

**This is the post-print accepted manuscript in Journal of Child Psychology and Psychiatry:**  
Breux, R., Dvorsky, M. R., Marsh, N. P., Green, C. D., Cash, A. R., Shroff, D. M.,  
Langberg, J. M., & Becker, S. P. (In Press). Prospective impact of COVID-19 on adolescent  
mental health functioning in adolescents with and without ADHD: Protective role of emotion  
regulation abilities. *Journal of Child Psychology and Psychiatry*.  
<https://doi.org/10.1111/jcpp.13382>

**Prospective Impact of COVID-19 on Mental Health Functioning in Adolescents with and  
without ADHD: Protective Role of Emotion Regulation Abilities**

Rosanna Breux, PhD<sup>1</sup>, Melissa R. Dvorsky, PhD<sup>2</sup>, Nicholas P. Marsh, BA<sup>3</sup>,  
Cathrin D. Green, MS<sup>4</sup>, Annah R. Cash, BS<sup>1</sup>, Delshad M. Shroff, MA<sup>1</sup>, Natalie Buchen, BA<sup>4</sup>,  
Joshua M. Langberg, PhD<sup>4</sup>, Stephen P. Becker, PhD<sup>3,5</sup>

<sup>1</sup> Department of Psychology, Virginia Polytechnic Institute and State University

<sup>2</sup> Children's National Hospital; George Washington University

<sup>3</sup> Division of Behavioral Medicine and Clinical Psychology, Cincinnati Children's Hospital  
Medical Center

<sup>4</sup> Department of Psychology, Virginia Commonwealth University

<sup>5</sup> Department of Pediatrics, University of Cincinnati College of Medicine

Correspondence concerning this article should be addressed to Rosanna Breux, 460 Turner Street NW,  
Suite 207, Blacksburg, VA 24060. Email: [rbreux@vt.edu](mailto:rbreux@vt.edu), Phone: 540-231-8511.

### Abstract

**Background.** The impact of chronic stressors like the COVID-19 pandemic is likely to be magnified in adolescents with pre-existing mental health risk, such as attention-deficit/hyperactivity disorder (ADHD). This study examined changes in and predictors of adolescent mental health from before to during the COVID-19 pandemic in the Southeastern and Midwestern United States. **Methods.** Participants include 238 adolescents (132 males; ages 15-17; 118 with ADHD). Parents and adolescents provided ratings of mental health symptoms shortly before the COVID-19 pandemic and in spring and summer 2020. **Results.** Adolescents on average experienced an increase in depression, anxiety, sluggish cognitive tempo, inattentive, and oppositional/defiant symptoms from pre-COVID-19 to spring 2020; however, with the exception of inattention, these symptoms decreased from spring to summer 2020. Adolescents with ADHD were more likely than adolescents without ADHD to experience an increase in inattentive, hyperactive/impulsive, and oppositional/defiant symptoms. Adolescents with poorer pre-COVID-19 emotion regulation abilities were at-risk for experiencing increases in all mental health symptoms relative to adolescents with better pre-COVID-19 emotion regulation abilities. Interactive risk based on ADHD status and pre-COVID-19 emotion regulation abilities was found for inattention and hyperactivity/impulsivity, such that adolescents with ADHD and poor pre-COVID-19 emotion regulation displayed the highest symptomatology across timepoints. Lower family income related to increases in inattention but higher family income related to increases in oppositional/defiant symptoms. **Conclusions.** The early observed increases in adolescent mental health symptoms during the COVID-19 pandemic do not on average appear to be sustained following the lift of stay-at-home orders, though studies evaluating mental health across longer periods of time are needed. Emotion dysregulation and ADHD increase risk for sustained negative mental health functioning and highlight the need for interventions for these populations during chronic stressors. Results and clinical implications should be considered within the context of our predominately White, middle class sample.

**Keywords:** novel coronavirus; COVID-19; adolescence; mental health; emotion regulation; attention-deficit/hyperactivity disorder; psychopathology

**Abbreviations:** COVID-19 = novel coronavirus; ADHD = attention-deficit/hyperactivity disorder; SCT = sluggish cognitive tempo; VADRS = Vanderbilt ADHD Diagnostic Rating Scale; CCI-2 = Child Concentration Inventory, Second Edition; RCADS = Revised Children's Anxiety and Depression Scale

Mounting evidence highlights the profound early impact of the COVID-19 pandemic on mental health functioning. Specifically, elevated rates of anxiety and depression symptoms have been documented in several large, cross-sectional adolescent and adult samples (e.g., Ahmed et al., 2020; Asanov et al., 2020; Cao et al., 2020; Huang & Zhao, 2020). However, prospective longitudinal studies that include assessments of mental health prior to COVID-19 are scarce (McGinty et al., 2020), as are studies including multiple timepoints during COVID-19 (Wang et al., 2020). These studies find preliminary support that individual mental health symptoms have increased among adults in the United States from pre-COVID-19 to spring 2020 (McGinty et al., 2020) and that this increase may be short-lived, with reductions in psychological impact observed four weeks after the onset of COVID-19 in China (Wang et al., 2020). To our knowledge, no studies have utilized both prospective adolescent data with pre-COVID-19 assessment *and* multiple timepoints during COVID-19. It will be particularly important for such research to examine individual factors that may increase or decrease risk in predicting mental health trajectories throughout the COVID-19 pandemic.

