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Sarah E. Duncan & Rachel A. Annunziato

To cite this article: Sarah E. Duncan & Rachel A. Annunziato (2018) Barriers to self-management behaviors in college students with food allergies, Journal of American College Health, 66:5, 331-339, DOI: [10.1080/07448481.2018.1431898](https://doi.org/10.1080/07448481.2018.1431898)

To link to this article: <https://doi.org/10.1080/07448481.2018.1431898>



Accepted author version posted online: 06 Feb 2018.
Published online: 12 Mar 2018.



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MAJOR ARTICLE



Barriers to self-management behaviors in college students with food allergies

Sarah E. Duncan , MA^a and Rachel A. Annunziato, PhD^{a,b}

^aDepartment of Psychology, Fordham University, Bronx, New York, USA; ^bDepartment of Pediatrics, Icahn School of Medicine at Mount Sinai and Kravis Children's Hospital, New York, New York, USA

ABSTRACT

Objective: This study examined barriers to engagement in self-management behaviors among food-allergic college students (1) within the frameworks of the health belief model (HBM) and common sense self-regulation model (CS-SRM) and (2) in the context of overall risky behaviors. **Participants:** Undergraduate college students who reported having a physician-diagnosed food allergy ($N = 141$). Research was conducted from February 2015 through May 2016. **Methods:** Participants were recruited from college campuses through email and social media. The frequency of adherence to self-management behaviors was measured along with HBM, CS-SRM, and risk-taking behaviors through a self-report survey. **Results:** Among all participants, HBM and CS-SRM constructs and Tobacco Use explained 30.6% of the variance in adherence. CS-SRM constructs and Tobacco Use explained 44.8% of the variance for participants with self-injectable epinephrine (SIE). **Conclusions:** Food-allergic college students demonstrate inconsistent adherence, and interventions designed to improve adherence should take both SIE prescription status and contextual factors into consideration.

ARTICLE HISTORY

Received 4 December 2016
Revised 15 August 2017
Accepted 19 September 2017

KEYWORDS

Adherence; barriers; college students; food allergy self-management

Food allergies are potentially serious, life-threatening conditions. Within the food-allergy population, research suggests adolescents and young adults are at the highest risk for death from anaphylaxis,¹ and studies aimed at better understanding this heightened risk have revealed that this population frequently does not adhere to prescribed self-management behaviors. For example, these individuals often choose to eat food containing a known allergen, do not alert people around them to their allergy, and inconsistently carry self-injectable epinephrine (SIE)—emergency medication intended to be administered immediately upon experiencing anaphylaxis symptoms.^{2,3}

This pattern of poor self-management appears to be especially problematic during the transition to college as adolescents gain new-found freedom⁴ and increased oversight of their health.⁵ An estimated 436,000 to 700,000 college-aged students may suffer from food allergies, and research shows that they engage in even fewer relevant self-management behaviors than their adolescent counterparts.⁵ One study of food-allergic college students at a Northeastern university indicated that only 9.6% of surveyed students reported always carrying SIE.⁶ Another study of Midwestern college students identified a higher reported rate of consistent SIE carriage (51.2%); yet, this still demonstrates deficits in this

important self-management behavior for a substantial portion of students.⁷ This failure to adhere to self-management behaviors is reflected in the mortality rates among this population; in a case series of food allergy-related deaths between 1994 and 2006 in the U.S., 25% occurred in individuals between the ages of 18 and 22 years, and half of these deaths took place on college campuses.^{1,8}

Few studies have explored barriers to self-management behaviors specific to college students; however, the limited data on this topic in food-allergic adolescents and young adults offer potential insight into college students' nonadherence. For example, aspects of the environment that impede adolescents' adherence are perhaps relevant in college settings as well. Students may believe they are not at risk for a reaction when in familiar places or places where they do not anticipate food will be served,^{2,9,10} and SIE carriage may be perceived as particularly incompatible with college life. The cumbersome design of the SIE device,^{2,10} forgetfulness,¹⁰ and the need to store the device within a specific temperature range² may also serve as deterrents to consistent carriage. Furthermore, research has demonstrated that peer and social influences that stigmatize individuals with food allergies^{3,7,11} and perceptions that an allergic reaction will be mild¹² may impede regular adherence.

