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Abstract

Rationale. In spring 2020, many states in the United States enacted stay-at-home orders to limit the spread of COVID-19 and lessen effects on hospitals and health care workers. This required parents to act in new roles without much support. Although studies have asked parents about stress before and during the pandemic, none have examined how stress may have fluctuated throughout the day and the characteristics related to those daily changes.

Objective. Our study assesses how time-varying (e.g., presence of a focal child) and day-varying (e.g., weekend vs. weekday) factors were related to parents' level of stress.

Methods. We use Ecological Momentary Assessment to examine stress three times a day (10 a.m., 3 p.m., and 9 p.m.) for 14 days. We include two different dates hypothesized to be related to parents' stress levels: (1) when Ohio announced schools would go virtual for the rest of the academic year and (2) when most retail businesses were allowed to re-open. Our sample of 332 individuals, recruited via Facebook, Craigslist, and word of mouth, completed 13,360 of these brief surveys during April-May, 2020. Data were analyzed using generalized ordered logit models.

Results. Parents report lower levels of stress when completing the 9 p.m. survey, but higher levels when they were at work, during weekdays (compared to weekends) or when they were with the focal child. COVID-19 milestone dates were not related to stress levels.

Conclusions. Parents need some form of respite (e.g. child care, child-only activities) to reduce stress, especially during the week when parents are juggling their outside employment and their child(ren)'s schooling. Providing parents with skills and tools to identify and reduce stress, such as apps monitoring heart rate or providing deep breathing techniques, may be one way of helping parents cope with extremely stressful situations.

Keywords: Ecological momentary assessment; stress; parents; COVID-19; generalized ordered logit models

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Introduction

The coronavirus (COVID-19) pandemic has caused widespread psychosocial stress and social and economic disruption. In spring 2020, it disrupted life. Government and public health officials in a majority of states in the United States enacted shelter-in-place or stay-at-home orders to limit the spread of the virus and lessen the effects on hospitals and health care workers. These extraordinary measures required parents to act in a variety of new roles without much support. During this time, parents felt higher levels of stress due to forced changes in their routines, including through loss of childcare and the switch to virtual K–12 school—often while trying to work from home (American Psychological Association [APA], 2020a; Hiraoka & Tomoda, 2020). Essential workers, including cashiers at local grocery and big box stores, had to navigate childcare center closures and making new arrangements with pandemic childcare centers (Patrick et al., 2020). Extracurricular activities for children were cancelled, leaving children with few outlets for engagement or entertainment outside of the home. Yet, while there is indication that parental stress may be increased during the COVID-19 pandemic, little is known about how that stress may fluctuate over time and circumstances. Identifying the situations and contexts where parents experience the most stress could help the development of targeted interventions to promote family well-being.

In Ohio, the first cases of COVID-19 were detected on March 9, 2020, with the first death occurring 11 days later on March 20, 2020. K–12 schools were initially shut down on March 17 and ultimately shut down for the rest of the academic year on April 20, 2020. The first stay-at-home order began on midnight March 24, 2020. Stay-at-home restrictions ultimately lasted until May 29, 2020; however, a phased roll out of businesses re-opening began May 1,

2020. Most consumer and retail businesses were able to open on May 12, 2020 (Bischoff & Spicker, 2020).

Stress, Health, and Well-Being among Parents. Parenting stress is not unique to the COVID-19 pandemic. Parents generally report feeling more stressed (Umberson et al., 2010) and less happy (Glass et al., 2016) than comparable groups of non-parents throughout the developed world. Some of this stress is attributable to the act of parenting itself (Musick et al., 2016; Nelson et al., 2014; Skreden et al., 2012) and is variable depending on children's gender, age, and number of children (Barroso et al., 2018). Mothers of boys, for example, have been found to experience higher levels of parenting stress than mothers of girls (Vierhaus et al., 2013). Child age has also been associated with parental stress, with findings suggesting that stress is particularly high among parents of infants and toddlers (Neece et al., 2012; Nelson et al., 2014; Skreden et al., 2012), decreases into the preschool and early school age years (Williford et al., 2007) and then increases as children enter adolescence (Meier et al., 2018). The addition of subsequent children to a family also increases the stress felt by parents (Nomaguchi & Fetto, 2018; Skreden et al. 2012). A preponderance of research evidence demonstrates that the act of parenting, regardless of the individual characteristics of children, is stressful.

