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ORIGINAL CONTRIBUTION

Monthly correlates of longitudinal child mental health during the COVID-19 pandemic according to children and caregivers

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Abstract

Multiple reviews identify the broad, pervasive initial impact of the global COVID-19 pandemic on the mental health of children, who may be particularly vulnerable to long-term psychiatric sequelae of the ongoing pandemic. However, limited longitudinal research examines persistence of, or change in, children's distress or psychiatric symptomatology. From June 2020 through December 2021, we enrolled two cohorts of families of children aged 8–13 from Southwestern Ontario into a staggered baseline, longitudinal design that leveraged multi-informant report ($N = 317$ families). In each family, one child and one parent/guardian completed a baseline assessment, 6 monthly follow-up assessments, and one final follow-up assessment 9 months post-baseline. At each assessment, the child and parent/guardian completed the CoRonavIruS health Impact Survey and measures of child anxiety, depressive, irritability, and posttraumatic stress syndromes. Children's mental health, indexed by the severity of multiple syndromes, fluctuated over the study period. Elevated local monthly COVID-19 prevalence, hospitalization, and death rates were associated with monthly elevations in children's reported worry about contracting COVID-19 and stress related to stay-at-home orders. In turn, both elevated monthly worry about contracting COVID-19 and stress related to stay-at-home orders were associated with monthly elevations in child- and parent-/guardian-report of children's emotional distress and psychiatric syndromes. This study illustrates the importance of, and informs the potential design of, longitudinal research to track the mental health of children, who may be particularly vulnerable to broad psychosocial sequelae of health crises such as the COVID-19 pandemic.

Keywords COVID-19 pandemic · Longitudinal studies · Child · Anxiety · Depressive symptoms

Introduction

Beyond the physical health implications of the SARS-CoV-2 virus, the ongoing COVID-19 pandemic may pose a long-term risk for the mental health of children and youth worldwide. Multiple reviews summarize initial global research on children's mental health during the onset of the pandemic (e.g., through Summer 2020). Briefly, they document that a substantial minority of children and youth in both community and clinical samples reported elevated severity of a variety of psychiatric syndromes [e.g., 1, 2]. However, there is an urgent need to understand not only the acute, initial impact of the pandemic, but also the psychosocial implications of its chronic course. Longitudinal research is needed to clarify the psychosocial sequelae that commonly follow global disasters, especially to safeguard the mental health of children, who are particularly vulnerable [3].

Longitudinal research has begun to document the sustained psychosocial impact of the ongoing COVID-19 pandemic, such as higher rates of depressive and anxiety disorders [e.g., 4]. However, results are mixed [e.g., 5], even across countries within the same study [6]. Variability in empirical findings may result from the timing of longitudinal assessments (e.g., during months marked by high COVID-19 severity). Consequently, in one longitudinal

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study of youth, mood concerns increased at the outset of the pandemic, decreased over summer 2020, and increased in the fall [7]. Similarly, American health registry data illustrates substantial variability over months of each year in the rate of pediatric emergency department visits for mental health conditions [8]. Additionally, most prior research assessed child mental health through January 2021 at the latest [9]. Ongoing longitudinal research with more frequent (e.g., monthly) assessment is needed to track change in, or sustained impact on, children's mental health throughout the ongoing pandemic to guide clinical assessment and inform the development and provision of mental health resources.

Prior research also inferred the impact of constructs of interest to public policy (e.g., attending school virtually) based on local policy in place when assessments occurred. Higher temporal resolution (e.g., monthly) assessment over a longer time span facilitates within-person examination of how variation in public policy and children's experiences are associated with monthly variation in child distress. Moreover, it is important to assess the impact of the pandemic on each child rather than rely solely on environmental data from public databases [e.g., 10].

The present study

This study sought to characterize the sustained psychosocial impact of the COVID-19 pandemic on children within three aims: (i) evaluate change in child distress and psychiatric symptomatology, specifically internalizing symptomatology, over time; (ii) evaluate the magnitude and type of sustained distress and internalizing symptomatology over time; (iii) identify time-varying correlates of acute child distress and internalizing symptomatology to clarify contexts in which children demonstrate acutely worsened distress. Practically, this study enrolled two cohorts of families of children aged eight to thirteen years using a staggered baseline design to maximize coverage of the ongoing pandemic by a planned series of baseline assessment and seven follow-up assessments over nine months. Specifically, this study examined whether monthly fluctuations in child distress and internalizing symptomatology were associated with monthly fluctuations in (i) the local monthly case prevalence per 100,000 persons; (ii) the local monthly hospitalization rate; (iii) the local monthly death rate; (iv) child attendance at school virtually or in person; (v) child worry that they or a loved one would contract COVID-19 or that contracting COVID-19 would adversely affect their mental or physical health; and (vi) stress related to stay-at-home orders or the cancelation of events to curtail the spread of the SARS-CoV-2 virus.

Methods

Participants

Families of a child aged eight to thirteen years were recruited between June and July 2020 or November 2020 and January 2021 from Southwestern Ontario via local school boards, news, and social media. From each family, one child and one parent/guardian participated for the duration of the study, which was completed entirely online. Study inclusion criteria required that both children and adults be sufficiently proficient in English to provide informed consent and complete study questionnaires and have regular internet access. There were no explicit exclusion criteria. Based on preliminary power analyses, this study was designed to recruit 330 families to provide 80% statistical power to detect change in emotional distress over time. For a separate aim outside the scope of this paper, we recruited additional families to augment power to examine baseline psychosocial predictors of sustained emotional distress.

