BACKGROUND: The coronavirus disease 2019 (COVID-19) pandemic has profoundly affected the lives of the global population. Little is known on how the pandemic has affected anxiety and stress in young adults, and the influence of asthma and allergic rhinitis.

OBJECTIVE: To explore anxiety and stress in relation to COVID-19 among young adults, and the potential influence of asthma and allergic rhinitis.

METHODS: This cross-sectional study included 1644 participants from the population-based birth cohort BAMSE (Swedish abbreviation for Children, Allergy, Milieu, Stockholm, Epidemiology), participating in a follow-up at age 24 years and a COVID-19 follow-up conducted in August-November 2020 (mean age, 25.3 years). Anxiety and concern related to COVID-19 were analyzed as general anxiety, concern of own health and health of family members, and contact with online health care providers due to concern about COVID-19. Stress was measured with the perceived stress scale.

RESULTS: Around half the participants reported increased anxiety due to COVID-19, and this was more common among females (57.0%, compared with 42.6% in males; \(P < .001\)). Young adults with asthma reported more concern about their own health (adjusted odds ratio, 1.50; 95% CI, 1.12-2.02) and anxiety due to COVID-19, and this was more common among females and those with uncontrolled asthma. Symptoms of allergic rhinitis were not associated with increased concern or anxiety in relation to COVID-19.

What is already known about this topic? The coronavirus disease 2019 pandemic has profoundly affected the lives of the global population. Little is known on how the pandemic has affected anxiety and stress in young adults, and the influence of asthma and allergic rhinitis.

What does this article add to our knowledge? Young adults with asthma expressed more coronavirus disease 2019–related concern about their own health, reported more contact with online health care, and more perceived stress than did participants without asthma, especially females and young adults with uncontrolled asthma.

How does this study impact current management guidelines? Health caregivers should be aware of the increased levels of stress and health concerns related to the pandemic and offer appropriate support to young individuals with asthma.
CONCLUSIONS: Young adults with asthma experience more COVID-19—related health concerns, compared with those without asthma, especially females and participants with uncontrolled asthma. This needs to be considered in the care of young people with asthma. © 2021 The Authors. Published by Elsevier Inc. on behalf of the American Academy of Allergy, Asthma & Immunology. This is an open access article under the CC BY license (http://creativecommons.org/licenses/by/4.0/). (J Allergy Clin Immunol Pract 2022;10:108-15)

Key words: COVID-19; Anxiety; Asthma; Health concerns; Perceived stress; Rhinitis

INTRODUCTION

Early adulthood is for most individuals an active period of life, when intensive social interaction with friends, starting a new family, the beginning of a working career, and many founding events for the rest of life may take place. The coronavirus disease 2019 (COVID-19), caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), has profoundly affected the lives of a large part of the global population since it was declared a pandemic by the World Health Organization in March 2020. The measures taken to reduce the spread such as quarantines, travel bans, and restrictions on public gatherings have caused a major impact socially and economically on people in addition to the threat of the disease in itself. In Sweden, in contrast to many other countries, no lockdown has been imposed, although several restrictions (such as closed universities and schools for adolescents, prohibition of larger gatherings, and recommendations against visiting people older than 70 years) have been implemented. Still, among young people, often having a large part of their social lives outside the family, these restrictions may have had a major impact on psychological well-being.

Asthma, the most common respiratory condition among young adults, was early suspected to be a risk factor for severe COVID-19, especially when uncontrolled or undertreated. This was based on the experience that asthma exacerbations and loss of asthma control are commonly triggered by respiratory viral infections and tends to be worse in uncontrolled asthma. Also, allergic rhinitis was early linked to COVID-19 infection and a worse outcome of the disease. However, in most studies performed later, asthma or allergic rhinitis has not been linked to an increased risk of becoming diagnosed with COVID-19 or developing a more severe COVID-19.

There have been several studies observing an increase in anxiety and worse mental health since the onset of the pandemic, and female sex has been found to be a risk factor for COVID-19—related anxiety. One Swedish study of mental health symptoms in adults during the beginning of the pandemic found physical risk factors, including respiratory conditions, to have a significant correlation to anxiety and insomnia. In contrast, a study conducted among university students, also in Sweden, found no increase in levels of stress, anxiety, or depression compared with before the onset of the pandemic. However, specific data on increased anxiety and perceived stress in young adults with asthma and allergic disease related to the COVID-19 pandemic are missing. It is important to investigate COVID-19—related anxiety in individuals with asthma, because anxiety has previously been shown to be related to asthma both in childhood and later and clinical worsening among middle-aged individuals with severe asthma. Uncontrolled asthma has in turn been found to associate with worse quality of life. Allergic rhinitis and atopic diseases have also been reported to associate with increased anxiety; however, so far no association between allergic rhinitis and increased levels of anxiety has been established in relation to COVID-19.

