Iron deficiency anemia: higher prevalence in Mexican American than in non-Hispanic white females in the third National Health and Nutrition Examination Survey, 1988–1994[1–3]

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ABSTRACT

Background: Mexican American females have a higher prevalence of iron deficiency than do non-Hispanic white females.

Objective: The objective was to estimate the prevalence of iron deficiency anemia and examine potential reasons for this difference between Mexican American (*n* = 1194) and non-Hispanic white (*n* = 1183) females aged 12–39 y.

Design: We used data from the third National Health and Nutrition Examination Survey (1988–1994). Iron deficiency anemia was defined as abnormal results from ≥2 of 3 tests (erythrocyte protoporphyrin, transferrin saturation, and serum ferritin) and a low hemoglobin concentration. We used multiple logistic regression to adjust for factors that were more prevalent in Mexican American females and significantly associated with iron deficiency anemia.

Results: The prevalence of iron deficiency anemia was 6.2 ± 0.8% ($\bar{x}$ ± SE) in Mexican American females and 2.3 ± 0.4% in non-Hispanic white females. Mean dietary iron intake, mean serum vitamin C concentrations, and the proportion of females using oral contraceptives were similar in the 2 groups. Age < 20 y and education were not associated with iron deficiency anemia. After adjustment for poverty level, parity, and iron supplement use, the prevalence of iron deficiency anemia was 2.3 times higher in Mexican American than in non-Hispanic white females (95% CI: 1.4, 3.9). In those with a poverty income ratio (based on household income) > 3.0, however, the prevalence of iron deficiency anemia was 2.6 ± 0.9% in Mexican American and 1.9 ± 0.6% in non-Hispanic white females (NS).

Conclusion: Although much of the ethnic disparity in iron deficiency anemia remains unexplained, factors associated with household income may be involved. *Am J Clin Nutr* 2000;72:963–8.

KEY WORDS Mexican females, non-Hispanic white females, nutrition, iron, poverty index ratio, obesity, iron supplements, vitamin C supplements, iron deficiency anemia, third National Health and Nutrition Examination Survey, NHANES III

INTRODUCTION

Iron deficiency anemia, the most severe form of iron deficiency, has important functional consequences for females of childbearing age. Iron deficiency reduces work efficiency in nonpregnant women (1) and may impair memory in adolescent girls (2). Pregnant women with low iron stores may be at increased risk of iron deficiency anemia because pregnancy increases requirements for iron (3, 4). Women with iron deficiency anemia are 2–3 times more likely to deliver preterm or low-birth-weight babies than are women without iron deficiency anemia (5).

The prevalence of iron deficiency in the United States is > 2 times greater in Mexican American females than in non-Hispanic white females of childbearing age (20–49 y) (6). Although previous estimates suggest that the prevalence of iron deficiency anemia is higher in Mexican American females than in non-Hispanic white females, this comparison was made across different studies conducted during different years (7). Current ethnicity-specific estimates of iron deficiency anemia have not been reported. Additionally, reasons for an ethnic disparity in iron deficiency and in iron deficiency anemia are not clear.

Iron status is a function of iron intake, storage, and loss (8, 9). Absorption of iron from the diet depends on the amount of iron in the body, the rate of red blood cell production, the amount and kind of iron in the diet, and the presence of absorption enhancers and inhibitors in the diet (10–12). As iron stores decrease, absorption of iron from the diet increases. A small amount of iron is lost daily though feces and desquamated, mucosal, and skin cells. Females of childbearing age require additional iron because of the loss of iron in menstrual blood and because of the demands of pregnancy (13).

Approximately 10% of females of childbearing age experience heavy menstrual blood loss (≥80 mL/mo), which is an important risk factor for iron deficiency anemia (13). Other risk factors include use of an intrauterine device (which is associated with heavy menstrual blood loss), high parity, previous diagnosis of iron deficiency anemia, and low iron intake (6, 14). Use of

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oral contraceptives is associated with a decreased risk of iron deficiency (15). In the present investigation, we determined the prevalence of iron deficiency anemia in nonpregnant Mexican American and non-Hispanic white females aged 12–39 y and examined factors that may account for known ethnic differences in the prevalence of iron deficiency anemia.

