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College students' knowledge and management of food allergies

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ABSTRACT

Objective: This study explored predictors of food allergy management in college students, including participants' reported allergy severity, history of allergic reactions, and allergy knowledge. Further, we compared allergy knowledge in participants with food allergy to a matched sample of college students without food allergy. **Method:** Participants were recruited from a larger nationwide study of knowledge and attitudes toward food allergy in college students, with purposeful oversampling of students with food allergies. Participants completed measures assessing their food allergy(ies), symptoms, history of reactions, and current allergy management behaviors. Participants with food allergies and control participants without food allergies completed a measure of food allergy knowledge. **Results:** Hierarchical regression revealed that food allergy knowledge accounted for an additional 20% of variance in students' allergy management behaviors, above and beyond severity and allergic reactions, R^2=.39, $F(3,48)$=10.09, p<.001. There was not a statistically significant difference in food allergy knowledge between participants with food allergy and matched controls, $t(49)$=−1.85, p=.07, 95% CI=−1.42 to 0.06. **Conclusions:** This study suggests allergy knowledge is an important factor in food allergy management. Knowledge significantly predicted food allergy management behaviors above and beyond food allergy severity and recent food allergy reactions. College students with food allergies did not demonstrate greater knowledge than controls, suggesting a need for psychoeducational intervention to target college students' allergy knowledge as they transition to independent allergy management.

Abbreviations: AYA: Adolescents and young adults; IgE: Immunoglobulin-E; SIE: Self-injectable epinephrine

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Introduction

Food allergies are increasing in incidence in both children[1] and adults.[2] Although many children outgrow their food allergies over time, some childhood food allergies persist into the young adult years.[3] Immunoglobulin-E(IgE)-mediated allergies can result in life-threatening anaphylaxis, and adolescents and young adults (AYA) are at greater risk of death due to anaphylaxis[4] compared to children. Allergy management includes informing others about one's food allergy and allergy management plan, carrying self-injectable epinephrine (SIE) or other emergency medication, and reading labels to strictly avoid allergens.[5] Research has found that adolescents with food allergies may not always carry SIE and may ignore labels indicating the food "may contain" their food allergen.[5] Adolescents with food allergy have endorsed risk-taking behaviors when not accompanied by their parents,[6] and college students have reported high risk-taking behaviors and poor adherence to allergy management, including sub-optimal use of SIE.[7] The present study extended the literature by assessing allergy knowledge and predictors of allergy management in college students with food allergy.

Despite increasing research on the psychosocial impact of food allergies, AYA populations, particularly college students, remain relatively understudied.[8] As they transition out of their parents' home, college students with food allergy must balance inconsistent schedules, social pressures, lack of control over food, and greater autonomy and perceived invincibility. Additionally, peer stigmatization, expectation that reactions will be mild (perceived invincibility), and difficulty following best practices for carrying SIE may contribute to inconsistent management in college environments.[8] Duncan and Annunziato[8] found that college students with a food allergy who endorsed that anaphylaxis is a serious condition were more likely to report higher adherence, suggesting that a student's accurate knowledge of what poses a threat to their health may be an important predictor of allergy management behaviors in college students with allergies. These findings are consistent with research with other chronic illness populations, such as Type 1 diabetes, that suggests that time management, stress, diet management difficulties, and finances are barriers to diabetes management in college students.[9] Similarly, college students' adherence to a healthy diet may be affected by time management, finances, and inconvenience.[10] Barnard and colleagues[11] identified harmful rates of alcohol consumption in college students with diabetes, warranting increased focus on educational interventions for college-aged chronic illness populations.

