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Review

# Psychological impacts of coronavirus disease 2019 on people with asthma, allergic rhinitis, and food allergy

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ABSTRACT

**Objective:** To summarize the current literature of the psychological impacts of coronavirus disease 2019 (COVID-19) on people with allergic diseases and to identify gaps in need of future research.
**Data Sources:** Ovid MEDLINE(R) and Embase Classics + Embase from 1947 to present (October 18, 2021) were searched using a search strategy that included the following keywords: allergic diseases, covid*, and psychological disorders.
**Study Selections:** Primary manuscripts and abstracts using online and telephone surveys, mixed-method studies capturing patient and caregiver experiences, case studies, and published guidelines from allergic disease-specific expert groups were included.
**Results:** People with asthma and other chronic respiratory conditions are at higher risk of negative psychological outcomes, and risk factors include asthma severity, female sex, and previous history of anxiety and depression, likely owing to the perceived risk of severe disease from COVID-19. One study identified that people with allergic rhinitis had significantly high anxiety and depression scores compared with healthy controls (both, $P < .001$). The psychological impacts of food allergy during COVID-19 were most strongly felt by parents and caregivers. Similarly, parents of children with asthma experienced substantial psychological burden.
**Conclusion:** COVID-19 had a considerable psychological impact on patients with asthma. Limited data have been published on the mental health impacts of COVID-19 on patients with allergic rhinitis and food allergy. As COVID-19 research continues to evolve and the literature captures later stages of the pandemic, it is important that physicians be aware of the potential coincidence of mental illness and chronic allergic diseases and refer these patients, and their caregivers, to appropriate resources while also continuing to manage their allergic disease(s).
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## Key Messages

- With some exceptions, people with asthma are not at a higher risk of more severe disease, hospitalization, or death owing to severe acute respiratory syndrome coronavirus 2; however, the perceived risk of being at higher risk has substantially affected the mental well-being of people with asthma, and disease severity, asthma control, female sex, and previous history of anxiety and depression are risk factors. More research is needed, particularly in postlockdown periods.
- Patients with allergic rhinitis reported higher anxiety and depression scores than healthy controls. Behavior changes during the pandemic, such as mask wearing, spending less time outdoors, more time spent indoors, and decreased air pollution during lockdown periods, have affected the symptom scores.

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- Coronavirus disease 2019 (COVID-19) mental burden on people with food allergies (FAs) was exclusively studied in children, adolescents, and caregivers. Generally, people with FA reported concerns regarding the activation of emergency services and emergency department visits owing to COVID-19, delays in allergy office visits, delays in oral immunotherapy, and difficulties with finding allergy-safe products during grocery shopping.
- Substanial burden was experienced by parents and caregivers of children with asthma and FA compared with control groups. Referring these patients' caregivers to appropriate support groups and mental health resources may be salient.
- In general, anaphylactic reactions to vaccinations, including the COVID-19 vaccines, are very rare, but do occur. In the case of a previous allergic reaction to the COVID-19 vaccine, allergists have been influential in determining which patients can proceed with receiving a vaccine according to evolving evidence-based guidelines.

## Introduction

Coronavirus disease 2019 (COVID-19) is a respiratory illness characterized by fever, cough, dyspnea, fatigue, and lymphopenia. Severe COVID-19 complications can manifest as viral pneumonia and may lead to severe acute respiratory syndrome and, in some cases, death.[1,2] As of December 2021, severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) has caused more than 263,300,000 infections, and more than 5,221,000 deaths. Since December 2020, more than 8,033,000,000 vaccine doses have been administered.[3] A global systematic review conducted during the COVID-19 pandemic of the psychological outcomes of the general public found relatively high rates of anxiety (6.33%-50.9%), depression (14.6%-48.3%), posttraumatic stress disorder (7%-53.8%), psychological distress (34.43%-38%), and stress (8.1%-81.9%).[4]

The acute symptoms of COVID-19 overlap with those of allergic rhinitis (AR) and asthma, potentially affecting mental well-being and condition management (Fig 1).[5] Mental health has a considerable impact on chronic disease management, particularly during COVID-19, the impacts of such are beginning to emerge for people with chronic allergic diseases, including asthma, AR, and food allergy (FA) (Fig 2).[6] At the beginning of the pandemic, some health authorities suggested that asthma and allergic disease may be risk factors for COVID-19. Though this sentiment has been discounted by many health authorities, it has potentially made a detrimental impact on the perception of patients of their COVID-19 risk and mental health status.[7] In a survey of 4106 people, the group with allergic disease (ie, AR, asthma, FA, urticaria, and atopic dermatitis) (n = 1656) had a higher risk of developing symptoms of depression on the Patient Health Questionnaire—9 (PHQ-9). Other risk factors of developing depressive symptoms were female sex ($P$ =.000; odds ratio [OR], 1.65, confidence interval [95% CI], 1.43-1.91), aged 18 to 59 years old ($P$ =.000; OR, 3.97; CI, 2.86-5.51), and single marital status in both sexes ($P$ =.000; OR, 1.2; CI, 1.11-1.29).[8] Adults with self-reported physician-diagnosed allergies and asthma are more likely to report feelings of nervousness (crude [c]OR, 1.34; 95% CI, 1.13-1.60), depression (cOR, 1.32; 95% CI, 1.11-1.57), loneliness (cOR, 1.23; 95% CI, 1.04-1.47), and hopelessness (cOR, 1.44; 95% CI, 1.21-1.72) compared with those without allergies during COVID-19.[9] These studies have revealed that people with allergic diseases had a higher negative psychological impact as a result of the pandemic.[8,9] These findings have important implications for diagnostic and treatment challenges for physicians who care for people with allergic diseases and will be further explored in this review. Lastly, tackling COVID-19 vaccine hesitancy owing to perceived allergy has been an ongoing challenge for allergists; however, many individuals, including those who reacted to their first dose, with some exceptions, can safely receive the second dose in a controlled setting.[10]

