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The Impact of the COVID-19 Pandemic on Adolescent Mental Health and Substance Use

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A B S T R A C T

Purpose: The aim of this study is to determine whether COVID-19-induced financial impact, stress, loneliness, and isolation were related to perceived changes in adolescent mental health and substance use.

Methods: Data were from Baseline (2018) and Wave 3 (2020; mean age = 14.8; 50% female) of 1,188 adolescents recruited from 12 Texas public middle schools as part of a randomized controlled trial. Participants were primarily Black (23%), Latinx (41%), Asian (11%), and White (9%). We assessed mental health and substance use (Baseline and Wave 3) and pandemic-related physical interaction, loneliness, stress, family conflict, and economic situation (Wave 3).

Results: COVID-19-induced stress and loneliness were linked to depression (beta = 0.074, $p \leq .001$; beta = 0.132, $p \leq .001$) and anxiety (beta = 0.061, $p = .001$; beta = 0.088, $p \leq .001$) among ethnically diverse adolescents. Adolescents who did not limit their physical interactions due to COVID-19 had fewer symptoms of depression (beta = −0.036, $p = .03$); additionally, adolescents who did not restrict their socializing were substantially more likely to report using a variety of substances (e.g., for episodic heavy drinking; odds ratio = 1.81, $p = .001$). Increased use of a food bank was linked to depression (beta = 0.063, $p \leq .001$) and a negative change in financial situation was linked to increased alcohol use (odds ratio = 0.70, $p = .04$) among adolescents.

Discussion: After controlling for prepandemic psychopathology and race/ethnicity, COVID-19 induced isolation, loneliness, stress, and economic challenges were linked to poor mental health and substance misuse. Substantial structural, community, school, and individual level resources are needed to mitigate the impact of the COVID-19 pandemic on adolescent psychosocial health.

IMPLICATIONS AND CONTRIBUTION

In this study of 1,188 ethnically diverse adolescents, the stress and isolation caused by the COVID-19 pandemic was associated with psychosocial health problems, even after accounting for prepandemic health. This generation of adolescents will benefit from interventions designed to mitigate these mental and behavioral health impacts.

Even prior to the COVID-19 pandemic, recent (2019) data highlight the enormous burden of mental health disorders on children and adolescents in the United States. The national prevalence of at least one mental health disorder among those under 18 years old is 16.5% (weighted average 7.7 million) [1], with emotional disorders (i.e., depression and anxiety) and behavioral problems among the most prevalent [2]. Of particular note, rates of depression and anxiety in youth continue to grow over time [3], and comorbidity is especially high. Indeed, roughly 75% of children with depression also experience anxiety [4]. Rates of depression and other mental health disorders have been shown to increase from childhood into adolescence [4], increasing by a factor of 1.6 (for anxiety) to 3.6 (for depression)

Conflicts of interest: The authors have no real or perceived conflicts of interest to report.

Clinical trials registry site and number: Not applicable as data were derived solely from students in the control group of a randomized controlled trial.

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between the ages of 10–11 and 12–17. Adolescent mental health concerns have a multidirectional relationship with substance misuse, increasing risk for co-occurring conditions [5,6]. Adolescent substance use rates are high—over 8% of 12–17 year olds report (past 30 days) drug use and 9.15% report recent alcohol use [7]. Put simply, the "storm and stress" of adolescence is understandably difficult to navigate and appears to be becoming more complicated in the face of contemporary challenges (e.g., social media). Early indications suggest that the COVID-19 pandemic has put unprecedented mental health strain on this already taxed population [8,9]. Adolescents rely on peer and school networks to address mental health needs [10]; however, the mandated lockdowns and quarantines meant that access to informal (e.g., peers, teachers, coaches) and formal (e.g., school-based mental health services) forms of support were substantially reduced during this time of developmental change and global crisis.

