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Exploring the Impact of COVID-19 Stress on Sleep Outcomes Mediated by Technology Use

Among Adolescents: A Cross-Sectional Study

By

Anmol Minaz

Master of Public Health

Epidemiology

_____

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Thesis Chair

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An abstract of

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Master of Public Health in Epidemiology

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Abstract

Exploring the Impact of COVID-19 Stress on Sleep Outcomes Mediated by Technology Use

Among Adolescents: A Cross-Sectional Study

Background: COVID-19 pandemic was an adversarial event globally and constituted unique mental health impacts on the adolescent populations, including psychological stress and worries. Though research exist on the impact of stress on adolescents' sleep, studies are limited in the context of pandemic as well as potential mediating factors. This study sought to examine the impact of COVID-19 stress on sleep outcomes and to determine if technology use mediated this relationship.

Methods: This cross-sectional survey was conducted in two semi-rural schools during the Fall of 2020. Descriptive statistics were examined for all study measures. Bivariate analyses were conducted to assess associations between demographic variables, exposure (COVID-19 stress), and ou,tcome measures (sleep). Linear and logistic regression analyses were run to identify predictors of sleep duration and daytime sleepiness.

Results: More than one-third of adolescents reported short sleep (37.1%) and 28.1% reported excessive daytime sleepiness. A significant percentage of adolescents reported moderate (38.0%) and extreme (17.5%) COVID-19 stress. The bivariate analysis showed differences in COVID-19 stress by gender, race, and SES (p value <0.05). Technology use was high with 55.5% reported 4 or more hours of TV/digital media watching while 43.5% reported use of social media for 4 or more hours. COVID-19 stress was also associated with use of social media. Logistic regression indicated that as COVID-19 stress increased, the odds of short sleep duration were slightly greater (OR: 1.03, 95%CI: 1.004, 1.055) compared to the odds of recommended sleep duration when adjusting for gender, race,

parent education and employment. For daytime sleepiness, as COVID-19 stress increased, the odds of excessive daytime sleepiness were slightly higher (OR: 1.04 95%CI: 1.004, 1.075) than the odds of no/small chance of daytime sleepiness after controlling for covariates.

Conclusion: While this study revealed no or very weak relationship between COVID-19 stress and sleep outcomes, it identifies high COVID-19 stress and technology use as well as important demographic differences in COVID-19 stress among 10th-graders. The study findings call for programmatic interventions at school and community levels and affirms the need for integrated activity guidelines to limit screen time, increase physical activity and meet sleep recommendations among adolescents.

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1. Introduction

Sleep is an integral part of human functioning and is linked to many physical and mental health outcomes (Samson and Nunn, 2015). The Centers for Disease Control and Prevention (CDC) has declared insufficient sleep as a public health problem in the United States (Liu et al., 2016). Insufficient sleep refers to persistent curtailed sleep pattern that lasts for most days of the week for at least three months and is accompanied with problems of daytime sleepiness (Chattu et al., 2018). Globally, insufficient sleep is common among a large proportion of children and adolescents (Wheaton et al., 2018; Zhang et al., 2017).

While adolescence is a period with high rates of insufficient and delayed sleep, the COVID-19 pandemic has impacted adolescent's sleep in many ways (Bothe et al., 2022; Jamieson et al., 2021; Ma et al., 2021; Mayra et al., 2022; Richter et al., 2023; Sharma et al., 2021). The occurrence of the COVID-19 pandemic was an adversarial event globally and constituted unique mental health impacts on the adolescent populations including psychological stress and worries (Furstova et al., 2022). Evidence suggest that the COVID-19 related stress is associated with fears about the severity of COVID-19, worries and fears about future, loss of a sense of safety and security, and personal socio-economic impact of COVID-19 (Gruber et al., 2021; Panchal et al., 2021; Taylor et al., 2020). Though, studies by Zhou et al (2020), Imran et al (2020) and Benham (2020) have highlighted the impact of stress related to COVID-19 pandemic on adolescent's health and sleep pattern, there is a need to understand this relationship because the pandemic has long-lasting yet poorly understood effects over the life course and how it is mediated through different factors like technology use.

Technology use, which has been rapidly increasing in the past twenty years, surged even more during the pandemic, and further shifted sleep patterns among adolescents.

Technology use is highlighted as a significant factor in sleep deprivation among adolescents. It is also linked to daytime sleepiness and increased frequency of waking too early (Johansson et al., 2016). A study highlighted that screen time among college students doubled at the onset of the pandemic (Spring 2020) from about 2.2 hours to 5.2 hours per day by the end of the term and it declined significantly by Fall 2020 and remained steady during spring 2021. However, screen time remained significantly higher than the pre-pandemic levels (Barbieri et al., 2021). Several studies have identified feelings of fears and stress during pandemic with social media use leading to COVID-19 related stress (Gao et al., 2020; Moghanibashi-Mansourieh, 2020; Xiong et al., 2020). However, little is known whether technology use mediates the effect of COVID-19 stress and sleep outcomes among adolescents.

2. Literature Review

a. Insufficient Sleep: A Public Health Epidemic

Sleep problems are concerning particularly for young age groups like adolescents both because of its higher prevalence in this age group as well as potential health consequences. In the United States, it is estimated that 72.7% of high school students and 57.8% of middle schoolers sleep less than the recommended number of hours (National Sleep Foundation, n.d.). Moreover, the prevalence of short sleep duration among high school students in the US has increased from 69.1% to 77.9% between 2009 and 2019 (Centers for Disease Control and Prevention, 2022).

Another important result of sleep loss reported by adolescents is daytime sleepiness. Daytime sleepiness is described as the inability to remain wakeful and alert during the day and having sleep episodes and lapses happening unintentionally or at inappropriate times (Brown & Makker, 2020). A study by Owens et al. (2020) conceptualized daytime

sleepiness to be caused by four factors, two of them are insufficient sleep duration and disturbed sleep. A study conducted with 6-18 years old children and adolescents found excessive daytime sleepiness to be prevalent in almost one-third (29.2%) of the participants (Liu et al., 2019). Other studies have reported prevalence of excessive daytime sleepiness due to various causes from 16% to 47% among adolescents (Joo et al., 2005; Meyer et al., 2017). Excessive daytime sleepiness is likely underreported because of the possibility of being unrecognized by parents and children and adolescents' inability to communicate about their internal state (Owens et al., 2020).

Researchers have highlighted recommended duration for sleep across lifespan and the plausible mechanism for poor sleep outcomes in adolescents. According to the National Sleep Foundation guidelines, the appropriate sleep duration for school-aged children (children with ages from 6 to 12 years) is between 9 and 11 hours while for teenagers (with ages typically from 13 to 18 years) it is recommended 8 to 10 hours (Hirshkowitz et al., 2015). The American Academy of Sleep Medicine has provided similar recommendations (Paruthi et al., 2016). Research has highlighted that the susceptibility to chronic sleep deprivation among adolescents is the result of both biologically driven circadian rhythm late-shift happening around puberty and social factors like waking up early for school (Hagenauer et al., 2009). Although the link between both inadequate and excessive sleep and negative health outcomes is present, the former is more direct than the latter and thus seems to be discussed more in the research studies (Chattu et al., 2018). While the proportion of adolescents with poor sleep measures was higher pre-pandemic, COVID-19 pandemic has impacted sleep in different ways.

b. Adolescence Sleep During Covid-19 Pandemic

Studies examining adolescent sleep outcomes during COVID-19 pandemic have found changes in sleep patterns during the pandemic. According to a survey conducted by the

CDC, about three-fourth of high school students experienced short sleep duration during the COVID-19 pandemic, and around 37.1% of the sample reported poor mental health which correlated with short sleep duration (Sliwa et al., 2021). Similarly, a study by Zhou et al. (2020) found insomnia symptoms to be present in 23.2% of Chinese adolescents and young adults. In addition, a systematic review of studies conducted on children and adolescent sleep patterns during the pandemic found that the pooled prevalence of any sleep disturbance was 54% and that of short sleep duration was 49% (Sharma et al., 2021).

In contrast to these studies, one study conducted with adolescents found longer school night sleep duration and less daytime sleepiness during COVID-19. However, it was also reported by parents that adolescents had more difficulties initiating and maintaining sleep during the pandemic as compared to pre-pandemic period with rates increasing from 24% in pre-pandemic phase to 36% during the pandemic. The study also highlighted more delayed sleep/wake patterns during COVID-19 (Becker et al., 2021). Similar findings were reported by a study conducted in the UK where adolescents reported deterioration in sleep despite the longer sleep times during the COVID-19 pandemic (Illingworth et al., 2022). One survey found that the average sleep duration had initially increase by 30 minutes at the start of pandemic period but returned to pre-pandemic levels by June 2020 (Barbieri et al., 2021). This is interesting to note as sleep duration might had varied during different phases of the pandemic.

Similar findings related to increased sleep duration and shift in bedtime were highlighted in other studies (Benham, 2020; Richter et al., 2023). The switch to virtual classes has been thought to explain this change (Benham, 2020; Jamieson et al., 2021). A systematic review also found disruption in sleep routines as a major finding (Mayra et al., 2022). Besides this, it was found that sleep latency (the time an individual takes to fall

sleep) and use of sleep medication increased, and sleep efficiency became poorer during COVID-19 (Benham, 2020).

