



Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

Elsevier hereby grants permission to make all its COVID-19-related research that is available on the COVID-19 resource centre - including this research content - immediately available in PubMed Central and other publicly funded repositories, such as the WHO COVID database with rights for unrestricted research re-use and analyses in any form or by any means with acknowledgement of the original source. These permissions are granted for free by Elsevier for as long as the COVID-19 resource centre remains active.

The impact of COVID-19 on a national sample of US adults with food allergy

Christopher Warren, PhD^{a,b}, Janell Sherr, MD^c,
Sayantani Sindher, MD^{a,c}, Kari C. Nadeau, MD, PhD^{a,c},
Thomas B. Casale, MD^d, Dana Ward, BS^d,
Ruchi Gupta, MD, MPH^b, and R. Sharon Chinthrajah, MD^{a,c}



Clinical Implications

This study highlights how psychosocial burden associated with food allergy management increased during the pandemic for many individuals with food allergy and that those who were highly impacted by COVID-19–related stressors may be particularly at risk for suboptimal management.

Recent estimates suggest that approximately 1 in 10 US adults has food allergy (FA), with approximately 1 in 20 reporting FA history and physician diagnosis. Although fatality rates are low, FA-related health care utilization is common and contributes to direct, indirect, and intangible costs for affected individuals, their families, and society more broadly.¹ Living with FA also often involves well-documented psychosocial burdens, including profound changes in how daily activities such as grocery shopping, cooking, and dining out are performed, to achieve allergen avoidance.²

Severe acute respiratory syndrome coronavirus 2 has infected more than 79 million, killed more than 970,000 Americans,³ and its resulting socioeconomic impact has led to hardship and disruption in many communities. Factors associated with this ongoing pandemic also led to significant changes in the lives of adults living with FA. Understanding how adults who reported perceived FA adapted to changes in FA care and the food environment, as well as the psychosocial burden imposed by the coronavirus disease 2019 (COVID-19) pandemic, may be instructive for informing ongoing and future public health efforts. Consequently, a survey was developed and administered to two large US FA patient registries.

This survey was developed via a rapid-cycle process from March 24, 2020, to April 30, 2020. Participants were recruited via Food Allergy Research and Education and the Sean N. Parker Center for Allergy and Asthma Research at Stanford University's ("Stanford") patient registries. REDCap survey responses from each registry were comparable and pooled for further hypothesis testing. Surveys were completed by 505 adults (mean age, 40.90 ± 16.14 years) who reported perceived FA; 351 surveys were completed by Food Allergy Research and Education registrants between May 20, 2020, and June 15, 2020 (where response rates of 8% and 5% were observed to the two bulk emails) and 154 by Stanford registrants between June 1, 2020, and April 16, 2021 (15% of adult registrants). Table I reports demographic and clinical characteristics by recruitment source.

Surveys evaluated changes in FA-related psychosocial burden, prompting participants to compare current perceptions with

their perceived levels of each construct in 2019. For each numerical response (0-10), 0 represents "much less now," 5 represents "no change," and 10 represents "much more now." Significant ($P < .05$) increases in worry were reported (Table II) now compared with prepandemic regarding respondent expectation of the following adverse FA outcomes: (a) accidental allergen exposure; (b) experiencing severe symptoms on accidental ingestion; (c) FA-related fatality; and (d) perceived inability to successfully identify and treat food-induced anaphylaxis. Compared with prepandemic, respondents reported greater stress, anxiety, and worry about FA in general ($P < .001$). Respondents also reported greater worry ($P < .001$) about their ability to (e) eat a diverse, nutritious diet because of FA; (f) obtain safe/allergen-free foods or ingredients; and (g) avoid allergen cross-contact when purchasing prepared/delivered foods. The greatest reported increases were observed for worry regarding (h) calling 911; (i) potentially receiving FA treatment in the emergency department (ED); and (j) going to the ED for FA treatment.

