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## Abstract

Background: During the COVID-19 pandemic in the United States, mental health among youth has been negatively impacted. Youth with a history of adverse childhood experiences (ACEs), as well as youth from minoritized racial-ethnic backgrounds, may be especially vulnerable to experiencing COVID-19-related distress. The current aims are to examine whether exposure to pre-pandemic ACEs predicts mental health during the COVID-19 pandemic in youth and whether racial-ethnic background moderated these effects.

Methods: From May to August 2020, 7,983 youth ($M_{age}$= 12.5, range= 10.6-14.6 years old) in the Adolescent Brain Cognitive Development Study℠ (ABCD Study®) completed at least one of three online surveys measuring the impact of the pandemic on their mental health. Data was evaluated in relation to youth's pre-pandemic mental health and ACEs.

Results: Pre-pandemic ACE history significantly predicted poorer mental health (across all outcomes) and greater COVID-19-related stress and impact of fears on well-being. Youth reported improved mental health during the pandemic (from May to August 2020). While reporting similar levels of mental health, youth from minoritized racial-ethnic backgrounds had elevated COVID-19-related worry, stress, and impact on well-being. Race and ethnicity generally did not moderate ACE effects. Older youth, girls, and those with greater pre-pandemic internalizing symptoms also reported greater mental health symptoms.

Conclusions: Youth who experienced greater childhood adversity reported greater negative affect and COVID-19-related distress during the pandemic. Although they reported generally better mood, Black, Asian American, and multiracial youth reported greater COVID-19-related worry

and experienced COVID-19 related discrimination compared to non-Hispanic White youth, highlighting potential health disparities.

The COVID-19 pandemic may have created an international secondary mental health crisis with significant increases in mental health problems being reported (1-9). Preadolescents and adolescents may be particularly vulnerable to changes in mental well-being during the pandemic due to the combined stress of adolescent development (10), transitions to virtual learning (11), routine disruptions (12), reduced interaction with peers (13), and additional family stressors (14). Since the onset of the pandemic, several studies have shown increases in the mental health symptoms in children and adolescents in China (2-4), Western Europe (1, 15), Canada (16), and the United States (U.S.) (5, 7). Given this emerging mental health crisis, identifying particularly vulnerable youth is important for targeted interventions.

Adverse childhood experiences (ACEs) may be a central risk factor for COVID-19-related mental health problems. ACEs include traumatic experiences such as physical abuse, neglect, and family history of psychiatric and substance use disorders (17, 18), with more recent research including other traumatic events like community violence (19, 20) and racial discrimination (20-23). ACEs have been linked with negative physical health outcomes (24, 25) and alterations in biological stress response (26, 27) and neural development (28, 29). Experiencing childhood adversity has also been associated with poorer mental health during adolescence through adulthood (18, 30, 31). These findings support the diathesis-stress and stress-sensitization models that posit exposure to chronic, early life stress, such as ACEs, can lead to dysregulation in biological responses to stress reducing one's tolerance to future stressful events and increasing one's risk for dysregulated affect and downstream poorer mental health (32, 33).

Aligning with these models, children who have experienced ACEs may be more susceptible to mental health challenges during large-scale stressful circumstances, such as the

recent COVID-19 pandemic. Indeed, studies have shown links between ACEs and greater anxiety, post-traumatic stress, and depressive symptoms during the pandemic in Chinese adolescents (34) and college students (35), German adults (36), and U.S. adolescents (37) and college students (38). However, studies investigating ACEs and mental health have been limited in sample size (36, 37), primarily conducted outside of the U.S., and only two study to date assessed ACEs pre-pandemic (36, 37) while others (34, 35, 38) were cross-sectional.

Notably, children from racial and ethnic minority backgrounds disproportionately experience more ACEs (39-41). In the U.S., 45% of children (61% of Black and 50% of Latinx children) report at least one ACE, and Black children have nearly twice the odds of having 2+ ACEs compared to non-Hispanic White children (39). Differences in ACEs across racial-ethnic groups may reflect how forms of childhood adversity relate to systemic social inequalities across community environments (e.g., community violence, disparities in incarceration rates) and access to resources (e.g., extreme financial hardship, access to healthcare) which differentially impact people of color (41). Within the U.S., COVID-19 infection, hospitalization, and mortality rates have been significantly higher in historically marginalized communities, with Black, Latinx, and Indigenous adults being two times more likely to die of COVID-19 compared to White adults (42-45). Furthermore, during the pandemic, adults from Black, Latinx, and multiracial backgrounds have reported greater impacts on their mental health compared to non-Hispanic White adults (46, 47). Public health models propose that this differential impact of COVID-19 across communities represents a syndemic, where the global health pandemic is co-occurring and intersecting with structural racism and mental health inequities leading to poorer outcomes (48-51). However, few studies have examined the impact of ACEs on mental health

during the COVID-19 pandemic in preadolescents and adolescents from minoritized racial-ethnic backgrounds in the U.S.

To expand upon this literature, the current study examined whether ACEs measured *before* the COVID-19 pandemic predicts mental health outcomes during the pandemic in youth enrolled in the nationwide, longitudinal Adolescent Brain Cognitive Development℠ Study (ABCD Study®; n=7,983) and whether youth from minoritized racial-ethnic backgrounds demonstrate a stronger relationship between ACEs and mental health outcomes across multiple timepoints in the early months of the COVID-19 pandemic. Based on prior literature, we hypothesize that those who have experienced ACEs will be more likely to experience increased symptoms of negative affect, reduced positive affect, and poorer mental health on general and COVID-19-related outcomes during the COVID-19 pandemic.