These pressures experienced by parents have been associated with a number of parental and family characteristics as well. Stressors experienced by parents are lessened by having adequate financial resources (Glass et al., 2016; Pollman-Schult, 2014; Puff & Renk, 2014) and higher levels of educational attainment independent of financial well-being (Respler-Herman et al., 2012), though Parkes and colleagues (2015) found increased stress among parents with both high and low levels of education compared to parents with intermediate levels and Nomaguchi and Brown (2011) also found increased stress among highly-educated parents. Parents who are

parenting within the context of a partnered relationship generally have lower stress compared to single parents; this pattern holds for children of a variety of ages (Anderson, 2008; Cairney et al., 2003; Copeland et al., 2005; Parkes et al., 2015).

Parents' stress is likely heightened by the interaction between their role as parent and other life domains. Parents experience significant financial pressures (Glass et al., 2016; Pollman-Schult, 2014) that increases their overall experiences of life stress (Puff & Renk, 2014). Employed parents also experience strain as a result of conflict between their role as parent and their role as employee (Braunstein-Bercovitz et al., 2012; Khan, 2014) and spillover of work stress into their parenting life (Malinen et al., 2017; Repetti & Wood, 1997). Increased relationship conflict (Nelson et al., 2014; Twenge et al., 2003) and feelings of social isolation (Skreden et al., 2012) have further been theorized to be associated with increased feelings of stress and decreased well-being for parents.

Many of these stressors became commonplace during the COVID-19 stay-at-home restrictions (Lee et al., 2021; Patrick et al., 2020). For example, parents who were sheltering in place may experience social isolation, while those that are juggling both working from home and assisting with children who are distance learning may feel enhanced role conflict. This stress could vary throughout the day, with spikes at particular times, such as during work and distance learning hours. In the current study, we were able to assess how parents' stress levels changed throughout the day and those characteristics that varied with stress levels. Parents may find some relief or respite when they are able to spend even small amounts of time away from the home.

Stress and Parenting: COVID-19, Natural and Macroeconomic Disasters. The impact of other community-level disrupters—natural and macroeconomic disasters—may provide important insight into parental behavior when families are thus challenged. Natural disasters lead

to closing schools and businesses, shifts in routines, decreased resources, and increased stress (Campbell, 2020); and macroeconomic events can lead to job loss and recession, similar to the pandemic event. Natural disasters and macroeconomic events contributed to parental disengagement and avoidance behavior such as refusal to talk about the situation (Cobham et al., 2016; Garfin et al., 2014; Kilic et al., 2003), use of substances to self-soothe (Kelley et al., 2010), and inability to monitor and support children (Hafstad et al., 2012; Motti-Stefanidi & Asendorph, 2017). Natural disasters, regardless of the type or location, were linked to fear-oriented maladaptive parenting strategies such as excessive parental control, reduction in child autonomy, increased protectiveness, and hypervigilance (Bokszczanin, 2008; Cobham & McDermott, 2014; Kelley et al., 2010; McFarlane, 1987; Pynoos, 1994). Macroeconomic events were associated with decreased parenting satisfaction and increased authoritative mothering (Leionen et al., 2002), and maternal harsh parenting (Lee et al., 2013). Family-level factors can mitigate the consequences of disasters. Education level was associated with coping and resource utilization, contributing to lower negative impacts (Muttarak & Lutz, 2014) and family resiliency (Hackbarth et al., 2012). Intimate partners were found to be both contributors to and alleviators of family stress (Reid & Reczek, 2011). Taken together, this research indicates that significant disruptions to work, school, and economic institutions such as those during the COVID-19 pandemic, may negatively impact parenting behaviors, potentially through increased parental stress. This suggests that children throughout the United States may be experiencing COVID-19 related maladaptive parenting. A more nuanced understanding of the factors associated with parental stress during the COVID-19 pandemic could reveal potential opportunities for preventive intervention.

Emerging research indicates that parent perceptions of the impact of COVID-19 are associated with increased parenting stress (Chung et al., 2020). The attempts to mitigate the transmission of COVID-19 have created challenges of financial insecurity, caregiver burden, and isolation that are likely to increase parent stress (Brown et al., 2020; Prime et al., 2020). Cumulative stressors resulting from COVID-19 were significantly and positively related to perceived stress (Brown et al., 2020), and poor work-family balance, economic uncertainty, and reduced social support experienced due to COVID-19 containment measures were linked to higher parenting stress (Carroll et al., 2020; Chung et al., 2020). Although mothers (Bikmazer et al., 2020) were at higher risk for distress, both parents in co-parenting households showed increased depression, anxiety, and stress (Achterberg et al., 2021; Calvano et al., 2021). Parents world-wide reported higher levels of stress after school closures (Calvano, 2021; Carroll, 2020; Davis, 2020; Hiraoka & Tomoda, 2020). Poor work-family balance may lead to higher levels of stress during the week when these role conflicts are likely to be highest with virtual schooling. Notably, these effects of increasing stress associated with COVID-19 appear independent of characteristics such as child's age (Chung et al., 2020; Spinelli et al., 2020) and the number of children in a household (Brown et al., 2020; Chung et al., 2020).