Design and procedure

Following consent and assent, parents/guardians then completed a baseline assessment of children's demographic information; the broad impact of the COVID-19 pandemic on the child and family; and the child's emotional distress including symptoms of common internalizing (i.e., irritability, depressive, posttraumatic stress, and anxiety) syndromes. Children then completed the same measures to self-report on their emotional distress including symptoms of internalizing syndromes. Following baseline assessment, families completed 6 monthly assessments wherein the same parent/guardian and child reported on the broad impact of the COVID-19 pandemic on the child over the past two weeks and on the child's distress on the same measures from baseline assessment. Finally, each child and parent/guardian completed one final longitudinal assessment of the same measures nine months after baseline assessment. Each family was compensated CAD $12 for time spent completing the baseline assessment; CAD $9 for each follow-up assessment. This study was cleared by the University of Windsor Research Ethics Board (#20–123). Following recruitment, parents/guardians provided informed consent; children provided assent.

Measures

COVID-19 impact

At each assessment, each child and adult completed the CoRonavIruS health Impact Survey [CRISIS; 11] to assess diverse impacts of the COVID-19 pandemic on children's daily lives (e.g., emotional distress). Baseline assessment queried the three months prior to the pandemic and the past two weeks. Each follow-up assessment queried only the past two weeks. Only data regarding the past two weeks were used from the baseline assessment. Baseline parent/guardian assessment included demographic items designed to harmonize data collected across international research [12]. In October 2020, we added one question to assess whether each child attended school in person or virtually in response to provincial policy that allowed each family to choose the mode of school attendance. Due to the staggered baseline, longitudinal design, enough participants provided data between July 2020 and October 2021 to compute monthly interitem reliability for each study measure (see Figs. 1, 2 and 3 and Figures S1–S3). Child- ($\omega_{polychoric} = 0.88–0.96$; $\alpha_{polychoric} = 0.87–0.94$) and parent-/guardian-report ($\omega_{polychoric} = 0.85–1.06$; $\alpha_{polychoric} = 0.86–0.95$) of child emotional distress evidenced high interitem reliability at each month. From the CRISIS, two scales, child worry about contracting COVID-19 ($\omega_{polychoric} = 0.81–0.94$; $\alpha_{polychoric} = 0.84–0.92$) and stress related to stay-at-home orders or the cancelation of events ($\omega_{polychoric} = 0.74–0.87$; $\alpha_{polychoric} = 0.77–0.90$) were extracted based on conceptual similarity and interitem reliability (see Supplement). During baseline assessment, children ($M = 2.86$, $SD = 0.90$) and parents/guardians ($M = 3.09$, $SD = 0.85$) each completed one item to report on the child's current physical health from 0 ("Poor") to 4 ("Excellent").

Psychiatric symptomatology

At each assessment, each child and parent/guardian reported on the child's irritability and depressive, posttraumatic stress, and anxiety syndrome severity over the preceding two-week period. Each measure was chosen for validation in epidemiological assessment of psychopathology per child- and parent-/guardian-report in community samples including disorder-specific thresholds (see Supplement). Each family completed the Screen for Child Anxiety Related Emotional Disorders [13] to assess the dimensional severity of four anxiety (i.e., panic/somatic anxiety, generalized anxiety, social anxiety, separation anxiety) syndromes. School-related anxiety was omitted given the intermittent provincial closure of schools during the study period. In this study, interitem reliability was high at each month for child- ($\omega_{polychoric} = 0.85–1.13$; $\alpha_{polychoric} = 0.88–0.96$) and parent-/guardian-report ($\omega_{polychoric} = 0.86–1.17$; $\alpha_{polychoric} = 0.87–0.95$) on all 4 subscales.

Each child and parent/guardian reported on each child's depressive symptom severity on the Short Mood and Feelings Questionnaire [SMFQ; 14] and irritability on the Affective Reactivity Index [ARI; 15]. In this study, interitem reliability was high at each month for the SMFQ based on child- ($\omega_{polychoric} = 0.93–1.10$; $\alpha_{polychoric} = 0.95–0.99$) and parent-/guardian-report ($\omega_{polychoric} = 0.92–1.02$; $\alpha_{polychoric} = 0.94–0.98$) and ARI based on child- ($\omega_{polychoric} = 0.81–1.03$; $\alpha_{polychoric} = 0.89–0.97$) and parent-/guardian-report ($\omega_{polychoric} = 0.83–0.98$; $\alpha_{polychoric} = 0.91–0.96$). Finally, each child and parent/guardian reported the severity of each child's posttraumatic stress symptoms on the Child PTSD Symptoms Scale for DSM-5 [16]. Interitem reliability was high at each month based on child- ($\omega_{polychoric} = 0.98–1.07$; $\alpha_{polychoric} = 0.96–0.99$) and parent-/guardian-report ($\omega_{polychoric} = 0.95–1.04$; $\alpha_{polychoric} = 0.93–0.99$).

Data analytic plan

Multilevel, mixed effects models estimated average change in child distress and psychiatric symptoms (i.e., irritability and symptoms of depressive, anxiety, and posttraumatic stress syndromes) from June 2020 through December 2021. Putative time-varying correlates (e.g., worry about contracting COVID-19) were added to each model to evaluate correlates of children's monthly distress. Models included random effects for each statistically significant fixed effect to simultaneously estimate interindividual heterogeneity. Data on the monthly mean local prevalence, hospitalization, and death rates were drawn from Public Health Ontario for each family's geographic region [17].