## Methods and Materials

### Participants and Design Overview

Participants in the current study were drawn from the larger ABCD Study® cohort of 11,880 children (recruited in 2016-2018 at ages 9 or 10 years, from 22 sites throughout the U.S.) (52, 53). School-based recruitment was used to match the demographic profile of the American Community Survey enrollment statistics within catchment regions (54). All study procedures were approved by the centralized UCSD IRB. Each youth and parent in the ABCD Study were sent links to optional surveys about the impact of the pandemic via email and text in May, June, and August of 2020. Youth and parents were both compensated $5 per completed survey. Participants in the current analyses completed the ABCD Study baseline and 1-year follow-up

assessments and at least one mental health outcome in the COVID-19 impact survey [survey 1 (*n*=5,620 youth), survey 2 (*n*=5,903 youth), survey 3 (*n*=5,411 youth)].

**Measures**

Only selected measures included in the current analyses are described here. The current study used baseline and 1-year follow up data from demographic, physical health, mental health (55), substance use (56), and family, culture, and environment (57) modules.

***Demographic Variables and Additional Covariates.***

Demographic variables for sex assigned at birth, race, ethnicity, parental educational attainment, and household income were all reported by parents pre-pandemic at the study baseline (55), and visit and age were measured at the first COVID-19 impact survey. Additional COVID-19-related stressors that may also relate to youth's mental health and affect, such as family job/wage loss and changes in school environment (e.g., virtual learning), were also reported by parents at each COVID-19 impact survey.

***Coding of Adverse Childhood Experiences from Pre-COVID/Baseline Data***

ACEs were coded based on measures collected at the ABCD Study baseline and 1-year follow-up assessments (55-59). **Cumulative coded ACE risk scores** were created by summing across parent and youth-identified experiences with endorsement *of ever experiencing an event from an ACE category* (e.g., emotional abuse, physical neglect) counting as one point (60). (Information related to specific measures and ACE scoring algorithm can be found in supplemental materials). ACE categories included in coded scoring were as follows: emotional, physical, and sexual abuse, household substance use, mental illness in household, parental separation/divorce, family member involvement with legal system, emotional and physical

neglect, extreme financial adversity, racial discrimination, bullying, domestic violence, grief, community violence, natural disaster, witnessing death or destruction in a war zone, witnessing or being present during an act of terrorism, car accident, or other significant accident requiring medical attention (see Table S1 in supplement for proportions for each ACE category). The cumulative coded ACE score ranged from 0-21.

***Baseline Internalizing Symptoms***

Baseline age-corrected *t*-scores from the *internalizing problems scale* on the Child Behavior Checklist-Parent form (CBCL) (55, 61) were used, which includes parental report of child psychopathology (i.e., anxious/depressed, withdrawn/depressed, and somatic complaints syndrome scores) in the last 6 months.

***ABCD COVID-19 Impact Survey Measures***

**NIH Toolbox Emotion Battery v2.0.** The Sadness Scale (assessed survey 1 (S1 and S3)) and Fear Scale (S2) are 8-item scales assessing youth's report of low mood and cognitive elements of depression and anxiety related to threat, respectively. Both scales' responses ranged from 1="never" to 5="almost always." The Positive Affect Scale (S2) is a 9-item scale measuring youth's report of emotions such as happiness, excitement, and joy, and responses ranged from 1="not true" to 3="very true." Scores across all measures were converted to normalized t-scores for analyses. One question was also created to assess youth's experiences of anger and frustration in the past week (S1 and S3).

**Perceived Stress Scale (PSS)-4.** The PSS-4 (assessed S1-S3) (62) is brief measure designed to assess broad psychological stress in the past month, and responses ranged from 0="never" to 4="very often."

**Coronavirus Health Impact Survey (CRISIS) V0.2 Short Form- Worry and Uncertainty Stress** (https://creativecommons.org/licenses/by/4.0/). Two questions were chosen to assess youth report of COVID-19 related worry (assessed S1-S3) and stress associated with COVID-19 uncertainty (S2). Both item responses ranged from 1="not at all" to 5="extremely."

**Fear of Illness and Virus Evaluation (FIVE) Scale-Impact of Illness and Virus Fears.** Questions were included to assess youth's appraisal of the impact the virus has had on their emotional well-being and life enjoyment (assessed S1 and S3) (Ehrenreich-May, 2020), and responses ranged from 1="not true" to 4="definitely true."

**Experienced Racial Discrimination Related to COVID-19.** Youth were asked whether they had directly experienced racial discrimination related to COVID-19 (assessed S1-S3), and responses ranged from 0="never" to 4="very frequently."

**Statistical Analyses**

The current study utilized data from the ABCD 3.0 data release (DOI: 10.15154/1519007) and the ABCD COVID-19 Survey first data release (DOI: 10.15154/1520584). All analyses were run in R version 4.0.3 (63). Models for each mental health outcome were estimated using a linear mixed-effects (LME) design using the lme4 package (64). Primary predictors in each model included ACEs, race, ethnicity, and a measure of time (i.e., survey timepoints), and ACE×time. Covariates included age, sex, parental educational attainment, household income, baseline CBCL internalizing symptoms, and COVID-19 stressors (i.e., family job/wage loss and school environment). Further, to test the secondary aims, LME models with the additions of ACE×race (or ethnicity) or ACE×race×time (or ethnicity) analyses were conducted. All models accounted for the independent second-level random effects of

sibling/twin status, ABCD Study collection site, and subject (i.e., repeated measure analyses). Benjamini-Hochberg corrections were used to adjust significance levels for general mental health and COVID-19 specific outcomes separately to reduce false discovery rate at .05 level (65); these corrections provided a threshold of .0.019 for general mental health outcomes and 0.049 for COVID-19 specific outcomes.

To better understand observed racial/ethnic differences in COVID-19-related mental health outcomes, post-hoc LME analyses were conducted to examine whether race or ethnicity were associated with experiencing COVID-19 discrimination after controlling for aforementioned demographic, covariates, and random effects. Further, we added the experienced COVID-19 racial discrimination variable to models with a significant ACEs×race (or ethnicity) interaction for COVID-19 specific outcomes (i.e., COVID-19 worry) (see supplement).