Current Study. Although we know parents have experienced significant stress during the COVID-19 pandemic, no studies to date have examined how parents' stress levels fluctuate throughout the day and factors associated with that fluctuation. Examining this variation may help us identify small changes parents can make in their routine to help them better manage those stress levels. The research question for the current study is: How do time-varying, day-varying, and individual-level varying characteristics relate to at-the-moment stress during COVID-19 stay-at-home restrictions in Ohio? Based on the work presented here, we hypothesize (1) higher

levels of stress later in the day when role conflict is likely to be highest; (2) higher levels of stress for those parents who spent time at work; (3) higher levels of stress in the time period after the April 20, 2020 announcement that K–12 schooling would remain virtual through the end of the 2019–20 academic year; and (4) lower stress (possibly due to reduced social isolation) after most retail businesses are allowed to be open in some fashion on May 12, 2020.

We use ecological momentary assessment (EMA) to identify factors related to at-the-moment stress for parents during a two-week time period during COVID-19 stay-at-home restrictions in Central Ohio. EMA is a research technique that pushes out brief surveys multiple times a day to understand how microcontexts might affect behavior (Freisthler et al., 2014). These factors are time-varying (e.g., time of day, location, presence of focal child), day-varying (e.g., day of week), or individual-varying (e.g., app version downloaded). We include measures that track specific COVID-19 restrictions, to assess their relationship to stress experience by parents.

Methods

Study Design. An ecological momentary assessment (EMA) study was conducted with parents of at least one child between the ages of 2 and 12 in Central Ohio during COVID-19 stay-at-home orders. As part of this study, parents responded to survey prompts three times a day (10 a.m., 3 p.m., 9 p.m.) for a total of 14 days. The 3 to 5 minute brief surveys asked questions about level of stress, location where the survey was being taken, and whether the focal child had been with the parent since the last survey. Parents were recruited online through advertisements on Facebook and Craigslist and word of mouth. We posted those recruitment advertisements and began assessing initial eligibility via online surveys on April 11, 2020.

Eligibility was determined using a Qualtrics survey that assessed participant age (≥ 18 years), number of children between the ages of 2 and 12 (must have at least one), primary residence (must be in Central Ohio), availability of a smartphone to be used to for the research team to push out the brief surveys, and their contact information. Once eligibility was determined, the study team contacted the potential participant via email to set up a time to obtain verbal consent and provide the next steps of the study. Verbal consent was obtained for all participants. We enrolled our first participants on April 13th, about a month after Ohio's stay-at-home restrictions were ordered. Our first EMA surveys were conducted on April 14, 2020, with data collection ending on May 27, 2020.

As an incentive, participants received \$1 for every brief survey completed, an extra \$2 per day if all three EMA surveys were completed on a particular day, and an additional \$10 for completing at least 90% (at least 37) of the surveys. The average number of surveys completed for those who provided verbal consent and completed at least one EMA survey, was 40.4 (range 18 to 42). IRB approval was obtained [BLINDED FOR REVIEW]. Participants were also asked to complete a baseline survey with information on demographics. These data are used to understand the characteristics of parents included in the sample. However, as they are not time-varying characteristics, we do not include them in the multivariate analyses.

Sample. Our final sample includes 332 individuals, who completed 13,360 brief surveys. We had 629 individuals begin the screening survey. 150 were found to be ineligible or did not complete the screening survey (e.g., dropped off when required to provide a first name), with the remaining 479 successfully screening into the survey. Of those that screened in, 342 consented to participate in the study, with 332 of those who consented completing at least one EMA brief survey. Our sample is primarily female ($> 90\%$), highly educated with greater than 40% of

respondents having a graduate degree, and high income (30.8% of households had incomes with greater than \$120,000). Focal children in our sample were primarily white (77.3%), with slightly more boys (56.5%) than girls (see Table 1).

---TABLE 1---

Measures. Our dependent variable—stress—was measured using a one-item question asking participants to rate their level of stress from 1 (low) to 10 (high) since the last survey, adapted from a study conducted by the American Psychological Association (2014). The specific question asks “How would you rate your stress since the last survey?” The one-item measure has face validity. Comparing this measure with the Perceived Stress Scale (10-items; Cohen et al., 1983), the one-item measure was highly positively correlated ($\rho = 0.682$; APA, 2014). The original responses were poorly distributed for Gaussian models, making the most efficient approach to using these data through an ordinal categorical model. We recoded the variables to five categories (see Table 2) in order to aid in interpretation and model convergence. On average, parents reported that their stress level was 3.25 out of 10.

