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A behavioral economics intervention to encourage epinephrine-carrying among food-allergic adults: a randomized controlled trial

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ABSTRACT

Background: Adolescents and young adults with food allergies are at increased risk of adverse events, including death from anaphylaxis. Epinephrine is the cornerstone of emergency response, yet few individuals with serious food allergies consistently carry their emergency medication. Behavioral economics offers promising, previously untapped opportunities for behavior change in this arena.

Objective: To test the effectiveness of modest financial incentives in promoting the carrying of epinephrine and to evaluate the acceptability of text messaging for delivering reminders and key health messages to young adults with food allergies.

Methods: A mixed-methods randomized controlled trial in young adults with food allergies investigated the carrying of epinephrine auto-injectors using financial incentives plus text message reminders vs text message reminders alone. Epinephrine carriage was assessed 10 times during the 49-day intervention using rapid-reply cell phone photographs plus daily code words.

Results: The intervention (financial incentive) group had their epinephrine auto-injectors at 54% of check-ins vs 27% of check-ins in the control (text-only) group ($P = .023$). Participants in the 2 groups consistently reported favorable impressions of text messaging as a desirable, unobtrusive way to receive information and support for food allergy management.

Conclusion: Although the intervention and control groups reported favorable impressions of text message-based reminder systems, the intervention group performed significantly better than the control group on a photograph-based measurement of epinephrine carriage. There remained ample room for improvement in the 2 groups given the goal of consistent, uninterrupted epinephrine carriage by people with potentially life-threatening food allergies.

Trial Registration: <https://clinicaltrials.gov>; NCT02354729.

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Introduction

Because there is no cure for food allergies, the estimated 2.5% of Americans¹—including 8% of children²—who have them must be unfailingly vigilant, by reading ingredient labels and avoiding allergens, to prevent adverse events.³ Considering that individuals make an average of 200 food decisions each day,⁴ sustained

behavioral control can become a daunting task, and errors are likely to occur.³ When behavioral errors lead to anaphylaxis, the prompt administration of epinephrine is the treatment of choice to minimize morbidity and mortality.⁵ Therefore, it is imperative for individuals at risk of anaphylaxis to carry their epinephrine auto-injectors with them at all times.⁵

Adolescents and young adults with food allergies are particularly at risk of serious adverse events, with reports from 2 registries of food-induced anaphylaxis deaths showing that a substantial proportion of deaths (53% in one study and 29% in another) occurred in individuals 18 to 30 years old.^{6,7} During adolescence and young adulthood, heightened vulnerability can result from increasing independence, risk-taking, participation in a larger number of activities outside the home, and decreased parental

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involvement.^{8,9} One survey reported that only 6.6% of college students with food allergies carried their epinephrine auto-injectors with them at all times and 60% engaged in risky behavior.¹⁰ Another study of adolescents and young adults with food allergy (13–21 years old) showed that more than half (54%) the participants engaged in risky behavior, such as eating small amounts of food containing known allergens.⁹ In the same study, only 61% of participants consistently carried their epinephrine auto-injectors, although this sample, recruited through an allergy advocacy organization, could have been especially motivated.⁹ In other research, adolescents attributed their inconsistent epinephrine carriage to inconvenience,¹¹ which they particularly experienced while participating in sports, social activities with friends, school dances, and outings to bars or nightclubs.^{9,11} In addition, adolescents and young adults might resist being identified as different from their friends, which can contribute to inconsistent epinephrine carriage.⁹ Moreover, several studies have identified barriers to using epinephrine auto-injectors to treat serious allergic reactions, including uncertainty of how to recognize the symptoms of anaphylaxis and fear of injections.^{9,11–13}

Despite this information about barriers to carrying and using epinephrine auto-injectors, there are few empirically-based interventions to encourage safer food allergy management in adolescents and young adults. One published intervention, conducted in high school students, called for multiple check-ins with a school nurse throughout the academic year to determine whether students with food allergies were carrying their epinephrine auto-injectors. Although the check-ins did not promote the carrying of epinephrine auto-injectors per se, more frequent check-ins were associated with maintenance of unexpired medication.¹⁴

