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The COVID-19 pandemic: asthma control, tobacco use, and mental health among African American and Latinx college students

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ABSTRACT

Objective: This study investigated the impact of COVID-19 on tobacco use and mental health in US African American and Latinx college students with asthma. Associations among asthma control, tobacco use, and mental health were also examined.

Methods: 105 African American and Latinx college students with asthma (18–23 years) completed two online questionnaires (June 2019–March 2020 for Time 1; August 2020–October 2020 for Time 2). Participants completed the Epidemic-Pandemic Impacts Inventory (measure of COVID-19 impact), Asthma Control Test, Generalized Anxiety Disorder scale, Patient Health Questionnaire (measure of depression), Perceived Stress Scale, and items related to tobacco use.

Results: Asthma control improved ($t = -3.326$, $p = 0.001$) from Time 1 to 2, and e-vapor product use decreased ($\chi^2_{104} = 6.572$, $p = 0.010$). COVID-19 impact was positively associated with students' symptoms of anxiety, depression, and perceived stress ($B = 0.201$, $p < 0.001$; $B = 0.179$, $p < 0.001$; and $B = 0.199$, $p = 0.001$, respectively) at Time 2. These results remained significant with the Benjamini-Hochberg correction. Asthma control at Time 1 was negatively associated with anxiety symptoms at Time 2 ($B = -0.418$, $p = 0.023$); however, associations with perceived stress ($B = -0.514$, $p = 0.019$) and all other tobacco product use ($B = -0.233$, $p = 0.030$) did not remain significant with the Benjamini-Hochberg correction.

Conclusions: As hypothesized, a higher COVID-19 impact score was associated with students endorsing more mental health symptoms. Better control of asthma symptoms before the pandemic predicted fewer anxiety symptoms during the pandemic.

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The past three years have been stressful, especially for African Americans and Latinxs. For instance, the killings of unarmed African American community members by police and the national protests that arose affected the mental health of African American and Latinx college students (1). In 2020, college students' mental health was further impacted by the COVID-19 pandemic; published reports suggest that depressive and anxious symptoms and general stress increased during the pandemic (2–4). In fact, pandemic related disruptions (e.g. housing relocation, food insecurity, social isolation) likely contributed to college students' increased mental health symptoms and stress (5). Further, COVID-19 exacerbated inequalities experienced by African American and Latinx college students (6) and has disproportionately affected African American and Latinx communities (7,8). For instance, African American and Latinx college students likely know someone who has had and/or died from

COVID-19 compared to other non-minoritized students (8). Wiley et al. (9) found that of 94,683 COVID-19 patients that presented to the emergency department, 26.7% were African American, and 33.6% were Latinx. These percentages suggest an overrepresentation of African American and Latinx patients in comparison to the general population of African Americans and Latinxs in the US (9). Further, research shows that there is a significant association between counties with higher proportions of African American and Latinx residents and higher COVID-19 related deaths (10,11). The losses and worries associated with COVID-19 may have contributed to increased mental health symptoms among African American and Latinx college students (8).

Much of the literature on the impact of the pandemic among college students primarily focused on its negative impact on students' mental health (3–5). There is also literature to support that college students

decreased their smoking behaviors during the pandemic (12). While some work has documented the effect of the pandemic on college students more generally, relatively few studies have examined the psychological impact of the pandemic on college students with asthma. This research is critical given that college students with asthma often experience worse psychological functioning than their peers without asthma (13) and use tobacco products at rates similar to their peers without asthma despite living with a chronic medical condition (13,14). Accordingly, a goal of the current study was to examine the impact of the pandemic on the mental health and tobacco use of African American and Latinx college students with asthma.

Given the respiratory nature of COVID-19, it is also possible that African American and Latinx college students' control of their asthma symptoms may have changed during the pandemic. Indeed, emerging literature suggests that children's asthma symptoms improved during the pandemic (15). In fact, Ferraro et al. (16) noted better asthma control for pediatric patients in April 2020, compared to asthma control reported in April 2019. They hypothesized that reduced asthma triggers during isolation contributed to improved overall asthma control during the pandemic (16). While these findings indicate an improvement in asthma control in children, similar trends have not necessarily been observed for adults. Some studies suggest no changes in asthma control for adults (17); however, a qualitative study by Tyson et al. (18) reported that adults with asthma took their asthma more seriously and became more health-conscious during the pandemic. Given these findings, we hypothesized an increase in asthma control over time. Thus, the current study contributes to our understanding of asthma control trends among African American and Latinx college students during the pandemic.