SUBJECTS AND METHODS

Subjects

Data from the third National Health and Nutrition Examination Survey, 1988–1994 (NHANES III), represent the total civilian noninstitutionalized population aged ≥2 mo in the United States (16). A stratified, multistage probability design was used to select participants. Data were collected via household interviews and physical examinations in mobile examination centers by the National Center for Health Statistics, Centers for Disease Control and Prevention. Ethical approval was obtained and written consent was received from all participants. Procedures for data collection and analysis were published previously (16).

Our study sample was restricted to Mexican American and non-Hispanic white, nonpregnant females aged 12–39 y (n = 3138). Mexican Americans are one of the fastest growing minority groups in the United States and have the highest prevalence of iron deficiency of any minority group studied thus far (6, 7, 17). Women older than 39 y were excluded because of their increased risk of anemia due to chronic disease (18). We included adolescent girls (12–19 y of age) because this group is also at risk of iron deficiency anemia (6). Two hundred forty-four females were excluded from the study because they had missing data for 4 iron-status indicators (erythrocyte protoporphyrin, transferrin saturation, serum ferritin, and hemoglobin); 458 were excluded because they had missing data for ethnicity, age, poverty income ratio (PIR; the total household income divided by the poverty threshold for the year of the interview), education level, parity, oral contraceptive use, iron supplement use, or daily dietary iron intake; and 59 were excluded because they had reported having been treated for anemia in the previous 3 mo. The final analytic sample consisted of 2377 females: 1194 Mexican American and 1183 non-Hispanic white adolescent girls and women of childbearing age.

Individuals with missing data for serum iron-status indicators (serum ferritin concentration, transferrin saturation, erythrocyte protoporphyrin, and hemoglobin) did not differ significantly from the final sample with regard to household income or education level. Participants with missing data for age, PIR, education level, parity, oral contraceptive pill use, daily dietary iron intake, or iron supplement use did not differ significantly in their ethnicity or iron status from the final sample.

Methods

All iron assays were conducted at the NHANES laboratory, National Center of Environmental Health, Centers for Disease Control and Prevention. Serum ferritin was measured with the Quantimune Ferritin immunoradiometric assay kit (Bio-Rad Laboratories, Hercules, CA) (19). Transferrin saturation was determined by dividing the serum iron concentration (μmol/L) by the total-iron-binding capacity (μmol/L) as assessed by using a modified version of the automated AAII-25 colorimetric method (19). Erythrocyte protoporphyrin was measured by using a modified version of the method of Sassa et al (20). We used a corrected millimolar absorptivity of 297 $L \cdot mmol^{-1} \cdot cm^{-1}$, whereas Sassa et al used one of 241 $L \cdot mmol^{-1} \cdot cm^{-1}$, after protoporphyrin was extracted from EDTA-treated whole blood and measured fluorometrically. Hemoglobin was measured by using the counter model S-Plus JR electronic counter (Coulter Electronics, Hialeah FL) (19).

Subjects were classified as iron deficient if they had abnormal values for ≥2 of 3 iron-status indicators: serum ferritin (<12 μg/L), transferrin saturation (<14% for 12–15-y-olds and <15% for 16–39-y-olds), and erythrocyte protoporphyrin (≥1.24 μmol/L red blood cell) (6, 21–23). Hemoglobin values were adjusted for cigarette smoking as recommended by the Centers for Disease Control and Prevention on the basis of the number of packs of cigarettes smoked daily (0.5 to <1 pack: −3 g/L; 1 to <2 packs: −5 g/L; and ≥2 packs: −7 g/L) (23). If a subject was classified as iron deficient and had a hemoglobin concentration below the age-specific values for anemia (ie, 118 g/L for 12–14-y-olds or 120 g/L for 15–39-y-olds), they were categorized as having iron deficiency anemia (23).

