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Associations of Food Allergy-Related Dietary Knowledge, Attitudes and Behaviors Among Caregivers of Black and White Children with Food Allergy

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Abstract

Background—The increasing prevalence of pediatric food allergy (FA) in the US has disproportionately affected non-Hispanic Black youth. However, racial and other socioeconomic disparities in FA management among caregivers of children with FA remain unclear.

Objective—To determine associations between socioeconomic, clinical, and healthcare factors and FA-related knowledge, attitudes and behaviors (KAB) among caregivers of Black and White children with FA.

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Design—Cross-sectional survey analysis from the Food Allergy Outcomes Related to White and African American Racial Differences (FORWARD) Study.

Participants/Settings—Longitudinal cohort of caregivers of 385 Black and White children with FA ages birth-12 years of age residing in Chicago, IL, Cincinnati, OH and Washington, D.C. from 2017- March 2021.

Main Outcome Measures—There were three primary outcomes of interest: 1) FA knowledge assessed by scores from the Knowledge Survey, 2) FA-related attitudes assessed by newly developed survey and 3) food- related behaviors assessed by the FORWARD Diet and Purchasing Habit Surveys completed six months post-enrollment.

Analyses—Multivariable linear and logistic regression.

Results—The overall response rate to the six months post-enrollment survey was 51.3% (385 of 751). White caregivers represented 69.4% of the participants. Black race was associated with a 1.5-point lower FA knowledge score (95% Confidence Interval (CI):: −2.2, −0.7) while earning a graduate degree or bachelor's degree was associated with associated with a 1.7-point increase (95% CI: 0.8, 2.7) and 1.1-point increase (95% CI: 0.2, 2.0) in overall FA knowledge score, respectively, compared with caregivers earning less than a bachelor's degree. Having multiple food allergies and having ever visited the ED for a food-related allergic reaction were also associated with higher levels of FA knowledge. Having visited the ED for FA was also associated with higher odds of two measures of FA attitudes reflecting parental anxiety. Greater FA knowledge scores were consistently associated with lower odds of several FA related food purchasing and eating behaviors assumed to have elevated risk. Eating food prepared at school was the only FA behavior associated with race. Compared to White children, Black children were 2.5 times more likely to eat school-prepared foods (95% CI: 1.2 – 5.6).

Conclusions—Findings from this study identified socioeconomic, racial, and clinical factors associated with caregivers' FA-related KAB, but further research is warranted to better understand these relationships.

Keywords

FORWARD; food allergy; race; dietary knowledge; attitudes; behaviors

Introduction

The estimated prevalence of pediatric food allergy (FA) in the United States (US) is as high as 8% and continues to increase.[1, 2] Approximately a third of youth with FA have multiple FA, which can complicate allergen avoidance. Also, the incidence and morbidity of FA disproportionately affects non-Hispanic Black youth.[2, 3] Furthermore, in comparison to White children with FA, Black children with FA are more likely to experience anaphylaxis and seek Emergency Department (ED) treatment.[4]

Allergen avoidance is the cornerstone of FA management.[5] Yet, consumer confusion of unregulated precautionary allergen labeling (PAL) such as "may contain" statements possibly contributes to accidental ingestion and subsequent adverse reactions.[6, 7] Considering these challenges, FA experts[8] recommend improvements in patient education

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to enhance FA-related knowledge influencing food purchasing practices among caregivers to mitigate accidental allergen ingestion among those affected by FA.

Growing evidence suggests that FA-related knowledge, attitudes and behaviors among caregivers of children with FA food allergy are associated with factors affecting their FA management practices.[9] One study from the UK reported high knowledge scores related to understanding the severity of allergic reactions, preventing reactions and identifying hidden allergen ingredients. These researchers also found strong attitudes around label checking and a preference for more allergen-free food choices. However, these positive FA-related knowledge and attitudes were not related to food preparation or dining out practices (behaviors) for their child with FA.[9] Furthermore, data from a national US survey of 3000 primarily white, highly educated caregivers of children with FA reveal that only one out of four correctly answered PAL policy questions.[7] About the same percentage of survey participants also reported that a family member with FA experienced an allergic reaction after consuming a product with PAL. Interestingly, half of caregivers of children with FA in this sample were advised by their allergist to avoid purchasing PAL products. These findings highlight gaps in knowledge among caregivers with high socioeconomic status related to purchasing safe foods for their child with FA. However, little is known about knowledge, attitudes, and behaviors (KAB) in racially and socioeconomically diverse children with FA.

There has been limited research on FA KAB in diverse samples. Tackett et al. surveyed 172 caregivers of a multiethnic, low-income sample of US children with FA to explore the inter-relationships of food purchasing practices, food insecurity and related FA behaviors.[10] Many of these study participants received governmental food assistance. Also, the majority reported gas stations/convenience stores as their primary location of food purchases, which was associated with greater perceived risk of accidental allergen ingestion in comparison to caregivers who shopped at supermarkets. Larger, more diverse studies are necessary to reveal important cultural differences affecting the purchasing behaviors of caregivers of children with FA.

Although there is growing evidence[11] of racial differences in FA prevalence, little is known about whether socioeconomic, racial, and clinical factors are associated caregivers' KAB. Therefore, the purpose of this study is to identify socioeconomic, clinical, and healthcare factors associated with caregivers' FA-related KAB in a multi-site, longitudinal cohort of Black and White children with FA.