It is well documented that there is a bidirectional link between mental health issues in adults with asthma and level of disease control (19). If an individual is experiencing symptoms of anxiety and/or depression, they may be more likely to overperceive their respiratory symptoms or believe their asthma is worse than it is (20). The reverse is also true in that if an individual is experiencing respiratory symptoms or distress, stress may accentuate the inflammatory response, which can worsen asthma symptoms and ultimately lead to symptoms of anxiety or depression (21). In this study, we chose to focus on asthma control pre-pandemic as a predictor of psychological functioning during the pandemic. Better asthma control is an indication that an individual is managing their health specific to their asthma and experiencing

fewer asthma symptoms (22). Thus, we hypothesized that the degree to which a college student was attending to their asthma symptoms before the COVID-19 pandemic (i.e. health-related behaviors) would carry over to behaviors during the pandemic and predict fewer psychological symptoms. Following the documented association between asthma symptoms and psychological functioning, this would suggest that students with asthma would not experience an increase in anxiety symptoms during the pandemic that can often occur from elevated asthma symptoms. In essence, if an individual's asthma was well controlled pre-pandemic, it is possible that they would experience less anxiety and better psychological functioning (23) during a pandemic that largely impacts the lungs and causes a respiratory illness (24).

This study contributes to the literature by investigating the differences in mental health symptoms, asthma control, and tobacco use in a sample of African American and Latinx college students prior to and during COVID-19 using a prospective design. We also examined associations among asthma control prior to the pandemic, COVID-19 impact scores, tobacco use, and mental health symptoms. We hypothesized that students would experience an increase in symptoms of anxiety and depression, perceived stress, asthma control, and a decrease in tobacco use from Time 1 and Time 2. We hypothesized that a higher COVID-19 impact score would be associated with more mental health symptoms and tobacco use. Finally, we hypothesized that level of asthma control prior to the pandemic would be associated with fewer mental health symptoms and less tobacco use during the pandemic.

Method

Participants and procedures

Participants were recruited from colleges and universities across central Virginia. Colleges refer to academic institutions that have smaller student populations and emphasize undergraduate studies; universities refer to institutions that often include undergraduate and graduate programs, and larger student populations. For reporting purposes in this study, we will refer to our sample as "college students" given that the students attended colleges and universities. Flyers were posted on campus, emails were sent to African American and Latinx campus student groups, and instructors presented study information to their classes in person or via email. Students who were interested in participating were sent a screener survey that asked questions to ensure they were eligible to participate.

Students were eligible to participate if they were a college student, self-identified as African American or Latinx (or “Mixed” or “Multiple Responses” included African American or Latinx), were 18–20 years of age (this age range was a condition of the funding source), and self-reported physician-diagnosed asthma, or endorsed two or more breathing symptoms indicative of asthma (25). As asthma is often underdiagnosed among African American and Latinx individuals (26), using the endorsement of at least two asthma symptoms as a proxy for asthma captured those who likely had undiagnosed asthma (27). Two more recent studies focused on asthma among high school students from African American and Latinx backgrounds used these items as criteria for classifying students as having current undiagnosed asthma (28,29). Studies in adulthood have used similar screening items focused on breathing symptoms to identify undiagnosed asthma (30). Students were excluded if they self-reported additional pulmonary disease (e.g. cystic fibrosis), or a condition or ability level that would prevent them from understanding project forms.

Eligible students were then directed to the confidential survey in REDCap. Students read an information sheet about the study and indicated their consent to participate before completing the online questionnaires. Participants were again asked to report their age and nine participants older than 20 completed the survey. We decided to include the data from eight of these participants in the analyses since they are still considered young adults (i.e. not older than 23 years of age). Data from a 35-year-old were excluded from analyses. Time 1 data from 205 college students were collected prior to the pandemic (between June 2019 and March 2020). The modal date for completion at Time 1 was in September 2019 ($n=5$); 95% of participants completed the questionnaire before March 2020. One hundred and five students who completed the Time 1 survey also completed the Time 2 (August 2020 and October 2020) online survey that was administered during the pandemic. The Time 2 survey was available to participants for the first time on August 6, 2020, which was the modal date for Time 2 surveys; 36% of participants completed the survey on this date. Participants received a \$25 gift card for completing the Time 1 survey and \$15 for the Time 2 survey.

Measures

Demographics

Participants reported their age, gender (e.g. man, woman, transgender, other), race/ethnicity, family household income per year, and academic year.

Asthma characteristics

Participants completed the 5-item Asthma Control Test (ACT) to measure the frequency of daily asthma symptoms, activity limitations, and their perception of disease control over the past four weeks (22). Item scores were summed, with higher scores indicating well-controlled asthma (i.e. scores above 19 considered well-controlled asthma). The ACT measure has demonstrated unidimensional factor structure and reliability estimates between 0.86 and 0.88 (31). Cronbach's alpha was 0.74 at Time 1 and 0.84 at Time 2.

