (p<0.05). Finalmente, la prevalencia de depleción de depósitos de hierro fue de 20, 6 y 10%, respectivamente (p<0.05). **Conclusiones.** La prevalencia de anemia por deficiencia de hierro en mujeres chilenas en edad fértil clasifica como leve entre 1981 y 2010. Más de 60% de las mujeres en edad fértil presentó estado nutricional normal de hierro en todos los periodos. Sin embargo, la depleción de depósitos de hierro fue moderada durante 1981-1990, y fue leve durante 1991-2000 y 2001-2010.

Palabras clave: prevalencia; anemia; hierro; deficiencia de hierro; Chile

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Anemia is a condition that is characterized by a reduction in the oxygen carrying capacity of hemoglobin (Hb).[1] Iron deficiency (ID) is the most common cause of anemia and most prevalent nutritional deficiency worldwide, affecting primarily infants, young children and women of childbearing age.[2-5] Anemia can also be caused by folate and vitamin B12 deficiencies, hematological disorders, inflammation and/or infections.[6,7] ID adversely affects the cognitive development of children, increases maternal and infant mortality, and reduces physical work capacity in adulthood.[8-13]

ID occurs in stages. First, there is a depletion of Fe stores, characterized biochemically by low levels of serum ferritin (SF). Secondly, the Fe supply to different tissues is reduced, a process characterized by increased levels of transferrin receptors, Zn protoporphyrin (Znpp), and a decrease in transferrin saturation (TS). Finally, the last and more severe stage is a reduction of Hb concentration below normal level.[14]

In Chile, there are representative studies that have evaluated the prevalence of anemia and Fe status in different risk groups, including pregnant women, infants and young children, using the aforementioned biomarkers.[15-18] However, few studies have assessed the prevalence of anemia and iron deficiency anemia (IDA) in women of childbearing age. According to the 2003 Chilean Health Survey, the prevalence of anemia in women ≥17 years old was 5.1%, (mean Hb 137±4 g/L).[19]

In the present article we assessed the prevalence of anemia and Fe status between 1981 and 2010 of Chilean women of childbearing age using data from multiple cross-sectional samples. This study has potential implications for public health policy, especially for the micronutrient fortification of wheat flour in Chile.

Materials and methods

Multiple cross-sectional studies were performed between 1981 and 2010 in women of childbearing age recruited from an urban, low-income area of south-east Santiago. The main goal of these studies was to evaluate Fe absorption in women with normal body mass index (18.5–24.9 kg/m^2). Recruitment was done from non-random convenience samples. Overall, a total number of 1 880 women aged 16 to 56 years were invited to these studies and of these, 888 women were selected for the present analysis. Only women with the following criteria were included in the analysis: women of childbearing age (20 to 49 years of age), without illness at the time of visit (except for those with anemia defined as Hb < 120 g/L), non-pregnant and who at the time of study did not want to be pregnant (with a negative pregnant test result prior to the start of the study), non-breastfeeding, not using Fe supplements or medications, not postmenopausal and not participating in other clinical studies.

Hemoglobin and iron status assessment

Ten milliliters of venous blood samples were obtained after an overnight fast. Hb and mean corpuscular volume (MCV) were assessed with a hematology analyzer (Coulter model, ZBI or CELL-DYN 1700). TS was determined by the method of Fischer and Price[20] and Znpp was measured with a hematofluorometer (AVIV model ZPP 206d). SF was determined using an enzyme-linked immunosorbent assay (ELISA), according to the International Anemia Consultative Group.[21]

Anemia was defined as Hb below 120 g/L and IDA as Hb below normal plus ≥2 abnormal laboratory measurements (MCV <80 fL, SF <15 μg/L or TS <15%).[21] Iron deficiency without anemia (IDWA) was defined as normal Hb plus ≥2 abnormal laboratory results; depleted Fe stores (DIS) was defined as SF <15 μg/L. Fe status was considered to be normal when all of these laboratory indexes were within the reference range.[21,22] The prevalence of anemia and Fe status was grouped in three decades (1981-1990, 1991-2000, and 2001-2010) due to possible differences as a result of changes in the epidemiological profile in Chile.[23]

Ethical approval

All studies were approved by the Ethical Committee at the Institute of Nutrition and Food Technology (INTA), University of Chile before their execution, in accordance with the Helsinki Declaration and the Nuremberg code. All women participated voluntarily after reading and signing a written informed consent.

Statistical analysis

Data obtained in different periods were assessed using analysis of variance (ANOVA) to compare continuous data and Chi-square tests to compare prevalence across decades. A significance level <0.05 was used for all statistical tests. The distributions of SF and Znpp concentration were skewed; therefore were log-transformed. The results were then retransformed into antilogarithms to recover the original units and are presented as geometric means and range ± 1 SD. All statistical analyses were performed with STATA, version 10.1.