Methods

Data Source

Cross-sectional analyses were based on caregiver-reported data from the Food Allergy Outcomes Related to White and African American Racial Differences (FORWARD) study, a National Institutes of Health funded, multi-site, prospective cohort of Black and White children with FA. Study recruitment began in 2017 and is currently ongoing; these analyses captured data from 2017 through March 2021. Four urban medical centers are actively recruiting study participants: Chicago, IL (Northwestern University/Ann & Robert H. Lurie Children's Hospital of Chicago, Rush University Medical Hospital), Cincinnati, OH

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(Cincinnati Children's Hospital), and Washington, D.C. (Children's National Hospital). Potential participants are enrolled during allergist visits, and consenting caregivers complete electronic surveys at enrollment as well as every three months post- enrollment. Baseline data (Table 1) were analyzed along with data from the Diet and Purchasing Survey (Table 2) and the Food Allergy Knowledge survey (Table 2), both completed six months post-enrollment. The Institutional Review Boards of all participating institutions approved the study protocol and all caregivers provided written informed consent.

Eligibility Criteria

Caregivers of children ages 12 years and under who identified as Black or White with at least one physician-diagnosed FA were eligible for study participation. A maximum of two children with FA per household were eligible for enrollment in the FORWARD study. Only participants who completed all relevant six months post- enrollment surveys were included in these analyses.

Response Rate

As of March 2021, there were 278 Black and 473 White children enrolled in the FORWARD study. The overall response rate to the six months post-enrollment survey was 51.3% (385 of 751). The response rate for caregivers of Black children was 42.4% (118 of 278) and 56.4% (267 of 473) for caregivers of White children.

Outcomes of Interest

FA-related KAB consists of three different outcomes of interest: 1) FA knowledge assessed by scores from the Knowledge Survey, 2) FA-related attitudes assessed by a newly developed survey and 3) food- related behaviors assessed by the FORWARD Diet and Purchasing Habit Surveys.

FA Knowledge

FA knowledge was assessed by a 16-item Knowledge Survey (16=maximal score) that was adapted from the Chicago FA Research Survey for Parents of Children with FA[6, 12], a validated tool to evaluate FA-related knowledge. Six of the 15 items from the original survey were used in addition to ten new items designed by the FORWARD project multi-site investigators. Each correct item was assigned one point and the total number of correct points was summed to produce each participant's total score. The questions in this survey assessed the caregiver's FA-knowledge and were not child-specific. Because caregivers could enroll up to two children with FA in the study, these caregivers were invited to complete the FA-knowledge survey more than one time. In order to create caregiver-level responses, researchers selected the first child's survey. To test the sensitivity of the results to this selection, researchers also examined the association of independent variables to the maximum score per caregiver.

FA Attitudes

FA-related attitudes and behaviors were based on items created, pre-tested, and revised by a group of pediatric health researchers at Northwestern University/Ann & Robert H.

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Lurie Children's Hospital of Chicago (see Table 2). Attitudes were evaluated by items that pertained to caregivers' anxiety around allergic reactions. Two items asked participants to indicate (yes/no) whether: 1) "When purchasing food for your child at the grocery store, are you worried making a mistake that will result in an allergic reaction?" and 2) Are you fearful that your child may have an allergic reaction when eating food prepared outside of home?" FA-related attitudes questions were child-specific.

FA Behaviors

FA-related behaviors were assessed via questions inquiring about parent/caregiver food PAL purchasing habits and the child's dietary habits (see Table 2). Participants were asked to indicate (never/sometimes/always) "How often would you buy an item if it contained the phrase below: 1) May contain allergen, 2) Manufactured in a facility that also processes allergen, 3) Manufactured on the same equipment as products containing allergen". Additionally, participants were asked to indicate (yes/no), "Does your child eat food prepared outside of the home (not including food from school)?" and/or "Does your child eat lunch/food provided by the school?". FA-related behaviors related behavior questions were child-specific.

Independent Variables of Interest

Child race was categorized as Black or White, based on participant response to the question "With which race does your child with food allergy primarily identify?" at enrollment. Other demographic data were gleaned from FORWARD's enrollment survey, including male or female child sex, current child age in years, caregiver's education (less than bachelor's degree, bachelor's degree, graduate degree), annual household income (<$50,000, $50,000-$100,000, and >$100,000) and recruitment site. Because race is a social, not biological, construct in this study, it is associated with several other socioeconomic variables in this cohort (i.e., education and income). As a result, researchers focus their description on the fully adjusted analyses. Additionally, clinical variables including the number of top nine food allergies[13] per child were calculated and summed based on the survey item that asked participants to indicate "To which food is [child name] currently allergic?". A binary variable was also created to indicate whether the child had multiple (i.e., more than one) current FA. Finally, as a proxy for severe disease, the authors created a binary variable to indicate whether the child had ever visited the emergency department (ED) due to a severe food-related allergic reaction, and a count variable to indicate the number of times the child had visited the ED.

Statistical Analyses

Descriptive statistics were calculated for child and household-level demographic and clinical characteristics. Comparisons by race (Black/White) between items were evaluated using chi square tests of independence for categorical variables and independent samples t-test for continuous variables. For non-normal variables, statistical comparisons were evaluated using Wilcoxon rank-sum tests. Multivariable linear and logistic regressions were used to examine the adjusted associations with all independent variables (child's race, sex, age, number of food allergies, and frequency of ED visits, caregivers' education, household income, and recruitment site). Logistic models for FA-related attitudes and behaviors also controlled

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for caregiver's FA knowledge. Coefficients in the linear model for FA knowledge reflect the degree of change in the total FA knowledge score for each one unit change (positive or negative) in the independent variable, controlling for all other variables in the model. Similarly, the logistic regression coefficients are expressed as adjusted odds ratios, which can be interpreted as the change in the odds of each FA-related attitude or behavior outcome for each one unit change in the independent variable controlling for all others. To account for the clustered study design by recruitment site and family, the intraclass correlation (ICC) of both types of clustering were examined. The ICC at the site level was approximately zero for all outcomes and likelihood ratio tests confirmed that site level random-intercepts were not warranted. The ICC at the family level for child-specific outcomes ranged from 0.38 to 0.99 indicating substantially correlated responses within families. Because only 24 of 361 families in the sample had two children enrolled, researchers were not able to fit models for all outcomes with family-level random intercepts. In order to minimize the risk of overfitting all models for the few outcomes for which a random intercepts approach performed better and to preserve consistent interpretation across models, researchers presented the results of multilinear and logistic regressions without random effects while accounting for the ICC for children within the same family using clustered standard errors. Models were checked for collinearity and specification error by examining the variance inflation factor and link test, respectively. No collinearity problems or specification error were found in any of the models. All statistical analyses were based on caregivers who answered the survey items (complete case analysis). Statistical tests were two-sided and a p-value of <0.05 was considered statistically significant. All statistical analyses were performed using Stata software, version 15[14].

