HHS Public Access

Author manuscript

J Allergy Clin Immunol Pract. Author manuscript; available in PMC 2022 July 01.

Published in final edited form as:

J Allergy Clin Immunol Pract. 2021 July ; 9(7): 2867–2873.e1. doi:10.1016/j.jaip.2020.12.026.

African American children are more likely to be allergic to shellfish and finfish: findings from FORWARD, a multisite cohort study

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Abstract

Background: Despite major differences in health profiles and rates of health care utilization between African American (AA) and White children with food allergy (FA), the detailed phenotypic variables that can potentially impact these outcomes have not been thoroughly studied.

Objective: We aimed to characterize phenotypic differences such as allergies to different foods and allergic comorbidities between AA and White children with FA enrolled in the Food allergy management & Outcomes Related to White and African American Racial Differences (FORWARD) study.

Methods: Our active, prospective, multi-center cohort study is currently enrolling AA and White children aged 0–12 years diagnosed with FA and followed by allergy/immunology clinics at four urban tertiary centers in the US. To evaluate associations between race and phenotypic variables,

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Conflict of Interest Statement: 1- All authors are supported by FORWARD (NIH number: 1R01AI130348–01A1)
2 - Mahboobeh Mahdavinia is supported by KL2TR002387–02 from NIH and Brinson Foundation grant.

we used multivariable logistic regression, adjusting for important demographic and cofounding factors, as well as potential household clustering.

Results: As of May 2020, there were 239 AAs and 425 Whites with complete intake information enrolled in the study. In comparison to Whites, we found that AAs had significantly higher adjusted odds of allergy to finfish (OR: 2.54, p<0.01) and shellfish (OR: 3.10, p< 0.001). AAs also had higher adjusted odds of asthma than Whites (asthma prevalence of 60.5% in AAs and 27.2% in Whites, OR: 2.70, p<0.001). In addition, shellfish allergy was associated with asthma, after controlling for race.

Conclusion: Among a diverse cohort of children with physician-diagnosed FA, we observed that AA children had higher odds of allergy to shellfish and finfish, and higher rates of asthma. Interestingly, having asthma was independently associated with allergy to shellfish, after controlling for race.

Keywords

FORWARD; Food allergy; race; African American; asthma

Introduction:

Despite advancements in science and medicine, many children lack essential health-related necessities. This problem is not confined to underdeveloped or developing populations; even in advanced and developed countries such as the United States (US), medical care is not distributed equitably. Health disparities impact health outcomes, and in the case of some diseases such as food allergy (FA), the impact can be very significant. A major public health concern, FA affects approximately 8% of children in the US and its prevalence has increased in recent decades.(1–4) The impact of FA spans beyond reactions such as anaphylaxis and can result in chronic anxiety, diminished quality of life (QoL), and impaired psychosocial development.(5, 6) Recent studies from our group and others have found African American (AA) children to be at an increased risk for FA and its associated morbidities. (1, 7, 8)

Previous research indicates that FA and food sensitization are often associated with other common allergic conditions such as atopic dermatitis (AD), allergic rhinitis (AR), and asthma.(1) In children with asthma, food-allergic reactions can result in life-threatening asthma attacks, leading to hospitalization or even death. (9, 10) In fact, a previous retrospective study showed that AA children with FA had a higher rate of comorbid asthma compared with White children with FA.(7) Therefore, further understanding of the phenotype of FA in AAs may not only improve management practices for FA itself, but also can alleviate its potential detrimental impact associated with other atopic comorbidities in these children. Dietary differences of children with diverse racial backgrounds (11, 12) may also affect the development of FA. For example, racial disparities may exist in the rates of allergy to different foods and the amount of exposure in early life, the association between early life diet and atopy and FA, and the impact of FA on QoL. Previous studies based on chart review and retrospective data acquisition have shown different food allergen profiles in AA and White children. (7) However, prospective data on the association of race on allergies

to different foods, adjusting for important confounding variables such socioeconomic factors is limited.