Nascent research on youth and family health and stability during the COVID-19 pandemic communicates an ominous warning about the potential for long-term negative outcomes for a generation of young people [11]. The economic toll of the pandemic resulted in a peak unemployment rate of nearly 15% and the largest labor force decline in 50 years [12], contributing to widespread economic instability, food insecurity, and housing loss. Economic downturns alone—even without the added stress of a pandemic—have been shown to negatively affect youth mental health [13]. Parental job loss is particularly impactful for adolescents, and linked to increased exposure to family conflict and parental stress, youth mental health symptoms, suicidal ideation, and decreased academic achievement [14]. These challenges, coupled with stay-at-home orders, quarantines, and lockdowns, which in the United States began in March 2020, resulted in widespread social isolation, increased family conflict, and financial strain [15]. Emerging research from across the globe illustrates that during COVID-19, adolescent depression, anxiety, and substance misuse significantly increased, and social support and connection significantly decreased [8,9]. COVID-19-related concerns, such as fear of illness, challenges with online schooling, and social isolation have been demonstrated in short-term findings to contribute to depression and anxiety for adolescents [9]. Furthermore, negative and avoidant coping, including substance misuse, have been shown to contribute to adolescent mental health shifts during COVID-19 [16]. Although early data indicate disconcerting trends in the COVID-19 era, studies examining the trajectory of mental health impacts for adolescents are lacking, prompting researchers and organizations to call for increased scholarly focus on these psychological effects [17]. Our study responds to a gap in understanding by using longitudinal assessments taken before and after the pandemic began to examine the mental health and substance use impact of COVID-19 in a group of ethnically diverse adolescents.

We collected real-time data on the impact of the COVID-19 pandemic on the psychosocial health of adolescents. We hypothesize that COVID-induced stress, loneliness, and lack of physical interaction will be positively linked to substance misuse and increased symptoms of depression and anxiety—even after accounting for prepandemic substance use and psychological health. We further expect that pandemic-related economic factors (e.g., job loss) will be linked to poor psychosocial health.

Methods

In 2018, we randomized 24 urban middle schools in ethnically diverse communities in which seventh grade students received either standard health curriculum (n = 12 control schools) or a dating violence prevention program (*Fourth R*; n = 12 intervention schools). Students were recruited during school hours through mandated classes (e.g., health). Active parental consent and student assent were obtained prior to data collection. A total of 3,738 students were recruited and 3,028 completed the baseline survey via paper-pencil in class. Of these 3,028, 260 did not meet the study inclusion criteria yielding a sample of 2,768 (mean age = 12.7; 50% female).

Wave 3 (W3) was conducted via a web-based platform in the spring/summer of 2020 (during the height of the COVID-19 pandemic). Because we found the intervention to have a significant short-term impact on relevant variables, we limited participants to those in control schools and to those who completed W3. Of these 1,255 adolescents, 67 were excluded because they completed the survey prior to the addition of the COVID-19 measures, yielding an analytic sample size of 1,188. As shown in Table 1, participants were Black/African-American (23%), Latinx (41%), Asian (11%), White (9%), and other or multiple races (16%). Sixty-two percent of participants reported living with "both parents," while the rest reported living with "one parent or

Table 1
Baseline sample characteristics

	Study sample
Total (N)	1,188
Female, n (%)[a]	590 (49.7)
Race/ethnicity, n (%)	
Hispanic	487 (41.0)
Non-Hispanic White	103 (8.7)
Non-Hispanic Black	276 (23.2)
Asian	134 (11.3)
Other[b]	150 (15.8)
Living situation, n (%)	
Live with both parents	717 (61.8)
One parent and one stepparent	156 (13.4)
Mother only or father only	245 (21.2)
Other[c]	43 (3.7)
Parent education, n (%)[d]	
Did not graduate from high school	121 (10.3)
Finished high school or GED	120 (10.2)
Some college or training	106 (9.0)
College graduate	506 (43.1)
Don't know[e]	321 (27.3)
Mental health symptoms, mean (standard deviation)	
Depression	1.82 (0.52)
Anxiety	1.78 (0.48)
Substance use, n (%)	
Alcohol use	158 (13.8)
Episodic heavy drinking	29 (2.4)
Marijuana use	64 (5.6)
Hard drug use[f]	68 (6.0)
Rx drug misuse	66 (5.8)
e-cigarette use	98 (8.6)

Rx = medical prescription.
[a] All percentages are among those providing a valid response.
[b] Other includes those endorsing American Indian, other, multiple, and unknown.
[c] Other includes those endorsing grandparents and other.
[d] Highest education level of mother or father.
[e] Don't know includes student who endorsed they did not know the education level of mother or father.
[f] Includes synthetic marijuana, cocaine, amphetamines, inhalants, hallucinogens, over-the-counter medication, and ecstasy.