To encourage young adults diagnosed with food allergies to carry their epinephrine auto-injectors with them, the authors conducted a mixed-methods randomized controlled trial incorporating quantitative and qualitative assessments. Three strategies informed by behavioral economics were used. First, frequent text message-based reminders were used to increase the salience of food allergies and keep the issue of allergy management foremost in the minds of participants.¹⁵ Text messaging was selected as the communication medium because mobile phone use and text messaging are ubiquitous in young adults in the United States, where 98% of 18- to 29-year-olds own a cell phone¹⁶ and 97% use their phones to send and receive an average of 88 text messages each day.¹⁷ Second, financial incentives were used to reward the carrying of epinephrine. In prior studies, financial incentives have been remarkably effective at “nudging” individuals to adopt other hard-to-change health behaviors such as weight loss and smoking cessation.^{15,18,19} Third, feedback on performance was provided to participants in the intervention group.²⁰

The primary objective in this study was to test the effectiveness of using modest financial incentives, coupled with feedback, to promote the carrying of epinephrine—a strategy that has not been applied in prior interventions in people with food allergies. A secondary objective was to evaluate whether text messaging was an

appropriate vehicle to disseminate allergy management messages to young adults with food allergies.

Methods

The institutional review board of the University of Pennsylvania (Philadelphia) approved this study protocol. The study enrolled 33 people 18 to 30 years old with a known food allergy, a previous epinephrine auto-injector prescription, and access to a cell phone with an ability to send and receive Short Message Service messages and photographs. Most study participants ($n = 23$) were recruited through review of emergency department rosters from the electronic health records system of 3 hospitals in the University of Pennsylvania Health System. Study staff (E.S., S.K., A.G.) contacted patients who had been seen in the emergency department from January 2012 to May 2014 for anaphylaxis and received epinephrine prescriptions, thus assuring that the sample included individuals with severe allergies. Patients from the Department of General Internal Medicine’s clinical practices also were recruited by telephone ($n = 5$) based on outpatient records indicating prior receipt of an epinephrine auto-injector prescription. Additional patients ($n = 5$) were recruited through word-of-mouth referrals by colleagues to the study team.

The authors obtained oral consent and conducted an intake survey by telephone. The intake survey consisted of 38 questions regarding participants’ demographic information, history of food allergies, and current food allergy attitudes and management practices. After recruitment and intake interviews, participants were randomized into 2 groups, intervention and control, using the iPhone application NumeroRama.²¹ In the 2 groups, participants received text messages containing reminders to carry epinephrine auto-injectors and information regarding food allergy management. In addition to text messages, the intervention group received financial incentives and feedback linked to successful documentation of their carrying of epinephrine, which are described further below.

During the study, participants received 40 text messages over the span of 49 days in July and August 2014 (Fig 1). Text messages were sent using an automated system created by the authors (D.L.) specifically for the study. Messages were organized, assigned, and delivered with custom-built software using Ruby on Rails²² and Twilio.²³ The software allowed researchers to tailor communication schedules in advance and it automatically sent outbound messages and collected text replies into Web-based views showing the bidirectional conversations with each participant.

