

Anaphylaxis in America: The prevalence and characteristics of anaphylaxis in the United States

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Background: Although anaphylaxis is recognized as an important life-threatening condition, data are limited regarding its prevalence and characteristics in the general population.

Objective: We sought to estimate the lifetime prevalence and overall characteristics of anaphylaxis.

Methods: Two nationwide, cross-sectional random-digit-dial surveys were conducted. The public survey included unselected adults, whereas the patient survey captured information from household members reporting a prior reaction to medications, foods, insect stings, or latex and idiopathic reactions in the previous 10 years. In both surveys standardized questionnaires queried anaphylaxis symptoms, treatments, knowledge, and behaviors.

Results: The public survey included 1,000 adults, of whom 7.7% (95% CI, 5.7% to 9.7%) reported a prior anaphylactic reaction. Using increasingly stringent criteria, we estimate that 5.1% (95% CI, 3.4% to 6.8%) and 1.6% (95% CI, 0.8% to 2.4%) had probable and very likely anaphylaxis, respectively. The patient survey included 1,059 respondents, of whom 344 reported a history of anaphylaxis. The most common triggers reported were medications (34%), foods (31%), and insect stings (20%). Forty-two percent sought treatment within 15 minutes of onset,

34% went to the hospital, 27% self-treated with antihistamines, 10% called 911, 11% self-administered epinephrine, and 6.4% received no treatment. Although most respondents with anaphylaxis reported 2 or more prior episodes (19% reporting ≥ 5 episodes), 52% had never received a self-injectable epinephrine prescription, and 60% did not currently have epinephrine available.

Conclusions: The prevalence of anaphylaxis in the general population is at least 1.6% and probably higher. Patients do not appear adequately equipped to deal with future episodes, indicating the need for public health initiatives to improve anaphylaxis recognition and treatment. (*J Allergy Clin Immunol* 2014;133:461-7.)

Key words: Anaphylaxis, prevalence, epinephrine

Anaphylaxis is an acute, life-threatening systemic allergic reaction associated with different mechanisms, triggers, clinical presentations, and severity.¹⁻⁴ Estimates of anaphylaxis prevalence vary widely, and many studies suggest that the prevalence is increasing, particularly in developed countries.⁵⁻²¹ The different estimates might be due to differences in the populations studied,

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Abbreviation used

RDD: Random-digit-dial

as well as the many different study designs used, including retrospective reviews of medical records of allergy clinic visits, emergency department visits, hospital admissions, critical care unit admissions, and deaths in addition to reviews of medication-dispensing databases to ascertain dispensing rates for epinephrine autoinjectors. Studies that have focused on anaphylaxis related to specific triggers, such as foods, insect stings, and medications, have also yielded highly variable results. For example, in studies of food-induced anaphylaxis, rates ranging from as low as 1 per 100,000 to as high as 70 per 100,000 have been reported by using data from hospitalizations, emergency department visits, and medical records reviews, whereas the proportion of anaphylaxis cases determined to be due to foods also varied between 13% and 65%.¹¹⁻¹⁷

In this study we sought to assess the lifetime prevalence of anaphylaxis in the United States from the general adult population, as well as to gather data on the characteristics of anaphylactic reactions from the general adult population and a more focused population that included patients of all ages.

METHODS

Two independent, nationwide, cross-sectional random-digit-dial (RDD) landline telephone surveys were conducted between July and November 2011 by using screening questions and standardized questionnaires, including demographic data and detailed information regarding anaphylaxis symptoms, treatments, knowledge, awareness, perceptions, behaviors, and quality of life (see Supplemental documents 1 and 2 in this article's Online Repository at www.jacionline.org). The study and survey instruments were approved by the Institutional Review Board of Abt SRBI (New York, NY).

The first survey, which was referred to as the public survey, was primarily intended to capture the lifetime prevalence of anaphylaxis. Eight thousand five hundred fifteen telephone contacts were made from a total sample of 11,153 RDD numbers found to be associated with a household (Table 1). A total of 1,200 eligible respondents age 18 years and older were identified, among whom 1,000 interviews were completed (83% of screened eligible respondents). The survey included more than 75 questions, and the average interview duration was 14 minutes, with a range of 7 to 34 minutes. For analysis, these data were weighted by age and sex to be representative of the adult population of the United States.