Ethnicity was based on self-reported data. As mentioned previously, the PIR is the total household income divided by the poverty threshold for the year of the interview (24). The poverty threshold is determined annually by the US Bureau of the Census, taking into account geographic location, rate of inflation, and family size (25). The last year of school completed by the head of the household was used for females aged 12–18 y and the last year of school completed was used for women aged 19–39 y. Parity was classified as 0, 1, or ≥2 live births. Oral contraceptive pill use was self-reported and subjects were categorized as current users or nonusers.

Dietary iron was estimated from a single 24-h dietary recall collected through an automated dietary interview by using the Dietary Data Collection system (16). Dietary iron intake was adjusted for energy intake (mg/kJ consumed) (26); however, because the data were not normally distributed, values were transformed to their natural logarithm for testing hypotheses.

Daily intakes of iron supplements were calculated from a series of questions about the vitamins or minerals the subject had taken within the previous month. For example, if total supplemental iron for 1 mo was estimated at 4800 mg, the average daily intake was calculated as 160 mg. Supplemental iron intake was divided into categories based on recommended dietary allowances for nonpregnant and pregnant women (eg, 0 mg, >0–15 mg, >15–30 mg, and >30 mg) (4).

Serum vitamin C was assayed at the NHANES laboratory at the National Center of Environmental Health, the Centers for Disease Control and Prevention, by using reversed-phase HPLC with multiwavelength detection. Detailed laboratory procedures for this assay were published elsewhere (19). To improve the normality of the serum vitamin C distribution, we log transformed serum vitamin C concentrations.

Statistical analysis

We weighted all statistical analyses and used SUDAAN (version 7.5; Research Triangle Institute, Research Triangle Park, NC) to account for the complex sample design. We used multiple logistic regression models to determine the association of ethnicity and iron deficiency anemia, adjusting for factors that were positively associated with iron deficiency anemia and more prevalent in Mexican American than in non-Hispanic white females. We

TABLE 1

Hemoglobin and other iron-status indicators in Mexican American and non-Hispanic white females aged 12–39 y: NHANES III[1]

Iron-status indicator	Mexican American (*n* = 1194)	Non-Hispanic white (*n* = 1183)
Hemoglobin (g/L)	131.5 ± 0.6[2]	133.5 ± 0.5
Transferrin saturation (%)	22.5 ± 0.5[3]	25.3 ± 0.4
Serum ferritin (μg/L)	39.3 ± 1.2[3]	48.8 ± 2.2
Erythrocyte protoporphrin (μmol/L)	1.1 ± 0.02[4]	0.9 ± 0.01
Iron deficiency (%)[5]	16.6 ± 0.7[4]	6.1 ± 1.0
Anemia (%)[6]	10.1 ± 1.4	6.6 ± 1.0
Iron deficiency anemia (%)[7]	6.2 ± 0.8[3]	2.3 ± 0.4

[1] $\bar{x}$ ± SE. NHANES III, third National Health and Nutrition Examination Survey.

[2–4] Significantly different from non-Hispanic white females: [2] $P < 0.005$, [3] $P < 0.001$, [4] $P < 0.0001$.

[5] Defined as ≥2 abnormal values for serum ferritin (<12 μg/L), transferrin saturation (<14% for 12–15 y-olds or <15% for 16–39-y-olds), or erythrocyte protoporphyrin (≥1.24 μmol/L red blood cells).

[6] Defined as a smoking-adjusted hemoglobin concentration <118 g/L for 12–14-y-olds and < 120 g/L for 15–39-y-olds.

[7] Defined as iron deficiency plus anemia.

examined interactions between ethnicity and each covariate by comparing the log-likelihood ratios of the models with and without the interaction terms included. We set statistical significance at $P < 0.05$ and $P < 0.15$, respectively, for the covariates and the interaction terms between ethnicity and each covariate. Results are reported as means ± SEEs and as odds ratios with 95% CIs.

RESULTS

Mean hemoglobin concentration, transferrin saturation, and serum ferritin concentration were significantly lower and mean erythrocyte protoporphyrin was significantly higher in Mexican American females than in non-Hispanic white females (**Table 1**). The prevalence of iron deficiency, anemia, and iron deficiency anemia was 2.7, 1.5, and 2.7 times greater, respectively, in Mexican American females than in non-Hispanic white females. In females with iron deficiency, ≈37% also had anemia, regardless of ethnic group. In females with anemia, higher proportions of Mexican American females (61%) than of non-Hispanic white females (35%) were iron deficient.