### *Asthma*

The Global Initiative for Asthma defines asthma as "a heterogeneous disease, characterized by chronic airway inflammation." Respiratory symptoms include wheezing, shortness of breath, chest tightness, and cough that are intermittent and present with reversible expiratory airflow obstruction. Asthma triggers include viral infections, exercise, allergen exposure, weather changes, laughter, and irritants, such as strong smells, car emissions, and disinfectants.[11] Asthma is estimated to affect more than 300 million people worldwide.[11] Mental health can play a critical role in managing chronic diseases, including asthma, and it has been found that 12% to 14% of people with asthma have depression compared with only 7% of people with other chronic respiratory conditions.[12] Furthermore, elevated anxiety levels are a potential risk factor for loss of asthma symptom control and a decline in disease-related quality of life (QoL).[6] In the context of COVID-19, 64% of people with a chronic respiratory condition, including asthma (83% of the surveyed population), reported high levels of anxiety on their respiratory condition and COVID-19.[13]

COVID-19 may cause increased stress and anxiety in people with asthma, especially after the Centers for Disease Control and Prevention warning early on (before August 31, 2020) in the pandemic stating that people with chronic illness may be at a higher risk for severe illness from the disease.[14] At present, people with asthma do not have an increased risk of being more susceptible or at an increased risk of severe disease from COVID-19, with the exception of people with severe asthma who have recently used oral corticosteroids (OCSs) (asthma with no recent OCS hazard ratio [HR] for COVID-19 death (95% CI) adjusted for age and sex 1.13 (1.07-1.20), adjusted (a) HR, 0.99 (0.93-1.05); asthma with recent OCS use HR adjusted for age and sex 1.55 (1.51-1.64), aHR, 1.13 (1.01-1.26)).[15,16] Lee et al[17] also found that asthma was not a significant risk factor for respiratory failure or mortality among patients with COVID-19; however, a history of acute exacerbation within the last year was a significant risk factor (OR, 2.63; $P < .05$) for COVID-19 deaths among people with asthma, especially in cases of old age (OR, 1.10; $P < .001$) and male sex (OR, 2.26; $P = .02$). Indeed, many countries saw a reduction in asthma exacerbations, hospitalizations, and diagnosis. This was attributed to increased handwashing, masking, physical distancing, and an overall decrease in influenza and other viral respiratory illnesses, which are a trigger for asthma. Many patients also reported better asthma control.[11,18-20] Nevertheless, some people with asthma may have experienced an increase in asthma symptoms owing to increased use of disinfectants.[21]

Survey studies have found an increase in anxiety, depression, asthma symptoms, decreased symptom control, and QoL (Table 1).[6,21,22] An online questionnaire (n = 264) in people who were 12 to 78 years old found that 70% of the study participants had poorly controlled asthma (Asthma Control Test [ACT] $\leq$19), 46% of the participants found that their symptoms increased during a lockdown, and 90% attributed this increase to disinfectant use which may contribute to feelings of anxiety.[21] Using the hospital anxiety and depression scale (HADS), researchers found that 35% and 26% of study participants reported anxiety and depression. Elevated anxiety and depression scores were associated with uncontrolled asthma in 50%

| Symptoms | COVID-19 | Asthma | Allergic Rhinitis | Food Allergy |
|---|---|---|---|---|
| Fever | Common | N/a | N/a | N/a |
| Cough | Common | Common | Common | Common |
| Tiredness | Common | Less common | N/a | N/a |
| Anosmia | Common | N/a | Less common | N/a |
| Rhinorrhea | Less common | N/a | Common | Less common |
| Sore throat | Less common | Less common | Less common | Less common |
| Headache | Less common | N/a | Less common | N/a |
| Myalgia | Less common | N/a | N/a | N/a |
| Diarrhoea | Less common | N/a | N/a | Common |
| Rash | Less common | N/a | Less common | Common |
| Red eyes | Less common | N/a | Common | Less common |
| SOB | Infrequent, Severe | Severe | Less common | Severe |
| Chest pain | Infrequent, Severe | Severe | N/a | Severe |

**Figure 1.** COVID-19 and allergic disease symptom overlap. Patients should be taught to identify their allergic symptoms and how they differentiate from symptoms of COVID-19. Familiarity with symptom history of allergic disease and relief with treatment makes allergy symptoms easy to differentiate from COVID-19. COVID-19, coronavirus disease 2019; n/a, not available; SOB, shortness of breath.

of the participants.[21] Mask wearing is important for preventing SARS-CoV-2 transmission; however, it is potentially challenging for people with severe asthma as 1 study found. People with uncontrolled asthma (ACT≤19) were significantly less likely to wear a surgical mask and more likely to wear a 1-layered cloth mask (*P* values not provided).[23] Respondents with uncontrolled asthma reported more subjective discomfort, trouble breathing, shortness of breath, wheeze, and anxiety when wearing a mask compared with people with controlled asthma (ACT ≥ 20); however, not contracting COVID-19 was a strong incentive among both groups for mask wearing (*P* values not provided).[23] A question yet to be answered is if mask use increased asthma exacerbations or rescue inhaler use among patients with severe asthma. People with severe asthma were more significantly affected than those with mild or moderate asthma (eg,