A convenience sample of 10 colleagues and associates of the study team, 4 of whom have serious food allergies, participated in a pilot test of the automated system and provided feedback to the study team regarding the timing and content of the text messages. Pretesting influenced the content of messages used during the study period. In particular, informants with food allergies judged that frequent messages related to anaphylaxis and food allergy emergencies stimulated anxiety. Thus, the content of messages was

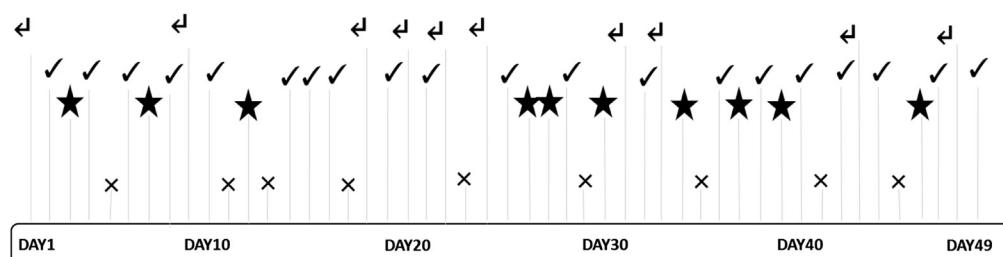


Figure 1. Study timeline with type of text message. ↵, text back your answer; ➤, fact or tip; ★, check-in; x, no text.

changed, as indicated in Table 1, to include practical suggestions and news stories—especially stories that described successful food allergy management. As indicated in Figure 1 and Table 1, throughout the 49-day intervention period, participants in the 2 study arms received 3 types of messages. They received 20 messages containing informational or social support, including tips on how to safely manage food allergies. On 10 occasions, participants were asked open-ended questions by text message to engage them in active reflection on their food allergies. On 10 randomly selected dates and times during the study period, they received “check-in” text messages, which asked them to send, by text message, a photograph of their epinephrine auto-injector and the handwritten code word of the day. Participants who replied within 30 minutes, with a photograph that contained the appropriate code word (Fig 2), were classified as having successfully documented that they were carrying their epinephrine auto-injector at that time; all other respondents were classified as unsuccessful for the primary analyses. All randomized participants were included in the intention-to-treat analysis. Automated text messages and check-in messages were sent from 9 AM to 9 PM on any day of the week. Participants’ time zones were accounted for when sending text messages.

The primary study end point, intended to reflect consistency of epinephrine carriage, was the proportion of check-ins (out of 10) at which the participant successfully demonstrated that he or she was carrying an epinephrine auto-injector.

As described at recruitment, participants in the control group were to be compensated \$20 at the completion of the study. Those in the intervention group could receive up to \$100 at the end of the study—a \$10 reward at each of the 10 check-ins when they successfully documented they were carrying their epinephrine auto-injectors. After checking in with the study team, participants in the intervention group received feedback regarding their performance to date, including their updated financial reward status. Those in the control group received a “thank you for your participation” text message once they responded, regardless of whether they were carrying their epinephrine auto-injector. If participants had any questions during the study, they were invited to contact the study team by phone, text, or email.

Follow-up debriefing surveys were conducted from September through October 2014, after the close of the intervention period. The survey consisted of 29 questions, including open-ended questions, regarding food allergy management challenges; the acceptability, content, and timing of text messages; the feasibility of responding to text message-based questions and epinephrine auto-injector check-ins; and recommendations for improving the design



Figure 2. Sample photograph of a successful participant check-in.

Table 1
Examples of text messages sent

Type of Text	Example
Check-in	Are you carrying your epinephrine now? If not, text “no” in response. If so, text a photo of your auto-injector next to the written word <i>poker</i> .
Fact/tip	Food for thought: which of the following products could contain tree nuts? (1) Gin; (2) maraschino cherries; (3) barbecue sauce. Answer: All of the above. Tough to find allergen-free food at work or school? See how students at one university took matters into their own hands: http://tinyurl.com/bx9j2ax . Eating out can be tricky. Carry a printed card that explains your food allergy and make sure it gets to the chef.
Text back	Text your answer: on a scale from 1 to 10, how stressed are you about your food allergy today? 1 is lowest stress and 10 is highest. In 160 characters or less, what’s the most important advice you would give to a friend with food allergies? Tell us your story: what was your best or worst restaurant experience related to accommodating food allergies?