Table 2
Description of study measures

Measure	Description	Prompt	Scale	Sample descriptive, mean (standard deviation)/%
COVID measures				
Physical interaction	Degree of physical interaction during COVID	Since the Coronavirus pandemic, besides your immediate family (the people you live with), how much physical contact have you had with others in the last 2 weeks?	Scaled 1 = almost no outside contact to 4 = normal contact	2.03 (0.91)
Use of food bank	Use of food bank during COVID	In the last 2 weeks, how often have you or your family depended on a local food bank, church, or school for food during the Coronavirus pandemic due to money issues?	Scaled 1 = did not use to 4 = used often (more than once a week)	1.43 (0.79)
Change in money situation	Change in money situation due to COVID	How would you describe the money situation in your family BEFORE the Coronavirus pandemic? How would you describe the money situation in your family AFTER the Coronavirus pandemic?	Response 1 = comfortable to 3 = not enough money to pay the bills. Scaled as the difference between before/after with −1 = got worse, 0 = stayed the same, 1 = got better	−0.11 (0.50)
Job loss/reduced hours	Lost job or reduced hours of immediate family member due to COVID	Because of the Coronavirus pandemic, did anyone in your immediate family (people you live with) lose their job or have their hours reduced?	1 = yes, 0 = no	43.7%
Loneliness	Degree of loneliness due to COVID	How often have you felt lonely because of the Coronavirus?	Scaled 1 = not at all to 4 = a whole lot	2.11 (1.06)
Increased difficulty with family	Degree of family relationship difficulty due to COVID	How much has your relationship with your family been more difficult since the Coronavirus pandemic?	Scaled 1 = not at all to 4 = a whole lot	1.82 (0.89)
Stress	Stress level during COVID	In general, how stressed have you been during the Coronavirus pandemic?	Scaled 1 = not at all to 4 = a whole lot	2.15 (0.97)
Mental health symptoms				
Anxiety	Generalized Anxiety Disorder subscale of the Screen for Child Anxiety Related Emotional Disorders	In general, how true are the following statements about you: I am nervous	Mean of 9 items, scaled 1 = not true/hardly ever true to 3 = very true/often true	1.89 (0.53)
Depression	Center for Epidemiologic Studies Short Depression Scale	Below is a list of the ways you might have felt or behaved. How often have you felt this way during the past week?	Mean of 10 items, scaled 1 = rarely or never (<1 day) to 4 = more or all of the time (5–7 days)	1.87 (0.55)
Substance use				
Alcohol use	Past year alcohol use	In the past year, have you ever used: alcohol (more than a few sips)	Coded 1 = yes, 0 = no	14.1%
Episodic heavy drinking	Episodic heavy drinking in the last month	Binge drinking is defined as 5 or more drinks for boys and 4 or more drinks for girls. In the past month, how many days would you say your participated in binge drinking?	Coded 1 = 1 or more days, 0 = 0 days	3.4%
Marijuana use	Past year marijuana use	In the past year, have you ever used: marijuana	Coded 1 = yes, 0 = no	10.0%
Hard drug use	Past year hard drug use	In the past year, have you ever used: synthetic marijuana, cocaine, amphetamines, inhalants, hallucinogens, over-the-counter cold or cough medicine with the intent of getting high, ecstasy	Seven drug use items, coded 1 = yes to any, 0 = no to all	4.6%

(*continued on next page*)

Table 2
Continued

Measure	Description	Prompt	Scale	Sample descriptive, mean (standard deviation)/%
Rx drug misuse	Past year Rx drug misuse	In the past year, have you ever used: prescription pain medications such as oxycodone, hydrocodone, codeine, morphine, fentanyl, or Adderall, Ritalin, Xanax, or Valium, not prescribed to you or in an amount more than directed	Four Rx drug use items (not prescribed, more than prescribed), coded 1 = yes to any, 0 = no to all	3.2%
e-Cigarette use	Past year e-cigarette use	In the past year, have you ever used: electronic cigarettes (e-cigs, vapors, JUUL)	Coded 1 = yes, 0 = no	8.3%

Rx = medical prescription.

one stepparent" (13%), "mother or father [only]" (21%), or other situation (4%). More than half (52%) reported at least one parent had some college education, 21% had lower than college education, and 27% did not know or report.