The second survey, which was referred to as the patient survey, focused specifically on subjects who reported experiencing some type of generalized allergic reaction to a food, insect sting, medication, and/or latex and/or an exercise-induced or idiopathic reaction within the past 10 years. Household screening was conducted to identify all persons with an eligible history of an allergic reaction, and if more than 1 person was eligible, the respondent with a history of anaphylaxis or any reaction requiring immediate medical attention was chosen; otherwise, he or she was chosen at random. If the person with a history of an allergic reaction was less than 18 years old, the parent or most knowledgeable adult completed the proxy interview. Screening interviews were completed in 7,512 households from a total sample of 29,595 household contact numbers; 1,651 respondents were identified as eligible, among whom 1,059 interviews were completed (97% of screened eligible respondents, Table 1). The median respondent age was 52 years of age, 93% were high school graduates, and 44% had a 4-year college degree or greater. The average interview length for this more extensive interview, which included more than 100 questions, was 33 minutes, with a range of 14 to 107 minutes.

To define allergic reactions that might represent anaphylaxis, symptom reports from the questionnaires were categorized into 5 organ systems:

(1) respiratory, defined as positive responses to questions about increased breathing rate, cough, wheeze, chest tightness, throat itching, and/or hoarse voice; (2) skin and subcutaneous tissue, including itching, rash, hives, eye swelling, lip swelling, or tongue swelling; (3) gastrointestinal, including cramps, abdominal pain, vomiting, and/or diarrhea; (4) neurologic, including feelings of uneasiness and/or sudden behavioral change (in young children); and (5) cardiovascular, including dizziness, loss of consciousness, low blood pressure, and/or loss of bladder or bowel control. Reported reactions were then categorized as those involving 1, 2, 3, or more than 3 systems, and for the purposes of analysis, "confirmed" anaphylaxis in the patient survey was defined as those reactions that involved 2 or more systems with respiratory and/or cardiovascular symptoms or those leading to loss of consciousness, even if only that single system was involved.¹

Data were processed by using SPSS software (SPSS, Chicago, Ill), and descriptive statistics were generated. The weights for the public survey were calculated by using 2010 Census numbers with adjustments of the sample by sex and age by using poststratification. CIs were calculated with the SAS system (SAS Institute, Cary, NC) and the Surveyfreq procedure because of the use of weighted percentages in the public data file.

RESULTS**Public survey**

Overall characteristics of the 1,000 respondents are presented in Tables I and II. The median respondent age was 45 years, 93% were high school graduates, and 38% had a 4-year college degree or greater. Of note, 8.6% of respondents who had visited the emergency department in the past 12 months (1.9% of the total surveyed population) did so for allergy-related reasons (which could include environmental allergens), and 5.6% of those hospitalized in the past 12 months (0.7% of the total population) were hospitalized for allergy-related reasons. A history of asthma was reported by 17% of respondents. There were reports of a history of allergies to medications by 33%, to foods by 15%, to insect stings by 19%, and to latex by 6.2%. Nearly 3 in 5 American adults (59%) reported that they had heard the term anaphylaxis, with 41% reporting that they were somewhat or very familiar with the term.

Before asking specific questions about anaphylaxis, a definition and a general question were presented to the respondents as follows: "Anaphylaxis is a severe, sudden allergic reaction that typically involves two or more organs, such as the skin, airways, lungs, stomach, heart or blood pressure. Have you ever had an anaphylactic or a severe, sudden, multi-system allergic reaction within minutes to a few hours after being exposed to something?" Of the 1,000 respondents, the answer was yes in 7.7% (weighted percentile, actual n = 87; 95% CI, 5.7% to 9.7%), no in 91%, and do not know in 0.9%. For the 87 answering yes, the most recent reaction occurred within the past year in 17%, 1 to 2 years ago in 10%, and 3 or more years ago in 72%; 1.5% did not know or refused to answer. The symptoms reported in their most recent reaction are summarized in Fig 1, A, whereas Fig 2, A, categorizes these symptoms into the 5 predefined organ systems. Respiratory symptoms were most common (73%), followed by skin (61%), cardiovascular (24%), neurologic (15%), and gastrointestinal (7%) symptoms. Although 30% of reactions involved only a single organ system, most respondents reported multisystem reactions, including 2 or more systems in 67% and 3 or more systems in 16%.