of the intervention. Open-ended questions were used to obtain nuanced participant reflections and inform larger-scale efforts. All data were stored in REDCap²⁴ and analyzed using SPSS 22 statistical software (SPSS Inc, Chicago, Illinois),²⁵ STATA 13 statistical software (STATA Corp, College Station, Texas),²⁶ and NVivo 10 qualitative data analysis software (QSR International, Doncaster, Australia).²⁷

For comparison of proportions, the Fisher exact test was used. For assessment of differences between the intervention and control groups with regard to the primary end point (consistency of carrying epinephrine auto-injectors), we used the Kruskal-Wallis one-way analysis of variance. Qualitative responses to open-ended follow-up questions were systematically analyzed. Two members of the study team (A.G., R.D.) used NVivo to code responses for content and identified key themes using an iterative approach that involved review and team discussion of survey responses within each coded category.^{28–31} Agreement between the coders was high and ranged from 93% to 100%.

Results

The study sample included 33 participants 18 to 30 years old, with 18 allocated at random to the intervention group and 15 to the control group (Table 2). The most common self-reported food allergies were to tree nuts (45%), peanuts (39%), and shellfish (33%). Overall, 82% of participants reported an allergy to at least 1 of the “top 8” food allergens. Moreover, most participants (61%) reported a history of allergies to additional foods not included among the “top 8” most common food allergens (eTable 1). Most participants were women, and most participants had completed at least some college. The modal age group was 23 to 26 years old. Based on χ^2 tests for differences in proportion, there were no significant differences between the intervention (financial incentive) and control (text message only) groups with regard to key clinical or

Table 2
Demographic characteristics of study population^a

Characteristic	Intervention (n = 18), %	Control (n = 15), %	Total (n = 33), %
Sex			
Men	28	27	27
Women	72	73	73
Age (y)			
18–22	33	27	30
23–26	44	60	52
27–30	22	13	18
Education			
HS/GED or below	6	13	9
Some college or above	94	87	91
Allergic to			
Peanuts	33	47	39
Tree nuts	50	40	45
Soy	11	7	9
Wheat	0	20	9
Dairy	0	7	3
Eggs	0	0	0
Fish	0	20	9
Shellfish	39	27	33
Other	50	73	61
Last reaction			
<6 mo ago	39	40	39
6 mo–1 y ago	22	20	21
1–5 y ago	28	27	27
5–10 y ago	11	13	12
Have you ever used epinephrine?			
Yes	33	40	36

Abbreviations: GED, Graduate Equivalency Diploma; HS, high school.

^aThere were no significant differences between the intervention and control groups.

demographic characteristics, suggesting that randomization was successful in balancing the distribution of covariates and thus decreasing the potential for confounding or bias in comparisons of outcomes between the 2 study groups.

Figure 3 presents the proportion of participants who successfully demonstrated that they were carrying epinephrine auto-injectors at each of the 10 unannounced check-in points. In general, the intervention group fared better than the control group in documenting that they were carrying their epinephrine auto-injectors. At 9 of the 10 check-ins, a larger absolute proportion of participants in the intervention vs control group successfully demonstrated that they were carrying their epinephrine auto-injectors. In the intervention group, the proportion of participants who were successful in documenting that they were carrying their auto-injectors at the individual check-ins ranged from a low of 22% to a high of 72%. In the control group, the proportion of participants who successfully demonstrated that they were carrying epinephrine auto-injectors ranged from a low of 13% to a high of 40%.

Next, the authors considered the proportion of all check-ins at which individual participants successfully demonstrated that they were carrying their epinephrine auto-injectors—the primary end point (Table 3). On this summary measurement, the intervention group performed significantly better than the control group. The intervention group demonstrated that they were carrying their epinephrine auto-injectors at more than half (54%) of the check-ins, whereas the control group demonstrated that they were carrying their epinephrine auto-injectors at less than one third (27%) of the check-ins ($P = .023$). A sensitivity analysis that included late responses as “successful” showed a similar pattern: the intervention and control groups demonstrated that they were carrying epinephrine auto-injectors at 61% and 34% of the check-ins, respectively ($P = .026$).