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Disease-specific knowledge plays a role in adherence to medical management in a number of populations. For example, diabetes knowledge may be associated with adherence, both in youth with Type 1 diabetes[12] and in adults with Type 2 diabetes, who were more adherent with greater knowledge.[13] Adults with food allergies have demonstrated limited knowledge relevant to food allergies, including the effects of alcohol on allergic reactions,[14] but less is known about food allergy knowledge in college students. Further, measurement of allergy knowledge needs to be developmentally appropriate for the college population. Existing food allergy knowledge measures focus on parents of children[15] and lack items assessing alcohol consumption and sexual encounters. Alcohol can influence the absorption rate of allergens, causing faster or more intensive onset of reactions.[14] College students drink more compared to non-college-student peers[16] and therefore, party scenarios create risky environments for college students with food allergies. Additionally, knowledge measures often omit sexual contact as a secondary cause of allergy reactions. Akeson, Worth, and Sheikh[17] presented qualitative data, including one teen who identified the need to ask those she might kiss if they had eaten her allergen, which prevented her from kissing others. Grello, Welshe, and Harper[18] found that 76% of college participants reported being sexually active, with more than half of this group reporting they were not romantically involved with their sexual partner. This "hook-up" culture on college campuses may endanger students with food allergies if they are not discussing allergies prior to kissing. College students with food allergy have indicated that more knowledgeable and supportive peers might improve their quality of life as they manage their allergies,[18] but many non-allergic college students lack critical knowledge, such as understanding what anaphylaxis is.[19]

Given increasing rates of food allergy, potential for fatal anaphylaxis in AYA with food allergy, and the importance of knowledge for adherence to disease management, this study addressed several gaps in our understanding of allergy management in college students. We examined predictors of allergy management in college students, including participants' reported allergy severity, history of allergic reactions, and allergy knowledge. A second aim was to compare allergy knowledge in participants with food allergy to a matched sample of students without food allergy to delineate gaps in allergy knowledge specific to college student populations. We hypothesized that knowledge would predict adherence to an allergy management plan in students with food allergy, and that students with allergy would have higher allergy knowledge than controls without allergy.

Method

Participants

Participants were recruited as part of a larger study of knowledge and attitudes toward food allergy in a national sample of college students, with oversampling of students with food allergies. From an overall sample of 382 college students, 51 college students self-reported a food allergy diagnosed by a healthcare professional. For the second aim, these 51 participants were matched with controls based on age group, sex, and region; however, one participant with food allergy could not be matched to a control due to reporting "Other" for their sex. As such, the second analysis was on 100 students total: 50 with food allergy matched on age, sex, and geographic region to 50 controls. Demographic characteristics of participants with food allergies are presented in Table 1.

Table 1. Demographic and food allergy descriptive information for participants who endorsed a food allergy ($N = 51$).

	M (SD)	Range	*N* (%)
Age		18–35	
18–25			50 (98.0%)
26–35			1 (2.0%)
Sex			
Male			6 (11.8%)
Female			43 (84.3%)
Other			2 (3.9%)
Race			
White			35 (68.6%)
Black/African American			9 (17.6%)
Middle Eastern			1 (2.0%)
Asian			1 (2.0%)
Bi-racial			3 (5.9%)
Other			2 (3.9%)
Class Standing			
Freshman			15 (29.4%)
Sophomore			9 (17.6%)
Junior			9 (17.6%)
Senior			12 (23.5%)
Graduate student			3 (5.9%)
Other			3 (5.9%)
Allergens			
Milk			14 (27.5%)
Eggs			6 (11.8%)
Fish			8 (15.7%)
Shellfish			8 (15.7%)
Tree nuts			20 (39.2%)
Peanuts			17 (33.3%)
Wheat			8 (15.7%)
Soy beans			5 (9.8%)
Sesame			4 (7.8%)
Other			19 (37.3%)
Number of allergic reactions in the past 6 months	2.11 (1.61)		
0			27 (52.9%)
1			7 (13.7%)
2			6 (11.8%)
3			3 (5.8%)
4			2 (3.9%)
5 or more			4 (7.8%)
Severity			
High			38 (74.5%)
Low			13 (25.5%)
Food allergy knowledge score	0.73 (0.19)	0–1	
Food allergy management score	3.69 (0.96)	1–5	

Procedure

Survey items were disseminated nationally in an online Qualtrics survey via social media. Social media accounts (e.g., Facebook groups) that specifically target college students with food allergy were contacted and agreed to post the link to the online survey so as to oversample for college students with food allergy. All recruitment methods and materials were approved by the Eastern Michigan University human subjects review committee.

Participants self-selected and electronically consented into the study; following completion, they could choose to enter their email address into a separate survey to enter a raffle for one of ten $10 gift cards. The datasets were never linked, so identifying information could not be linked to participant responses.