Compared with non-Hispanic white females, a higher proportion of Mexican American females were 12–19 y, had a PIR ≤ 1.3, had <12 y education, had a parity ≥2, and were not taking iron supplements (**Table 2**). The proportion of females using oral contraceptives did not differ significantly by ethnicity. Mean iron intake from food was equivalent in Mexican American and non-Hispanic white females and was less than the recommended dietary allowance for iron of 15 mg for this age and sex group (4). Additionally, the mean serum vitamin C concentration was the same for the Mexican American and non-Hispanic groups.

In Mexican American females, oral contraceptive use was associated with a lower prevalence of iron deficiency anemia (**Table 3**). The association between iron supplement use and iron deficiency anemia was not significant ($P = 0.09$), but the number of females who used iron supplements was small. Females with PIRs > 1.30–1.85 had the highest prevalence of iron deficiency anemia of any subgroup, whereas females with PIRs > 3.0 had the lowest prevalence of iron deficiency anemia. The overall association between poverty level and iron deficiency anemia was suggestive but not significant ($P = 0.09$). Age group, education level, parity, dietary iron intake (data not shown), and serum vitamin C concentration (data not shown) were not associated with iron deficiency anemia in Mexican American females.

In non-Hispanic white females, parity ≥2 was associated with a higher prevalence of iron deficiency anemia, whereas the prevalence of iron deficiency anemia in females who used iron supplements was not different from zero (Table 3). Age group, poverty level, education level, oral contraceptive use, dietary iron intake (not shown), and mean serum vitamin C concentrations (not shown) were not associated with iron deficiency anemia.

Despite differences in the significance of the associations between covariates and iron deficiency anemia between ethnic groups, the direction and magnitude of the associations for covariates and iron deficiency anemia were similar, except for the PIR (Table 3). In females with a PIR > 3.0, the prevalence of iron deficiency anemia in Mexican American females (2.6 ± 0.9%) was not significantly different from that in non-Hispanic white females (1.9 ± 0.6%). In Mexican American

TABLE 2

Characteristics of Mexican American and non-Hispanic white females aged 12–39 y: NHANES III[1]

	Mexican American (*n* = 1194)	Non-Hispanic white (*n* = 1183)
Age (y)	24.9 ± 0.2[2]	26.9 ± 0.3
Age (%)		
12–19 y	29.0 ± 1.7[3]	21.6 ± 1.7
20–39 y	71.0 ± 1.3	78.4 ± 1.7
Poverty income ratio (%)		
≤1.3	54.6 ± 2.8[2]	16.8 ± 1.6
>1.3–1.85	15.7 ± 1.1	10.9 ± 1.2
>1.85–3.0	16.1 ± 1.6	26.9 ± 1.8
>3.0	13.6 ± 1.3	45.4 ± 2.6
Education level (%)		
<12 y	52.9 ± 3.6[2]	36.0 ± 1.9
12	27.1 ± 2.2	14.2 ± 1.5
>12 y	19.9 ± 2.4	49.8 ± 2.4
Parity (%)		
0	42.2 ± 1.9[4]	51.2 ± 1.8
1	15.4 ± 1.2	16.5 ± 1.2
≥2	42.4 ± 1.4	32.3 ± 1.7
Oral contraceptive use (%)		
Yes	18.7 ± 1.4	21.7 ± 1.0
No	81.3 ± 1.4	78.3 ± 1.1
Iron supplement use (mg/d)		
0	86.2 ± 1.0[2]	77.5 ± 1.5
>0–15	4.6 ± 0.6	7.2 ± 1.0
>15–30	4.3 ± 0.6	11.4 ± 1.0
>30	4.9 ± 0.7	4.0 ± 0.8
Mean dietary iron (mg/d)	13.1 ± 0.4	13.0 ± 0.4
Serum vitamin C (μmol/L)		
Arithmetic mean	42.9 ± 1.1	44.3 ± 1.6
Logarithmic mean	3.6 ± 0.04	3.5 ± 0.04

[1] $\bar{x}$ ± SE. NHANES III, third National Health and Nutrition Examination survey.