Participants received a $5 gift card for returning a signed consent form, regardless of whether they were permitted to participate, as well as a $5 and $20 gift card for participating in the Baseline and W3 survey, respectively. The study was approved by the first author's Institutional Review Board.

Measures

As shown in Table 2, we assessed symptoms of depression and anxiety (Baseline and W3), substance misuse (Baseline and W3), and COVID-19-related experiences (W3). The Generalized Anxiety Disorder subscale of the Screen for Child Anxiety Related Emotional Disorders [18] measured symptoms of anxiety (Cronbach's $\alpha = 0.88$). The Center for Epidemiologic Studies Short Depression Scale [19] measured symptoms of depression (Cronbach's $\alpha = 0.80$).

For substance use, participants reported past-year use of alcohol, e-cigarettes, marijuana, prescription medication (misuse), synthetic marijuana, cocaine, amphetamines, inhalants, hallucinogens, over-the-counter medication, and ecstasy. Due to their relative low rates of use, the latter seven substances were combined to form a "hard drug" category where participants who reported using one or more types of these substances were coded as having used hard drugs.

To assess participant experiences and behaviors related to the COVID-19 pandemic, we added items to the W3 survey, including the degree of physical interaction, perceptions of loneliness and stress, family conflict, and several economic questions (i.e., use of a food bank, change in household financial situation, and employment of family members). Questions were based on existing reliable measures, developed in consultation with adolescent health experts on the potential consequences of the pandemic, and piloted in a qualitative study [20].

Data analysis

We used multilevel regression models to account for potential intraclass correlation among students sampled from the same school. The intraclass correlation varied depending on the outcome and ranged from 0.000 to 0.049. All models were adjusted for race/ethnicity. The baseline value for each of the mental health and substance use outcomes were included in the model so that the relationship could be interpreted as the change from baseline behavior. All dependent variables and COVID items were measured at W3. Linear multilevel models were used to fit the continuous mental health outcomes and multilevel logistic regression models were used to analyze the dichotomous substance use outcomes. The set of independent variables measuring the impact of COVID were determined a priori. Two sets of models were run for each outcome. For Model 1, we entered each COVID measure into a separate model to look at the independent relationship with the dependent variable. For Model 2, we entered all COVID measures that were independently associated with the outcome at $p < .05$ into a single model for each outcome to estimate the relative strength of association. All models were fit using STATA software and utilized maximum-likelihood estimation.

Results

As shown in Tables 3 and 4, *physical interaction during COVID-19* was independently related to a reduction in depression symptoms (beta = −0.036, $p = .03$); however, this association did not persist when all other COVID-19 items were accounted for (i.e., Model 2). Physical interaction was also independently and positively linked to use of all substances. Specifically, students reporting little change to their prepandemic contact (i.e., normal physical interactions) were more likely to participate in episodic heavy drinking (odds ratio [OR] = 1.81, $p = .001$) and use alcohol (OR = 1.41, $p < .001$), marijuana (OR = 1.39, $p = .003$), hard drugs (OR = 1.37, $p = .04$), prescription drugs (OR = 1.57, $p = .01$), and e-cigarettes (OR = 1.39, $p = .005$). These relationships persisted in all of the adjusted models: alcohol (OR = 1.45, $p < .001$), episodic heavy drinking (OR = 1.81, $p = .001$), marijuana (OR = 1.42, $p = .002$), hard drugs (OR = 1.39, $p = .04$), prescription drugs (OR = 1.57, $p = .01$), and e-cigarettes (OR = 1.43, $p = .003$).