## Results

### Demographic Analysis

See Table 1 for the full ABCD cohort and current sample (*n*= 7,983) demographics. Compared to the full ABCD cohort, the current sample was more likely to have higher parental education and household income, identify race as White, and identify as non-Hispanic. Average participant age at survey 1 was 12.5 years old. In the current sample, average ACE scores were lower (*M*= 2.45, *SD*= 1.96) compared to scores in the full ABCD cohort (*M*= 3.09, *SD*= 2.18).

ACE scores significantly differed by age at first COVID-19 survey [$F(1, 6503)=10.06$, $p=.0015$] (ACE scores decreased as age increased), sex assigned at birth [$F(1, 7994)=4.81$, $p=.028$] (males reported more ACEs), race [$F(3, 7904)=120$, $p<.001$)] (Black youth reported the highest ACE scores, then Other/Multiracial, White, and Asian American), ethnicity [$F$(1,

7900)=10.24, *p*=.001) (Latinx youth reported more ACEs), baseline household income [*F*(2, 7448)=554.4, *p*<.001] (youth with lower household income had higher ACEs), baseline parental educational attainment [*F*(4, 7982)=203.8, *p*<.001] (youth with parents with a high school diploma or some college had higher ACEs compared to other groups), and baseline internalizing scores [*F*(1, 7994)=833.2, *p*<.001] (more ACEs was related to higher baseline internalizing scores).

**Primary Findings:**

***General Mental Health***

**Sadness Scale**. *ACEs.* Greater ACEs significantly predicted greater sadness (see Table 2 and Figure 1). *Time.* Sadness significantly decreased across the three surveys with no ACEs*time interaction. *Race&Ethnicity*. Race was significantly related to sadness. Compared to non-Hispanic White youth, Black youth reported less sadness. *ACEs*Race or Ethnicity*Time*. No effects were significant. *Demographics.* Older youth, girls, and those with greater internalizing scores (*p*'s<.001) reported greater sadness.

**Positive Affect Scale**. *ACEs.* Higher ACE scores significantly predicted less positive affect. *Race&Ethnicity*. Race was significantly related to positive affect. Compared to non-Hispanic White youth, Black youth reported more positive affect. *ACEs*Race or Ethnicity.* No effects were significant. *Demographics.* Older youth (*p*=.017), girls (*p*=.001), and those with greater internalizing scores (*p*<.001) reported less positive mood.

**Fear/Worry Scale**. *ACEs.* Greater ACEs significantly predicted more fear and worry . *Race&Ethnicity.* Race was significantly related to fear/worry. Compared to non-Hispanic White youth, Other/Multiracial youth reported greater fear/worry. *ACEs*Race or Ethnicity*. No effects

were significant. *Demographics.* Those with household incomes between 50-100K ($p$=.003) and ≥100K ($p$=.015), greater internalizing scores ($p$<.001), and girls ($p$<.001) reported greater fear and worry.

**Anger/Frustration**. *ACEs.* Increased ACEs significantly predicted greater anger and frustration. *Time.* Anger and frustration significantly decreased over time with no ACEs*time interaction. *Race&Ethnicity.* Race was significantly related to anger/frustration. Compared to non-Hispanic White youth, Black youth reported less anger and frustration. *ACEs*Race or Ethnicity*Time*. No other effects were significant. *Demographics.* Girls ($p$<.001) and those with household incomes ≥100K (p=.02) and greater internalizing scores ($p$<.001) reported more anger and frustration.

**Perceived Stress Scale-4**. *ACEs.* Increased ACEs significantly predicted greater perceived stress. *Time.* Perceived stress significantly decreased over time with no ACEs*time interaction. *Race&Ethnicity and ACEs*Race or Ethnicity*Time.* No effects were significant. *Demographics.* Older youth, girls, and those with greater internalizing scores ($p$'s<.001) reported greater perceived stress.

***COVID-19 Specific Mental Health Outcomes***

**CRISIS-COVID-19 Worry.** *ACEs.* ACEs did not significantly predict COVID-19 related worry (see Table 3 and Figure 2). *Time.* Worry significantly decreased over time with no ACEs*time interaction. *Race&Ethnicity.* Race and ethnicity were significantly related to worry. Compared to non-Hispanic White youth, Black, Asian American and Other/Multiracial youth reported greater COVID-19-related worry. Latinx youth also reported more COVID-related worry compared to non-Hispanic youth. *ACEs*Race*Time*. A significant three-way interaction

showed Black youth demonstrated unique patterns between ACEs and COVID-19 related worry across time. Compared to non-Hispanic White youth, Black youth with higher ACEs demonstrated a more robust reduction in peak worry from survey 2 to 3 while youth from other racial backgrounds had similar COVID-19 worry trajectories across ACE scores (see Figure 3). *ACEs*Ethnicity*Time*. No effects were significant. *Demographics.* Girls and those with family wage loss and greater internalizing scores (*p's*<.001) reported more COVID-19-related worry.

**CRISIS-COVID-19 Uncertainty Stress**. *ACEs.* Greater ACEs significantly predicted more COVID-19-related uncertainty stress. *Race&Ethnicity.* Race was significantly related to stress. Compared to non-Hispanic White youth, Black and Other/Multiracial youth reported significantly more COVID-19-related uncertainty stress. *ACEs*Race or Ethnicity*. No effects were significant. *Demographics.* Girls (*p*<.001), and those with family wage loss (p=.01) and greater internalizing scores (*p*<.001) reported more COVID-19 uncertainty stress.