Theoretical framework: HBM and CS-SRM

A recent study by Jones et al. has helped to conceptualize previous findings about barriers to self-management in food-allergic adolescents within two well-known theories of health behavior: the health belief model (HBM) and the common sense self-regulation model (CS-SRM).¹² The HBM framework for understanding individuals' decisions to act on health-related problems is composed of five main components: perceived susceptibility, perceived severity, perceived benefits, perceived barriers, and cues to action.¹³ Perceived susceptibility refers to individuals' evaluations of how likely they are to contract a disease or condition, perceived severity is the individual's perception of the seriousness of a health problem, and perceived benefits refer to individuals' beliefs about whether steps taken to prevent or treat the disease or condition will be effective. The perceived barriers component reflects the perceived disadvantages of treating a disease or disorder, and cues to action are signals that remind an individual to engage in a behavior.¹³

The common sense self-regulation model (CS-SRM) serves as a framework for understanding individuals' representations of and beliefs about their disease.¹⁴ The original model consisted of five major belief dimensions: identity, consequences, timeline (acute or chronic), control/cure, and cause. Identity refers to how an individual labels his condition, consequences describe expectations about the outcome of the disease, timeline represents beliefs about the duration of the disease, control/cure refers to beliefs about whether the individual can control the disease and whether he will fully recover from it, and cause is the individual's belief about the origins of the disease.¹² Three additional components have since been added to the original model: emotional representation (how the individual feels about his disease), cyclical timeline beliefs (whether the individual believes his symptoms will change over time), and coherence (whether an individual understands his disease).¹²

Importantly, Jones et al. found that juxtaposing these models helped explain some of the variation in adherence behaviors for adolescents with food allergies. Specifically, the HBM perceived severity scale was positively related to adherence while the perceived barriers scale was negatively associated with adherence. From the CS-SRM, the emotional representation scale (for example, experiences of anxiety or anger related to one's allergy) was associated with higher levels of adherence.¹²

Engagement in general risky behavior

The HBM and CS-SRM may help to explain food-allergic college students' self-management behaviors;

however, the aforementioned behaviors must also be considered in terms of college students' developmental stage and their environmental context. Specifically, college students tend to engage in risky behaviors such as binge drinking,¹⁵ texting while driving,¹⁶ not wearing a seatbelt while driving or a helmet on a bicycle, driving while intoxicated, and engaging in unsafe sex.¹⁷ Food-allergic college students' poor self-management behaviors may be a manifestation of risk-taking tendencies in general rather than risk-taking that is limited to their food allergy. It is also possible that general risk-taking behaviors exacerbate college students' nonadherence to self-management behaviors. Understanding the connection to self-management behaviors may provide insight into food-allergic college students' poor adherence rates.

Study aim

The purpose of this study was to identify barriers to self-management behaviors in college students with food allergies for the purpose of intervention development. The HBM and CS-SRM were used as theoretical frameworks for this investigation. Additionally, the study examined nonadherence in the context of emerging adulthood and engagement in risky behavior generally. It was hypothesized that (1) the HBM and CS-SRM would explain variance in adherence to self-management behaviors and (2) a tendency to engage in risky behaviors would moderate the relationship between the independent variables and adherence to self-management behaviors.

Methods

Design

A cross-sectional self-report survey was employed to identify barriers to self-management behaviors within the framework of the HBM, CS-SRM, and general risk-taking.

Participants and procedures

Eligible participants included individuals between the ages of 18 and 25 years who were enrolled as undergraduate students at the time of the study and were diagnosed with a food allergy by a physician. Exclusion criteria included (1) not having a college email address to verify student status and (2) having a food intolerance—a less serious, usually digestive, reaction to a food that may not occur every time the food is ingested¹⁸—as opposed to a food allergy.

Participants were recruited through social media and through a liberal arts university via a posting on the school's psychology research participation system, emails to psychology majors, and campus flyers. Students were provided an electronic link for the eligibility screening questionnaire; those who met the inclusion criteria then received informed consent. Individuals who consented to participate in the study were directed to the survey, which took approximately 15 to 20 minutes to complete. Participants received either one research credit or a five-dollar Amazon gift card as compensation. These procedures were approved by the university's Institutional Review Board.