Experiencing chronic stress is a well-established catalyst for mental health difficulties, particularly for individuals who are at-risk due to biological, psychological, or social factors (Zuckerman, 1999). The COVID-19 pandemic, including stay-at-home orders and longer-term public health recommendations, may be particularly impactful for adolescents, given that adolescence is associated with the onset of many mental health problems, increased emotion dysregulation, increased parent-child conflict, and prioritization of peer relationships (Brown & Larson, 2009; Collins, 1990; Paus et al., 2008; Sobanski et al., 2010). Further, the impact of COVID-19 is likely to be magnified in adolescents with pre-existing mental health and neurodevelopmental risk, such as attention-deficit/hyperactivity disorder (ADHD). ADHD is a highly prevalent neurodevelopmental disorder (Willcutt, 2012) associated with high levels of psychiatric comorbidity, poor social and academic functioning, and emotion dysregulation (e.g., Becker & Fogleman, 2020; Steinberg & Drabick, 2015). Emotion dysregulation has been linked to comorbidity among youth with ADHD (Steinberg & Drabick, 2015), making it an important predictor of mental health during COVID-19. Although adolescents with ADHD display higher levels of emotion dysregulation than their peers, not all adolescents with ADHD experience these difficulties, and these difficulties are not unique to ADHD (Bunford et al., 2015). In fact, emotion dysregulation is conceptualized as a transdiagnostic risk factor for psychopathology and is a core feature of both internalizing and externalizing disorders (McLaughlin et al., 2011; Sloan et al., 2017). As such, it is important to examine whether ADHD status may result in unique risk for poorer mental health functioning, above and beyond the effects of emotion dysregulation. Just as emotion dysregulation serves as a risk factor for psychopathology, well-developed emotion regulation abilities may serve as an important buffer against chronic stress. Prior research examining the impact of crises/stressors have shown that emotion regulation plays an important role in determining the effects on an individual (Jenness et al., 2016; Terranova et al., 2009), with some early evidence among adults that emotion regulation abilities are linked to better mental health functioning during the COVID-19 pandemic (Jiang et al., 2020; Moccia et al., 2020). Finally, it is possible that ADHD and emotion dysregulation confer interactive risk, and that having well-developed emotion regulation abilities may serve as a protective factor for both adolescents with and without ADHD.

Given this backdrop, the present study sought to use a prospective, longitudinal sample of adolescents with and without ADHD to examine changes in and predictors of mental health functioning during the COVID-19 pandemic. We examine both risk and protective processes,

which is critical for identifying which adolescents might be most impacted by this and future chronic stressors as well as targets for intervention (Dvorsky et al., 2020). As such, the first aim of this study was to examine changes in mental health functioning during COVID-19 in adolescents. The second aim was to examine whether ADHD status, pre-COVID-19 emotion regulation abilities, and demographic variables were predictors of change in mental health functioning. Given that adolescents with ADHD experience poorer emotion regulation abilities on average, but that not all adolescents with ADHD experience such difficulties and that these difficulties are not unique to ADHD (Bunford et al., 2015), both independent and interactive effects were examined for ADHD and emotion regulation abilities in predicting mental health functioning.

## Methods

### Participants

Participants were 238 adolescents (132 males; ages 15-17 years) from two sites in the Southeastern and Midwestern United States. Although the two study site locations are in Richmond, Virginia and Cincinnati, Ohio, Cincinnati borders Kentucky, thus families resided in Ohio (23%), Kentucky (33%), and Virginia (42%)<sup>1</sup>. Adolescent participants each participated with a primary caregiver (89% mothers, 9% fathers, 2% other). Approximately half of the sample ( $n=118$ ) was comprehensively diagnosed at the initial evaluation prior to COVID-19 with ADHD (85 ADHD predominantly inattentive presentation, 33 ADHD combined presentation). Adolescents identified as predominantly White (82%), with 7% identifying as biracial/multiracial, 6% identifying as Black, 4% Asian, and 1% identifying as another race; 4% of the sample identified as Hispanic/Latinx. Participants came from a range of socioeconomic backgrounds ( $M$  family income=\$93,073,  $SD$ =\$34,856), with 19% of families falling below the 2019 United States median household income.

### Procedures

Participants who provided permission for further contact pre-COVID-19 (visits between September 2018-February 2020;  $N = 262$ ; 90.8% retention) were invited to participate in the current study, with COVID-19 data being collected between May 15-June 14, 2020 during stay-at-home orders (spring 2020)<sup>2</sup> and between July 1-August 5, 2020 after these orders had lifted (summer 2020). The 238 participants who participated in the COVID-19 timepoints did not differ from 24 participants who were contacted for possible participation on adolescent sex, race, ethnicity, ADHD symptoms, or family income ( $ps>.07$ ).

For the larger study, adolescents and their parents were recruited across two consecutive years for a prospective longitudinal study examining sleep in adolescents with and without ADHD (Becker et al., 2019; Langberg et al., 2019). Inclusion criteria included enrolled in eighth grade, estimated Full Scale IQ  $\geq 80$ , and enrolled in regular education classes. Exclusion criteria were meeting criteria for autism spectrum disorder, bipolar disorder, or a dissociative or psychotic disorder; previous diagnosis of an organic sleep disorder (e.g., obstructive sleep apnea); and not meeting criteria for either the ADHD or comparison groups. During the initial assessment, all participants underwent a comprehensive ADHD diagnostic evaluation. To be eligible for the ADHD group, adolescents were required to meet all Diagnostic and Statistical

---

<sup>1</sup> Six families (2% of the sample) moved to other states after being recruited to the initial study but resided in these other states during all three timepoints used in this study.

<sup>2</sup> Stay-at-home orders for Ohio were March 23–May 29, stay-at-home orders for Kentucky were March 26–May 22 with additional restrictions through June 29, and stay-at-home orders in Virginia were March 30 – June 10 (“Map of COVID-19,” 2020). After formal stay-at-home, orders lifted in Ohio “strong recommendations” for residents to “stay at their place of residence when possible” were issued.

Manual for Mental Disorders, Fifth Edition (DSM-5) criteria for either ADHD combined or predominantly inattentive presentation on the Children's Interview for Psychiatric Syndromes (ChIPS; Weller et al., 1999) and evidence impairment in home, academic, and/or social settings. Participants were included in the comparison group if parents endorsed <4 symptoms in both domains of ADHD (i.e., inattention, hyperactivity/impulsivity) on the ChIPS. Adolescents and parents provided consent and assent for participation and were compensated for participation at all timepoints. This study was approved by the Cincinnati Children's Hospital Medical Center and Virginia Commonwealth University Institutional Review Boards.

### Measures

**Vanderbilt ADHD Diagnostic Rating Scale (VADRS; Wolraich et al., 2003).** Parents completed the VADRS to assess DSM-5 based symptoms of hyperactivity/impulsivity, inattention, and oppositionality/defiance. Ratings are provided based on behaviors while the adolescents are on medication, when relevant. Symptoms are rated on a 4-point scale ranging from 1=*Never* to 4=*Very Often*, with symptoms rated as occurring *often* or *very often* counting as being clinically present. Reliability was good in this sample at all timepoints ( $\alpha$ s=.89-.94).