**FIVES: Impact of Illness and Virus Fears.** *ACEs.* Greater ACEs significantly predicted greater impact of virus fears on well-being. *Time.* The impact of virus fears significantly decreased over time with no ACEs*time interaction. *Race&Ethnicity.* Race was significantly related to impact. Compared to non-Hispanic White youth, Other/Multiracial youth reported greater impact of the virus on their well-being. *ACEs*Race or Ethnicity*Time*. No effects were significant. *Demographics.* Girls and those with higher internalizing scores (*p*'s<.001) reported greater impact of virus-related fears and those with parents with a high school diploma (p=.02), some college (p=.02), and bachelor's (p=.008) and post graduate degrees reported less impact (p=.01).

## Discussion

Prior research has shown that experiencing childhood adversity predicts mental health trajectories during adolescence to mid-adulthood, which likely relates to how experiencing adversity impacts future responses to environmental stressors (18, 30, 31). Hence, the present study examined the relationship between pre-pandemic ACEs and affective state and mental health in youth during a large-scale stressor, the COVID-19 pandemic. We found that in a diverse group of youth enrolled in the longitudinal ABCD Study, greater ACEs measured *prior to* the COVID-19 pandemic significantly predicted greater negative mood symptoms and COVID-19-related stress and fear during the first months following the pandemic onset (spring and summer 2020) after controlling for demographics, internalizing symptoms, and co-occurring COVID-19 family and school stressors. Youth from minoritized racial-ethnic backgrounds experienced differential relationships between ACEs and COVID-19-related worry. We also identified that other factors, including race, ethnicity, sex at birth, internalizing symptoms, and age were also linked with mental health and COVID-19-related distress during the pandemic.

Specifically, more ACEs predicted greater past-week sadness, fear and anger, past-month perceived stress, and lower levels of past-week positive affect in a *dose-dependent* fashion, with effect sizes ranging from small to medium. As ACE risk scores increased, youth reported significantly greater COVID-related stress and impact of COVID-19 fear on their daily lives, with more subtle, smaller effect sizes. These findings are consistent with results from other studies during the pandemic (34-36) and suggest that contributions of childhood stressors or trauma experiences have a predictive relationship with preadolescent/adolescent mental health during the pandemic in the U.S. Notably, longitudinal analyses accounted for pre-pandemic internalizing symptoms, suggesting the mood symptoms experienced during the pandemic are

not simply continuation of premorbid distress levels. In a promising trend, mood symptoms and COVID-19-related distress improved across the three waves of data collection from May to August 2020. These improvements in mood and mental health across the early months of the pandemic could be explained by how exposure to early life stress may help provide resistance to future stressors (66). Still, findings primarily suggest that adolescents and preadolescents who have experienced elevated ACEs should be targeted for prevention and intervention efforts as the field attempts to reduce the negative mental health consequences of the pandemic.

Our secondary aim was to examine whether youth from minoritized racial-ethnic backgrounds experienced a stronger relationship between ACEs and mental health symptoms during the pandemic. Across general mood and mental health outcomes, we did not find that race or ethnicity moderated these relationships. However, significant main effects of race/ethnicity and ACE×race interactions, with small effect sizes, were found for COVID-19-specific worry, stress, and impact of virus fears. Findings showed that youth from minoritized racial-ethnic backgrounds reported greater COVID-19-worry, wherein Black youth with higher ACEs reported greater COVID-19-related worry at survey 2 compared to non-Hispanic White youth. Black and Other/Multiracial youth also reported greater COVID-19 stress and impact of fears on well-being compared to non-Hispanic White youth. While these race findings typically had smaller effect sizes or some did not stand after corrections, small effect sizes in large samples may have meaningful impact in prevention work when replicated. Therefore, replication of these findings is warranted to better understand potential racial/ethnic differences in mental health responses to the COVID-19 pandemic to ensure scientific and clinical communities are addressing potential health disparities.

One potential explanation for elevated COVID-19-related distress in youth from minoritized communities is their families' increased exposure to the effects of COVID-19 (48-51). Within some minoritized racial-ethnic communities (i.e., Black, Latinx, and some indigenous groups), COVID-19-related health disparities have been documented in elevated risk for infection, hospitalization, and mortality (42-45). While not directly assessed, these findings may reflect the repercussions of generations of multilevel systemic inequalities that disproportionately impact some minoritized communities (e.g., Black and Latinx) where COVID-19 circumstances compound upon existing stressors (50, 67). In these communities, greater risk for underlying conditions that exacerbate COVID-19, limited healthcare access (e.g., COVID-19 testing, vaccines, and treatment), and overrepresentation in essential workers are likely contributors to COVID-19 racial-ethnic health disparities (68). Another contributor to elevations in COVID-19-related distress could be racial-ethnic minorities' experiences of racial discrimination during COVID-19. However, during the pandemic, racial-ethnic minority groups have likely experienced racial discrimination but for different reasons. Specifically, Asian American have experienced greater discrimination related to the virus, while Black individuals have faced increased discrimination due to societal responses to the Black Lives Matter movement (69). Consistent with this hypothesis, racial minority youth reported greater COVID-19 discrimination, and experiencing COVID-19-related racial discrimination was a significant predictor of COVID-19-related worry (see supplement). These specific differences in COVID-19-related mental health symptoms in youth from minoritized racial-ethnic backgrounds suggest they are experiencing unique COVID-19 distress and increased incidents of racial discrimination. Culturally sensitive mental health interventions that target COVID-19-related concerns and integrate cultural and contextual factors are needed (70).

While the primary focus of this study was on ACEs and its interactions with of race/ethnicity, other factors including demographics (i.e., sex) and internalizing symptoms were robust predictors of pandemic mental health. One of the most consistent predictors was pre-pandemic internalizing symptoms. Increased pre-pandemic internalizing symptoms predicted increased sadness, fear, anger, perceived stress, COVID-19-related worry, stress, and fear and reduced positive affect and general well-being. This aligns with findings of early internalizing problems predicting adolescent mental health trajectories (71) and emphasizes the public health need for early screening for childhood and preadolescent mental health symptoms, especially during the current pandemic.