---TABLE 2---

In addition to stress, the time-varying characteristics used as independent variables included location where the parent was completing the survey, the trigger time for the survey, and whether a focal child was with the parent since the last survey. Locations included home (used as referent category in our study), work, store, child’s activities (including at child’s school), traveling between locations, or other (including restaurants). The majority of daily EMAs were completed with participants at home (86.7%, $n = 11,581$) and when the child had been with the parent during the survey time period (91.4%, $n = 12,209$). Daily characteristics included the day of the week (with Sunday as the reference group) and week of the study

(reference group was week of April 12, 2020). The only participant-varying characteristic was the version of the app installed on the participant's cellular telephone. During the duration of our study, the research app we used released two versions to fix patches and provide additional functionality. Although we did not expect this variable to be statistically significant, we include it as a control variable where Version 4:04.0 is used as the reference group. Finally, we include two different dates we hypothesized to be related to parents' stress levels. Ohio Governor DeWine announced on April 20, 2020 that K–12 schooling would remain virtual through the end of the 2019–20 academic year. The second date, May 12, 2020, was the date most retail businesses were allowed to open with social distancing requirements in place, indicating greater freedom for families.

We also include specific information about the child and family as covariates in this model: age of the focal child, his or her biological sex, number of children in the family, number of adults in the family, and education of the parent. We recoded child age into three categories: ages 2 to 5; ages 6 to 9; and ages 10 to 12.

Data Analysis. For this study, we had observations (Level 1) nested within days (Level 2), nested within participants (Level 3). We used generalized ordered logit models (Williams, 2016) to account for clustering due to nesting of observations within days and participants and assess proportional effects for each covariate on the ordered outcome. This procedure incorporates a robust variance estimator that accounts for nesting of observations within days within participants. A key assumption of ordered logit models is that covariates have proportional effects across all levels of the dependent measure's ordered categories; in our case this is the five levels of stress. When this assumption is violated covariates may nevertheless be found to have effects related to one level of the ordinal outcome, but not others. To address this,

we tested for non-parallel effects for all covariates with $p < .05$. If significant, we present tests for effects at each level within that block of measures, again assessing significance at $p < .05$.

We also conducted missing data analyses to assess how our results may differ due to missing data. By design, the 332 respondents included in the final analyses were to provide 3 assessments per day over 14 days (42 total) for a study total of 13,944 assessments. We obtained 13,360 such assessments (95.8% of the total expected). For the missing assessments, 49.2% of the respondents were missing one or more assessments and 27% were missing two or more assessments. The median number of missed assessments among those missing assessments was 6. There were few missing data among variables measured within assessments (less than 0.5% for any respondent) and no missing data within assessments for the 332 respondents included in the reported analyses. Missing data arose from missing assessments, not from missing responses within assessments.

Based on this information, we examined how our results differed among respondents who completed all their daily assessments vs. those who did not complete all of their assessments. However, it remains possible that systematic biases existed between respondents who did and did not miss assessments which could bias assessments of covariate relationships. To be certain, we conducted logistic regression analyses of missingness across assessments. We present our findings from these analyses in the results section below.

Results

As shown in Table 3, Wald chi-square tests indicated that statistically significant relationships were observed between measured days of the week, parent locations, the presence of the focal child, one of the two COVID-19 orders, the trigger time of the survey, and the week the assessments occurred. A non-significant Wald test was found for the version of the app that

was used by the participant. Daily stress varied by day of the week with parents reporting significantly more stress Monday through Friday (compared to Sunday). Parents completing the 9 p.m. survey (which could be completed between 9 p.m. and 1 a.m. the following day) reported significantly less stress compared to the 10 a.m. survey. Being at work (compared to being at home) was related to significantly higher levels of stress among our sample. Across all parents, stress levels increased progressively throughout the period, peaking in the last week observed.

---TABLE 3---

As also shown in Table 3, presence of the focal child and the occurrence of the early April COVID order both had disproportionate effects across the ordered set of stress categories. Presence of the focal child during the survey window was related to greater stress, but only at the lowest categories of stress (1 and 2). Stress was somewhat greater when the participant was with the child during the timeframe, but only among parents reporting relatively low levels of stress. The first of the two COVID-19 specific milestones (announcing schools will remain virtual through the remainder of the academic year) exhibited disproportional odds and an overall significant Wald test, but no specific effect was significant. There was some indication that this order affected low levels of stress once again.

