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Adherence to COVID-19 Protective Measures in a Longitudinal Sample of Male Youth

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Abstract

Background Adherence to COVID-19 protective measures is lowest for young people and males. The current study investigated characteristics associated with adherence to COVID-19 protective measures among male youth during the early months of the pandemic.

Method The study used data from a prospective cohort study among male youth with baseline assessment in 2015/2016 and follow-up measurements in 2019 and summer 2020. Attrition-weighted multivariable ordinal logistic and log-binomial regression models were used to assess factors associated with adherence to overall and specific adherence measures, respectively.

Results Among 571 male youth (mean age 18.5), overall adherence was higher for those who were older (OR: 1.15; 95% CI: 1.03–1.30), non-White (OR: 1.96; 95% CI: 1.20–3.32), and residing in an urban area (OR: 2.06; 95% CI: 1.46–3.01). Overall adherence was lower for those who had a history of being drunk (OR: 0.65; 95% CI: 0.42–0.99). For outdoor mask-wearing, adherence was higher for youth with attention-deficit disorder or attention-deficit/hyperactivity disorder (RR: 1.58; 95% CI: 1.16–1.97) and lower for youth who currently used tobacco products (RR: 0.42; 95% CI: 0.21–0.70). Before a statewide mask mandate was issued, non-White youth were more likely to report wearing masks in outdoor spaces than their non-Hispanic White peers (RR: 2.34; 95% CI: 1.75–3.23).

Conclusion The study identified demographic, psychosocial, and behavioral factors associated with adherence to COVID-19 protective behaviors among male youth. The findings illustrate characteristics that could be leveraged for targeted preventive efforts during the ongoing pandemic and future outbreaks in a low-compliance group.

Keywords COVID-19 · Social Distancing · Adherence · Adolescent health · Prevention

Introduction

Even amidst the availability of vaccines, social distancing, mask use, and avoiding large gatherings remain vital in preventing the spread of COVID-19, particularly among unvaccinated individuals. COVID-19 infection rates and outcome severity have steadily progressed among young people [1, 2], with males having more severe outcomes than females [3]. Most recently, following the surge of the Delta and Omicron variants of the virus, hospital admissions and emergency department visits among adolescents increased [4, 5]. Yet, throughout the pandemic, the practice of protective measures (i.e., adherence) remains lowest for youth [6–12] and males [6, 9, 10, 12–15].

Adherence to COVID-19 protective measures among youth has been associated with policy and community-level (e.g., mask mandates), interpersonal, and individual

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factors. For example, state and local lockdown orders, stay-at-home advisories, and mask mandates improved motivations to engage in social distancing behaviors [16]. Similarly, peer influence and social pressure–including reward-seeking for social status and fear of exclusion–are associated with adherence to protective measures [17, 18]. Most current studies also highlight the role of sociodemographic and behavioral characteristics in the practice of COVID-19 protective measures among youth. For instance, higher adherence is associated with both lower [19] and higher [13] socioeconomic status, whereas lower adherence is linked with an existing asthma diagnosis and smoking [14]. Antisocial behavioral and personality traits such as having deviant peers, deceitfulness, risk-taking, self-interest, and impulsivity are linked with lower adherence [8, 13], while high risk perceptions [8, 18] and a sense of responsibility towards others [16, 18] are associated with greater adherence. Although social distancing during the pandemic is associated with increased psychological distress, lower positive affect, and anxiety and depressive symptoms among youth [20, 21], there is no direct evidence linking adherence to protective measures and mental health symptoms among youth [16].

Adherence to COVID-19 protective measures among young males is not well understood. Moreover, among most studies that examined COVID-19 protective measures among youth, the cross-sectional designs make it difficult to ascertain the direction of the relationship between some of the aforementioned factors and adherence to protective measures. For instance, the role of existing mental health status (e.g., depressive symptoms) in adherence is unclear as mental health problems among youth have also spiked due to the pandemic [22].

To better understand the role of sociodemographic, behavioral, and psychosocial characteristics in adherence to COVID-19 protective behaviors among male youth, we used a longitudinal study where potential determinants of adherence were measured before the onset of the pandemic, minimizing temporal ambiguities. Since studies show that sociodemographic and psychosocial characteristics in early adolescence predict trajectories in health behaviors into young adulthood [23, 24], by examining factors ascertained during early and mid-adolescence, this study aimed to provide new insights into health behaviors of male youth during the COVID-19 pandemic. We hypothesized that adherence to protective factors would be higher among male youth who are older and from an urban area. Moreover, building on previous findings on health risk perceptions, health behaviors, and decision making among youth [8, 13, 16, 18, 25–28], we hypothesized that lower adherence would be associated with higher sensitivity to rewards (i.e., sensation seeking) and impulsiveness, antisocial traits (i.e., deviant behavior), lower family connectedness, and alcohol or tobacco use.