Several definitions with increasingly stringent criteria were used to define anaphylaxis prevalence (Fig 3). Although any history of anaphylaxis was reported in 7.7%, probable anaphylaxis, which was defined as 2 or more systems with respiratory and/or cardiovascular symptoms, was reported in 5.1% (95% CI, 3.4%

TABLE I. Survey methods and results

	Public survey	Patient survey
Total sample size of telephone numbers in study	35,079	104,084
Total sample size of household telephone numbers	11,153	29,595
Total contacts	8,515	25,866
No. of households screened	1,244	7,512
Identified eligible respondent in household screen	1,200	1,651
Reasons not eligible		
Callback or refusal after identification	75	36
Partial interview	125	
Respondent not eligible after initial screen		424
Reported reaction >10 y ago		132
Total no. of completed interviews	1,000	1,059
Response rate for screened eligible respondents	83%	97%
Median age of respondents (completed interviews only)	45 years	52 years
Median age of persons with history of allergic reaction	47 years	51 years
Median age of persons reporting anaphylaxis (range)	51 years (26-88)	50 years (1-87)
Education level of respondents (completed interviews only)*		
High school graduate or above	93%	93%
College graduate or above	38%	44%
Annual household income of respondents (completed interviews only)		
<\$50,000	45%	41%
≥\$50,000	37%	44%
≥\$100,000	15%	18%
Do not know/refused	18%	15%

Public survey data are weighted, and patient survey data are unweighted.
*For comparison, in the 2012 Census, these numbers were 87% for high school graduate or above and 34.7% for college graduate or above.

to 6.8%), and very likely anaphylaxis, which was defined as 2 or more systems with respiratory and/or cardiovascular symptoms and a trip to the hospital and a feeling that the patient's life was in danger, was reported in 1.6% (95% CI, 0.8% to 2.4%).

Patient survey

As outlined in [Tables I and III](#), the patient survey was completed by 1,059 subjects with a history of allergic reactions in the previous 10 years. With regard to the subject in the household designated with a history of an allergic reaction, 70% were female, and the median age was 51 years, with 9.4% less than age 10 years, 9.0% ages 10 to 19 years, 5.6% ages 20 to 29 years, 8.2% ages 30 to 39 years, 14% ages 40 to 49 years, 35% ages 50 to 64 years, and 19% age 65 years or older. Approximately one third (38%) of respondents reported being very familiar with the term anaphylaxis, with 28% reporting being somewhat familiar. Among all respondents with a history of an allergic reaction, 16% spontaneously reported a history of anaphylaxis, and an additional 17% reported such a history after a definition of anaphylaxis was provided (n = 344).

TABLE II. Characteristics of the public survey population (n = 1,000)

Characteristic	Positive response
ED visit in last 12 mo	22%
Of those with ED visit, % for severe allergic reaction*	8.6%
Hospitalized in last 12 mo	13%
Of those hospitalized, % for severe allergic reaction	5.6%
Ever given diagnosis of asthma	17%
Ever given diagnosis of hay fever	19%
Ever given diagnosis of eczema or other skin allergy	12%
Ever had an allergic reaction to:	
Food	15%
Insect sting	19%
Medication	33%
Latex	6.2%
Ever heard of anaphylaxis	59%
Ever had an anaphylactic reaction (after definition provided)	7.7%
If yes, time since last reaction	
Within past year	17%
1-2 y ago	10%
≥3 y	72%
Do not know/refused to answer	1.5%
If yes, went to hospital or ED for treatment	52%
Hospitalized overnight	40%
If yes, felt life was in danger during anaphylactic reaction	45%
If yes, number of systems involved	
1	30%
2	51%
3	15%
≥4	0.7%
≥2 with respiratory and/or cardiovascular symptoms	66%