Importantly, each successive week of the study (compared to the first week) was related to higher stress among parents; with this being statistically significant for the final weeks of the study. Note that this corresponds to when the Ohio Governor had begun to ease stay-at-home restrictions, including opening retail stores, bars, and restaurants for general public use. Those parents whose focal child was 10 to 12 years old reported lower levels of at-the-moment stress compared to parents with a focal child 2 to 4 years of age. Having one adult in the home is related to higher stress than two adults. The number of children under 18 years of age in the

family, biological sex of the child, and parent's education was not related to at-the-moment stress for parents.

Missing Data Analysis Results. As described above, we assessed covariate relationships among respondents with one or more missing assessments, which may differ from those with no missing assessments. We conducted a complete case analysis, using only data from those respondents with all 42 assessments, to see how they may differ from the results including all respondents. While substantially reduced in power, with $N = 169$ instead of 332, the results of this complete case analysis showed the same well-supported effects with one exception: Statistical support for the age effect was weak, shifting to $p = .1344$. Nevertheless, age effect parameters from the complete case model were much the same as those from the full analysis; greatest stress was reported among parents of the youngest children.

It remains possible that systematic biases were to be found between respondents who did and did not miss assessments and these could bias assessments of covariate relationships. Logistic regression analyses of missingness across assessments revealed three differences: Missing assessments were more likely when reporting "between places," earlier in the evening, and earlier in the day. A supplementary analysis of the full dataset, once reweighted using propensity scores for missingness at the assessment level, again showed that the same effects remained statistically well-supported.

Discussion

Our study sought to identify what at-the-moment situational characteristics were related to stress among parents during the COVID-19 pandemic. Although it is generally agreed that parents were likely under much higher levels of stress (APA, 2020a), we do not have much information on 'real-time' factors that might be affecting stress levels. In this study, we focused

on situational (e.g., with child, location), time-varying (e.g., time of day), and day-varying (e.g., day of week) characteristics to assess when and where higher stress levels among parents occurred. Notably, our survey of parents reported lower levels of stress (average = 3.25 out of 10) than a study conducted by the APA (2020a), which found a mean of 6.7 among parents. One major difference in these studies is we asked parents about their level of stress three times a day, while the APA study asked parents to rate their stress for the past month. In our study, being with the child during the survey window was also related to higher levels of stress during COVID-19, but only at very low levels of stress.

Further, we found that specific locations of where the parent was when completing the brief surveys were related to stress levels. If parents were working, then they reported higher stress levels, which matches prior work that suggests parents often experience stress due to conflicting roles as caregiver and employee (Braunstein-Bercovitz et al., 2012; Khan, 2014). The role of teacher during this time—as Ohio switched to virtual K–12 school—is likely to have only increased this conflict between roles. Given the unique circumstances of COVID-19, a portion of our parents could be working at home where their children are participating in virtual school. This would be the ultimate case of work-life spillover, which is known to increase stress for parents (Malinen et al., 2017; Repetti & Wood, 1997). If so, this location might be capturing the stress of trying to work at home with children present and, in many cases, assisting them in completing their schoolwork. If parents are not working from home when they completed this item, then the significant relationship with stress may indicate that being at work, during these unprecedented times may increase stress. This pattern may be especially true if our parents are essential workers, regardless of whether they are health care professionals, first responders, or retail workers at grocery or big box stores. It may also be that work for parents in our study is

inherently stressful and that this relationship would be found under more 'usual' parenting circumstances. However, other locations, such as being at a child's activity or traveling between locations were unrelated to stress or reduced stressed (as evidenced by the Wald test showing that there are well-supported differences in stress across locations).

Mirroring the findings from above, parents reported higher levels of stress on weekdays, compared to the weekends, in general. These findings are not surprising given the stressed experienced by parents to support and virtually teach their children, in the absence of daily on-site learning opportunities for schooling (APA, 2020a). On weekends, parents have greater freedom to arrange schedules or activities for their children that focus on enjoyable activities, rather than ensuring specific learning milestones occurred or homework was completed. We also found that parents' stress varied based on the time of day. We theorized that parents would report higher levels of stress later in the day, due to stress related to role conflict. We found no difference between stress at the morning and mid-day surveys. Our final survey was deployed at 9 p.m. and parents had until 1 a.m. the following day to complete it. Parents reported significantly less stress during that time period. Parents are likely to have been completing these surveys at the end of the day as parents are relaxing after their children have gone to bed. These lower levels of stress may be indicative of the relief that comes with having quiet time or extra time to one's self.

