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Racial/ethnic and socioeconomic differences in self-reported food allergy among food-sensitized children in National Health and Nutrition Examination Survey III



During the past several decades, self-reported food allergy (FA) has increased rapidly among all racial/ethnic groups in the United States, but it appears that this increase has been sharpest for non-Hispanic black children.¹ Although black children have much higher rates of sensitization to common foods than children of other race/ethnicities,² changes in food sensitization are unlikely to be the reason for the recent increase in FA, as documented by the recent finding that IgE sensitization to common foods did not increase among any racial/ethnic group from the early 1990s to the mid-2000s.³ It is possible that black children who are food sensitized were historically less likely to report FA; however, to our knowledge, no population-based studies in the United States have directly examined this

question. This study used a nationally representative sample (the National Health and Nutrition Examination Survey [NHANES] III) in which we recently measured food specific IgE (sIgE) to determine whether there were racial/ethnic and socioeconomic differences in the association between sensitization to common foods and self-reported FA.

Participants aged 6 to 19 years from NHANES III part 2 (1991–1994) were included. Frozen stored serum samples were recently analyzed for peanut, milk, egg, and shrimp sIgE by ImmunoCap as previously described.³ Food sensitization was defined as peanut, milk, egg, or shrimp sIgE levels of 0.35 kU/L or higher. Self-reported FA was defined as a positive response to the following question: “Within an hour after eating something, has [the subject] ever had a severe reaction, such as itching all over, trouble breathing, flushing, hives, or swelling of the face or hands or feet?” Race/ethnicity was obtained by self-report and was categorized as non-Hispanic white, non-Hispanic black, and Mexican American. Household income was defined as the ratio of family income to the poverty threshold, as defined by the US Census Bureau, and a Poverty Income Ratio less than 1 was considered poor.

Overall, 2,673 children had sIgE measured and questionnaire data regarding food reactions (eTable 1). A total of 23.5% (95%

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Table 1
Distribution of Food Sensitization and Self-report of Food Allergy by Race and Sex (N = 2,673)

Variable	All foods sIgE	P value	Peanut sIgE	P value	Egg sIgE	P value	Milk sIgE	P value	Shrimp sIgE	P value	FA	P value	FA and sIgE ^a	P value
Total	23.5 (21.0–26.2)	NA	10.1 (8.1–12.3)	NA	3.0 (2.2–4.1)	NA	8.5 (7.1–10.2)	NA	11.3 (9.7–13.2)	NA	8.0 (6.2–10.3)	NA	2.7 (1.8–4.0)	NA
Race/ethnicity														
White	17.2 (14.4–20.4)	<.001	9.0 (6.9–11.7)	.39	3.0 (1.9–4.8)	.005	5.6 (4.1–7.5)	<.001	6.6 (4.8–9.1)	<.001	9.0 (6.7–12.0)	.09 ^b	2.5 (1.5–4.2)	.05
Black	36.0 (33.4–38.6)		13.0 (10.9–15.4)		4.9 (3.8–6.2)		12.8 (11.0–14.8)		20.6 (18.2–23.3)		4.5 (3.4–5.9)		2.1 (1.5–3.0)	
Mexican American	28.5 (23.9–33.5)		9.8 (7.2–13.1)		2.2 (1.3–3.5)		12.2 (9.9–14.9)		12.5 (10.3–15.1)		4.9 (3.3–7.3)		0.9 (0.4–2.1)	
Sex														
Male	25.6 (22.2–29.3)	.04	11.9 (8.9–15.7)	.06	3.2 (2.1–5.0)	.43	9.6 (7.5–12.3)	.17	12.0 (9.7–14.7)	.40	8.6 (6.2–11.7)	.57	3.6 (2.2–6.1)	.09
Female	21.2 (18.3–24.4)		8.1 (6.1–10.8)		2.7 (1.9–3.8)		7.4 (5.6–9.7)		10.7 (8.7–13.0)		7.5 (5.2–10.7)		1.7 (0.9–3.3)	

Abbreviations: FA, food allergy; PN, peanut; NA, not applicable; sIgE, specific IgE.

Values are expressed as percentages (95% confidence intervals).

^aFood sIgE to peanut, egg, milk, or shrimp.^bP = .001 for black vs white and P = .02 for Mexican American vs white. P values were obtained by the χ^2 test.

confidence interval [CI], 21.0%–26.2%) were sensitized to peanut, milk, egg, or shrimp, 8.0% (95% CI, 6.2%–10.3%) reported FA, and 2.7% (95% CI, 1.8%–4.0%) were both sensitized to food and reported FA (Table 1). Sensitization to foods was significantly higher among black than white or Mexican American children (Table 1). In contrast, self-reported FA was significantly less common among black and Mexican American children than white children ($P = .001$ and $P = .02$, respectively).