Notably, a significant effect of biological sex at birth was observed wherein female youth reported significantly poorer mood and greater distress on COVID-19-related measures compared to males. Findings align with studies that have observed significant sex differences in mental health symptoms during the COVID-19 pandemic (4, 72). These findings may reflect the interaction of documented increases in internalizing symptoms in girls (73, 74) co-occurring with additional pandemic stress. While not a primary focus of the current investigation, future research is warranted to examine the sex effects related to mental health during COVID-19.

The current study is not without limitations. Within the ABCD Study design, more direct assessments of some ACEs were included (e.g., household substance use); however, some ACE categories were determined through proxy variables (e.g., emotional neglect assessed through youth's perceptions of caregiver warmth; see supplement). Further, the present ACE score does not account for experiences that may have occurred between 1-year follow-up and first COVID-19 impact survey. We also did not measure frequency, timing, or severity of ACEs. Given the impact of ACEs here, future research should include more explicit assessment of ACEs that can

tease apart the unique impact of frequency, severity, and timing of events. The current study sample was also under sampled in minoritized populations and low-income families relative to the overall ABCD Study cohort (51). Further, the ABCD Study was not designed to disentangle multifaceted associations between developmental outcomes and race/ethnicity; accordingly, ABCD assessments about race and ethnic identity are not exhaustive and are often conflated with nationality. Limited measurements of racial-ethnic identity led ABCD to collapse across under sampled racial groups likely minimizing other-group differences in COVID-19 pandemic experiences in addition to implying experiences across groups are homogeneous. Future research addressing health disparities should prioritize proportional representation of racial-ethnic minority groups. While the current study accounted for some co-occurring COVID-19-related stressors (i.e., family job/wage loss and changes in school environment) other stressors like experiencing household pandemic-related illness or the severity or timing of COVID-19 stressors were not included. To further understand potential public health disparities, incorporating geocoded data that includes COVID-19 severity rates, hospital capacity, access to testing and vaccines, and public policy (e.g., mask mandates, stay-at-home orders) may help to elucidate mental health trajectories during the pandemic in future work. Finally, the current findings were assessed during the summer of 2020, and rapid changes in the fall of 2020 such as differential school openings and closings and significant increases in virus cases could impact reports of mental well-being; thus, research with more assessment points is necessary. To highlight study strengths, the ABCD Study sample is the largest and most diverse preadolescent/adolescent sample used to date to examine how pre-pandemic exposure to ACEs may predict mental health outcomes during the COVID-19 pandemic.

In summary, experiencing childhood adversity prior to the pandemic was consistently associated with poorer mood and mental health outcomes during the COVID-19 pandemic. Youth from minoritized racial-ethnic backgrounds experienced greater distress on COVID-19-related outcomes, with ACE×race interaction being found for experiences of COVID-19 worry. Notably, across the early months of the pandemic onset (summer 2020), youth reported improvements in mental health suggesting potential resiliency as the pandemic continues. Current study findings provide support for early assessment of ACEs to address the pandemic-related mental health crisis in youth, with particular focus given to youth from minoritized racial-ethnic backgrounds who reported more COVID-19-related distress and discrimination. From a public health perspective, results highlight the urgency for schools, mental health clinics, and pediatricians to partner with parents and community leaders to screen adolescents with ACEs history for emerging mental health needs. Although racial-ethnic minority youth demonstrated resilient general mental health, results suggest that culturally sensitive prevention and intervention efforts aimed at alleviating COVID-19-related distress in minoritized youth are also a public health priority.

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## Author Disclosure Statement

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Figure 1. *Greater ACE Scores Relate to Poorer Mood During the COVID-19 Pandemic*

Notes: Graph shows bivariate relationship between ACE scores and sadness, positive affect, and fear/worry outcomes (shaded portions represent standard error). The presented data for sadness represents the mean sadness scores across time (assessed at surveys 1 and 3), while fear/worry and positive affect represent mean scores at survey 2. As ACE scores increase, sadness and fear increase and positive affect decreases.

Figure 2. *Greater ACE Scores Relate to Greater COVID-19-related Stress and Greater Impact of Virus Fears During the COVID-19 Pandemic*

Notes: Graph shows bivariate relationship between ACE scores and COVID-19 specific outcomes (shaded portions represent standard error). The presented data for COVID-19 worry represents the mean worry scores (assessed at surveys 1-3) and mean impact of illness/virus fears scores (assessed at surveys 1 and 3) across time, while COVID-19 uncertainty stress represents mean scores at survey 2. As ACE scores increase, COVID-19 stress and impact of virus fears increase, while COVID-19 worry was not significantly associated with ACEs.

Figure 3. *Changes in COVID-19 Worry Across Early Months of the COVID-19 Pandemic*

Notes: Graphs shows changes in mean COVID-19 worry across time as a function of ACEs (low vs high) and race. While continuous variables were used in the ACE*race*time interaction, ACEs is presented as a categorical variable for visual graphing purposes.