Measures

Brief screening instrument

Individuals interested in participating in the study completed a brief screening questionnaire to ensure eligibility. This instrument included questions about whether the potential participant was: diagnosed with a food allergy by a physician, between the ages of 18 and 25 years old, and an undergraduate college student. College student status was verified after the individual consented to the study by asking the participant to provide his or her college email address.

Demographic information and food allergy characteristic questionnaire

This questionnaire ascertained data on several demographic variables including gender, year in school, age, and race/ethnicity. Participants were also asked to indicate the food(s) to which they were allergic, their primary food allergy, and whether they had been prescribed SIE.

Adherence to self-management behaviors

This measure of self-management behaviors was adapted for college students from Jones et al.'s study of food-allergic adolescents. Their original measure included four items rated on a 5-point scale that were related to the frequency with which individuals carry SIE and the extent to which they avoid allergens and inform others about their allergy (refer to Jones et al. for specific items).¹² The adapted version for the current study included two additional items about eating on campus. All item responses were combined to form one total adherence score for participants who had been prescribed SIE; additionally, all item responses excluding SIE carriage were combined to form a total adherence score for all participants regardless of SIE prescription status. The adapted adherence measure had acceptable internal consistency (including the SIE item: $\alpha = .81$; excluding the SIE item: $\alpha = .82$).

Adapted Brown allergy grading system

This measure of allergy severity was adapted for use as a self-report from Brown's physician allergy grading system.¹⁹ The adapted self-report measure created for this study maintained the criteria from the original measure for classifying the severity of an allergic reaction and added laymen's descriptions of each of the symptoms (i.e., "Rash" was added in parentheses next to "generalized erythema"). Participants were instructed to select from one of three severity grades—mild, moderate, or severe—based on their most severe allergic reaction or to select "Don't know."

Health belief model (HBM) questionnaire

The HBM questionnaire used in this battery was adapted by Jones et al. for food allergy management behaviors from Champion's original HBM questionnaire for breast self-examination.²⁰ In their adapted measure, 32 questions rated on a 5-point scale were used to assess each of the five HBM scales (provided in Jones et al.), and several items were worded specifically for food allergies. Factor analysis supported a five-factor structure.¹² In the present study, each of the scales, with the exception of Perceived Benefits ($\alpha = .48$), demonstrated satisfactory internal consistency ($\alpha = .62$ to $.90$).

Illness Perception Questionnaire-Revised (IPQ-R)

The version of the IPQ-R used in the current study was adapted by Jones et al. from Moss-Morris et al.'s Illness Perception Questionnaire-Revised²¹ and was used as a measure of the CS-SRM.¹² The IPQ-R included 38 items rated on a 5-point scale to assess seven areas including emotional representation of the food allergy, personal control of the allergy, having a coherent understanding of the allergy, perceptions of allergy chronicity and fluctuations in severity, consequences of the allergy, and treatment control (refer to Jones et al. for specific items). Illness identity was also assessed by asking whether individuals had experienced any of 14 symptoms and whether they believed their food allergy accounted for these symptoms. Factor analysis confirmed a seven-factor structure,¹² and in the present study, each of the scales, with the exception of Treatment Control ($\alpha = .53$), demonstrated adequate internal consistency ($\alpha = .73$ to $.93$).

Youth Risk Behavior Survey (YRBS)

This measure was adapted by Vuotto, Procidano, and Annunziato from the Center for Disease Control's 2013 National Youth Risk Behavior Survey.²² The measure included questions about tobacco use, alcohol use, marijuana use, body weight, diet, physical activity, sun safety,

sleep, general safety, dental hygiene, health screening behaviors, and medication adherence. Responses were indicated in terms of frequency or age when the behavior first began. The measure included three scales: Risk/Neglectful Behaviors, Tobacco Use, and Unhealthy Lifestyle Behaviors. Factor analysis has supported a three-factor structure,²² and in the current study, each scale demonstrated acceptable internal consistency ($\alpha = .61$ to $.80$).