**Child Concentration Inventory, Second Edition (CCI-2; Becker, 2015; Sáez et al., 2019).** Self-reported CCI-2 was used to assess sluggish cognitive tempo (SCT) symptoms (e.g., daydreaming, fogginess). Items are rated on a 4-point Likert scale ranging from 0=*Never* to 3=*Always*. A mean score across 15 items was used in the present study. The CCI-2 has been validated for use with adolescents with and without ADHD (Becker et al., 2020). Reliability was excellent at all timepoints ( $\alpha$ s=.93 - .94).

**Revised Child Anxiety and Depression Scales (RCADS; Chorpita et al., 2005).** Self-report on the RCADS was used to assess DSM-based anxiety and depression symptoms. Symptoms are rated on a 4-point scale ranging from 1=*Never* to 4=*Always*. *T*-scores normed based on grade and sex for the Depression and Total Anxiety composites were used in the present study. Reliability was good at all timepoints ( $\alpha$ s=.89-.96).

**Difficulties in Emotion Regulation Scale – Short Form (DERS; Kaufman et al., 2015).** Adolescents completed the DERS short form consisting of 18 items rated on a 5-point scale indicating how often they engage in various behaviors ranging from 1=*Almost Never* (0-10%) to 5=*Almost Always* (91-100%). The global emotion dysregulation composite was used in the present study to create a dichotomized variable representing poor pre-COVID-19 emotion regulation abilities (1=scores greater than mean emotion dysregulation composite) and good emotion regulation abilities (0=scores less than mean emotion dysregulation composite). Reliability was excellent in this sample ( $\alpha$ =.90).

**Demographic Variables.** Adolescent sex (male=0; female=1) and family income were reported by parents in a demographic form. Adolescents reported on their own race and ethnicity (non-Black or Latinx=0, Black and/or Latinx=1).

### Analyses

Descriptive statistics, repeated measures ANOVAs, and follow-up paired-sample *t*-tests were examined to assess change in mental health functioning. To examine predictors of changes in mental health functioning, linear mixed-effects models with ADHD status and pre-COVID-19 emotion regulation abilities as between-subjects factors were run. Relevant demographic variables of sex, race, and family income were included as additional predictors, and cohort and medication status were included as covariates. Three medication status covariates were used based on parent-report of medication status on the VADRS at each timepoint (1=on medication, 0=not on medication or unsure). Cohen's *d* was calculated as a measure of effect size, with .3, .5,

and .8 representing small, medium, and large effects, respectively (Cohen, 1988). Post-hoc power analyses indicated adequate power to detect small effects for the repeated measure ANOVA analyses (Cohen's  $f=.1$ ,  $\text{power}=.93$ ), assuming a .5 correlation among the repeated measures. Similarly, post-hoc power analyses indicated adequate power to detect small effects of  $f^2>.07$  for the linear mixed effects analyses.

## Results

### Preliminary Analyses

Descriptive statistics for the total sample are presented in Table 1. Across the entire sample significant change was observed across timepoints for every mental health symptom domain ( $ds=0.26-0.75$ ) except hyperactivity/impulsivity ( $d=0.19$ ). For depression, anxiety, SCT, and oppositional/defiant symptoms, this change was quadratic ( $Fs=8.02-46.42$ ,  $ps<.006$ ,  $ds=0.54-1.14$ ), with spring 2020 scores being significantly higher than pre-COVID-19 and summer 2020 ( $ts=2.58-6.19$ ,  $ps<.012$ ). For inattention symptoms, this change was linear ( $F=6.51$ ,  $p=.011$ ,  $d=0.34$ ), with spring and summer 2020 scores being significantly higher than pre-COVID-19 scores ( $t=2.69$  and  $2.55$ ,  $p=.008$  and  $.011$ , respectively).

### Predictors of Change in Mental Health Functioning from Pre-COVID-19 to During COVID-19

Results for the linear mixed-effects models can be found in Tables 2 and 3. ADHD status was a unique predictor of SCT, inattention, hyperactivity/impulsivity, and oppositionality/defiance symptom trajectories. Specifically, relative to adolescents without ADHD, adolescents with ADHD had significantly more inattention, hyperactivity/impulsivity, and oppositional/defiant symptoms at all timepoints ( $ts=3.75-9.87$ ,  $ps<.001$ ) and significantly more SCT symptoms pre-COVID-19 and in summer 2020 ( $t=3.67$  and  $2.92$ ,  $p<.001$  and  $p=.004$ , respectively). Adolescents with and without ADHD did not differ on SCT symptoms in spring 2020, as adolescents without ADHD experienced an increase in SCT from pre-COVID-19 to spring 2020,  $t=3.95$ ,  $p<.001$ , but adolescents with ADHD did not experience a change in SCT symptoms,  $t=0.76$ ,  $p=.451$ .

Pre-COVID-19 emotion regulation abilities were a unique predictor of all mental health symptoms. Specifically, adolescents with poor pre-COVID-19 emotion regulation abilities displayed more depression, anxiety, SCT, and inattention symptoms at all timepoints ( $ts=2.94-8.82$ ,  $ps<.006$ ); more hyperactivity/impulsivity symptoms in spring and summer 2020 ( $ts=2.60$  and  $2.00$ ,  $ps=.010$  and  $.040$ , respectively); and more oppositionality/defiance symptoms pre-COVID-19 and in spring 2020 ( $ts=2.53$  and  $2.30$ ,  $ps=.012$  and  $.023$ , respectively), relative to adolescents with good pre-COVID-19 emotion regulation abilities. An interaction between ADHD status and pre-COVID-19 emotion regulation abilities was found for inattention and hyperactivity/impulsivity symptoms suggesting additive risk among adolescents with ADHD and poor emotion regulation abilities (Figure 1).