Analyses were conducted in a stepwise fashion. As participants were enrolled in two cohorts, all analyses included an effect-coded variable to adjust for any difference between cohorts. Similarly, all analyses accounted for monotonic, linear change from baseline assessment to the last survey administered to each family to adjust for a potential initial elevation bias relative to later responses [18]. Initial analyses examined the association of child distress and psychopathology with COVID-19 epidemiological data. Next, increasing polynomial fixed then random effects were added to model change in child- and parent-/guardian-reported distress and psychopathology over time (see Tables S1–S4). Time was coded as the number of months from March 2020. Next, putative time-varying correlates were added to each model. Each correlate was person-centered to examine intraindividual associations with distress and psychopathology while adjusting for any interindividual associations [19]. Each correlate

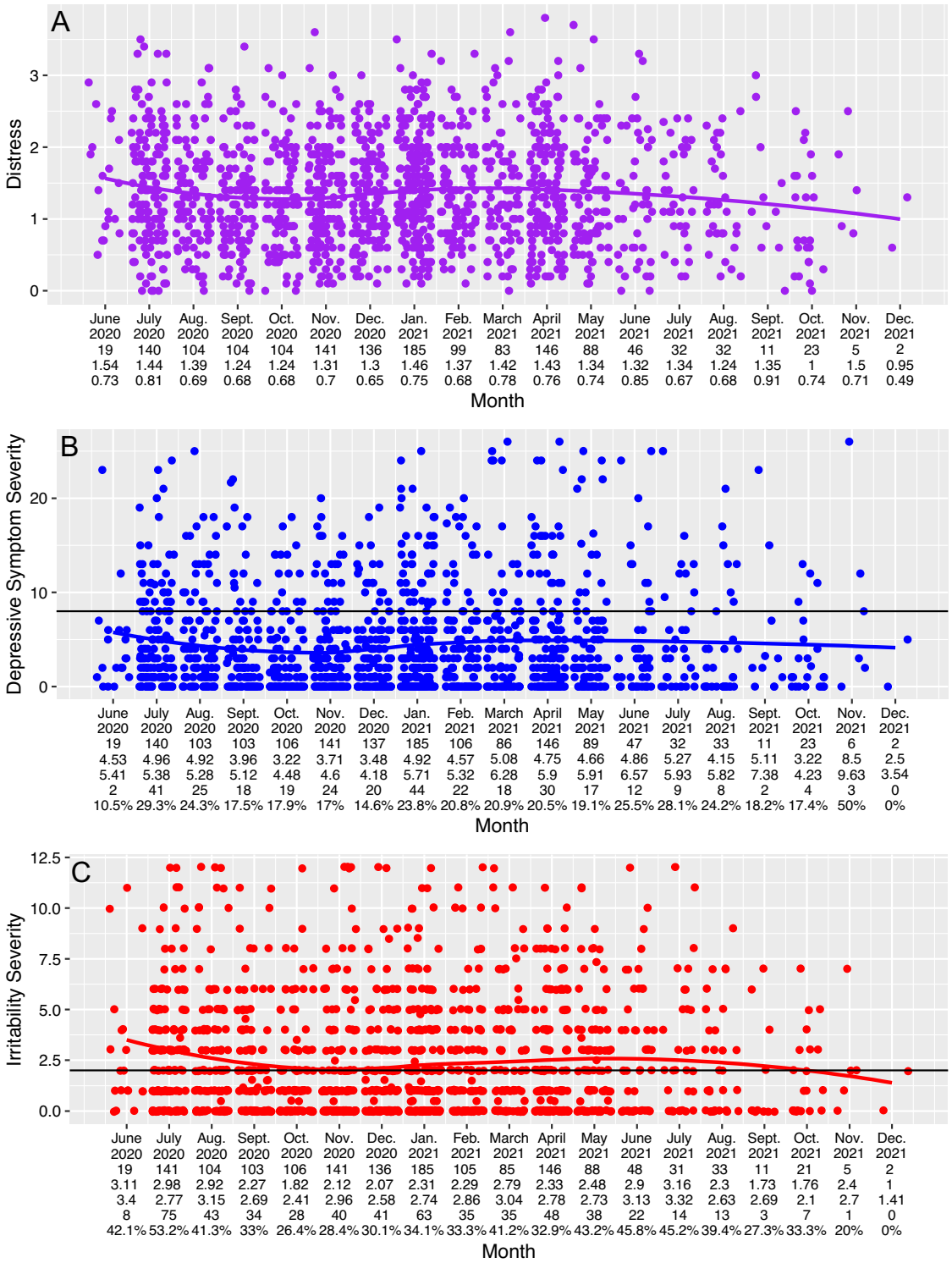

Fig. 1 Change in child-reported distress (**A**), depressive symptomatology (**B**), and irritability (**C**). The x-axis reflects, at each month, the number of children who provided data, mean, standard deviation, and number and percent of children who exceeded any available clinical threshold

was examined separately (see Tables S5–S10). Lastly, all putative time-varying covariates were added to final models to evaluate their unique association with monthly variation in child distress and psychopathology. Additional analyses examined the association of local COVID-19 prevalence, hospitalization, and death rates with child