Data analysis

A recruitment goal of 140 participants was based on power analyses for detection of at least medium effects in multiple regression analyses with 10–15 predictors.²³ Scales for participants who completed fewer than 90% of the items were excluded from the data analysis; the series mean was substituted for scales with fewer than 10% of items omitted. Because the range of possible values for each of the scales excluded zero, scales were centered at their mean to allow for interpretation of beta coefficients.²⁴ Data analysis was completed using SPSS version 24.

All data analyses were run using adherence scores for the full sample and then for the subgroup of participants who had reported being prescribed SIE (SIE subgroup) as the outcome measure. Independent samples *t*-tests were conducted to compare average adherence scores for gender and for presence of multiple food allergies. One-way analysis of variance (ANOVA) was computed to compare average adherence scores for race/ethnicity, year in college, and allergic reaction severity. Pearson's correlations were computed between adherence to self-management behaviors and each of the HBM, IPQ-R, and YRBS scales. Multiple regressions were then run with the variables that demonstrated a significant relationship with adherence. Significance levels for each of the statistical tests were two-tailed.

Results

Sample demographics

Three hundred twenty individuals completed the study eligibility questionnaire. A total of 109 individuals were not eligible for the study; 88.1% ($n = 96$) did not have a physician-diagnosed food allergy, 11.0% ($n = 12$) were not undergraduate students, and less than 1% ($n = 1$) were not between the ages of 18 and 25 years. The final sample included 141 participants who reported having a physician-diagnosed food allergy. Seven participants were excluded from the analyses because they selected "Does not apply" for adherence items related to dining

on campus, and their total possible adherence scores were lower than the remaining participants'. A post-hoc analysis was run to determine the impact of this sample size on the ability to detect at least medium effects. Because the actual number of predictors included in the regression analysis ($n = 9$) was smaller than the estimated number of predictors used for determining the recruitment goal, power was higher than anticipated (0.90). The average age of the sample was 19.83 years ($SD = 1.35$), and the sample was predominantly female (75.2%). The majority of participants reported their race and ethnicity as non-Hispanic white (73.0%).

About half of the sample (48.2%) indicated having an SIE prescription, and the majority of the sample reported experiencing moderate reactions when exposed to an allergen (50.4%). Most participants reported one food allergy (77.3%); for participants who identified as having multiple food allergies, primary food allergy was defined as the food to which the participant experiences the most severe allergic reaction. The most common primary food allergy was nuts (37.6%), followed by fruit (21.3%), shellfish and seafood (12.1%), gluten and wheat (9.2%), and dairy (5.7%). This allergy distribution is similar to that of other studies.^{25,26} Primary food allergy was significantly associated with SIE prescription status, $\chi^2(5) = 36.93$, $p < .001$. Specifically, 75.5% of participants with a primary nut allergy reported having an SIE prescription, followed by 58.8% of those with shellfish/seafood, 25.0% with dairy, 23.3% with fruit, and 15.4% with gluten/wheat. Similar to previous research, the sample reported overall inconsistent rates of adherence to self-management behaviors. Of the 67 participants who reported that they had been prescribed SIE, only 16.4% ($n = 11$) reported that they always carried SIE, while 17.9% ($n = 12$) reported that they never carried SIE (Table 1 displays adherence rates for each self-management behavior).

Participants reported engaging in other risky behaviors in addition to nonadherence, particularly regarding substance use. Slightly over 40% of participants indicated that they had tried cigarettes in the past. Additionally, 31.8% of participants reported that they had consumed five or more alcoholic beverages within a few hours at least once within the previous month, and 13.4% indicated that they had consumed 6 to 9 consecutive drinks at least once over the past month.

Relationship between demographic variables and adherence

Males' average adherence scores ($M = 19.88$, $SD = 5.07$) were lower than females' ($M = 22.52$, $SD = 4.64$) for the full sample, $t(131) = 2.77$, $p = .006$. Participants in the full sample (FS) and the SIE subgroup who reported

Table 1. Rates of adherence to specific self-management behaviors.