The association between overall food sensitization and self-reported FA was strongly dependent on race/ethnicity and income (eFig 1 and eFig 2). When examining the individual foods, peanut sensitization and self-reported FA were strongly associated but only among white children (eFig 1). Similarly, there was an association among these measures only among higher-income children (eFig 2). Race/ethnicity did not explain the poverty association completely or vice versa (data not shown). Similar results were seen for egg but not milk or shrimp sensitization; shrimp sensitization had no association with report of FA overall or in any group (data not shown).

In conclusion, we found that the association between self-reported FA and food sensitization was strongly dependent on race/ethnicity and socioeconomic status in a population-based sample from the early 1990s, suggesting historical under-recognition of FA among poorer and minority children or alternatively overrecognition among high-income and nonminority groups. Although sensitization to foods is a poor marker for clinical FA,⁴ we would expect some association between food sensitization and clinical FA and thus self-reported FA, as we indeed found for certain groups here. The fact that this association was seen only among higher income and white children may explain why, historically, there were not disparities in reported FA despite higher levels of sensitization to common foods among black children.

Other evidence to support differential recognition and diagnosis of FA by race/ethnicity and income includes the finding of Gupta et al⁵ that poor and minority children are less likely to receive a physician's evaluation when FA is suspected and our recent observation that despite high rates of clinical FA in inner-city children when rigorously assessed,⁶ children living in inner-city areas report less FA than their suburban and affluent counterparts after adjusting for race/ethnicity.⁷

Differences in recognition, however, may not solely explain these findings; it is also possible that the association between sensitization and FA varies among different racial/ethnic and socioeconomic groups. Differences in allergen introduction, for example, could lead to differences in the association between sIgE and FA symptoms. In a recent clinical trial, early introduction of allergenic foods did not affect IgE sensitization, whereas clinical FA and skin prick wheal size were suppressed.⁸ It is possible that in response to expert opinion, higher-income families delayed introduction of allergenic foods in the late 1980s and that this trend spread to other groups later.

We further found that the association between food sensitization and self-reported FA was different for peanut, egg, milk, and shrimp. Although there was an overall correlation between sensitization to peanut, egg, or milk and self-reported severe reactions to food, no such correlation was seen for shrimp. This finding suggests that alternative exposures, such as dust mite or cockroach, may be driving shrimp sensitization, as has been previously hypothesized,⁹ and that much of the shrimp sensitization may be clinically meaningless. In terms of the other foods, the association between peanut and egg sensitization and self-reported allergy was most strongly affected by race/ethnicity and income. This may reflect the fact that all participants were older than 6 years, when most milk allergy has resolved, or may reflect different patterns of introduction and recognition of symptoms for milk allergy.

Limitations of this analysis include the fact that FA is defined based on self-report, which has been found to overestimate FA when defined by positive oral food challenges.¹⁰ However, because the question used in this survey assessed acute reactions, positive responses are more likely to represent true IgE-mediated FA. Furthermore, sIgE was only measured to peanut, milk, egg, and shrimp, which do not comprise all the known food allergens. These allergens, however, account for approximately 80% of FA in children.¹¹ In addition, these are historical data, with no comparison available to current times. Because self-reported FA has increased among non-Hispanic blacks in recent times, we might expect that a current study would reveal more correlation between sensitization and self-reported FA among all racial/ethnic groups.

These limitations are balanced by the large representative sample, rigorous procedures within NHANES, and measurement of sIgE in an unselected population. To our knowledge, there are no other population-based studies that have examined the contribution of demographic features to the association between self-reported FA and markers of sensitization.

In summary, this study, combined with our recent finding that sIgE to peanut, milk, egg, and shrimp did not increase across a period where self-reported FA increased, supports a hypothesis that changes in recognition of FA may underlie recent increases in the report and diagnosis of this condition. However, we cannot exclude the possibility that environmental exposures correlated with socioeconomic status modify the association between sensitization and clinical FA.

Supplementary Data

Supplementary data related to this article can be found at <http://dx.doi.org/10.1016/j.anai.2016.08.034>.