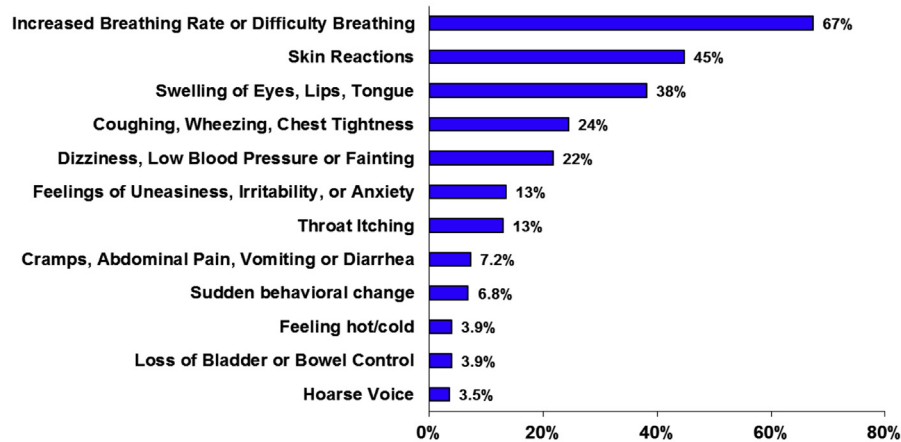
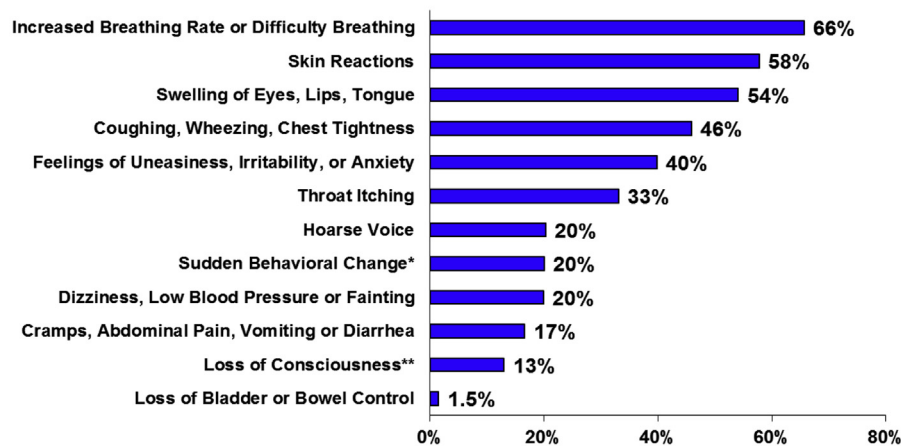
Public survey data are weighted.

ED, Emergency department.

*A severe allergic reaction could include environmental allergens, and in fact, reactions were reported to pollens in 30.6%, dust in 9.7%, and animals in 8.5%.

Responses from the 344 household members reporting a history of anaphylaxis are detailed in [Tables IV and V](#), as well as in [Figs 1, B, and 2, B](#). In addition, similar data are provided in the tables on a subset of 261 subjects with confirmed anaphylaxis, which was defined as episodes involving 2 or more organ systems, including the respiratory and/or cardiovascular systems, as well as all episodes with loss of consciousness, even if that was the only symptom involved. Although most reported symptoms were more common than in the public survey, aside from a higher proportion reporting neurologic symptoms, the overall patterns of symptom and organ system involvement were similar across the 2 surveys. In the patient survey the additional question on loss of consciousness revealed that this had occurred in 13% of subjects, with the most common reported triggers being medications (56.5%), foods (23.9%), and insect stings (10.9%).

As detailed in [Table IV](#), additional data were collected in the patient survey to better characterize anaphylactic reactions and their treatment. Medications, foods, and insect stings were the most common triggers. Reported episodes of anaphylaxis occurred most commonly at home. Treatment was sought in less than 30 minutes in most reactions, although 6.4% received no treatment. Responses to questions on behaviors and

A Public Survey (n=87)**B Patient Survey (n=344)**

Patient survey notes: *Applies only to children age 6 and younger (n=10)

**Loss of consciousness was only queried in the patient survey

FIG 1. Reported symptoms in the most recent anaphylactic reactions for the public (A) and patient (B) surveys.

treatment of reactions included going to the hospital for 34% of respondents, self-administering an antihistamine for 27%, self-administering epinephrine for 11%, and calling 911 for 10%. Fifty percent of reported reactions had resolved within 2 hours, although 13% lasted more than 24 hours. Reported recurrence of symptoms in the absence of further exposure to the trigger, which is suggestive of biphasic anaphylaxis, was uncommon (4.7%).