These alarming differences between racial groups prompted our multicenter collaborative group to conduct studies on FA disparity among AA and White children. The objective of FORWARD (Food Allergy Outcomes Related to White and African American Racial Differences) is to compare FA clinical and psychosocial outcomes, FA phenotypes and endotypes, and FA management practices among a large, socioeconomically and geographically diverse sample of AA and White children. Characterizing these differences will inform future interventions and policies to address the specific needs of patients with FA and their families to ultimately improve FA outcomes. In the current report we have focused on the food allergen profiles and associated comorbidities of AA and White children while investigating these differences in the context of socioeconomic disparities.

Methods

Data Source

Data were sourced from the FORWARD study, NIH-funded, multi-center prospective cohort of AA and White children with FA at four urban tertiary centers in the US. Data collection has been ongoing since 2017 and will continue through 2021. These centers include the Allergy and Immunology Divisions of Ann & Robert H. Lurie Children's Hospital of Chicago/Northwestern University (NU/Lurie), Cincinnati Children's Hospital Medical Center (CCHMC), Children's National Health Systems (CNHS), and Rush University Medical Center (RUMC). The study was approved by the Institutional Review Boards of all involved institutes.

Eligibility for FORWARD includes AA and White children, 0 to 12 years of age with an allergist confirmed diagnosis of IgE-mediated FA. There were 12 participants excluded from the current analyses given that they reported race other than AA or White (i.e., Other n=10, Native Hawaiian Pacific Islander n=1, Unknown n=1). A maximum of two eligible children from each household were enrolled; 7.3% of households in the current sample had more than one child enrolled. When the analyses were performed on the sample of children from n=619 households with only a single child enrolled, the results were similar. Diagnosis of FA required convincing clinical symptoms (i.e., cutaneous, respiratory, gastrointestinal, systemic) of an IgE-mediated reaction to a specific food and either an elevated serum specific IgE measured by ImmunoCAP assay (Phadia AB, Uppsala, Sweden) based on manufacturers values or a positive skin test measured by a wheal of 3mm or above on standard skin prick test (Greer Laboratories Inc, Lenoir, North Carolina) to that specific food(s). In the case of food groups such as tree nuts, fish and shellfish, evidence of allergy to one or more types of food allergens within the group was considered positive allergy history to that food group.

The present study utilized cross-sectional data from FORWARD's intake survey, based on participant-report (Repository Text). Specifically, during the intake visit, parents/guardians of eligible children met with research coordinators from the respective site and completed FA surveys on multiple phenotypic variables, including participant-report of physician-

confirmed items on type of food allergen, food-related allergic reactions, and history/current status of atopic comorbidities. The diagnosis of comorbid conditions (including asthma, allergic rhinitis and eczema) was confirmed by chart review and consulting with their primary allergist, given that these children were active patients at one of the study sites and FA was the primary eligibility criterion for the FORWARD study. Additionally, surveys acquired participant-report of demographic information including race, ethnicity, date of birth, gender, and yearly household income.

Primary Outcomes of Interest

The primary outcomes of interest were current "top 9" food allergens and presence and/or history of atopic comorbidities. Current food allergies were based on participant report of the survey item "To which food(s) is [Child's name] currently allergic". Categories of "top 9" food allergens (i.e., peanuts, tree nuts, milk, egg, wheat, soy, finfish, shellfish, sesame) included positive, negative, or unknown/missing. Atopic comorbidities including asthma, eczema, and allergic rhinitis were also categorized according to positive, negative, or unknown/missing participant response. Current asthma status was based on the survey item, "Does your child have asthma?" while eczema and allergic rhinitis were based on participant report of having ever been diagnosed with these conditions

Primary Independent Variable

The primary independent variable of interest was race, based on the survey item which asked participants to report "With which race does (Child's name), your child with food allergy primarily identify?". Children from mixed-race background were not included in the study. Each participant was assigned to AA or White groups based on their response to NIH recommended race and ethnicity categories (NIH policy notice NOT-OD-01–053). Specifically, responses for race included "White or Caucasian", "Black or African-American," "American-Indian or Alaskan Native", "Asian or Asian American," "Native Hawaiian or Pacific Islander", "Other", or "Unknown". Participants also responded to a survey item asking, "Is your child of Hispanic or Latinx origin?". Children of White race and non-Hispanic/Latinx ethnicity were categorized as White. Children who identified as AA and non-Hispanic were categorized as AA. The present study included non-Hispanic/Latinx White and AA children whose parents self-identify as either AA or White.