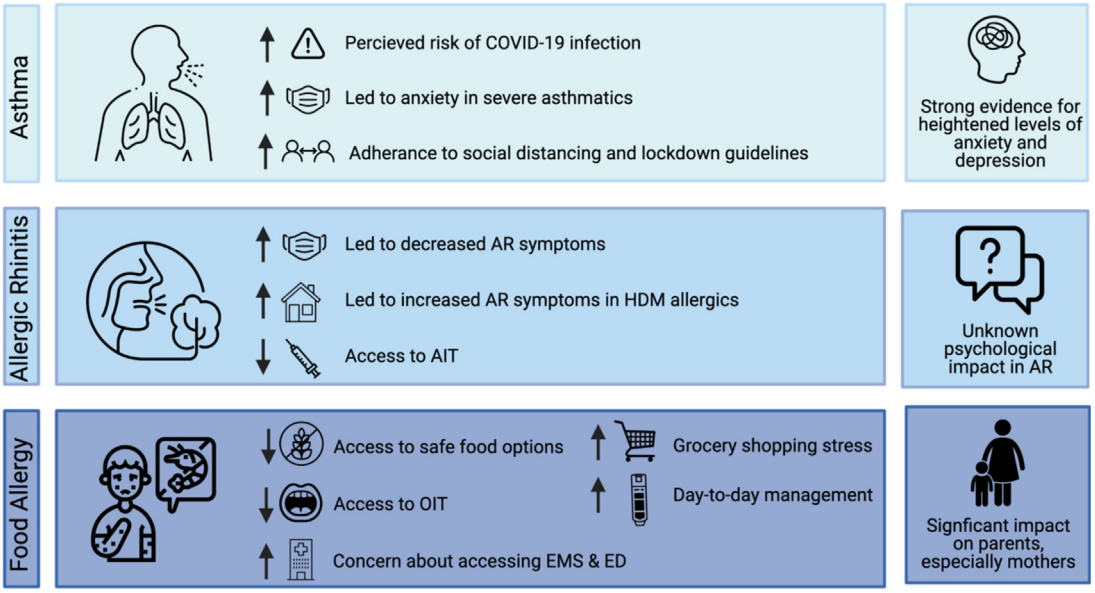


**Figure 2.** Graphical illustration of the factors of COVID-19 affecting patients with asthma, allergic rhinitis, and food allergy. AIT, allergen immunotherapy; AR, allergic rhinitis; COVID-19, coronavirus disease 2019; ED, emergency department; EMS, emergency medical services; HDM, house dust mites; OIT, oral immunotherapy.

**Table 1**
Psychological Impacts of COVID-19 on People With Asthma

| Author, y | Participants | Region, time frame | Validated surveys | Outcomes |
|---|---|---|---|---|
| Sheha et al,[21] 2021 | 264 | Egypt | ACT, HADS | 70% reported poor asthma control, 46% reported asthma symptom increase during lockdown associated with disinfectant use (90%), 35% reported anxiety, 26% reported depression, depression and anxiety associated with poor asthma control in 50% of participants. |
| Polivka et al,[23] 2021 | 455 | United States | ACT | People with uncontrolled asthma (ACT ≤ 19) were substantially less likely to wear a surgical mask and more likely to wear a 1-layered cloth mask. Respondents with uncontrolled asthma reported substantially more discomfort, trouble breathing, shortness of breath, wheeze, and anxiety when wearing a mask compared with people with controlled asthma (ACT ≥ 20); however, not contracting COVID-19 was a strong incentive among both groups for mask wearing. |
| Arora et al,[24] 2021 | 1171 Patients, 225 physicians | April-May 2020 | ACT | Patients with asthma more likely to believe than their physicians that they are at higher risk of COVID-19 (37.5% vs 12.0%; $P < .001$) and have increased anxiety owing to COVID-19 (79.6% vs 70.0%; $P = .002$); people with severe asthma more likely to be unemployed (OR, 2.15) or have concerns on obtaining asthma medication (OR, 2.37); 40% of physicians believed that patients with asthma should practice more strict social distancing measures; 78% of asthma respondents believed that they were being more careful than others. |
| Lacwik et al,[6] 2021 | 88 Patients with severe asthma on biologics | Poland and Sweden, March-June 2020 | STATI, ACQ, mAQLQ | 25% of patients had a considerable decline in symptom control, and 21% experienced a decline in QoL. There were 30 patients qualified as having high state anxiety (34%), whereas 7 had high trait anxiety (8%). Linear regression analysis revealed that both state and trait anxiety were significantly associated with the change in ACQ ($P < .001$ and $P < .01$, respectively), but not the mAQLQ scores. |
| Çölkesen et al,[25] 2020 | 80 Patients with severe asthma on biologics | Turkey, April-May 2020 | HADS, HADS-A, HADS-D, FIVE | 35% reported high HADS-Anxiety scores and 30% reported high HADS-Depression scores. FIVE was also used for evaluation. |
| Taillé et al,[26] 2021 | 106 with asthma, 10,859 people with chronic disease | France, May 2020 | ACT | 95% of patients with asthma reported anxiety and depression. |
| Jacob et al,[32] 2021 | 21,008 records | Germany, March-June 2020 compared with March-June 2019 | N/a—database study | Increase in the anxiety diagnosis between March and June 2020 compared with the same time frame in 2019 ($P < .001$); however, antidepressant and anxiolytics were less frequently prescribed. Newly diagnosed people with anxiety were more likely to have comorbid asthma or COPD. |
| Chaix et al,[35] 2020 | 1771 | France, March-April 2020 | PDI | Prevalence of psychological distress as per the PDI (PDI ≥ 14) was 42% for patients with asthma (n = 497) compared with 38.06% for the general respondents. |
| Chen et al,[27] 2020 | | United Kingdom, March-April 2020 compared with March-April 2019 | N/a—database study | Substantial drop in overall mental health referrals during the first lockdown followed by an accelerated referral rate for people with specific comorbidities including asthma. |
| Tasnim et al,[33] 2021 | 971 | Bangladesh, November 2020-January 2021 | SQL, GAD-7, PHQ-9 | People with asthma were more likely to report depression (14.6%) and anxiety (6.64%). |
| Wei et al,[29] 2021 | | United States, April-June 2020 | | Adults with asthma were more likely to report feeling nervous, anxious, or on edge (aOR, 1.61; 95% CI, 1.30-2.01), depressed (aOR, 1.73; 95% CI, 1.39-2.15), lonely (aOR, 1.90; 95% CI, 1.53-2.37), hopeless on the future (aOR, 1.65; 95% CI, 1.32-2.05), and having a physical reaction when thinking on their experiences during the COVID-19 pandemic (aOR, 2.28; 95% CI, 1.57-3.29) compared with adults without asthma. |
| Cumella et al,[30] 2021 | 23,917 | United Kingdom, April-May 2020 | | Reported the anxiety levels on COVID-19 in people with preexisting respiratory conditions, including asthma, and found that mean anxiety levels were slightly higher in women (8.131.99, April; 7.532.00, May) than in men (7.552.28, April; 7.012.26, May) in both April and May 2020, and mean anxiety levels were decreased from April (8.032.07) to May (7.042.02), which is encouraging |
| de Boer et al,[31] 2021 | 37 | Netherlands, April-July 2020 | HADs, ACQ, mAQLQ | Observed clinically relevant increase in anxiety ($3.32 \pm 2.95$ vs $6.68 \pm 3.78$; $P < .001$) and depression ($1.30 \pm 1.15$ vs $3.65 \pm 3.31$; $P < .001$) over the course of the lockdown. Nevertheless, the ACQ and the mAQLQ did not significantly differ between pre–COVID-19 assessment and COVID-19 assessment or in moderate and severe asthma cohorts. |