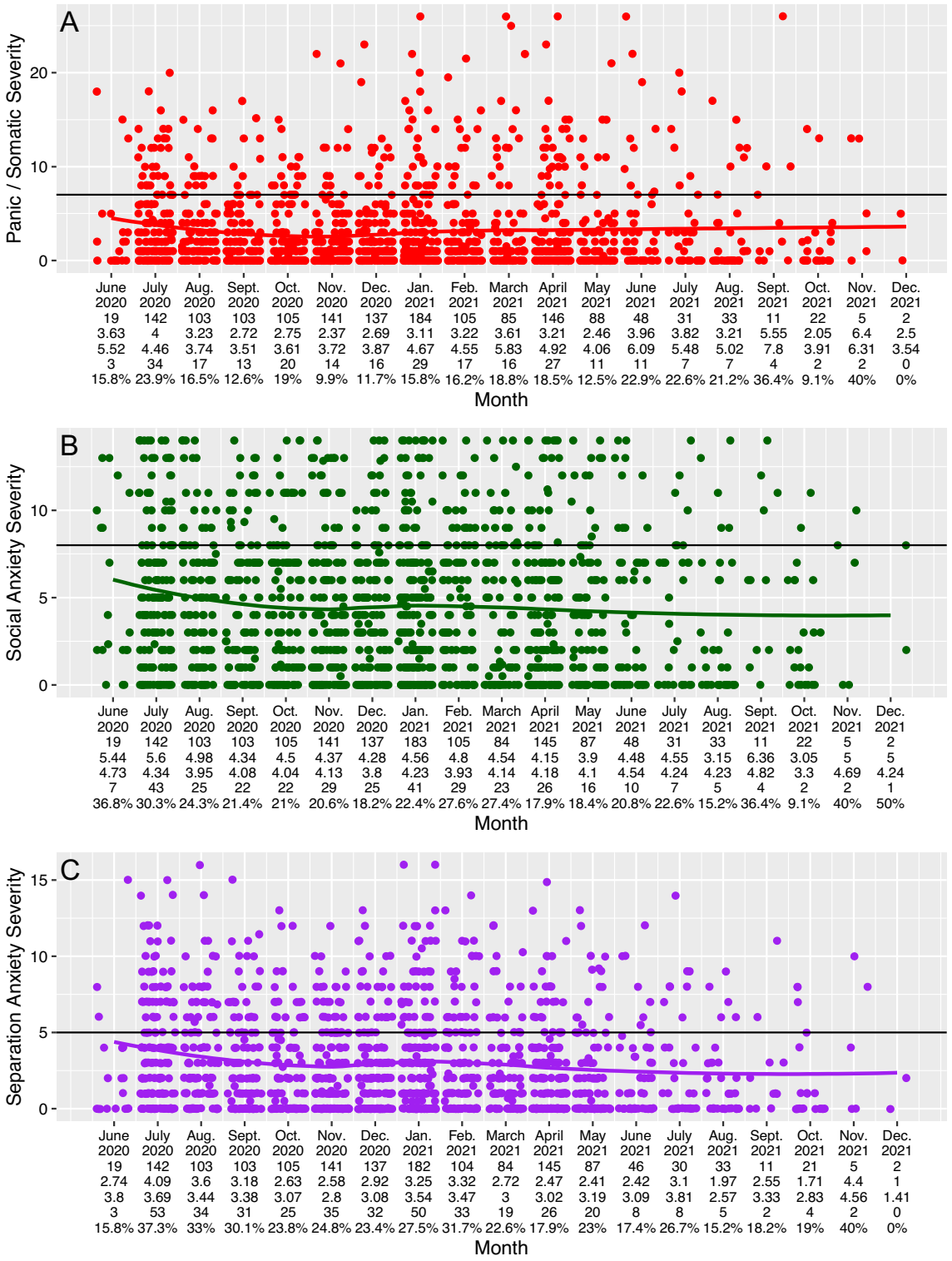

Fig. 2 Change in child-reported panic/somatic (**A**), social anxiety (**B**), and separation anxiety (**C**) syndrome severity. The x-axis reflects, at each month, the number of children who provided data, mean, standard deviation, and number and percent of children who exceeded any available clinical threshold