Methods

Design

Established in 2015–2016, the Buckeye Teen Health Study (BTHS) is a prospective cohort study of 1220 adolescent males aged 11–16 years at baseline and residing in urban or Appalachian Ohio (see Fig. 1 in Supplement). Parents or legal guardians gave permission to participate in the study, and the adolescents provided assent. Probability address-based sampling ($N = 991$) and convenience sampling ($N = 229$) were used to establish the cohort. Additional details about sampling and recruitment procedures are provided elsewhere [29].

The Institutional Review Board at our university approved the protocol. The baseline survey was administered in-person, and topics included (self) tobacco use, peer tobacco use, and psychosocial and behavioral measures. Parents or guardians were also asked questions about their tobacco use, family income, level of education, and household smoking rules. Follow-up surveys assessed tobacco use and related behaviors and have been conducted every 6 months by telephone. For the current study, data collected on the baseline survey in 2015/2016 and at the last survey a participant completed in 2019 were used to represent demographics, psychosocial, and behavioral measures before the onset of the COVID-19 pandemic.

Sample

The COVID-19 Supplemental Survey was launched in June 2020 and completed in August 2020. All active BTHS subjects were eligible to complete the COVID-19 survey. Each subject received a postcard indicating that a voluntary survey would soon arrive via email. Depending on the subject's age, informed consent or assent and permission were obtained before starting the survey. Subjects who did not respond to the online survey were called and asked to complete a phone survey. Questions were focused on COVID-19 diagnosis, social distancing, household impact, changes in education and employment, health behaviors, and mood.

Measures

Outcome Variables

Adherence to protective measures was assessed with four items: (1) "During the last 30 days**,** I am trying to stay 6 feet from people I don't live with when I leave my home"; (2) "During the last 30 days, I am wearing a face-covering when going inside a store or other indoor place beside my home";

(3) "During the last 30 days, I am wearing a face-covering when I am outdoors"; and (4) "During the last 30 days, have you attended any gatherings, not including work, with more than ten people who do not live in the same house as you?" Adherence was defined as answering "yes" to the first three questions and "no" to the last question. Due to low numbers, subjects who answered "don't know" or "prefer not to answer" were treated as missing. The study's primary outcome was overall adherence computed by summing up the four protective measures (range: 0–4). Additionally, adherence to each of the four protective measures was investigated separately.

Explanatory Variables (Baseline)

From the baseline parent and youth surveys, region was classified upon sampling as urban vs. Appalachian, with nearly all subjects (95%) living in the same county at follow-up. Youth's age and race/ethnicity (dichotomized as non-Hispanic (NH) White vs. non-White) were obtained from the youth survey. From the parent's survey, the following variables were included: parent's age, parental education (college degree or above vs. no college degree), household income (< $50,000 vs. $50,000 or more), presence of an adult (someone over age 18) in the home who used tobacco products (yes/no), whether the youth was ever clinically diagnosed with asthma (yes/no), and whether the youth was ever clinically diagnosed with attention-deficit disorder (ADD) or attention-deficit/hyperactivity disorder (ADHD). Parent-reported grades were used to estimate youths' grade point average (GPA).

The presence of any deviant or antisocial behavior self-reported by the youth (e.g., lying to parents) was dichotomized (yes/no) [30]. Sensation seeking represented liking of higher sensation experiences (e.g., enjoying new and exciting experiences even if they involve breaking the rules); a higher mean sensation-seeking score indicated higher enjoyment of high sensation experiences (Cronbach's alpha = 0.74) [31]. Family connectedness [32] was assessed with four items (e.g., "My family understands me") that were averaged (Cronbach's alpha = 0.72). To assess mental health symptoms, youth were asked if they had "significant problems with feeling trapped, lonely, sad, blue depressed or hopeless" or "significant problems with feeling anxious, nervous, tense, scared, panicked or like something bad was going to happen" in the past 12 months. Subjects were categorized as having a history of depressive or anxiety symptoms (yes/no) if they indicated "yes" to either question.

Explanatory Variables (2019 Follow-Up)

To better characterize the role of variables that likely changed since baseline assessment in 2015/2016, we used additional follow-up data from measurements carried out during 2019. These variables included ever use of tobacco products (yes/no); current (past 30-days) use of tobacco products (yes/no); peer use of any tobacco products (yes/no), ever use of alcohol (yes/no), history of ever being drunk (yes/no), and frequency of engagement in social media platforms (daily/less frequent).