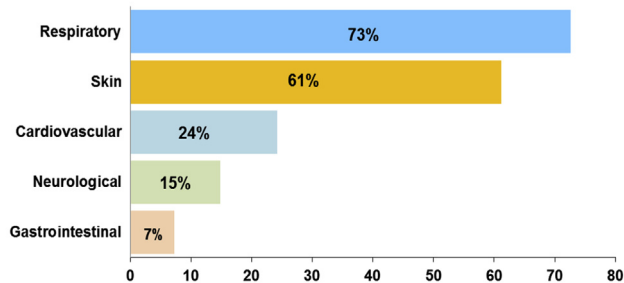
Finally, data were gathered on a variety of attitudes and behaviors regarding anaphylaxis, including plans for coping with future episodes (Table V). A majority of respondents with anaphylaxis had 2 or more anaphylactic reactions in their lifetimes, with 19% reporting 5 or more reactions. However, most respondents with a history consistent with anaphylaxis had not been provided with an emergency care plan, only 32% reported that they planned to use epinephrine with future reactions, 52% had never received a prescription for self-injectable epinephrine, and 60% did not currently have self-injectable epinephrine available.

DISCUSSION

We performed 2 national RDD surveys to evaluate the prevalence and characteristics of anaphylaxis in the United States. In the public survey we sought to estimate the prevalence of anaphylaxis in subjects 18 years of age and older. Remarkably, 7.7% of respondents reported a history of anaphylaxis. By using increasingly stringent criteria, 5.1% were deemed to have a probable history of anaphylaxis, and 1.6% were deemed to have a very likely history of anaphylaxis. This final case definition required involvement of at least 2 organ systems, including respiratory systems, cardiovascular systems, or both, as well as seeking treatment in the emergency department and feeling their life was in danger. Even a prevalence estimate of 1.6% indicates that anaphylaxis is common, and these national data suggest that the true prevalence is probably higher.

Although these prevalence estimates are higher than those reported in most other studies, they are somewhat consistent with a working group estimate of a lifetime prevalence of anaphylaxis (from all triggers) between 0.05% and 2% of the general

A Public Survey (n=87)



Note: Public Survey data are weighted

B Patient Survey (n=344):

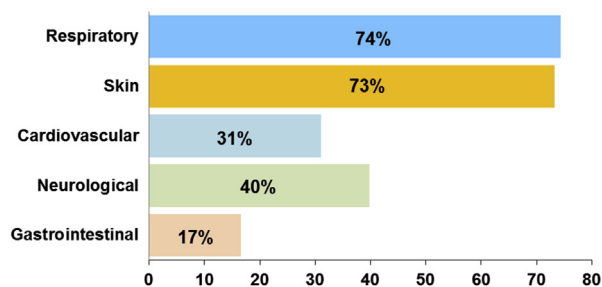


FIG 2. Categorization of organ system involvement for the most recent anaphylactic reactions for the public (A) and patient (B) surveys.

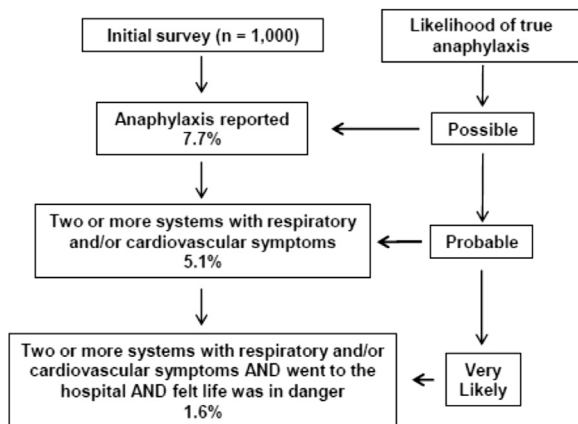


FIG 3. Flow chart for the public survey describing the overall report of anaphylaxis, followed by definitions of probable and very likely anaphylaxis. Ninety-five percent CIs were 5.7% to 9.7% for any report of anaphylaxis, 3.4% to 6.8% for probable anaphylaxis, and 0.8% to 2.4% for very likely anaphylaxis.

population.⁵ At best, community-based general population estimates of a specific disease are difficult to obtain and even more difficult to compare because of the different methods used for case ascertainment. Underdiagnosis, underreporting, and undercoding of anaphylaxis are also relevant issues.²² Many studies have focused on incidence estimates from emergency department populations^{6,12,16} or on anaphylaxis related only to specific triggers, such as foods¹¹⁻¹⁷ or insect stings.²³ Discrepancies among studies might also occur because there could truly be differences among different populations²⁴ and because