Abbreviations: ACQ, asthma control questionnaire; ACT, asthma control questionnaire; aOR, adjusted odds ratio; COVID-19, coronavirus disease 2019; FIVE, fear of illness and virus evaluation; HADS, hospital anxiety and depression levels; HADS-A, HADS—anxiety; HADS-D, HADS—depression; GAD-7, generalized anxiety disorder—7; GHQ-12, general health questionnaire; MAC-RF, multidimensional assessment of COVID-19–related fears; mAQLQ, mini asthma-related quality of life questionnaire; PDI, psychological distress inventory; SQL, self-reported quality of life; STAI, state-trait anxiety inventory.

became unemployed [OR, 2.15] and had difficulty obtaining asthma medications [OR, 2.37]).[24] Of high concern is that neither physicians nor patients felt confident in their ability to differentiate between asthma and COVID-19 symptoms. Of the physicians, 40% believed that patients with asthma should practice more strict social distancing measures.[24] Of asthma respondents, 78% believed that they were being more careful than others.[24] Lastly, this survey from April to May 2020 found that patients (n = 1171) were more likely than physicians (n = 225) to believe that individuals with asthma are at a higher risk to get COVID-19 (37.5% patients vs 12.0% physicians; $P < .001$) and have increased anxiety owing to COVID-19 (79.6% patients vs 70.0% physicians; $P = .002$).[24] These findings represent a potential gap in physician communication on the perceived vs true risk of COVID-19 to their patients with asthma early in the pandemic which has hopefully improved.

### *Severe and Uncontrolled Asthma*

Studies thus far have primarily focused on all asthma severities; few have explicitly focused on severe asthma during COVID-19. A survey of patients with severe asthma (n = 87) undergoing biological treatments found that 25% of patients had a substantial decline in symptom control and 21% experienced a decline in QoL.[6] Another survey study, which ran from April 20 to May 15, 2020, in people with severe asthma requiring treatment with biologics found that 35% reported high HADS—anxiety (HADS-A) scores and 30% reported high HADS—depression (HADS-D) scores.[25] Lastly, people with uncontrolled asthma (ACT < 20) were more likely to consider themselves at higher risk for COVID-19 and were more likely to be strongly affected by the lockdown. Compared to people with controlled asthma (ACT > 20), the uncontrolled group had increased feelings of anxiety and depression ($P < .001$), had a feeling of abandonment ($P < .001$), and reported more difficulties meeting their needs ($P < .001$).[26]