With regard to demographic variables, adolescent sex significantly predicted hyperactivity/impulsivity, with males experiencing a marginal increase from pre-COVID-19 to spring and summer 2020 ( $ts=1.93$  and  $1.83$ ,  $ps=.056$  and  $.069$ , respectively), but females showing no change across timepoints ( $ts=0.21-0.74$ ,  $ps>.464$ ). Family income was a significant predictor of inattention and oppositionality/defiance. Specifically, when probing the continuous income variable based on incomes below/above the national median household income, adolescents from families with higher incomes did not change in inattention symptoms, whereas adolescents from families with lower incomes experienced an increase in inattention. The opposite pattern was found for oppositionality/defiance, with higher income families

experiencing an increase in oppositionality/defiance. Race/ethnicity did not significantly predict change in any mental health symptoms.

### Discussion

This study utilized a prospective longitudinal design to examine changes in mental health functioning among adolescents with and without ADHD using data collected shortly before the COVID-19 pandemic, during spring 2020, and during summer 2020 in the Southeastern and Midwestern United States. Overall, significant increases in depression, anxiety, SCT, inattention, and oppositionality/defiance symptoms were observed across adolescents from pre-COVID-19 to spring 2020; however, these symptoms generally returned to pre-COVID-19 levels in summer 2020, with the exception of inattention. ADHD status was associated with increases in SCT and externalizing symptoms. Poor pre-COVID-19 emotion regulation abilities predicted increases in internalizing and externalizing symptoms during the COVID-19 pandemic. Results also highlight that individuals with ADHD and poor emotion regulation abilities were at the greatest risk for sustained elevations in externalizing symptoms during spring and summer 2020. These findings have important clinical implications for helping prevent negative mental health outcomes during the COVID-19 pandemic and future chronic stressors.

Our findings that adolescents experienced increases in mental health symptoms during COVID-19 stay-at-home orders extend cross-sectional research suggesting increased prevalence rates of anxiety and depression during COVID-19 (e.g., Ahmed et al., 2020; Asanov et al., 2020; Cao et al., 2020; Huang & Zhao, 2020) and the limited prospective research with adults finding increases in psychological distress and loneliness from 2018 to 2020 (McGinty et al., 2020). However, our results also provide promise that these increases in mental health symptoms did not remain, on average, once stay-at-home orders had lifted. This is consistent with the very limited research to date examining changes throughout the COVID-19 pandemic (Wang et al., 2020), and extends these findings to suggest that the decrease in symptoms is back to pre-COVID-19 levels.

Our results suggest that adolescents with ADHD are experiencing a greater increase in SCT and externalizing symptoms during the COVID-19 pandemic. This increase in SCT, ADHD, and oppositional/defiant symptoms among adolescents with ADHD is particularly noteworthy as this is above and beyond the effects of medication status, suggesting that the elevated rates in spring and summer 2020 are not merely a result of adolescents with ADHD being on medication holidays during remote learning and the summer months. Additionally, results extend prior research with adults suggesting that emotion regulation abilities are associated with better mental health during crises and chronic stressors including the COVID-19 pandemic (Jenness et al., 2016; Jiang et al., 2020; Moccia et al., 2020; Terranova et al., 2009). Our findings are the first to prospectively support that emotion regulation abilities prior to COVID-19 predict better mental health functioning during the pandemic. We found adolescents with better pre-COVID-19 emotion regulation abilities experience less of an increase in both internalizing and externalizing symptoms during COVID-19, consistent with emotion dysregulation being a transdiagnostic risk factor (McLaughlin et al., 2011; Sloan et al., 2017). However, there was some evidence of interactive risk for externalizing symptoms for adolescents with ADHD and poor emotion regulation. These findings have important clinical implications as they suggest that improving emotion regulation abilities could be a protective factor, particularly for at-risk adolescents, for coping with chronic stressors such as the COVID-19 pandemic.

Cross-sectional research regarding sex differences in mental health functioning during the COVID-19 pandemic has been mixed, with some studies finding similar rates of mental health

difficulties among men and women (e.g., Ahmed et al., 2020; Huang & Zhao, 2020), and others finding women to be at increased risk (e.g., Asanov et al., 2020; Holland, 2020; Jiang et al., 2020). Findings from our prospective study suggest minimal sex differences, with the only difference being males experiencing increases in hyperactivity/impulsivity. Similarly, other demographic factors did not display a consistent pattern of risk. Specifically, adolescents from families with lower incomes experienced more of an increase in inattention, but no change in oppositional/defiant symptoms, whereas the opposite pattern was found for adolescents from higher income families for oppositional/defiant symptoms. These limited and inconsistent findings may be due to only 19% of families falling below the United States median household income. Surprisingly, adolescent race/ethnicity was not related to changes in mental health. This is likely due to our sample being predominately White, with only 10.5% of participants identifying as Black and/or Latinx. There is prior evidence that Black and Latinx individuals have experienced significantly greater levels of stress, economic impact, and mental health symptoms during COVID-19 relative to White and Asian individuals (e.g., Holland, 2020; Mental Health - Household Pulse Survey - COVID-19, 2020). It will be important for future research with larger, more diverse adolescent samples to examine the role of race/ethnicity in mental health functioning during the pandemic.

Results of the present study should be interpreted within the context of several limitations. First, given our predominately White sample and the disproportionate impact of the COVID-19 pandemic on Black and Latinx Americans, it is possible that our observed increases in mental health symptoms may be an underestimate. Despite efforts to recruit through school and community settings, including schools with large Black and Latinx populations, the vast majority of families who responded to flyer distribution identified as White. Second, as ratings of ADHD and oppositional/defiant symptoms were provided based on behaviors on medication, rates of reported externalizing symptoms were low pre-COVID-19 and during COVID-19. However, the ADHD sample still displayed significantly more externalizing symptoms than the comparison sample, and analyses focused on changes within the samples across time, somewhat reducing this concern. Third, it is possible that families who continued to participate in the study are families with better overall mental health functioning and/or that are experiencing less difficulties during the pandemic. Finally, it is impossible to disentangle whether the change in mental health symptoms from spring to summer 2020 was a result of COVID-19 restrictions lessening (i.e., removal of stay-at-home orders), a result of this timepoint occurring in the summer, or a combination of both. It will be critical for research to continue following students through the 2020-2021 school year to examine trajectories of mental health symptoms, and predictors of such trajectories.