The aim of the larger study was to assess knowledge and attitudes toward food allergy in college students. After the attitude and knowledge items, participants were asked if they had a food allergy diagnosed by a physician. Those who clicked "No" were finished, whereas those who clicked "Yes" were directed to questions about their food allergy(ies), symptoms, history of reactions, and current allergy management behaviors.

Measures

All participants reported demographic information (e.g., age, sex, education, marital status, grade point average, geographic region). Participants who endorsed having a physician-diagnosed food allergy also answered questions about their food allergy, as follows.

Food allergy severity

Although the research is mixed on defining allergy severity, we followed the dichotomous (mild-moderate versus severe) approach used by researchers (e.g., Gupta et al.[19]) suggesting that presence of respiratory symptoms (e.g., wheezing, shortness of breath, anaphylaxis) and/or hypotension marked a more severe allergic reaction. Therefore, allergy severity was coded based on an indication of hypotension (e.g., weak pulse) or any respiratory symptoms (e.g., wheezing, shortness of breath, throat-tightening) as a proxy for risk of anaphylaxis. Participants who endorsed respiratory symptoms or symptoms of hypotension were characterized as high severity, and those who did not were characterized as mild severity.

Number of allergic reactions

Participants reported the number of allergic reactions they had experienced within the past 6 months.

Food allergy knowledge

The study authors developed 10 items to assess food allergy knowledge that targeted college students (see Table 2). Several items assessed domains similar to existing measures of allergy knowledge (e.g., Gupta et al.[20]), such as whether children outgrow allergies. Following a review of the empirical literature and published resources for college students with food allergies, we added items specific to college settings, including alcohol-related risks, party-related scenarios, and the risk of kissing a person who had recently ingested the allergen.[5] These items were scored "correct" or "incorrect," and scores were averaged to create a composite food allergy knowledge score. Among the 51 participants with food allergy, this measure demonstrated acceptable, although not strong, internal consistency (Cronbach's alpha=.67). Given the heterogeneity associated with management of many chronic conditions (i.e., many patients may

Table 2. Food allergy knowledge and allergy management items.

Knowledge of food allergies		% Correct (with food allergy diagnosis)	% Correct (matched controls)
True	People with food allergies should read labels on packaged foods.	94	100
True	People with food allergies can die from an exposure to whatever they are allergic to.	98	88
False	People with food allergies can safely drink alcoholic beverages, including beer, wine, and mixed drinks.	44	32
True	People with food allergies should not eat food set out at parties.	42	32
True	People with food allergies can be exposed to whatever they are allergic to by kissing someone who has recently eaten that food.	82	80
False	Children with food allergies will outgrow them, so they are not as serious by the time they get to college.	78	70
True	Food allergies can result in a reaction that affects the person's breathing.	92	94
False	If a person is allergic to a food, the reaction always occurs within a few minutes.	64	46
True	Walking into a room where food containing a food allergen was prepared can trigger an allergic reaction.	76	84
True	Alcohol can cause someone's body to absorb a food allergen faster, resulting in a quicker onset of symptoms.	48	28

Management of food allergies:
I ask about ingredients in food/drinks, especially when it's unclear (e.g., at potlucks, mixed drinks at parties).
I read food labels on food I am not familiar with.
I avoid food if I don't know the ingredients.
I inform my professors about my food allergy at the start of each semester.
I inform my roommate(s)/hallmates/residential staff about the presence of my food allergy.
I carry an auto-injector or some other emergency medication with me to class.
I carry an auto-injector or some other emergency medication with me during meals (e.g., going out to eat, eating in the cafeteria).
I carry an auto-injector or some other emergency medication with me when I go to parties or bars.
I am careful about kissing/hooking up with other because of my food allergy.

be adherent to one recommendation but not others), this level of internal consistency is not unexpected.

Food allergy management

Food allergy management was assessed through nine items assessing behaviors that can prevent an allergic reaction or improve implementation of a food allergy management plan after exposure to an allergen (see Table 2). Based on the literature indicating that effective management of IgE-mediated food allergies calls for strict allergen avoidance, prompt use of SIE, and notification of others of the allergy management plan,[5] the authors included items to capture frequency of these behaviors. Responses were recorded in Likert-style scale format ranging from 1 = strongly disagree to 5 = strongly agree, with higher scores indicating better adherence. All 9 items were averaged to create a food allergy management composite score. This measure demonstrated good internal consistency (Cronbach's alpha=.92).

