Anemia and iron deficiency in Mexican elderly population. Results from the Ensanut 2012

Alejandra Contreras-Manzano, Sc,(1) Vanessa de la Cruz, Sc,(1) Salvador Villalpando, MD, PhD,(1) Rosario Rebollar, Tec Lab, (1) Teresa Shamah-Levy, PhD,(1)

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Abstract

Objective. To describe the prevalence of iron deficiency (ID) and anemia in a sample of Mexican elderly population from the National Health and Nutrition Survey (Ensanut) 2012. Materials and methods. 1 920 subjects ≥60 years of age were included. Hemoglobin, serum concentrations of ferritin and CRP were measured. The risk for ID and anemia adjusted for potential confounders was assessed in logistic regression models. Results. The overall prevalence of anemia was 13.9%, 15.2% in males and 12.8% females. For ID, overall it was 4.2%, males 4.0% and females 4.3%. The greatest prevalence of ID was found in males and females over 80 years old (6.9 and 7.0%, respectively). ID was present in 1.5 of 10 Mexican elders with anemia. Conclusion. The prevalence of anemia was high in the elderly, however the prevalence of ID was low; there is a need to further investigate the causes of anemia in this age group.

Key words: iron deficiency; anemia; elderly

Resumen

Objetivo. describir la prevalencia de deficiencia de hierro (DH) y anemia en adultos mayores (AM) mexicanos participantes de la Encuesta Nacional de Salud y Nutrición 2012. Material y métodos. 1 920 sujetos ≥ 60 años fueron incluidos. Se midió hemoglobina, concentraciones séricas de ferritina y PCR. El riesgo de DH y anemia ajustada por confusores fueron evaluados por medio de modelos de regresión logística. Resultados. La prevalencia de anemia fue 13.9% (15.2% hombres, 12.8% mujeres) y de DH 4.2%, (4.0% hombres, 4.3% mujeres). La mayor prevalencia de ID se encontró en mayores de 80 años (6.9% hombres, 7.0% mujeres). 1.5 de 10 adultos mayores mexicanos con anemia presentaron DH. Conclusión. La prevalencia de anemia continua siendo alta en los adultos mayores, mientras que la prevalencia de DH es baja. Es necesario investigar las causas de anemia en este grupo de edad.

Palabras clave: deficiencia de hierro; anemia; adultos mayores

Anemia is a common condition in the elderly, its prevalence increases with age and it is associated with higher risk of morbidity, disabilities, low quality of life, cardiovascular or neurological diseases and risk of death. Anemia was 17.1% in elder population in 2006 and 16.5% in 2012, in national representative surveys of Mexico. Smith and colleagues in a cohort study found that in the elderly the most frequent cause of anemia were chronic diseases (30-45%), followed by iron deficiency.
Anemia and iron deficiency in elderly population

Materials and methods

Study population. Information for the present analysis was extracted from the Ensanut 2012 dataset. This is a probabilistic survey, representative at the national, regional, and urban and rural levels, stratified by clusters and survey design. 1 920 adults older than 60 years (900 males, 1 020 females) have a complete registry of personal data and hemoglobin, C reactive protein (CRP) and ferritin data. Demographic and socioeconomic information was collected using specific questionnaires. Ethnicity was classified as indigenous when an indigenous language was spoken by a member of the family. Localities with less than 2 500 habitants were considered as rural and otherwise urban.

A household wealth index (HWI) was constructed based on the household characteristics and family assets by a principal component analysis, the index was divided into tertiles to stratify the population into low, middle and high HWI categories. The country was divided in three geographic regions: Northern, Center-Mexico City, and Southern. Weight and height was collected using validated and standardized methods. The intra assay variability for ferritin was 3.35% and for CRP 4.4%. Serum ferritin concentrations were measured by chemiluminescent microparticle immunoassay method and CRP was measured by immunoassay, using ultrasensitive monoclonal antibodies; Abbott commercial kits were used for the determination. The measurements were performed in an automatic autoanalyzer (Architect i2000, Abbott Diagnostic, Wiesbaden, Germany).

The objective of this study is to describe the prevalence and predictors for ID and anemia in elderly Mexican population participating in the National Health and Nutrition Survey (Ensanut) 2012, by sex, age, rural or urban dwelling, and geographic region, affiliation to social programs and health services.