Results

Demographics

Among the 385 completed surveys, most children with FA were White (69.4%), male (65.7%), or with multiple food allergies (61.0%) as indicated by Table 1. Among the 361 caregivers who responded to the six months post-enrollment survey; 6.2% percent had two children. Statistically significant age differences by race were observed with Black children being older than White children (Black median age: 8.5 years, White median age: 6.3 years; $p<0.001$). There was also a statistically significant difference in the annual household income of Black children compared to White children. Specifically, among Black children, 50.9% were part of families with annual household incomes of < $50,000 compared to 4.5% of White children ($p<0.001$). Most caregivers of White children (89.9%) earned at least a bachelor's degree compared to less than half of caregivers of Black children (38.9%). There were no significant racial differences related to lifetime ED visit due to food-related allergic reaction ($p > 0.05$).

Bivariate Analysis

Table 2 presents the unadjusted bivariate analysis of each of the outcome variables and race. Statistically significant racial differences associated with 13 of 16 FA knowledge items, the total allergy knowledge score, one of the two FA attitudes, and four of the six FA behaviors ($p<0.05$) were observed.

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FA Knowledge

For the overall FA knowledge scores, statistically significant differences were observed between racial groups after adjustment for covariates including child sex, current child age, multiple FA, annual household income, caregiver education, lifetime FA-related ED visit (yes/no), and recruitment site (Table 3).

Black race was associated with a 1.5-point decrease (95% CI: −2.2, −0.7) in overall FA knowledge score compared to white race. Earning a graduate degree or a bachelor's degree was associated with a 1.7-point increase (95% CI: 0.8, 2.7) and a 1.1-point increase (95% CI: 0.2, 2.0) in overall FA knowledge score, respectively, compared to earning less than a bachelor's degree. With respect to child-level factors, having more than 1 "Top 9" food allergy was associated with a 0.7-point increase (95% CI: 0.1, 1.3) compared to having one food allergy and having ever visited the ED for a food-related allergic reaction was associated with a 0.7-point increase (95% CI: 0.2, 1.3) in FA knowledge score compared to never having visited the ED for this purpose. A sensitivity analysis conducted with an alternative FA knowledge score, defined as the maximum score per caregiver, revealed that these associations between FA knowledge and the independent variables did not change significantly.

FA Attitudes

The first two columns of Table 4 report adjusted odds ratios for food-allergy related attitudes. Having ever visited the ED for a food-related allergic reaction was associated with an 80% increase in the odds of caregiver purchasing anxiety (95% CI: 1.1, 2.8) and a 140% increase in the odds of caregiver anxiety about a reaction occurring due to food prepared outside of the home (95% CI: 1.4, 4.1) compared to never having visited the ED for this concern. Compared to those who earned less than a bachelor's degree, earning a bachelor's degree was associated with a 60% reduction (95% CI: 0.2, 0.9) in caregiver anxiety about a reaction occurring due to food prepared outside of the home and having a child with more than 1 food allergy was associated with a 90% increase (95% CI: 1.1, 3.3) in the odds of anxiety around this outcome compared to those who had a child with one food allergy.

FA Behaviors

The last six columns of Table 4 report the associations between survey variables and food allergy-related behaviors. A one point increase in the food allergy knowledge score was associated with a 20% reduction (95% CI: 0.7, 0.9) in the odds of purchasing food items with the label "May contain allergen", a 20% reduction (95% CI: 0.7, 0.9) in the odds of purchasing food items with the label "Manufactured in a facility that also processes allergen", a 10% reduction (95% CI: 0.8, 1.0) in the odds of purchasing food items with the label "Manufactured on the same equipment that also processes allergen", a 20% reduction (95% CI: 0.6, 1.0) in the odds of the caregiver's child eating food prepared outside of the home, and a 10% reduction (95% CI: 0.8, 1.0) in the odds of the caregiver's child eating lunch or food prepared by the school. Conversely, a one point increase in the food allergy knowledge score was associated with a 30% increase (95% CI: 1.1, 1.5) in the odds of the caregiver purchasing online allergen-free foods.

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Having a child with more than one food allergy was associated with a 90% (95% CI: 1.1, 3.4) increase in the odds of purchasing allergen-free foods online and a 60% decrease (95% CI: 0.2, 0.6) in the odds of the caregiver's child eating lunch or food prepared by the school, compared to a child who had one food allergy. Being a caregiver of a Black child was associated with a 150% increase (95% CI: 1.1, 5.5) in the odds of eating lunch or food prepared by the school compared to being a caregiver of a White child.

Having ever visited the ED for a food allergy-related reaction was associated with between a 60% to 80% reduction in the odds of purchasing food items with the label "May contain allergen" (AOR: 0.2, 95% CI: 0.1, 0.5), purchasing food items with the label "Manufactured in a facility that also processes allergen" (AOR: 0.4, 95% CI: 0.2, 0.7), purchasing food items with the label "Manufactured on the same equipment that also processes allergen" (AOR: 0.4, 95% CI: 0.2, 0.6), and a 50% reduction in the odds of the caregiver's child eating food prepared outside of the home (95% CI: 0.3, 0.9), compared to children who had never visited the ED for a food-allergy related reaction.