Table 1. *Demographics for the Adolescent Brain Cognitive Development (ABCD) Study and the Current Study Sample*

| | **Release 3.0 (%) (Baseline Data) n=11,880** | **Current Study Sample (%) n=7,983** |
|---|---|---|
| **Sex (Female)** | 48 | 49 |
| **Race** | | |
| Youth identifies as White | 63 | 69 |
| Youth identifies as Black | 16 | 11 |
| Youth identifies as Asian American | 2 | 3 |
| Youth identifies as Other/Multiracial identity | 17 | 16 |
| Missing/Undefined | 1 | 1 |
| **Ethnicity** | | |
| Youth identifies as Hispanic or Latinx | 20 | 18 |
| Missing/Undefined | 1 | 1 |
| **Parental Education** | | |
| Less than HS Diploma | 5 | 2 |
| HS/Diploma/GED | 10 | 7 |
| Some College | 26 | 22 |
| Bachelor | 25 | 28 |
| Post Graduate | 34 | 40 |
| **Household Income** | | |
| < 50K | 27 | 21 |
| >= 50K & <100K | 26 | 28 |
| >=100K | 38 | 44 |
| Missing/Undefined | 9 | 7 |

Table 2. *Predictors of Adolescent General Mental Health Outcomes During COVID-19 Pandemic*

| **Outcome** Factors/Covariates | Survey Timepoint | Estimate | Std. Error | df | t | Uncorrected p-value | FDR p-value |
|---|---|---|---|---|---|---|---|
| **Sadness** | **Survey 1&3** | | | | | | |
| ACEs | | 0.59 | 0.14 | 7032.30 | 3.92 | **p< .001*** ** | p<.001 |
| Time | | -1.56 | 0.25 | 4062.51 | -6.36 | p<.001 | |
| ACEs*Time | | 0.07 | 0.08 | 3999.14 | 0.87 | p=0.38 | p=0.72 |
| Race | | | | | | | |
| Black | | -1.63 | 0.54 | 4471.59 | -3.00 | p=0.0027 | |
| Asian American | | -0.26 | 0.85 | 4145.30 | -0.30 | p=0.76 | |
| Other/Multiracial | | 0.37 | 0.40 | 4502.79 | 0.93 | p=0.35 | |
| Ethnicity | | 0.38 | 1.17 | 6326.79 | 0.33 | p=0.74 | |
| ACEs*Race | | | | | | | |
| Black | | 0.77 | 0.48 | 6558 | 1.61 | p=0.11 | p=0.36 |
| Asian American | | 1.60 | 1.053 | 6519 | 1.51 | p=0.13 | p=0.37 |
| Other/Multiracial | | 0.038 | 0.34 | 6498 | 0.11 | p=0.91 | p=0.98 |
| ACEs*Ethnicity | | 0.055 | 0.37 | 6523.60 | 0.15 | p=0.88 | p=0.98 |
| ACE*Race*Time | | | | | | | |
| Black | | -0.74 | 0.29 | 4368 | -2.57 | p=0.01 | p=0.07 |
| Asian | | -0.80 | 0.60 | 3519 | -1.346 | p=0.18 | p=0.48 |
| Other/Multiracial | | -0.0027 | 0.20 | 3881 | -0.013 | p=0.99 | p=0.99 |
| ACExEthnicity*Time | | -0.057 | 0.22 | 4118.42 | -0.257 | p=0.79 | p=0.97 |
| | | | | | | | |
| **Positive Affect** | **Survey 2** | | | | | | |
| ACEs | | -0.46 | 0.11 | 3321.04 | -4.24 | **p<.001*** ** | p<.001 |
| Race | | | | | | | |
| Black | | 1.95 | .76 | 3074.96 | 2.56 | p=.01 | |
| Asian American | | -0.59 | 1.06 | 3075.60 | -0.56 | p=0.58 | |
| Other/Multiracial | | -0.02 | 0.53 | 3120.15 | -0.038 | p=0.97 | |
| Ethnicity | | -1.12 | 0.87 | 2779.34 | -1.26 | p=0.21 | |
| ACEs*Race | | | | | | | |
| Black | | 0.60 | 0.35 | 3410.42 | 1.72 | p=0.086 | p=0.36 |
| Asian | | 0.42 | 0.69 | 3392.51 | 0.61 | p=0.54 | p=0.75 |
| Other/Multiracial | | 0.41 | 0.25 | 3340.69 | 1.68 | p=0.094 | p=0.36 |
| ACEs*Ethnicity | | 0.34 | 0.26 | 3347.84 | 1.30 | p=0.19 | p=0.48 |
| | | | | | | | |
| **Fear/Worry** | **Survey 2** | | | | | | |
| ACEs | | 0.46 | 0.092 | 3792.71 | 4.98 | **p<.001*** ** | p<.001 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Race | | | | | | | |
| Black | | -0.16 | 0.61 | 2846.98 | -0.25 | p=0.80 | |
| Asian American | | 0.12 | 0.91 | 2837.32 | 0.13 | p=0.89 | |
| Other/Multiracial | | 0.95 | 0.45 | 3175.43 | 2.13 | p=0.034 | |
| Ethnicity | | -0.31 | 0.74 | 2361.73 | -0.42 | p=0.67 | |
| ACEs*Race | | | | | | | |
| Black | | 0.12 | .28 | 3891 | 0.42 | p=0.67 | p=0.84 |
| Asian American | | 0.47 | .61 | 3886 | 0.77 | p=0.44 | p=0.74 |
| Other/Multiracial | | -0.14 | .21 | 3774 | -0.67 | p=0.50 | p=0.74 |
| ACEs*Ethnicity | | 0.16 | 0.22 | 3783.14 | 0.72 | p=0.47 | p=0.74 |
| | | | | | | | |
| **Anger/Frustration** | **Survey 1&3** | | | | | | |
| ACEs | | 0.046 | 0.015 | 6466 | 3.03 | **0.0024*** | p=0.02 |
| Time | | -0.15 | 0.028 | 4390 | -5.440 | p<.001 | |
| ACEs*Time | | 0.0051 | 0.0091 | 4309 | 0.56 | 0.57 | p=0.76 |
| Race | | | | | | | |
| Black | | -0.11 | 0.051 | 4412 | -2.10 | 0.036 | |
| Asian American | | -0.083 | 0.079 | 3965 | -1.05 | 0.29 | |
| Other/Multiracial | | -0.0063 | 0.037 | 4358 | -0.17 | 0.87 | |
| Ethnicity | | 0.21 | 0.13 | 6031 | 1.63 | 0.10 | |
| ACEs*Race | | | | | | | |
| Black | | 0.0090 | 0.052 | 6303 | 0.17 | 0.86 | p=0.98 |
| Asian American | | -0.085 | 0.11 | 5732 | -0.74 | 0.46 | p=0.74 |
| Other/Multiracial | | -0.057 | 0.038 | 5958 | -1.52 | 0.13 | p=0.37 |
| ACEs*Ethnicity | | -0.027 | 0.040 | 6104 | -0.68 | 0.50 | p=0.74 |
| ACEs*Race*Time | | | | | | | |
| Black | | -0.021 | 0.033 | 4792 | -0.64 | 0.52 | p=0.72 |
| Asian American | | 0.006269 | 0.069 | 3672 | 0.091 | 0.93 | p=0.98 |
| Other/Multiracial | | 0.024 | 0.023 | 4161 | 1.03 | 0.30 | p=0.61 |
| ACEs*Ethnicity*Time | | 0.027 | 0.025 | 4480 | 1.07 | 0.30 | p=0.60 |
| | | | | | | | |
| **Perceived Stress** | **Survey 1-3** | | | | | | |
| ACEs | | 0.19 | .029 | 12030 | 6.38 | **p<.001*** ** | p<.001 |
| Time | | -0.28 | 0.034 | 8190 | -8.14 | p<.001 | |
| ACEs xTime | | .00016 | 0.011 | 8201 | 0.014 | p=0.98 | p=0.99 |
| Race | | | | | | | |
| Black | | 0.14 | 0.13 | 4682 | 1.05 | p=0.29 | |
| Asian American | | 0.30 | 0.21 | 4371 | 1.47 | p=0.14 | |
| Other/Multiracial | | 0.16 | 0.098 | 4658 | 1.68 | p=0.094 | |
| Ethnicity | | 0.39 | 0.24 | 9926 | 1.63 | p=0.10 | |
| ACEs*Race | | | | | | | |
| Black | | 0.11 | 0.097 | 12230 | 1.14 | p=0.26 | p=0.58 |
| Asian American | | 0.10 | 0.22 | 12470 | 0.47 | p=0.64 | p=0.82 |
| Other/Multiracial | | -0.01 | 0.071 | 12270 | -0.15 | p=0.88 | p=0.98 |
| ACEs*Ethnicity | | -0.15 | 0.076 | 12160 | -1.96 | p=0.05 | p=0.29 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| ACEs*Race*Time | | | | | | | |
| Black | | -0.075 | 0.041 | 8757 | -1.84 | p=0.066 | p=0.33 |
| Asian American | | -0.063 | 0.085 | 7421 | -0.74 | p=0.46 | p=0.74 |
| Other/Multiracial | | -0.032 | 0.028 | 7993 | -1.12 | p=0.26 | p=0.58 |
| ACEs*Ethnicity*Time | | 0.050 | 0.031 | 8282 | 161 | p=0.11 | p=0.36 |