TABLE III. Characteristics of the patient survey population (n = 1,059)

Characteristic	Positive response
ED visit in last 12 mo	29%
For severe allergy symptoms	12%
For anaphylactic reaction	4.3%
Hospitalized in last 12 mo	19%
For severe allergy symptoms	6.8%
For anaphylactic reaction	4.4%
Ever given diagnosis of asthma	32%
Ever given diagnosis of hay fever	41%
Ever given diagnosis of eczema or other skin allergy	26%
Ever had an allergic reaction to:	
Food	38%
Insect sting	41%
Medication	61%
Latex	13%
Possible idiopathic reaction	39%
Familiarity with term anaphylaxis	
Very familiar	38%
Somewhat familiar	28%
Not too familiar	10%
Not at all familiar	23%
Ever had an anaphylactic reaction	
No	65%
Yes, spontaneous response	16%
Yes, after definition provided	17%
Do not know/refused to answer	3.0%

Patient survey data are unweighted.

ED, Emergency department.

the prevalence appears to be increasing.^{10,13,14,22,25} Therefore this study represents a major advance in defining the prevalence of anaphylaxis in a nationally representative sample.

In the patient survey we sought to capture additional details about anaphylaxis by targeting a higher-risk population of subjects with a history of allergic reactions. Overall, the reported symptoms and system involvement were similar in the public and patient surveys, lending additional credibility to the shorter public survey that was primarily intended to characterize the lifetime prevalence of anaphylaxis. Consistent with prior reports, medications, foods, and stinging insects were the most common reaction triggers, although we might have underestimated the proportion of anaphylaxis caused by foods by focusing on a predominantly adult population in which more than half the respondents were older than age 50 years. The survey data confirmed that most reactions began at home, that treatment was usually sought within 15 to 60 minutes, and that nearly half of the reactions led to a hospital visit, a call to 911, or both. Although these results regarding the care of anaphylactic reactions are somewhat reassuring, it is worrisome that far more respondents reported self-administration of an antihistamine (27%) than epinephrine (11%) and that 6.4% never sought any treatment. Although spontaneous recovery from an acute anaphylactic episode is common,²⁶ progression to life-threatening respiratory or cardiovascular symptoms cannot be accurately predicted. Respiratory or cardiac arrest can occur within 5 minutes in cases of iatrogenic anaphylaxis, 15 minutes in insect venom-triggered anaphylaxis, and 30 minutes in food-triggered anaphylaxis.²⁷

Concerning results also emerged when respondents were queried regarding their preparation and plans for dealing with

TABLE IV. Patient survey: characteristics of the most recent anaphylactic reaction

Characteristic	Reported anaphylaxis (n = 344)	Confirmed anaphylaxis* (n = 261)
Time since most recent reaction		
Within last 4 wk	8.1%	6.1%
Within past 6 mo	8.4%	8.8%
Within past y	10%	11%
1-2 y ago	11%	12%
≥3 y ago	61%	61%
Do not know/refused to answer	1.5%	0.8%
No. of systems involved		
1	22%	3.4%
2	31%	37%
3	27%	35%
≥4	17%	22%
≥2 with respiratory and/or cardiovascular symptoms	72%	94%
Lost consciousness	13%	18%
Reaction trigger		
Medication	34%	35%
Food	31%	32%
Insect sting	20%	19%
Latex	2.6%	3.1%
Exercise	1.2%	1.5%
Environmental allergen	7.5%	5.7%
Other/unknown	11%	11%
Location of reaction		
Home	54%	51%
Hospital/clinic	13%	14%
Family/friend's home	6.4%	7.3%
Work	6.1%	6.1%
Restaurant	6.1%	6.1%
Outdoors	4.4%	3.1%
Traveling	3.8%	4.6%
School	2.9%	3.4%
Time to treatment		
Within 15 min	42%	45%
15-29 min	14%	16%
30-59 min	14%	14%
1-2 h	9.3%	8.4%
>2 h	11%	9.6%
Never	6.4%	5.7%
Do not know/refused to answer	2.6%	1.5%
Treatment received		
Went to hospital	34%	36%
Self-administered antihistamine	27%	28%
Went to doctor's office/clinic	14%	13%
Call 911/ambulance	10%	12%
Self-administered epinephrine	11%	11%
Self-administered asthma inhaler	6.7%	7.3%
Other	27%	28%
Nothing	6.4%	5.7%
Do not know/refused to answer	3.8%	2.7%
Duration of reaction		
<1 h	32%	34%
1-2 h	18%	20%
3-5 h	16%	15%
6-12 h	7.3%	6.9%
12-24 h	4.1%	3.8%
>24 h	13%	12%
Do not know/refused to answer	10%	9%
Reaction recurrence within 72 h	4.7%	4.6%

*Confirmed anaphylaxis was defined as involving at least 2 systems, including the respiratory and/or cardiovascular systems, and/or loss of consciousness, even as a lone symptom.