Stress level during COVID-19 was independently and positively associated with depression (beta = 0.157, $p < .001$) and anxiety (beta = 0.118, $p < .001$), as well as marijuana (OR = 1.29, $p = .01$) and e-cigarettes (OR = 1.53, $p < .001$). Notably, effect sizes were robust representing relative impact per change on the stress level scale. With the exception of marijuana, these associations persisted in all of the adjusted models: depression (beta = 0.074,

$p < .001$), anxiety (beta = 0.061, $p < .001$), and e-cigarette use (OR = 1.50, $p < .001$).

Loneliness due to COVID-19 was independently and positively associated with depression (beta = 0.176, $p < .001$) and anxiety (beta = 0.125, $p < .001$), as well as the use of alcohol (OR = 1.23, $p = .01$), marijuana (OR = 1.23, $p = .04$), and hard drugs (OR = 1.30, $p = .05$). The effect sizes represent the relative impact for each level of the loneliness scale (1–4). Using depression as an example, the average difference on the depression scale for participants with a loneliness scale of 1 versus 2 is 0.176, whereas the average difference on the depression scale for participants with a loneliness score of 1 versus 3 is 0.352 (1 vs. 4 is 0.528), making current effect sizes rather large. With somewhat attenuated effect sizes, the associations persisted in the adjusted models for depression (beta = 0.132, $p < .001$) and anxiety (beta = 0.088, $p < .001$).

Increased difficulty with family relationships during COVID-19 was independently and positively associated with depression (beta = 0.108, $p < .001$) and anxiety (beta = 0.078, $p \leq .001$), as well as the use of hard drugs (OR = 1.41, $p = .02$) and e-cigarettes (OR = 1.31, $p = .02$). These associations did not persist in any of the adjusted models.

A negative *change in self-reported financial situation* (from before to during COVID-19; coded as −1) was independently associated with an increased likelihood of alcohol consumption (OR = 0.70, $p = .04$) and hard drug use (OR = 0.54, $p = .03$). Although the link between negative changes in financial situation and use of hard drugs did not persist in the adjusted model, less income since COVID-19 was linked to increased use of alcohol even after accounting for all COVID-19 items (OR = 0.71, $p = .05$).

More *frequent use of a food bank during COVID-19* was linked to more symptoms of depression in both the independent (beta = 0.066, $p < .001$) and the adjusted (beta = 0.063, $p \leq .001$) model. Specifically, a change of 0.063 in the depression scale related to a unit increase in the item assessing use of a food bank (scaled 1–4).

Students with an immediate family member with a *job loss or reduced hours due to COVID-19* had heightened symptoms of depression (beta = 0.061, $p = .04$) and anxiety (beta = 0.069, $p = .02$); however, these associations did not persist in the adjusted models.

Discussion

Study findings reveal that the COVID-19 pandemic resulted in individual and household changes connected to mental health and substance use impacts for adolescents. Perhaps not surprisingly, feeling stressed and lonely during the COVID-19 pandemic was associated with symptoms of anxiety and depression, even after accounting for prepandemic mental health, race/ethnicity, and other COVID-19-related variables. More physical interaction was also linked to less depression (even after controlling for Baseline depression); however, the strength of this association was more tenuous, diminishing once we accounted for other COVID-19 measures. These longitudinal findings mirror other nascent studies on the impact of COVID-19 on adolescents, indicating increases in depression, anxiety, isolation, and stress [8,9].

Individual factors

Consistent with the broader literature [21,22], COVID-related stress was associated with increased use of substances, including alcohol, marijuana, and e-cigarettes; the association with the latter substance was strong. The link to e-cigarettes is noteworthy given a recent study showing that vapers experience a higher frequency of COVID-19 symptoms relative to their nonvaping counterparts [23]. Feeling lonely since the pandemic began was also linked to use of alcohol, marijuana, and hard

Table 3
Multilevel linear regression models associations of COVID measures to mental health symptoms[a,b]