The aim of the present study was to describe the prevalence of COVID-19—related anxiety and stress among young adults from a population-based Swedish birth cohort approximately 6 months into the COVID-19 pandemic, and to explore the potential influence of asthma and symptoms of allergic rhinitis.

METHODS

Study population and study design

The study population includes participants from the population-based prospective birth cohort BAMSE (Swedish abbreviation for Children, Allergy, Milieu, Stockholm, Epidemiology), previously described in detail. The BAMSE cohort originally includes 4089 participants, born between 1994 and 1996 and recruited at age 2 to 3 months in the northwestern and central parts of Stockholm, Sweden. The participants have been subsequently followed with repeated questionnaires and clinical examinations, with the primary aim to study risk factors and consequences of allergic diseases. The response rate has remained high throughout the years, with 75% (n = 3064 for the questionnaire, n = 2270 for the clinical investigation) of the original cohort participating in the latest follow-up in 2016-2019 at age 22 to 24 years (referred to as the 24-year follow-up).

In August 2020, a new follow-up of the BAMSE cohort was initiated, focusing on long-term effects of COVID-19 (referred to as the COVID-19 follow-up). All 2270 participants who completed the clinical investigation at the 24-year follow-up study were invited to the study. Starting August 11, 2020, an invitation letter was sent by e-mail with information about the study and a link to a web questionnaire. The questionnaire was open to answer for 3 months (until November 10, 2020) and covered questions related to the COVID-19 pandemic, including mental health, stress, lifestyle factors, and symptoms related to asthma and allergic disease. Of the 2270 invited participants, 1644 (72% of invited) answered the questionnaire and were included in the current study population.

The study was approved by the Swedish Ethical Review Authority (approval no. 2020-02922). Participants provided written informed consent when answering the questionnaire.

Definition of asthma and symptoms of rhinitis

Asthma was defined as having a doctor’s diagnosis of asthma (ever) in combination with symptoms of wheeze in the last 12 months and/or any asthma medication use in the last 12 months. Uncontrolled asthma was defined on the basis of a modified version of the Global Initiative for Asthma definition as at least 1 of the following: 12 or more episodes of breathing difficulties in the last 12 months, activity limitation due to respiratory symptoms in the last 4 weeks, night-time awakening due to respiratory symptoms in the...
| Characteristic                                           | All (n = 1644) | No increased anxiety (n = 800) | Increased anxiety (n = 844) | \( P \) value |
|---------------------------------------------------------|---------------|--------------------------------|-----------------------------|---------------|
| Age (y), mean ± SD                                      | 25.3 ±0.79    | 25.2 ±0.78                     | 25.3 ±0.79                  | .13           |
| Male sex                                                | 648 (39.4)    | 372 (46.5)                     | 276 (32.7)                  | .58           |
| Month of answering the questionnaire                    |               |                                |                             |               |
| August 2020                                             | 1374 (83.6)   | 668 (83.5)                     | 706 (83.7)                  | <.001         |
| September 2020                                          | 163 (9.9)     | 85 (10.6)                      | 78 (9.2)                    |               |
| October 2020                                            | 95 (5.8)      | 41 (5.1)                       | 54 (6.4)                    |               |
| November 2020                                           | 12 (0.7)      | 6 (0.8)                        | 6 (0.7)                     |               |
| Occupation                                              |               |                                |                             | .002          |
| - Working                                               | 845 (51.5)    | 446 (55.9)                     | 399 (47.3)                  |               |
| - Studying                                              | 620 (37.8)    | 279 (35.0)                     | 341 (40.5)                  |               |
| - Other                                                 | 176 (10.7)    | 73 (9.2)                       | 103 (12.2)                  |               |
| Current smoking                                         |               |                                |                             | .10           |
| No/ex-smoker                                            | 1399 (85.3)   | 686 (86.0)                     | 713 (84.6)                  |               |
| Occasional smoking                                     | 181 (11.0)    | 77 (9.7)                       | 104 (12.3)                  |               |
| Daily smoking                                           | 61 (3.7)      | 35 (4.4)                       | 26 (3.1)                    |               |
| Reduced social contacts during the COVID-19 pandemic||| | | <.001 |
| No                                                      | 221 (13.4)    | 169 (21.1)                     | 52 (6.2)                    |               |
| Yes                                                     | 1423 (86.6)   | 631 (78.9)                     | 792 (93.8)                  |               |
| BMI status at 24 y                                      |               |                                |                             | .83           |
| Underweight                                             | 88 (5.4)      | 47 (5.9)                       | 41 (4.9)                    |               |
| Normal weight                                            | 1206 (73.4)   | 585 (73.1)                     | 621 (73.6)                  |               |
| Overweight                                              | 279 (17.0)    | 134 (16.8)                     | 145 (17.2)                  |               |
| Obese                                                   | 71 (4.3)      | 34 (4.3)                       | 37 (4.4)                    |               |