Analysis

For categorical variables, the Cochran-Armitage test was used to examine the association of baseline and follow-up characteristics with increasing or decreasing trends in the overall adherence score. For continuous variables, one-way analysis of variance and Kruskal–Wallis tests were used to assess the association between overall adherence and continuous characteristics (i.e., age, mean sensation-seeking score, mean family connectedness score, and GPA).

A multivariable ordinal logistic regression model was fit to assess factors associated with overall adherence. This model extends a logistic regression model to examine more than two ordered response categories. Multivariable log-binomial regression models were used to assess factors associated with adherence to each of the four protective measures. For both outcome models, purposeful selection algorithm [33], starting with a global set of variables selected a priori and kept in the model regardless of statistical significance [34], was used as a guide for variable inclusion. The variables selected a priori were youth's age, region, race/ethnicity, and time measured as days since the launch of the COVID-19 supplemental survey.

Given that outcome ascertainment took place within 2 months, controlling for a time since the first survey launch helps to account for changing trends of the pandemic and increased public awareness about the disease, which influence adherence [11]. Models that assessed mask-wearing behaviors were adjusted for the possible role of a statewide mask mandate in Ohio, which took effect on July 23, 2020 [35]. The proportional odds assumption was assessed for the primary outcome model [36, 37].

Our sample was from a cohort study, with potential selection bias due to differences between survey respondents and non-respondents. We performed a comparison of respondents vs. non-respondents to the COVID-19 supplemental survey, noting that non-respondents were slightly older and more likely to be non-White, from Appalachia, have parents without a college degree, and come from a lower-income household (Supplemental Table 1). Given the assumption that data were missing at random, we used inverse-probability-of-attrition weights (IPAW) to minimize bias due to selective attrition in our analytic models [38]. To summarize, this entailed fitting a propensity score model to predict the probability of responding to the survey based on baseline

Table 1 Characteristics of respondents at baseline and follow-up stratified by overall adherence to COVID-19 protective measures