Ferritin and hemoglobin determinations. Blood samples were drawn from an antecubital vein, centrifuged at 3 000 g, in situ. Serum was separated and stored in coded cryovials, preserved in liquid nitrogen until delivery to the central laboratory in Cuernavaca, Mexico where stored at -70 °C until determination.

Serum ferritin concentrations were measured by chemiluminescent microparticle immunoassay method and CRP was measured by immunoassay, using ultrasensitive monoclonal antibodies; Abbott commercial kits were used for the determination. The measurements were performed in an automatic autoanalyzer (Architect i2000, Abbott Diagnostic, Wiesbaden, Germany).

The intra assay variability for ferritin was 3.35% and for CRP 4.4%. Serum ferritin concentrations were adjusted for inflammation when CRP was >5 mg/L using the equation of Thurnham and colleagues.

Hemoglobin concentrations were measured with a fingerprick in capillary blood using a portable photometer (Hemocue, Angelholm, Sweden) and concentrations were adjusted by altitude using the equation of Haas.

Low iron stores was defined when serum concentrations of ferritin was<15 µg/L. Anemia was defined when adjusted Hb concentrations was <120 g/L for females or <130 g/L for males. Iron deficiency anemia (IDA) was defined when an abnormally low Hb value coexisted with values of ferritin <15 µg/L.

Data from the Ensanut 2006, a probabilistic, multistage, stratified, clustered survey were used to compare anemia, ID and IDA prevalences of 2012 survey. Ensanut 2006 methodology is described elsewhere in detail.

Statistical analysis. The characteristics of the sample and prevalence of anemia and ID are described as frequencies and 95% confidence intervals, stratified by sex. Differences in characteristics and prevalence were tested through simple logistic regression adjusted by sex and group of age. We constructed to test the risks for anemia, ID and IDA, and heterogeneity of effects by sex and age, through multivariate logistic regression models adjusting by HWI status, BMI, CRP, dwelling, geographical region, ethnicity and affiliation of households to social programs.

Data from Ensanut 2006 were reanalyzed with the same criteria than for Ensanut 2012. Statistical significance was set at a=0.05 and a=0.10 for interactions. All analyses were adjusted for the sampling design of the survey, using STATA v 13.

Ethical aspects. The protocol was approved by the Research, Ethics and Biosafety Committees of Instituto Nacional de Salud Pública, Mexico. Individual informed consent letters were obtained from all participants after explaining the nature, goals and methods of the survey.
Results

This analysis includes 2,328 adults older than 60 years. The characteristics of the sample are presented in table I. Briefly, more than half of the sample was 60-69 years, 32.8% 70-79 years and 15.5% ≥80 years old, with a proportion male/female of 44.9/55.2%. Most of them live in urban (77.5%) and about 8.5% were of indigenous ethnicity; 26.3% belonged to the tertile 1, and 42.7% to the tertile 3 of HWI. A great majority presented overweight (40.9%) or obesity (27.8%). The households affiliated to Social programs were: to Prospera, 28.7%, to Liconsa, 9.2%, and to Adultos mayores, 26.1% (table I).

Prevalence of anemia, ID and IDA

Anemia. The overall prevalence of anemia was 13.9%, males 15.2%, females 12.8%. There was an increment of anemia with increasing age, i.e. it went from 8.7% to 23.6% in the three groups of age. The anemia gradient was affected by sex so that the younger group of males had a lower prevalence than the other two groups of males.

In rural areas, Center and Southern regions of the Country and in low and middle tertiles of HWI anemia was more prevalent than in urban areas, North region or high tertile of HWI. It was observed an inverse tendency for the BMI and anemia, ranking from 44.9% in the low weight category to 10.6% in obese elders. There were no differences by ethnicity.

In subjects affiliated to Prospera or Adultos mayores, the prevalence of anemia was higher, around 9.5 pp and 7.4 pp, respectively than in non-affiliated, disparities that were more evident in males than in females. Liconsa program affiliation was associated with almost half the prevalence of anemia than in non-affiliated (14.8%). These differences were observed between males affiliated and non-affiliated to Liconsa, but not in females. In iron deficient, anemia rose to 51.5%, fourfold the prevalence in non-iron deficient. No differences by sex were found (table II).