COVID-19 pandemic and associated lockdown has influence daytime sleepiness as well. A study reported that approximately 44% of adolescents reported excessive daytime sleepiness (Silva et al., 2022). Another study highlighted that around one-fifth of the adolescents surveyed reported daytime sleepiness (Hu et al., 2021). In addition, the study by Bothe et al., 2022 found the incidence of sleep problems including daytime sleepiness was nearly double during the COVID-19 pandemic compared to pre-pandemic period. Contrary to these findings, few studies found improvement in daytime sleepiness among adolescents during the COVID-19 pandemic (Santos & Louzada., 2022; Socarras et al., 2021). One explanation could be the lack of early wake up pressure during the lockdown (Santos & Louzada., 2022).

c. Insufficient Sleep and Poor Health Outcomes

While the prevalence of poor sleep outcomes among adolescents is problematic, its impact on health outcomes is equally concerning. A number of research studies have suggested a link between lack of sleep and adverse health outcomes (Kochanek et al., 2014; National Sleep Foundation, n.d.). One underlying reason is the role of proinflammatory markers. It has been found that IL-6, IL1 receptor antagonist and salivary amylase are the markers that have been associated with dysregulation in acute sleep deficiency (Chattu et al., 2018). It is estimated that individuals having less than six hours of sleep per night have a 13% higher mortality risk compared to individuals sleeping between seven and nine hours (Hafner et al., 2016). Seven out of fifteen leading causes of death in the United States has been linked to insufficient sleep duration (Kochanek et al., 2014).

Insufficient sleep is also linked with many health outcomes including mental health. A study among a nationally representative sample of US adolescents found that shorter sleep

duration during weeknight, delayed weeknight bedtime, greater delay in weekend bedtime, and weekend oversleep were found to be associated with anxiety, mood issues, behavioural disorders, suicidality, substance use, tobacco smoking, and poor perceived mental and physical health with OR ranging from 1.27 to 2.15 (Zhang et al., 2017). A systematic review involving five longitudinal and 41 cross-sectional studies conducted across 21 countries and including 208,992 individuals suggested that later sleep timing is associated with several different health outcomes like poorer cognitive function, academic performance, emotional regulation and eating behaviours (Dutil et al., 2022). Another study highlighted that the reduced time in bed and delayed sleep subgroups had poorer sleep outcomes like sleep duration, onset latency, and circadian preference misalignment index, and psychological changes during the pandemic. The subgroup with reduced time in bed had significant decrease in total sleep duration while the delayed sleep subgroup showed increase in sleep onset latency and in the circadian preference misalignment index (Robillard et al., 2020).

While sleep duration is linked to many health outcomes, research has also examined the impact of daytime sleepiness on adolescents' health. Excessive daytime sleepiness was found to be associated independently with poor mental health, alcohol and energy beverage consumption, and emotional and behaviour issues (Liu et al., 2019; Owens et al., 2020). Another study identified a reciprocal relationship of daytime sleepiness with anxiety and depression (Luo et al., 2018). Moreover, excessive daytime sleepiness resulting from chronic sleep loss is linked to the risk of type 2 diabetes and cardiovascular dysfunction (Owens et al., 2020). Another important health risk associated with insufficient sleep among adolescents includes unintentional injuries and automobile accidents (Owens et al., 2020; Wheaton et al., 2018).

d. Risk Factors Associated with Poor Sleep Outcomes

The current body of literature identifies several risk factors that are associated with sleep outcomes among adolescents. According to Youth Risk Behavior Survey (YRBS), the prevalence of short sleep duration was more among female students compared with male students (Wheaton et al., 2018). Other studies have found similar results (Bermejo-Franco et al., 2022; Illingworth et al., 2022). In addition, short sleep is more prevalent among black students at both middle and high school level and among Native Hawaiian/Pacific Islanders and Asian at middle and high school level respectively (Wheaton et al., 2018). A 2018 review found that sleep disparities among adolescents exist among ethnic/racial groups with black and Hispanic experiencing more insufficient sleep than other groups (Guglielmo et al., 2018). It is also interesting to know that the estimates differ according to states as well (Wheaton et al., 2018).

Other important determinants associated with insufficient sleep or sleep difficulties includes psychosocial factors like stress related to health-related concerns, changes in financial situations of families, and future uncertainties (Tsai et al., 2018). One study indicated education related concerns and employment as risk factor of sleep problems among adolescents. Moreover, use of technology and video games was also showed as being associated with sleep patterns among this group (Miguez et al., 2020). Another study indicated similar findings in which significant differences in COVID-19 exposure were observed across racial/ethnic and income strata of the household (Raviv et al., 2021) suggesting that COVID-19 has disproportionately impacted different racial/income groups.

e. Role of COVID-19 Stress

While there is evidence suggesting risk factors associated with short sleep duration and daytime sleepiness, COVID-19 related stress is one of the determinants of insufficient sleep among adolescents. A study by Sharma and colleagues (2021) showed an increase in

psychological concerns among children and adolescents during the pandemic. One survey indicated that 19% of undergraduate students had stress of severe and extremely severe levels during COVID-19 pandemic (Nano et al., 2022). A systematic review including 19 research studies found that younger population especially students was a risk factor for higher rates of psychological distress and stress (Xiong et al., 2020).

A study on adolescents found association between sleep duration and adolescent's perceived stress during COVID-19 pandemic (Gruber et al., 2021). Another study highlighted the relationship between COVID-19 stress and sleep. A study by Samuolis (2023) reported pandemic specific psychological distress among college students was associated with difficulty in falling asleep, difficulty staying asleep and with waking too early and this relationship was mediated by perceived stress.

Many reasons could explain the increased stress among younger population, one of which could be the ability of children and adolescents to comprehend the global situation during the COVID-19 pandemic (Sharma et al., 2021). Furthermore, several factors like home confinement, technology use like social media and internet, and financial strain have been reported to be related to COVID-19 stress (Jones et al., 2021). Moreover, closing of schools and recreational activities which resulted in disruption of routine, reduced face-to-face social interaction with peers and friends and home quarantine impacted adolescents' mental wellbeing (Dalton et al., 2020; Ellis et al., 2020; Golberstein et al., 2020; Sharma et al., 2021). Another study highlighted similar factors related to stress during pandemic which included rapid changes especially associated with occupation or finances, and restriction and cancellation of important activities (Rodríguez-Rey et al., 2020).

Other studies have suggested that psychological stress, fear of illness and getting infected, and sleep issues in caregivers which might have contributed to poor quality of

sleep among children and adolescents by introducing uncertainty and worry among adolescents (Ellis et al., 2020; Sharma et al., 2021). One researcher noted that stress could be result of excessive worry of being infected, which is referred to as the "hypochondria concerns" theory (Khademian et al., 2020). Another study found that pandemic related stress in both parent and children intensified the association between parents' maltreatment of their children and sleep problems among boys. This maltreatment includes threat and deprivation i.e., neglect. However, this relationship between maltreatment and sleep problems were not noted in girls (Zhang et al., 2022). However, another study indicated that students surveyed during COVID-19 pandemic had significantly lower stress than students in the pre-COVID-19 period. One possible explanation for this finding is that the use of validated measure may be insensitive to any effect of COVID-19 pandemic on stress levels. This study also found significant correlation between sleep variables and stress (Benham, 2020).

f.   Effect of Technology Use

Another important aspect is the changes in technology use during COVID-19 pandemic which could be another factor, in addition to stress, influencing sleep behaviours and patterns among adolescents. The use of technology among US adolescents is vast and it is estimated that around 95% of teenagers have a smartphone to use and 85% of individuals use social media. One study indicated that 45% of adolescents describe their internet use as constant (Anderson & Jiang, 2018). Several studies have suggested that there has been significant increase in technology use among adolescents especially during the pandemic. A cross-sectional study highlighted an alarmingly high screen time during COVID-19 confinement than ever reported with 96% adolescents spending 9 hours or more on screen and 64% of them reporting at least 12 hours screen time per day. Moreover, inconsistent sleep habits were reported by 82% of the sample. Another important finding in this study is

the higher occurrence of stress feelings (70%) among those spending 9 or more hours on screen per day (Wehbe et al., 2022). Another study found that problematic smartphone use was prevalent in 16.4% of the sample and that its use mediated the relationship between exposure to COVID-19 pandemic and daytime sleepiness (Hu et al., 2021).

While the technology use during pandemic has increased significantly, the pandemic has also changed the motive of using technology among adolescents. Different reasons for technology use among high school students include social, informational, leisure and educational purposes and to keep in touch with friends and family (Guazzini et al., 2022). While technology use increased virtual connections, it was speculated as one of the determinants in poor sleep outcomes among adolescents (Johansson et al., 2016). This was likely because during COVID-19 pandemic, misinformation and fake news were being spread via social media platforms creating feelings of unnecessary fears and stress (Gao et al., 2020; Moghanibashi-Mansourieh, 2020; Xiong et al., 2020).

The existing literature shows increased stress and technology use and varied sleep outcomes among adolescents. Less is known about how technology use mediates the effect of COVID-19 stress and sleep outcomes among adolescents. To address this question, this study sought to investigate the effect of COVID-19 stress on sleep outcomes and whether technology use mediates the relationship between COVID-19 stress and sleep outcomes among adolescents.

3. Methodology

a. Conceptual Framework

The theoretical framework draws on the biopsychosocial model of health and social cognitive theory. The biopsychosocial model of health given by George Engel in 1977 builds on the idea that health outcomes are influenced by biological, psychological, and

social factors whereas social cognitive theory given by Bandura (1986) suggest that behaviour is influenced by personal, environmental, and behavioural factors (Engel, 1977; Bandura, 1986). The conceptual framework hypothesizes that COVID-19 stress is negatively associated with sleep outcomes and that this relationship is mediated by technology use during pandemic (Figure 1). The framework assumes that COVID-19 stress is a significant predictor of sleep outcomes among adolescents. It also assumes that gender and socio-demographic conditions influence this relationship.

b. Study Design

This study uses a cross-sectional online survey which was administered through Qualtrics (Qualtrics, Provo, UT) in the Fall of 2020. This analysis is an ancillary study from a multiple wave cohort study conducted in two semi-rural high schools in Winder Barrow County, Georgia in 2020. The surveys were administered to study effects of sleep on education and health outcomes among adolescents.

c. Study Participants

The study enrolled a cohort of 10th grade students who were attending either of the two participating high schools. Both schools are racially and economically diverse public high schools and are the only public high schools in the county. Since the survey was administered at time of COVID-19 pandemic, study participants were recruited both in-person and virtually. Parental permission and assent from students were required for participation. An opportunity to participate in a raffle to receive one of 50 Amazon gift cards worth $25 each was given to all students who completed the survey. Approval from Emory University Institutional Review Board was obtained.