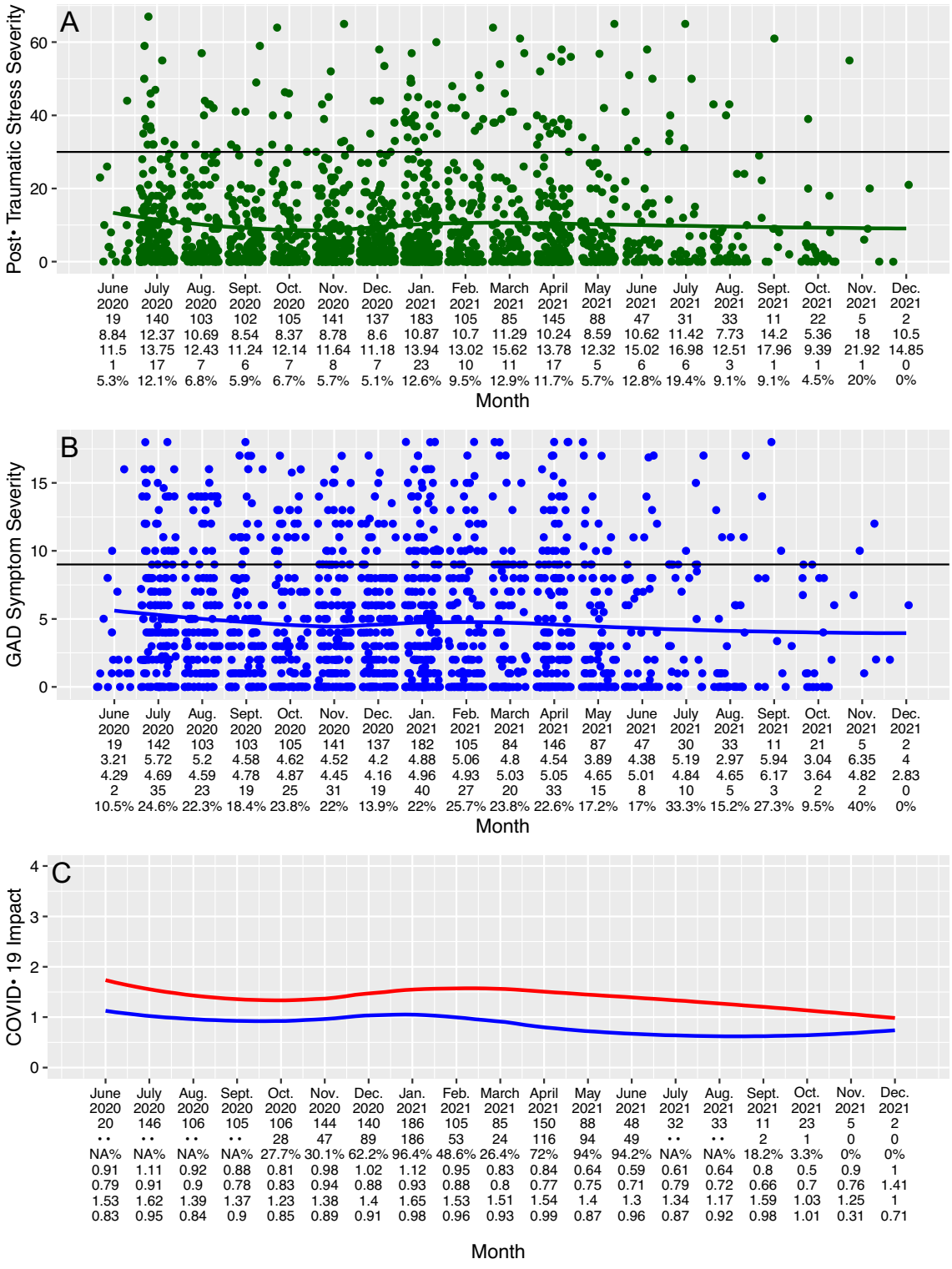

Fig. 3 Change in child-report of posttraumatic stress symptomatology (**A**), generalized anxiety symptomatology (**B**), worry about contracting COVID-19 (**C**), and stress related to stay-at-home orders or the cancelation of important events (**C**). For plots (**A**) and (**B**), the x-axis reflects, at each month, the number of children who provided data, the mean, standard deviation, and number and percent of children who exceeded any available clinical threshold. For plot (**C**), blue depicts worry about contracting COVID-19; red depicts stress related to stay-at-home orders or the cancelation of important events. The x-axis reflects the number of children who provided data; number and percent of children who reported attending school virtually; monthly mean and standard deviation of worry about contracting COVID-19; and monthly mean and standard deviation of stress related to stay-at-home orders or the cancelation of important events

worry about contracting COVID-19 and stress related to stay-at-home orders or the cancelation of important events to examine potential indirect associations of COVID-19 epidemiological data with child emotional distress and psychopathology.

Models were fit with full information maximum likelihood estimation using the lavaan [20], ggplot2 [21], and nlme packages [22] in R version 4.1.2 [23]. We present raw *p*-values but note whether *p*-values would be retained following false discovery rate adjustment [24]. Analyses were checked for normality of residuals; all primary results discussed below were robust to removal of potential outliers based on Cook's D. Data and analytic code are available upon specific request to the corresponding author.

Results

Participants

In total, 377 families completed baseline assessment. Software obstacles (e.g., captcha) blocked most potential non-human respondents, though 60 responses resulted from non-human respondents who were subsequently removed from analyses. Data from 317 families were retained for analysis. Of these families, children ranged in age from eight to thirteen ($M = 10.83$, $SD = 1.48$); parents/guardians ranged in age from 21 to 58 ($M = 41.26$, $SD = 5.85$). Most parents/guardians identified as female [287 (90.45%)]; children's sex was balanced between female [164 (51.74%)] and male [153 (48.26%)]. Parent-/guardian-report of children's ancestry approximated the demographic composition of Southwestern Ontario [see Table S11; 25] with slightly greater representation of children with ancestry from England, Ireland, Scotland or Wales.

Most adult respondents were parents [282 (88.96%)]; 29 (9.15%) were grandparents and five were siblings or an unrelated guardian (1.58%). In 237 (74.76%) families, at least one parent/guardian completed a four-year postsecondary degree. In 124 (39.12%) families, someone in the home was an essential worker, 26 (20.97%) of whom were first responders or healthcare providers. Almost all families lived in the Windsor-Essex region [297 (93.69%)]; 12 (3.79%) families were from Middlesex-London and seven (2.21%) were from Sarnia-Lambton or Chatham-Kent. 160 (50.47%) families endorsed receiving government assistance prior to the pandemic. However, to facilitate comparison with data from other countries, this study operationalized government assistance according to the CRISIS [12] to include social assistance programs widely available in Canada and Ontario including the Ontario Child Benefit provided to low- and moderate-income families [26].

Descriptive data

Descriptive data for each month of the study are reported in Figs. 1, 2 and 3 and S1–S3 (see Supplement). The severity and prevalence of child distress and psychiatric syndromes fluctuated over time. According to normative data for each scale, fluctuations were small yet statistically robust (see Supplemental Tables S1–S4). However, within this convenience sample, a substantial percent of children remained above putative clinical thresholds on a broad set of internalizing syndromes over time.

Of the 317 families whose data were retained for analysis, 250 (78.86%) completed at least 33% of the scheduled one-month follow-up assessment; 232 (73.19%) the two-month follow-up assessment; 212 (66.88%) the three-month follow-up assessment; 204 (64.35%) the four-month follow-up assessment; 199 (62.78%) the five-month follow-up assessment; 190 (59.94%) the six-month follow-up assessment; and 183 (57.73%) completed the scheduled nine-month follow-up assessment. Sixteen families (5.05%) withdrew from the study; otherwise, individual reasons why families chose not to complete a given follow-up assessment are unknown. Following a liberal alpha threshold of 0.10 to adjust for multiple testing, missing data at the final, 9-month follow-up was associated only with worse baseline child physical health as self-reported ($p = 0.033$) or observed by a parent/guardian ($p = 0.036$). Otherwise, there was no statistically significant evidence that data missing at the final 9-month follow-up assessment was associated with demographic information reported at baseline assessment by the child or parent/guardian ($ps > 0.12$; see Supplement). Child and parent/guardian baseline report of children's physical health were moderately to strongly correlated, $r = 0.59$, 95% CI [0.51, 0.67], $p < 0.01$. Therefore, subsequent analyses adjusted for child overall physical health at baseline computed as the average of child- and parent/guardian-report at baseline.