Data analysis

Of the 54 participants who endorsed a food allergy diagnosed by a healthcare professional, 3 dropped out before answering critical items in all domains; thus, they were removed in listwise deletion. Of the remaining 51 participants, regression imputation was used to replace 7 missing values with the mice package[21] in Rstudio.[22] Since the missing data represent less than 5% of the values in the dataset, these missing values are not of great importance.[23] However, the variables analyzed failed Little's[24] test of missing completely at random, and therefore it is not known whether these missing variables are missing at random, or represent systematic missingness. Lastly, the variable that indicates the number of allergic reactions in the past 6 months was skewed beyond the accepted cutoff of $z = 1.96$, or $\alpha < .05$.[25] However, upon further analysis, even the most extreme transformation (inverse) still resulted in skewed distribution, and the results of the inversed data were comparable to the original data. Therefore, original data were retained. Lastly, analyses revealed that a sample size of 50 matched pairs (one participant could not be matched) would yield appropriate power to detect at least medium effects ($\alpha = 0.93$) for dependent t tests.[26]

Results

Food allergy descriptive information

Participants with food allergies reported demographic characteristics and food allergy descriptive information (see Table 1). This sample was predominantly female (84.3%), White (68.6), and aged 18-25 (98%). Participants endorsed numerous food allergies, with tree nuts, peanuts, and milk as the most common; 43.1% endorsed more than one food allergy. Data on allergy severity, knowledge, management, and history of reactions are also presented in Table 1.

Table 3. Means, standard deviations, and correlations.

Variable	*M*	SD	1	2	3
1. Severity	0.75	0.44			
2. Number of allergic reactions in the past 6 months	2.11	1.61	.12		
3. Management	3.69	0.96	.35*	.31*	
4. Knowledge	0.73	0.19	–.19	.21	.42**

Note. *$p<.05$; **$p<.01$. *M* and SD are used to represent mean and standard deviation, respectively.

Hierarchical multiple regression on management behaviors

The first aim was to examine food allergy management behaviors in college students with a food allergy. Allergy severity, number of allergic reactions, and food allergy knowledge were hypothesized predictors of the management outcome variable in the 51 participants with food allergy. Hierarchical multiple regression tested the contribution of each predictor, and the specific unique prediction of knowledge, on the outcome of allergy management. Correlations are presented in Table 3. Variables that explain management behaviors were entered in two steps. In step 1, management was the dependent variable with severity and number of allergic reactions as the independent variables. Step 1 indicated that the overall model was significant: $R^2 = .19$, $F(2,48) = 5.73$, $p < .01$. Severity and number of allergic reactions were both significant independent variables. In step 2, food allergy knowledge was entered in addition to severity and allergic reactions. The overall model fit with three independent variables was also significant, $R^2 = .39$, $F(3,48) = 10.09$, $p < .001$. In this model, severity and knowledge were both significant, but number of allergic reactions was no longer significant. The change in variance accounted for was significant, $\Delta R^2 = .20$, $\Delta F(1,47) = 15.38$, $p < .001$. In other words, knowledge accounted for an additional 20% of variance in management behaviors, above and beyond severity and allergic reactions. The unstandardized regression coefficients (b) and the standardized regression coefficients (β) for both models are presented in Table 4. Knowledge was predictive of higher food allergy management, controlling for severity and number of allergic reactions.

Food allergy knowledge and management in students with food allergy

Food allergy knowledge

Participants with food allergy demonstrated a mean food allergy knowledge score of .73 (SD=0.19) on the 10 items. Participants were most likely to incorrectly respond to items related to parties (e.g., "People with food allergies can safely drink alcoholic beverages, including beer, wine, and mixed drinks") or allergy reaction time (e.g., "If a person is allergic to a food, the reaction always occurs within a few minutes"). However, students were frequently correct on items related to anaphylaxis (e.g., "People with food allergies can die from an exposure to whatever they are allergic to," or, "Food allergies can result in a reaction that affects the person's breathing") and the importance of reading food labels (e.g., "People with food allergies should read labels on packaged foods") with average accuracy at 92% or higher.