Overall, younger, female respondents reported greater psychosocial burden than their older, male counterparts, particularly regarding general FA-related worry/anxiety/stress, and concern about allergen cross-contact and obtaining allergen-free foods. Respondents from households reporting annual income below the poverty line and those reporting decreased family income reported greater worry about allergen cross-contact when purchasing prepared or delivered foods, greater worry about their ability to eat a diverse, nutritious diet, and greater worry about their ability to obtain safe/allergen-free foods as well as greater worry, anxiety, and stress about FA generally. These lower socioeconomic status households were also more likely to report difficulty getting food, medicine, and necessary health care—consistent with recent reports.⁴

Mean COVID-19 Exposure and Family Impact Scale (CEFIS)⁵ scores were significantly higher among respondents with asthma, and those living below the 2020 poverty line. A series of covariate-adjusted linear regression models were fit (data available from the authors by request), which evaluated the impact of CEFIS scores on all assessed psychosocial constructs. In general, as COVID-related impacts increased, so did expectation of adverse FA outcome ($B = 0.05-0.13$; $SE = 0.03-0.04$), FA-related stress, anxiety, and worry ($B = 0.07-0.09$; $SE = 0.04$). Respondents with higher CEFIS scores also expressed greater worry about potentially receiving FA care in the ED ($B = 0.10$; $SE = 0.04$) and calling 911 if they started experiencing FA symptoms ($B = 0.07$; $SE = 0.04$). The latter finding—although understandable given well-publicized reports about health care systems being stretched to capacity by patients with COVID-19—is worrisome, given the importance of rapid identification and treatment of anaphylaxis with epinephrine⁶ and low rates of epinephrine carriage among the general adult food-allergic population.⁷

Early in the COVID-19 pandemic, previously proposed changes to emergency anaphylaxis management plans—which specifically highlighted the lack of value and efficacy of immediately activating emergency medical services and recommended this be removed from the action plan in nonpandemic

TABLE I. Sample demographic characteristics by recruitment site

Demographic characteristic	FARE Registry	Stanford Registry	All sites	χ^2	P value
Sex					
Female	299 (85.7)	90 (58.4)	389 (77.3)	49.8	<.001
Male	47 (13.5)	64 (41.6)	111 (22.1)		
Other	3 (0.09)	0 (0)	3 (0.6)		
Race and ethnicity					
Asian, NH	15 (4.3)	27 (17.5)	42 (8.3)	23	<.001
Black, NH	9 (2.6)	5 (3.2)	14 (2.8)	0.02	.89
Hispanic	18 (5.1)	9 (5.8)	27 (5.3)	0.01	.9
White, NH	319 (90.9)	102 (66.2)	421 (83.4)	45.1	<.001
Age (y)					
18-30	114 (32.6)	69 (44.8)	183 (36.3)	16	<.001
31-50	126 (36.0)	62 (40.3)	188 (37.3)		
>50	110 (31.4)	23 (14.9)	133 (26.4)		
Hx of FA-related psychosocial therapy					
Yes, I saw a mental health professional	51 (14.5)	19 (12.5)	70 (13.9)	0.23	.63
No, I have not seen a mental health professional	300 (85.5)	133 (87.5)	432 (86.1)		
Hx of physician-diagnosed anxiety disorder					
Yes, I have been diagnosed	117 (33.3)	39 (25.7)	156 (31.1)	2.6	.1
No	233 (66.4)	113 (74.3)	346 (68.9)		
Household income (annual, US \$)					
<\$75,000	119 (37.9)	22 (15.7)	156 (31.1)	52.5	<.001
\$75,000-\$149,999	114 (36.3)	33 (23.6)	147 (32.4)		
\$150,000+	81 (25.8)	85 (60.7)	166 (36.6)		
Household size					
1	57 (16.2)	16 (10.5)	73 (14.5)	20.9	.007
2	138 (39.3)	40 (26.3)	178 (35.4)		
3	56 (16.0)	36 (23.7)	92 (18.3)		
4	61 (17.4)	42 (27.6)	103 (20.5)		
5	22 (6.3)	12 (7.9)	34 (6.8)		
6	11 (3.1)	4 (2.6)	15 (3.0)		
7+	6 (1.7)	2 (1.3)	8 (1.6)		
Below 2020 federal poverty line					
Yes	49 (14)	8 (5.2)	57 (11.3)	7.4	.007
No	302 (86.0)	146 (94.8)	448 (88.7)		
If you lost all your sources of household income, how long could you continue to live at your current address and standard of living?					
<3 mo	87 (27.2)	19 (14.1)	106 (23.3)	20.2	<.001
3-12 mo	135 (42.2)	46 (34.1)	181 (39.8)		
>12 mo	98 (30.6)	70 (51.9)	168 (36.9)		