*Increased anxiety due to COVID-19 was defined as answering “Yes” to the question “Have you felt increased anxiety due to COVID-19?”
†Numbers may not add up to total due to internal missing.
\( P \) value obtained by t test.
\( P \) value obtained by \( \chi^2 \) test.
From February 2020 to the date of answering the questionnaire.
last 4 weeks, and regular use of short-acting beta agonists in the last 4 weeks.

Symptoms of allergic rhinitis were defined as having symptoms, from the eyes or nose after exposure to pollen or furred animals without simultaneous common cold or flu in the last 12 months.

Assessment of anxiety and stress

Anxiety and concern related to COVID-19 were analyzed as general anxiety, concern about the health of own family or close relatives, concern for own health, and contact with online health care providers due to concern about COVID-19. The following questions were used to define these outcomes:

Have you felt increased anxiety due to COVID-19?
Have you felt increased concern about the health of your family/close relatives due to COVID-19?
Have you felt increased concern about your own health due to COVID-19?
Have you been in contact with online health care providers due to concerns about COVID-19?

Stress was defined on the basis of perceived stress scale (PSS-10) consisting of 10 questions on how the participants have perceived stress in the last 4 weeks. Each question has 5 answer categories from “never” to “very often,” which are given 0 to 4 points depending on the answers (scores are reversed for 4 questions with positive statements), in total 0 to 40 points. Complete data on the questions included in the PSS-10 were provided by 1626 of the 1644 participants.

Assessment of covariates

Information on current occupation, current smoking, and reduction in social activities during the COVID-19 pandemic was collected in the COVID-19 follow-up questionnaire, whereas body mass index was calculated on the basis of measured weight and height at the 24-year examination. Occupation was categorized as student, worker, and other (including “parental leave or unpaid leave,” “unemployed,” “furloughed due to the current pandemic,” or “other”). Current smoking was defined as daily or occasional smoking. Body mass index status was categorized into underweight (<18.5 kg/m²), normal weight (18.5-24.9 kg/m²), overweight (25-29.9 kg/m²), or obesity (≥30 kg/m²) using normal weight as the reference group.

Statistical analyses

Descriptive data are presented as number (n) and percent (%) for categorical variables (background factors, covariates, asthma, asthma control, allergic rhinitis, and anxiety/concern) and as mean and SD for the PSS score. Differences in background factors between the groups reporting no increased versus increased anxiety due to the COVID-19 pandemic were assessed with χ² tests. Differences between sex with regard to anxiety, concern, and perceived stress were tested using the χ² test for categorical variables and the t test for the PSS score.

Logistic regression analyses were performed to investigate the associations between the exposures (asthma, asthma control, symptoms of allergic rhinitis) and anxiety/concern in relation to COVID-19, in crude models and in models adjusted for sex, current occupation, current smoking, and body mass index status at the 24-year follow-up. For differences in mean PSS scores, linear regression analyses were performed with the same covariates.

All analyzes were performed using the statistical software Stata (Stata Corp, College Station, Texas), version 16.0. P values less than .05 were considered statistically significant.

RESULTS

Description of the study population

The study population (n = 1644) consisted of 996 females (60.6%) and 648 males (39.4%). Most of the participants (83.6%) answered the COVID-19 questionnaire in August 2020, at a mean age of 25.3 ± 0.79 years. Around half the participants (51.3%) reported increased anxiety due to COVID-19. Table I presents a description of the study population in relation to reported anxiety due to COVID-19. Among participants who reported increased anxiety, a lower proportion was working (47.3% compared with 55.9% among those with no increased anxiety; P = .002). The prevalence of smoking was 3.7% for daily smoking and 11.0% for occasional smoking, with no significant difference in relation to anxiety. At 24 years, overweight and obesity were present in 17.0% and 4.3% of the participants, respectively, also with no difference in relation to anxiety. Most participants reported that they had reduced their social contacts during the pandemic, and this was more common among participants with increased anxiety (93.8% compared with 78.9% among those with no increased anxiety; P < .001).