Characteristic	All[a]	Overall adherence[a]					*p*-value[b]
	(*n* = 571)	0 (*n* = 63)	1 (*n* = 92)	2 (*n* = 136)	3 (*n* = 192)	4 (*n* = 88)	
Age, mean (SD)	18.5 (1.6)	18.3 (1.4)	18.2 (1.5)	18.5 (1.8)	18.7 (1.6)	18.3 (1.6)	0.244
Race/ethnicity, *n* (%)							
NH White	456 (79.9)	56 (88.9)	81 (88.0)	112 (82.4)	147 (76.6)	60 (68.2)	< 0.001
Non-White	115 (20.1)	7 (11.1)	11 (12.0)	24 (17.6)	45 (23.4)	28 (31.8)	
Region, *n* (%)							
Urban	362 (63.4)	24 (38.1)	50 (54.3)	85 (62.5)	138 (71.9)	65 (73.9)	< 0.001
Appalachia	209 (36.6)	39 (61.9)	42 (45.7)	51 (37.5)	54 (28.1)	23 (26.1)	
Parental education, *n* (%)							
College or above	363 (63.6)	38 (60.3)	50 (54.3)	87 (64.0)	137 (71.4)	51 (58.0)	0.208
No college degree	208 (36.4)	25 (39.7)	42 (45.7)	49 (36.0)	55 (28.6)	37 (42.0)	
Household income, *n* (%)							
$50,000 or more	423 (74.1)	48 (76.2)	67 (72.8)	91 (66.9)	159 (82.8)	58 (65.9)	0.945
Less than $50,000	148 (25.9)	15 (23.8)	25 (27.2)	45 (33.1)	33 (17.2)	30 (34.1)	
School performance (GPA), median (IQR)	3.6 (0.9)	3.6 (0.8)	3.5 (1.2)	3.6 (0.8)	3.8 (0.6)	3.6 (1.0)	0.194
Any deviant behavior, *n* (%)							0.819
Yes	374 (66.3)	39 (62.9)	61 (68.5)	93 (69.4)	124 (64.9)	57 (64.8)	
No	190 (33.7)	23 (37.1)	28 (31.5)	41 (30.6)	67 (35.1)	31 (35.2)	
Sensation seeking, mean (SD)	2.8 (0.9)	2.8 (0.9)	2.9 (1.1)	2.9 (0.8)	2.8 (0.8)	2.7 (0.9)	0.26
Family connectedness, median (IQR)	3.5 (0.5)	3.5 (0.8)	3.5 (0.8)	3.5 (0.8)	3.5 (0.5)	3.5 (0.5)	0.515
Adult tobacco user in household, *n* (%)							
Yes	147 (25.7)	23 (36.5)	24 (26.1)	35 (25.7)	42 (21.9)	23 (26.1)	0.106
No	424 (74.3)	40 (63.5)	68 (73.9)	101 (74.3)	150 (78.1)	65 (73.9)	
History of asthma, *n* (%)							
Yes	112 (19.9)	12 (19.4)	27 (29.3)	24 (18.2)	32 (16.9)	17 (19.3)	0.206
No	451 (80.1)	50 (80.6)	65 (70.7)	108 (81.8)	157 (83.1)	71 (80.7)	
History of ADD/ADHD, *n* (%)							
Yes	116 (20.9)	7 (11.3)	23 (25.8)	28 (21.5)	34 (18.1)	24 (27.9)	0.223
No	439 (79.1)	55 (88.7)	66 (74.2)	102 (78.5)	154 (81.9)	62 (72.1)	
History of depressive or anxiety symptoms, *n* (%)							
Yes	333 (64.8)	34 (59.6)	50 (60.2)	84 (70.0)	115 (65.7)	50 (63.3)	0.501
No	181 (35.2)	23 (49.4)	33 (39.8)	36 (30.0)	60 (34.3)	29 (36.7)	
Ever use of tobacco products, *n* (%)							
Yes	187 (34.1)	20 (32.8)	37 (43.5)	49 (36.8)	58 (31.9)	23 (26.4)	0.078
No	361 (65.9)	41 (67.2)	48 (56.5)	84 (63.2)	124 (68.1)	64 (73.6)	
Current use of tobacco products, *n* (%)							
Yes	92 (17.0)	11 (18.0)	23 (27.4)	22 (16.8)	27 (15.3)	9 (10.3)	0.021
No	448 (83.0)	50 (82.0)	61 (72.6)	109 (83.2)	150 (84.7)	78 (89.7)	
Ever use of alcohol, *n* (%)							
Yes	205 (37.4)	22 (36.1)	36 (42.4)	58 (43.6)	64 (35.2)	25 (28.7)	0.116
No	343 (62.6)	39 (63.9)	49 (57.6)	75 (56.4)	118 (64.8)	62 (71.3)	
History of being drunk, *n* (%)							
Yes	141 (25.8)	16 (26.2)	27 (31.8)	39 (29.5)	45 (24.7)	14 (16.1)	0.051
No	406 (74.2)	45 (73.8)	58 (68.2)	93 (70.5)	137 (75.3)	73 (83.9)	
Peer use of tobacco products, *n* (%)							
Yes	452 (82.8)	54 (88.5)	75 (88.2)	109 (82.0)	146 (80.2)	68 (80.0)	0.051
No	94 (17.2)	7 (11.5)	10 (11.8)	24 (18.0)	36 (19.8)	17 (20.0)	
Social media use, *n* (%)							
Daily	458 (85.4)	52 (89.7)	73 (89.0)	111 (84.1)	155 (85.6)	67 (80.7)	0.121
Less frequently	78 (14.6)	6 (10.3)	9 (11.0)	21 (15.9)	26 (14.4)	16 (19.3)	

NH non-Hispanic, *GPA* grade point average, *ADD* attention-deficit disorder, *ADHD* attention-deficit/hyperactivity disorder

[a]Column sums might not always add up due to missing observations

[b]*p*-value for Cochran-Armitage test for trend for categorical variables. One-way ANOVA/Kruskal–Wallis test was used for continuous variables

characteristics that were different between respondents and non-respondents, computing analytical weights that are the inverse of the probabilities of response, and using these weights in the outcome models where characteristics associated with lower probabilities of responding were ultimately assigned larger weights. As conventional variance estimation methods can be biased when using IPAW estimation, a bootstrap estimator was employed for calculating confidence intervals [38, 39]. Two-sided p-value < 0.05 indicated statistical significance. All analyses were conducted in R (version 4.0) [40].

Results

A total of 571 males between the ages of 15 and 21 were included in the study. The mean age of the sample at the time of their 2020 survey was 18.5 years, and subjects were predominantly NH White (79.9%) and from an urban location (63.4%). Among non-White youth, 50 (43.5%) identified as NH Black, 33 (28.7%) as NH multi-racial, 19 (16.5%) as Hispanic, and 13 (11.3%) as NH Other. Most were from households where at least one parent had a college degree (63.6%) and a household income of $50,000 or more (74.1%). Differences were observed for specific characteristics stratified by overall adherence to COVID-19 protective measures. NH White youth and youth residing in Appalachian areas adhered to fewer measures than non-White youth and youth from urban areas, respectively. There were also differences by self- and peer-use of tobacco products and history of ever being drunk (Table 1).