DISCUSSION

To the authors' knowledge, this is one of the first studies to assess caregivers' FA-related KAB in a diverse sample. The study found that after adjusting for educational level and income, caregivers of Black children with FA had significantly lower FA-related knowledge scores compared to caregivers of White children with FA. Caregivers with higher FA knowledge scores were less likely to purchase products with PAL, more likely to make online allergen-free food purchases, and their children with FA were less likely to eat foods prepared outside the home. Furthermore, FA-related ED medical care was significantly associated with greater caregivers' anxiety around their food purchasing habits as well as accidental allergen ingestion from foods prepared outside the home. Significant racial differences in the likelihood of eating food prepared by school also persisted in this cohort after controlling for other socioeconomic characteristics. These findings suggest that racial, socioeconomic and clinical factors may be associated with caregivers' KAB in this cohort.

The high percentage of incorrect responses to FA Knowledge survey items related to FA diagnosis, risk behaviors and PAL are indicative of FA knowledge gaps among caregivers of both Black and White children. For instance, only 33% of caregivers of White children with FA and 9% of caregivers of Black children with FA correctly believed that teens with FA have a higher risk for fatal food-related allergic reactions compared with younger children with FA. Although children in the current study have yet to enter adolescence, this survey question reflects the belief among clinicians and stakeholders that understanding the elevated risk associated with teenagers is important for all caregivers of children with FA.[15] While caregivers' misunderstanding regarding FA diagnostic testing, specifically skin-prick tests, was apparent in both racial groups, disproportionately fewer correct answers were reported by the caregivers of Black children with FA. Finally, most caregivers of Black children and almost half of caregivers of White children with FA mistakenly considered "may contain" and "manufactured in" as legally mandatory PAL terms for the food industry.

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Consumer purchasing frequency of PAL products by caregivers in diverse populations of children with FA is not well established. In the current cohort, caregivers with greater FA knowledge were significantly less likely to report purchasing PAL products. Consumer confusion about PAL is well known[6, 7] and constant vigilance of product label reading may contribute to "label fatigue" among caregivers of children with FA; yet most of these studies are conducted in primarily White samples. For example, in a recent national survey[7] examining PAL practices among mostly White respondents with FA, the majority reported they routinely read food labels but expressed ongoing frustration with PAL. Further research focused on consumer knowledge and purchasing habits surrounding PAL in diverse samples is warranted.

Prior research on FA-related knowledge has been limited in racial and socioeconomic scope. Previous studies have examined caregivers' knowledge of FA using consumer survey responses from primarily White, highly educated patients or parents of children with FA. Gupta et al. demonstrated that only one-fourth of 3,008 mostly White participants with FA surveyed in the US correctly answered food allergen labeling questions.[7] In a British sample of 252 primarily White adults with FA or caregivers of children with FA, 67% of respondents earned a "relatively good" score for knowledge of food allergens.[9] Yet, these scores did not significantly associate with recommended FA management behaviors. However, in the current study, greater FA knowledge scores were associated with less desirable PAL food purchasing behaviors. Additionally, caregivers with greater FA knowledge were less likely to report their child with FA consumed foods prepared outside the home. Conversely, caregivers of Black children with FA were 2.5 times more likely than caregivers of White children to describe that their child consumes school lunch. Although consuming food outside the home potentially raises accidental allergen exposure, the authors found no difference in the prevalence of severe reactions as measured by ED visits between Black and White children with FA in this cohort. Overall, these data suggest that race and FA knowledge are associated with caregivers' FA management practices in this cohort.

Caregivers who had greater FA knowledge also reported more anxiety about the possibility of their child with FA accidentally ingesting allergen-containing foods outside the home compared to caregivers with lower FA knowledge. This suggests that anxiety related to greater FA knowledge may negatively influence caregivers' quality of life. Warren et al. reported that constant parental anxiety related to maintaining avoidance of allergy-containing foods for their child with FA was a key determinant of lower caregiver quality of life particularly in contexts outside of direct parental control (e.g., school, friends' houses).[16] Chow et al. also demonstrated that greater maternal stress related to FA child's dietary restrictions in and outside of the home were significantly associated with greater food-related anxiety and overall poorer emotional wellbeing in the child with FA.[17] These findings suggest parental anxiety can potentially have negative effects on the psychosocial health of both caregivers as well as children with FA.

In the current cohort, FA-related ED visits and multi-FA was significantly associated with heightened caregivers' anxiety about FA management practices. For example, caregivers of children with multi-FA were almost two times as likely to worry about their child ingesting allergen-containing foods outside the home, in comparison to caregivers of children with one

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FA. Moreover, caregivers of children who had a FA-related ED visit were 2.4 times as likely to report anxiety around accidental allergen ingestion of foods prepared outside the home, in comparison to caregivers of children who never required FA-related ED medical care. In a sample of nearly 6000 children with FA residing in New York and Florida, Sakai-Bizmark et al. reported that ED visits for food allergen-induced anaphylaxis were more common among Black youth as well as children under four years of age from all racial/ethnic groups living in urban areas.[18] These researchers suggest Black urban children with FA are more likely to have asthma, a comorbidity contributing to the need for FA-related ED visits. Although the number of ED visits between Black and White children in the current study did not significantly differ, they all resided in urban communities, a known environmental risk factor[18] for FA-related anaphylaxis.

Even after controlling for socioeconomic, clinical, and healthcare factors, the current study demonstrated that Black children with FA were 2.5 times as likely than White children with FA to consume school prepared foods. It is unclear what this difference means in terms of the risk of accidental allergen exposures. In the FORWARD cohort, there was no difference in the proportion of Black and White children reporting ED visits (study proxy for severe reactions) at enrollment. The school environment and policies around FA vary across U.S. schools and impact parental perception of their child's safety at school.[19] Although guidelines for managing FA in schools, which include relevant protocols for food prepared by school, were issued by the Centers for Disease Control and Prevention in 2013,[20] they are voluntary. However, by law, students participating in the U.S. Department of Agriculture's Child Nutrition Programs may receive a food substitution or modification with a signed statement by a doctor attesting to their FA as a disability.[21] Further research is needed to understand the implication of the racial difference in consumption of school prepared foods found in this study.