Descriptive results on exposures and outcomes

A large proportion of the participants (83.9%) reported increased concern about the health of family members and/or close relatives due to COVID-19, whereas 30.5% reported increased concern about their own health due to COVID-19 (Table II). These aspects of anxiety/concern were more common among females, compared with males (all P < .05, Table II). Around 1 in 10 (10.6%) reported that they had been in contact with an online health care provider due to worry against COVID-19, with no significant difference with regard to sex.

PSS-10 scores ranged from 0 to 36 points, with a mean of 14.9 ± 7.2 points and a median of 14 points. Females had higher

| Outcome | All (n = 1644) | Females (n = 996) | Males (n = 648) | P value* |
|---------|---------------|------------------|----------------|---------|
| Increased anxiety due to COVID-19 | 844/1644 51.3% | 568/996 57.0% | 276/648 42.6% | <.001 |
| Increased concern for family or close relative’s health due to COVID-19 | 1379/1643 83.9% | 871/995 87.5% | 508/648 78.4% | <.001 |
| Increased concern about own health due to COVID-19 | 500/1642 30.5% | 349/995 35.1% | 151/647 23.3% | <.001 |
| Contact with online health care due to concerns for COVID-19 | 175/1644 10.6% | 114/996 11.5% | 61/648 9.4% | .19 |

PSS-10 score

| N | Mean ± SD | N | Mean ± SD | N | Mean ± SD | P value† |
|---|-----------|---|-----------|---|-----------|---------|
| 1626 | 14.9 ± 7.2 | 985 | 16.1 ± 7.1 | 641 | 13.1 ± 7.0 | <.001 |

*P value obtained by χ² test.
†P value obtained by t test.
TABLE III. Anxiety and concern due to COVID-19, and PSS-10 score, in relation to asthma and symptoms of allergic rhinitis (n = 1644)

| Subgroup | n/N | % | OR crude | 95% CI | OR adjusted | 95% CI |
|----------|-----|---|----------|-------|-------------|-------|
| No asthma | 716/1413 | 50.7 | 1.00 (reference) | 1.00 (reference) |
| Asthma | 128/231 | 55.4 | 1.21 | 0.91 to 1.60 | 1.16 | 0.87 to 1.55 |
| No symptoms of allergic rhinitis | 476/926 | 51.4 | 1.00 (reference) | 1.00 (reference) |
| Symptoms of allergic rhinitis | 367/716 | 51.3 | 0.99 | 0.82 to 1.21 | 0.98 | 0.80 to 1.20 |

Increased anxiety due to COVID-19

| Subgroup | n/N | % | OR crude | 95% CI | OR adjusted | 95% CI |
|----------|-----|---|----------|-------|-------------|-------|
| No asthma | 1182/1413 | 83.7 | 1.00 (reference) | 1.00 (reference) |
| Asthma | 197/231 | 85.7 | 1.17 | 0.79 to 1.73 | 1.16 | 0.77 to 1.73 |
| No symptoms of allergic rhinitis | 775/926 | 83.7 | 1.00 (reference) | 1.00 (reference) |
| Symptoms of allergic rhinitis | 603/716 | 84.3 | 1.05 | 0.80 to 1.37 | 1.05 | 0.80 to 1.38 |

Increased concern for family or close relative’s health due to COVID-19

| Subgroup | n/N | % | OR crude | 95% CI | OR adjusted | 95% CI |
|----------|-----|---|----------|-------|-------------|-------|
| No asthma | 409/1411 | 29.0 | 1.00 (reference) | — | 1.00 (reference) | — |
| Asthma | 91/231 | 39.4 | 1.59 | 1.19 to 2.12 | 1.50 | 1.12 to 2.02 |
| No symptoms of allergic rhinitis | 279/926 | 30.1 | 1.00 (reference) | — | 1.00 (reference) | — |
| Symptoms of allergic rhinitis | 221/714 | 31.0 | 1.04 | 0.84 to 1.28 | 1.01 | 0.81 to 1.25 |

Increased concern about own health due to COVID-19

| Subgroup | n/N | % | OR crude | 95% CI | OR adjusted | 95% CI |
|----------|-----|---|----------|-------|-------------|-------|
| No asthma | 141/1413 | 10.0 | 1.00 (reference) | — | 1.00 (reference) | — |
| Asthma | 34/231 | 14.7 | 1.56 | 1.04 to 2.33 | 1.52 | 1.01 to 2.28 |
| No symptoms of allergic rhinitis | 91/231 | 9.8 | 1.00 (reference) | — | 1.00 (reference) | — |
| Symptoms of allergic rhinitis | 84/716 | 11.7 | 1.22 | 0.89 to 1.67 | 1.18 | 0.86 to 1.62 |