Table 4. Predicting food allergy management with severity, allergic reactions, and knowledge.

	B	SE	Β	*T*	ΔR^2
Step 1					.19**
Severity	0.70	0.28	0.32*	2.43	
Allergic reactions	0.16	0.08	0.27*	2.05	
Step 2					.20**
Severity	0.92	0.26	0.42**	3.58	
Allergic reactions	0.09	0.07	0.16	1.32	
Knowledge	2.34	0.60	0.47**	3.92	

Note. *$p<.05$; **$p<.01$. Step 1 model: $R^2=.19$, $F(2,48)=5.73$, $p<.01$, Step 2 model: $R^2=.39$, $F(3,48)=10.09$, $p<.001$.

Food allergy management

Students demonstrated moderate adherence to common food allergy management recommendations ($M=$ 3.69, SD=0.96, range 1–5). Most participants endorsed that they strongly agree or agree with the following statements: "I ask about ingredients in food/drinks, especially when it's unclear" (e.g., at potlucks, mixed drinks at parties; 92.2%), and, "I read food labels on food I am not familiar with" (90.2%). Participants were least likely to agree with the following statements: "I inform my professors about my food allergy at the start of each semester" (19.6% agree), "I am careful about kissing/hooking up with others because of my food allergy" (41.2%), "I carry an auto-injector (e.g., EpiPen) or some other emergency medication with me when I go to parties or bars" (45.1%), and, "I inform my roommate(s)/hallmates/residential staff about the presence of my food allergy" (47.1%).

Allergy knowledge in students with allergy versus matched controls

The second aim of the study was to examine how allergy knowledge among participants with food allergy compared to those without food allergy to identify gaps in knowledge of both allergic and non-allergic students. The 51 participants with food allergy were matched to non-allergic controls based on age group, sex, and region. One participant was excluded because an appropriate matched control could not be found, so this analysis used 50 participants with food allergies, and 50 without. A paired samples *t* test revealed no statistically significant difference between individuals with a food allergy ($M=$ 0.72, SD= 0.19) and individuals without a food allergy ($M=$ 0.65, SD= 0.17) in food allergy knowledge, $t(49)=-1.85$, $p=.07$, 95% CI=–1.42 to 0.06. The lack of a significant difference was contrary to the hypothesis that students with food allergy would demonstrate greater knowledge.

Discussion

With growing numbers of adults and children with food allergies,[1,3] college students with food allergies represent a vulnerable population that may be managing their allergy for themselves for the first time. Despite increasing focus on adherence to food allergy management, and the awareness of barriers such as limited control of food options, lack of food labeling in dining halls, and the potential for stigma or lack of knowledge and understanding from their peers, there remains a gap in our knowledge of how college students are managing their food allergies. This study points to food allergy knowledge as an important factor in food allergy management. Not only did food allergy knowledge significantly predict food allergy management behaviors in the present sample, but it predicted allergy management above and beyond food allergy severity and recent food allergy reaction count. Given that knowledge may be modifiable with intervention, these findings underscore the need to monitor AYA populations as they learn how to manage their condition independently and suggest that they would benefit from intervention that directly targets their knowledge at a critical developmental transition.

The second aim of our study was to better delineate patterns and gaps in knowledge of college students, not only to define targets for intervention in allergy clinics for patients transitioning to college, but also to inform educational initiatives in college settings for students and employees. Contrary to expectation, there was no statistically significant difference. Both sets of participants, with or without allergies, answered approximately 70% of questions correctly. Many participants were not sure on items assessing risks related to alcohol, for example (see Table 2), indicating an important target for improving allergy education. These results underscore the implication that food allergy knowledge, specific to college life and party situations, may be an important target for psychoeducational intervention to positively impact food allergy management in the AYA population. The Food Allergy Research and Education (FARE)[27] organization developed the College Food Allergy Program with guidelines for managing food allergies on college campuses, although these are targeted to the systems level (e.g., campus employees) rather than the individual patient. FARE guidelines suggest training for college employees and creating advocacy groups to help students manage their food allergy in a college environment, in addition to providing these students with appropriate accommodations. Despite these guidelines, however, no research was identified that studied the implementation of these guidelines, such as how many college students receive specific anticipatory guidance from their healthcare provider before leaving for college, nor how many seek out resources or guidance once on campus. Our results indicate that training and educational efforts should be focused on all college students, not just employees, given the link between patient allergy knowledge and allergy management practices in the AYA population.