### *Impact of Lockdowns on People With Asthma*

Globally, numerous studies documented the impact of lockdown (April to July 2020) on people with asthma (Table 1). Participants with asthma (n = 410) reported increases in shortness of breath, difficulty sleeping, eating, and sleep changes ($P$ values not provided).[22] Furthermore, people with asthma reported higher rates of worsening mental health, higher perceived risk of COVID-19, higher worry on COVID-19 infection, longer self-isolation periods, and were more likely to waive medical appointments than individuals without asthma and other chronic conditions potentially owing to fear of contracting COVID-19 from medical visits.[22,26-28] Substantially increased anxiety and depression scores were found through validated questionnaires, and worse outcomes were associated with female sex, asthma severity, and history of anxiety and depression.[6,26,29-33] Alarmingly, one study found that 95% of patients with asthma in this survey reported anxiety or depression (median 5 [1.25-8] vs 2 [0-6]; $P < .001$).[26] An analysis of patient records found that there was an increase in anxiety diagnosis during March to June 2020 compared with the same time frame in 2019 ($P < .001$); however, antidepressant and anxiolytics were less frequently prescribed (30.4% in 2020 vs 35.6% in 2019, $P$ value <.001).[27,32] In 1 study, patients with newly diagnosed anxiety in 2020 were more likely to be older (>50 years, $P < .001$), have comorbid asthma ($P < .001$) or chronic obstructive pulmonary disease ($P < .001$), and were more likely to have an accelerated referral rate for mental health reasons.[32] The authors of this study suggested that providing accurate information to people with asthma on their true risk of COVID-19 could decrease the incidence of anxiety.[32] High levels of depression have been reported across age groups, adults (31% mild, 14% moderate to severe) followed by children (22.7% mild, 8% moderate to severe) and then adolescents (33.3% mild, 0% moderate to severe) experienced the highest levels of depression measured by PHQ-9. In addition, 14% of subjects from this study who reported depression symptoms had no previous history of depression.[34] The prevalence of psychological distress in as per the Peritraumatic Distress Inventory (PDI) (PDI $\geq$ 14) was higher in patients with asthma (42%) than healthy controls (38%), and PDI was significantly higher in regions where COVID-19 prevalence was higher (F = 2.263; $P = .02$, Pearson correlation coefficient = 0.58).[35] The impact on QoL measures has been debated, as the asthma control questionnaire (ACQ) (0.67 [0.03-1.25] vs 1.00 [0.3-1.67]; $P = .27$) did not significantly differ between pre–COVID-19 assessment and COVID-19 assessment or in moderate and severe asthma cohorts.[28,31] In contrary, Lacwik et al[6] found that although asthma control increased as per ACQ score (mean change, 0.214) in 46% of respondents (n = 87), 62% had a reduced mAQLQ score (mean change, −0.248).

### *Pediatric Asthma*

Hepkaya et al[36] measured the impact of the lockdown on Turkish children more than 8 years old through a teleconference call with parents (n = 60) from April 20 to May 15, 2020, and found that most of the parents had never considered stopping the current medications of their children. Most of the parents contacted reported concerns on the failure of the emergency medical services (EMS), and most viewed their children as being at high risk for COVID-19 infection. There was no significant relationship between these concerns and their psychological status ($P > .05$) as assessed by HADS and State-Trait Anxiety Inventory.[36] A qualitative interview study with caregivers of children with asthma found that caregivers reported improved asthma control, decreased willingness to seek medical care driven by fear of contracting COVID-19, increased adherence to asthma medication, and developed new coping strategies for managing new challenges in asthma control caused by COVID-19.[37] Black, indigenous, people of color and non-Hispanic White parents of children with asthma were more concerned on resource losses and greater reduction in health care access when compared with non-Hispanic White parents of healthy controls.[38] In a postlockdown survey of children with asthma (ages 7 to 14) and their mothers (n = 45 dyads) compared with healthy control dyads, it was found that patients with asthma did not significantly differ from healthy peers in reporting psychological well-being ($P = .18$) and separation anxiety symptoms ($P = .41$). Children with asthma had normative functioning in a postlockdown period. Nevertheless, the parents had greater concern on their child getting sick with COVID-19 ($P = .01$).[39] The mothers of children with asthma reported lower but not significantly different general psychological well-being (51.1%; $P = .76$) with 31.1% needing possible intervention compared with control suggesting mothers of children with chronic illness such as asthma need additional support throughout the COVID-19 pandemic.[39,40] Mothers of children with asthma reported stronger COVID-19–related fears than the controls, roughly comparable with the mothers of children with FA (Fig 3).

Overall, these studies reveal how COVID-19 has adversely affected people with asthma. These studies address a specific time period early on in the pandemic when there was limited information available on the relationship between asthma and COVID-19. It would be beneficial to investigate the association between asthma control and the psychological impact of COVID-19 in long term as our understanding of asthma and COVID-19 evolves.

## Allergic Rhinitis

Compared with asthma and FA, less research has been conducted on the specific psychological impacts of the COVID-19 pandemic on