Contact with online health care due to concerns for COVID-19

| Subgroup | n | Mean ± SD | β crude | 95% CI | β adjusted | 95% CI |
|----------|----|-----------|---------|-------|------------|-------|
| No asthma | 1396 | 14.6 ± 7.2 | 0.00 (reference) | — | 0.00 (reference) | — |
| Asthma | 230 | 16.4 ± 7.1 | 1.79 | 0.79 to 2.79 | 1.49 | 0.52 to 2.45 |
| No symptoms of allergic rhinitis | 914 | 14.6 ± 7.1 | 0.00 (reference) | — | 0.00 (reference) | — |
| Symptoms of allergic rhinitis | 710 | 15.3 ± 7.2 | 0.73 | 0.02 to 1.43 | 0.65 | −0.02 to 1.33 |

PSS-10 score

Bold values represent statistically significant associations.

*Adjusted for sex, current occupation, current smoking, and BMI status at 24 y.

mean PSS-10 scores compared with males (14.9 points vs 13.1 points; P < .001; Table I).

The prevalence of asthma according to definition was 14.1% (15.3% in females and 12.2% in males; P = .08), and the prevalence of symptoms of allergic rhinitis was 43.6% (44.8% in females and 41.7% in males; P = .22). Among the participants with asthma at the COVID-19 follow-up (n = 231), 29.4% had uncontrolled asthma, 31.6% in females and 25.3% in males (P = .32).

Perceived stress and anxiety/concern due to COVID-19 in relation to asthma and allergic rhinitis

Compared with participants without asthma, participants with asthma reported more concern about own health due to COVID-19 (39.4% vs 29.0%; P = .001) and more contact with online health care due to concerns for COVID-19 (14.7% vs 10.0%; P = .03), whereas there was no difference in increased anxiety (in general) or in increased concern about the health of family or close relatives (Table III). These associations were confirmed in the adjusted regression models (adjusted odds ratio [OR] for increased concern about own health: 1.50, 95% CI, 1.12-2.02, and adjusted OR for contact with online health care: 1.52, 95% CI, 1.01-2.28). Asthma was also associated with a higher PSS-10 score (16.4 compared with 14.6; adjusted β, 1.49; 95% CI, 0.52-2.45). Symptoms of allergic rhinitis were not associated with increased anxiety/concern, but a slightly higher PSS-10 score (15.3 compared with 14.6; P = .04), significant in the unadjusted model only (Table III).

Because females reported more anxiety and concern than males, Figure 1 shows the prevalence of increased anxiety/concern in relation to COVID-19 by sex and asthma status. This result showed that the increased concern about own health among participants with asthma was statistically significant among females (44.7% among females with asthma compared with 33.3% among females without asthma; P = .007), but not among males (29.1% among males with asthma compared with 22.5% among males without asthma; P = .20). In addition, the association between asthma and contact with online health care was present only among females, whereas no association was observed among males (Figure 1).

Perceived stress and anxiety/concern due to COVID-19 in relation to asthma control

Among the 231 participants with asthma, uncontrolled asthma was associated with increased concern about own health.
(OR, 1.86; 95% CI, 1.05-3.30) and higher PSS-10 score (β, 2.35; 95% CI, 0.36-4.35) in the unadjusted models (Table IV). These associations were somewhat attenuated and no longer significant in the adjusted models (adjusted OR, 1.76, 95% CI, 0.98-3.18, and adjusted β, 1.83, 95% CI, −0.11 to 3.77, respectively). Uncontrolled asthma was associated with lower concern for family or close relative's health due to COVID-19 in both models (adjusted OR, 0.31; 95% CI, 0.14-0.71). There were no significant associations between asthma control and increased anxiety due to COVID-19 (in general) or with contact with online health care due to concerns for COVID-19.

DISCUSSION

In the present study, based on data from a population-based cohort, the main aim was to investigate COVID-19–related anxiety and stress in young adults and the potential influence of asthma and symptoms of allergic rhinitis. Around half the participating young adults reported increased anxiety, and this was more common among females, compared with males. Participants with asthma expressed more COVID-19–related concern about their own health, reported more contact with online health care, and perceived more stress than did participants without asthma; this was more pronounced among females with asthma and in participants with uncontrolled asthma. Participants with symptoms of allergic rhinitis did not report more anxiety or concerns related to COVID-19 compared with participants without symptoms of allergic rhinitis, although they had a somewhat higher level of perceived stress assessed with the PSS-10 questionnaire.