COVID-19 impact

At Time 2, participants completed 56 items from the Epidemic-Pandemic Impacts Inventory (EPII) (32). As done in previous studies (33,34), participants were asked a subset of items from the original 92-item EPII that were most appropriate for the sample (e.g. exclusion of items associated with childcare): “Work and Employment” – 11 items; “Social activities” – 10 items; “Economic” – 5 items; “Emotional health and well-being” – 6 items; “Physical health problems” – 8 items; “Physical distancing and quarantine” – 8 items; and “Infection history” – 8 items. Sample items included, “Since the coronavirus disease pandemic began, what has changed for you or your family?” Response options included “had to move or relocate,” “unable to get enough food or healthy food,” and “more time sitting down or being sedentary.” Participants rated response options as having impacted them personally (no = 0, yes = 1), a person in their home (no = 0, yes = 1), or not applicable (0). Responses within each item were summed, with higher scores indicating greater COVID-19 impact; possible scores ranged from 0 to 112. Grasso et al. (35) noted that traditional factor analysis to determine scale validity is inappropriate for the EPII given the event-type data structure of the measure. Moreover, they found that a subset of the items in the EPII was significantly correlated with Cohen et al.'s (36) Perceived Stress Scale (35). The EPII has been used to assess the impact of COVID-19 on college student populations (37). Cronbach's alpha in our sample was 0.94.

Anxiety symptoms

Participants completed the 7-item Generalized Anxiety Disorder (GAD-7) scale (38). Participants rated each item on a scale from 0 (not at all) to 3 (nearly every day) to indicate how frequently they experienced

various problems (e.g. “feeling nervous, anxious, or on edge”) within the past two weeks. Item scores were summed, with higher scores indicating greater anxiety symptom severity. Scores of 5, 10, and 15 represent cutoff scores for mild, moderate, and severe anxiety, respectively (38). The GAD-7 measure has demonstrated a single factor structure with strong loadings, high reliability coefficient (0.85 and 0.93), and stability in scores for college students (39). Cronbach’s alpha was 0.93 at Time 1 and 0.91 at Time 2.

Depressive symptoms

Participants completed the 8-item Patient Health Questionnaire (PHQ-8) (40). Participants rated each item on a scale from 0 (not at all) to 3 (nearly every day) to indicate how frequently in the past two weeks they were bothered by a particular problem (e.g. “little interest or pleasure in doing things”). Item scores were summed, with higher scores indicating greater depression symptom severity. Scores of 5, 10, 15, and 20 represent cutoff scores for mild, moderate, moderately severe, and severe depression, respectively (40). The PHQ-8 has demonstrated unidimensional factor structure, criterion and construct validity, and is a good indicator for depressive symptomatology (41). Cronbach’s alpha was 0.88 at Time 1 and 0.89 at Time 2.

Perceived stress

Participants completed the 14-item Perceived Stress Scale (PSS) (36). Participants rated each item on a scale from 0 (never) to 4 (very often) to indicate whether they experienced a particular feeling or thought in the last month (e.g. “how often have you felt that you were on top of things?”). Item scores were summed, with higher scores on the PSS indicating more perceived stress. The PSS measure has demonstrated acceptable internal consistency reliability (>0.70), test-retest validity, and a two-factor structure (42). Cronbach’s alpha was 0.82 at Time 1 and 0.81 at Time 2.

Tobacco use

At Times 1 and 2, participants completed four items from the Youth Risk Behavior Survey to assess their past 30-day tobacco use (43). Participants were asked, “During the past 30 days, on how many days did you smoke cigarettes?” and “During the past 30 days, on how many days did you use an electronic vapor

product (e.g. e-cigarettes, vapes, vape pens, e-cigars, e-hookahs)?” Similar questions were asked about cigar products (cigars, cigarillos, or little cigars), chewing tobacco and other dissolvable tobacco products. We created two dichotomous (yes/no) variables of tobacco use in the past 30 days: (1) electronic vapor product use (e-vapor product) and (2) all other tobacco product use (i.e. items about cigarettes, cigars, chewing tobacco, and any other tobacco products).

Data analysis

All statistical analyses were conducted using IBM SPSS Statistics (Version 27). Demographic, asthma control scores, COVID-19 impact scores, and tobacco use characteristics were generated. Little’s Missing at Random (MCAR) test was run to assess for systematic differences. We also used t-tests and chi-square analyses to assess for differences in sample demographics between those participants who completed Time 1 and Time 2 surveys and those who only completed surveys at Time 1. Correlational analyses were used to determine associations among gender, age, and variables of interest. We also created a change in income score to assess for differences in participants’ income from Time 1 to Time 2. An analysis of variance (ANOVA) with Tukey’s Honest Significant Difference (HSD) for *post hoc* comparisons was used to evaluate differences in continuous variables by categorical variables. Paired sample t-tests were used to assess differences between continuous study variables across Time 1 and 2; chi-square analyses were used to assess for differences in tobacco use across time.