Even though risk-taking is common in adolescents and college students with food allergy,[5,7] this study adds to our understanding that food allergy knowledge may be one mechanism to better understand and ameliorate risk-taking behavior. One might expect that students with diagnosed food allergies would demonstrate high knowledge on basic allergy knowledge items. Surprisingly, on some items, students with food allergies actually had lower rates of accuracy, and on one important item ("Alcohol can cause someone's body to absorb a food allergen faster, resulting in a quicker onset of symptoms"), students with food allergy

answered correctly less than half the time. These critical knowledge items with low accuracy may serve as one important explanation for why there are higher rates of risky behaviors and death in this vulnerable population.

The methodology and sample size present limitations that constrain generalizability of the findings of this study. First, the research design was cross-sectional, so further research should be conducted longitudinally in AYA with food allergies to better determine the causal nature of the predictors in this study. Additionally, our questionnaire asked for self-report of food allergy diagnosed by a healthcare professional, but we were unable to confirm the diagnosis through medical records. Also, our data in this anonymous online survey were only self-report of food allergy symptoms, reactions, and management; therefore, responses may be subject to recall bias or social desirability bias. Future studies should review medical records to verify the accuracy of self-report responding. Despite having sufficient power to detect differences, our small sample of college students with food allergy limited the statistical modeling available to more fully examine predictors of adherence to food allergy management, and the sample was largely female, making generalizability to males difficult. Finally, due to the use of new items in the measures used in this analysis and the relatively low internal consistency of the knowledge measure, future research should expand upon these measures and provide psychometric analysis of validity and reliability in larger samples.

Future studies should build upon this research utilizing prospective, longitudinal designs with clinical populations to better understand allergy knowledge as a protective factor for food allergy management. Additionally, potential cognitive predictors of food allergy management in college students should be examined, such as executive functioning, as has been studied in the Type 1 diabetes population.[28] Finally, randomized controlled trials are needed to determine efficacy of interventions focusing on improving knowledge as a mechanism to decrease risk-taking behavior in AYA with food allergy. Although no studies were identified that tested interventions specific to food allergy, similar populations, such as asthma and diabetes, have been well-studied. One study of AYA with Type 1 diabetes followed adolescents from age 12 to 23 years old and found that, at age 23, *parent* knowledge of diabetes best predicted improved self-care behavior in emerging adulthood.[29] Allergy teams may benefit from following similar scaffolding models to better prepare AYA with food allergies and their families to work toward greater independence in adulthood. For example, targeting self-efficacy in food allergy management may be one mechanism, as low self-efficacy has been linked to avoidance strategies (e.g., keeping allergies a secret from peers) in children and adolescents, thereby putting them at risk for poor management.[30] Self-management interventions have improved self-efficacy in similar populations, such as asthma,[31] and tailoring interventions based on levels of self-efficacy could improve intervention outcomes.[32] Integrated mental health providers in allergy centers may be able to target self-efficacy in AYA with food allergy.

These findings generate important clinical implications for the AYA allergy population as they must increase their self-management to navigate barriers to adherence upon leaving their parents' home. As with any population facing a developmental transition, AYA with food allergies likely would benefit from specific intervention approaches that provide anticipatory guidance in advance of their leaving for college. Moreover, researchers should examine how to best increase awareness and advocacy for employees and residents on college campuses to better support this growing population of college students managing life-threatening food allergies. Employees of university residential halls, student health services, and dining hall services (e.g., dietitians, cafeteria workers) may benefit from educational intervention targeting allergy management support.[7] Finally, embedded mental health providers on interdisciplinary allergy teams could be beneficial in addressing the many needs for adherence intervention.

Conflict of interest disclosure

The authors have no conflicts of interest to report. The authors confirm that the research presented in this article met the ethical guidelines, including adherence to the legal requirements, of the United States and received approval from the Institutional Review Board of Eastern Michigan University.

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