The proportion of adherence differed by the type of protective measure (Fig. 1). However, adherence to mask-wearing improved after the issuance of a statewide mask mandate in Ohio; indoor mask-wearing increased from 72.4 to 92.0% (p-value < 0.01), whereas outdoor mask-wearing increased from 27.1 to 44.9% (p-value < 0.01).

Overall Adherence to COVID-19 Protective Measures

Higher adherence was associated with older age (OR: 1.15; 95% CI: 1.03–1.30), non-White race/ethnicity (OR: 1.96; 95% CI: 1.20–3.32), and urban residence (OR: 2.06; 95% CI: 1.46–3.01). A history of being drunk (OR: 0.65; 95% CI: 0.42–0.99) and a history of asthma (OR: 0.63; 95% CI: 0.41–1.00) were associated with lower overall adherence (Table 2).

Adherence to Specific COVID-19 Protective Measures

Youth who reported maintaining a distance of 6 feet were more likely to be older (RR: 1.04; 95% CI: 1.01–1.07) and non-White (RR: 1.18; 95% CI: 1.03–1.31), but no regional differences were observed (Table 3).

Similarly, youth who reported wearing masks indoors were more likely to be non-White (RR: 1.05; 95% CI: 1.01–1.12) and from an urban region (RR: 1.23; 95% CI: 1.12–1.38). Adherence to mask-wearing in outdoor spaces was also associated with older age (RR: 1.10; 95% CI: 1.01–1.18), urban residence (RR: 1.74; 95% CI: 1.28–2.53), and history of ADD/ADHD (RR: 1.58; 95% CI: 1.16–1.97). Lower adherence was associated with current use of tobacco products (RR: 0.42; 95% CI: 0.21–0.70). Racial/ethnic differences in adherence to outdoor mask-wearing behavior were observed before and after the statewide mask mandate took effect (Fig. 1). Before the mask mandate, non-White youth were more than twice as likely to report wearing masks outdoors compared to NH White youth (RR: 2.34;

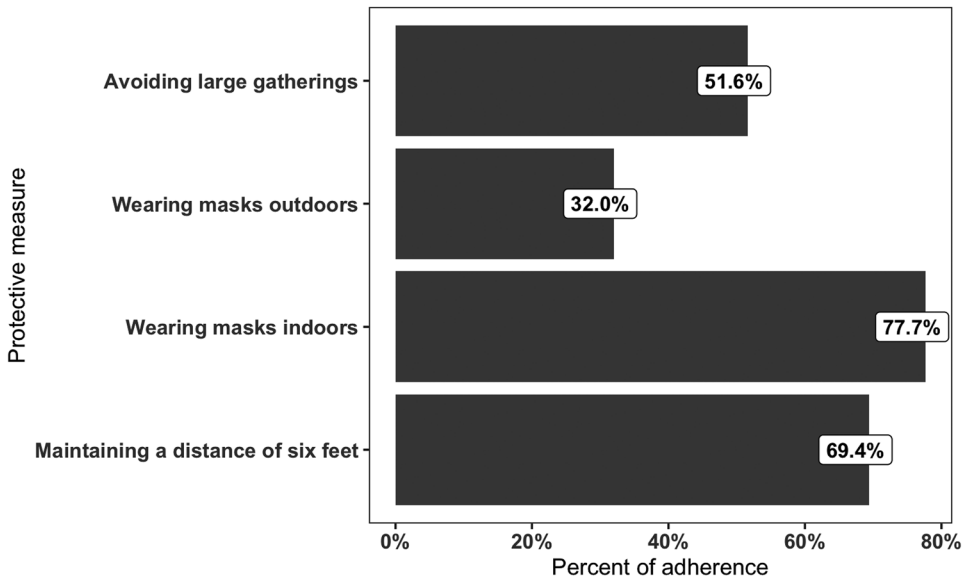

Fig. 1 Distribution of adherence to COVID-19 protective measures among male youth