Taken together, results highlight that the early observed increase in mental health symptoms during the COVID-19 pandemic may not extend for all adolescents after stay-at-home orders have lifted. Some youth, such as youth with ADHD and poor ER abilities, appear to be more likely to experience sustained elevations in mental health symptoms during chronic stress. Future longitudinal research with larger samples that can consider rates of infection and local restrictions, and how such factors may be related to changes in mental health throughout the pandemic, will be necessary. Additionally, research with more diverse samples is needed to explore how changes in and predictors of mental health during chronic stressors may differ based on race, ethnicity, and socioeconomic status. Results suggest that emotion regulation is one possible intervention target for reducing the negative mental health impact of chronic stressors. Online and single-session efforts (e.g., The BEST-TECH Project; Project YES; Lab for Scalable

Mental Health, 2020) to address emotion regulation abilities among adolescents are an important avenue to continue to explore, as are interventions targeting emotion regulation among adolescents with ADHD (Breux & Langberg, 2020) given our evidence for increased risk.

### **Key Points**

- Substantial evidence of the early impact of COVID-19 on mental health, but minimal prospective research examining changes in mental health symptoms with multiple COVID-19 timepoints
- Mental health symptoms increased from pre-COVID-19 to spring 2020 among adolescents in the United States; these increases largely did not remain in summer 2020
- Adolescents with ADHD experienced increases in sluggish cognitive tempo, inattention, hyperactivity/impulsivity, and oppositional/defiant symptoms above and beyond the effects of medication status
- Poor pre-COVID-19 emotion regulation abilities predicted increases in internalizing and externalizing symptoms during COVID-19; interventions improving emotion regulation abilities could decrease risk during chronic stressors
- More research with large, diverse samples needed to better examine changes in and predictors of mental health among Black and Latinx adolescents

**Acknowledgements:** The authors would like to thank the families, project coordinators, and graduate students who made this research possible. This research was supported by the Institute of Education Science (IES), U.S. Department of Education (grant R305A160126), Cincinnati Children's Research Foundation, and a Virginia Tech COVID-19 Rapid Response Seed Grant. The funding sources had no role in the design and conduct of the study; collection, management, analysis, and interpretation of the data; preparation, review, or approval of the manuscript; or decision to submit the manuscript for publication.

**Correspondence to:** Rosanna Breaux, PhD, 460 Turner St. NW, Suite 207, Blacksburg, VA 24060, phone: 540-231-8511, rbreaux@vt.edu,

### References

- Ahmed, M. Z., Ahmed, O., Aibao, Z., Hanbin, S., Siyu, L., & Ahmad, A. (2020). Epidemic of COVID-19 in China and associated psychological problems. *Asian Journal of Psychiatry*, *51*, 102092.
- Asanov, I., Flores, F., McKenzie, D. J., Mensmann, M., & Schulte, M. (2020). Remote-learning, time-use, and mental health of Ecuadorian high-school students during the COVID-19 quarantine. *World Bank Policy Research Working Paper No. 9252*.
- Becker, S. P. (2015). Child concentration inventory, (CCI-2). *Cincinnati, OH: Author*.
- Becker, S. P., Breaux, R., Cusick, C. N., Dvorsky, M. R., Marsh, N. P., Sciberras, E., Langberg, J. M. (2020). Remote learning during COVID-19: Examining school practices, service continuation, and difficulties for adolescents with and without ADHD. *Journal of Adolescent Health*. Advanced Online Publication.
- Becker, S. P., Burns, G. L., Smith, Z. R., & Langberg, J. M. (2020). Sluggish cognitive tempo in adolescents with and without ADHD: Differentiation from adolescent-reported ADHD inattention and unique associations with internalizing domains. *Journal of Abnormal Child Psychology*, *48*, 391-406.
- Becker, S. P., Fogleman, N. D. (2020) Psychiatric co-occurrence (comorbidity) in adolescents with ADHD. In S.P. Becker, ed. *ADHD in adolescents: Development, assessment, and treatment*. New York, NY: Guilford Press (170-203).
- Becker, S. P., Langberg, J. M., Eadeh, H. M., Isaacson, P. A., & Bourchtein, E. (2019). Sleep and daytime sleepiness in adolescents with and without ADHD: Differences across ratings, daily diary, and actigraphy. *Journal of Child Psychology and Psychiatry*, *60*, 1021-1031.
- Bor, J., Venkataramani, A. S., Williams, D. R., & Tsai, A. C. (2018). Police killings and their spillover effects on the mental health of black Americans: a population-based, quasi-experimental study. *The Lancet*, *392*(10144), 302-310.
- Breaux, R., & Langberg, J. M. (2020). Development and refinement of the RELAX intervention, an intervention targeting emotion dysregulation and interpersonal conflict in adolescents with ADHD: Results from a pilot study. *Evidence-Based Practice in Child & Adolescent Mental Health*, *5*, 147-163.
- Brown, B. B., & Larson, J. (2009). Peer relationships in adolescence. In R. M. Lerner, L. Steinberg, eds. *Handbook of Adolescent Psychology*. Vol 1. (74-100).
- Bunford, N., Evans, S. W., & Wymbs, F. (2015). ADHD and emotion dysregulation among children and adolescents. *Clinical Child and Family Psychology Review*, *18*, 185-217.
- Cao, W., Fang, Z., Hou, G., Han, M., Xu, X., Dong, J., & Zheng, J. (2020). The psychological impact of the COVID-19 epidemic on college students in China. *Psychiatry Research*, *287*, 112934.
- Chorpita, B. F., Moffitt, C. E., & Gray, J. (2005). Psychometric properties of the Revised Child Anxiety and Depression Scale in a clinical sample. *Behaviour Research and Therapy*, *43*(3), 309-322.
- Cohen, J. (1988). *Statistical power analysis for the behavioural sciences*, 2nd edn. Hillsdale, NJ: L. Erlbaum Associates.
- Collins, W. A. (1990). *Parent-child relationships in the transition to adolescence: Continuity and change in interaction, affect, and cognition*. In R. Montemayor, G. R. Adams, & T. P. Gullotta (Eds.), *Advances in adolescent development: An annual book series, Vol. 2. From childhood to adolescence: A transitional period?* (p. 85–106). Sage Publications, Inc.