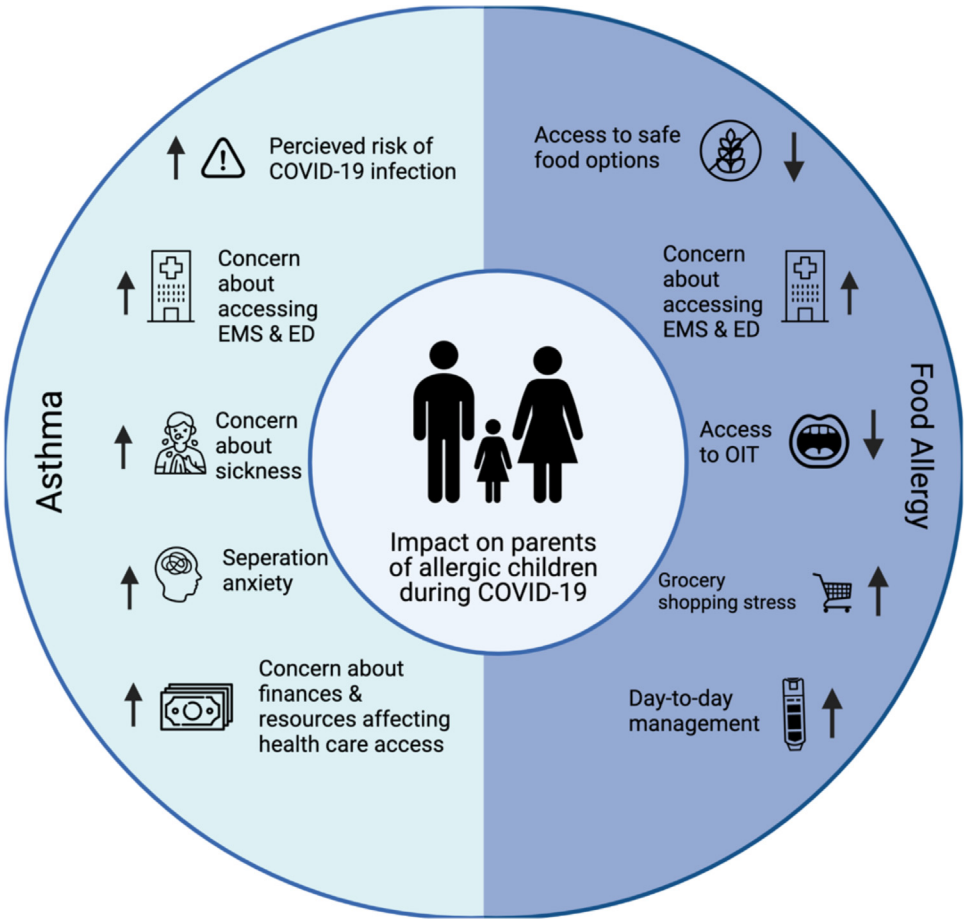


**Figure 3.** Graphical illustration of the impact of COVID-19 on parents of children with asthma and food allergy. COVID-19, coronavirus disease 2019; ED, emergency department; EMS, emergency medical services; OIT, oral immunotherapy.

people with AR. AR is a chronic inflammatory condition that affects 10% to 30% of Americans.[41] Evidence from population-based studies suggests that patients with AR have a higher rate of depression, anxiety, sleep disturbances, and psychosocial problems compared with individuals without allergic disease.[42-46] Cuffel et al[44] evaluated health care claims of more than 85,000 individuals and found that anxiety symptoms were 1.41 times higher (95% CI, 1.35-1.47) in individuals with AR than individuals without AR. Bedolla-Barajas et al[47] found that the frequency of anxiety and depression was 45.9% ($P$ <.001) and 38.7% ($P$ <.001), respectively, in patients with AR compared with controls. Several studies have reported that the inflammatory cells and mediators, such as interleukin 6, tumor necrosis factor, and interleukin 1β, contribute to the development of psychological dysfunction in patients with AR.[48]

During COVID-19, people with AR experienced decreased access to allergy and immunology services, such as allergen immunotherapy, owing to reduced clinical capacity.[5,49] Patients needing sublingual immunotherapy experienced less disruptions in their treatment because it can be done at home, and 1 study suggested that increased telehealth practices increased sublingual immunotherapy compliance.[49,50] Clinical access has continued to fluctuate throughout the pandemic by region depending on local public health guidelines and the personal practice of allergists.[5] Initially, it was proposed that nasal, respiratory, and ocular symptoms of AR could potentially be misinterpreted as COVID-19 potentially leading to anxiety.[7] Nevertheless, evidence has revealed that AR and COVID-19 symptoms can be easily differentiated, by familiarness with one's own previous AR symptom history, lack of fever and malaise, and response to typical antiallergic therapies.[51] Behavior changes have affected allergen exposure and changed symptom scores. A study found that both N95 use (12.6%; $P$ =.02) and surgical mask use (13.0%; $P$ =.03) significantly decreased AR symptom burden, hypothesizing that this was because of decreased allergen exposure.[52] A study conducted in Korea found a significant decrease ($P$ <.001) in the incidence in AR from 2019 (19.5%) to 2020 (16.3%); asthma incidence also decreased, whereas atopic dermatitis remained the same (6.4% vs 6.4%; $P$ >.05).[53] The changes in air pollution levels during strict lockdown measures may have improved seasonal AR symptoms. Increased time spent indoors increased exposure to perennial allergens, specifically to house dust mite (HDM). People with HDM allergies reported higher SNOT-22 scores and increased antihistamine use ($P$ =.01) and nasal decongestant use ($P$ =.02), compared with those in 2019.[54] In addition, in 2020, individuals with HDM allergics had significantly increased difficulty falling asleep ($P$ =.03), were waking up at night ($P$ =.01), felt frustrated, restless, or irritable ($P$ =.001), and sad ($P$ =.29) compared with 2019, further illustrating the psychological impacts from the pandemic.[54]

Wang et al[55] investigated the early impacts of COVID-19 on their AR outpatients (n = 222) by collecting the Self-rating Anxiety Scale (SAS) and Self-rating Depression Scale (SDS) scores. SAS and SDS were 24.8% and 19.4%, respectively, higher for patients with AR than the healthy controls (both $P$ <.001). Furthermore, 98 patients with AR and 56 healthy controls completed the questionnaire before the COVID-19 pandemic. The SAS and SDS scores of patients with AR were lower than before COVID-19 pandemic and were correlated with AR severity and education level (all, $P$ <.000), whereas the healthy controls had no change as a result of the pandemic; however, the small sample size is a limitation.[55] One case study detailed an

extreme example of a patient with AR who halted their topical nasal steroid after misinterpreting information on the internet, and the patient's obsessive preoccupation with the perception of being at higher risk for COVID-19 owing to her AR medication led to severe psychological distress warranting a delusional disorder—delusional infestation diagnosis.[56] At present, the research on the impacts of COVID-19 and AR is limited.