Covariates

Other demographic variables of interest included gender (male/female), current age in years, and yearly household income. Current age was calculated from the participant reported date of birth and analyzed as an indicator of < 5 years of age (yes/no). Yearly household income was categorized as less than $50,000 per year, $50,000 to $99,000, or $100,000 or greater.

Statistical Analysis

Data from each respective FORWARD recruitment site were exported from Research Electronic Data Capture (REDcap) databases and pooled for the purpose of the current analyses. We used univariable statistics to describe the primary phenotypic variables of interest and demographics. We performed a complete case analyses whereby the

denominator for each calculation included participants with non-missing data on the survey item of interest. Chi-square tests evaluated unadjusted associations between race (AA/White) and primary outcome indicators. We used separate multivariable logistic regressions to calculate the adjusted probability of having each of the “top 9” food allergies and/or atopic comorbidities, with White race as the reference group for all adjusted odds ratios. For inclusion into multivariable analyses, food allergies and atopic comorbidities were analyzed as binary indicators of having (or had) the condition (yes/no). All multivariable models included family-level robust standard errors to adjust for potential household clustering. Additionally, all models were adjusted for current age, gender, household income, and recruitment site. Significance tests were two-sided with an alpha level of < 0.05. All statistical analyses were performed using Stata SE Version 15.1 (StataCorp. 2017. College Station, TX.).

Results

A total of 239 AAs and 425 White children with a diagnosis of FA were included in these analyses. Demographic and clinical characteristics, as well as comparisons between the four sites are detailed in Table 1. The racial distribution of enrolled cases was different among the centers, as AA constituted a larger percentage of enrolled cases at RUMC compared with Lurie Children’s Hospital.

The adjusted comparisons of the two races in terms of demographic factors are detailed in Table 2. Whites had a median age of 5.7 years (interquartile range [IQR]: 3.4 to 9.5) while AAs had a median age of 8.0 years (IQR: 5.2 to 11.5). Gender was similarly distributed between races. As seen in Table 2, families of AA and White children had significantly different distributions of annual household income. Among White families, 80.0% had annual incomes of $100,000 or greater, whereas 21.8% of AA families had annual incomes of $100,000 or greater.

Race and comorbid allergic conditions:

Also shown in Table 2, AA children had significantly higher odds of comorbid asthma than White children after adjusting for gender, age, annual household income, and recruitment site (OR: 2.70, $P<0.0001$). The adjusted odds of other atopic comorbidities such as allergic rhinitis and atopic dermatitis were similar between the two race groups.

Race and types of foods associated with FA:

As indicated in Table 3, we found a significantly higher adjusted odds of allergy to two food group allergens in AAs compared to White children; finfish (OR [95%confidence interval (CI)] = 2.54 [1.42 – 4.56]) and shellfish (OR[95%CI]= 3.11 [1.63 – 5.93]). Furthermore, we observed a trend towards higher odds of wheat allergy among AAs compared to Whites (OR [95%CI] = 2.10 [0.87 – 5.04], P=0.097). We also observed a trend towards a lower odds of sesame allergy among AAs compared to Whites (OR [95%CI]=0.52 [0.27 – 1.00], P=0.053).

Association of food allergens and asthma:

Children with shellfish allergy had a significantly higher odds of asthma (OR: 1.94, P=0.024) after adjusting for race, gender, age, household income, and recruitment site. Other food allergens were not associated with presence of asthma.