We should note, however, that these relationships of day of the week and time of day may exist even when parenting is not occurring during a pandemic. Work by Hibel and colleagues (2014), for example, documents a pattern of increased stress for parents working outside of the home on workdays compared to non-work days. Muscik and colleagues (2016) also demonstrate a pattern of mothers rating their time with their children as generally stressful

albeit more enjoyable, than time without children present. Both results are likely to represent decreased stress as a result of a reduction in the daily hassles of parenting (Crnic & Greenberg, 1990). Additional research is needed in both crisis and non-crisis times on patterns of parental stress both across the course of their parenting days, including time with and away from their children, and across a parenting week, including school/non-school days.

We hypothesized that specific milestones during this COVID-19 time period would increase a parent's stress level. However, we did not notice an increase in stress after the Governor of Ohio announced that schools would not re-open and learning would remain virtual through the end of the academic year, as had been found in Japan (Hiraoka & Tomoda, 2020). Nor did we see a decrease in stress as parents had more freedom to go to retail stores, despite our hypothesis that this increased ability to move around might decrease social isolation among parents. As the pandemic continued to restrict movement and activities of families, we observed that stress levels increased compared to the first week we conducted the study (week of April 12, 2020). In particular, we see the highest levels of reported stress during the final week of our data collection period. This pattern may be a cumulative effect of having little to no respite from parenting duties, general concerns about staying safe during re-opening (APA, 2020b), or concern about keeping children safe as some activities began to resume, as suggested by Brown and colleagues (2020).

We find no difference in levels of stress for parents who reported on male vs. female focal child or based on the number of children in the family. These findings are similar to other COVID-19 studies examining parent stress (Brown et al., 2020; Chung et al., 2020). We did find that parents who had an older child, aged 10 to 12 years old, as the focal child had significantly lower stress than parents where the focal child was 2 to 4 years old. Here, our findings differ

from those recent COVID-19 studies that show stress was not related to child age (Chung et al., 2020; Spinelli et al., 2020). Yet, our findings are similar to other studies that show higher stress among families with toddlers and younger children (Neece et al., 2012; Nelson et al., 2014; Skreden et al., 2012). The difference may be due to the daily nature of at-the-moment stress where parents are providing real-time assessments. In our study, daily interactions with younger children are likely to be at the forefront of a parent's mind as he or she completes the survey compared to a global measure of stress where parents are retrospectively thinking about a past month. These results should be interpreted with caution due to the results of one of our missing data analyses. We found no difference in stress by parents education level, which differs from previous work (cf. Nomaguchi & Brown, 2011; Parkes et al., 2015). Having only one adult was also related to higher levels of stress. This is not surprising as parents had to adapt to act in multiple roles, made more complicated if there is no one else to share responsibilities during the pandemic. Historically, single parents have higher levels of stress compared to partnered parents (Anderson, 2008; Cairney et al., 2003; Copeland et al., 2005; Parkes et al., 2015).

Limitations. Our study is limited in a number of ways. We did not ask about specific stressors related to COVID-19, such as whether a parent had lost a job or faced reduced hours, whether they had to work from home or going in to work, or whether a family member had been diagnosed with the COVID-19. Instead, we had to rely on the government response to try and identify significant factors in that response that might be related to parents' at-the-moment stress level. As a convenience sample of families recruited primarily through web-based ads and word of mouth in central Ohio, these results may not be generalizable beyond this setting. Similarly, our sample is largely white, female, and highly educated. These parents are likely to have more financial means at their disposal to buffer some of the financial effects of the pandemic. Studies

examining whether the time-varying situational contexts found to be important predictors of stress in this study remain important under ‘usual’ parenting circumstances. Future work should examine whether these same time-varying situational contexts are related to stress in parents or if different contexts are more stressful for parents. In order to keep the daily surveys brief, we used one item to assess stress level of parents. Although this item has face validity, a multi-item scale or more robust measures of stress may provide better information on a parent’s stress level. We also only assessed a small number of situational characteristics (e.g., time of day, location of parent) and did not get an assessment during homework and dinnertime hours. Future efforts may want to incorporate additional characteristics that may increase stress for parents and add additional measurement time periods. Given the lack of diversity in our sample, we are unable to fully assess whether populations are differentially affected by the situational characteristics presented here. Conducting the study with participants who have different characteristics, possibly recruited through non-web strategies, would allow us to assess a broader range of situational characteristics that might affect parenting when under extreme stress.

One potential source of stress not measured here is reliable access to internet and availability of devices (e.g., computer, laptop, tablet) for children to obtain and complete assignments. Finally, we did not tease out whether parents who said they were at work during a survey time period were physically at work or working from home when the assessment was completed. Different stressors and stress levels during the pandemic might be present for parents who are conducting employment activities and monitoring virtual schooling, than those who are performing paid work outside of the home.