[2–4] Significantly different from non-Hispanic white females: [2] $P < 0.0001$, [3] $P < 0.01$, [4] $P < 0.001$.

TABLE 3
Associations for categorical variables with prevalence of iron deficiency anemia in Mexican American and non-Hispanic white females aged 12–39 y: NHANES III[1]

	Prevalence of iron deficiency anemia[2]	
	Mexican American (n = 1194)	Non-Hispanic white (n = 1183)
	%	
Age		
12–19 y	5.2 ± 1.4	1.8 ± 0.7
20–39 y	6.7 ± 0.9	2.5 ± 0.4
Poverty income ratio		
≤1.3	6.9 ± 1.3	1.9 ± 0.8
>1.3–1.85	8.8 ± 2.2	4.9 ± 1.8
>1.85–3.0	4.4 ± 1.6	2.2 ± 0.8
>3.0	2.6 ± 0.9	1.9 ± 0.6
Education level		
<12 y	7.0 ± 1.1	3.1 ± 1.1
12	5.0 ± 1.3	2.2 ± 0.6
>12 y	5.5 ± 1.4	2.2 ± 0.6
Parity		
0	4.6 ± 0.9	1.6 ± 0.5[3]
1	5.1 ± 1.4	0.5 ± 0.4
≥2	8.3 ± 1.8	4.3 ± 1.0
Oral contraceptive use		
Yes	4.0 ± 0.8[3]	1.4 ± 0.6
No	6.7 ± 0.9	2.6 ± 0.5
Iron supplement use (mg/d)		
0	6.5 ± 0.8	2.7 ± 0.5[4]
>0–15	2.7 ± 2.0	0.7 ± 0.7
>15–30	2.9 ± 2.1	0.0 ± 0
>30	7.2 ± 3.6	4.2 ± 3.0

[1] $\bar{x}$ ± SE. NHANES III, third National Health and Nutrition Examination Survey.
[2] Iron deficiency anemia defined as a smoking-adjusted hemoglobin concentration <118 g/L for 12–14-y-olds and <120 g/L for 15–39-y-olds and ≥2 abnormal values for serum ferritin (<12 μg/L), transferrin saturation (<14% for 12–15-y-olds or <15% for 16–39-y-olds), or erythrocyte protoporphyrin (≥124 μmol/L red blood cells).
[3,4] Significant association of covariate with iron deficiency anemia within ethnic group (Mantel-Haensel chi-square test): [3] $P < 0.01$, [4] $P < 0.0001$.

females, lower income was generally associated with a higher prevalence of iron deficiency anemia; this association was not as clear in non-Hispanic white females. We tested the interactions between each covariate and ethnic group by comparing log-likelihood ratios of models with and without the interaction terms included. No interactions were significant.

In the total sample, the estimated risk of iron deficiency anemia was 2.8 times higher in Mexican American than in non-Hispanic white females (**Table 4**). The estimated risk of iron deficiency anemia was 2.9 times higher (95% CI: 1.2, 7.1) in females with a PIR > 1.30–1.85 than in females with a PIR > 3.0. The risk of iron deficiency anemia was also elevated in females with a PIR ≤ 1.3, but the CIs surrounded 1. Females with a parity of ≥2 were 2.7 times more likely to have iron deficiency anemia than were nulliparous females (95% CI: 1.3, 5.7) and females who took iron supplements providing >15–30 mg Fe/d, on average, were less likely to have iron deficiency than were females who did not take supplements. Higher dietary iron intake was also slightly associated with a decreased prevalence of iron deficiency anemia (P = 0.08), but after adjustment for the females' energy intake, this association was not significant. None of the other characteristics examined was significantly associated with iron deficiency anemia in the total sample.