Individuals with respiratory diseases have been identified as a risk group for COVID-19, even if data regarding asthma have pointed toward a low or absent risk increase both to become infected and to become severely ill in COVID-19.7,8,10,28,29 Still, our data suggest asthma to be associated with more health-related concerns due to COVID-19 also among young, in general healthy, individuals. This confirms that previous findings on an association between anxiety and asthma in children18 are highly relevant also for concerns due to COVID-19.

The COVID-19 pandemic has been shown to increase anxiety in the general population in Sweden and elsewhere.15,30-32 Also, younger age, not targeted as a risk factor, has been reported to correlate with poorer mental health related to the COVID-19 pandemic.15 Female sex has been identified as a risk for more COVID-19–related anxiety symptoms,13 despite male sex being associated with a higher risk for COVID-19–related death.28 In the present study, females were also more anxious in relation to COVID-19 in general and about both their own and close relatives' health compared with males, and even more so among females with asthma. In contrast, obesity, an established risk factor for severe COVID-19,33 was not found to be more common in the group with increased anxiety. The group with increased anxiety had however, to a higher extent, reduced its social contacts, compared with those who reported no increased anxiety. In line with previous studies,22 we did however not find...
increased anxiety due to COVID-19 in participants with symptoms of allergic rhinitis.

In the beginning of the pandemic, asthma was hypothesized to be an important risk factor for severe disease and death, which may have impacted on health-related anxiety in individuals with asthma. However, it may be possible that anxiety has lessened in subsequent months of the pandemic because more recent studies indicated that asthma does not increase the risk of severe COVID-19. Another factor possibly increasing the anxiety among patients with asthma is the lower access to regular health care during the pandemic. A qualitative British study investigating fears and anxiety related to COVID-19 among individuals with chronic respiratory conditions (including asthma) among adults revealed fears not only for being at a higher risk but also for not being prioritized by the health care due to the preexisting condition. In line with these results, we found that participants with uncontrolled asthma experienced more concern about their own health in relation to COVID-19. However, they expressed less concerns about their family or close relatives' health in relation to COVID-19 than did participants with controlled asthma. This finding was somewhat unexpected, and possibly reflects that uncontrolled asthma is a highly stressful condition, leaving less room for focus on other concerns.

The strengths of the present study include the well-characterized study population of young adults from a population-based cohort with information collected recently before and around 6 months after the onset of the COVID-19 pandemic. The population-based design contributes with information on asthma of different severity, in contrast to data from a clinic. The included population is relatively large and has a high response rate.

There are however limitations with our study. Because of the population-based design, the group with asthma contains a limited number of individuals, especially when divided into controlled and uncontrolled asthma. Furthermore, the data on health care contacts due to the pandemic are self-reported, however with a low risk of recall bias with questions covering a relatively short period of time (6 months). We had no information on anxiety-related disorders from before the onset of the pandemic and were not able to adjust for prepandemic levels of stress and anxiety potentially higher in individuals with asthma or allergic disease. However, our study did specifically measure anxiety and concerns related to COVID-19, not general anxiety or health concerns. The higher level of perceived stress found in both participants with asthma and allergic rhinitis was in contrast not asked in relation to COVID-19 and could possibly reflect the generally higher stress level associated with these conditions.

### TABLE IV. Anxiety and concern due to COVID-19, and PSS-10 score, in relation to asthma control among participants with asthma (n = 231)

| Asthma control status | n/N | %  | OR crude | 95% CI  | OR adjusted* | 95% CI  |
|-----------------------|-----|----|----------|---------|--------------|---------|
| Controlled asthma     | 91/163 | 55.8 | 1.00 (reference) | —       | 1.00 (reference) | —       |
| Uncontrolled asthma   | 37/68  | 54.4 | 0.94  | 0.53 to 1.67 | 0.90  | 0.50 to 1.60 |

| Asthma control status | n/N | %  | OR crude | 95% CI  | OR adjusted* | 95% CI  |
|-----------------------|-----|----|----------|---------|--------------|---------|
| Controlled asthma     | 145/162 | 89.5 | 1.00 (reference) | —       | 1.00 (reference) | —       |
| Uncontrolled asthma   | 52/68  | 76.5 | 0.38  | 0.18 to 0.81 | 0.31  | 0.14 to 0.71 |

| Asthma control status | n/N | %  | OR crude | 95% CI  | OR adjusted* | 95% CI  |
|-----------------------|-----|----|----------|---------|--------------|---------|
| Controlled asthma     | 57/163 | 35.0 | 1.00 (reference) | —       | 1.00 (reference) | —       |
| Uncontrolled asthma   | 34/68  | 50.0 | 1.86  | 1.05 to 3.30 | 1.76  | 0.98 to 3.18 |