To examine the association between COVID-19 impact scores and asthma control on other study variables, linear and logistic regression analyses were performed. Age, gender, and race/ethnicity were included as covariates in all analyses. Given the established associations among stress, anxiety, depressive symptoms, and tobacco use, for any significant associations between COVID-19 impact scores/asthma control and tobacco use outcome variables, we reran these regression models controlling for stress, anxiety, and depressive symptoms. For significant regression analyses, we used the Benjamini-Hochberg (44) correction to control for Type 1 error in multiple comparisons. This type of correction controls for false discovery rate by ranking observed *p* values from lowest to highest. The false discovery rate, in this case 0.05, is multiplied by *p* values rank for each test over the total number of tests. The original *p* values for the test is then compared to the adjusted *p* values; if the original *p* values

is less than the adjusted p values using the Benjamini-Hochberg correction, the result for that comparison remains significant.

Results

Sample characteristics

One hundred and five participants who completed both Time 1 and 2 surveys were included in analyses (Table 1). Students were on average 19.09 ± 1.10 years old and 85.7% were women and 14.3% were men. Sixty-nine percent of students identified as African American, 21.9% as Latinx, and 9.5% as multi-racial. Approximately 72% of participants reported a yearly household income less than \$100,000 at Time 1 and about 66% of participants at Time 2. Most of the sample (65 participants, 62%) reported no change in income from Time 1 to Time 2. On the other hand, 23 participants (22%) reported an increase in yearly income level and 14 participants (13.3%) reported a

decrease in their family's yearly income level. On average, participants reported their asthma was relatively well-controlled at Times 1 and 2, with means of 20.50 ± 3.33 and 21.62 ± 3.52 , respectively. The mean COVID-19 impact score was 24.20 ± 12.72 , with participant scores ranging from 0 to 78.

Little's MCAR test resulted in a non-significant p values ($p=0.785$), indicating that data were missing at random. Thus, missing data were excluded from analyses using pairwise deletion. While we had relatively little missing data overall, seven participants did not complete the EPII (a measure of COVID-19 impact) and thus, they were excluded from analyses using the measure. The sample for this study did not statistically differ from the larger sample of 205 participants who only completed the surveys at Time 1 on any sample demographics (age, gender, race/ethnicity, academic year).

When considering covariates, COVID-19 impact scores differed across race/ethnicity, ($F(2, 95) = 4.923$, $p=0.009$), such that Latinx students reported higher COVID-19 impact scores, 29.86 ± 10.43 , compared to African American students, 21.57 ± 11.28 ; the mean score for multi-racial students, 30.00 ± 21.02 , did not differ from African American or Latinx students. No other variables were associated with race/ethnicity. Gender was associated with COVID-19 impact scores ($r=0.242$, $p=0.016$), Time 1 PSS ($r=0.219$, $p=0.027$), Time 2 PSS ($r=0.304$, $p=0.002$), and Time 2 PHQ-8 ($r=0.284$, $p=0.004$), such that women reported higher COVID-19 impact scores, more perceived stress, and more depressive symptoms than men. Age was positively associated with all other tobacco product use at Time 1 ($r=0.250$, $p=0.011$) and Time 2 ($r=0.211$, $p=0.033$).

Table 1. Characteristics of sample ($N=105$).

	<i>n</i> (%)
Age, mean (SD) years	19.09 (1.10)
Range in years	18–23
Gender ^a	
Man	15 (14.3)
Woman	90 (85.7)
Transgender	0 (0)
Other	0 (0)
Race ^b	
African American	72 (68.6)
Latinx	23 (21.9)
Multi-racial ^{1b}	10 (9.5)
Academic year ^c	
Freshman	48 (45.7)
Sophomore	30 (28.6)
Junior	22 (21.0)
Senior	5 (4.8)
Time 1: Household income (yearly)	
\$200,000 and up	11 (10.5)
\$100,000–\$199,999	16 (15.2)
\$60,000–\$99,999	27 (25.7)
\$30,000–\$59,999	29 (27.6)
\$15,000–\$29,999	16 (15.2)
Less than \$14,999	4 (3.8)
Not reported	2 (1.9)
Time 2: Household income (yearly)	
\$200,000 and up	17 (16)
\$100,000–\$199,999	18 (17)
\$60,000–\$99,999	25 (23.6)
\$30,000–\$59,999	27 (25.5)
\$15,000–\$29,999	15 (14.2)
Less than \$14,999	3 (2.8)
Not reported	1 (0.9)
Controller medication	
Yes	44 (41.9)
No	61 (58.1)
Quick relief medication	
Yes	73 (69.5)
No	32 (30.5)

Note. ^aMan = 0, woman = 1, transgender = 3. ^bAfrican American = 0, Latinx = 1, Multi-racial = 2. ^{1b}Multi-racial included African American or Latinx. ^cFreshman = 0, Sophomore = 1, Junior = 2, Senior = 3.