	Carry SIE	Avoid allergens	Ask about ingredients at restaurants	Ask about ingredients at friends' houses	Ask about ingredients on campus	Read posted ingredients on campus	Inform friends of food allergy
Never true	17.9	0.7	8.6	8.6	16.3	2.9	0.7
Usually not true	16.4	3.6	17.1	17.1	25.9	9.6	11.4
Occasionally true	20.9	5.0	27.1	27.9	24.4	13.2	21.4
Usually true	28.4	25.0	27.1	27.1	20.0	25.7	35.7
Always true	16.4	65.7	20.0	19.3	13.3	48.5	30.7

Note: Values represent percentages.

severe allergic reactions had higher average adherence scores (FS: $M = 24.33$, $SD = 3.70$; SIE: $M = 28.42$, $SD = 4.14$) than participants with mild allergic reactions (FS: $M = 20.73$, $SD = 4.66$; SIE: $M = 23.59$, $SD = 5.46$), $F(2,128) = 3.75$, $p = .03$ and $F(2,59) = 3.28$, $p = .045$, respectively. Additionally, the average adherence score (excluding SIE carriage) for participants with an SIE prescription ($M = 22.83$, $SD = 4.44$) was significantly higher compared to participants without an SIE prescription ($M = 21.03$, $SD = 5.08$), $t(132) = 2.17$, $p = .03$. The presence of multiple food allergies, race/ethnicity, and year in college were not related to adherence.

Regression analyses of the HBM, CS-SRM, and adherence

Regression analyses were run to test whether the health belief model (HBM) and the common sense self-regulation model (CS-SRM) explained variance in adherence to self-management behaviors. All HBM, IPQ-R (a measure of the CS-SRM), and YRBS scales and demographic and allergy variables that demonstrated a significant relationship with adherence were selected as predictors for the regression analyses.

Table 2 shows the standardized regression coefficients of the final models for the full sample and the SIE subgroup. The final regression model for the full sample demonstrated that the Consequences, Perceived Severity,

and Coherence scales each had a positive effect on adherence, while Tobacco Use had a negative effect. A comparison of the standardized regression coefficients revealed that Consequences had the largest effect on adherence. The model accounted for 30.6% of the variance in adherence for the full sample.

The final regression model for the SIE subgroup demonstrated that the Perceived Severity and Coherence scales were not significant predictors of adherence when the outcome measure included the SIE carriage item and the sample was restricted to individuals who reported having SIE prescriptions. The model showed that Timeline Acute/Chronic and Consequences both had positive effects on adherence for the SIE subgroup, while Tobacco Use had a negative effect. Consequences remained the variable with the largest effect. The model accounted for 44.8% of the variance in adherence behaviors among participants who reported having an SIE prescription.

Moderation analyses of risk-taking behavior

Because the Unhealthy Lifestyle Behaviors and Risk/Neglectful Behaviors scales were not significantly correlated with adherence, these two scales were excluded from the moderation analyses. The final variables included in the analyses were Tobacco Use as a measure of risky behavior; Consequences, Perceived Severity, and Coherence as predictors for the full sample; and

Table 2. Regression tables for full sample and SIE subgroup.

	Full sample			SIE subgroup		
	<i>B</i>	<i>S.E.</i>	β	<i>B</i>	<i>S.E.</i>	β
Health Belief Model (HBM)						
Perceived Severity	0.32*	0.13	0.21*	N/A	N/A	N/A
Illness Perception Questionnaire (IPQ-R)						
Timeline Acute/Chronic	N/A	N/A	N/A	0.39**	0.11	0.37**
Consequences	0.38**	0.09	0.38**	0.43**	0.12	0.38**
Coherence	0.19*	0.08	0.20*	N/A	N/A	N/A
Youth Risk Behavior Survey (YRBS)						
Tobacco Use	-0.28*	0.12	-0.20*	-0.60**	0.20	-0.31**

**Coefficient is significant at the .01 level, $p < .01$.

*Coefficient is significant at the .05 level, $p < .05$.

Note: Full sample adjusted $R^2 = .306$; SIE subgroup adjusted $R^2 = .448$.

Consequences and Timeline Acute/Chronic as predictors for the SIE subgroup. The addition of the interaction terms between Tobacco Use and each of the predictor variables did not lead to a significant change in the R^2 for either the full sample model or the SIE subgroup model. Therefore, the analysis did not provide support for the presence of a moderating effect of Tobacco Use.