Practice Implications. Through technological advances, we demonstrated that parent stress levels can be assessed in real-time, which offers several potential possibilities for

intervention. As parents were able to engage with the smartphone-based research study, it is likely that they would be amenable to potential smartphone app interventions. Providing parents with skills and tools to identify and reduce stress, such as apps monitoring heart rate or providing deep breathing techniques, may be one way of helping parents cope with extremely stressful situations. These interventions could assess stress and provide resources when parents report high scores and use geodata to notify parents of local resources or support services as they pass nearby.

Our findings also present implications for the continuing COVID-19 pandemic, or other future disasters that require sheltering-in-place. For example, parents need some form of respite (e.g. childcare, child-only activities) in order to reduce stress, especially during the week when parents are juggling their outside employment and their children's schooling. Locations or programs that would usually provide group activities (e.g., YMCA, youth sports leagues) might invest in identifying programming that maintains physical distance requirements and use of protective personal equipment (e.g., masks) for children. These activities could provide parents with a break and reduce their overall levels of stress. Foundations or other funding agencies (e.g., Department of Education) could subsidize these activities for low income and vulnerable children, youth, and families. Anecdotally, parents who have the financial ability to do so, are examining the possibility of using nannies during the school hours to help with virtual schooling to free up parents' time (Horn, 2020). This practice may further educationally harm children living in working class or poor homes that do not have the funds for this option. This may be exacerbated by whether the family has access to reliable internet (Stelitano et al., 2020). In a more equitable solution than private "pods," public schools or non-profit agencies could form small groups of families to assist each other with childcare or distance learning, potentially

providing a virtual staffed weekly "check-in" that would allow parents to process stress and emotions arising from sheltering-in-place with children. Expansion of the free lunch program to all students has been enacted in Ohio. This helps all families at least reduce the stress of having additional food on hand and is helpful for those families who are just above the income threshold for qualifying for free lunch. As stress can lead to a variety of health problems (McEwen, 2008; Health Resources and Services Administration Maternal and Child Health Bureau, 2018; Giallo et al. 2011; Skreden et al., 2012) and result in harsh parenting (Lorber, 2012; Malinen et al., 2017; Mikolajczak et al., 2019), identifying real-time situational contexts and developing strategies to change the environment that leads to these contexts may promote overall well-being in families.

Conclusions

Given the current context, much remains unknown about the immediate effects of the pandemic on families. Our work identifies a variety of factors that are related to higher levels of stress in parents. The parents and families in our study are not considered 'at-risk' and do not appear to be dealing with the same socio-economic challenges that many other families are facing. Yet, our study shows that even these relatively advantaged parents have been experiencing stress that is likely the result of change in routines and social connections due to COVID-19 restrictions (APA, 2020a; Chung et al., 2020). Although the specific milestones related to Ohio's stay-at-home orders were not related to higher levels of stress, we do identify situational characteristics that may serve to increase stress (e.g., being with the focal child). As such, this study provides a baseline of stress-levels found during the pandemic that can be compared to situational characteristics related to stress when life returns to something viewed as more 'normal' parenting conditions.

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Table 1. Characteristics of analytic sample for study participants ($N=332$).

	Mean (SD) or % (n)
Parent Characteristics	
Parent Biological Sex	
Female	92.7 (306)
Male	7.3 (24)
Parent Age	37.5 (5.9)
Marital Status	
Married or Living in a Marriage-Like Relationship	86.1 (285)
Single/Widowed/Divorced	13.9 (46)
Parent Education	
\leq High School Diploma	3.3 (11)
Some College	20.3 (67)
Bachelor Degree	34.5 (114)
Graduate Degree	41.8 (138)
Child Characteristics	
Child Biological Sex	
Female	43.3 (144)
Male	56.5 (187)
Focal Child Age	6.2 (3.0)
Child Race/Ethnicity	
Caucasian/White	77.3 (256)
African American/Black	12.7 (42)
Other Race or Ethnicity	10.0 (33)
Family Characteristics	
Income	
\leq \$40,000	11.2 (36)
\$40,001 - \$80,000	27.7 (89)
\$80,001 - \$120,000	30.2 (97)
$>$ \$120,000	30.8 (99)
Number of Adults	2.0 (0.5)
Number of Children	2.1 (1.0)

Table 2. Descriptive statistics for dependent and independent variables.