Mental health symptoms, asthma control, and tobacco use

Anxiety and depressive symptoms and perceived stress did not differ across Time 1 and Time 2; however, level of asthma control at Time 2 was significantly better than level of asthma control at Time 1 ($t = -3.326$, $p=0.001$; Table 2). There was a decrease in e-vapor product use ($\chi^2_{104} = 6.572$, $p=0.010$) and all other tobacco product use ($\chi^2_{99} = 41.161$, $p<0.001$), across Time 1 and Time 2 (see Table 3). Specifically, of those who reported e-vapor product use at Time 1, 60.9% ($n=14$) reported not using an e-vapor product at Time 2. Nineteen percent of participants ($n=3$) who reported all other tobacco product use at Time 1 reported not using a tobacco product at Time 2.

Table 2. Mean differences in measures across Time 1 and Time 2.

	Range	Time 1 Mean (SD)	Time 2 Mean (SD)	t-statistic	Paired Samples Test (p-value)
Generalized Anxiety Disorder-7 item (<i>n</i> = 98)	0–21	15.40 (6.20)	14.52 (5.57)	1.677	0.097
Patient Health Questionnaire-8 item (<i>n</i> = 96)	0–27	15.78 (5.57)	15.90 (5.94)	−0.224	0.823
Perceived Stress Scale (<i>n</i> = 96)	0–40	28.35 (8.18)	27.41 (7.43)	1.114	0.268
Asthma Control Test (<i>n</i> = 101)	5–25	20.50 (3.33)	21.62 (3.52)	−3.326	0.001**

* $p < 0.05$, ** $p < 0.01$.

Table 3. Chi-square differences in Time 1 and Time 2 substance use.

	Time 2 use past 30 days		Chi-square value	<i>P</i>
	No (0)	Yes (1)		
Time 1 E-vapor product use past 30 days	<i>N</i> = 83	<i>N</i> = 21	6.572	0.010*
No (0)	85.2%	14.8%		
	<i>N</i> = 69	<i>N</i> = 12		
Yes (1)	60.9%	42.9%		
	<i>N</i> = 14	<i>N</i> = 9		
Time 1 Other tobacco product use past 30 days	<i>N</i> = 78	<i>N</i> = 21	20.201	<0.001**
No (0)	90.4%	9.6%		
	<i>N</i> = 75	<i>N</i> = 8		
Yes (1)	18.8%	81.3%		
	<i>N</i> = 3	<i>N</i> = 13		

* $p < 0.05$, ** $p < 0.01$.

Table 4. Regression results of COVID-19 impact scores on Time 2 mental health and asthma control.

Predictor variable	<i>B</i>	<i>S.E.</i>	<i>df1, df2</i>	Original <i>p</i> -value	Adjusted <i>p</i> -value
Outcome variable					
Covariates					
COVID-19 impact scores (EPH; Range 0–112)					
Generalized Anxiety Disorder-7 item	0.201	0.045	4, 89	<0.001**	0.013*
Age	−0.198	0.471		0.676	
Gender	0.896	1.512		0.555	
Race/ethnicity	0.093	0.832		0.911	
Patient Health Questionnaire-8 item	0.179	0.046	4, 89	<0.001**	0.025*
Age	−0.234	0.493		0.636	
Gender	2.961	1.602		0.068	
Race/ethnicity	0.257	0.879		0.771	
Perceived Stress Score	0.199	0.059	4, 89	0.001**	0.038*
Age	−0.882	0.620		0.159	
Gender	4.987	2.032		0.016*	
Race/ethnicity	0.654	1.204		0.588	
Asthma Control Test	−0.055	0.029	4, 93	0.063	0.050
Age	0.370	0.310		0.237	
Gender	−1.274	1.022		0.216	
Race/ethnicity	0.173	0.557		0.757	

Note. All analyses controlled for age, gender, and race/ethnicity; adjusted *p* values reflects Benjamini-Hochberg correction.

* $p < 0.05$, ** $p < 0.01$.