- Dvorsky, M. R., Breaux, R., & Becker, S. P. (2020). Finding ordinary magic in extraordinary times: child and adolescent resilience during the COVID-19 pandemic. *European Child & Adolescent Psychiatry*, Advanced Online Publication.
- Ebesutani, C., Bernstein, A., Nakamura, B. J., Chorpita, B. F., & Weisz, J. R. (2010). A psychometric analysis of the Revised Child Anxiety and Depression Scale—Parent Version in a clinical sample. *Journal of Abnormal Child Psychology*, *38*, 249-260.
- Holland K. (2020, May 8). What COVID-19 is doing to our mental health. Healthline. <https://www.healthline.com/health-news/what-covid-19-is-doing-to-our-mental-health>. Accessed June 21, 2020.
- Huang, Y., & Zhao, N. (2020). Mental health burden for the public affected by the COVID-19 outbreak in China: Who will be the high-risk group? *Psychology, Health & Medicine*, Advanced Online Publication.
- Jenness, J. L., Jager-Hyman, S., Heleniak, C., Beck, A. T., Sheridan, M. A., & McLaughlin, K. A. (2016). Catastrophizing, rumination, and reappraisal prospectively predict adolescent PTSD symptom onset following a terrorist attack. *Depression and Anxiety*, *33*, 1039-1047.
- Jiang, H. J., Nan, J., Lv, Z. Y., & Yang, J. (2020). Psychological impacts of the COVID-19 epidemic on Chinese people: Exposure, post-traumatic stress symptom, and emotion regulation. *Asian Pacific Journal of Tropical Medicine*, *13*, 252-259.
- Kaufman, E. A., Xia, M., Fosco, G., Yaptangco, M., Skidmore, C. R., & Crowell, S. E. (2016). The Difficulties in Emotion Regulation Scale Short Form (DERS-SF): Validation and replication in adolescent and adult samples. *Journal of Psychopathology and Behavioral Assessment*, *38*, 443-455.
- Kantamneni, N. (2020). The impact of the COVID-19 pandemic on marginalized populations in the United States: A research agenda. *Journal of Vocational Behavior*, *119*, 103439.
- Lab for Scalable Mental Health. Accessed June 18, 2020. <http://www.schleiderlab.org/ongoingstudies.html>
- Langberg, J. M., Breaux, R. P., Cusick, C. N., Green, C. D., Smith, Z. R., Molitor, S. J., & Becker, S. P. (2019). Intraindividual variability of sleep/wake patterns in adolescents with and without attention-deficit/hyperactivity disorder. *Journal of Child Psychology and Psychiatry*, *60*, 1219-1229.
- Map of COVID-19 case trends, reopening status and mobility. (2020, October 30) Retrieved from <https://www.usatoday.com/storytelling/coronavirus-reopening-america-map/>
- McGinty, E. E., Presskreischer, R., Han, H., & Barry, C. L. (2020). Psychological distress and loneliness reported by US adults in 2018 and April 2020. *JAMA*, Advanced Online Publication.
- McLaughlin, K. A., Hatzenbuehler, M. L., Mennin, D. S., & Nolen-Hoeksema, S. (2011). Emotion dysregulation and adolescent psychopathology: A prospective study. *Behaviour Research and Therapy*, *49*, 544-554.
- Mental Health - Household Pulse Survey - COVID-19. Centers for Disease Control and Prevention. <https://www.cdc.gov/nchs/covid19/pulse/mental-health.htm>. Published June 17, 2020. Accessed June 21, 2020.
- Moccia, L., Janiri, D., Pepe, M., Dattoli, L., Molinaro, M., De Martin, V., ... & Di Nicola, M. (2020). Affective temperament, attachment style, and the psychological impact of the COVID-19 outbreak: an early report on the Italian general population. *Brain, Behavior, and Immunity*, *87*, 75-79.

- Paus, T., Keshavan, M., & Giedd, J. N. (2008). Why do many psychiatric disorders emerge during adolescence? *Nature Reviews Neuroscience*, *9*, 947-957.
- Sáez, B., Servera, M., Burns, G. L., & Becker, S. P. (2019). Advancing the multi-informant assessment of sluggish cognitive tempo: Child self-report in relation to parent and teacher ratings of SCT and impairment. *Journal of Abnormal Child Psychology*, *47*, 35-46.
- Sloan, E., Hall, K., Moulding, R., Bryce, S., Mildred, H., & Staiger, P. K. (2017). Emotion regulation as a transdiagnostic treatment construct across anxiety, depression, substance, eating and borderline personality disorders: A systematic review. *Clinical Psychology Review*, *57*, 141-163.
- Sobanski, E., Banaschewski, T., Asherson, P., Buitelaar, J., Chen, W., Franke, B., ... & Stringaris, A. (2010). Emotional lability in children and adolescents with attention deficit/hyperactivity disorder (ADHD): clinical correlates and familial prevalence. *Journal of Child Psychology and Psychiatry*, *51*, 915-923.
- Steinberg, E. A., & Drabick, D. A. (2015). A developmental psychopathology perspective on ADHD and comorbid conditions: The role of emotion regulation. *Child Psychiatry & Human Development*, *46*, 951-966.
- Terranova, A. M., Boxer, P., & Morris, A. S. (2009). Factors influencing the course of posttraumatic stress following a natural disaster: Children's reactions to Hurricane Katrina. *Journal of Applied Developmental Psychology*, *30*, 344-355.
- Wang, C., Pan, R., Wan, X., Tan, Y., Xu, L., McIntyre, R. S., ... & Ho, C. (2020). A longitudinal study on the mental health of general population during the COVID-19 epidemic in China. *Brain, Behavior, and Immunity*, Advanced Online Publication.
- Willcutt, E. G. (2012). The prevalence of DSM-IV attention-deficit/hyperactivity disorder: A meta-analytic review. *Neurotherapeutics*, *9*, 490-499.
- Wolraich, M. L., Feurer, I. D., Hannah, J. N., & Baumgaertel, A. (2003). Vanderbilt ADHD teacher rating scale (VADTRS) and the Vanderbilt ADHD parent rating scale (VADPRS). *Oklahoma City, OK: University of Oklahoma Health Sciences Center*.
- Zuckerman, M., & Riskind, J. H. (2000). Vulnerability to psychopathology: A biosocial model. American Psychological Association.