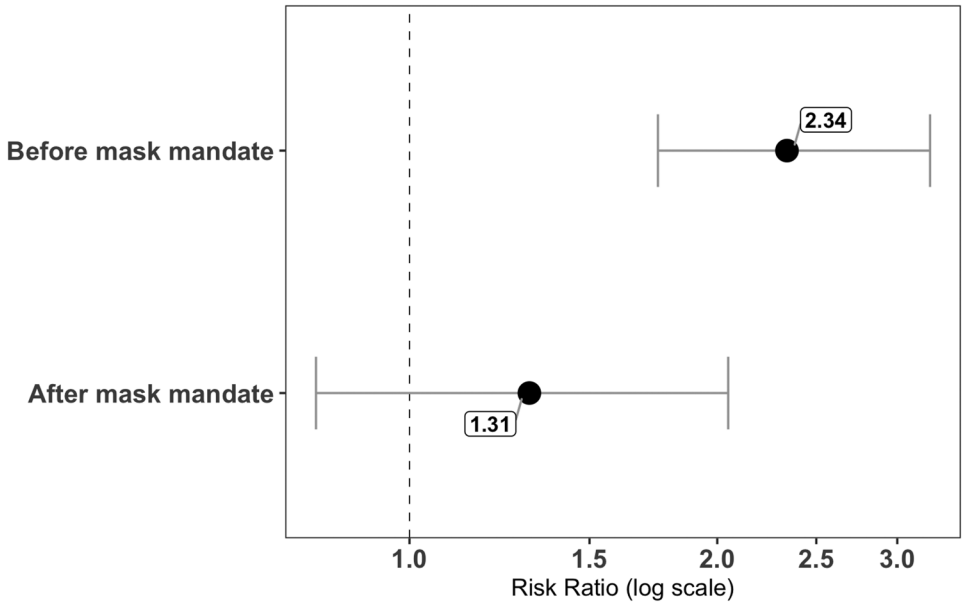

Fig. 2 Weighted risk ratios[a] and 95% confidence intervals comparing outdoor mask-wearing between non-White and non-Hispanic White youth before and after the issuance of a statewide mask mandate in Ohio. [a] Referent: non-Hispanic White

Table 2 Weighted odds ratios[a] and 95% confidence intervals for overall adherence to COVID-19 protective measures among male youth

Characteristic	Odds ratio (95% CI)
Age	1.15 (1.03–1.30)
Race/ethnicity	
Non-White	1.96 (1.20–3.32)
NH White	Ref
Region	
Urban	2.06 (1.46–3.01)
Appalachia	Ref
History of ADD/ADHD	
Yes	1.30 (0.83–2.12)
No	Ref
History of asthma	
Yes	0.63 (0.41–1.00)
No	Ref
History of being drunk	
Yes	0.65 (0.42–0.99)
No	Ref
Peer tobacco use	
Yes	0.78 (0.48–1.25)
No	Ref
Current use of tobacco products	
Yes	0.75 (0.46–1.26)
No	Ref

NH non-Hispanic, *ADD* attention-deficit disorder, *ADHD* attention-deficit/hyperactivity disorder

[a]Estimates are from an ordinal logistic regression model

95% CI: 1.75–3.23). However, these racial/ethnic differences were not detected after the statewide mask mandate was issued (RR: 1.31; 95% CI: 0.81–2.05) (Fig. 2).

Finally, youth who reported avoiding large gatherings were more likely to be older (RR: 1.09; 95% CI: 1.02–1.15) and from an urban location (RR:1.36; 95% CI: 1.04–1.79). There were no differences in adherence by race/ethnicity or other characteristics.

Discussion

Overall adherence to COVID-19 protective measures was higher for male youth who were older, non-white, residing in an urban region, and with no history of ever being drunk. Adherence to specific measures further varied by age, race/ethnicity, region, and health behavior indicators. Mask mandate orders moderated racial/ethnic differences for outdoor mask-wearing.

Consistent with previous literature and our hypothesis, older age [6, 7, 11, 41] was associated with higher adherence to COVID-19 protective measures. Younger youth may perceive COVID-19 as a minor threat to their health given that susceptibility to infection and likelihood of severe outcomes are higher for older adults [42], possibly influencing adherence to protective measures. Older youth display more pro-social behaviors such as concern and responsibility for others, which are linked with higher adherence [16, 18]. Older youth are also more likely to have a job, which could reinforce the practice of protective measures in work settings.

Table 3 Weighted risk ratios[a] and 95% confidence intervals for adherence to specific COVID-19 protective measures among male youth