A total of 506 participants consented to participate in this survey (Table 1). A total of 408 students completed the survey. Among total participants, 212 participants had missing

data on exposure, outcome, or mediator. To handle missing data, complete case analysis was conducted. Table 1 shows the comparison of sociodemographic characteristics of included and excluded participants in the study. The participants only differ in terms of School attended and parent's employment. All other characteristics are similar for both included and excluded participants. One reason for the difference in School could reflect class time given to complete the survey, with School A providing more in-class time to complete the survey.

d. Data Source

This study is utilizing data from an online survey administered to 10th graders from November 16-December 17, 2020. The survey was designed by researchers at the Rollins School of Public Health at Emory University with input from a local high school student. The survey instrument had 97 questions. The questions assessed the following areas: demographics, knowledge of and reactions to COVID-19, general health and activities, pandemic behaviours, mental health and discrimination, and sleep patterns and behaviours. A pilot survey was conducted with four high school students independent from study implementation and they were asked to provide feedback. Feedback on the survey instrument was also provided from the school administrators. The survey was conducted in English language. The survey was emailed to virtual students' school email addresses by school administrators. For in-person learners, the survey was provided on school laptops during an advisory period or health class. The approximate completion time for survey was 10 minutes and all the questions were optional.

e. Data Measures

i. Exposure variables: COVID-19 Related Stress

COVID-19 Related Stress: This analysis focused on responses to the fourteen questions related to COVID-19 stress (Table 2). One item was taken from the March 2020-

AP NORC Center Poll survey (The Associated Press-NORC Center for Public Affairs Research, 2020) and all other questions were developed by the study team. These questions are relevant to assessing COVID-19 related stress as it directly measures adolescent's worry, perceived seriousness of COVID-19 if the respondent contract the virus and which provides insight into their level of fear, and perception of safety related to the pandemic. The perception of risk and safety in different contexts can be a significant source of stress during the pandemic. The responses initially had a score from 1 to 5. Cronbach's alpha was estimated to assess the internal consistency. For ease of data collection and some small sample sizes in some response categories, several of the Likert scales were combined (e.g., extremely serious/very serious; not too serious/not at all serious). The scale had a total scoring of 21 to 63 with 21 indicating no stress and 63 indicating extreme stress.

To assess the interrelationships between the 14 items of our COVID-19 stress questionnaire, pearson correlation analysis was conducted. Most items revealed moderate to strong correlation with correlation coefficients ranging from 0.3 to 0.7 or -0.3 to -0.5, all of which were statistically significant with p values < 0.001. However, one item (How safe do you feel from COVID when you are inside your home?) showed weaker correlation with other items. Overall, these finding suggest that the measures were associated with each other. All fourteen items were included to measure COVID-19 stress. For the current analysis, COVID-19 stress was examined both continuously and categorically. However, it is only reported continuously in this thesis, and the categorical data results can be provided on request.

ii.   Outcome Variables: Sleep Health

The current study focuses on two outcome variables *sleep duration* and *daytime sleepiness* as measures of sleep health.

Sleep Duration: Sleep duration, average number of hours of sleep per night, was calculated based on student-reported bed and wake times on weekdays and weekends, and the hours were weighted according to weekdays and weekends to calculate an overall weekly average sleep duration. Sleep duration was categorized for analyses into three levels: short (<8 hours)**,** recommended (8-10 hours) and long (>10 hours) period.

Daytime Sleepiness: Participants were asked to rate their sleepiness on a typical school day on a scale of 0 to 10 where zero is not sleepy at all and 10 is extremely sleepy. The Daytime sleepiness was examined as both a continuous (0-10 scale) and categorical variable. For categorical variable, the response from 0 to 3 was indicating no or slight chance of dozing (coded as 1), from 4 to 6 showing moderate chance of dozing (coded as 2) and from 7 to 10 specifying high chance of dozing (coded as 3).

iii. Mediator Variable: Technology Use

Time spend on screen was hypothesized as used as a mediator in the relationship between exposure and outcome and was measured by three different questions determining how much time respondents spent watching TV or digital media, watching social media, and playing videogames. The responses to all these three variables included no use in past 2 weeks (coded as 0), <1 hour/day (coded as 1), 1-3 hours/day (coded as 2), 4-6 hours/day (coded as 3), & >6 hours/day (coded as 4). All three variables were examined separately.

iv. Covariates

This study considered two factors as potential covariates: gender (male or female) and sociodemographic status. These variables were self-reported by participants. Since sociodemographic status is a broad term, it was assessed by several measures including race (Asian, Black, Hispanic, White, or Multiracial), and free and reduced lunch (FRL) eligibility. FRL eligibility indicated SES status (Harwell & LeBeau, 2010) and coded as

yes/no. Moreover, participant employment (yes or no) and parent's education (Some high school or less, finished high school, some college or special school, college or higher) were considered as well.

f. Statistical Analysis

Socio-demographic characteristics of all study participants were reported using descriptive statistics. Bi-variate analysis examined responses to each COVID-19 stress question by demographic characteristics. t-test and Chi-square/Fishers' tests were conducted to determine significant differences by gender, race/ethnicity, FRL, parent education, and participant's employment. Unadjusted and adjusted multiple linear and logistic regression models were used to assess the direct effect of COVID-19 stress on sleep health. Models were adjusted for variables found significant in bivariate analysis and those suggested in the literature. For all analyses, a priori α of 0.05 was set and SAS 9.4 programming software was used.

4. Results

a. Participant demographics

A total of 292 participants were included in analyses. More than half of the students identified as female (54.8%). The sample largely reported their race as white (55.5%) followed by Hispanic (20.2%), Black (11.0%), Asian (5.5%) and multiracial (7.9%). Approximately 54.7% of the participants were eligible for Free and Reduced Lunch (FRL), 85.6% were not employed, and 57.9% of the participants' parent have finished college or have some college education (Table 2).

b. Sleep outcomes during COVID-19 pandemic

The average sleep duration for the sample participants was reported as 8.0 hours (+/-1.4 hours) (Table 3). Furthermore, 43.2% of the adolescents reported sleep duration less

than the recommended 8 hours, about half (49.6%) reported recommended hours of sleep duration and 7.2% of the adolescents reported long hours of sleep duration.

Sleep duration was approximately the same for both genders and did not differ by FRL status or parent education (Table 3a). However, sleep duration was relatively low among students who were employed compared to those not working (p value: <0.05).

In terms of daytime sleepiness, the average score was reported as 5.2 on a scale of 0 to 10, indicating a moderate chance of dozing among the participants (Table 3b). Further categorizing of the measure revealed a significant number of participants reported moderate and high daytime sleepiness i.e., 46.6% reported chances of dozing during the day as moderate and 28.1% reported sleepiness during the day as high. In contrast, no or slight chance of dozing off was reported by 25.3% of participants. Furthermore, higher daytime sleepiness was reported by participants whose parent had either studied at college level or finished college compared to the participants whose parents' highest education was either high school or graduate degree (5.7 vs 4.6, p value <0.05) (Table 3b).

c. **COVID-19 Related Stress**

Overall, the participants reported an average score of 37.5 for COVID-19 stress on a scale of 21 to 63 with 21 representing minimal stress and 63 signifying extremely high stress (Table 4). Significant differences were noted in the means of COVID-19 stress by gender, race and FRL status. Chi-square test of independence or Fisher's Exact test indicated a significant relationship between gender and many of the items for COVID-19 related stress scale (p = <0.05) with females reporting higher levels of COVID-19 stress than males (See Supplemental Table S1). COVID-19 stress was also associated with race with Asians followed by Black individuals reporting higher stress levels compared to others

(Table S2). There was not a significant relationship between FRL eligibility, student's employment status, parent education, and COVID-19 stress items (Tables S3-S5).

d. Screen time during COVID-19 pandemic

Overall, screen time, excluding classes and schoolwork, increased for most adolescents (69.9%) since the COVID-19 pandemic began. As noted in Table 5, only 6.2% reported that their screen time decreased. About a quarter of the sample (24.0%) reported no change in screen time. Of the total participants, 55.5%, 43.5% and 24.0% reported more than 4 hours of watching TV/digital media, using social media, and playing video games respectively.

Additionally, when looking specifically at time spent on watching television or digital media, 24.3% adolescents spent more than 6 hours, 31.2% between 4 to 6 hours and 33.6% spent between 1 to 3 hours per day. A very small number of participants either spent less than 1 hour/day (9.6%) or did not watch in past 2 weeks (1.4%). For time on social media, 18.2% reported use for more than 6 hours per day and 25.3% used it for 4 to 6 hours daily. Almost one-third (34.2%) of the participants use social media for 1 to 3 hours and 8.2% reported no use in the past 2 weeks. The screen time for playing video games was comparatively lower than social media and television/digital media. About 10% participants play video games for more than 6 hours per day while 14.7% spent 4-6 hours on this activity. Among all participants, 34.6% reported no video games playing in past 2 weeks. It is interesting to note that approximately every 1 in 5 participant spend more than 60 minutes on mobile device before falling asleep (Table 5).

e. COVID-19 stress and Sleep outcomes across screentime categories: Results from t-tests

A t-test was conducted to determine whether the mean of sleep duration, daytime sleepiness and COVID-19 stress differed across the categories of technology use (Table 6). The results revealed no significant difference in the mean of sleep duration or daytime sleepiness across the categories of time spent on different media.