Results

The mean age of the subjects was 39±5 years. Mean Hb concentrations were within the normal range in all peri-

ods assessed. However, the mean Hb during 1991-2000 was significantly higher than both 1981-1990 and 2001-2010 (139±13 g/L vs 136±14 g/L and 134±13 g/L, respectively; ANOVA F=11.0; $p<0.001$). No data for MCV and Znpp was available between 1981 and 1990. However, there were no differences in MCV between 1991-2000 and 2001-2010 (87±6 fL vs. 87±6 fL, F=0.01. NS). The geometric mean (range of ±1SD) of Znpp was significantly lower during the decade of 2001-2010 than that for the decade of 1991-2000 [65 (45-95) vs. 73 (51-106) µg/dL RBC, respectively; F=15.2; $p<0.001$)]. There were no significant differences in SF or TS between periods (table I).

The prevalence of anemia was low in all decades, without significant differences across decades, being 9, 6 and 10% for periods 1981-1990, 1991-2000 and 2001-2010, respectively ($Chi^2= 5.1$; $p=$ NS). The prevalence of IDA was also low, reaching 5, 5, and 8%, respectively ($Chi^2=4.2$; $p=$ N.S). Nevertheless, ID was the most frequent cause of anemia in all periods assessed (55, 85 and 75%, respectively; $Chi^2=4.0$; p=NS). The prevalence of IDWA was 7, 20 and 12%, respectively ($Chi^2=19.1$; $p<0.05$). The frequency of DIS was 20, 6 and 10%, respectively ($Chi^2=25.0$; $p<0.05$). Finally, a high frequency of women with normal Fe status was observed for the three decades (64, 69, and 67%, respectively; $Chi^2= 1.0$; $p=$ NS) (figure 1).

Discussion

The present article shows that the prevalence of IDA in Chilean women of childbearing age was low between 1981 and 2010. Although ID was the main cause of anemia, a high proportion of women (more than 60%) presented normal Fe status. The prevalence of IDWA was mild during 1981-1990 and 2001-2010, but moderate during 1991-2000.[24] Although the data was obtained from non-representative studies, the results are consistent with the only national representative sample for this age group in Chile.[19]

Data from the 2003 national health survey showed that the prevalence of anemia in women ≥17 years old was 5.1%, (mean Hb 137±4 g/L).[19] The percentage increased to 7.8% in women of low socioeconomic status. The prevalence of anemia in the current study is comparable with the results found in the national survey. On the other hand, the national survey did not include an evaluation of Fe status. According to the category of public health significance proposed by the WHO 2001, the prevalence of anemia in women of childbearing age in Chile could be defined as a mild public health problem.[24]

The prevalence of anemia in Latin America and the Caribbean (LAC) in women of childbearing age is close to 19 and 49%, respectively.[25] The prevalence of anemia reported in the present article is much lower to the aforementioned data and is more similar to that observed in developed countries. For example, the prevalence of anemia in the United States between 1999 and 2002 was 6.9%.[26] However, in our study the prevalence of IDWA and DIS was relatively high. An explanation could be that Fe ingested from food was not sufficient to increase iron stores.

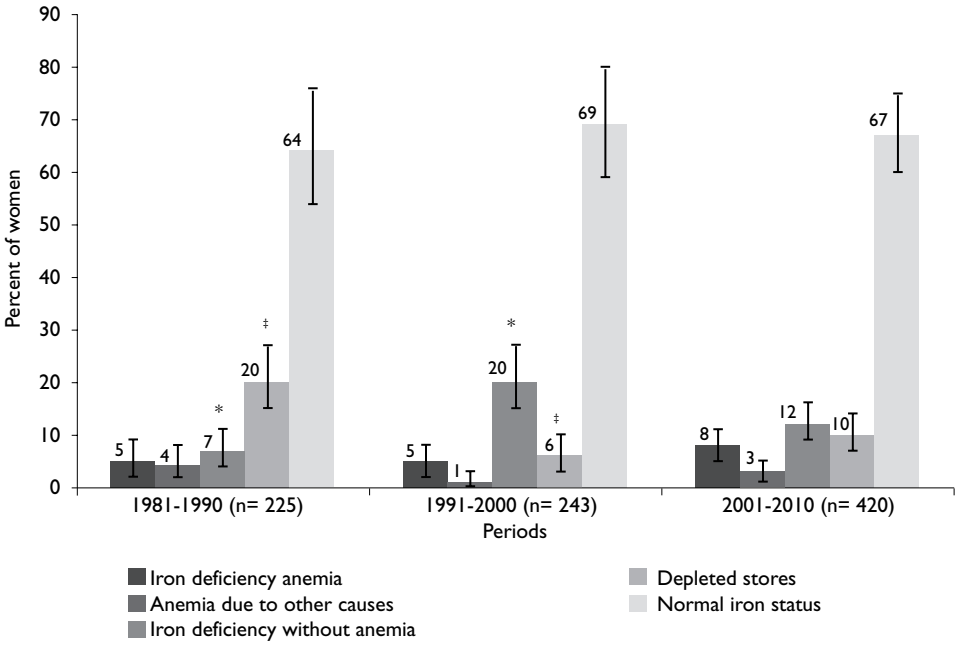
The prevalence of anemia in middle and low-income countries in LAC, as evaluated by national health surveys, has changed over time. The most significant reductions can be seen in Peru, Nicaragua, El Salvador and Guatemala. In contrast, in Bolivia, Colombia and Panama the prevalence of anemia in women of childbearing age has increased.[25] In Mexico, a country with a similar economic situation to Chile, the prevalence