## Food Allergy

It is estimated that 2% to 10% of Americans have FA.[57] FA encompasses a range of disorders that result from adverse immune responses to dietary reactions which can be acute or potentially fatal reactions or chronic conditions that affect the gastrointestinal tract or skin. Symptoms of FA frequently have a rapid onset, shortly after digestion of the offending allergen.[7] Whether FA increases patient anxiety and depression has been questioned, and the studies that address this question are inconsistent in their design.[58-61] A longitudinal survey on adolescents (ages 10-16 years) with FA found an increase in symptoms of generalized anxiety disorder and depression; however, this was not associated with a higher likelihood of meeting diagnostic criteria.[61] Perceived risk of fatal reaction may be the primary contributor for feelings of anxiety.[62] Another study found that the "uncertainty" surrounding potential allergic reaction gave rise to distress.[63] Unlike asthma and AR, the symptoms of FA and COVID-19 are dissimilar; however, people with FA and anaphylaxis have encountered different situations that may have affected their mental well-being during COVID-19.

COVID-19 has limited the capacity in which allergists can see patients with FA resulting in delayed referrals, allergy testing, in-office oral food challenges, and oral immunotherapies, affecting in-office FA patient care.[5,64,65] Parents have reported concern with their children's care, specifically owing to modified appointments and delayed oral immunotherapy (OIT).[40,66] Cianferoni et al[68] reported that 8% of participants discontinue OIT owing to COVID-19 delays, and another group reported no changes in AEs from OIT during this period of time.[67] COVID-19 has placed a immense burden on the medical system, including the emergency services. In the unlikely event of an anaphylactic reaction occurring, the emergency department may be particularly challenging to access during the COVID-19 pandemic either owing to fear of SARS-CoV-2 infection or hospital capacity.[40] In some areas, the recommendations during the pandemic suggest a "wait and see" where patients experiencing anaphylaxis should treat with epinephrine immediately and if symptoms do not resolve promptly (within 15 minutes), EMS should be activated.[65] This "wait and see" approach after epinephrine self-administration in individuals with peanut allergy has been found to be more cost-effective than immediately activating EMS but is not integrated in current non–COVID-19 guidelines, and many may be hesitant to do so.[69] Some experts have expressed concerns on parental hesitancy in introducing allergens, particularly peanuts at home during the pandemic despite it being safe to do so. Allergists and physicians should reassure that the benefits of introducing peanuts early[70] greatly outweigh the perceived risks of introducing peanuts at home during the COVID-19 pandemic and beyond.[71] Observing the prevalence of FAs post–COVID-19 may be of interest, given children's decreased exposure to people, environments, and potential delays in introducing certain foods. Lastly, limited financing owing to job loss and supply chain issues can make it difficult for people with FAs or their caregivers to access safe food options.[40,72] Inaccessibility of safe food options increases the risk of anaphylaxis, further highlighting the importance of having an epinephrine autoinjector available.[64]

### *Impact of Coronavirus Disease 2019 on Children and Adolescents With Food Allergy and Their Caregivers*

A Canadian mixed-methods study reported higher anxiety levels measured by GAD-7 (33.8%, above cutoff) ($P$ <.05) in mothers of children with FA compared with mothers of children without FA (27.2%) early on in the pandemic (approximately 2 months). Mothers of children with FA reported lower QoL with the Food Allergy Quality of Life Questionnaire—Parent Form despite day-to-day FA management being better during the pandemic. In a follow-up semistructured interview between May 18 and 22, 2020, several themes emerged. These included unexpected challenges when grocery shopping (ie, feeling stressed or rushed or inability to find certain common ingredients to make allergen-safe foods), reporting less food-related anxiety during the pandemic because child was in direct care of one and both parents, and easing logistics. Younger families reported delays in FA testing and therapy.[40] Warren et al[72] surveyed 671 parents of children with FA from 3 USA databases (FARE's patient registry, FORWARD study, and Stanford clinical database). Compared with surveys conducted in 2019, FARE respondents reported slightly elevated levels of concern about accidental ingestion, anaphylaxis management self-efficacy, FA-related worry, stress, and anxiety, and fatal FA outcomes. These parents reported greater concern regarding the ability to obtain safe foods, cross contamination with prepared or delivered foods, activating EMS, and presenting to the ED. FARE parents were found to experience a higher burden than their child during COVID-19 in a parental self vs child proxy report. FORWARD and Stanford parents reported less concern compared with those in 2019, with the exception of activating EMS and going to the ED for FA treatment ($P$ values not provided).[72] Lastly, a survey of 54 adolescents with FA-caregiver dyads found that 7% of adolescents and 9% of caregivers were above the cutoff (>10) for GAD-7 and 13% were above the cutoff (>10) for PHQ-9. Adolescents with FA reported poorer resiliency (Connor-Davidson Resilience Scale; 76%) than their caregivers (44%), whereas caregivers reported higher mean stress owing to COVID-19 (COVID-19 Exposure and Family Impact Surveys; 5.69 ± 2.20) than adolescents (COVID-19 Exposure and Family Impact Surveys—adolescent/young adult; 3.98 ± 2.25).[73] It is evident that adolescents with FA and their caregivers endured substantial impacts during COVID-19,[73] and improving resiliency and mental health is an important consideration for FA management across all age groups (Fig 3; Table 2).

Overall, research on the psychological impacts of FA before and during COVID-19 primarily focuses on children, adolescents, and parents, representing a gap in our understanding of the psychological effects of both young adults and adults with FA.