In terms of COVID-19 stress and technology use, the t-test revealed a difference in the mean of COVID-19 stress across the categories of time spent on social media use. The mean score and standard deviation for COVID-19 stress was reported as 36.4 (+/- 9.9) for those using social media for less than 1 hour, 36.2 (+/- 10.0) for those using it for one to three hours, 40.7 (+/- 10.3) for individuals using social media for 4-6 hours and 38.6 (+/- 11.4) among those reporting more than 6 hours of daily social media use. In contrast, non-users of social media reported the mean as 32.3 (+/-10.4). The results showed a difference of statistical significance for COVID-19 stress among different categories of time spent on social media (p value: <0.05).

f. Linear Regression

The linear regression analysis indicated a non-significant relationship between COVID-19 stress and sleep duration (β: -0.007, p value: >0.05) (Table 7). This relationship remained not significant after adjusting for potential confounders i.e., gender, race, parent employment and parent education, the relationship (β: -0.008, p value: >0.05). For daytime sleepiness, SLR indicated similar results. A non-significant relationship was found between COVID-19 stress and daytime sleepiness for both crude (β: 0.023, p value: >0.05) and adjusted models (β: 0.026, p value: >0.05).

g. Multinomial Logistic Regression

Logistic regression analysis indicated that as COVID-19 stress increased, the odds of short sleep duration were slightly greater (OR:1.03, 95% CI: 1.00, 1.06) compared to the

odds of normal sleep duration when adjusting for gender, race, parent education and employment (Table 8a). Also, the odds for long sleep duration compared to recommended sleep was 1.03 as COVID-19 stress increase, however, the association was not statistically significant (95% CI: 0.985, 1.080, p value > 0.05).

In terms of relationship between COVID-19 stress and daytime sleepiness, the Multinomial Logistic Regression analysis showed an odds ratio of 1.04 (95% CI: 1.004, 1.075), indicating a slightly increased odds of the excessive daytime sleepiness associated with increase in the COVID-19 stress when compared to having no or small chance of daytime sleepiness after adjusting for gender, race, parent education and employment (Table 8b). The odds ratio for moderate chance vs no/small chance was not significant (OR 1.02, 95% CI: 0.989, 1.051).

Since the findings from the regression analysis did not indicate a significant relationship between stress and sleep, mediation analysis was not conducted.

5. Discussion

This cross-sectional study adds to the limited body of research examining the impact of COVID-19 stress among adolescents. Our primary result was surprising that there was no or a very weak relationship between COVID-19 stress and sleep measures. This is contrary to the findings from earlier studies (Gruber et al., 2021; Samuolis, 2023). One probable reason could be the self-reporting and overestimation of sleep duration by adolescents. It is also possible that the association was influenced by unmeasured confounding variables like academic pressure, smoking and drug use. Nevertheless, stress and sleep are important determinants of overall wellbeing in adolescents and therefore, it is important to consider the importance of these factors.

Despite not finding a significant association between COVID-19 stress and sleep measures, there are other significant findings that are worthy to note. This study conducted during Fall 2020 revealed that more than half of the study participants had moderate to extreme stress related to pandemic. Earlier studies have also demonstrated similar results showing that young individuals experienced significant stress during pandemic (Nano et al., 2022). Results also indicated that COVID-19 stress was particularly higher among female participants, those identifying as Asian or Black, and with low SES as indicated by the FRL status. The association of the financial toll of COVID-19 pandemic on adolescents' mental health was also highlighted in previous research (Argabright et al., 2022). This may be indicative of the disproportionate impact of COVID-19 pandemic on different socioeconomic and racial groups in terms of finances or academics.

The current study also suggests that, on average, adolescents were getting recommended levels of sleep, however, more than one-third had less than recommended hours of sleep. These findings are consistent with the survey conducted by CDC where they found 37.1% of surveyed individuals reporting short sleep (Silwa et al., 2021). Besides this, the study showed that the average sleep duration was different for employed versus unemployed adolescents. In the current study sample, employed adolescents had significantly shorter sleep duration compared to those not doing any job. This could suggest that those pursuing studies as well as working might get shorter sleep due to added responsibilities of work. Also, similar to two other studies, the current study highlights significant number of adolescents with excessive daytime sleepiness (Hu et al., 2021; Silva et al., 2022).

Our findings also indicate a high use of technology for using social media, watching TV/digital media or for playing video games, which likely could be explained by home confinement and lockdown resulting from pandemic. However, the technology use was not

associated with sleep duration and daytime sleepiness. It is interesting to note that use of social media was significantly related to COVID-19 stress. This is consistent with previous studies showing increased mental health issues in individuals frequently exposed to social media (Gao et al., 2020; Jones et al., 2021). One possible explanation is that during the pandemic, fake news and misinformation was high and many false reports would have increased fears among the users. Furthermore, many adolescents were getting to know about families, friends, and acquaintances' health and overall wellbeing through social media, leading to feelings of worries.

a. Strengths and Limitations

There are several strengths of this study. This study involved diverse groups of adolescents with different racial and socioeconomic backgrounds. The schools were present in semi-rural areas which often lack representation in public health research. Furthermore, the current study focused on assessing stress related to factors associated with COVID-19 pandemic and thus could provide insight for future studies assessing the effect of COVID-19 stress in a post-pandemic era.

Despite these strengths, there are several limitations. First, this study relied on self-reported information from the study participants, and this led to a large amount of missing information which could have introduced bias in the study by missing information on those with insufficient sleep. To make sure that missingness of the data is at random, we compared sociodemographic characteristics of complete versus incomplete (excluded) data. Second, the use of subjective responses to assess sleep duration often results in an overestimate among adolescents and might have influenced its relationship with COVID-19 stress. Third, the study examined data from one point in time, making it difficult to establish trends or changes over time. Still, the findings from the study could help the adolescents' sleep in the context of Fall 2020 period and therefore could help in identifying other

significant predictors like school timing or virtual classes, etc. Finally, this study only looked at student's sleep duration and daytime sleepiness and thus sleep quality was not accounted for which may impacted largely by COVID-19 related stress.

b. Future Research Direction

Many aspects of the current study can help guide future direction for researchers. More research is needed to explore factors associated with high COVID-19 related stress among different racial groups. Beside this, studies exploring the impact of COVID-19 stress on other sleep outcomes like sleep onset latency or sleep quality could give us more information about the impact of COVID-19 stress. Moreover, future studies could use actigraphy to estimate sleep duration instead of relying on self-reporting measures among adolescents.

c. Implications

The current study can help in terms of providing a groundwork for future intervention programs to address COVID-19 related stress and high screen time. This is important from the lens of educators, public health practitioners, and policymakers who could intervene at individual, school, community, and societal level to help address the current issue. In this regard, wellness checks could be initiated in schools for all the adolescents. This could help identify the appropriate type of support for adolescents. Also, it is significant to integrate activity guidelines to limit the daily screen time, increase physical activity and meet sleep recommendations among adolescents. Overall, insufficient sleep among adolescents is a significant problem that needs our attention and therefore it is important to take necessary steps targeting sleep health.

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Tables and Figures

Figure 1: Conceptual framework used for the current study
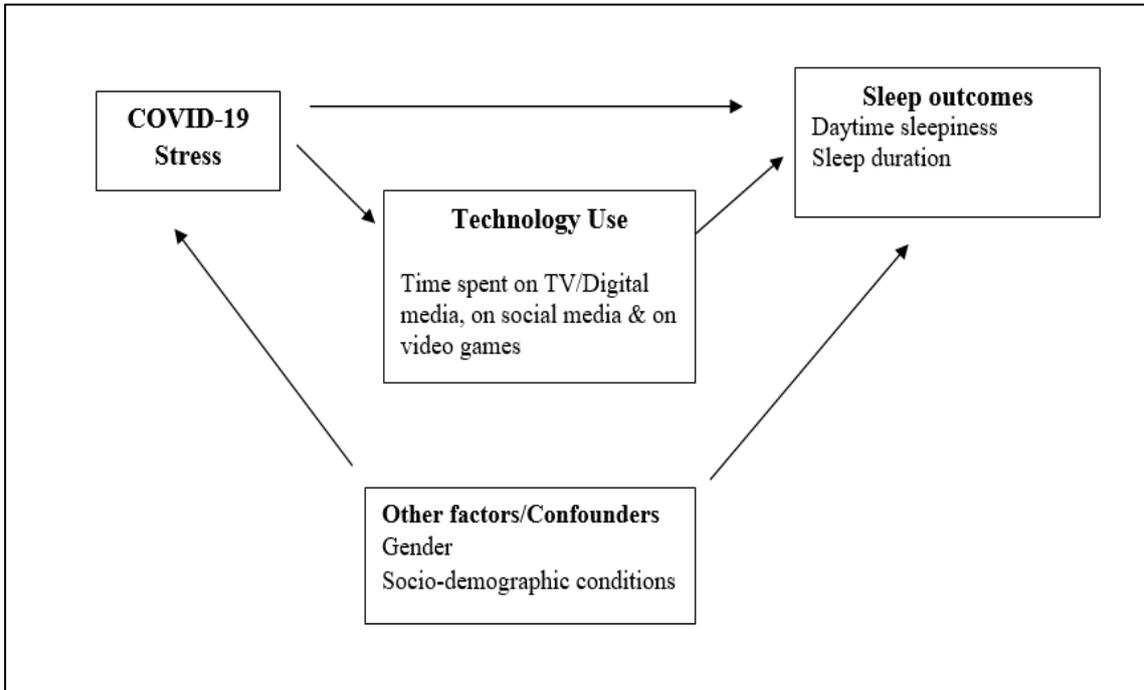
Table 1: Sociodemographic characteristics of 10th grade students attending semi-rural public schools that participated in Fall 2020 survey (*N* = 506).

Characteristic	Non-missing data n = 292		Missing data n = 214		
	n	**%**	**n**	**%**	***p* value**
School					
School A	186	63.7%	98	53.8%	**0.033**
School B	106	36.3%	84	46.2%	
Gender					
Male	127	44.2%	90	51.7%	0.119
Female	160	54.8%	84	48.3%	
Race/Ethnicity					
White	162	55.5%	94	51.9%	0.056
Black or African American	32	11.0%	31	17.1%	
Hispanic	59	20.2%	44	24.3%	
Asian	16	5.5%	6	3.3%	
Multiracial	23	7.9%	6	3.3%	
Parent Education					
Some High School (HS) or finished HS	95	32.7%	59	36.0%	0.394
Some college or finished college	168	57.9%	85	51.8%	
Graduate school	27	9.3%	20	12.2%	
Parent's Employment					
Yes	218	98.2%	122	96.1%	0.295
No	4	1.8%	5	3.9%	
Student's Employment					
Yes	42	14.4%	25	15.4%	0.774
No	249	85.6%	137	84.6%	
Free or Reduced Lunch eligibility					
Yes	116	54.7%	66	44.9%	0.936
No	140	45.3%	81	55.1%	

Note: The missing data includes the participants who lack information on COVID-19 stress (Exposure), Technology use (Mediator), Sleep duration or daytime sleepiness (Sleep outcomes). Non-missing data includes complete cases used in all subsequent analysis.