FARE, Food Allergy Research and Education; Hx, history; NH, non-Hispanic.

contexts⁸—were adopted into a modified action plan for implementation during the pandemic.⁹ In a context of potentially overwhelmed emergency medical services dealing with higher priority health care issues and elevated risk of patients contracting COVID-19 during a potentially unnecessary ED observation, this plan adopted the conclusions of the aforementioned cost-effectiveness analysis: proposing watchful waiting to see if the initial reaction resolved on administration of epinephrine, and recommending emergency medical services activation only until after administration of a second dose of epinephrine (if allergic symptoms do not resolve).⁸ To assess whether physician-recommended approaches to anaphylaxis management changed during the pandemic, survey respondents were asked if they had an FA emergency care plan recommending

epinephrine autoinjector (EAI) use, to which 66.2% answered “yes.” Among these respondents, only 9.7% reported changes in anaphylaxis management due to COVID-19—including recommended EAI use upon allergen ingestion for any symptoms (5.9% of respondents) and recommended EAI use on allergen ingestion even without symptoms (2.8%). In 3.1% of cases, patients were informed that they were no longer required to go to the ED after receiving epinephrine under certain circumstances. Taken together, these data suggest that the recommendations to modify anaphylaxis management plans during the pandemic were neither broadly, nor promptly implemented. That said, given that routine FA follow-up generally occurs on an annual (or less frequent) basis, some adult patients with FA surveyed here may not have had interval follow-up with a health care