We estimated the risk of iron deficiency anemia in Mexican American females relative to that in non-Hispanic white females after adjusting for factors that were associated with iron deficiency anemia and that were more prevalent in Mexican American females. Although higher proportions of Mexican American females were younger than non-Hispanic white females, the prevalence of iron deficiency anemia was lower in the younger age groups. When age and parity were included in the same model (data not shown), age was no longer associated with iron deficiency anemia, suggesting that the lower prevalence of iron deficiency anemia in younger females was because of their lower parity. After adjustment for poverty level, parity, and iron supplementation, the prevalence of iron deficiency anemia was still 2.3 times higher in Mexican American females than in non-Hispanic white females (95% CI: 1.4, 3.9).

DISCUSSION

In 1988–1994 we found that Mexican American females had a 2.7 times higher prevalence of iron deficiency anemia than did non-Hispanic white females. Compared with non-Hispanic white females in 1976–1981, the prevalence of iron deficiency anemia was 2.7 times higher in Mexican American females living in the United States in 1982–1984 (7). Although the results of comparisons between surveys should be interpreted with caution, our data suggest that the disparity in the prevalence of iron deficiency anemia between Mexican American and non-Hispanic white females has not decreased.

TABLE 4
Unadjusted and adjusted odds ratios (and 95% CIs) for the association between iron deficiency anemia, ethnic group, and other characteristics in females aged 12–39 y: NHANES III[1]

Characteristic	Unadjusted	Adjusted[2]
Ethnic group		
Mexican American	2.8 (1.7, 4.5)	2.3 (1.4, 3.9)
Non-Hispanic white	1.0 (referent)	1.0 (referent)
Poverty income ratio		
≤1.3	1.6 (0.8, 3.5)	0.8 (0.4, 1.8)
>1.3–1.85	2.9 (1.2, 7.1)	1.9 (0.8, 4.3)
>1.85–3.0	1.2 (0.5, 3.1)	0.9 (0.4, 2.2)
>3.0	1.0 (referent)	1.0 (referent)
Parity		
0	1.0 (referent)	1.0 (referent)
1	0.5 (0.2, 1.2)	0.4 (0.2, 1.1)
≥2	2.7 (1.3, 5.7)	2.5 (1.2, 5.2)
Iron supplement use (mg/d)		
0	1.0 (referent)	1.0 (referent)
>0–15	0.3 (0.04, 1.7)	0.3 (0.04, 1.8)
>15–30	0.03 (0.01, 0.1)	0.03 (0.01, 0.1)
>30	1.5 (0.4, 5.5)	1.3 (0.4, 4.3)

[1] NHANES III, third National Health and Nutrition Examination Survey. Iron deficiency anemia defined as a smoking-adjusted hemoglobin concentration <118 g/L for 12–14-y-olds and <120 g/L for 15–39-y-olds and ≥2 abnormal values for serum ferritin (<12 μg/L), transferrin saturation (<14% for 12–15-y-olds or <15% for 16–39-y-olds), or erythrocyte protoporphyrin (≥124 μmol/L red blood cells).
[2] Adjusted for all covariates shown in the table by using multiple logistic regression.

This is the first study to confirm that the risk of iron deficiency anemia is greater in Mexican American than in non-Hispanic, white, adolescent girls and women of childbearing age after adjustment for potential risk factors. Data on heavy menstrual blood loss and use of intrauterine devices were not available. Mean dietary iron intake, mean serum vitamin C concentrations, and the proportion of females using oral contraceptives were similar in Mexican American and non-Hispanic white females. Age <20 y and education were not associated with iron deficiency anemia. The prevalence of iron deficiency anemia was 2.3 times higher in Mexican American than in non-Hispanic white females (95% CI: 1.4, 3.9) after adjustment for poverty level, parity, and iron supplement use.

Smoking was not associated with iron deficiency (data not shown). It is important to note, however, that we adjusted hemoglobin concentrations for smoking status. Smokers maintain higher hemoglobin concentrations than do nonsmokers to compensate for decreased oxygen delivery (27); 33 ± 1.7% of non-Hispanic white females and 13.0 ± 1.2% of Mexican American females smoked. Without adjustment for smoking, the prevalence of iron deficiency anemia was the same in Mexican American females (6.2 ± 0.8%) but slightly lower in non-Hispanic white females (2.0 ± 0.4%). Hence, some of the ethnic difference in the prevalence of iron deficiency anemia was accounted for by the high prevalence of smoking in non-Hispanic white females.