All significant *p* values (<0.05) reported in bold text.

Table 2: Fourteen items and response options for measuring COVID-19 stress.

Items
1. Generally, how worried are you about the coronavirus pandemic?
2. How worried are you getting the COVID?
3. How worried are you that someone in your family getting the COVID?
4. How worried are you about your physical health being influenced by COVID
5. How worried are you about your mental health being influenced by COVID?
6. How worried are you about the financial impact of COVID on you and your
7. family?
8. How worried are you about the impact of COVID on your grades and/or high
9. school graduation?
How worried are you about your college admissions and enrolment?
How worried are you about your career trajectory and employment opportunities?

Response Options
• Not at all worried/not too worried
• Somewhat worried
• Very worried/extremely worried

10. If you got COVID, how serious do you think it would be?

Response Options
• Not at all serious/not too serious
• Somewhat serious
• Very serious/extremely serious

Items
11. How safe do you feel from COVID when you are inside your home?
12. How safe do you feel from COVID when you are outdoors in public spaces (e.g., in a park or walking around your neighbourhood)?
13. How safe do you feel from COVID when you are indoors in public spaces, not including school (e.g., in a grocery store)?
14. How safe do you feel from COVID when you are at school?

Response Options
• Very safe/somewhat safe
• Neither safe nor unsafe
• Somewhat unsafe/very unsafe
Scoring: 21-63

Table 3a: Sleep duration by sociodemographic characteristics across all 10th graders attending semi-rural public school that participated in Fall 2020 survey (n = 292).

	M (*SD*)	*p* value	Sleep Duration						*p* value
			Short		Recommended		Long		
			n	%	n	%	n	%	
Sleep Duration	8.0 (1.4)	--	126	43.2%	145	49.6%	21	7.2%	--
Sociodemographic characteristic									
Gender									
Male	8.0 (1.4)	0.795	55	44.7%	65	45.4%	7	33.3%	0.574
Female	8.1 (1.3)		68	55.3%	78	54.6%	14	66.7%	
Race									
White	8.1 (1.3)	0.676	65	51.6%	87	60.0%	10	47.6%	0.139
Black	8.0 (1.5)		18	14.3%	10	6.9%	4	19.1%	
Hispanic	8.1 (1.4)		24	19.1%	31	21.4%	4	19.1%	
Asian	7.6 (1.6)		11	8.7%	4	2.8%	1	4.8%	
Multiracial	8.1 (1.4)		8	6.4%	13	9.0%	2	9.5%	
FRL Eligibility									
Yes	8.2 (1.5)	0.215	48	44.0%	55	43.0%	13	68.4%	0.108
No	8.0 (1/3)		61	56.0%	73	57.0%	6	31.6%	
Student Employment									
Yes	7.6 (1.6)	**0.032**	22	17.6%	17	11.7%	3	14.3%	0.373
No	8.1 (1.3)		103	82.4%	128	88.3%	18	85.7%	
Parent Education									
Some HS or finished High School	8.1 (1.4)	0.698	40	32.3%	47	32.4%	8	38.1%	0.490
Some college or finished college	8.0 (1.2)		73	58.9%	85	59.3%	9	42.9%	
Graduate School	8.1 (1.8)		11	8.9%	12	8.3%	4	19.1%	

Note: All significant *p* values (<0.05) reported in bold text.

Table 3b: Daytime sleepiness by sociodemographic characteristics across all 10th graders attending semi-rural public school that participated in Fall 2020 survey (*n* = 292).

			Daytime Sleepiness						
	M (SD)	*p* value	No/Small chance		Moderate chance		High chance		*p* value
			n	%	n	%	n	%	
Daytime Sleepiness	5.2 (2.4)	--	74	25.3%	136	46.6%	82	28.1%	--
Sociodemographic characteristic									
Gender									
Male	5.0 (2.6)	0.170	39	54.2%	55	40.7%	33	41.3%	0.147
Female	5.4 (2.2)		33	45.8%	80	59.3%	47	58.8%	
Race									
White	5.2 (2.6)	0.341	42	56.8%	72	52.9%	48	29.6%	0.768
Black	5.2 (2.7)		9	12.2%	14	10.3%	9	28.1%	
Hispanic	4.7 (2.0)		16	21.6%	32	23.5%	11	18.6%	
Asian	5.8 (2.2)		3	4.1%	7	5.2%	6	37.5%	
Multiracial	5.8 (2.1)		4	5.4%	11	8.1%	8	34.8%	
FRL Eligibility									
Yes	5.4 (2.4)	0.473	25	39.1%	56	47.1%	35	48.0%	0.506
No	5.1 (2.4)		39	60.9%	63	52.9%	38	52.1%	
Student Employment									
Yes	4.8 (2.7)	0.237	15	20.3%	15	11.1%	12	14.6%	0.197
No	5.3 (2.4)		59	79.7%	120	88.9%	70	85.4%	
Parent Education									
Some HS or finished High School	4.6 (2.3)	**0.002**	33	45.8%	43	31.6%	19	23.2%	**0.009**
Some college or finished college	5.7 (2.4)		30	41.7%	80	58.8%	58	70.7%	
Graduate School	4.6 (2.7)		9	12.5%	13	9.6%	5	6.1%	

Note: All significant *p* values (<0.05) reported in bold text.

Table 4: COVID-19 stress by sleep outcomes and sociodemographic covariates across all 10th graders attending semi-rural public school that participated in Fall 2020 survey (n = 292).

	COVID-19 Stress	
	M (SD)	*p* value
Continuous, *M (SD)*	37.5 (10.6)	
Characteristics		
Daytime Sleepiness		
Continuous		0.093
No/Small chance	35.6 (10.7)	0.128
Moderate chance	37.6 (9.8)	
High chance	39.0 (11.4)	
Sleep Duration		
Continuous		0.375
Short (1-7 Hours)	38.8 (10.4)	0.073
Recommended (8-10 Hours)	36.1 (10.4)	
Long (11 Hours or more)	39.6 (12.0)	
Gender		
Male	35.1 (10.3)	**<0.001**
Female	39.2 (10.3)	
Race		
White	34.6 (9.5)	**<0.001**
Black	42.0 (10.3)	
Hispanic	40.8 (10.9)	
Asian	45.8 (9.5)	
Multiracial	37.4 (10.7)	
FRL status		
Yes	38.8 (11.4)	**0.040**
No	36.1 (9.9)	
Student Employment		
Yes	39.3 (10.8)	0.240
No	37.2 (10.5)	
Parent Education		
Some HS or finished High School	39.2 (10.8)	0.173
Some college or finished college	36.7 (10.3)	
Graduate School	37.5 (11.4)	

Note: COVID-19 Stress was scored on a scale of 21 to 63 with 21 indicating no stress and 63 indicating extreme stress.

All significant *p* values (<0.05) reported in bold text.

Table 5: Technology use characteristics among 10th grade students attending semi-rural public school that participated in Fall 2020 survey (n = 292).

Characteristic	n	%
How has your screen time (aside from classes and schoolwork) changed since the COVID pandemic began (March 2020)?		
More screen time	204	69.9%
Less screen time	18	6.2%
No change in screen time	70	24.0%
Time spent on mobile device before falling asleep		
No use on regular weekday night or less than 5 mins of use	85	31.8%
6-30 minutes	96	35.9%
31-60 minutes	37	13.9%
More than 60 minutes	49	18.3%
Time spent per day . . .		
On watching TV or digital media		
Did not use this in past 2 weeks	4	1.4%
< 1 hour/day	28	9.6%
1-3 hours/day	98	33.6%
4-6 hours/day	91	31.2%
> 6 hours/day	71	24.3%
< 4 hours/day	130	44.6%
≥ 4 hours/day	162	55.5%
Using social media		
Did not use this in past 2 weeks	24	8.2%
< 1 hour/day	41	14.0%
1-3 hours/day	100	34.2%
4-6 hours/day	74	25.3%
> 6 hours/day	53	18.2%
< 4 hours/day	165	56.4%
≥ 4 hours/day	127	43.5%
Playing video games		
Did not use this in past 2 weeks	101	34.6%
< 1 hour/day	63	21.6%
1-3 hours/day	55	18.8%
4-6 hours/day	43	14.7%
> 6 hours/day	30	10.3%
< 4 hours/day	219	75.0%
≥ 4 hours/day	73	25.0%

Table 6: Association of technology use with COVID-19 stress (path a) and sleep outcomes (path b)

across all 10th graders attending semi-rural public school that participated in Fall 2020 survey (n = 292).

Technology use	COVID-19 Stress (Path A)		Daytime Sleepiness (Path B)		Sleep Duration| (Path B)	
	M (SD)	*p* value	*M (SD)*	*p* value	*M (SD)*	*p* value
On watching TV or digital media						
Did not do this in past 2 weeks	32.2 (17.6)	0.391	4.0 (4.9)	0.062	7.9 (2.2)	0.935
< 1 hour/day	35.4 (8.6)		4.3 (2.3)		8.1 (1.3)	
1-3 hours/day	36.8 (10.5)		5.1 (2.4)		8.1 (1.4)	
4-6 hours/day	38.9 (10.5)		5.2 (2.4)		8.0 (1.5)	
>6 hours/day	37.8 (11.0)		5.8 (2.4)		8.0 (1.2)	
Using social media						
Did not do this in past 2 weeks	32.3 (10.4)	**0.004**	4.6 (2.9)	0.545	8.4 (1.4)	0.085
< 1 hour/day	36.4 (9.9)		5.0 (2.4)		8.5 (1.2)	
1-3 hours/day	36.2 (10.0)		5.4 (2.4)		7.9 (1.3)	
4-6 hours/day	40.7 (10.3)		5.4 (2.5)		8.1 (1.5)	
>6 hours/day	38.6 (11.4)		5.1 (2.3)		7.9 (1.2)	
Playing video games						
Did not do this in past 2 weeks	38.1 (10.8)	0.286	5.0 (2.3	0.617	8.1 (1.5)	0.922
< 1 hour/day	38.0 (9.4)		5.1 (2.3)		8.2 (1.1)	
1-3 hours/day	39.0 (11.7)		5.1 (2.6)		8.0 (1.6)	
4-6 hours/day	35.1 (9.5)		5.7 (2.8)		8.0 (1.3)	
>6 hours/day	35.4 (10.8)		5.3 (2.2)		8.0 (1.4)	

Note: All significant *p* values (<0.05) reported in bold text.