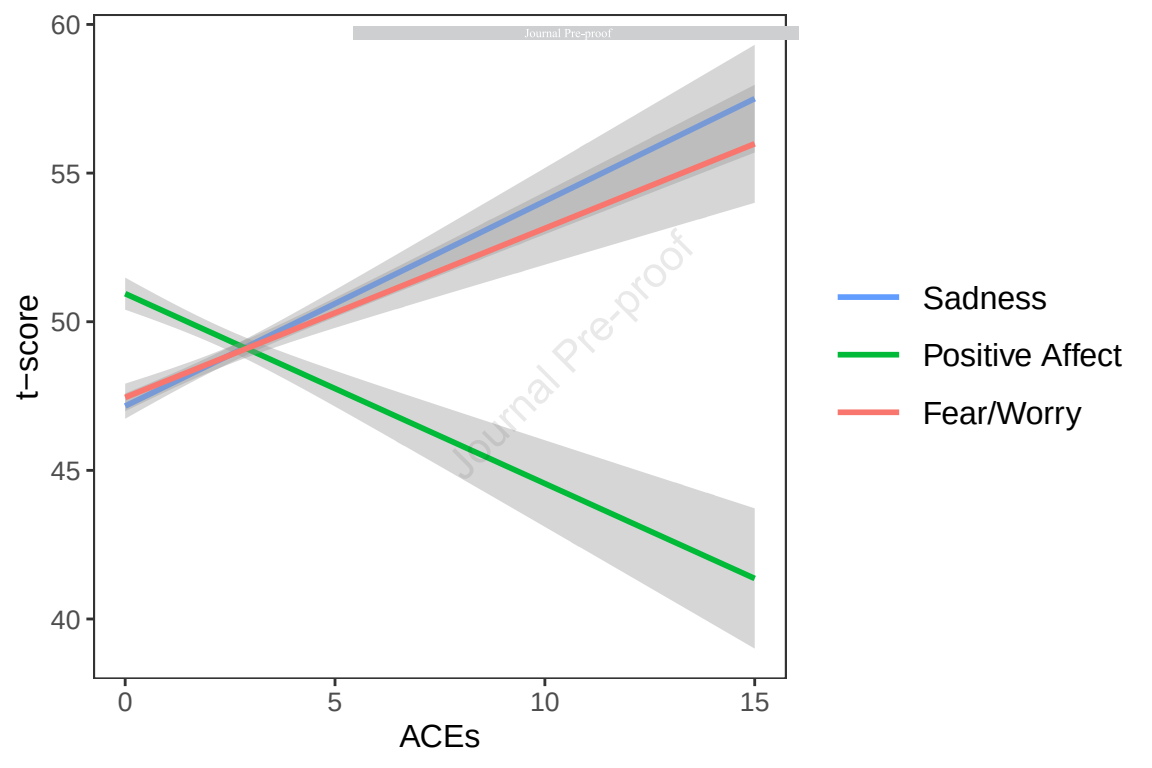
Note. Stars indicate p-value remained significant after corrections: * = p<.05, ** = p<.01, *** = p<.001