Association of monthly COVID-19 prevalence, hospitalization rate, and death rate with child mental health

Elevated local monthly COVID-19 prevalence, $b = 0.01$, 95% CI (0.007, 0.014), $p = 4.31 \times 10^{-10}$, rate of hospitalization, $b = 0.27$, 95% CI (0.19, 0.35), $p = 2.53 \times 10^{-10}$, and death rate due to COVID-19, $b = 0.26$, 95% CI (0.17, 0.35), $p = 1.04 \times 10^{-8}$ were associated with children's elevated monthly reported worry about themselves or a loved one contracting COVID-19. Similarly, as stay-at-home orders increased to address acute increases in both local and provincial prevalence, hospitalization rates, and death rates, children reported elevated stress related to stay-at-home orders or the cancelation of important events on months characterized by elevated local monthly COVID-19 prevalence,

$b = 0.005$, 95% CI (0.002, 0.008), $p = 0.002$, hospitalization rate, $b = 0.15$, 95% CI (0.07, 0.23), $p = 0.0004$, and death rate, $b = 0.14$, 95% CI (0.05, 0.22), $p = 0.001$. Regarding indices of child mental health, parents/guardians reported elevated child distress on months characterized by elevated COVID-19 prevalence, $b = 0.003$, 95% CI (0.001, 0.005), $p = 0.004$, hospitalization rate, $b = 0.09$, 95% CI (0.04, 0.14), $p = 0.0009$, and death rate, $b = 0.09$, 95% CI (0.03, 0.14), $p = 0.003$. Monthly variation in COVID-19 prevalence was weakly associated with children's self-reported monthly distress, $b = 0.002$, 95% CI (0, 0.005), $p = 0.046$, while monthly variation in COVID-19 prevalence, $b = 0.01$, 95% CI (0.001, 0.019), $p = 0.023$, and hospitalization rate, $b = 0.28$, 95% CI (0.06, 0.51), $p = 0.014$, were associated with children's self-reported separation anxiety symptoms. There was otherwise limited evidence of a direct association of children's psychopathology with COVID-19 prevalence, hospitalization rate, or death rate ($ps > 0.055$).

Change in child mental health over time

Child- and parent-/guardian-report of child distress; irritability; and symptoms of depressive, panic, and posttraumatic stress syndromes decreased initially but varied over time from June 2020 through December 2021 (see Figs. 1, 2 and 3 and Figures S1–S3). Anxiety symptoms, specifically symptoms of generalized anxiety disorder, social anxiety disorder, and separation anxiety disorder increased over time after accounting for the documented tendency for initial participant responses to be elevated [see Tables S1–S2; 18], though parent-/guardian-reported separation anxiety disorder severity decreased initially (see Table S4).

Correlates of monthly child mental health

Final analyses considered all putative time-varying correlates of child emotional distress and psychopathology concurrently along with adjustment for covariates based on methodology and systematic change over time. Preliminary analyses examined the association of each time-varying correlate with child emotional distress and psychiatric syndromes without adjustment for any covariates or systematic change in child distress or psychopathology over time (see Table S5–S10). Monthly elevations in child-reported fear that their health or the health of a loved one would be harmed by COVID-19 were associated with elevated monthly child emotional distress and broad psychiatric symptoms of irritability, depressive, posttraumatic stress, and generalized anxiety syndromes based on child-report (see Table 1) and parent-/guardian-report (see Table 2) as well as elevated monthly child-reported symptoms of panic or somatization even after adjustment for multiple testing as described above. Similarly, monthly elevations in child-reported stress related to stay-at-home orders or the cancelation of important events were associated with elevated monthly child emotional distress and symptoms of depressive, posttraumatic stress, and generalized anxiety syndromes based on child-report (see Table 1) or parent-/guardian-report as well as symptoms of irritability and separation anxiety disorder based on parent-/guardian-report (see Table 2). However, in final analyses, monthly variation in children's attendance at school virtually was associated only with parent-/guardian-report of elevated child monthly emotional distress and depressive symptoms (see Table 2).

Discussion

Longitudinal data here from June 2020 through December 2021 document a broad impact of the COVID-19 pandemic on children's emotional distress and internalizing symptomatology. Child- and caregiver-report of children's symptomatology also indicate a substantial minority of children who consistently exceed clinical thresholds indicative of a possible internalizing disorder (see Figs. 1, 2 and 3 and Figures S1–S3). Evidence of a broad impact over time that affects a substantial minority of children and youth extends data on the initial emotional and psychiatric impact of the COVID-19 pandemic to children and youth worldwide [1, 2] including in this study [27]. The pattern of change through January 2021 begins to harmonize results of otherwise seemingly discordant longitudinal investigations [e.g., 5, 9], which may result from the timing of longitudinal assessments. Through monthly assessment of children's emotional distress, this study illustrates variability in children's distress and psychiatric symptomatology over time. This identifies potential correlates of variability in the rate of American pediatric emergency department visits for mental health conditions [8].