	Depression				Anxiety			
	Beta (SE)	Wald test	*p* value	95% CI	Beta (SE)	Wald test	*p* value	95% CI
Model 1: independent associations[c]								
Physical interaction during COVID	−0.036 (0.016)	−2.19	.03	(−0.068 to −0.004)	0.007 (0.016)	0.44	.66	(−0.024 to 0.038)
Use of food bank during COVID	0.066 (0.019)	3.48	<.001	(0.029–0.10)	0.003 (0.018)	0.17	.87	(−0.033 to 0.039)
Change in money situation	−0.022 (0.030)	−0.74	.46	(−0.081 to 0.036)	−0.052 (0.029)	−1.79	.07	(−0.11 to 0.005)
Job loss/reduced hours due to COVID	0.061 (0.030)	2.06	.04	(0.003–0.12)	0.069 (0.029)	2.40	.02	(0.012–0.13)
Loneliness during COVID	0.176 (0.013)	13.1	<.001	(0.15–0.20)	0.125 (0.014)	9.21	<.001	(0.10–0.15)
Increased difficulty with family	0.108 (0.017)	6.51	<.001	(0.075–0.14)	0.078 (0.016)	4.86	<.001	(0.047–0.11)
Stress during COVID	0.157 (0.015)	10.7	<.001	(0.13–0.19)	0.118 (0.015)	8.03	<.001	(0.089–0.15)
Model 2: relative associations[d]								
Physical interaction during COVID	−0.025 (0.015)	−1.68	.09	(−0.055 to −0.004)				
Use of food bank during COVID	0.063 (0.018)	3.53	<.001	(0.028–0.10)				
Change in money situation								
Job loss or reduced hours due to COVID	0.011 (0.028)	0.41	.68	(−0.043 to 0.066)	0.035 (0.028)	1.26	.21	(−0.020 to 0.090)
Loneliness during COVID	0.132 (0.016)	8.10	<.001	(0.10–0.16)	0.088 (0.017)	5.27	<.001	(0.055–0.12)
Increased difficulty with family	0.010 (0.017)	0.58	.57	(−0.024 to 0.044)	0.008 (0.018)	0.43	.66	(−0.027 to 0.042)
Stress during COVID	0.074 (0.018)	4.17	<.001	(0.039–0.11)	0.061 (0.018)	3.39	<.001	(0.026–0.096)

CI = confidence interval; SE = standard error.
[a] All estimates are from multilevel linear regression models to adjust for intraclass correlation present from students sampled from the same school. The beta represents the mean change in the dependent variable scale (depression, anxiety) per unit change in the independent measure.
[b] All models are adjusted for the baseline measure of the dependent variable and race/ethnicity.
[c] Model 1: each COVID measure was entered into a separate model to estimate individual association.
[d] Model 2: all COVID measures that were statistically significant in Model 1 were entered into a single model to estimate relative association.

Table 4
Multilevel logistic regression models associations of COVID measures to substance use[a,b]