Table I
Iron biomarkers in Chilean women of childbearing age between 1981 and 2010, by decade

	1981-1990	*1991-2000*	*2001-2010*	*F*	*p*
n	225	243	420		
Hemoglobin (g/L)	136±14[a]	139±13[b]	134±13[a]	10.96	<0.001
Mean corpuscular volume (fL)	NA	87±6	87±6	0.01	NS
Zinc protophorphyrin (µg/dL RBC) *	NA	73 (51-106)[a]	65 (45-95)[b]	15.25	<0.001
Transferrin saturation (%)	24.7±10.9	25.2±9.9	25.2±11.5	0.20	NS
Serum ferritin (µg/L) *	22 (9-55)	23 (9-56)	20 (9-47)	1.57	NS

* Values present as geometric mean (range of ±1 SD)

Analysis of variance and Bonferroni tests
Values presented as mean (SD)
NA= not available



* Significant difference ($p<0.05$) in iron deficiency without anemia in 1981-1990 in comparison with 1991-2000
‡ Significant difference ($p<0.05$) in depleted iron stores in 1981-1990 in comparison with 1991-2000

Data presented as percentage (CI95%)

FIGURE 1. PREVALENCE OF ANEMIA AND IRON STATUS IN CHILEAN WOMEN OF CHILDBEARING AGE BETWEEN 1981 TO 2010, BY DECADE

of anemia in women of reproductive age continues to be a medium public health problem according to the WHO.[27] The present article shows that the prevalence of anemia in Chile is low and has remained stable for the last three decades.

The low prevalence of anemia observed in this study is likely the result of an adequate policy of mandatory Fe fortification of wheat flour in Chile. This program began in 1951 with the incorporation of B vitamins (niacin, riboflavin, and thiamin) together with an iron-calcium premix that was the only one available at that time. In 1967 the Fe in the premix was changed to ferrous sulfate (30 mg Fe/Kg) without calcium, which resulted in an increase in the bioavailability of Fe. In January 2000, folic acid (2.2 mg/Kg) was also incorporated into the national flour fortification normative.[28-30] The success of this program is therefore a consequence of a high consumption of fortified bread by the majority of the Chilean population.[31,32] Peña *et al* in 1990 observed that 100 g of bread had 2.4 mg of Fe, and that 71% of bakeries were using wheat flour that had adequate Fe content. Therefore, the current study showed that compliance with the relevant legal standards has improved the Fe status of the Chilean population. Furthermore, other success factors are the high bioavailability of Fe in the premix, the low content of inhibitory elements of Fe absorption in the Chilean diet, the monitoring and evaluation system and the sustainability of this intervention, obtained through political awareness.[33]

Chile has undergone an epidemiological, economical and nutritional transition, which has modified both feeding and physical activity patterns, thus increasing the rates of overweight and obesity in all age groups.[34,35] Several strategies have been implemented, such as the reduction of high-density energy food intake. The consumption of bread could be reduced as a result of these strategies and as a result the prevalence of anemia and IDA could increase in the medium to long term. While wheat fortification has had success in Chile in reducing and sustaining comparatively low levels of Fe deficiency, high consumption of bread can lead to obesity. Therefore, comprehensive nutritional interventions that advocate dietary diversification should be promoted throughout Chile, with a special emphasis on poor areas.

On the other hand, Hb screening, in some cases with SF, is the most widespread method used by LAC countries to determine the prevalence of anemia and ID. However, anemia is the manifestation of the most severe form of ID.[36] In this study, we evaluated different categories of Fe status, using five iron-related tests (Hb, MCV, Znpp, TS and SF). Our findings are relevant for the decision and reevaluation of the current public policy in other countries in LAC.

The present study was not conducted using a nationally-representative or probabilistic sample, therefore it is possible that the differences in the prevalence of IDWA and IDS were due to systematic bias as a result of non-representative sampling. However, the prevalence of anemia and Fe status remained constant during the last three decades and these results are in accord with the only national survey in this age group.[17]

Conclusion

Chilean childbearing age women from a low-income rural location in Santiago had a low prevalence of IDA between 1981 and 2010. More than 60% presented normal Fe status in all periods. However, DIS was moderate during 1981-1990, and was mild during 1991-2000 and 2001-2010.

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Declaration of conflict of interests. The authors declare that they have no conflict of interests.

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