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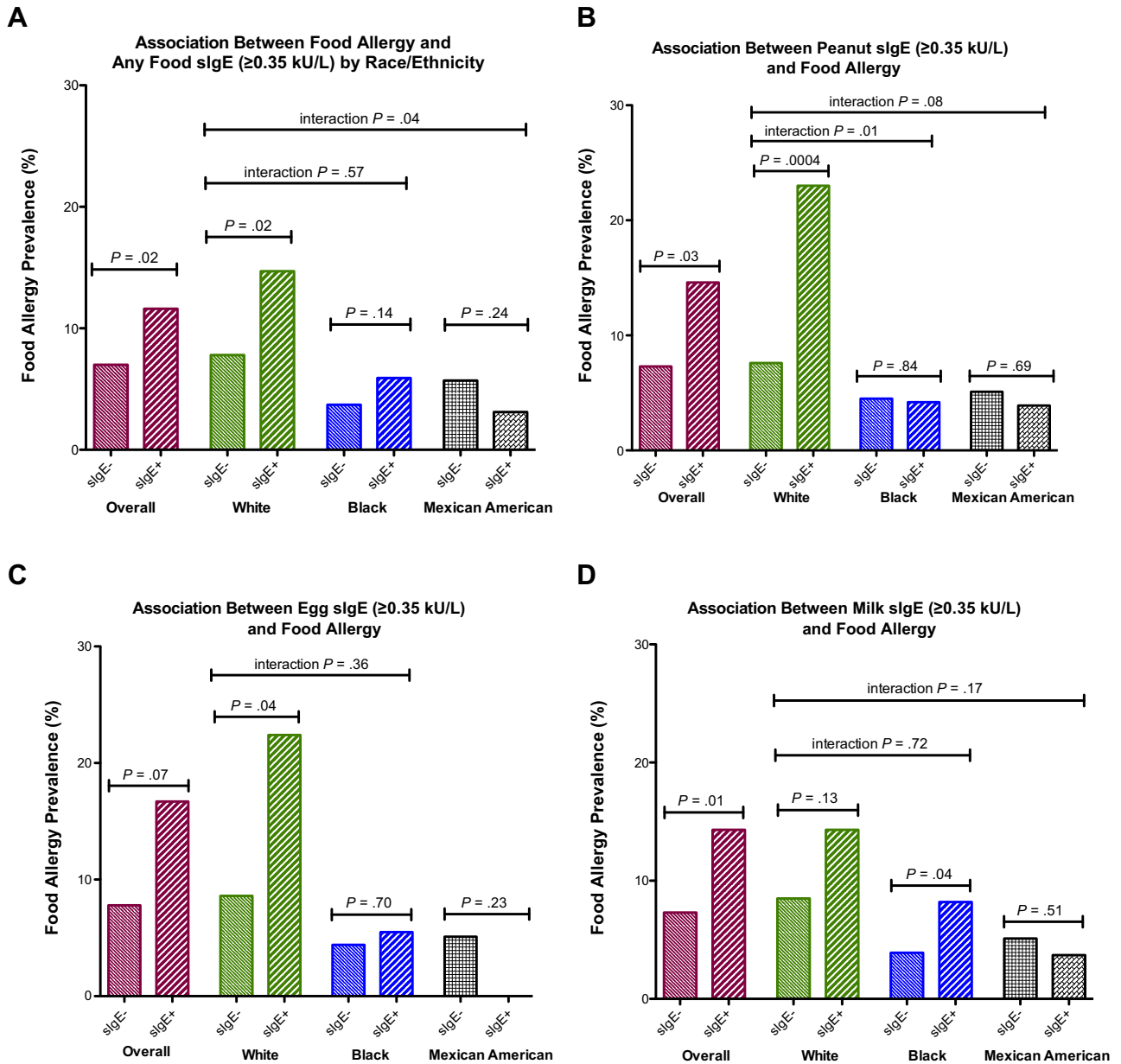


Figure 1. Association between food sensitization and self-reported food allergy (FA) by race/ethnicity. Food sensitization was defined as a specific IgE (sIgE) level of 0.35 kU/L or greater to peanut, milk, egg, or shrimp (A), peanut (B), egg (C), and milk (D).