### *Vaccines and Allergic History*

In early December, the Pfizer-BioNTech COVID-19 vaccine was temporarily halted in some European countries for people with severe allergies after 2 health care workers had anaphylactic reactions, but after further observation, the Medicines and Healthcare Products Regulatory Agency revised their statement allowing people with severe allergies to receive the vaccine.[74] The reporting of allergy as synonymous with anaphylaxis is of concern, as approximately 25% of the population in developed countries have some form of allergic disease. Statements such as these may create unnecessary fear and vaccine hesitancy where in reality the benefits of the COVID-19 vaccine outweigh the risks, which can be managed in the appropriate setting.[10] In general, anaphylactic reactions to vaccinations, including the COVID-19 vaccines, are very rare, occurring at a rate of approximately 2 to 5 people per million.[75] Polyethylene glycol (PEG), which is used in many medications and cosmetics, was identified as the ingredient of concern in both market messenger RNA vaccines (Pfizer-BioNTech, Moderna). A Canadian study using electronic

**Table 2**
Psychological Impacts of COVID-19 on People With FA and Their Caregivers

| Author and year | Participants | Region, time frame | Validated surveys | Outcomes |
|---|---|---|---|---|
| Protudjer et al,[40] 2021 | 580 (5.5% mothers of children with FA) | Canada, April 14-28, 2020 (survey), May 18-22, 2020 (telephone interview) | HRQL, GAD-7, Food Allergy Quality of Life Questionnaire—Parent Form (FAQLQ-PF) | Mothers of children with FA aged 1.5 to 8 y reported higher anxiety levels (33.8% above cutoff) ($P$ <.05) with the GAD-7 score when compared with mothers of children without FA (27.2%). Mothers of children with FA also reported lower QoL yet day-to-day FA management improved. Several themes emerged including unexpected challenges when grocery shopping (ie, feeling stressed or rushed or inability to find certain common ingredients to make allergen-safe foods), reporting less food-related anxiety during the pandemic because child was in direct care of one and both parents, easing logistics, and younger families reported delay in FA testing and therapy. |
| Warren et al,[73] 2020 | 671 Parents of children with FA across 3 databases (FARE, FORWARD, and Stanford) | United States | COVID-19 Exposure and Family Impact Surveys | CEFIS was similar among the participants from the 3 databases. It is important to note that there were more white respondents and respondents of higher SES in the FARE and Standford databases compared to the FORWARD respondents suggesting impact on parents of children with FA was heterogeneous. Compared with surveys conducted in 2019, FARE respondents reported slightly elevated levels of concern on accidental ingestion, anaphylaxis management self-efficacy, FA-related worry/stress/anxiety, and fatal FA outcomes. These parents reported greater concern regarding the ability to obtain safe foods, cross contamination with prepared or delivered foods, activating EMS, and presenting to the ED. FARE parents were found to experience a higher burden than their child during COVID-19 in a parental self vs child proxy report. FORWARD and Stanford parents reported less concern compared with 2019, with the exception of activating EMS and going to the ED for FA treatment. |
| Rogers et al,[74] 2021 | 54 adolescent -caregivers | United States | Generalized Anxiety Disorder—7 (GAD-7); 2) Patient Health Questionnaire—9 (PHQ-9); 3) Connor-Davidson Resilience Scale (CD-RISC), and 4) COVID-19 Exposure and Family Impact Scale (CEFIS, CEFIS-AYA). | 7% of adolescents and 9% of care givers were above the cutoff (>10) for GAD-7, 13% of both adolescents and care givers were above the cutoff (>10) for PHQ-9, adolescents with FA reported poorer resiliency (CD-RISC; 76%) than their caregivers (44%) whereas, caregivers reported higher mean stress owing to COVID-19 (CEFIS; 5.69 ± 2.20) than adolescents (CEFIS-adolescent/young adult; 3.98 ± 2.25). |

Abbreviations: CD-RISC, Connor-Davidson Resilience Scale; CEFIS, COVID-19 Exposure and Family Impact Survey; CEFIS-AYA, CEFIS—adolescent/young adult; COVID-19, coronavirus disease 2019; ED, emergency department; EMS, emergency medical services; FAQLQ-PF, Food Allergy Quality of Life Questionnaire—Parent Form; GAD-7, Generalized Anxiety Disorder—7; HARAQLQ, Health-Related Quality of Life; PHQ-9, Patient Health Questionnaire 9; SES, social economic status.

medical record data from the Canadian Primary Care Sentinel Surveillance record found that vaccine allergy in Canada was 0.037% and PEG allergy was 0.0009%, as reported by primary care providers. Patients with both vaccine allergy and PEG allergy were significantly more likely to have other atopic comorbidities, including asthma ($P$ <.001 for both), eczema ($P$ <.001 and $P$ =.001, respectively), AR ($P$ =.002 and $P$ <.001, respectively), and FA ($P$ <.001 for both). Significantly higher rates of depression ($P$ <.001 and $P$ <.001, respectively) and anxiety ($P$ =.003 and $P$ <.001, respectively) were found in those with vaccine allergy or PEG allergy than those without vaccine allergy or PEG allergy.[76] In most cases, the first reaction to the COVID-19 vaccine may not be considered severe enough to recommend not getting the second dose which reveals that first-dose reactors can be triaged appropriately and be given the second vaccination dose.[77]

## Conclusion

In conclusion, patients with asthma perceived their risk of severe disease from COVID-19 as greater which negatively affected their psychological well-being, early in the pandemic. Limited data have been published on the impacts of COVID-19 in patients with AR and FA; however, some patients with AR experienced high anxiety and depression compared with healthy controls. Parents and caregivers of children with asthma and FA were also affected with a higher psychological burden during COVID-19. COVID-19 vaccines are safe and effective for people with and without allergic diseases, and the risk of anaphylaxis is extremely small. As COVID-19 research continues to evolve and the literature captures later stages of the pandemic, it is important that physicians be aware of the potential coincidence of mental illness and chronic allergic diseases and refer these patients, and their caregivers, to appropriate resources while also continuing to manage their allergic disease(s).

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