TABLE II. FA-related psychosocial impacts by site

Psychosocial factors		FARE Registry	Stanford Registry	Combined sample	Tests comparing FARE vs STANFORD registries		One-sample <i>t</i> tests of null hypothesis of no change	
					<i>t</i> test	<i>P</i> value	<i>t</i> test	<i>P</i> value
Expectation of adverse FA outcome	“Compared to 2019, how worried are you now about the possibility of accidentally eating your allergen?”	5.71 ± 2.61	4.3 ± 2.48	5.28 ± 2.65	5.8	<.001	2.36	.02
	“Compared to 2019, how worried are you now about having a severe reaction if you accidentally eat your allergen?”	6.53 ± 2.26	5.35 ± 2.31	6.17 ± 2.33	2.21	.03	11.2	<.0001
	“Compared to 2019, how worried are you now about dying if you accidentally eat your allergen?”	5.94 ± 2.22	5.04 ± 2.09	5.67 ± 2.22	4.36	<.001	6.73	<.001
	“Compared to 2019, how worried are you now about not being able to successfully identify and treat a severe food-allergic reaction with epinephrine?”	5.4 ± 2.18	4.72 ± 1.79	5.2 ± 2.09	3.69	<.001	2.09	.04
	“Compared to 2019, how stressed are you now about your food allergy in general?”	5.77 ± 2.42	4.9 ± 2.2	5.5 ± 2.39	3.96	<.001	4.71	<.001
FA-related psychosocial burden	“Compared to 2019, how anxious are you now about your food allergy in general?”	5.76 ± 2.38	4.92 ± 2.13	5.51 ± 2.34	3.9	<.001	4.85	<.001
	“Compared to 2019, how worried are you now about your food allergy in general?”	5.79 ± 2.41	4.95 ± 2.09	5.53 ± 2.35	3/96	<.001	5.1	<.001
	“Compared to 2019, how worried are you now about your ability to eat a diverse, nutritious diet because of your food allergy?”	5.61 ± 2.29	5.03 ± 1.96	5.43 ± 2.21	2.88	.004	4.33	<.001
Food-related behavior	“Compared to 2019, how worried are you now about your ability to obtain safe/allergen-free foods or ingredients?”	6.19 ± 2.34	4.82 ± 2.06	5.78 ± 2.35	6.61	<.001	7.41	<.001
	“Compared to 2019, how worried are you about the risk of allergen cross-contact when purchasing prepared or delivered foods?”	6.42 ± 2.39	5.17 ± 2.01	6.04 ± 2.35	6.04	<.001	9.92	<.001
	“Compared to 2019, how worried are you about calling 911 if you started experiencing symptoms of potentially life-threatening anaphylaxis?”	6.77 ± 2.31	5.83 ± 2.14	6.48 ± 2.3	4.41	<.001	14.43	<.001
Health care utilization	“Compared to 2019, how worried are you now about the possibility of receiving emergency food allergy treatment in the emergency department?”	7.21 ± 2.35	6.2 ± 2.39	6.9 ± 2.4	4.36	<.001	17.7	<.001
	“Compared to 2019, how worried are you about going to the emergency department/ER for food allergy treatment?”	7.58 ± 2.31	6.74 ± 2.49	7.33 ± 2.39	3.56	<.001	21.76	<.001
	“Imagine you had a severe food-allergic reaction at home. You have 2 epinephrine autoinjectors and can communicate with your doctor via phone. Would you prefer to treat yourself at home or go to the emergency department (ED)?”*	5.04 ± 3.74	4.48 ± 3.6	4.87 ± 3.71	1.57	.12	-0.79	.43

ER, Emergency room; FARE, Food Allergy Research and Education.

Values are mean ± SD unless otherwise indicated.

Response options for each question ranged from 0 (much less worried now) to 5 (equally worried now) to 10 (much more worried now).

*Response options for this question ranged from 0 (much prefer staying home) to 5 (no preference) to 10 (much prefer going to ED).

provider where they would have been informed of the aforementioned changes to anaphylaxis management.

Although this study has numerous strengths, these data were self-reported and thus subject to corresponding recall and responder bias. Selection bias also remains of high concern, particularly given the low response rates. Moreover, participants were recruited from patient registries and thus compared with the general FA population, respondents may have (or perceived themselves to have) more severe disease, and may have been disproportionately impacted by pandemic-related changes in FA management. However, this sample was more affluent than the general FA population and thus likely better resourced to cope with these changes.

In conclusion, these data suggest that the COVID-19 pandemic and associated traumatic events have adversely impacted the mental health and well-being of adults with FA surveyed from two major US FA registry populations.

^aSean N. Parker Center for Allergy and Asthma Research, Stanford University School of Medicine, Stanford, Calif

^bCenter for Food Allergy and Asthma Research, Northwestern University Feinberg School of Medicine, Chicago, Ill

^cDivision of Allergy and Immunology, Stanford University School of Medicine, Stanford, Calif