Although these findings are novel, there are several limitations to the present study. The survey response rate was just over 50%; therefore, selection bias is a possibility. However, demographics among non-responders were not significantly different from the current sample at a pre-determined Type I error rate of 0.05. Although the FA-related attitudes and behaviors instrument was pre-tested, it was not validated among racially and socioeconomically diverse caregivers of children with FA. Hence, study results could reflect a misinterpretation of the items assessed. Most caregivers in this study were from urban areas as the FORWARD study was designed to enroll patients from four major urban academic allergy practices. All children were diagnosed by a board-certified allergist. Whether these results are applicable to other urban regions or rural areas of the US needs further investigation. In addition to selection bias, there is also a possibility that the study sample is underpowered to detect substantively meaningful differences in all of the outcomes examined in this study. Further, it is also possible that racial and socioeconomic differences exist for FA-related KAB outcomes which were not examined in this study. Finally, because of the incomplete understanding of the ways in which race and socioeconomic position are related, all of the models used in the study are susceptible to residual confounding, unmeasured confounding, and model misspecification which may limit the validity of the results.

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CONCLUSION

This study elucidates racial, socioeconomic, and clinical differences in caregivers' KAB, which may subsequently affect their FA management. These findings indicate some aspects of FA-related knowledge and behaviors vary by socioeconomic characteristics. Therefore, further research is needed to determine effective strategies to mitigate these differences, thereby improving KAB among caregivers of children with FA in diverse populations.

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Abbreviations:

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

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Research Snapshot

Research Question:

Are socioeconomic, clinical, and healthcare factors associated with the food allergy (FA)-related knowledge, attitudes, and behaviors (KAB) of caregivers of Black and White children with diagnosed FA?

Key Findings:

In this cross-sectional survey of 385 children with physician-diagnosed FA, Black children with FA were more likely than White children with FA to consume foods prepared at school. Greater FA knowledge scores were observed among White caregivers and participants with high levels of education compared to caregivers of low education or of black children with FA. Additionally, greater FA knowledge scores were associated with lower probability of purchasing products with precautionary allergen labeling.

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Table 1.

Demographic and clinical characteristics among food allergy outcomes related to White and African American racial differences: 6 months post enrollment

Characteristic	**Total**	**White**	**Black**	***P* value**[a]
	(n=385)	**(n=267)**	**(n=118)**	
Child Current Age (years),[b] median (IQR)	7.1 (4.5–10.6)	6.3 (4.2–10.2)	8.5 (6.0–11.7)	< 0.001
Child Sex, n (%)				
Female	132 (34.3)	89 (33.3)	43 (36.4)	0.6
Male	253 (65.7)	178 (66.7)	75 (63.6)	
Child "Top 9" Food Allergies[c], n (%)				
One	150 (39.0)	106 (39.7)	44 (37.3)	0.7
One or more	235 (61.0)	161 (60.3)	74 (62.7)	
Child Ever visited Emergency Department due to Food Allergy, n (%)				
Yes	157 (40.8)	105 (39.3)	52 (44.1)	0.4
No	226 (58.7)	161 (60.3)	65 (55.1)	
Missing/Unknown	2 (0.5)	1 (0.4)	1 (0.9)	
Child Number Emergency Department visits due to Food Allergy, n (%)				
1	99 (63.1)	64 (61.0)	35 (67.3)	0.5
2	34 (21.7)	24 (22.9)	10 (19.2)	
3	13 (8.3)	10 (9.5)	3 (5.8)	
4+	11 (7.0)	7 (6.7)	4 (7.7)	
Annual Household Income, n (%)				
Less than $50,000	72 (18.7)	12 (4.5)	60 (50.9)	< 0.001
$50,000 to $100,000	54 (14.0)	33 (12.4)	21 (17.8)	
Greater than $100,000	218 (56.6)	196 (73.4)	22 (18.6)	
Missing/Unknown	41 (10.7	26 (9.7)	15 (12.7)	
Caregiver Education, n (%)				
Less than Bachelor's Degree	97 (25.2)	27 (10.1)	70 (59.3)	< 0.001
Bachelor's Degree	113 (29.4)	91 (34.1)	22 (18.6)	
Graduate Degree (Master's/Professional/ Doctorate)	173 (44.9)	149 (55.8)	24 (20.3)	
Missing/Unknown	2 (0.5)	0	2 (1.7)	
Recruitment Site				
Rush Medical Center	57(14.8)	31(11.6)	26(22.0)	0.03
Cincinnati Children's Hospital	104(27.0)	80(30.0)	24(20.3)	
DC Children's Hospital	90(23.9)	62(23.2)	28(23.7)	
Northwestern University /Lurie Children's Hospital	134(34.8)	94(35.2)	40(33.9)	

[a] *P* value represents significance of chi-squared independence test between survey item and race (Black/White); in the case of age, *P* value represents significance of Wilcoxon rank-sum test.

[b] 1% (n=4) of total observations missing for age calculation.

[c]"Top 9" food allergies are the nine food allergies with the highest prevalence in U.S. children under age 18 years. The nine most prevalent allergens are milk, egg, peanut, tree nuts, sesame, soy, fin fish, shellfish and wheat.[13]

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Table 2.