	Alcohol use		Episodic heavy drinking		Marijuana use		Hard drug use[c]		Rx misuse		E-cigarette use	
	OR (95%CI)	*p* value	OR (95%CI)	*p* value	OR (95% CI)	*p* value	OR (95% CI)	*p* value	OR (95% CI)	*p*-value	OR (95% CI)	*p* value
Model 1: independent association[d]												
During COVID												
Physical interaction	1.41 (1.17–1.71)	<.001	1.81 (1.27–2.60)	.001	1.39 (1.12–1.73)	.003	1.37 (1.01–1.86)	.04	1.57 (1.10–2.24)	.01	1.39 (1.10–1.76)	.005
Use of food bank	0.98 (0.78–1.21)	.82	1.09 (0.74–1.60)	.67	1.02 (0.80–1.31)	.87	1.02 (0.72–1.45)	.92	0.87 (0.55–1.37)	.55	1.04 (0.80–1.36)	.76
Change in money situation	0.70 (0.50–0.98)	.04	0.90 (0.46–1.76)	.76	0.84 (0.56–1.27)	.40	0.54 (0.31–0.95)	.03	1.71 (0.85–3.44)	.13	1.12 (0.72–1.73)	.62
Job loss/reduced hours	1.32 (0.92–1.87)	.13	0.87 (0.44–1.72)	.69	1.41 (0.93–2.15)	.11	1.18 (0.66–2.11)	.58	0.94 (0.48–1.85)	.85	1.22 (0.78–1.89)	.38
Loneliness	1.23 (1.05–1.45)	.01	1.07 (0.78–1.46)	.70	1.23 (1.02–1.48)	.04	1.30 (1.00–1.68)	.05	0.89 (0.64–1.24)	.49	1.19 (0.97–1.46)	.09
Increased difficulty with family	1.19 (0.99–1.45)	.06	1.19 (0.83–1.71)	.34	1.17 (0.94–1.46)	.17	1.41 (1.05–1.91)	.02	1.33 (0.93–1.89)	.12	1.31 (1.04–1.65)	.02
Stress	1.17 (0.98–1.40)	.08	1.16 (0.83–1.61)	.39	1.29 (1.05–1.59)	.01	1.27(0.96–1.69)	.10	1.00 (0.71–1.41)	.99	1.53 (1.23–1.90)	<.001
Model 2: relative association[e]												
During COVID												
Physical interaction	1.45 (1.20–1.76)	<.001	1.81 (1.27–2.60)	.001	1.42 (1.14–1.77)	.002	1.39 (1.01–1.90)	.04	1.57 (1.10–2.24)	.01	1.43 (1.13–1.83)	.003
Use of food bank												
Change in money situation	0.71 (0.50–0.99)	.05					0.59 (0.33–1.04)	.07				
Job loss/reduced hours												
Loneliness	1.24 (1.05–1.46)	.01			1.12 (0.88–1.42)	.36	1.19 (0.89–1.60)	.25				
Increased difficulty with family							1.23 (0.88–1.73)	.23			1.10 (0.85–1.41)	.47
Stress					1.21 (0.94–1.57)	.14					1.50 (1.18–1.91)	<.001

Rx = medical prescription.
[a] All estimates are from multilevel logistic regression models to adjust for intraclass correlation present from students sampled from the same school.
[b] All models are adjusted for the baseline measure of the dependent variable and race/ethnicity.
[c] Includes synthetic marijuana, cocaine, amphetamines, inhalants, hallucinogens, over-the-counter medication, and ecstasy.
[d] Model 1: each COVID measure was entered into a separate model to estimate individual association.
[e] Model 2: all COVID measures that were statistically significant in Model 1 were entered into a single model to estimate relative association.

drugs, even after accounting for prepandemic use of these substances. Similar to prior research documenting adolescent use of substances as a coping mechanism [24,25], it is possible that given the uncertainty of the pandemic and the swift loss of community resources and social connections, youth self-medicated by misusing substances.

Despite our finding that pandemic-induced stress and loneliness were linked to substance misuse, the relationship between COVID-19 and alcohol and drug use appears more nuanced. Indeed, we found a robust inverse association between feeling isolated and the misuse of a range of substances. This finding is noteworthy considering studies indicating an overall acceleration in alcohol use [22] and increases in adolescent use facilitated by parents during the COVID-19 shutdown [26,27]. Our findings indicate that regardless of their prepandemic consumption, youth who restricted their social interaction secondary to COVID-19 were consistently less likely to misuse alcohol (including heavy episodic use), marijuana, hard drugs, prescription medication, and e-cigarettes. It is possible that increased family time, and thus parental monitoring, resulting from stay-at-home orders, quarantines, and working-from-home reduced opportunities for adolescents to use substances. It may also be that school closures resulted in fewer opportunities for youth to access licit and illicit substances—especially in schools with a climate conducive to drug use [28–31]. Indeed, adolescents perceive substances to be less available during the pandemic [32].