Discussion

In this multi-center prospective study, the adjusted odds of allergy to shellfish was significantly higher among AAs in comparison to Whites, and this association remained in magnitude when the analyses were stratified by site, lending further evidence to the robustness of this observation. It is hypothesized that sensitization to shellfish might occur through inhalation of a similarly structured protein with a common peptide chain between some inhaled allergens and shellfish; tropomyosin. (13–15) Shrimp tropomyosin (Pen a 1) and cockroach (Per a 7) share 80% amino acid sequencing.(13) Increase in cockroach allergen exposure in the home is seen with higher shrimp allergen and cockroach IgE. (16, 17) Positive skin test to shrimp allergen in an observant population of Jewish individuals who were allergic to cockroach and/or dust mite but unexposed to shellfish further confirmed that sensitivity to shellfish could be due to cross-reacting tropomyosins. (18) An increase in the level of cockroach allergen which is known to be higher in low socioeconomic inner-city areas where most residents are AA (19) may provoke cross sensitization for shellfish allergy in the AA children. Similarly, we have observed a higher rate of finfish allergy in AA children compared to whites. Tropomyosins are identified as allergens in commonly consumed finfish.(20) and IgE-binding to fish tropomyosins was recently demonstrated in fish allergic patients.(21, 22) While further investigation is needed to tease out the exact mechanism of this link, preventive studies to decrease the exposure of these at-risk AA children to cockroach can potentially prevent food allergy and improve asthma control. Further analysis of fish and shellfish as individual allergens showed significant racial differences in the unadjusted analyses for all analyzed finfish and shellfish (Table E1) which indicates that the differences are shared among most allergens in these groups. To understand whether the geographic distribution and proximity to large bodies of water can impact the association to race with seafood allergy we evaluated the relationship between race and the adjusted probability of having finfish or shellfish allergies in Chicago, Cincinnati and DC separately. We found that in all Midwest centers, Black children had significantly higher adjusted probability of both finfish and shellfish allergies. However, when the sample is restricted to only DC (our only east coast center), the adjusted probabilities are maintained in magnitude with respect to shellfish but not finfish. Given that very few children (n=15) had finfish allergy in the DC site, there is a lack of statistical power to detect these associations which could have resulted in the negative finding. Further larger studies are needed to investigate the link between AA race and seafood allergy stands in all geographic areas.

The higher prevalence of asthma in AA children with FA compared with White children with FA is an important epidemiologic finding. Asthma accompanies fatal food anaphylaxis 70 % of the time with cardiovascular collapse attributed to respiratory failure.(23, 24) What further signifies this increased rate of asthma is the fact that AA children bear an unequally

higher burden of asthma-related morbidity and mortality in comparison to their White counterparts. (25) This is markedly pertinent to FA because uncontrolled asthma is a risk factor for fatal anaphylaxis in the food allergy setting (9, 10), which places these AA children at significantly greatest risk. Specifically, AA girls and boys are at a nearly two-fold and three-fold greater risk of FA-related fatal anaphylaxis than White girls and boys, respectively. (26) This is evident by previously reported increased need for immediate healthcare utilization in AA children for both ED visits (7) and hospital admissions for food-induced anaphylaxis. Unfortunately, this problem in AA children has been increasing, at least regionally, from 2008–2012 in Illinois. (27)

The significant difference in household incomes between AA and white families in our study is yet again an evidence of the economic disparities between these children. These economic burdens can directly affect social determinants of health and food access in children and have significant impacts in children with food allergy. These results emphasize the necessity of specialty programs for these AA children with FA and asthma. Programs that are multi-level, meaning that they address organizations as well as individuals within the community. Such programs could be the most helpful when addressing health disparities and access to care.(28, 29) An example of such a model that addresses the social determinants of health through an innovated Medicaid model is the Coordination of Healthcare for Complex Kids (CHECK).(30) This program included chronic diseases in children, most commonly asthma, to ensure adequate resources were available to families to navigate the complicated health system.(30, 31) Preliminary outcomes in asthma are described in the literature, and Illinois has adopted this chronic disease model by introducing policy that calls for large-scale care coordination programs that work with managed care organizations to address health disparities. These models, and others, that address health disparities at the core, can help families improve access to equitable care.(32) Similar programs are necessary to address food allergy management issues such as food insecurity and access, to reduce the risk of accidental ingestions that could put these children at greater risk.

Although this study provides important findings on the relation between race and food allergy, it has some limitations. Race is a self-reported variable in this study. Furthermore, this large cohort includes FA children from four urban allergy and immunology clinics, three in the Midwest and one on the East coast of the US; while these centers are fairly well distributed geographically, the overall participant distribution may not represent US children with FA in general. The percentage of enrolled children above age of 5 was lower at CCHMC and CNHS compared to Lurie Children hospital which represents a slightly different overall age groups of these clinics. However, as all analysis are adjusted for age, this difference would not impact the findings. Another limitation is that the number of enrolled white children is higher than AA children. AA children constituted a lower percentage of enrolled cases at Lurie Children hospital compared to RUMC, which reflects the different racial distribution of patients in these centers across the same city. Inclusion of centers with different racial break down and economic background (as evidenced by annual income) was intentional to represent a more diverse population.