Comment

Previous research examining college students with food allergies has suggested that this subset of young adults has particularly poor adherence to self-management behaviors potentially related to greater mortality from food-related anaphylaxis. The results of the current study were consistent with this previously reported pattern of poor adherence in college students. Only 30% of the present sample who reported having an SIE prescription indicated that they usually or always carry SIE. Participants more commonly reported that they always or usually avoid foods with known allergens, although they indicated that they less frequently ask about the ingredients of food prepared by others. Unfortunately, little research has been conducted to understand the reasons for poor self-management in this population. The aim of the current study was to fill this gap and identify factors associated with poor adherence to self-management behaviors in college students with food allergies.

Health belief model, common sense self-regulation model, and adherence

The use of the HBM and CS-SRM was guided by research on food-allergic adolescents and young adults suggesting that perceived hassles of self-management behaviors, beliefs about the benefits of avoiding and ability to avoid foods and carry/use SIE, and peer/social perceptions impacted adherence to self-management behaviors. Furthermore, Jones et al.'s study framed these barriers in terms of the HBM and CS-SRM and found that these models accounted for some of the variance in adherence to self-management behaviors for food-allergic adolescents.¹² Consistent with their findings and findings in other chronically ill populations,²⁷ perceived severity explained some of the variance in adherence to self-management behaviors in the current sample. Specifically, for the full sample, participants who reported stronger agreement with statements that anaphylaxis is a serious condition reported higher adherence scores than those who reported less agreement with these statements.

The remaining scales in the current study that were associated with adherence differed from those identified in the Jones et al. study, highlighting the unique

experience of college students. In addition to perceived severity, having a coherent understanding of their food allergies was positively related to adherence for the full sample. In their introduction to the IPQ-R, Moss-Morris et al. suggested that such an understanding may be particularly salient for long-term adjustment.²¹ It is possible that illness coherence emerged as a significant contributor to adherence in the current sample given likely longer time since diagnosis than adolescents and because, developmentally, identify formation may be more relevant.

Perceptions of adverse consequences of an allergic reaction were positively related to adherence in both the full sample and the SIE subgroup. Past research has demonstrated mixed evidence regarding the role of perceived consequences in adherence. A recent literature review examining this relationship cited studies of asthma and heart failure patients where perceptions of more serious consequences were associated with lower adherence, as well as a study of individuals with hypertension that demonstrated such perceptions were associated with higher adherence.²⁸ It is possible that the role of perceived consequences varied among these studies because it is influenced by the type of illness and the recommendations specific to managing these conditions.

Finally, students' beliefs about the permanence of their food allergies explained adherence exclusively in the SIE subgroup: the more participants with an SIE prescription agreed with the idea that their food allergy was an unrelenting health condition, the more adherent they reportedly were to self-management behaviors. Beliefs that food allergies are permanent may indicate acceptance of the allergy, which would be consistent with previous research demonstrating that people's acceptance of their health conditions is associated with increased adherence to self-management recommendations.²⁹

Risky behavior and adherence

The inclusion of general risky behaviors in the current study was informed by the well-documented increase in risk-taking that accompanies adolescence and young adulthood. Engaging in risky behavior did not moderate the relationship between the HBM and the CS-SRM and adherence; however, risky behavior—specifically, tobacco use—was independently and inversely related to adherence for both the full sample and the SIE subgroup. These findings suggest that perhaps poor food allergy management indicates a general tendency to engage in risk-taking behaviors and that this risk-taking also manifests itself in other ways, such as tobacco use. This notion that risky behaviors may group together—or that individuals who engage in risk-taking in one domain are more likely to engage in risk-taking in other areas—appears to be

consistent with neuroscience research that points to specific brain structures, such as the prefrontal cortex, as influencing risk-taking behavior in college students.³⁰

Limitations

This study has several limitations. First, self-report of food allergy diagnosis was used to minimize the burden of survey completion and selection bias. Similarly, we chose to recruit from social media—and consequently rely on self-report—in order to increase heterogeneity. Notably, the distribution of food allergies in this study reflected established prevalence rates in children and adults,^{25,26} suggesting that this sample was representative of the larger population. Second, because of the cross-sectional design of the study, conclusions cannot be drawn about how barriers develop from adolescence to young adulthood. The barriers identified in this data analysis may have developed upon the transition to college; conversely, these barriers may have been present before the transition, but became more salient with the increase in independence associated with attending college. Third, the current study sought to understand barriers for college students broadly; however, because participants were recruited through social media, we are unable to determine how many students had access to the survey and to draw conclusions about selection bias present in this sample.