^dFood Allergy Research and Education, McLean, Va

Conflicts of interest: C. Warren reports research support from the National Institute of Allergy and Infectious Diseases (NIAID), Food Allergy Research and Education (FARE), and the Sunshine Charitable Foundation. R. S. Chinthrajah reports grants from NIAID, CoFAR, Aimmune, DBV Technologies, Astellas, Regeneron, FARE, and Stanford Maternal and Child Health Research Institute, is an advisor/consultant for Alladapt Therapeutics, Novartis, Genentech, Sanofi, Allergenics, and Nutricia, all outside the submitted work, and reports funding from the Sunshine Foundation, the Crown Foundation, and the Parker Foundation. K. C. Nadeau reports grants and other fees from NIAID and FARE, personal fees and other fees from Regeneron, grants from EAT, other fees from Sanofi, Astellas, Nestle, BeforeBrands, Alladapt, ForTra, Genentech, Aimmune Therapeutics, and DBV Technologies, personal fees from Astrazeneca, ImmuneWorks, and Cour Pharmaceuticals, grants from Allergenics, Ukko Pharma, Novartis, AnaptysBio, Adare Pharmaceuticals, Stallergenes-Greer, National Heart, Lung, and Blood Institute, National Institute of Environmental Health Sciences, US Environmental Protection Agency, WAO Center of Excellence, Iggenix, Probio, Vedanta, Centecor, Seed, Immune Tolerance Network, and National Institutes of Health (NIH). R. Gupta receives research grant support from the NIH, FARE, Stanford Sean N.

Parker Center for Allergy Research, UnitedHealth Group, Thermo Fisher Scientific, Genentech, and the National Confectioners Association and has served as a medical consultant/advisor for Aimmune Therapeutics, Genentech, Before Brands, Kaléo, DBV Technologies, ICER, DOTS Technology, and FARE. T. B. Casale reports being an investigator for grants from Novartis, Genentech, Sanofi, and Regeneron, received consultant/advisory board fees from Novartis, Genentech, Sanofi, Regeneron, GlaxoSmithKline, and Astra Zeneca, serves as chief medical officer for FARE, whose patient registry population was surveyed as part of the present project, and was lead author of *Acute At Home Management of Anaphylaxis During the Covid-19 Pandemic*, which recommended modification of anaphylaxis action plans as discussed in the present article. The rest of the authors declare that they have no relevant conflicts of interest.

Received for publication June 24, 2021; revised July 15, 2022; accepted for publication July 18, 2022.

Available online August 13, 2022.

Corresponding author: Christopher M. Warren, PhD, 750 N Lake Shore Dr, 6th Floor, Ste 653, Chicago, IL 60611. E-mail: christopher.warren@northwestern.edu. 2213-2198

© 2022 American Academy of Allergy, Asthma & Immunology

<https://doi.org/10.1016/j.jaip.2022.07.036>

REFERENCES

1. Warren CM, Jiang J, Gupta RS. Epidemiology and burden of food allergy. *Curr Allergy Asthma Rep* 2020;20:6.
2. Feng C, Kim JH. Beyond avoidance: the psychosocial impact of food allergies. *Clin Rev Allergy Immunol* 2019;57:74-82.
3. Centers for Disease Control and Prevention. COVID Data Tracker. Accessed March 22, 2022. <https://covid.cdc.gov/covid-data-tracker/#data-tracker-home>
4. Brown E, Das R, Brewer AG, Martinez E, Bilaver LA, Gupta RS. Food insecure and allergic in a pandemic: a vulnerable population. *J Allergy Clin Immunol Pract* 2020;8:2149-51.
5. The Center for Pediatric Traumatic Stress. COVID-19 Exposure and Family Impact Survey (CEFIS). Accessed April 20, 2020. https://www.nlm.nih.gov/dr2/CEFIS_COVID_questionnaire_English_42220_final.pdf
6. Yue D, Ciccolini A, Avilla E, Wasserman S. Food allergy and anaphylaxis. *J Asthma Allergy* 2018;11:111-20.
7. Gupta RS, Warren CM, Smith BM, Jiang J, Blumenstock JA, Davis MM, et al. Prevalence and severity of food allergies among US adults. *JAMA Netw Open* 2019;2:e185630.
8. Shaker M, Kanaoka T, Feenan L, Greenhawt M. An economic evaluation of immediate vs non-immediate activation of emergency medical services after epinephrine use for peanut-induced anaphylaxis. *Ann Allergy Asthma Immunol* 2019;122:79-85.
9. Casale TB, Wang J, Nowak-Wegrzyn A. Acute at home management of anaphylaxis during the Covid-19 pandemic. *J Allergy Clin Immunol Pract* 2020; 8:1795-7.