In debriefing interviews after the completion of the 49-day intervention period, a research assistant (A.G.) asked participants a series of questions to assess the acceptability of the intervention.

Participants in the intervention and control groups consistently reported favorable impressions of study participation, with many of them indicating that text messaging was a desirable, unobtrusive way to receive information and support about food allergy management. After qualitative coding of participants’ open-ended responses, 3 major themes were observed. First, participants perceived that text-based reminders assisted them in remembering to carry their epinephrine auto-injectors—noting that the study “made me more conscious of needing to carry it” and “Now I always make sure to have my Epipen with me. ... I used to never have my Epipen.” Of note, a study participant explained that the messages encouraged her to keep her epinephrine auto-injector within “easy access” rather than far away—as in a locker at work, where she previously kept it.

A second qualitative theme was that the study prompted participants to ask about ingredients when dining out and to read food labels more closely, although the authors did not specifically seek to measure these behaviors as study outcomes. A third qualitative theme was that participants appreciated learning new information about food allergy risks and management. In particular, many participants mentioned that they specifically recalled and appreciated informational text messages that provided facts about allergens found in foods. Some participants noted that they were unaware that particular foods, such as maraschino cherries or chili, could contain nuts or other allergens. As one participant mentioned, this information led him to be more careful when eating out: “I’m also more conscious of asking restaurants. I asked the other day with my family and they all gave me a weird look ‘cause it was chili, but I learned in the texts [that nuts] can be in there.” Another participant noted that the study offered a virtual peer network, which was valued: “It made me feel like I was part of a community knowing you were sending the same messages to a bunch of different people.” The effect of peer support should be explored in future studies.

When asked about the acceptability of the intervention design, participants consistently agreed that the frequency of text messages was acceptable (an average of 6 messages per week)—with some participants even suggesting that more texts would be desirable. Importantly, it was easy for participants to take photographs of their epinephrine auto-injectors to document that they were carrying their medication. Seven participants noted that they had modest challenges in finding paper and pen to write the code word of the day to include in each new photograph, although none mentioned they would change this requirement. Participants also mentioned that when they were at school or work, it was sometimes difficult for them to respond to check-ins within the required 30 minutes.

On several occasions, the authors sought participants’ responses to open-ended questions. For example, participants were asked to reply by text to the question, “In 160 characters or less, what do you most want other people to understand about the challenges of living with food allergies?” Only 43% of participants who received this message responded. Responses showed diverse and sometimes conflicting views, ranging from “it’s not as bad as people may think it is; just be aware of what you’re putting in your body” to “it’s harder than you might think” and “it is really hard to think about everything you eat.” Responses also reflected the burden and in some cases the fear associated with food allergy management, which participants handled in different ways. As 1 participant said, “there is a huge fear eating out that you have to constantly deal with and try to ignore.” Another explained that “it’s a disease just like any other. You can’t just be carefree.” The low response to open-ended questions suggests that respondents might have preferred receiving over sending detailed information by text message. This finding was supported by the qualitative debriefing responses of some participants, including 1 participant who