COVID-19 impact and mental health symptoms, asthma control, and tobacco use

Regression analyses showed COVID-19 impact scores were positively associated with symptoms of anxiety ($B = 0.201$, $p < 0.001$), depression ($B = 0.179$, $p < 0.001$), and perceived stress ($B = 0.199$, $p = 0.001$; see Table 4) at Time 2. The Benjamini-Hochberg test indicated significance beyond false discovery for these tests. An association between COVID-19 impact scores and asthma control at Time 2 was not found. No associations between COVID-19 impact scores and e-vapor product use and all other tobacco product use (see Table 5) were found.

Asthma control and mental health symptoms/tobacco use during the pandemic

Better asthma control at Time 1 was associated with fewer anxiety symptoms ($B = -0.418$, $p = 0.023$), and less perceived stress ($B = -0.514$, $p = 0.019$; see Table 6) at Time 2. With the Benjamini-Hochberg correction, only the association between asthma control and fewer anxiety symptoms remained significant (see Table 6 for adjusted *p* values). There was no association between asthma control at Time 1 and depressive symptoms at Time 2. Logistic regression analyses revealed no association between asthma control at Time 1 and e-vapor product use at Time 2

Table 5. Logistic regression results of COVID-19 impact scores on Time 2 tobacco use.

Predictor Variable Outcome Variable Covariates	OR	95% CI	P
COVID-19 impact scores (EPII; Range 0–112)			
Past 30-day e-vapor product use (n = 97)	1.020	.976–1.066	0.383
Age	0.731	.421–1.270	0.267
Gender	2.873	.334–24.682	0.336
Race/ethnicity	0.852	.350–2.075	0.725
Past 30-day other tobacco product use (n = 95)	1.007	.962–1.053	0.767
Age	1.692	1.073–2.670	0.024*
Gender	1.022	.210–4.976	0.978
Race/ethnicity	0.503	.185–1.369	0.179

Note. All analyses controlled for age, gender, and race/ethnicity. OR=odds ratio, CI=confidence interval.

(see Table 7). Better asthma control at Time 1 was associated with no other tobacco product use ($B = -0.233$, $SE = 0.107$, $p = 0.030$, $OR = 0.792$) at Time 2. However, this finding did not remain significant

with the Benjamini-Hochberg test (see Table 7 for adjusted p values).

Discussion

The present study assessed the role of asthma control and COVID-19 impact on the mental health and tobacco use of African American and Latinx college students with asthma. Most literature to date has explored the effects of the pandemic on the mental health and tobacco use of college students without chronic conditions. Our prospective study provides new information related to asthma control among African American and Latinx college students with asthma during the pandemic, and especially how asthma control prior to the pandemic predicted mental health symptoms and tobacco use during the pandemic.

Contrary to our hypothesis, participants' mental health scores did not differ from Time 1 to Time 2.

Table 6. Regression results of Time 1 asthma control on Time 2 mental health.

Predictor Variable Outcome Variable Covariates	B	S.E.	df1, df2	Original p-value	Adjusted p-value
Asthma Control Test (ACT)					
Generalized Anxiety Disorder-7 item	−0.418	0.180	4, 94	0.023*	0.034*
Age	−0.248	0.497		0.618	
Gender	2.209	1.517		0.149	
Race/ethnicity	1.712	0.846		0.046*	
Patient Health Questionnaire-8 item	−0.300	0.174	4, 95	0.088	0.050
Age	−0.310	0.510		0.545	
Gender	3.975	1.598		0.015*	
Race/ethnicity	1.538	0.860		0.077	
Perceived Stress Score	−0.514	0.216	4, 94	0.019*	0.017
Age	−1.026	0.630		0.107	
Gender	5.394	1.961		0.007**	
Race/ethnicity	2.432	1.166		0.040*	

Note. All analyses controlled for age, gender, and race/ethnicity; adjusted p values reflects Benjamini-Hochberg correction.

* $p < 0.05$, ** $p < 0.01$.

Table 7. Logistic regression results of Time 1 asthma control on Time 2 tobacco use.

Predictor variable Outcome variable Covariates	OR	95% CI	Original p-value	Adjusted p-value
Asthma Control Test (ACT)				
Past 30-day e-vapor product use (n = 104)	0.862	.740–1.004	0.057	0.050
Age	0.674	.403–1.129	0.134	
Gender	1.314	.258–6.701	0.742	
Race/ethnicity	1.179	.554–2.508	0.669	
Past 30-day other tobacco product use (n = 89)	0.792	0.649–.978	0.030*	0.025
Age	1.498	.899–2.496	0.121	
Gender	0.693	.149–3.231	0.641	
Race/ethnicity	1.173	.416–3.305	0.763	
Time 2 PSS	0.988	.897–1.088	0.801	
Time 2 GAD-7	0.975	.821–1.159	0.777	
Time 2 PHQ-8	0.884	.730–1.071	0.208	

Note. All analyses controlled for age, gender, and race/ethnicity. Because the association between ACT and tobacco use was significant, we also included stress, anxiety, and depressive symptoms as covariates in this regression model. OR=odds ratio, CI=confidence interval; adjusted p values reflects Benjamini-Hochberg correction.