Clinical and campus life implications

The present study identified both distinct and overlapping factors that were associated with adherence for food-allergic college students in general and those specifically with SIE prescriptions. Based on these results, it appears that broad groups of food-allergic college students may benefit from approaches that educate about the potential consequences and severity of allergic reactions, foster a coherent understanding of food allergy, and address risk-taking behavior. Interventions that are targeted more specifically to students with SIE prescriptions may benefit from including a component about the stability of food allergies in adulthood in addition to educating students about the potential consequences of allergic reactions and addressing risk-taking behavior. An important future consideration is when, ideally, such an intervention package should be delivered: during adolescence or upon arrival in college.

Furthermore, the findings about specific adherence behaviors in which students more frequently engage point to steps college campuses can take to protect their food-allergic student populations. In the current sample, the majority of students reported usually or always

avoiding foods with known allergens and paying attention to posted ingredients of foods prepared on campus. Conversely, they indicated that they oftentimes do not explicitly ask about ingredients in foods prepared by others. Posting the ingredients in foods served on campus may help to address students' apparent unwillingness to explicitly ask about ingredients, perhaps because asking draws attention to their allergy or because it is inconvenient. Importantly, the current findings suggest that students tend to pay attention to these postings.

Future directions

Multiple factors that may contribute to poor engagement in self-management behaviors were identified in the current study. However, the amount by which adherence needs to increase to reduce the likelihood of adverse health events has not been investigated. The identification of a benchmark adherence level—or rate of adherence improvement—at which the likelihood of negative health outcomes would be reduced could provide a target for adherence improvement interventions.

Furthermore, the current study demonstrated a relationship between tobacco use and nonadherence to self-management behaviors; however, the nature of this relationship remains unclear. One possibility, as described above, is that tobacco use and lower adherence group together because of a general underlying tendency to engage in risky behaviors. Further research in this area would help to clarify the benefits of addressing general risk-taking behaviors.

Finally, an important area of future research is the impact of recent dramatic increases in auto-injector costs on college students' adherence behaviors. In 2016, the list price for a 2-pack of EpiPens (Mylan, Canonsburg, PA), a major epinephrine auto-injector brand, climbed to over \$600—a 400% increase from 2007.³¹ Research suggests that, even with insurance coverage, consumers bear the burden of at least a portion of this price increase: a study of commercially insured patients' out-of-pocket spending for EpiPens found that patients in 2014 paid more than double the cost they paid in 2007.³² Notably, research using Mylan data suggests that EpiPen prescription abandonment rates increase as the patients' costs increase.³³ While generic versions of the epinephrine auto-injector exist,³¹ the impact of the price of EpiPens on college students specifically and how to address these effects warrant investigation.

Conclusions

This study investigated the barriers to self-management behaviors in food-allergic college students, a group of

individuals who had received little attention to date. Using the theoretical frameworks of the HBM and the CS-SRM, different barriers were identified for food-allergic college students in general compared to those with SIE prescriptions, suggesting that information about SIE prescription status should be used to tailor interventions aimed at increasing adherence. Furthermore, this study expanded on the work of Jones et al. by introducing the role of risky behavior as a potential explanatory factor of differences in adherence to self-management behaviors. Overall, this study identified concrete, malleable beliefs and behaviors that could be targeted to increase adherence to self-management behaviors in college students with food allergies. Furthermore, the differences in factors identified in the current study and Jones et al.'s study of adolescents point to the importance of creating interventions targeted to specific age groups.

Funding

This work was supported by the YH Mirzoeff & Sons Foundation, Inc.

ORCID

Sarah E. Duncan  <http://orcid.org/0000-0001-9722-9845>

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