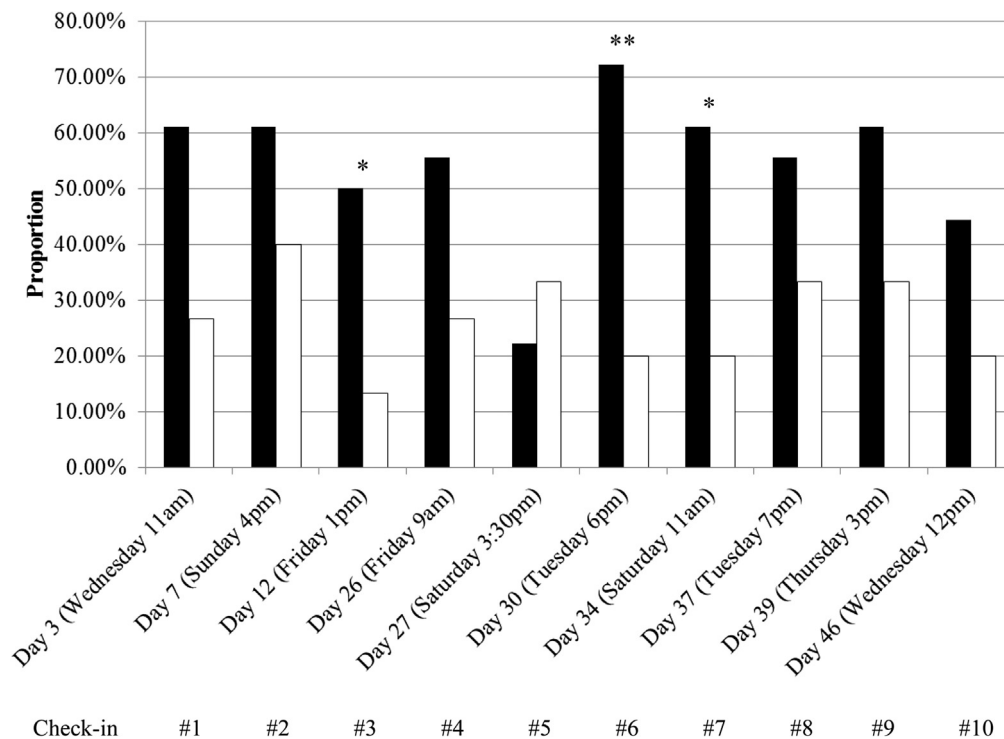


Figure 3. Proportion of participants in the intervention ($n = 18$) (black bars) and control ($n = 15$) (white bars) groups who successfully demonstrated that they were carrying their epinephrine at each check-in. * $P < .05$, ** $P < .01$.

mentioned that these types of messages were “the only ones I didn’t have the time for.”

Discussion

Overall, participants in the financial incentive group were more likely than those in the control group to carry their epinephrine auto-injectors. Although the intervention group tended to perform better than the control group on this measurement of food allergy management, there remained ample room for improvement in the 2 groups, given the goal of consistent, uninterrupted epinephrine carriage by all people with serious food allergies. This suggests a need to extend this work and enhance the impact of behavioral interventions on food allergy management practices, including but not limited to, carrying epinephrine. Importantly, the study showed that young adults with food allergies valued text message reminders and support. Taken together, the qualitative comments from debriefing evaluations suggest that there could be health and social benefits to the receipt of text messages alone. The effectiveness of such text message-based informational and social support alone on a range of behavioral outcomes should be explicitly assessed in future studies.

This research advances the literature on food allergy management in several ways.

Table 3

Proportion of 10 check points at which participants successfully demonstrated they were carrying their epinephrine auto-injectors

Study group	Response time	Carrying epinephrine, %	P value
Intervention ($n = 18$)	On time	54	.023
Control ($n = 15$)		27	
Intervention ($n = 18$)	On time and late	61	.026
Control ($n = 15$)		34	

First, this study used a randomized design to test the impact of incentives and feedback on epinephrine carriage, thus demonstrating that the behavior of young adults with food allergies is malleable. There are few published evidence-based strategies for behavior change in people with food allergies, including high-risk young adults and adolescents. One prior study, although not explicitly a behavioral change experiment, assessed food allergy-related quality of life in patients and families randomized to have access to a 24-hour helpline vs usual care.³² At follow-up, the intervention group showed better food allergy-related quality of life scores, which the investigators hypothesized was due to improved access to support. However, only 3 calls were made by study participants to the helpline during the 6-month intervention.³² Therefore, strategies that send (or “push”) information or support to people with food allergies might be more widely adopted than strategies that require active help-seeking from participants. The intervention previously discussed, in which school nurses checked whether students were carrying their epinephrine auto-injectors, also suggested that frequent contact with people with food allergies, such as by text message, could be important, because food allergy management requires sustained lifelong vigilance.¹⁴ These studies raise questions regarding the optimal strategies for interventions and suggest the need to develop new behavioral approaches to assist people with food allergies.