Food allergy-related knowledge, attitudes, and behaviors among caregivers of Black and White children with food allergy

Food Allergy Knowledge Survey,[a,b] n (%)	White (n = 251)	Black (n = 110)	Total (n = 361)	p-value
1. Food labels that have warnings such as ”may contain” or “manufactured in” are required by law.				<0.001
Correct (False)	82 (32.7%)	7 (6.4%)	89 (24.7%)	
Incorrect	121 (48.2%)	87 (79.1%)	208 (57.6%)	
Do not know	48 (19.1%)	16 (14.5%)	64 (17.7%)	
2. If you are worried that your child is having a severe allergic reaction (anaphylaxis), you should give him/her antihistamine (Benadryl) immediately.				<0.001
Correct (False)	148 (59.0%)	29 (26.4%)	177 (49.0%)	
Incorrect	97 (38.6%)	76 (69.1%)	173 (47.9%)	
Do not know	6 (2.4%)	5 (4.5%)	11 (3.0%)	
3. Eczema (a condition that makes your skin red and itchy) puts you at higher risk for a food allergy.				<0.001
Correct (True)	192 (76.5%)	56 (50.9%)	248 (68.7%)	
Incorrect	25 (10.0%)	24 (21.8%)	49 (13.6%)	
Do not know	34 (13.5%)	30 (27.3%)	64 (17.7%)	
4. The higher your blood test to a specific food, the more severe your reaction will be to that food.				<0.001
Correct (False)	132 (52.6%)	17 (15.5%)	149 (41.3%)	
Incorrect	90 (35.9%)	70 (63.6%)	160 (44.3%)	
Do not know	29 (11.6%)	23 (20.9%)	52 (14.4%)	
5. Asthma is an important risk factor for severe allergic reaction (anaphylaxis).				0.74
Correct (True)	177 (70.5%)	76 (69.1%)	253 (70.1%)	
Incorrect	19 (7.6%)	11 (10.0%)	30 (8.3%)	
Do not know	55 (21.9%)	23 (20.9%)	78 (21.6%)	
6. Teenagers are at higher risk for a fatal food allergy reaction compared to younger children.				<0.001
Correct (True)	82 (32.7%)	10 (9.1%)	92 (25.5%)	
Incorrect	61 (24.3%)	55 (50.0%)	116 (32.1%)	
Do not know	108 (43.0%)	45 (40.9%)	153 (42.4%)	
7. Taking a daily antihistamine can prevent food allergy reactions.				0.002
Correct (False)	178 (70.9%)	68 (61.8%)	246 (68.1%)	
Incorrect	18 (7.2%)	22 (20.0%)	40 (11.1%)	
Do not know	55 (21.9%)	20 (18.2%)	75 (20.8%)	
8. During an oral food challenge, children eat the food that they have been avoiding in order to see if they are still allergic.				<0.001
Correct (True)	235 (93.6%)	75 (68.2%)	310 (85.9%)	
Incorrect	9 (3.6%)	20 (18.2%)	29 (8.0%)	
Do not know	7 (2.8%)	15 (13.6%)	22 (6.1%)	
9. The best way to diagnose a food allergy is with a skin prick test.				<0.001
Correct (False)	130 (51.8%)	22 (20.0%)	152 (42.1%)	

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Food Allergy Knowledge Survey,[a,b] n (%)	White (n = 251)	Black (n = 110)	Total (n = 361)	p-value
Incorrect	73 (29.1%)	74 (67.3%)	147 (40.7%)	
Do not know	48 (19.1%)	14 (12.7%)	62 (17.2%)	
10. It is recommended to call 911 after using an epinephrine auto-injector.				0.025
Correct (True)	244 (97.2%)	100 (90.9%)	344 (95.3%)	
Incorrect	6 (2.4%)	7 (6.4%)	13 (3.6%)	
Do not know	1 (0.4%)	3 (2.7%)	4 (1.1%)	
11.The most common food allergens are milk, eggs, peanuts, treenut, fish, soy, shellfish and wheat. These foods are called the top 8 food allergens. If a food contains one of the top 8 food allergens, then it is required by law to be clearly labeled.				0.83
Correct (True)	218 (86.9%)	98 (89.1%)	316 (87.5%)	
Incorrect	9 (3.6%)	3 (2.7%)	12 (3.3%)	
Do not know	24 (9.6%)	9 (8.2%)	33 (9.1%)	
12. Lactose intolerance and milk allergy are the same thing.				<0.001
Correct (False)	225 (89.6%)	60 (54.5%)	285 (78.9%)	
Incorrect	8 (3.2%)	28 (25.5%)	36 (10.0%)	
Do not know	18 (7.2%)	22 (20.0%)	40 (11.1%)	
13. If you have eaten at a restaurant before, you do not need to ask about the ingredients the next time you eat there.				<0.001
Correct (False)	238 (94.8%)	92 (83.6%)	330 (91.4%)	
Incorrect	8 (3.2%)	15 (13.6%)	23 (6.4%)	
Do not know	5 (2.0%)	3 (2.7%)	8 (2.2%)	
14. Clothing must be removed in order to use an epinephrine auto-injector.				<0.001
Correct (False)	206 (82.1%)	69 (62.7%)	275 (76.2%)	
Incorrect	36 (14.3%)	33 (30.0%)	69 (19.1%)	
Do not know	9 (3.6%)	8 (7.3%)	17 (4.7%)	
15. Where is the best place to use an epinephrine auto-injector (Epi-Pen, Auvi-Q, Adrenaclick, generic)?				0.64
Correct (Outer Thigh)	248 (98.8%)	108 (98.2%)	356 (98.6%)	
Incorrect	3 (1.2%)	2 (1.8%)	5 (1.4%)	
16. A boy with a milk allergy accidentally drank some milk. Please mark which of the following could be a sign of a food allergy reaction. Mark all that apply.				<0.001
Correct (After 10 minutes, he has hives on his face and chest and vomits. Immediately his tongue swells and he has trouble breathing.)	179 (71.3%)	57 (51.8%)	236 (65.4%)	
Incorrect	72 (28.7%)	53 (48.2%)	125 (34.6%)	
Total Food Allergy Score[c], mean (SD)				
	11.6 (2.6)	8.6 (2.3)	10.7 (2.9)	< 0.001
Food-Allergy Related Attitudes[b], n (%)				
Parental anxiety about purchasing habits causing allergic reaction in child with FA				0.054
No	137 (54.6%)	72 (65.5%)	209 (57.9%)	
Yes	114 (45.4%)	38 (34.5%)	152 (42.1%)	
Parental anxiety about child with FA having allergic reaction due to eating food prepared outside home				0.004
No	67 (26.7%)	46 (41.8%)	113 (31.3%)	
Yes	184 (73.3%)	64 (58.2%)	248 (68.7%)	