Table 3. *Predictors of Adolescent COVID-19-related Mental Health Outcomes During COVID-19 Pandemic*

| **Outcome**<br>Factors/Covariates | Survey Timepoint | Estimate | Std. Error | df | t | Uncorrected p-value | FDR p-value |
|---|---|---|---|---|---|---|---|
| **COVID-19 Worry** | **Survey 1-3** | | | | | | |
| ACEs | | 0.013 | 0.010 | 12230 | 1.11 | p=0.27 | p=0.57 |
| Time | | -0.061 | 0.012 | 8233 | -5.06 | p<.001 | |
| ACEs*Time | | -0.00094 | 0.0039 | 8225 | -0.24 | p=0.81 | p=0.85 |
| Race | | | | | | | |
| Black | | 0.40 | 0.047 | 4661 | 8.579 | p<0.001 | |
| Asian American | | 0.29 | 0.074 | 4336 | 3.94 | p<0.001 | |
| Other/Multiracial | | 0.099 | 0.034 | 4709 | 2.90 | p=0.004 | |
| Ethnicity | | 0.14 | 0.085 | 10190 | 1.61 | p=0.11 | |
| ACEs*Race | | | | | | | |
| Black | | 0.071 | 0.034 | 12350 | 2.08 | p=0.037 | p=0.19 |
| Asian American | | 0.068 | 0.077 | 12500 | 0.87 | p=0.38 | p=.67 |
| Other/Multiracial | | -0.016 | 0.025 | 12400 | -0.66 | p=0.51 | p=.67 |
| ACEs*Ethnicity | | -0.0011 | 0.026 | 12310 | -0.043 | p=0.97 | p=0.97 |
| ACEs*Race*Time | | | | | | | |
| Black | | -0.039 | 0.014 | 8817 | -2.75 | **p=0.006*** | p=0.049 |
| Asian American | | -0.029 | 0.030 | 7455 | -1.09 | p=0.28 | p=0.57 |
| Other/Multiracial | | 0.011 | 0.010 | 8053 | 1.12 | p=0.26 | p=0.57 |
| ACEs*Ethnicity*Time | | 0.0040 | 0.011 | 8347 | 0.369 | p=0.71 | p=0.85 |
| | | | | | | | |
| **COVID-19 Stress** | **Survey 2** | | | | | | |
| ACEs | | 0.033 | 0.010 | 3857 | 3.19 | **p=0.001*** | p=0.018 |
| Race | | | | | | | |
| Black | | 0.30 | 0.069 | 3278 | 4.41 | p<.001 | |
| Asian American | | -0.036 | 0.10 | 3230 | -0.35 | p=0.73 | |
| Other/Multiracial | | 0.16 | 0.050 | 3416 | 3.167 | p=0.002 | |
| Ethnicity | | 0.11 | 0.083 | 2763 | 1.32 | p=0.19 | |
| ACEs*Race | | | | | | | |
| Black | | -0.024 | 0.031 | 3910 | -0.78 | p=0.44 | p=0.68 |
| Asian American | | -0.016 | 0.069 | 3902 | -0.23 | p=0.82 | p=0.85 |
| Other/Multiracial | | 0.013 | 0.023 | 3815 | 0.56 | p=0.58 | p=0.77 |
| ACEs*Ethnicity | | -0.018 | 0.025 | 3824 | -0.73 | p=0.47 | p=0.69 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Impact of Virus Fears** | **Survey 1&3** | | | | | | |
| ACEs | | 0.091 | 0.019 | 6334 | 4.79 | **p<.001*** ** | p<.001 |
| Time | | -0.096 | 0.035 | 4400 | -2.70 | p=0.007 | |
| ACEs*Time | | -0.022 | 0.012 | 4317 | -1.93 | p=0.053 | p=0.19 |
| Race | | | | | | | |
| Black | | 0.098 | 0.063 | 3886 | 1.57 | p=0.12 | |
| Asian American | | -0.069 | 0.097 | 3443 | -0.72 | p=0.47 | |
| Other/Multiracial | | 0.095 | 0.046 | 4007 | 2.09 | p=0.037 | |
| Ethnicity | | -0.0046 | 0.16 | 5801 | -0.03 | p=0.98 | |
| ACEs*Race | | | | | | | |
| Black | | -0.017 | 0.066 | 6221 | -0.26 | p=0.80 | p=0.85 |
| Asian American | | 0.080 | 0.14 | 5550 | 0.55 | p=0.58 | p=0.77 |
| Other/Multiracial | | 0.11 | 0.047 | 5833 | 2.32 | p=0.02 | p=0.13 |
| ACEs*Ethnicity | | 0.052 | 0.050 | 6003 | 1.05 | p=0.29 | p=0.57 |
| ACEs*Race*Time | | | | | | | |
| Black | | -0.046 | 0.041 | 4818 | -1.11 | p=0.27 | p=0.57 |
| Asian American | | -0.033 | 0.088 | 3.650 | -0.37 | p=0.71 | p=0.85 |
| Other/Multiracial | | -0.059 | 0.029 | 0.0042 | -2.00 | p=0.045 | p=0.19 |
| ACEs*Ethnicity*Time | | -0.040 | 0.032 | 4502 | -1.25 | p=0.21 | p=0.57 |

Note. Stars indicate p-value remained significant after corrections: * = p<.05, ** = p<.01, *** = p<.001


Journal Pre-proof
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ACEs
Journal Pre-proof
Sadness
Positive Affect
Fear/Worry