In conclusion, we found that AA children had different food allergen profiles and higher prevalence of associated asthma. As FA can increase the chance of life-threatening asthma

attack,(8, 9) the higher prevalence of asthma observed among AA children might increase their risk of severe respiratory reactions. These data reinforce previous findings and point to the need for implementation of strategies to create unique management tools for all children with food allergy, especially those from lower income families and AA children with comorbid asthma and eczema. Our ongoing studies on the FORWARD cohort are designed to further investigate different cultural practices and behavioral factors impacting risk factors such as early introduction of food/s by race and ethnicity. Quarterly surveys are being administered to obtain comprehensive data such as how socioeconomic and cultural difference impact the food and diet purchasing habits, accessibility to healthcare and parental/family burdens. Our goal is to understand differences by race and ethnicity in all aspects of food allergy to be able to provide individualized care to improve management and decrease FA morbidity and mortality.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgment:

FORWARD (NIH number: 1R01AI130348-01A1), MM is also supported by KL2TR002387-02 from NIH and Brinson Foundation grant.

Abbreviations:

FORWARD	Food allergy management & Outcomes Related to White and African American Racial Differences
FA	Food allergy
AA	African-American
AD	Atopic dermatitis
RUMC	Rush University Medical Center
CCHMC	Cincinnati Children’s Hospital Medical Center
EMR	electronic medical records

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Highlights Box

1. What is already known about this topic? Previous studies have shown that FA, food sensitization and dietary differences of children with diverse racial background and phenotype are often associated with other common allergic conditions such as atopic dermatitis, asthma and allergic rhinitis.
2. What does this article add to our knowledge? Higher prevalence of asthma and allergy to shellfish observed among AA children increases risk of severe potentially fatal reactions.
3. How does this study impact current management guidelines? Understanding the varied risk of allergy to different food allergens in AA children compared to whites, will guide our clinical practice in terms of history taking and additional testing.

Table 1.

Demographic and clinical characteristics of African-American and White children with food allergy enrolled in FORWARD

	Total	**Northwestern/Lurie**		**Rush**		**CCHMC**		**CNHS**	
	n (%)	**n (%)**	**Odds Ratio (95% CI)**[7]	**n (%)**	**Odds Ratio (95% CI)**	**n (%)**	**Odds Ratio (95% CI)**	**n (%)**	**Odds Ratio (95% CI)**
Individual Demographics									
Total n=664	**664 (100)**	**226 (100)**	–	**133 (100)**	–	**158 (100)**	–	**147 (100)**	
Race									
African-American	239 (36.0)	70 (31.0)	1 (ref)	75 (56.4)	–	44 (27.9)	–	50 (34.0)	–
White	425 (64.0)	156 (69.0)		58 (43.6)	**0.35 (0.22 – 0.54)** ***	114 (72.2)	1.16 (0.74 – 1.82)	97 (66.0)	0.87 (0.56 – 1.35)
Gender[1]									
Male	411 (62.7)	130 (57.8)	–	89 (68.5)	–	96 (61.9)	–	96 (63.8)	–
Female	245 (37.4)	95 (42.2)	1 (ref)	41 (31.5)	**0.63 (0.40– 0.99)** *	59 (38.1)	0.84 (0.55 – 1.27)	50 (32.9)	0.71 (0.46 – 1.09)
Current Age in Years[2]									
< 5	229 (35.0)	62 (27.7)	–	39 (30.0)	–	59 (38.3)	–	69 (47.3)	–
>=5	425 (65.0)	162 (72.3)	1 (ref)	91 (70.0)	0.89 (0.55 – 1.44)	95 (61.7)	**0.62 (0.40 – 0.95)** *	77 (52.7)	**0.43 (0.28 – 0.67)** ***
Household Demographics									
Total n=619	**619 (100)**	**208 (100)**	–	**124 (100)**	–	**153 (100)**	–	**134 (100)**	–
Income[3]									
< $50K	123 (22.9)	39 (21.4)	–	36 (34.3)	–	30 (22.9)	–	18 (15.0)	–
$50k-$99k	94 (17.5)	22 (12.1)	–	20 (19.1)	–	36 (27.4)	–	16 (13.3)	–
100k+	321 (59.7)	121 (66.5)	1 (ref)	49 (46.7)	**0.44 (0.27 – 0.72)** **	65 (49.6)	**0.50 (0.31 – 0.79)** **	86 (71.7)	1.27 (0.77 – 2.10)
Comorbidities									
Total	**664 (100)**	**226 (100)**	–	**133 (100)**	–	**158 (100)**	–	**147 (100)**	–
Asthma[4]									
Yes	247 (38.9)	88 (39.5)	1 (ref)	52 (42.3)	1.09 (0.70 – 1.72)	57 (38.8)	0.94 (0.61 – 1.44)	50 (35.2)	0.81 (0.52 – 1.26)
No	369 (58.1)	126 (56.5)	–	68 (55.3)	–	87 (59.2)	–	88 (62.0)	–
Outgrown	19 (3.0)	9 (4.0)	–	3 (2.4)	–	3 (2.0)	–	4 (2.8)	–