TABLE V. Patient survey: anaphylaxis attitudes and behaviors

Characteristic	Reported anaphylaxis (n = 344)	Confirmed anaphylaxis* (n = 261)
No. of anaphylactic reactions in lifetime		
1	38%	38%
2	18%	20%
3	11%	13%
4	7.0%	6.9%
5-10	10%	11%
>10	9.0%	7.7%
Do not know/refused to answer	6.1%	3.4%
Plan for future anaphylactic reaction		
Use an antihistamine	36%	37%
Call 911/ambulance	44%	46%
Lay down	13%	14%
Use epinephrine autoinjector	32%	34%
Seek immediate medical attention	13%	13%
Go to doctor's office	11%	10%
Current epinephrine practices		
Carry but have never used	21%	22%
Carry and have previously used	20%	21%
Prescribed in the past but never used and do not currently carry	7.8%	7.7%
None of the above	52%	50%
Provided with an anaphylaxis emergency action plan (if prescribed epinephrine)		
Yes	43%	48%
No	46%	42%
Do not know/refused to answer	12%	10%

*Confirmed anaphylaxis was defined as involving at least 2 systems, including the respiratory and/or cardiovascular systems, and/or loss of consciousness, even as a lone symptom.

future anaphylactic episodes. Even though most reported having had multiple prior episodes, with a substantial minority of prior reactions even requiring a visit to the hospital, only a third reported that they planned to use epinephrine with future reactions. Even worse, more than half had never even received a prescription for self-injectable epinephrine or an emergency action plan, and almost two thirds did not have this potentially life-saving medication available at the time of the survey. Although we recognize that many of these patients, for example those with a history of isolated antibiotic allergy, did not require a prescription for epinephrine, these results still raise concerns about overall preparedness for future episodes.

This national study provides the best estimates to date of the prevalence of anaphylaxis in the general US population. Strengths include a high response rate among eligible participants in both surveys and the use of standardized questionnaires developed by experts in allergy/immunology and emergency medicine. The patient survey also succeeded in capturing a larger target population to provide a more complete picture of anaphylaxis.

Potential limitations of these surveys, as with most others, include an inability to describe the sensitivity and specificity of the questionnaire for identifying anaphylaxis (there are no prior similar surveys), recall bias of interviewees, and potential bias caused by using solely a landline sample with the exclusion of respondents using only cell phones. Specific limitations of the public survey include the lack of data on specific anaphylaxis triggers and the exclusion of children from the survey. The focus on adults might have led to an underestimation of the true prevalence, given that anaphylaxis could be more common in

children,⁵ as well as a slightly different percentage of symptoms than previously reported.⁴ For the patient survey, even though children were included, there was still a bias toward an older population, which might misrepresent the relative proportion of anaphylaxis triggers, potentially underestimating foods and overestimating medications. However, we believe that these limitations are outweighed by the novel information provided by these 2 national surveys.

In summary, this is the first study to define the prevalence, characteristics, and attitudes regarding anaphylaxis among a representative of the US general population. Most importantly, the study demonstrated that anaphylaxis is very common, occurring in at least 1 in 50 adults and more likely closer to 1 in 20 adults. Furthermore, especially given the recurrent nature of anaphylaxis and the substantial proportion of reactions that include potentially life-threatening symptoms, these surveys demonstrate likely deficiencies in anaphylaxis care, as exemplified not just by the treatment of past episodes but also by the lack of adequate preparation for future episodes. Taken together, the results of these surveys indicate a pressing need for improved public health initiatives regarding anaphylaxis recognition and treatment.

Clinical implications: Anaphylaxis is common, with an estimated prevalence in the general population of at least 1.6%. Educational efforts are needed to improve patient preparedness for future episodes of anaphylaxis.

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