	Maintaining a distance of 6 feet	Wearing mask indoors	Wearing mask outdoors	Avoiding large gatherings
Age	1.04 (1.01–1.07)	1.01 (0.99–1.02)	1.10 (1.01–1.18)	1.09 (1.02–1.15)
Race/ethnicity				
Non-White	1.18 (1.03–1.31)	1.05 (1.01–1.12)	2.34 (1.75–3.23)[b]	0.98 (0.77–1.24)
NH White	Ref	Ref	Ref	Ref
Region				
Urban	1.11 (0.94–1.34)	1.23 (1.12–1.38)	1.74 (1.28–2.53)	1.36 (1.04–1.79)
Appalachia	Ref	Ref	Ref	Ref
Household income				
Less than $50,000	1.06 (0.91–1.24)	0.98 (0.92–1.04)		
$50,000 or more	Ref	Ref		
Parental education,				
No college degree		0.96 (0.89–1.02)		
College degree or above		Ref		
Adult tobacco user in household				
Yes				0.86 (0.62–1.14)
No				Ref
Family connectedness			1.18 (0.95–1.61)	1.04 (0.83–1.29)
Sensation seeking				0.98 (0.87–1.12)
School performance (GPA)	1.07 (0.97–1.19)			
History of depressive or anxiety symptoms				
Yes	1.02 (0.92–1.17)		1.28 (1.00–1.74)	0.90 (0.75–1.11)
No	Ref		Ref	Ref
History of ADD/ADHD				
Yes			1.58 (1.16–1.97)	
No			Ref	
History of asthma				
Yes	0.92 (0.78–1.06)			0.86 (0.63–1.11)
No	Ref			Ref
History of being drunk				
Yes	0.89 (0.77–1.05)		0.83 (0.60–1.12)	0.85 (0.68–1.06)
No	Ref		Ref	Ref
Peer tobacco use				
Yes	0.90 (0.80–1.10)	0.99 (0.94–1.05)	1.16 (0.83–1.55)	0.86 (0.71–1.11)
No	Ref	Ref	Ref	Ref
Current tobacco use				
Yes	0.98 (0.74–1.15)	0.97 (0.90–1.03)	0.42 (0.21–0.70)	0.96 (0.68–1.32)
No	Ref	Ref	Ref	

Blank cells indicate variables not included in the final multivariable model for the selected outcome

NH non-Hispanic, *GPA* grade point average, *ADD* attention-deficit disorder, *ADHD* attention-deficit/hyperactivity disorder

[a]Estimates are from a log-binomial regression model

[b]Significant interaction between race/ethnicity and the indicator for statewide issuance of a face covering mandate

The finding that youth from urban areas had higher overall adherence, outdoor mask-wearing, and social distancing than youth from Appalachia was in line with our hypothesis. From the onset of the pandemic until the end of August 2020, incidence rates had been substantially higher in large metro areas than in smaller rural areas [43]. During infectious disease outbreaks, residents of areas with lower infection rates display reduced risk perceptions and poorer practice of protective behaviors than those living in areas with higher infection rates [44]. Although Appalachian

youth tend to have a stronger sense of familism [45], lower infection rates in rural areas could have influenced youth to judge COVID-19 as a less-serious threat to them and their families. In addition, social and cultural norms could reinforce differences in protective behaviors among males in Appalachia. A strong emphasis on masculinity in rural cultures and the politicization of mask-wearing could explain low adherence to mask-wearing among Appalachian male youth during the pandemic [10]. Lower adherence could also be attributed to unique cultural aspects among Appalachian youth, including harm perceptions defined by past experiences and the prominence of personal strength on perceived risk [45].

Adherence to COVID-19 protective measures was lower for NH White youth than non-White youth. This difference, observed after accounting for region, is likely linked with racial and gender variations in harm perceptions where overall risk perceptions are lower for NH White males [46]. Also, it is plausible that non-White youth engaged in more protective behaviors against COVID-19 due to its disproportionate impact on communities of color, especially during the early months of the pandemic [47, 48]. Racial differences in harm perceptions and adherence to protective measures among adults are mixed. Some studies show that COVID-19 risk perceptions are higher for people of color than NH White individuals [49], and that non-White adults are more likely to wear masks [50]. Others, however, report that adherence to protective measures is lowest for Black adults [6, 41, 51]. Our finding on racial and ethnic variations in adherence to protective measures among youth has a few potential explanations. Youth might have different motivations for engaging in COVID-19 protective behaviors [16], with these likely varying by sociodemographic characteristics including race/ethnicity. Additionally, most studies that examined racial differences in adherence were conducted very early after the onset of the pandemic when knowledge and awareness about COVID-19 were lower among people of color [51], and perceptions about the disease and engagement in protective behaviors likely improved as the pandemic progressed. More studies are needed to understand these differences in risk perception during different time points of the pandemic and the impacts on adherence to protective measures among youth.