Iron deficiency (ID). The overall prevalence of ID was 4.2%, 4.0% in males and 4.3% in females. The higher prevalence of ID was observed in 70-79 y old males (6.9%) and females (7.0%) compared with the other two age categories.

In elders affiliated to Prospera ID was higher (5.2%) than in non-affiliated (3.7%); this was significantly higher in males (7.1 vs 2.9%) but not in females. The prevalence of ID was not different by dwelling, region, ethnicity, HWI or inflammation. The overall prevalence of anemia was very high in iron deficient (15.3%), being in males 11.8% and in females 18.1% (table II).

Risk of anemia, ID and IDA

In the multiple logistic regression, we found a different effect by sex and group of age for risk of anemia, being higher in males of 70-79 y (OR: 1.80) and in >80 y (OR: 2.49) than in younger males of 60-69 y. Characteristics associated with risk to present anemia were: living in the Southern region, low and middle tertile of HWI, and low BMI. On the other side, overweight and obesity were protective factors for anemia. The risk for anemia was not different by dwelling, ethnicity or affiliation to social programs. CRP >5 mg/L was associated with 1.85 times the risk for anemia than normal CRP, while ID was associated with 6.9 times the risk for anemia than non-iron deficiency (table III).

ID. The risk of ID suggests a different effect by sex and group of age, being higher for women ≥80 y old (OR: 7.9). Residents of the rural dwelling and indigenous presented higher risk factors of ID than their counterparts. Living in the Southern region was associated with less risk of ID, contrary to what was observed in anemia. (table III).

IDA. Risk of IDA was higher in males aged 70-79 y (OR: 3.7) than in 60-69 y. The higher risk of IDA was observed in females >80 y. The risk for IDA was not different by dwelling, region, ethnicity, HWI status or affiliation to social programs (table III).

Changes in the prevalence of anemia, ID and IDA between Ensanut 2006 and 2012

The overall prevalence of anemia between 2006 and 2012 did not change, remaining in 14% (figure 1A). In both surveys elderly ≥80 y old showed the highest prevalence of anemia.

The prevalence of ID significantly decreased 5.3 pp (figure 1B). In males the prevalence reduced 7.1 pp and in females 3.1 pp between surveys. The highest reduction of ID through time was found in elderly ≥80 y old from 17.22% in 2006 to 4.5% in 2012.

Overall IDA prevalence in elderly was 3.8% in 2006 and 2.2% in 2012. We found a significant reduction of 3.4 pp of IDA in the 60-69 y old group (figure 1C).

Discussion

Anemia in Mexican elderly is similar as that of older adults from Brazil (7.7%) and Mexican-Americans (10.4%) from the NHANES III, being more noticeable in elders over 70 y, and more prevalent in males than females. These differences between sex are consistent with other studies.
### Table 1
DESCRIPTION OF THE SAMPLE OF MEXICAN ELDERLY, ENSANUT 2012

<table>
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<th>Variable</th>
<th>Overall</th>
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<th>Females</th>
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<td></td>
<td></td>
</tr>
<tr>
<td>60-69</td>
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<td>1 062 (47 693.5)</td>
<td>1 266 (58 583.8)</td>
</tr>
<tr>
<td>70-79</td>
<td>1 156 (54 840.5)</td>
<td>536 (26 706.9)</td>
<td>620 (28 133.3)</td>
</tr>
<tr>
<td>&gt;=80</td>
<td>373 (16 518)</td>
<td>185 (8 651.3)</td>
<td>188 (8 966.6)</td>
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<td><strong>Nutritional status</strong></td>
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<td></td>
<td></td>
</tr>
<tr>
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<td>1 062 (47 693.5)</td>
<td>1 266 (58 583.8)</td>
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<tr>
<td>Normal</td>
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<td>371 (15 515.3)</td>
<td>304 (14 191.9)</td>
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<td>Overweight</td>
<td>858 (40 196.3)</td>
<td>410 (20 441.9)</td>
<td>448 (19 754.4)</td>
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<td>Obesity</td>
<td>616 (27 308.2)</td>
<td>311 (13 753.4)</td>
<td>305 (13 553.9)</td>
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<td><strong>High serum CRP concentrations</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Normal (&lt;5 mg/L)</td>
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<td>1 062 (47 693.5)</td>
<td>1 266 (58 583.8)</td>
</tr>
<tr>
<td>High (&gt;5 mg/L)</td>
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<td><strong>Serum ferritin concentration</strong></td>
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<td>1 266 (58 583.8)</td>
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<td>1 062 (47 693.5)</td>
<td>1 266 (58 583.8)</td>
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<td>Prospera (before Oportunidades)</td>
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<td>1 062 (47 693.5)</td>
<td>1 266 (58 583.8)</td>
</tr>
<tr>
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<td>1 062 (47 693.5)</td>
<td>1 266 (58 583.8)</td>
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<td>Licosa</td>
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<td>1 266 (58 583.8)</td>
</tr>
<tr>
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<td>1 062 (47 693.5)</td>
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<tr>
<td>Adultos Mayores</td>
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</tr>
<tr>
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<td>2 328 (106 277)</td>
<td>1 062 (47 693.5)</td>
<td>1 266 (58 583.8)</td>
</tr>
<tr>
<td>Yes</td>
<td>2 328 (106 277)</td>
<td>1 062 (47 693.5)</td>
<td>1 266 (58 583.8)</td>
</tr>
</tbody>
</table>