	Total	Northwestern/Lurie		Rush		CCHMC		CNHS	
	n (%)	**n (%)**	**Odds Ratio (95% CI)**[7]	**n (%)**	**Odds Ratio (95% CI)**	**n (%)**	**Odds Ratio (95% CI)**	**n (%)**	**Odds Ratio (95% CI)**
Allergic Rhinitis[5]									
Yes	297 (46.9)	98 (44.0)	1 (ref)	65 (47.5)	1.41 (0.91 – 2.19)	67 (45.6)	1.06 (0.70 – 1.62)	68 (47.9)	1.17 (0.76 – 1.79)
No	337 (53.2)	125 (56.1)	–	59 (43.1)	–	80 (54.4)	–	74 (52.1)	–
Eczema[6]									
Yes	524 (81.9)	185 (83.0)	1 (ref)	90 (73.8)	**0.58 (0.34 – 0.98)***	126 (85.1)	1.17 (0.66 – 2.08)	119 (83.8)	1.06 (0.60 – 1.87)
No	115 (18.1)	38 (17.0)	–	32 (26.2)	–	22 (14.9)	–	23 (16.2)	–

[1] n=8 individuals (1.2%) had missing gender data; n=1 from NU/Lurie, n=3 from Rush, n=3 from CCHMC, n=1 from CNHS

[2] n=10 individuals (1.5%) had missing age data; n=2 from NU/Lurie, n=3 from Rush, n=4 from CCHMC, n=1 from CNHS

[3] n=81 households (13.1%) had missing income data or declined to answer; n=26 from NU/Lurie, n=19 from Rush, n=22 from CNHS, n=14 from CCHMC

[4] n=29 individuals (4.4%) had missing asthma data; n=3 from NU/Lurie, n=10 from Rush, n=11 from CCHMC, n=5 from CNHS

[5] n=30 individuals (4.5%) had missing data on allergic rhinitis; n=3 from NU/Lurie, n=11 from Rush, n=11 from CCHMC, n=5 from CNHS

[6] n=29 individuals (4.4%) had missing data on eczema; n=3 from NU/Lurie, n=11 from Rush, n=10 from CCHMC, n=5 from CNHS

[7] Odds ratios represent the unadjusted probability estimate of the italicized row in each recruitment center compared to NU/Lurie (reference group). Odds ratios for income are based on probability of earning > 100k versus <$50k and for asthma are based on having asthma (outgrown asthma, n=19 was excluded) versus not having asthma.

Bold values represent statistical significance;

* P < 0.05;

** P < 0.01;

*** P < 0.001

Table 2.

Adjusted probability of demographic and clinical characteristics among African-American and White children with food allergy enrolled in FORWARD