Variable Name	Mean (SD) or %	<i>n</i>
Stress		
Levels 1 – 2	45.7	6,106
Levels 3 – 4	30.3	4,049
Levels 5 – 6	14.2	1,902
Levels 7 – 8	7.3	980
Levels 9 - 10	2.4	324
Average Stress Level	3.25 (2.14)	13,321
Weekdays		
Sunday	14.4	1,918
Monday	14.3	1,910
Tuesday	14.3	1,905
Wednesday	14.2	1,896
Thursday	14.4	1,920
Friday	14.3	1,906
Saturday	14.3	1,909
Locations		
Home	86.7	11,581
Work	6.2	822
Store	1.1	142
Child Activities	0.8	107
Traveling Between Places	2.1	284
Other	3.1	423
With Focal Child during Survey Period		
Yes	91.4	12,209
No	8.6	1,151
Focal Child Age		
5 through 9	35.0	4,658
10 through 12	18.8	2,498
Focal Child Biological Sex		
Female	43.3	5,771
Male	56.7	7,558
Number of Children		
	2.1	13,321
Trigger Time of Day		
10:00 AM	33.5	4,476
3:00 PM	33.3	4,451
9:00 PM	33.2	4,434
Week of Assessment		
Week of April 12	3.0	395
Week of April 19	22.8	3,048
Week of April 26	41.9	5,595
Week of May 3	26.7	3,564
Week of May 10	5.2	691
Week of May 17	0.5	62
Week of May 24	0.1	11
Application Version		
244	27.3	3,647
245	28.6	3,819
245.1	44.1	5,895

Table 3. Ordered logit models with tests for disproportional odds assessing relationships of five levels of stress with time- and situational-varying characteristics.

Covariate:	Non-Parallel Effects: [†]	Parameter Estimates:			Block Tests:	
		<i>b</i>	<i>se</i>	<i>p</i>	Wald χ^2 :	<i>p</i>
Weekdays (Sunday ref)					70.53	< 0.001
Monday		0.325	0.061	< 0.001		
Tuesday		0.362	0.073	< 0.001		
Wednesday		0.440	0.080	< 0.001		
Thursday		0.364	0.084	< 0.001		
Friday		0.333	0.060	< 0.001		
Saturday		-0.026	0.049			
Locations (Home ref)					15.72	0.008
Work		0.464	0.153	0.002		
Store		0.093	0.200			
Child Activities		-0.397	0.204			
Between Places		-0.083	0.137			
Other		0.223	0.207			
With Focal Child during Survey Period	1	0.411	0.147	0.005		
	2	0.201	0.144			
	3	-0.023	0.162			
	4	0.211	0.292			
Focal Child Age (2 to 4 years ref)					12.19	0.002
5 to 9 years		-0.145	0.158			
10 to 12 years		-0.759	.218	<0.001		
Focal Child Biological Sex (female ref)						
Male		0.182	0.146			
Number of Children		-0.066	0.077			
Number of Adults in Household (Two Parents ref)					27.76	<0.001
One Adult	1	.484	.282			
	2	1.052	.287	<0.001		
	3	1.229	.298	<0.001		
	4	1.488	.318	<0.001		
More than Two Adults		.088	.366			
Parents' Education (High School Grad or Less ref)					4.62	
Some College		.482	.465			
Bachelor Degree		.347	.454			
Graduate Degree		.637	.450			
COVID-19 Orders					9.68	
April 20, 2020: School Virtual	1	0.116	0.146			
	2	-0.163	0.163			
	3	-0.312	0.197			
	4	-0.095	0.343			
May 12, 2020: Retail Business Opens		-0.124	0.197			
Trigger Time of Day (10:00 AM ref)					33.21	< 0.001
3:00 PM		0.025	0.030			
9:00 PM		-0.181	0.040	< 0.001		
Week of Assessment (April 12, 2020 ref)					46.16	<0.001
Week of April 19		0.388	0.349			
Week of April 26		0.345	0.386			
Week of May 3		0.215	0.428			
Week of May 10		0.112	0.467			
Week of May 17		0.942	0.693			

Week or may 24	1	1.257	0.534	0.019	
	2	1.256	0.611	0.040	
	3	1.535	0.724	0.034	
	4	2.137	0.860	0.013	
Application Version (244 ref)					0.24
245		-0.092	0.191		
245.1		-0.072	0.193		
Constants					
1		-0.540	0.503		
2		-1.451	0.496	0.003	
3		-2.200	0.514	< 0.001	
4		-4.112	0.545	< 0.001	

†Model Components with proportional odds / parallel lines assumption violated; Wald $\chi^2=228.17$, $p<0.001$; effects indexed by ordered categories.

Journal Pre-proof

Highlights

We assess time- and day-varying characteristics related to stress during COVID-19.

Parents report higher stress in the evenings during COVID-19.

Working during COVID-19 was related to higher levels of stress.

Weekdays were more stressful than weekends.

Being with a focal child was related to higher stress, at lower levels of the scale.

Journal Pre-proof