| Asthma control status | n/N | %  | OR crude | 95% CI  | OR adjusted* | 95% CI  |
|-----------------------|-----|----|----------|---------|--------------|---------|
| Controlled asthma     | 23/163 | 14.1 | 1.00 (reference) | —       | 1.00 (reference) | —       |
| Uncontrolled asthma   | 11/68  | 16.2 | 1.17  | 0.54 to 2.57 | 1.04  | 0.46 to 2.35 |

| PSS-10 score          | N   | Mean ± SD | β crude | 95% CI  | β adjusted* | 95% CI  |
|-----------------------|-----|-----------|---------|---------|-------------|---------|
| Controlled asthma     | 162 | 15.7 ± 7.3 | 0.00 (reference) | —       | 0.00 (reference) | —       |
| Uncontrolled asthma   | 68  | 18.1 ± 6.2 | 2.35  | 0.36 to 4.35 | 1.83  | −0.11 to 3.77 |

Bold values represent statistically significant associations.

CONCLUSIONS

Our results found young people at risk for increased anxiety and perceived stress associated with COVID-19. Looking specifically at the group with asthma, COVID-19—related concerns about their own health were further increased and especially if asthma was uncontrolled. This emphasizes the need of awareness in caregivers regarding the risk of increased anxiety in vulnerable individuals not necessarily at higher risk.

Acknowledgments

We thank the children and parents participating in the BAMSE cohort and all staff involved in the study through the years.

REFERENCES

1. World Health Organization. Timeline: WHO’s timeline response 2020. Accessed February 24, 2021. https://www.who.int/emergencies/diseases/novel-coronavirus-2019/interactive-timeline#
2. Nicola M, Alsafi Z, Sornari C, Kerwan A, Al-Jabri A, Iosifidis C, et al. The socio-economic implications of the coronavirus pandemic (COVID-19): a review. Int J Surg (London, England) 2020;78:185-93.

3. Public Health Agency of Sweden. Recommendations to reduce the spread of COVID-19. Accessed March 18, 2021. https://www.folkhalsomyndigheten.se/the-public-health-agency-of-sweden/communicable-disease-control/covid-19/recommendations-to-reduce-the-spread-of-covid-19/

4. Global Initiative for Asthma. Global Initiative for Asthma Report 2020 Appendix 2020. Accessed February 24, 2021. https://ginaasthma.org/wp-content/uploads/2020/04/GINA-2020-appendix_final-wms.pdf

5. Johnston SL. Asthma and COVID-19: is asthma a risk factor for severe outcomes? Allergy 2020;75:1543-5.

6. Jackson DJ, Trujillo-Torralbo MB, del-Rosario J, Bartlett NW, Edwards MR, Mallia P, et al. The influence of asthma control on the severity of virus-induced asthma exacerbations. J Allergy Clin Immunol 2015;136:497-500.e3.

7. Yang JM, Koh HY, Moon SY, Yoo IK, Ha EK, You S, et al. Allergic disorders and susceptibility to and severity of COVID-19: a nationwide cohort study. J Allergy Clin Immunol 2020;146:790-8.

8. Halpin DMG, Faner R, Sibila O, Badia JR, Agusti A. Do chronic respiratory diseases or their treatment affect the risk of SARS-CoV-2 infection? Lancet Respir Med 2020;8:436-8.

9. Chihba KD, Patel GB, Vu THT, Chen MM, Guo A, Kudlaty E, et al. Prevalence and characterization of asthma in hospitalized and nonhospitalized patients with COVID-19. J Allergy Clin Immunol 2020;146:307-314.e4.

10. Skrevak C, Karasonova A, Karaulov A, Xie M, Renz H. Asthma-associated risk for COVID-19 development. J Allergy Clin Immunol 2020;146:1295-301.

11. Terry PD, Heidel RE, Dhand R. Asthma in adult patients with COVID-19. Prevalence and risk of severe disease. Am J Respir Crit Care Med 2021;203:893-905.

12. Timberlake DT, Narayanan D, Ogbogu PU, Raveendran R, Porter K, Scherzer R, et al. Severity of COVID-19 in hospitalized patients with and without atopic disease. World Allergy Organ J 2021;14:100508.

13. Xiong J, Lipsitz O, Nasri F, Liu LMW, Gill H, Phan L, et al. Impact of COVID-19 pandemic on mental health in the general population: a systematic review. J Affect Disord 2020;277:55-64.

14. Vindegaard N, Benno ME. COVID-19 pandemic and mental health consequences: systematic review of the current evidence. Brain Behav Immun 2020;89:531-42.