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Food Allergy Knowledge Survey,[a,b] n (%)	White (n = 251)	Black (n = 110)	Total (n = 361)	p-value
Food-Allergy Related Behaviors[b], n (%)				
Frequency of parental purchase of food item for child with food allergy when item label contains:				0.008
Never	223 (88.8%)	86 (78.2%)	309 (85.6%)	
Sometimes/Always	28 (11.2%)	24 (21.8%)	52 (14.4%)	
Manufactured in a facility that also processes the allergen				0.002
Never	60 (23.9%)	44 (40.0%)	104 (28.8%)	
Sometimes/Always	191 (76.1%)	66 (60.0%)	257 (71.2%)	
Manufactured on same equipment that also processes allergen				0.16
Never	128 (51.0%)	65 (59.1%)	193 (53.5%)	
Sometimes/Always	123 (49.0%)	45 (40.9%)	168 (46.5%)	
Online purchase of allergen free foods for child with FA				<0.001
No	157 (62.5%)	97 (88.2%)	254 (70.4%)	
Yes	94 (37.5%)	13 (11.8%)	107 (29.6%)	
Child with food allergy eats food prepared outside of the home				0.21
No	39 (15.5%)	23 (20.9%)	62 (17.2%)	
Yes	212 (84.5%)	87 (79.1%)	299 (82.8%)	
Child with food allergy eats lunch/food prepared by school				<0.001
No	152 (60.6%)	40 (36.4%)	192 (53.2%)	
Yes	99 (39.4%)	70 (63.6%)	169 (46.8%)	

[a] Items 3,5,6,7,15,16 of the Food Allergy Knowledge survey instrument were taken from the Chicago Food Allergy Research Surveys [6,12]

[b] *P* values represent the statistical significance of chi-square tests of independence between survey item categories and race (White/Black)

[c] *P* values represent the statistical significance of independent sample t-tests of mean food allergy-related knowledge score by race (White/Black).

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Table 3.

Associations between food allergy knowledge scores and demographic and clinical characteristics among caregivers of Black and White Children with food allergy (n = 319)

	Total Food Allergy Knowledge Score[a]	
Variables[b]	**Adjusted β (95% CI**[c]**)**	***P* value**
Current Child Age, years[d]	0.0 (−0.1, 0.1)	0.513
Child Race (Reference: White)		
Black	−1.5 (−2.2, −0.7)	< 0.001
Child Sex (Reference: Male)[e]		
Female	0.0 (−0.5, 0.6)	0.972
Top 9 Food Allergies[d,e] (Reference: One FA)		
More than one	0.7 (0.1, 1.3)	0.014
Ever visited Emergency Department due to Food Allergy (Reference: No)[e]		
Yes	0.7 (0.2, 1.3)	0.013
Annual Household Income (Reference: Less than $50,000)		
Greater than $100,000	0.9 (−0.1, 1.9)	0.083
$50,000 to $100,000	0.8 (−0.3, 1.8)	0.147
Caregiver/Respondent Education Level (Reference: Less than a Bachelor's Degree)		
Graduate Degree (Master's/Professional/Doctorate)	1.7 (0.8, 2.7)	<0.001
Bachelor's Degree	1.1 (0.2, 2.0)	0.017
Recruitment Site (Reference: Northwestern University/Lurie Children's Hospital)		
Rush Medical Center	−0.7 (−1.5, 0.2)	0.130
Cincinnati Children's Hospital	0.0 (−0.7, 0.7)	0.954
DC Children's Hospital	0.2 (−0.5, 0.9)	0.563

[a]Outcome from the six-month post Food Allergy Outcomes Related to White and African American Racial Differences Study enrollment. Food Allergy Knowledge survey instrument adapted from Chicago Food Allergy Research Surveys[6,12]

[b]Ordinary Least Squares (OLS) regression results of Food Allergy Knowledge Scores adjusted for race, sex, child age, annual household income, caregiver education level, number of "Top 9" food allergies (dichotomized), ever having visited the ED for a FA-reaction, and recruitment site.

[c]95% Confidence Interval

[d]Indicates a child-specific variable. Sex was coded as female if either of the children in a family were female, age was coded as the age of the oldest child, "Top 9" food allergies were coded as more than one if either of the children in a family had more than one food allergy, and ER visit was coded as yes if either of the children in family had ever visited the ER for a food allergy-related reaction.

[e]"Top 9" food allergies are the nine food allergies with the highest prevalence in U.S. children under age 18 years. The nine most prevalent allergens are milk, egg, peanut, tree nuts, sesame, soy, fin fish, shellfish and wheat.[13]

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Table 4.