Table 7: Linear Regression predicting sleep outcomes (Sleep duration and Daytime sleepiness) from

COVID-19 stress (total effect, c)

	Sleep duration				Daytime sleepiness			
	Model 1		Model 2[a]		Model 1		Model 2[b]	
	β	95% CI	β	95% CI	β	95% CI	β	95% CI
COVID-19 Stress	-0.007	(-0.022, 0.008) p value: 0.375	-0.008	(-0.024, 0.008) p value: 0.339	0.023	(-0.040, 0.049) p value: 0.093	0.026	(-0.002, 0.054) p value: 0.074

Note: [a]Adjusted for gender, race, employment, and parent education

[b]Adjusted for gender, race, and parent education

All significant p values (<0.05) reported in bold text.

Table 8a: Multinomial Logistic Regression predicting Sleep duration categories from COVID-19

Stress (total effect, c)

	Model 1			Model 2[a]		
Sleep Duration	OR	95% CI	p value	OR	95% CI	p value
Long	1.032	0.989, 1.078	0.148	1.031	0.985, 1.080	0.191
Short	1.025	1.001, 1.048	**0.039**	1.029	1.004, 1.055	**0.025**
Recommended (Ref)	--	--	--	--	--	--

Note: [a]Adjusted for gender, race, parent education and employment

All significant p values (<0.05) reported in bold text.

Table 8b: Multinomial Logistic Regression predicting Daytime sleepiness categories from COVID-19

Stress (total effect, c)

	Model 1			Model 2[a]		
Daytime Sleepiness	OR	95% CI	p value	OR	95% CI	p value
High chance	1.032	1.001, 1.064	**0.044**	1.039	1.004, 1.075	**0.027**
Moderate chance	1.019	0.991, 1.048	0.182	1.020	0.989, 1.051	0.210
No/small chance (Ref)	--	--	--	--	--	--

Note: [a]Adjusted for gender, race, parent education and employment

All significant p values (<0.05) reported in bold text.

Table S1: COVID-19 Stress by gender across all 10th graders attending semi-rural public school that participated

in Fall 2020 survey (n = 292).

COVID-19 stress questions	Total n = 292		Male n=127		Female n= 160		
	n	%	n	%	n	%	*p* value
Generally, how worried are you about the coronavirus pandemic?							
Not too worried/not at all worried	148	50.7%	73	57.5%	74	46.2%	**0.021**
Somewhat worried	88	30.1%	39	30.7%	47	29.4%	
Extremely/very worried	56	19.2%	15	11.8%	39	24.4%	
How worried are you about you being infected with the coronavirus?							
Not too worried/not at all worried	167	57.2%	78	61.4%	86	53.8%	0.411
Somewhat worried	81	27.7%	33	26.0%	48	30.0%	
Extremely/very worried	44	15.1%	16	38.1%	26	61.9%	
How worried are you about someone in your family being infected with the coronavirus?							
Not too worried/not at all worried	85	29.1%	48	37.8%	36	22.5%	**0.017**
Somewhat worried	91	31.2%	36	28.4%	53	33.1%	
Extremely/very worried	116	39.7%	43	33.9%	71	44.4%	
How worried are you about your physical health being influenced by COVID?							
Not too worried/not at all worried	156	53.4%	77	60.6%	77	48.1%	0.105
Somewhat worried	72	24.7%	26	20.5%	45	28.1%	
Extremely/very worried	64	21.9%	24	18.9%	38	23.8%	
How worried are you about your mental health being influenced by COVID?							
Not too worried/not at all worried	148	50.7%	76	59.8%	71	44.4%	**0.021**
Somewhat worried	62	21.2%	25	19.7%	36	22.5%	
Extremely/very worried	82	28.1%	26	20.5%	53	33.1%	
How worried are you about the financial impact of COVID on you and your family?							
Not too worried/not at all worried	116	39.7%	61	48.0%	55	34.4%	**0.057**
Somewhat worried	83	28.4%	30	23.6%	52	32.5%	
Extremely/very worried	93	31.8%	36	28.4%	53	33.1%	
If you got COVID, how serious do you think it would be?							
Not too serious/not at all serious	129	44.2%	61	48.0%	66	41.2%	0.506
Somewhat serious	96	32.9%	39	30.7%	54	33.8%	
Extremely serious/very serious	67	22.9%	27	21.3%	40	25%	
How safe do you feel from COVID when you are inside your home?							
Very/somewhat safe	270	92.5%	116	91.3%	150	93.8%	0.397
Neither safe nor unsafe	14	4.8%	6	4.7%	8	5.0%	
Very/somewhat unsafe	8	2.7%	5	3.9%	2	1.2%	
How safe do you feel from COVID when you are outdoors in public spaces (e.g., in a park or walking around your neighborhood)?							
Very/somewhat safe	164	56.2%	76	59.8%	87	54.4%	0.328
Neither safe nor unsafe	72	24.7%	32	25.2%	38	23.8%	
Very/somewhat unsafe	56	19.2%	19	15.0%	35	21.9%	
How safe do you feel from COVID when you are indoors in public spaces, not including school (e.g., in a grocery store)?							
Very/somewhat safe	96	32.9%	43	33.9%	52	32.5%	**0.002**

COVID-19 stress questions	Total n = 292		Male n=127		Female n= 160		
	n	%	n	%	n	%	*p* value
Neither safe nor unsafe	88	30.1%	50	39.4%	37	23.1%	
Very/somewhat unsafe	108	37.0%	34	26.8%	71	44.4%	
How safe do you feel from COVID when you are at school?							
Very/somewhat safe	98	33.6%	47	37.0%	50	31.2%	0.180
Neither safe nor unsafe	72	24.7%	35	27.6%	36	22.5%	
Very/somewhat unsafe	122	41.8%	45	35.4%	74	46.2%	
How worried are you about the impact of COVID on your grades and/or high school graduation?							
Not too worried/not at all worried	101	34.6%	55	43.3%	45	28.1%	**<0.001**
Somewhat worried	90	30.8%	43	33.9%	46	28.8%	
Extremely/very worried	101	34.6%	29	22.8%	69	43.1%	
How worried are you about the impact of COVID your college admissions and enrolment?							
Not too worried/not at all worried	138	47.3%	75	59.1%	62	38.8%	**<0.001**
Somewhat worried	74	25.3%	31	24.4%	42	26.2%	
Extremely/very worried	80	27.4%	21	16.5%	56	35.0%	
How worried are you about the impact of COVID your career trajectory and employment opportunities?							
Not too worried/not at all worried	131	44.9%	66	52.0%	63	39.4%	0.099
Somewhat worried	84	28.8%	33	26.0%	50	31.2%	
Extremely/very worried	77	26.4%	28	22.1%	47	29.4%	

Note: All significant *p* values (<0.05) reported in bold text.

Table S2: COVID-19 Stress by race across all 10th graders attending semi-rural public school that participated in Fall 2020 survey (n = 292).

COVID-19 stress question	Total n=292		White n=162		Black n=32		Hispanic n=59		Asian n=16		Multiracial n=23		
	n	%	n	%	n	%	n	%	n	%	n	%	p-value
Generally, how worried are you about the coronavirus pandemic?													
Not too worried/ not at all worried	148	50.7%	97	13.6%	10	31.2%	24	40.7%	6	37.5%	11	47.8%	**<0.001**
Somewhat worried	88	30.1%	43	26.5%	10	31.2%	21	35.6%	4	25.0%	10	43.5%	
Extremely/very worried	56	19.2%	22	13.6%	12	37.5%	14	23.7%	6	37.5%	2	8.7%	
How worried are you about you being infected with the coronavirus?													
Not too worried/ not at all worried	167	57.2%	109	67.3%	12	37.5%	27	45.8%	8	50.0%	11	47.8%	**<0.001**
Somewhat worried	81	27.7%	43	26.5%	7	21.9%	17	28.8%	5	31.2%	9	39.1%	
Extremely/very worried	44	15.1%	10	6.2%	13	40.6%	15	25.4%	3	18.8%	3	13.0%	
How worried are you about someone in your family being infected with the coronavirus?													
Not too worried/ not at all worried	85	29.1%	54	33.3%	6	18.8%	17	28.8%	2	12.5%	6	26.1%	**0.043**
Somewhat worried	91	31.2%	57	35.2%	9	28.1%	12	20.3%	4	25.0%	9	39.1%	
Extremely/very worried	116	39.7%	51	31.5%	17	53.1%	30	50.8%	10	62.5%	8	34.8%	
How worried are you about your physical health being influenced by COVID?													
Not too worried/ not at all worried	156	53.4%	106	65.4%	9	28.1%	26	44.1%	2	12.5%	13	56.5%	**<0.001**
Somewhat worried	72	24.7%	33	20.4%	9	28.1%	14	23.7%	8	50.0%	8	34.8%	
Extremely/very worried	64	21.9%	23	14.2%	14	43.8%	19	32.2%	6	37.5%	2	8.7%	
How worried are you about your mental health being influenced by COVID?													
Not too worried/ not at all worried	148	50.7%	88	54.3%	11	34.4%	28	47.5%	7	43.8%	14	60.9%	0.206
Somewhat worried	62	21.2%	36	22.2%	5	15.6%	13	22.0%	3	18.8%	5	21.7%	
Extremely/very worried	82	28.1%	38	23.5%	16	50.0%	18	30.5%	6	37.5%	4	17.4%	
How worried are you about the financial impact of COVID on you and your family?													
Not too worried/ not at all worried	116	39.7%	73	45.1%	12	37.5%	19	32.2%	2	12.5%	10	43.5%	**0.015**
Somewhat worried	83	28.4%	49	30.2%	4	12.5%	17	28.8%	6	37.5%	7	30.4%	
Extremely/very worried	93	31.8%	40	24.7%	16	50.0%	23	39.0%	8	50.0%	6	26.1%	
If you got COVID, how serious do you think it would be?													
Not too serious/ not at all serious	129	44.2%	88	54.3%	7	21.9%	23	39.0%	3	18.8%	8	34.8%	**<0.001**
Somewhat serious	96	32.9%	52	32.1%	9	28.1%	20	33.9%	4	25.0%	11	47.8%	
Extremely serious/ very serious	67	22.9%	22	13.6%	16	50.0%	16	27.1%	9	56.2%	4	17.4%	
How safe do you feel from COVID when you are inside your home?													
Very/somewhat safe	270	92.5%	153	94.4%	29	90.6%	53	89.8%	13	81.2%	22	95.6%	0.230