* $p < 0.05$.

Indeed, our sample's rates of mental health symptoms and stress were high before the pandemic and remained high after the onset of COVID-19. There are other social factors (e.g. racism, discrimination) that could have contributed to the relatively high levels of mental health symptoms endorsed at both Time 1 and 2 (45). Additionally, it is important to note that 36% of participants at Time 2 completed the survey in early August, a period that may have been stressful as students prepared for the start of a new academic year (46). Moreover, students with a chronic illness often experience higher mental health concerns than their peers without a chronic illness (47). Thus, it is possible an intersection of social and health factors contributed to the consistently high mental health scores reported and limited the ability of the scores to rise further. While our findings are inconsistent with previous literature (4,5), it is important to note that prior studies assessed participants' recall of changes in their mental health (e.g. increase or decrease in anxiety) that resulted from COVID-19, rather than over time.

Although participants' asthma was relatively well controlled prior to the pandemic, findings suggested an improvement in asthma control during the pandemic. One reason for this might be that at the onset of the pandemic, the Centers for Disease Control specifically warned patients with chronic illnesses about the high risk for severe illness from COVID-19 (48). This direct messaging might have contributed to improved asthma control and symptom management. For instance, to prevent asthma exacerbations during the pandemic, Abrams et al. (49) recommended adherence to routine asthma maintenance medication, review of proper inhaler techniques, and physical distancing. Philip et al. (50) surveyed patients with chronic respiratory conditions early in the pandemic and nearly half reported that they watched online inhaler videos suggestive of an interest in ensuring good self-management. Attention to better asthma management was also likely due, in part, to wanting to minimize unnecessary exposure to COVID-19 at acute healthcare visits. Furthermore, college students' reduced exposure to outdoor allergens and possible adherence to social distancing likely contributed to improvements in their asthma control. It is also possible that forced relocation from residential living prompted greater contact with relatives and promoted accountability and management of their symptoms. Although asthma control improved during the pandemic, the clinical difference in scores was a little over one point (20.5 vs. 21.62); thus, participants in our sample had well controlled asthma prior to the pandemic that improved

by about one point on the Asthma Control Test. Accordingly, it is important to interpret our findings regarding asthma control within this context.

Consistent with previous findings of college students without asthma (51,52), we found that e-vapor product use significantly decreased during the pandemic. Sixty percent of participants who reported e-vapor product use prior to the pandemic, denied e-vapor product use during the pandemic. Similarly, all other tobacco product use significantly decreased during the pandemic. However, it should be noted that although significant, this decline only occurred in 3 participants (19%) and should be interpreted with caution; findings need to be replicated in a larger sample of college students. This potential decrease in tobacco use, especially as it relates to e-vapor product use, could be attributed to the transition from living on a college campus with peers to living at home with relatives or children (12,53), or limited physical and financial access to retail environments to purchase tobacco or e-vapor products (54).

As hypothesized, higher COVID-19 impact scores were associated with more symptoms of anxiety and depression and perceived stress during the pandemic. These findings are similar to those found with college students without asthma (55,56). Previous literature suggests that college students have had to navigate difficulties with online learning, employment, housing, social isolation, and general concerns about the pandemic (3–5). We found Latinx college students reported greater COVID-19 impact scores than African American students. Previous findings suggest that Latinx college students are more likely to live in communities with higher rates of COVID-19 compared to African American and White students (57). This could be indicative of a more salient presentation of the pandemic for Latinx students.

We did not find that COVID-19 impact scores were associated with asthma control or tobacco use. The pandemic has had notable effects on individuals' mental health and presented a need for adjusted, and perhaps, unfamiliar independent coping strategies (e.g. reduced exposure to media coverage) (58,59). Nevertheless, students were likely already aware of how to manage and care for their asthma symptoms. As such, it appears that COVID-19 did not have a negative impact on asthma control, perhaps given participants' relatively well controlled asthma prior to the pandemic and any precautions (e.g. social distancing) taken during the pandemic. It could also be that the risk of contracting COVID-19 in social settings (60) played a role in our sample's decrease in tobacco use behaviors.