Table 1.

*Descriptive Statistics and Repeated Measure ANOVAs for Adolescent Mental Health Symptoms*

Variable	Pre-COVID	Spring 2020	Summer 2020	<i>F</i>	<i>p</i>	<i>d</i>
	<i>M (SD)</i>	<i>M (SD)</i>	<i>M (SD)</i>			
RCADS Depression	45.10 (13.04) <sup>a</sup>	50.95 (15.01) <sup>a, c</sup>	46.19 (13.70) <sup>c</sup>	20.40	<.001	0.75
RCADS Anxiety	41.51 (12.98) <sup>a</sup>	43.16 (12.95) <sup>a, c</sup>	40.97 (12.91) <sup>c</sup>	4.97	.008	0.37
Sluggish Cognitive Tempo	0.84 (0.55) <sup>a</sup>	0.94 (0.60) <sup>a, c</sup>	0.83 (0.60) <sup>c</sup>	8.26	<.001	0.39
VADRS Inattention	1.77 (2.72) <sup>a, b</sup>	2.16 (2.92) <sup>a</sup>	2.17 (2.95) <sup>b</sup>	5.34	.005	0.31
VADRS Hyperactivity/Impulsivity	0.65 (1.43)	0.79 (1.53)	0.79 (1.58)	2.04	.131	0.19
VADRS Oppositionality/Defiance	0.81 (1.70) <sup>a</sup>	1.03 (1.94) <sup>a, c</sup>	0.78 (1.73) <sup>c</sup>	3.65	.027	0.26

*Note.* RCADS=Revised Children's Anxiety and Depression Scale; VADRS=Vanderbilt ADHD Diagnostic Rating Scales; ADHD=attention-deficit/hyperactivity disorder. <sup>a</sup> = significant difference between pre-COVID-19 and Spring 2020; <sup>b</sup> = significant difference between pre-COVID-19 and Summer 2020, <sup>c</sup> = significant difference between Spring and Summer 2020.

Table 2.

*Repeated Measure ANOVAs for Predictors of Adolescent Internalizing Symptoms*

Measure	<i>F</i>	<i>p</i>	<i>d</i>
<u>RCADS Depression</u>			
Cohort	3.37	.069	0.32
Pre-COVID Medication Status	0.01	.940	0.01
Spring 2020 Medication Status	2.01	.159	0.25
Summer 2020 Medication Status	4.72	.032	0.38
Sex	1.49	.224	0.21
Race/Ethnicity	1.03	.312	0.18
Income	0.25	.616	0.09
ADHD Status	0.40	.529	0.11
<b>Emotion Regulation</b>	<b>20.97</b>	<b>&lt;.001</b>	<b>0.79</b>
ADHD x Emotion Regulation	0.42	.519	0.11
<u>RCADS Anxiety</u>			
Cohort	8.99	.003	0.52
Pre-COVID Medication Status	5.05	.026	0.39
Spring 2020 Medication Status	12.78	<.001	0.62
Summer 2020 Medication Status	2.87	.093	0.29
Sex	0.85	.359	0.16
Race/Ethnicity	2.47	.118	0.27
Income	0.08	.778	0.06
ADHD Status	0.37	.542	0.11
<b>Emotion Regulation</b>	<b>37.22</b>	<b>&lt;.001</b>	<b>1.05</b>
ADHD x Emotion Regulation	1.62	.206	0.22
<u>Sluggish Cognitive Tempo</u>			
Cohort	0.12	.729	0.06
Pre-COVID Medication Status	1.44	.231	0.17
Spring 2020 Medication Status	2.21	.138	0.21
Summer 2020 Medication Status	2.95	.087	0.24
Sex	3.08	.081	0.25
Race/Ethnicity	1.72	.191	0.18
Income	0.00	.951	0.01
<b>ADHD Status</b>	<b>8.12</b>	<b>.005</b>	<b>0.40</b>
<b>Emotion Regulation</b>	<b>33.34</b>	<b>&lt;.001</b>	<b>0.81</b>
ADHD x Emotion Regulation	1.54	.216	0.18

*Note.* RCADS=Revised Children's Anxiety and Depression Scale; ADHD=attention-deficit/hyperactivity disorder. Race/Ethnicity coded 1=Black and/or Latinx, 0=other. Medication statuses coded 1=on medication at that timepoint, 0=not on medication at that timepoint. Bolded rows represent significant coefficients. Coefficients for cohort and medication statuses were not interpreted to reduce risk of Type I Error.

Table 3.