Second, this study showed that concepts from behavioral economics could be leveraged to encourage safer food allergy management. Why do financial incentives work to encourage healthy behaviors? Behavioral economics suggests that individuals have a tendency to be biased toward immediate rather than long-term gains.^{33–35} On most days, carrying an epinephrine auto-injector is not inherently rewarding. People with food allergies only directly benefit from carrying epinephrine when they experience anaphylaxis. In contrast, receipt of a financial incentive provides an immediate, tangible reward for this desired behavior.³³ Other models and concepts from behavioral economics that could be tested in

young adults and other people with food allergies include different incentive structures—including small frequent rewards and lotteries.³⁶ Lotteries are attractive because they could be particularly cost-effective.^{37,38}

Perhaps the most effective strategies to encourage access to epinephrine will be “default” approaches, including policies that require epinephrine auto-injectors in schools, restaurants, transportation settings, and other social hubs—much as automated external defibrillators have been placed in these locations. The School Access to Emergency Epinephrine Act, which incentivizes states to allow access to undesignated epinephrine in schools and train personnel to administer it, is one step in this direction.³⁹ Progress also has been made in equipping basic life support providers with epinephrine in many states, although, depending on their level of training, not all emergency personnel are permitted to carry and administer epinephrine to patients experiencing anaphylaxis.⁴⁰ These advances do suggest that epinephrine auto-injectors are likely to become more widely accessible in emergency situations, shifting the onus of assuring epinephrine availability away from the individual and toward organizations or institutions, which also will need assistance in maintaining up-to-date medication, clearly placing and marking the medication, and training personnel and the public to use it appropriately. Currently, it is critical that individuals with food allergy carry epinephrine auto-injectors with them at all times to ensure immediate access in emergency situations. As such, improving the carriage of epinephrine auto-injectors by individuals with food allergy should remain a focus of testing interventions.

Third, the qualitative findings of this study showed that the intervention and control groups valued receipt of information and social support by text message. Text message reminders were favorably evaluated in text4baby, a maternal and child health program in which most pregnant women who received text messages were likely to attend their appointments and to ask their physicians questions based on the text reminders.⁴¹ Moreover, most text4baby participants in another study opted to continue to receive the messages after the evaluation was over, suggesting that they valued text-based support.⁴² With the development of automated text-message platforms, such interventions will become more feasible and sustainable and should be tested as standalone interventions.

The authors learned from pre-intervention testing of messaging that some types of allergy management information (especially about anaphylaxis) could induce anxiety rather than foster a sense of control. In future studies, it will be critical to cognitively test the framing of the message, which is strongly influential in determining health behavior.⁴³ In the present study, the authors learned from participants that it was feasible to use photographs to document their carriage of epinephrine.

For recruitment, the authors had the most success in identifying eligible patients from emergency department rosters. However, in the population of patients treated in the emergency department for anaphylaxis, many people were unaware of what allergen had caused their anaphylaxis, and the authors only recruited participants with known food allergies. A benefit of recruitment from the emergency department was that the participants represented a group at risk for anaphylaxis but not necessarily highly engaged in preventive health behaviors. It would be interesting to recruit from allergists’ offices and assess whether carriage rates are better in patients followed by specialists.

This study included a small, mostly female sample. With a larger sample of male participants who are commonly more tolerant of risk,⁴⁴ there might be even poorer compliance with epinephrine carriage. The present study also would have been strengthened by detailed clinical assessment of participants’ conditions, including asthma. The measurement of epinephrine

carriage required participants to check their phones and have access to pen and paper. New automated Global Positioning System tracking technologies eventually could be adapted for research purposes, such that investigators will be able to gather real-time data about whether participants are carrying their epinephrine auto-injectors.