	White		African-American	
	n (%)	**Odds Ratio (95% CI)**	**n (%)**	**Odds Ratio (95% CI)**[7]
Individual Demographics				
Total n=664	**425 (100)**		**239 (100)**	
Gender[1]				
Male	255 (60.6)	–	156 (66.4)	–
Female	166 (39.4)	1 (ref)	79 (33.6)	0.72 (0.44 – 1.18)
Current Age in Years[2]				
< 5	179 (42.7)	–	50 (21.3)	–
>=5	240 (57.3)	1 (ref)	185 (78.7)	**3.93 (2.32 – 6.67)** ***
Household Demographics				
Total n=619	**398 (100)**		**221 (100)**	
Income[3]				
< $50K	16 (4.6)	–	107 (56.9)	–
$50k-$99k	54 (15.4)	–	40 (21.3)	–
100k+	280 (80.0)	1 (ref)	41 (21.8)	**0.05 (0.03 – 0.08)** ***
Comorbidities				
Total n=664	**425 (100)**		**239 (100)**	
Asthma[4]				
Yes	112 (27.2)	1 (ref)	135 (60.5)	**2.70 (1.65 – 4.43)** ***
No	286 (69.4)	–	83 (37.2)	–
Outgrown	14 (3.4)	–	5 (2.2)	–
Allergic Rhinitis[5]				
Yes	158 (38.4)	1 (ref)	139 (62.6)	1.47 (0.85 – 2.53)
No	254 (61.7)	–	83 (37.4)	–
Eczema[6]				
Yes	334 (80.9)	1 (ref)	186 (83.8)	1.03 (0.55 – 1.92)
No	79 (19.1)	–	36 (16.2)	–

[1] n=8(1.2%) had missing gender data; n=4 White, n=4 African-Americans

[2] n=10 individuals (1.5%) had missing age data; n=4 White, n=6 African-Americans

[3] n=81 (13.1%) households had missing income data; n=48 White, n=33 African-American

[4] 29 individuals (4.4%) had missing data on asthma; n=13 White, n=16 African-Americans

[5] 30 individuals (4.5%) had missing data on allergic rhinitis; n=13 White, n=17 African-Americans

[6] n=29 individuals (4.4%) had missing data on eczema; n=12 White, n=17 African-Americans

[7] Odds ratios represent the probability of the italicized row outcome in comparison to White children (reference group), adjusted for demographic covariates. Adjusted ratios for income are based on probability of earning >= $100k in comparison to < $50k; ratios for asthma model are based on having asthma versus not.

Bold values represent statistical significance;

* P < 0.05;

** P < 0.01;

*** P < 0.001

Percentages may add to over 100 due to rounding

Table 3.

Adjusted probability of current food allergies among African-American and White children with food allergy enrolled in FORWARD

	Total	White		African-American	
	n(%)	n(%)	Odds Ratio (95% CI)	n (%)	Odds Ratio[1] (95% CI)
Total n=664	**664(100)**	**425 (100)**		**239 (100)**	
Number of "Top 9" Current Food Allergies					
None	21 (3.2)	10 (2.4)	–	11 (4.6)	–
One	224 (33.7)	154 (36.2)	–	70 (29.3)	–
Multiple (more than one)	419 (63.1)	261 (61.4)	1(ref)	158 (66.1)	1.13 (0.70 – 1.81)
Type of Current Food Allergy					
Peanut	421 (63.4)	266 (62.6)	1 (ref)	155 (64.9)	0.87 (0.55 – 1.40)
Milk	158 (23.8)	107 (25.2)	1 (ref)	51 (21.3)	0.81 (0.46 – 1.4)
Egg	263 (39.6)	179 (42.1)	1 (ref)	84 (35.2)	0.81 (0.51 – 1.30)
Wheat	52 (7.8)	22 (5.2)	1 (ref)	30 (12.6)	2.10 (0.87 – 5.04)
Soy	47 (7.1)	23 (5.4)	1 (ref) ^	24 (10.0)	0.97 (0.42 – 2.26)
Sesame	112 (16.9)	87 (20.5)	1 (ref)	25 (10.5)	0.52 (0.27 – 1.00)
Tree nuts (≥1)	353 (53.2)	218 (51.3)	1 (ref)	135 (56.5)	1.27 (0.79 – 2.05)
Fin fish (≥1)	92 (13.9)	35 (8.2)	1 (ref)	57 (23.9)	**2.54 (1.42 – 4.56)** **
Shellfish (≥1)	110 (16.6)	34 (8.0)	1 (ref)	76 (31.8)	**3.11 (1.63 – 5.93)** ***

[1]Odds ratios represent the adjusted probability of given food allergy in comparison to White children (reference group). All models adjusted for gender, age, household income, and site. Model for multiple FA evaluates adjusted probability of having multiple FA versus 1 FA.

Bold values represent statistical significance;

* P < 0.05;

** P < 0.01;

*** P < 0.001

Percentages may add to over 100 due to rounding