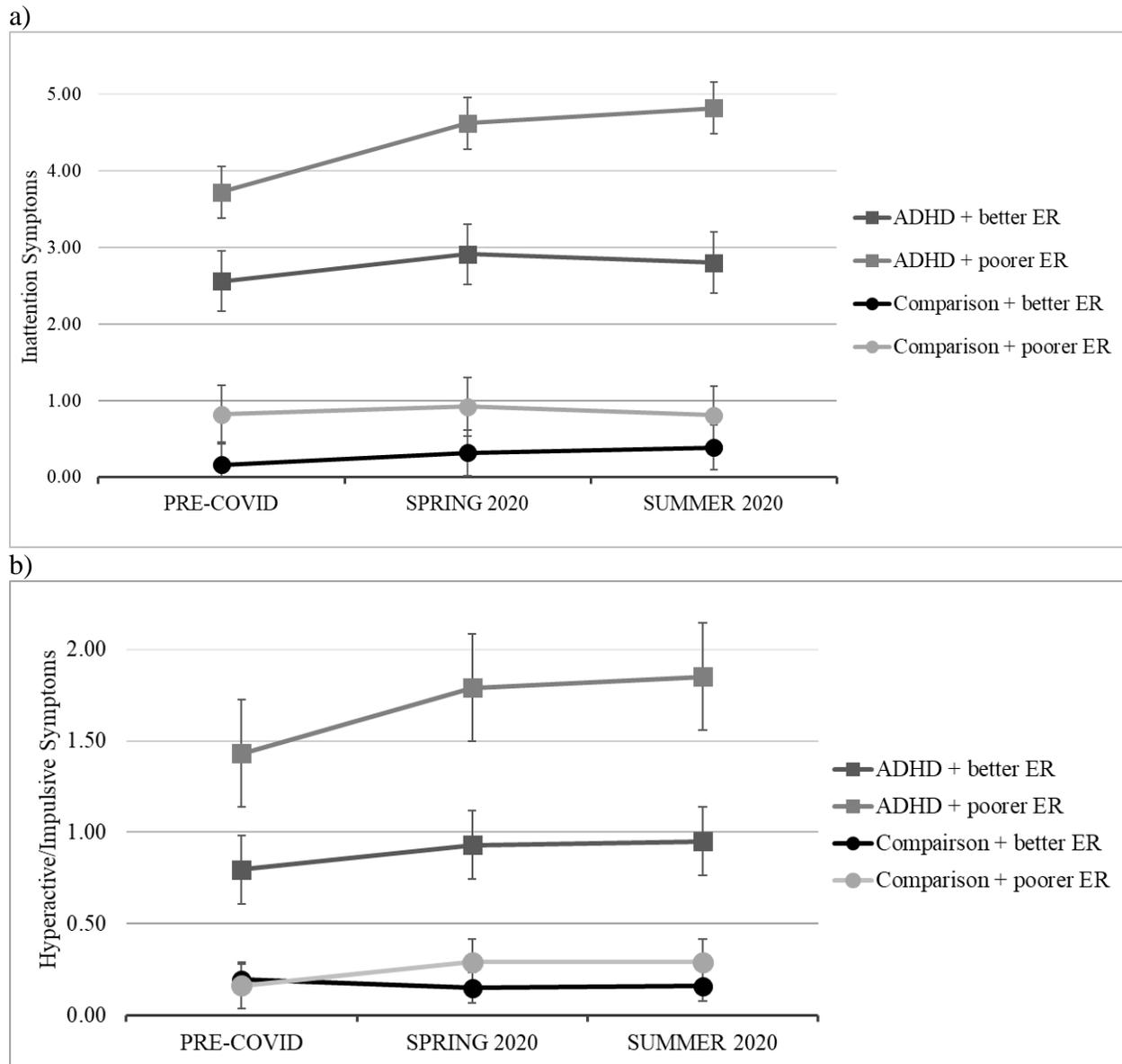
*Repeated Measure ANOVAs for Predictors of Adolescent Externalizing Symptoms*

Measure	<i>F</i>	<i>p</i>	<i>d</i>
<u>VADRS Inattention</u>			
Cohort	0.28	.598	0.06
Pre-COVID Medication Status	0.01	.933	0.01
Spring 2020 Medication Status	1.19	.277	0.16
Summer 2020 Medication Status	0.24	.623	0.06
Sex	0.20	.652	0.06
Race/Ethnicity	0.06	.809	0.03
<b>Income</b>	<b>5.81</b>	<b>.017</b>	<b>0.33</b>
<b>ADHD Status</b>	<b>78.55</b>	<b>&lt;.001</b>	<b>1.21</b>
<b>Emotion Regulation</b>	<b>15.55</b>	<b>&lt;.001</b>	<b>0.54</b>
<b>ADHD x Emotion Regulation</b>	<b>4.01</b>	<b>.047</b>	<b>0.27</b>
<u>VADRS Hyperactivity/Impulsivity</u>			
Cohort	3.93	.049	0.27
Pre-COVID Medication Status	1.68	.197	0.18
Spring 2020 Medication Status	0.57	.449	0.11
Summer 2020 Medication Status	1.85	.176	0.19
<b>Sex</b>	<b>6.41</b>	<b>.012</b>	<b>0.35</b>
Race/Ethnicity	0.19	.660	0.06
Income	1.45	.229	0.17
<b>ADHD Status</b>	<b>38.19</b>	<b>&lt;.001</b>	<b>0.85</b>
<b>Emotion Regulation</b>	<b>4.94</b>	<b>.027</b>	<b>0.31</b>
<b>ADHD x Emotion Regulation</b>	<b>5.34</b>	<b>.022</b>	<b>0.31</b>
<u>VADRS Oppositionality/Defiance</u>			
Cohort	0.03	.861	0.02
Pre-COVID Medication Status	0.64	.425	0.11
Spring 2020 Medication Status	0.15	.701	0.06
Summer 2020 Medication Status	2.04	.155	0.19
Sex	0.00	.986	0.00
Race/Ethnicity	1.41	.236	0.17
<b>Income</b>	<b>6.53</b>	<b>.011</b>	<b>0.35</b>
<b>ADHD Status</b>	<b>7.74</b>	<b>.006</b>	<b>0.38</b>
<b>Emotion Regulation</b>	<b>4.24</b>	<b>.041</b>	<b>0.29</b>
ADHD x Emotion Regulation	3.34	.069	0.25

*Note.* VADRS=Vanderbilt ADHD Diagnostic Rating Scales; ADHD=attention-deficit/hyperactivity disorder. Race/Ethnicity coded 1=Black and/or Latinx, 0=other. Medication statuses coded 1=on medication at that timepoint, 0=not on medication at that timepoint. Bolded rows represent significant coefficients. Coefficients for cohort and medication statuses were not interpreted to reduce risk of Type I Error.

Figure 1.

*Interactions Between ADHD Status and Pre-COVID Emotion Regulation in Relation to Inattention and Hyperactive/Impulsive Symptoms During COVID-19*



*Note.* ADHD = attention-deficit/hyperactivity disorder, ER = emotion regulation. Symptom ratings were made on medication. The ADHD + better and poorer ER groups both displayed significantly more inattention and hyperactivity/impulsivity symptoms than the Comparison + better and poorer ER groups at all three timepoints ( $p < .001$  and  $p < .047$ , respectively). The ADHD + poorer ER group displayed significantly more inattention and hyperactivity/impulsivity symptoms than the ADHD + better ER group at pre-COVID-19 ( $p = .043$  and  $.048$ ), spring 2020 ( $p = .001$  and  $.006$ ) and summer 2020 ( $p < .001$  and  $p = .005$ ). The comparison + poorer ER group did not significantly differ from the Comparison + better ER group on inattention nor hyperactivity/impulsivity at any timepoint ( $p > .438$  and  $p > .953$ ).