COVID-19 stress question	Total n=292		White n=162		Black n=32		Hispanic n=59		Asian n=16		Multiracial n=23		
	n	%	n	%	n	%	n	%	n	%	n	%	*p*-value
Neither safe nor unsafe	14	4.8%	7	4.3%	2	6.2%	3	5.1%	2	12.5%	0	0%	
Very/somewhat unsafe	8	2.7%	2	1.2%	1	3.1%	3	5.1%	1	6.2%	1	4.4%	
How safe do you feel from COVID when you are outdoors in public spaces (e.g., in a park or walking around your neighborhood)?													
Very/somewhat safe	164	56.2%	105	64.8%	12	37.5%	30	50.8%	4	25.0%	13	56.5%	**0.002**
Neither safe nor unsafe	72	24.7%	38	23.5%	9	28.1%	13	22.0%	7	43.8%	5	21.7%	
Very/somewhat unsafe	56	19.2%	19	11.7%	11	34.4%	16	27.1%	5	31.2%	5	21.7%	
How safe do you feel from COVID when you are indoors in public spaces, not including school (e.g., in a grocery store)?													
Very/somewhat safe	96	32.9%	61	37.6%	10	31.2%	16	27.1%	1	6.2%	8	34.8%	0.129
Neither safe nor unsafe	88	30.1%	52	32.1%	8	25.0%	18	30.5%	5	31.2%	5	21.7%	
Very/somewhat unsafe	108	37.0%	49	30.2%	14	43.8%	25	42.4%	10	62.5%	10	43.5%	
How safe do you feel from COVID when you are at school?													
Very/somewhat safe	98	33.6%	59	36.4%	10	31.2%	22	37.3%	2	12.5%	5	21.7%	0.522
Neither safe nor unsafe	72	24.7%	39	24.1%	10	31.2%	12	20.3%	5	31.2%	6	26.1%	
Very/somewhat unsafe	122	41.8%	64	39.5%	12	37.5%	25	42.4%	9	56.2%	12	52.2%	
How worried are you about the impact of COVID on your grades and/or high school graduation?													
Not too worried/not at all worried	101	34.6%	68	42.0%	13	40.6%	12	20.3%	2	12.5%	6	26.1%	**0.022**
Somewhat worried	90	30.8%	45	27.8%	8	25.0%	21	35.6%	5	31.2%	11	47.8%	
Extremely/very worried	101	34.6%	49	30.2%	11	34.4%	26	44.1%	9	56.2%	6	26.1%	
How worried are you about the impact of COVID your college admissions and enrolment?													
Not too worried/not at all worried	138	47.3%	94	58.0%	16	50.0%	15	25.4%	2	12.5%	11	47.8%	**<0.001**
Somewhat worried	74	25.3%	38	23.5%	6	18.8%	18	30.5%	7	43.8%	5	21.7%	
Extremely/very worried	80	27.4%	30	18.5%	10	31.2%	26	44.1%	7	43.8%	7	30.4%	
How worried are you about the impact of COVID your career trajectory and employment opportunities?													
Not too worried/not at all worried	131	44.9%	91	56.2%	15	46.9%	13	22.0%	2	12.5%	10	43.5%	**<0.001**
Somewhat worried	84	28.8%	41	25.3%	9	28.1%	23	39.0%	6	37.5%	5	21.7%	
Extremely/very worried	77	26.4%	30	18.5%	8	25.0%	23	39.0%	8	50.0%	8	34.8%	

Note: All significant *p* values (<0.05) reported in bold text.

Table S3: COVID-19 Stress by Free or Reduced Lunch (FRL) eligibility across all 10th graders

attending semi-rural public school that participated in Fall 2020 survey (n = 292).

COVID-19 stress question	Total n=292		FRL Non-Eligible n=140		FRL Eligible n=116		
	n	%	n	%	n	%	*p* value
Generally, how worried are you about the coronavirus pandemic?							
Not too worried/not at all worried	148	50.7%	69	49.3%	59	50.9%	0.937
Somewhat worried	88	30.1%	42	30.0%	35	30.2%	
Extremely/very worried	56	19.2%	29	20.7%	22	19.0%	
How worried are you about you being infected with the coronavirus?							
Not too worried/not at all worried	167	57.2%	86	61.4%	62	53.4%	0.154
Somewhat worried	81	27.7%	40	28.6%	33	28.4%	
Extremely/very worried	44	15.1%	14	10.0%	21	18.1%	
How worried are you about someone in your family being infected with the coronavirus?							
Not too worried/not at all worried	85	29.1%	45	32.1%	31	26.7%	0.617
Somewhat worried	91	31.2%	41	29.3%	35	30.2%	
Extremely/very worried	116	39.7%	54	38.6%	50	43.1%	
How worried are you about your physical health being influenced by COVID?							
Not too worried/not at all worried	156	53.4%	76	54.3%	60	51.7%	0.335
Somewhat worried	72	24.7%	38	27.1%	26	22.4%	
Extremely/very worried	64	21.9%	26	18.6%	30	25.8%	
How worried are you about your mental health being influenced by COVID?							
Not too worried/not at all worried	148	50.7%	75	53.6%	56	48.3%	0.203
Somewhat worried	62	21.2%	34	24.6%	23	19.8%	
Extremely/very worried	82	28.1%	31	22.1%	37	31.9%	
How worried are you about the financial impact of COVID on you and your family?							
Not too worried/not at all worried	116	39.7%	62	44.3%	42	36.2%	0.400
Somewhat worried	83	28.4%	38	27.1%	34	29.3%	
Extremely/very worried	93	31.8%	40	28.6%	40	34.5%	
If you got COVID, how serious do you think it would be?							
Not too serious/not at all serious	129	44.2%	71	50.7%	46	39.7%	0.189
Somewhat serious	96	32.9%	42	30.0%	40	34.5%	
Extremely serious/very serious	67	22.9%	27	19.3%	30	25.9%	
How safe do you feel from COVID when you are inside your home?							
Very/somewhat safe	270	92.5%	132	94.3%	106	91.4%	0.327
Neither safe nor unsafe	14	4.8%	6	5.0%	7	5.2%	
Very/somewhat unsafe	8	2.7%	1	3.5%	4	0.7%	
How safe do you feel from COVID when you are outdoors in public spaces (e.g., in a park or walking around your neighborhood)?							
Very/somewhat safe	164	56.2%	87	62.1%	57	49.1%	**0.041**
Neither safe nor unsafe	72	24.7%	34	24.3%	30	25.9%	
Very/somewhat unsafe	56	19.2%	19	13.4%	29	25.0%	
How safe do you feel from COVID when you are indoors in public spaces, not including school (e.g., in a grocery store)?							
Very/somewhat safe	96	32.9%	47	33.6%	37	31.9%	0.319
Neither safe nor unsafe	88	30.1%	47	33.6%	31	26.7%	
Very/somewhat unsafe	108	37.0%	46	32.9%	48	41.4%	
How safe do you feel from COVID when you are at school?							
Very/somewhat safe	98	33.6%	48	34.3%	36	31.0%	0.796
Neither safe nor unsafe	72	24.7%	36	25.7%	29	25.0%	

COVID-19 stress question	Total n=292		FRL Non-Eligible n=140		FRL Eligible n=116		
	n	%	n	%	n	%	*p* value
Very/somewhat unsafe	122	41.8%	56	40.0%	51	44.0%	
How worried are you about the impact of COVID on your grades and/or high school graduation?							
Not too worried/not at all worried	101	34.6%	55	39.3%	38	32.8%	0.327
Somewhat worried	90	30.8%	45	32.1%	35	30.2%	
Extremely/very worried	101	34.6%	40	28.6%	43	37.1%	
How worried are you about the impact of COVID your college admissions and enrollment?							
Not too worried/not at all worried	138	47.3%	72	51.4%	49	42.2%	0.116
Somewhat worried	74	25.3%	38	27.1%	29	25.0%	
Extremely/very worried	80	27.4%	30	21.4%	38	32.8%	
How worried are you about the impact of COVID your career trajectory and employment opportunities?							
Not too worried/not at all worried	131	44.9%	73	52.1%	46	39.7%	0.125
Somewhat worried	84	28.8%	35	25.0%	34	29.3%	
Extremely/very worried	77	26.4%	32	22.9%	36	31.0%	

Note: All significant *p* values (<0.05) reported in bold text.

S4: COVID-19 Stress by student employment across all 10th graders attending semi-rural public school that participated in Fall 2020 survey (n = 292).