Associations between food allergy attitudes and behaviors and socioeconomic characteristics among caregivers of Black and White children with food allergy (n=339)

	Food Allergy-Related Attitudes[a]		Food Allergy-Related Behaviors[a]					
Variables, Adjusted Odds Ratio (95% CI)[b,c]	**Parental anxiety about purchasing habits causing allergic reaction in child with food allergy**	**Parental anxiety about child with food allergy having allergic reaction due to eating food prepared outside home**	**Sometimes or always purchases food item with label: May contain allergen**	**Sometimes or always purchases food item with label: Manufactured in a facility that also processes the allergen**	**Sometimes or always purchases food item with label: Manufactured on same equipment that also processes allergen**	**Online purchase of allergen free foods for child with food allergy**	**Child with food allergy eats food prepared outside of the home**	**Child with food allergyeats lunch/food prepared by school**
Age	1 (0.9,1.1)	1 (0.9,1.1)	1 (0.9,1.1)	1 (0.9,1.1)	1 (0.9,1.0)	1 (0.9,1.0)	1.1 (1.0,1.2)	1.1 (1.0,1.1)
Sex *Reference: Males*								
Females	1.3 (0.8,2.0)	1.4 (0.8,2.4)	0.5 (0.2,1.1)	0.5 * (0.3,0.9)	0.7(0.4,1.1)	0.8 (0.5,1.4)	1.4 (0.7,2.8)	1.1 (0.7,1.8)
Race *Reference: White*								
Black	0.5 (0.2,1.1)	0.7 (0.3,1.6)	1.4 (0.6,3.4)	0.8 (0.3,1.8)	0.6 (0.3,1.3)	0.7(0.3,1.6)	0.6 (0.2,1.5)	2.5 * (1.1,5.5)
Top 9 Food Allergies *Reference: 1 Food Allergy d*								
More than 1	1.1 (0.7,1.8)	1.9 * (1.1,3.3)	0.5 (0.3,1.0)	1.2 (0.6,2.0)	0.9 (0.6,1.5)	1.9 * (1.1,3.4)	0.7(0.3,1.4)	0.4 *** (0.2,0.6)
Ever Visited the Emergency Room *Reference: No*								
Yes	1.8 * (1.1,2.8)	2.4 *** (1.4,4.1)	0.2 *** (0.1,0.5)	0.4 ** (0.2,0.7)	0.4 *** (0.2,0.6)	1.4 (0.8,2.3)	0.5 * (0.3,0.9)	1 (0.6,1.6)
Income *Reference: Less than $50,000*								
$50,000 - $100,000	1 (0.4,2.5)	1.9 (0.8,4.9)	0.4 (0.1,1.1)	2.6 (0.9,7.9)	0.7 (0.3,1.8)	3 (0.8,11.5)	0.7 (0.2,2.2)	0.6 (0.2,1.4)
More than 100,000	0.9 (0.3,2.4)	1.5 (0.6,3.7)	0.5 (0.2,1.4)	5.6 *** (2.1,15.0)	1.1(0.5,2.8)	3.9 (1.0,15.3)	1.1(0.3,3.9)	0.8 (0.3,2.0)
Education *Reference: Less than Bachelor's Degree*								

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	Food Allergy-Related Attitudes[a]		Food Allergy-Related Behaviors[a]					
Variables, Adjusted Odds Ratio (95% CI)[b,c]	**Parental anxiety about purchasing habits causing allergic reaction in child with food allergy**	**Parental anxiety about child with food allergy having allergic reaction due to eating food prepared outside home**	**Sometimes or always purchases food item with label: May contain allergen**	**Sometimes or always purchases food item with label: Manufactured in a facility that also processes the allergen**	**Sometimes or always purchases food item with label: Manufactured on same equipment that also processes allergen**	**Online purchase of allergen free foods for child with food allergy**	**Child with food allergy eats food prepared outside of the home**	**Child with food allergyeats lunch/food prepared by school**
Bachelor's Degree	0.6 (0.2,1.4)	0.4 * (0.2,0.9)	0.8 (0.3,2.1)	2.3 (0.9,5.8)	1(0.4,2.2)	1.3 (0.5,3.4)	1.8 (0.6,5.1)	0.8 (0.3,1.8)
Graduate Degree	0.6 (0.3,1.5)	0.8 (0.4,1.9)	1.3 (0.5,3.3)	1.8 (0.7,4.5)	1.5 (0.7,3.5)	0.8 (0.3,2.2)	1.6 (0.5,5.1)	1.5 (0.6,3.6)
Clinical Site *Reference: Northwestern/ Lurie*								
Rush Medical Center	0.8 (0.3,1.7)	0.9 (0.4,2.0)	1.2 (0.4,3.4)	0.8 (0.3,2.2)	0.9 (0.4,2.0)	1.2 (0.5,2.8)	0.4 (0.2,1.0)	0.8 (0.3,1.6)
Cincinnati Children's Hospital	1 (0.5,1.9)	0.7 (0.4,1.5)	1 (0.4,2.6)	0.8 (0.4,1.8)	1.3 (0.6,2.5)	0.9 (0.5,1.8)	1.2 (0.5,2.9)	1 (0.5,2.0)
D.C. Children's Hospital	1 (0.5,1.9)	1 (0.5,2.1)	1.3 (0.5,3.2)	1 (0.5,2.1)	1.3 (0.7,2.5)	1.3 (0.6,2.6)	1.3 (0.6,3.1)	0.8 (0.4,1.5)
Food Allergy Knowledge Score	1.1 (1.0,1.2)	1.2 ** (1.1,1.4)	0.8 ** (0.7,0.9)	0.8 *** (0.7,0.9)	0.9 ** (0.8,1.0)	1.3 ** (1.1,1.5)	0.8 * (0.6,1.0)	0.9 * (0.8,1.0)

[a] Outcomes from the six-month post enrollment Food Allergy Outcomes Related to White and African American Racial Differences Study Diet and Purchasing Survey.

[b] Adjusted Odds Ratio (95% Confidence Interval)

[c] Multivariable logistic regression of food allergy-related attitudes and behaviors adjusted for race, sex, child age, annual household income, caregiver education level, number of "Top 9" food allergies (dichotomized), ever having visited the ED for a FA-reaction, and recruitment site. Robust standard errors are clustered at the household level.

[d] "Top 9" food allergies are the nine food allergies with the highest prevalence in U.S. children under age 18 years. The nine most prevalent allergens are milk, egg, peanut, tree nuts, sesame, soy, fin fish, shellfish and wheat.[13]

* P value <0.05

** P value <0.01

*** P value <0.001