In fact, better asthma control prior to the onset of the pandemic was predictive of fewer anxiety symptoms during the pandemic. Although better asthma control was also associated with less perceived stress and less other tobacco product use reported during the pandemic, these findings did not remain significant when we controlled for Type 1 error. It might be that with a larger sample size, the test would have reached significance despite applying a correction for multiple comparisons. Regardless, these findings suggest that better controlled asthma might serve a protective role in the reduction of anxiety symptoms during a period of great uncertainty. This finding is somewhat consistent with a recent study finding that individuals ($M=36.05$ years) with controlled asthma were less likely to suffer from anxiety and depression during the pandemic (24). Although not significant with the Benjamini-Hochberg correction, with each point increase on the Asthma Control Test (22) before the pandemic, a participant was 20.8% less likely to use other tobacco products in the past 30 days during the pandemic. It is important to note that though asthma control can be a proxy for how well an individual is managing their asthma (i.e. recognizing symptoms, adhering to medications), it is also possible that students in this study had asthma that could be considered mild. Thus, our findings suggest that students who were doing well with their asthma prior to the pandemic, either by attending to symptoms and/or having a milder level of disease severity, exhibited less anxiety during the pandemic and possibly other health promoting behaviors (e.g. tobacco use prevention).

Limitations

Although a notable strength of this study is the prospective examination of an understudied population, African American and Latinx college students with asthma, it is not without limitations. The majority of the participants identified as women, which matches the higher prevalence of asthma among adult women (61). However, there are established differences in the presentation of mental health outcomes across genders (62). While we controlled for gender in most analyses to account for these differences, our sample primarily represents women with asthma. Furthermore, the sample primarily identified as African American (68.6%) in comparison to Latinx (21.9%). We controlled for participant race/ethnicity in most analyses. Although we controlled for several factors in the analyses, our study is limited in that we did not formally assess other social determinants of health (e.g. experiences

of discrimination or racism) nor college-student specific stressors (e.g. stress associated with the academic setting, start of the semester) that could influence mental health symptoms and tobacco use. For instance, the data collected during the pandemic (Time 2) also coincided with the beginning of the academic year. As such, the current study cannot definitively state the reasons behind the observed changes, or lack thereof, in participant responses across time. It would be beneficial for future work to include such constructs to identify the changes more adequately in mental health and tobacco use. Moreover, future research considering changes in psychological symptoms across time should consider controlling for age, gender, and race/ethnicity in these analyses. Our results did not indicate significant changes over time and, therefore, it was not necessary to control for these variables. Additionally, the sample size for the present study was small which may have prevented statistically significant findings for small changes in participant reports. Similarly, several findings were trending toward statistical significance or significant prior to applying the Benjamini-Hochberg correction and may have been significant if a larger sample was included.

Another limitation is that all data were self-report, including asthma symptoms and diagnosis. Future research should consider verifying asthma diagnosis by physician report as well. Other markers of asthma status, such as lung function, could also be included as the measure of asthma control used in this study, although used clinically, is a subjective measure. Students in our sample had predominately well controlled asthma overall; thus, findings may not generalize to college students with asthma that is not well controlled. While the Cronbach's alpha of the Asthma Control Test at Time 1 was 0.74, which is acceptable (63), this value was lower than the alpha of 0.84 at Time 2. It is important to note that this scale is only 5 items and thus, internal consistency values are often lower than those of scales with more items.

Finally, we also included participants with undiagnosed asthma who experienced at least two symptoms that are indicative of an asthma diagnosis and our findings should be interpreted within this context. We recognize that these items were self-report. Moreover, participants with undiagnosed asthma may have been different from those participants with diagnosed asthma. Unfortunately, we were not able to statistically test whether our findings were different among those with undiagnosed versus diagnosed asthma. Based on our IRB-approved protocol, participants completed a separate, online screening form for eligibility that

included items regarding asthma diagnosis; this screening form was not then linked to their confidential survey questionnaires. We suggest that future studies include items about asthma diagnosis and breathing symptoms in their main study questionnaires and examine whether findings differ between these two groups.

Conclusion

Despite the growing literature examining the effects of COVID-19 on college students, there are few prospective studies assessing the impact of the pandemic on health compromised (i.e. diagnosed with asthma) racial/ethnic minoritized students. In many ways, young adults with asthma were uniquely alerted to the heightened risk of the pandemic on their health (50). As such, our findings provide support for the importance of identifying and implementing asthma education for young adults to promote the self-efficacy and self-management of their asthma. We found that those students who were experiencing better asthma control before the pandemic, experienced fewer anxiety symptoms during the pandemic. Additional research should continue to investigate how asthma control differentially interacts with mental health and tobacco use as COVID-19 restrictions fluctuate due to variant strains and college students continue to experience changes in their learning environment and routines.

Declaration of interest

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