Household factors

Increased difficulty with family relationships during COVID-19 was associated with increased symptoms of depression and anxiety, as well as increased use of alcohol, e-cigarettes, and hard drugs. This is consistent with the extant literature, which shows that adolescents with poor parental relationships or who have parents with depression or anxiety have heightened risk for poor psychological health themselves [9,16]. Family financial instability, including use of a food bank, job loss, or self-reported changes in economic situation were linked to poor mental health (symptoms of depression and anxiety) and increased use of alcohol. Previous studies have shown that adolescents in families with economic challenges experience increased stress related to the pandemic, especially with respect to girls and older teens [8]. Parental stress has increased significantly during the pandemic, exacerbated by job loss, lack of child care and schooling, and increasing family demands [33]. Given this reality and our findings, it is likely that providing support to families (e.g., paying livable wages, rental assistance, child tax credits) will help mitigate the negative impact of this and future crises. Furthermore, increasing the number of, affordability, and access to mental health services will improve the nation's ability to manage and recover from inevitable stressors.

The importance of school

Although decreased physical interaction was linked to decreased substance misuse, it appears likely that school closures resulted in increased anxiety, depression, family conflict, and economic stress. Disruptions in school communities may be particularly deleterious to adolescent stability and development, as school is the major social connection for this group. Furthermore, the impact of school disruption on access to mental health services cannot be underestimated. Indeed, an estimated 13% of adolescents (approximately three million nationwide) report using school mental health care [10]. The loss of a physical learning community, the shift to online learning, inconsistent access to food, and the disconnection from health care provided by schools should all be examined, including whether each of these areas had differential outcomes based on ethnicity and gender. Furthermore, given the critical role of adult and peer relationships in adolescent development [34], the impact of the absence of teachers, mentors (e.g., coaches, music/art instructors), and peers on adolescents' attachment, social competence, social networks, intimate relationships, and friendships needs further exploration.

The potential for long-term COVID-19 impacts on mental and behavioral health necessitates a comprehensive approach to addressing adolescent psychological health, substance use, and economic stability. Given the high likelihood of future school disruptions through man-made and natural disasters, alternatives to physical closures should be immediately explored. Access barriers to community mental health services for adolescents need to be addressed to enhance service provision, especially for economically disadvantaged youth who are more likely to experience racism and discrimination, mistrust of systems, and face a scarcity of resources in areas of disinvestment [35]. More attention should be given to making chat, text, and video-based modalities more accessible for adolescent mental health care, including making them more equitable for low-income families [36–38]. Furthermore, longitudinal examinations of adolescent mental health can help identify protective factors that improve health and highlight risk factors to target with further intervention.

Limitations

As with all studies, findings must be interpreted in light of several limitations. First, all data were based on adolescent self-report. Although adolescents are reliable reporters of their distress and impairment [39], future studies could benefit from a multi-informant approach to include both parents and teachers. Second, the mental health and substance use outcomes were both measured at W3, limiting our ability to establish temporal relationships between these variables. Furthermore, our measure of substance misuse was limited to past-year use. Future studies should consider more recent misuse and the intensity of misuse. Third, while controlling for prepandemic mental health and substance use was a major strength, our study remains limited by having only one assessment point during the COVID-19 pandemic. Longitudinal studies that follow adolescents postvaccination and lockdowns are needed. Finally, some substances had relatively little endorsement making it impossible to conduct any subgroups analyses.

Public health implications

In this large sample of ethnically diverse adolescents, we found that COVID-19-induced isolation, loneliness, stress, and economic challenges were linked to increased mental health and misuse of licit and illicit substances. Critically, we assessed psychological health and substance use prior to and during the pandemic, which allowed us to control for baseline psychosocial factors. Adolescence is an important time to attend to new onset or worsening of mental health difficulties, particularly given that

this period represents a time of developmental change marked by greater desire for autonomy, pressure to conform, and ongoing development of self-regulation and executive function skills (including features associated with inhibitory behaviors and impulsivity) [40]. Furthermore, adolescence is the time period most linked to the onset of risk-taking behaviors, including substance use [41]. The COVID-19 pandemic disrupted multiple aspects of adolescent development. Understanding the short- and long-term impact of this global crisis on adolescent mental and behavioral health is necessary for the development of prevention and intervention programs, not only for the current crisis but for future global (e.g., war, future pandemics) and regional (e.g., natural disasters) events. To further inform prevention and intervention programs, future research should identify factors that mitigate or exacerbate the negative outcomes identified in this study.

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