15. McCracken LM, Badinou F, Buhram M, Brocki KC. Psychological impact of COVID-19 in the Swedish population: depression, anxiety, and insomnia and their associations to risk and vulnerability factors. Eur Psychiatry 2020;63:e81.

16. Johansson F, Côté P, Hogh-Johnson S, Rudman A, Holm LW, Grotle M, et al. Depression, anxiety and stress among Swedish university students before and during six months of the COVID-19 pandemic: a cohort study. Scand J Public Health 2021;49:741-9.

17. Brew BK, Lundholm C, Gong T, Larsson H, Almqvist C. The familial aggregation of atopic diseases and depression or anxiety in children. Clin Exp Allergy 2018;48:703-11.

18. Tedner SG, Lundholm C, Olsson H, Almqvist C. Depression or anxiety in adult twins is associated with asthma diagnosis but not with offspring asthma. Clin Exp Allergy 2016;46:803-12.

19. Laciw P, Szydlowska D, Kuczyński M, Palczynski C, Kuma P. High levels of anxiety during the COVID-19 pandemic as a risk factor of clinical worsening in patients with severe asthma. Allergy Clin Immunol Pract 2021;9:1381-3.

20. Li Y, Jiang Q, Ji Y, Cao A. Anxiety and depression may associate with poorer control and quality of life in adults with asthma. Allergy 2020;75:1759-62.

21. Muñoz-Cano R, Ribó P, Araujo G, Giralt E, Sanchez-Lopez J, Valero A. Severity of allergic rhinitis impacts sleep and anxiety: results from a large Spanish cohort. Clin Transl Allergy 2018;8:23.

22. Wang Y, Shi C, Yang Y, Zhang S, Li W, Huang N, et al. Anxiety and depression in allergic rhinitis patients during COVID-19 pandemic in Wuhan, China. Asian Pac J Allergy Immunol. Published online February 21, 2021. https://doi.org/10.12932/AP-140820-0941

23. Wickman M, Kull I, Pershagen G, Nordvall SL. The BAMSE project: presentation of a prospective longitudinal birth cohort study. Pediatr Allergy Immunol 2002;13:11-3.

24. Melén E, Bergström A, Kull I, Almqvist C, Andersson N, Asarnoj A, et al. Male sex is strongly associated with IgE-sensitization to airborne but not food allergens: results up to age 24 years from the BAMSE birth cohort. J Allergy Clin Immunol 2020;10:15.

25. Wang G, Hallberg J, Um Bergström P, Janson C, Pershagen G, Gruzieva O, et al. Assessment of chronic bronchitis and risk factors in young adults: results from BAMSE. Eur Respir J 2021;57:2002120.

26. Global Initiative for Asthma. GINA Pocket Guide 2010. Accessed February 24, 2021. https://ginaasthma.org/wp-content/uploads/2020/04/04-Main-pocket-guide__2020_04_03-final-wms.pdf

27. Cohen S, Kamarck T, Mermelstein R. A global measure of perceived stress. J Health Soc Behav 1983;24:385-96.

28. Bergman J, Ballin M, Nordström A, Nordström P. Risk factors for COVID-19 diagnosis, hospitalization, and subsequent all-cause mortality in Sweden: a nationwide study. Eur J Epidemiol 2021;36:1-12.

29. Morais-Almeida M, Pité H, Aguilar R, Ansoetgui I, Bousquet J. Asthma and the coronavirus disease 2019 pandemic: a literature review. Int Arch Allergy Immunol 2020;181:680-8.

30. Jacob L, Smith L, Koyanagi A, Oh H, Tanisclair C, Shin Ji, et al. Impact of the coronavirus 2019 (COVID-19) pandemic on anxiety diagnosis in general practices in Germany. J Psychiatr Res 2021;143:528-33.

31. Gustavsson J, Beckman L. Compliance to recommendations and mental health consequences among elderly in Sweden during the initial phase of the COVID-19 pandemic—a cross sectional online survey. Int J Environ Res Public Health 2020;17:5380.

32. Sønderskov KM, Dinesen FT, Santini ZI, Østergaard SD. The depressive state of Denmark during the COVID-19 pandemic. Acta Neuropsychiatr 2020;13:11-3.

33. Hopkinson NS. COVID-19 related concerns of people with long-term respiratory conditions: a qualitative study. BMC Pulm Med 2020;20:319.

34. Rod NH, Kristensen TS, Lange P, Prescott E, Diderichsen F. Perceived stress and risk of adult-onset asthma and other atopic disorders: a longitudinal cohort study. Allergy 2020;75:1759-62.