COVID-19 stress question	Total n=292		Student Unemployed n=249		Student Employed n=42		
	n	%	n	%	n	%	*p*-value
Generally, how worried are you about the coronavirus pandemic?							
Not too worried/not at all worried	148	50.7%	124	49.8%	23	54.8%	0.823
Somewhat worried	88	30.1%	76	30.5%	12	28.6%	
Extremely/very worried	56	19.2%	49	19.7%	7	16.7%	
How worried are you about you being infected with the coronavirus?							
Not too worried/not at all worried	167	57.2%	144	57.8%	22	52.4%	0.690
Somewhat worried	81	27.7%	67	26.9%	14	33.3%	
Extremely/very worried	44	15.1%	38	15.3%	6	14.3%	
How worried are you about someone in your family being infected with the coronavirus?							
Not too worried/not at all worried	85	29.1%	74	29.7%	11	26.2%	0.883
Somewhat worried	91	31.2%	76	30.5%	14	33.3%	
Extremely/very worried	116	39.7%	99	39.8%	17	40.5%	
How worried are you about your physical health being influenced by COVID?							
Not too worried/not at all worried	156	53.4%	133	53.4%	23	54.8%	0.612
Somewhat worried	72	24.7%	63	25.3%	8	19.1%	
Extremely/very worried	64	21.9%	53	21.3%	11	26.2%	
How worried are you about your mental health being influenced by COVID?							
Not too worried/not at all worried	148	50.7%	130	52.2%	18	42.9%	0.274
Somewhat worried	62	21.2%	54	21.7%	8	19.1%	
Extremely/very worried	82	28.1%	65	26.1%	16	38.1%	
How worried are you about the financial impact of COVID on you and your family?							
Not too worried/not at all worried	116	39.7%	102	41.0%	13	31.0%	0.466
Somewhat worried	83	28.4%	69	27.7%	14	33.3%	
Extremely/very worried	93	31.8%	78	31.3%	15	35.7%	
If you got COVID, how serious do you think it would be?							
Not too serious/not at all serious	129	44.2%	108	43.4%	21	50.0%	0.719
Somewhat serious	96	32.9%	83	33.3%	12	28.6%	
Extremely serious/very serious	67	22.9%	58	23.3%	9	21.4%	
How safe do you feel from COVID when you are inside your home?							
Very/somewhat safe	270	92.5%	231	92.8%	38	90.5%	0.542
Neither safe nor unsafe	14	4.8%	12	4.8%	2	4.8%	
Very/somewhat unsafe	8	2.7%	6	2.4%	2	4.8%	
How safe do you feel from COVID when you are outdoors in public spaces (e.g., in a park or walking around your neighborhood)?							
Very/somewhat safe	164	56.2%	139	55.8%	25	59.5%	0.876
Neither safe nor unsafe	72	24.7%	62	24.9%	9	21.4%	
Very/somewhat unsafe	56	19.2%	48	19.3%	8	19.1%	
How safe do you feel from COVID when you are indoors in public spaces, not including school (e.g., in a grocery store)?							
Very/somewhat safe	96	32.9%	81	32.5%	15	35.7%	0.422
Neither safe nor unsafe	88	30.1%	78	31.3%	9	21.4%	
Very/somewhat unsafe	108	37.0%	90	36.1%	18	42.9%	
How safe do you feel from COVID when you are at school?							
Very/somewhat safe	98	33.6%	84	33.7%	14	33.3%	0.170

COVID-19 stress question	Total n=292		Student Unemployed n=249		Student Employed n=42		
	n	%	n	%	n	%	*p*-value
Neither safe nor unsafe	72	24.7%	66	26.5%	6	14.3%	
Very/somewhat unsafe	122	41.8%	99	39.8%	22	52.4%	
How worried are you about the impact of COVID on your grades and/or high school graduation?							
Not too worried/not at all worried	101	34.6%	90	36.1%	11	26.2%	0.246
Somewhat worried	90	30.8%	78	31.3%	12	28.6%	
Extremely/very worried	101	34.6%	81	32.5%	19	45.2%	
How worried are you about the impact of COVID your college admissions and enrolment?							
Not too worried/not at all worried	138	47.3%	127	51.0%	11	26.2%	**0.008**
Somewhat worried	74	25.3%	60	24.1%	13	31.0%	
Extremely/very worried	80	27.4%	62	24.9%	18	42.9%	
How worried are you about the impact of COVID your career trajectory and employment opportunities?							
Not too worried/not at all worried	131	44.9%	116	46.6%	14	33.3%	0.215
Somewhat worried	84	28.8%	71	28.5%	13	31.0%	
Extremely/very worried	77	26.4%	62	24.9%	15	35.7%	

Note: All significant *p* values (<0.05) reported in bold text.

Table S5: COVID-19 Stress by parent education across all 10th graders attending semi-rural public school that participated in Fall 2020 survey (n = 292).

COVID-19 stress question	Total n = 292		Some High School (HS)/ finished HS n=95		Some college/ finished college n = 168		Graduate School n=27		
	n	**%**	**n**	**%**	**n**	**%**	**n**	**%**	*p* value
Generally, how worried are you about the coronavirus pandemic?									
Not too worried/not at all worried	148	50.7%	47	49.5%	86	51.2%	13	48.2%	0.590
Somewhat worried	88	30.1%	32	33.7%	50	29.8%	6	22.2%	
Extremely/very worried	56	19.2%	16	16.8%	32	19.0%	8	29.6%	
How worried are you about you being infected with the coronavirus?									
Not too worried/not at all worried	167	57.2%	48	50.5%	99	58.9%	18	66.7%	**0.048**
Somewhat worried	81	27.7%	27	28.4%	51	30.4%	3	11.1%	
Extremely/very worried	44	15.1%	20	21.0%	18	10.7%	6	22.2%	
How worried are you about someone in your family being infected with the coronavirus?									
Not too worried/not at all worried	85	29.1%	25	26.3%	51	30.4%	7	25.9%	0.720
Somewhat worried	91	31.2%	28	29.5%	52	31.0%	11	40.7%	
Extremely/very worried	116	39.7%	42	44.2%	65	38.7%	9	33.3%	
How worried are you about your physical health being influenced by COVID?									
Not too worried/not at all worried	156	53.4%	47	49.5%	95	56.6%	12	44.4%	0.244
Somewhat worried	72	24.7%	25	26.3%	42	25.0%	5	18.5%	
Extremely/very worried	64	21.9%	23	24.2%	31	18.5%	10	37.0%	
How worried are you about your mental health being influenced by COVID?									
Not too worried/not at all worried	148	50.7%	28	50.5%	87	51.8%	11	40.7%	0.785
Somewhat worried	62	21.2%	19	20.0%	37	22.0%	6	22.2%	
Extremely/very worried	82	28.1%	28	29.5%	44	26.2%	10	37.0%	
How worried are you about the financial impact of COVID on you and your family?									
Not too worried/not at all worried	116	39.7%	30	31.6%	70	41.7%	14	51.9%	0.285
Somewhat worried	83	28.4%	30	31.6%	48	28.6%	5	18.5%	
Extremely/very worried	93	31.8%	35	36.8%	50	29.8%	8	29.6%	
If you got COVID, how serious do you think it would be?									
Not too serious/not at all serious	129	44.2%	35	36.8%	79	47.0%	14	51.9%	0.349
Somewhat serious	96	32.9%	34	35.8%	55	32.7%	6	22.2%	
Extremely serious/very serious	67	22.9%	26	27.4%	34	20.2%	7	25.9%	
How safe do you feel from COVID when you are inside your home?									
Very/somewhat safe	270	92.5%	86	90.5%	156	92.9%	26	96.3	0.550
Neither safe nor unsafe	14	4.8%	4	4.2	9	5.4%	1	3.7%	
Very/somewhat unsafe	8	2.7%	5	5.3%	3	1.8%	0	0.0%	
How safe do you feel from COVID when you are outdoors in public spaces (e.g., in a park or walking around your									

neighborhood)?									
Very/somewhat safe	164	56.2%	48	50.53%	99	58.9%	17	63.0%	
Neither safe nor unsafe	72	24.7%	19	20.0%	45	26.8%	6	22.2	**0.045**
Very/somewhat unsafe	56	19.2%	28	29.5%	24	14.3%	4	14.8%	
How safe do you feel from COVID when you are indoors in public spaces, not including school (e.g., in a grocery store)?									
Very/somewhat safe	96	32.9%	29	30.5%	59	35.1%	8	29.6%	
Neither safe nor unsafe	88	30.1%	25	26.3%	51	30.4%	10	37.0%	0.607
Very/somewhat unsafe	108	37.0%	41	43.2%	58	34.5%	9	33.3%	
How safe do you feel from COVID when you are at school?									
Very/somewhat safe	98	33.6%	30	31.6	55	32.7%	11	40.7%	
Neither safe nor unsafe	72	24.7%	23	24.2%	43	25.6%	6	22.2%	0.917
Very/somewhat unsafe	122	41.8%	42	44.2%	70	41.7%	10	37.0%	
How worried are you about the impact of COVID on your grades and/or high school graduation?									
Not too worried/not at all worried	101	34.6%	27	28.42	60	35.7%	14	51.9%	
Somewhat worried	90	30.8%	35	36.8%	51	30.4%	2	7.4%	**0.046**
Extremely/very worried	101	34.6%	33	34.7%	57	33.9%	11	40.7%	
How worried are you about the impact of COVID your college admissions and enrolment?									
Not too worried/not at all worried	138	47.3%	40	42.1%	85	50.6%	13	48.25%	
Somewhat worried	74	25.3%	25	26.3%	43	25.6%	4	14.8%	0.351
Extremely/very worried	80	27.4%	30	31.6%	40	23.8%	10	37%	
How worried are you about the impact of COVID your career trajectory and employment opportunities?									
Not too worried/not at all worried	131	44.9%	37	39.0%	81	48.2%	13	48.2%	
Somewhat worried	84	28.8%	27	28.4%	49	29.2%	6	22.2%	0.405
Extremely/very worried	77	26.4%	31	32.6%	38	22.6%	8	29.6%	

Note: All significant *p* values (<0.05) reported in bold text.