Monthly assessment of children's emotional distress and mental health here also facilitated examination of time-varying correlates to characterize months when children reported elevated distress or psychopathology. Per child- and caregiver-report, child emotional distress and psychopathology were associated with local COVID-19 prevalence, hospitalization, and death rates indirectly via increased child worry that they or a loved one would contract COVID-19 or through stress related to stay-at-home orders or the cancelation of important events. The lack of evident associations with social anxiety or separation anxiety demonstrates specificity given the limited relevance of both syndromes with worry about contracting COVID-19 or stress related to stay-at-home orders or the cancelation of important events. We also note limited evidence that monthly variation in children's attendance in school virtually was associated with change in children's mental health. However, parent-/

Table 1 Correlates of child-report of distress and psychiatric symptomatology—*b* [*p* value] (95% CI)

	Distress	Depression	Irritability	PTSD	GAD	Panic/somatization	Social anxiety	Separation anxiety
Number of People	251	251	251	250	250	251	250	249
Number of assessments	1058	1068	1068	1065	1062	1068	1065	1059
Fixed effects								
Intercept	1.24 [0.122] (− 0.32, 2.81)	0.74 [0.898] (− 10.52, 12.00)	6.56 [0.056] (− 0.13, 13.26)	− 5.79 [0.666] (− 31.94, 20.37)	1.53 [0.319] (− 1.46, 4.52)	5.32 [0.317] (− 5.04, 15.67)	4.16** [0.005] (1.31, 7.01)	− 0.12 [0.912] (− 2.30, 2.06)
Virtual school attendance (within-person)	0.02 [0.550] (− 0.04, 0.08)	0.49* [0.038] (0.03, 0.95)	− 0.02 [0.883] (− 0.30, 0.25)	0.58 [0.290] (− 0.48, 1.64)	0.07 [0.669] (− 0.26, 0.41)	0.25 [0.240] (− 0.17, 0.68)	0.10 [0.553] (− 0.23, 0.43)	0.27 [0.056] (− 0.005, 0.55)
Virtual school attendance (between-person)	0.09 [0.397] (− 0.12, 0.29)	− 0.32 [0.731] (− 2.13, 1.49)	− 0.30 [0.545] (− 1.26, 0.66)	2.63 [0.230] (− 1.65, 6.90)	− 1.03 [0.213] (− 2.66, 0.59)	− 0.32 [0.668] (− 1.78, 1.14)	− 0.26 [0.743] (− 1.79, 1.28)	0.17 [0.778] (− 0.99, 1.32)
Worry about contracting COVID-19 (within-person)	0.13 + [2.585e−05] (0.07, 0.18)	0.56** [0.004] (0.18, 0.94)	0.26* [0.031] (0.03, 0.50)	1.43** [0.001] (0.57, 2.29)	0.54** [0.002] (0.20, 0.88)	0.50** [0.003] (0.18, 0.83)	0.04 [0.762] (− 0.21, 0.29)	0.18 [0.094] (− 0.03, 0.39)
Worry about contracting COVID-19 (between-person)	0.27 + [7.200e−07] (0.17, 0.37)	2.24 + [3.720e−06] (1.32, 3.17)	0.84*** [0.0008] (0.36, 1.33)	7.18 + [0] (4.99, 9.37)	2.62 + [0] (1.79, 3.45)	2.52 + [0] 3.28)	1.99 + [1.120e−06] (1.21, 2.77)	1.13*** [0.0002] (0.56, 1.71)
Stress related to y-at- home orders (within-person)	0.23 + [0] (0.17, 0.28)	0.67** [0.004] (0.21, 1.12)	0.20 [0.051] (0.0001, 0.41)	1.47** [0.002] (0.56, 2.39)	0.53** [0.003] (0.18, 0.88)	0.20 [0.216] (− 0.11, 0.50)	0.23 [0.075] (− 0.02, 0.49)	0.16 [0.134] (− 0.05, 0.38)
Stress related to stay-at- home orders (between-person)	0.33 + [0] (0.24, 0.42)	1.12** [0.007] (0.31, 1.93)	0.82*** [0.0002] (0.40, 1.25)	1.77 [0.072] (− 0.14, 3.68)	0.83* [0.024] (0.11, 1.55)	− 0.30 [0.366] (− 0.96, 0.35)	− 0.51 [0.141] (− 1.20, 0.17)	0.70** [0.007] (0.19, 1.21)

Each model is adjusted for recruitment cohort; survey in the longitudinal design; monthly local COVID-19 prevalence; and change over time as indicated by preliminary analyses; and random effects of each statistically significant within-person fixed effect term. See Table S12 for the full model

PTSD posttraumatic stress disorder, *GAD* generalized anxiety disorder

+$p < 0.0001$

***$p < 0.001$

**$p < 0.01$

*$p < 0.05$

Table 2 Correlates of parent-/guardian-report of child distress and psychiatric symptomatology—*b* [*p* value] (95% CI)