* Values are medians (95% CI)

‡ (thousands) is the expansion for overall population expressed in thousands

Ensanut: National Health and Nutrition Survey
**Table II**

**PRESALCE OF ANEMIA AND IRON DEFICIENCY (MEASURED THROUGH CAPILLARY HEMOGLOBIN) AND FERRITIN SERUM CONCENTRATIONS BY SEX IN MEXICAN ELDERLY, ENSANUT 2012**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Anemia Overall</th>
<th>Iron deficiency Overall</th>
<th>Anemia Males</th>
<th>Iron deficiency Males</th>
<th>Anemia Females</th>
<th>Iron deficiency Females</th>
</tr>
</thead>
<tbody>
<tr>
<td>n sample (thousands)</td>
<td>% (95%CI)</td>
<td>% (95%CI)</td>
<td>% (95%CI)</td>
<td>% (95%CI)</td>
<td>% (95%CI)</td>
<td>% (95%CI)</td>
</tr>
<tr>
<td>Overall</td>
<td>1032 (49 737.8)</td>
<td>13.94 (11.73-16.48)</td>
<td>15.27 (12.06-19.14)</td>
<td>12.83 (9.74-16.72)</td>
<td>2 328 (106 277)</td>
<td>4.2 (2.87-6.12)</td>
</tr>
<tr>
<td>Group of age (Years old)</td>
<td>60-69</td>
<td>13.71 (11.55-16.5)</td>
<td>15.1 (12.1-18.17)</td>
<td>12.83 (9.74-16.72)</td>
<td>2 328 (106 277)</td>
<td>4.2 (2.87-6.12)</td>
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<td>Nutritional status</td>
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<td></td>
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<tr>
<td>Low weight</td>
<td>38 (926.4)</td>
<td>44.99 (26.68-64.9)</td>
<td>61.76 (28.33-86.8)</td>
<td>30.88 (11.96-59.5)</td>
<td>43 (1 004.2)</td>
<td>2.47 (1.66-8.82)</td>
</tr>
<tr>
<td>Overweight</td>
<td>774 (36 981.4)</td>
<td>9.09 (6.67-12.08)</td>
<td>9.27 (11.74-16.05)</td>
<td>11.54 (5.08-26.01)</td>
<td>858 (40 196)</td>
<td>3.04 (2.17-5.33)</td>
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<td>Obesity</td>
<td>548 (29 488.7)</td>
<td>10.64 (7.34-15.17)</td>
<td>12.92 (7.63-21.35)</td>
<td>9.54 (6.21-14.37)</td>
<td>616 (27 308.2)</td>
<td>3.71 (1.63-8.2)</td>
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<td>High serum CRP concentrations</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Normal</td>
<td>1 200 (73 079)</td>
<td>11.94 (9.5-14.94)</td>
<td>12.50 (9.5-16.29)</td>
<td>11.45 (7.87-16.37)</td>
<td>1 723 (79 908.2)</td>
<td>4.3 (2.67-6.8)</td>
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<td>Overweight</td>
<td>544 (24 151)</td>
<td>19.97 (14.64-26.63)</td>
<td>24.30 (18.72-30.61)</td>
<td>16.68 (11.82-23.01)</td>
<td>605 (26 369)</td>
<td>3.9 (2.4-6.5)</td>
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<td>High (&gt;5 mg/L)</td>
<td>1 200 (73 079)</td>
<td>11.94 (9.5-14.94)</td>
<td>12.50 (9.5-16.29)</td>
<td>11.45 (7.87-16.37)</td>
<td>1 723 (79 908.2)</td>
<td>4.3 (2.67-6.8)</td>
</tr>
</tbody>
</table>

* (thousands) is the expansion for overall population expressed in thousands.