This study raises important questions for future work. First, epinephrine carriage rates were depressingly low, underscoring the urgency for further behavioral research to understand and improve food allergy management practices. Second, the study raises the question of whether text messaging alone, with cognitively tested message framing, could foster adherence to safer food allergy management practices. Messages that include performance feedback—modeled on the automated messaging and feedback supplied by popular activity tracking devices—might be a highly feasible, relatively low-cost intervention model. In addition, the study was conducted in a high-risk age group and should be repeated in other vulnerable groups—particularly adolescents. This study tested 1 model of a financial incentive, but many other types of incentives (financial and otherwise) should be tested. Advocacy groups and device manufacturers—who have a vested interest in encouraging adherence—could be potential allies in implementing and testing future interventions such as the one evaluated in the present study. Given that auto-injectors require frequent refills, manufacturers might be well positioned to develop customer loyalty programs that include incentives. Although financial incentives might not be sustainable, other types of incentive mechanisms should be explored, including rewards and badges, such as those delivered by activity monitors or video games. This study’s findings are a promising step for young adults with food allergies, suggesting opportunities for minimizing morbidity and mortality in this high-risk group.

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Supplementary Data

Supplementary data related to this article can be found online at <http://dx.doi.org/10.1016/j.anai.2015.05.018>.

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eTable 1
Food allergy distribution by participant

Participant	Allergy								
	Peanuts	Tree nuts	Soy	Wheat	Dairy	Eggs	Fish	Shellfish	Other allergies
1	–	+	–	–	–	–	–	–	No other allergy noted
2	+	+	–	–	–	–	–	+	Sesame seeds
3	–	+	–	–	–	–	+	+	Melons, cucumbers, pickles, carrots
4	+	+	–	–	–	–	–	–	Mustard
5	–	+	–	–	–	–	–	–	No other allergy noted
6	–	–	–	–	–	–	–	–	Blue cheese
7	–	+	+	–	–	–	–	+	Raw fruit (pears, apples, cherries, parsnips, peaches, plums)
8	–	–	–	–	–	–	–	+	No other allergy noted
9	–	–	–	–	–	–	–	–	Cherries
10	+	–	–	–	–	–	–	–	No other allergy noted
11	–	+	–	–	–	–	–	–	No other allergy noted
12	+	–	–	–	–	–	–	–	No other allergy noted
13	–	+	–	–	–	–	–	–	Chocolate
14	–	–	–	–	–	–	+	+	No other allergy noted
15	–	–	–	–	–	–	–	+	No other allergy noted
16	+	–	–	–	–	–	+	+	Sunflower seeds
17	+	+	–	–	–	–	–	–	Spinach, tomatoes, olives
18	–	–	–	–	–	–	–	+	No other allergy noted
19	–	–	–	–	–	–	–	–	Jalapenos, avocado, coconut, kiwi
20	–	–	–	–	–	–	–	–	Peaches, onions
21	–	–	–	–	–	–	–	–	Pork
22	–	–	–	–	–	–	–	+	Other kinds of seafood
23	+	+	–	–	–	–	–	–	No other allergy noted
24	+	+	+	+	+	–	–	–	Wine and grapes
25	+	+	–	–	–	–	–	+	No other allergy noted
26	–	+	–	–	–	–	–	–	Avocado
27	+	+	–	–	–	–	–	–	No other allergy noted
28	+	–	–	–	–	–	–	+	Unspecified
29	–	–	+	–	–	–	–	–	Strawberries
30	–	–	–	+	–	–	–	–	Corn
31	+	–	–	+	–	–	–	–	Gluten
32	–	–	–	–	–	–	–	–	White potatoes
33	+	+	–	–	–	–	–	–	No other allergy noted