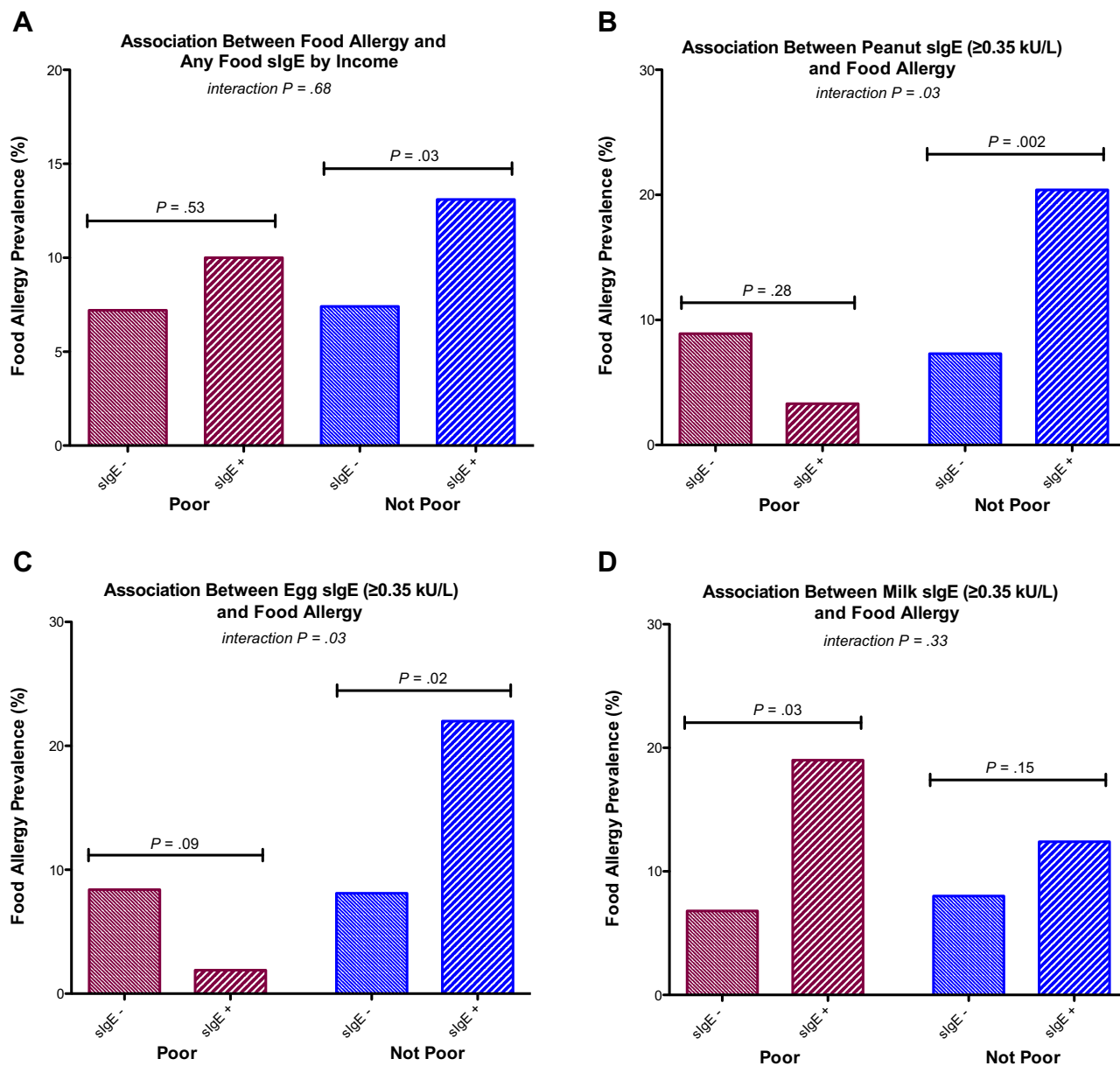


Figure 2. Association between food sensitization and self-reported food allergy (FA) by income. Food sensitization was defined as specific IgE (sIgE) level of 0.35 kU/L or greater to peanut, milk, egg, or shrimp (A), peanut (B), egg (C), and milk (D).

eTable 1Demographic Characteristics of Study Population in NHANES III (N = 2,673)^a

Characteristic	Finding
Age, mean (SE), y	12.4 (12.2–12.6)
Sex	
Male	51.6 (50.6–52.5)
Female	48.5 (47.6–49.4)
Race/ethnicity	
Non-Hispanic white	64.9 (59.8–69.6)
Non-Hispanic black	15.6 (13.8–17.6)
Mexican American	8.9 (8.2–9.7)
Other	10.6 (6.9–15.9)
Poverty Income Ratio	
≤1.0	25.4 (21.8–29.4)
>1.0	74.6 (70.6–78.2)
Food allergy outcomes	
Any food sIgE ≥0.35 kU/L ^b	23.5 (21.0–26.2)
Peanut sIgE ≥0.35 kU/L	10.1 (8.1–12.3)
Egg sIgE ≥0.35 kU/L	3.0 (2.2–4.1)
Milk sIgE ≥0.35 kU/L	8.5 (7.1–10.2)
Self-report of any food allergy	8.0 (6.2–10.3)

Abbreviations: NHANES, National Health and Nutrition Examination Survey; sIgE, specific IgE.

^aValues are expressed as percentages (95% confidence intervals) except where noted and are weighted.

^bDefined as milk, egg, peanut, or shrimp IgE level of 0.35 kU/L or higher.