A previous study found that iron deficiency was associated with Mexican American ethnicity, higher parity, and poverty (PIR <1.0) (6). We found that iron deficiency anemia was also associated with Mexican American ethnicity, higher parity, and a PIR >1.3–1.85. Similarly, we found that after adjustment for ethnicity the association between poverty and iron deficiency anemia was no longer significant. This is likely due to the weaker association between poverty and iron deficiency anemia in non-Hispanic white females than in Mexican American females. We also found no significant association between education level and iron deficiency anemia, but we used education level of the head of the household for females <19 y old, which may have diminished the association.

Our assessment of dietary iron and supplement intakes had some limitations. First, daily iron supplement intake was estimated by using an indirect method in which the daily intake was derived from the total monthly intake. This calculation may not represent daily amounts for persons who do not take supplements consistently. Second, daily dietary iron intakes were measured by using a single 24-h dietary recall, which can be used to assess the average intake of a population, but may misrepresent usual individual intakes (28). The 24-h dietary recall used in NHANES III was standardized, edited for completeness, and verified to determine the accuracy of extreme values (16). Although the quantity of dietary iron intake was similar, the sources and amounts of bioavailable iron may have differed between the diets of Mexican American and non-Hispanic white females (10, 29). Furthermore, these analyses were cross-sectional; thus, causal conclusions cannot be made.

Nonresponse bias should have been minimal because the data of those who received physical examinations in the mobile examination centers were adjusted by a nonresponse adjustment factor (16). Females with missing data for variables added to the models had a prevalence of iron deficiency that was similar to that of those included in the study sample.

Although many factors were examined to explain the ethnic difference in iron status, much of the ethnic difference in iron deficiency anemia remains unexplained. We found no significant interactions between race and other factors in relation to iron deficiency anemia, but the prevalence of iron deficiency anemia and the numbers of non-Hispanic white and Mexican American females in different subgroups may have diminished the statistical power to find interactions. The difference in the prevalence of iron deficiency anemia was lowest in females with a PIR > 3.0. In this group, the prevalence of iron deficiency anemia was 1.4 times higher in Mexican American than in non-Hispanic white females (95% CI: 0.5, 3.7). The prevalence of iron deficiency anemia was highest in Mexican American females with a PIR > 1.3–1.85. This subgroup did not qualify for Medicaid and many other federal assistance programs that may have increased their access to health care.

The findings suggest that unmeasured factors related to income may modify the difference in iron deficiency anemia between Mexican American and non-Hispanic white females. One such factor may be access to health care or other health programs and subsequent screening and treatment of iron deficiency anemia. Because we excluded females who reported being treated for anemia in the 3 mo before entry, females with iron deficiency anemia in this study were likely undetected and untreated at the time of the survey. Beyond the constraints that all low-income people face, compared with non-Hispanic white females of similar income, low-income Mexican American females may have additional constraints that limit their access to screening and treatment of iron deficiency. These constraints include language barriers and other cultural or social factors. Additionally, unmeasured ethnic disparities in environmental factors and diet may be greater in low-income females than in females with incomes >300% of the poverty level.

We found consistent differences in all iron measures between Mexican American and non-Hispanic white females. The ethnic difference in prevalence of iron deficiency anemia is a national concern that will have increasing implications as the number of low-income Mexican American females increases in the United States (17). There is little reason to think that the functional outcomes in nonpregnant Mexican American females would be different from those of other groups (1–3, 30–34).

The Centers for Disease Control and Prevention and the Federation of the American Societies for Experimental Biology recommend periodic screening for and treatment of anemia for all females of childbearing age to prevent iron deficiency (23, 35). The effectiveness of this strategy and differences in its application in population subgroups deserves further study. Investigating environmental exposures associated with ethnicity and income, including food patterns or the high intake of specific foods or food groups that influence iron status, may be useful in developing prevention programs that specifically address the needs of important subgroups at risk, such as low-income Mexican American females.

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