	Distress	Depression	Irritability	PTSD	GAD	Panic/somatization	Social anxiety	Separation anxiety
Number of people	251	251	251	251	251	251	251	251
Number of assessments	1073	2077	1077	1077	1072	1077	1073	1073
Fixed effects								
Intercept	− 0.22 [0.771] (− 1.72, 1.27)	− 3.69 [0.490] (− 14.11, 6.73)	0.93 [0.770] (− 5.28, 7.15)	22.62* [0.049] (0.27, 44.96)	4.27** [0.006] (1.25, 7.29)	5.99 [0.175] (–2.62, 14.59)	5.48 + [6.754e–05] (2.81, 8.15)	4.02** [0.003] (1.40, 6.65)
Virtual school attendance (within-person)	0.18 + [2.00e−08] (0.12, 0.25)	0.54* [0.012] (0.12, 0.96)	0.18 [0.161] (− 0.07, 0.44)	0.42 [0.368] (− 0.48, 1.32)	0.06 [0.687] (− 0.24, 0.36)	− 0.19 [0.278] (− 0.54, 0.15)	0.08 [0.556] (− 0.19, 0.35)	0.12 [0.331] (− 0.12, 0.35)
Virtual school attendance (between-person)	0.07 [0.498] (− 0.13, 0.27)	0.44 [0.606] (− 1.22, 2.10)	− 1.12* [0.036] (− 2.16, − 0.08)	1.70 [0.337] (− 1.76, 5.17)	− 0.64 [0.457] (− 2.31, 1.04)	− 0.49 [0.506] (− 1.93, 0.95)	− 0.41 [0.59] (− 1.89, 1.08)	− 0.08 [0.893] (− 1.24, 1.08)
Worry about contracting COVID-19 (Within-Person)	0.06** [0.010] (0.01, 0.10)	0.400* [0.013] (0.09, 0.70)	0.27** [0.006] (0.08, 0.46)	1.11** [0.002] (0.40, 1.82)	0.38** [0.004] (0.13, 0.64)	0.25 [0.052] (0, 0.50)	0.16 [0.126] (− 0.04, 0.37)	0.113 [0.218] (− 0.07, 0.29)
Worry about contracting COVID-19 (between-person)	0.14** [0.006] (0.04, 0.25)	1.08* [0.013] (0.23, 1.94)	0.52 [0.054] (− 0.006, 1.05)	5.30 + [2.000e–08] (3.52, 7.07)	1.55*** [0.0005] (0.69, 2.40)	1.87 + [9.200e–07] (1.14, 2.59)	1.59 + [5.930e–05] (0.83, 2.35)	1.01*** [0.0008] (0.43, 1.59)
Stress related to stay-at-home orders (within-person)	0.11 + [1.126e−05] (0.06, 0.16)	0.53** [0.008] (0.14, 0.91)	0.28** [0.009] (0.07, 0.49)	1.36*** [0.0009] (0.56, 2.15)	0.31* [0.025] (0.04, 0.58)	0.24 [0.068] (− 0.02, 0.49)	0.07 [0.517] (− 0.14, 0.27)	0.28** [0.007] (0.08, 0.48)
Stress related to stay-at-home orders (between-person)	0.31 + [0] (0.22, 0.40)	1.57 + [5.009e−05] (0.83, 2.31)	0.73** [0.002] (0.27, 1.19)	1.42 [0.075] (− 0.13, 2.97)	0.66 [0.087] (− 0.09, 1.40)	− 0.17 [0.606] (− 0.80, 0.47)	− 0.42 [0.214] (− 1.09, 0.24)	0.58* [0.026] (0.07, 1.09)

Each model is adjusted for recruitment cohort; survey in the longitudinal design; monthly local COVID-19 prevalence; change over time as indicated by preliminary analyses; and random effects of each statistically significant within-person fixed effect. See Table S13 for the full model

PTSD posttraumatic stress disorder, *GAD* generalized anxiety disorder

$+p < 0.0001$

$***p < 0.001$

$**p < 0.01$

$*p < 0.05$

guardian-report of children's mental health may identify an association of virtual school attendance with elevated monthly emotional distress and depressive symptoms less evident in children's report of their own distress.

The associations of child distress and mental health with worry about contracting COVID-19 and stress related to stay-at-home orders or the cancelation of important events were highlighted in another recent longitudinal investigation [10] and emphasize the delicate balance required of public policy. These results underscore the importance of sustained, widespread efforts to (i) track local COVID-19 and related epidemiology; (ii) comprehensively monitor child and adolescent mental health; and (iii) communicate with families, children, and the public about all measures taken to enhance safety in public spaces and rationale when implementing or removing non-pharmaceutical interventions.

We also note that, consistent with public health strategies employed in 2020 and 2021, the assessment of stress related to stay-at-home orders or the cancelation of important events used here emphasized disruptions to daily activities or interactions with family and friends (see Supplement). The evident empirical associations of worry about contracting COVID-19 and stress related to stay-at-home orders or the cancelation of important events with children's mental health highlight the importance, to children's mental health, of public health strategies that reduce risk while facilitating social interaction (e.g., widespread mask adoption, vaccination).

Results of this study should be considered in light of several limitations including potential type 2 error; uncertain generalizability to other populations given the convenience sampling strategy employed; and lack of a control sample either prior to the pandemic or concurrent (e.g., from another country). However, although a relatively modest sample size without assessment prior to the pandemic, this study provided higher temporal resolution, granular assessment of child distress and psychopathology over the course of the COVID-19 pandemic. The modest sample size also highlights the prominent effect size of evident associations of worry about contracting COVID-19 and stress related to stay-at-home orders or the cancelation of important events with children's acute, monthly fluctuations in myriad psychiatric outcomes. Future research is needed to compare data from the present study with that collected from other countries and regions, such as countries who implemented different public health strategies [e.g., 1]. In particular, given evidence of health disparities in the impact of the COVID-19 pandemic [e.g., 28], future research is critically needed to evaluate the impact of the pandemic on marginalized communities and in developing countries. Finally, this study examined internalizing syndromes. Future research is needed to explore the broad impact of the ongoing COVID-19 pandemic on externalizing psychopathology in children and youth including the implications of monthly variations in worry about contracting COVID-19 and stress related to stay-at-home orders or the cancelation of important events.

Conclusion

Critically, rather than provide inferences to be generalized globally, this study illustrates the importance of local efforts to track the broad, potentially sustained, psychosocial impact of the COVID-19 pandemic on children's mental health throughout the ongoing pandemic and its recovery. Moreover, this study highlights key methodological features for tracking efforts including broad assessment of psychopathology, the integration of multi-informant reports [e.g., 29], and frequent assessment. This study also indicates that a substantial minority of children may demonstrate a sustained psychosocial impact throughout the COVID-19 pandemic. Otherwise, child- and caregiver-report of children's well-being evidence variability in emotional distress and broad internalizing psychopathology over time. Finally, this study demonstrates that local COVID-19 severity (e.g., prevalence, hospitalizations) was associated with acute, monthly fluctuations in both children's worry that they or a loved one might contract COVID-19 and stress related to stay-at-home orders or the cancelation of important events, which were associated with acute elevations in emotional distress and broad psychopathology according to both child- and caregiver-report.

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Data availability Data, materials, and code are available by request to the corresponding author.

Declarations

Conflict of interest The authors have no relevant financial or non-financial interests to disclose.

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