Intravariability, intergroup differences: $p<0.01, b=p<0.05, c=p<0.01, d=p<0.001$.

Reference category: 60-69, urban dwelling, Northern Region, Non indigenous, high HVI, normal nutritional status, non-affiliated to Prospera, Licorsa or Adultos Mayores, Normal CRP serum concentrations, no iron deficiency or No anemia.

Logistic regression models were adjusted by sex and group of age.

The magnitude of anemia due to ID is expected to be less in elderly than in other age groups (2.5 times the prevalence of anemia, OMS 2002). In our study ID is one contributing factor for anemia, but not the most important, since less than a third part of the prevalence of anemia was associated with ID. The low prevalence of ID in our study is in line with those reported in other countries as Ecuador (1.6%), Netherlands (11% males 5% females 50-79 y), Taiwan (ferritin <12 µg/L; males 2.6% and females 1.9% >65 y), USA (4% for males 7% for females >70 y), Singapore (0.4% in males and 2.6% in females 50-60 y), and Denmark (ferritin <16 µg/L; 2

<table>
<thead>
<tr>
<th>Table III</th>
<th>Multivariate Logistic regression model for predicting variables for iron deficiency and anemia. México, Ensanut 2012</th>
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<tr>
<td>F&lt;0.001</td>
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<td></td>
<td>n sample (I 904)</td>
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<td></td>
<td>thousands (86 188.0)b</td>
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<tr>
<td></td>
<td>OR (95% CI)</td>
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<tr>
<td></td>
<td>p Value</td>
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<td>Gender</td>
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<td>Ref.</td>
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<td></td>
<td>OR (CI 95%)</td>
</tr>
<tr>
<td></td>
<td>p Value</td>
</tr>
<tr>
<td>Group of age (years old)</td>
<td>60-69 y (Males)</td>
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<td></td>
<td>70-79 y (Males)</td>
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<tr>
<td></td>
<td>≥80 y (Males)</td>
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<td>Sex</td>
<td>Males (60-60 y)</td>
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<td></td>
<td>Females (60-69 y)</td>
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<td></td>
<td>70-79 y oldSex (Females)</td>
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<td></td>
<td>≥80 y oldSex (Females)</td>
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<td>Interaction: Group of age and sex</td>
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<td>≥80 y oldSex (Females)</td>
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<td>Overweight</td>
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<td>Obesity</td>
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<td>Iron deficiency</td>
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<tr>
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<td>Prospera (before Oportunidades)</td>
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Ensanut: National Health and Nutrition Survey
Contreras-Manzano A y col.

Figura 1. Prevalencia de anemia, deficiencia de hierro y anemia de deficiencia de hierro en una muestra de ancianos del SNS 2006 y 2012. Generalidad, nacional y por década de edad. Prevalencia de a) anemia, b) deficiencia de hierro y c) anemia de deficiencia de hierro en ancianos. 2006: n muestra = 834 (mil=9 547) 2012: n muestra = 2 064 (mil=97 230)

14.2 14.0 14.9 15.3 13.4 12.9 14.9 11.0 11.9 11.3 19.5 23.8
National Males Females 60-69 y 70-79 y >80y

9.4 11.1 10.5 7.4 4.3 2.3 7.4 6.9 8.5 4.5 17.2 22.0
National Males Females 60-69 y 70-79 y >80y

3.8 2.2 4.5 1.9 2.9 2.4 4.3 0.9 1.6 4.4 6.9 1.9
National Males Females 60-69 y 70-79 y >80y