The Centers for Disease Control and Prevention recommended outdoor mask-wearing in April 2020 [52]. However, this was later revised and was left optional if one was physically distant from others, vaccinated, or without serious underlying health conditions [53]. Our results show that outdoor mask-wearing was the least practiced measure among youth, and racial differences in outdoor mask-wearing were modified by the issuance of a statewide mask mandate. Non-White youth were more likely to report outdoor use of masks than NH White youth before a statewide mask mandate was issued in Ohio in July 2020, suggesting that non-White youth engaged in outdoor mask-wearing earlier than their NH White peers. The absence of racial/ethnic differences in outdoor mask-wearing following a statewide mask mandate lends further support to the effectiveness of health directives in improving adherence during the start of the pandemic and before the availability of vaccines [11].

Surprisingly, adherence to outdoor mask-wearing was higher among youth who had a history of ADD/ADHD. ADHD is characterized by impairments in working memory [54, 55], and recent research has linked lower working memory with poorer adherence to social distancing recommendations among adults during the pandemic [56]. Our findings are also not readily explained by high risk-taking behaviors reported in individuals with ADHD/ADD [57]. However, given that ADHD symptoms in our sample were parent-reported, the observed association could be related to the role of parental monitoring in mediating the relationship between ADHD and risk-taking behaviors in youth [57]. Future studies are needed to understand how youth with ADD/ADHD perceived and practiced protective measures during the pandemic.

Finally, heavy alcohol consumption [58] and current smoking [14] have been associated with lower adherence to COVID-19 protective behaviors. Consistent with these findings and our hypothesis, we found that a history of self-reported drunkenness and current tobacco use were associated with lower overall adherence and lower adherence to outdoor mask-wearing behavior, respectively. Among youth, alcohol and tobacco use are associated with peer influence, reward-seeking, and fear of exclusion, influencing adherence to COVID-19 protective behaviors [17]. Youth who had a history of alcohol consumption and tobacco use might have continued to engage in social activities and gatherings during the pandemic. In particular, tobacco users, coupled with their need to smoke in outdoor spaces, could have perceived the risk of COVID-19 exposure in outdoor settings to be low and outdoor mask-wearing to be inconvenient. This is likely linked to smokers' distinct harm perceptions and decision-making processes [28].

Study Strengths and Limitations

The study examined sociodemographic, health-related, and behavioral factors in a population characterized by low practice of protective measures during the COVID-19 pandemic. The use of a longitudinal design provided the advantage of examining risk factors by using measures ascertained before the pandemic's onset, which improved temporal inferences and minimized spurious associations. Additionally, given that the study sample is from an ongoing cohort study, the use of IPAW reduced the potential impact of selection bias on the findings.

However, the study is not without some limitations. First, using a sum score as a measure of overall adherence and its validity is contingent on assumptions such as similarity of items in the scale and the equal contribution of each item to what is being measured [59]. However, our study's conclusions are strengthened by the separate examination of each item (i.e., each protective measure) comprising the sum score. Second, although parent-reported items were used for defining clinically diagnosed ADD/ADHD and asthma, these are subject to potential misclassification. Although national estimates for the prevalence of ADD/ADHD are highest for males (14.0%) and adolescents (13.5%) [60], both are larger than the estimate in our study (20.8%). Third, we could not further explore the reported racial/ethnic differences in adherence and variations across people of color as it was statistically impractical to classify respondents further. Fourth, we were also unable to assess other interactions by sociodemographic characteristics due to our modest sample size. For example, it would have been interesting to explore whether the observed racial/ethnic differences in adherence varied across urban vs. Appalachian regions. Fifth, we did not examine adherence to all officially recommended protective measures. For instance, we did not assess frequent handwashing in our survey. Sixth, self-reported COVID-19 protective behaviors are closely tied with social norms, and the role of social desirability bias on our findings could not be ruled out. However, assessing these behaviors via an online survey likely lessened such biases and improved accuracy [61]. Finally, as our sample is exclusively male youth, findings may not be readily generalizable to all youth.

Conclusion

The study showed that male youth, an amalgamation of subpopulations characterized by low practice to COVID-19 protective measures, had differences in adherence to protective measures against COVID-19 in the early months of the pandemic. In general, adherence was higher for older youth, those residing in an urban setting, and racial/ethnic minorities. We also found variations in adherence to specific protective measures. Notably, adherence to outdoor mask-wearing showed racial/ethnic variations until the issuance of a mask mandate. The findings highlight the need to design public health strategies and communication approaches tailored to youths' age, racial and ethnic background, area of residence, and underlying behavioral factors. For example, messaging to youth living in rural areas could relate to their strong sense of familism and the need to protect loved ones rather than risks to their health. Importantly, such tailored health communication approaches could be helpful in current efforts to improve vaccination rates among young people.

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Declarations

Informed Consent Informed consent (parental permission/male youth assent) was obtained from all individual participants included in the study.

Ethical Approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Conflict of Interest The authors declare no competing interests.

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