Ensanut 2006  Ensanut 2012

1.8% varones y 5.4% mujeres >80 años; estas prevalencias están diferentes por sexo como lo observamos en nuestra muestra. Desde 2006 a 2012 México parece haber tenido una importante reducción en la prevalencia de ID, pero es importante destacar que la alta prevalencia observada en 2006 fue probablemente asociada a un sobrepeso en la región del Sur en orden a que tuvimos una muestra representativa de personas pobres e indígenas. No hay evidencia de que otros factores pudieran estar asociados a esta reducción, como: un mejoramiento en los servicios de salud, un mejor estatus socioeconómico, una mejor distribución de cuidados de salud y utilización, o un efecto positivo de los programas sociales en esta población. En algunas subgrupos de ancianos, la data sugiere que estar afiliado a Prospera o Adultos mayores se asocia con un mayor riesgo de anemia o ID, probablemente evidenciando una buena targeteo de los programas sociales a la población más vulnerable a la malnutrición y desigualdades. Liconsa es un programa que, de acuerdo a Ensanut 2012, proporcionó leche fortificada a 5.8% de hogares pobres rurales y 10.8% de hogares pobres urbanos de México, y tiene una cobertura nacional de 9.7%. De ahí es posible que no encontramos diferencias en el riesgo de anemia y también porque la deficiencia de hierro en adultos juega un papel menor en la creación de anemia en esta población específica de edad. Sin embargo, características sociodemográficas de la población de ancianos como el sobrepeso o ingresos bajos muestran evidencia significativa de riesgo de ID y anemia en ancianos. No obstante, este estudio transversal no permite hacer inferencias causales.

La anemia fue consistente en ancianos con bajo peso, probablemente debida a la malnutrición de nutrientes esenciales en estas edades, como vitamina B12, fóluca, zinc, vitamina D, entre otros. En contraste, la ID fue más prevalente en sujetos con sobrepeso y obesidad que en aquellos con peso normal. Es posible que la obesidad refleje un estado inflamatorio subclínico que induce la retención de hierro, afectando la disponibilidad de hierro a las células para su utilización; lo que resulta en una condición de deficiencia de hierro-refractario y aumentando el riesgo de ID a un mayor riesgo en sujetos obesos. Según nuestro estudio, el incremento de CRP >5 mg/L fue un factor de riesgo para anemia y parece ser un factor protector para la ID, aunque una alta concentración de CRP condiciona un aumento en la ferritina durante las infecciones agudas. Países como Ecuador o Taiwán han reportado que en sus encuestas la alta prevalencia de concentraciones anormalmente altas de ferritina (61.7% >100 µg/L), 25 (15.7% varones y 9.8% mujeres >300 µg/L) 27. En nuestra población, 31.8% de los ancianos presentaba concentraciones de ferritina >100 µg/L y 3.8% >300 µg/L, estos puntos indican inflamación, hemochromatosis o cirrosis decompenada. 33 Este alto porcentaje de hiperferritinemia en los ancianos puede llevar a un subestimado de la prevalencia de ID debido a incrementos en las concentraciones de ferritina asociados a infecciones crónicas o agudas, inflamación y un mal diagnóstico de ID, incluso después de que se corrijan las concentraciones de CRP. Una limitación de este estudio es que no pudimos determinar la anemia para la respuesta inflamatoria y otros posibles tipos de anemia, ya sea por deficiencias de folato y cianocobalamina, y una evaluación completa de la condición de ID.

Nuestros resultados en la prevalencia de ID en ancianos mexicanos son comparables con algunos de NHANES III (16.6%). 21. El mayor porcentaje de anemia no explicado por...
ID suggests that other nutritional deficiencies, systemic inflammation or chronic renal insufficiency may be playing an important role in the pathogenesis of anemia. Structural factors, such as low HWI conditions, being Southerner, affiliated to any social programs or having a low weight, may contribute to understand the higher risk for anemia and ID in Mexican older adults.

This study is the first work to document the prevalence of anemia, ID and IDA in Mexican elder population. The main strength of this work is its probabilistic design, that provides a sampling that furnishes a national sample, with representativeness of the rural and urban dwelling and geographic regions.

Conclusion

Anemia is a major health problem in the elderly in Mexico, being the risk more severe in adults over 70 years. The prevalence of ID found in this study was low for men and women. Further research is required to identify the main causes of anemia at population-based studies in older adults to maintain and improve their health conditions.

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

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