



## EMPIRICAL ARTICLE

# A longitudinal study of how women's prenatal and postnatal concerns related to the COVID-19 pandemic predicts their infants' social–emotional development

Kyle S. Wiley<sup>1</sup> | Molly M. Fox<sup>1,2</sup> | Theresa E. Gildner<sup>3</sup> | Zaneta M. Thayer<sup>4,5</sup>

<sup>1</sup>Department of Anthropology, University of California, Los Angeles, Los Angeles, California, USA

<sup>2</sup>Department of Psychiatry and Biobehavioral Sciences, University of California, Los Angeles, Los Angeles, California, USA

<sup>3</sup>Department of Anthropology, Washington University in St. Louis, St. Louis, Missouri, USA

<sup>4</sup>Department of Anthropology, Dartmouth College, Hanover, New Hampshire, USA

<sup>5</sup>Ecology, Evolution, Environment & Society Program, Dartmouth College, Hanover, New Hampshire, USA

## Correspondence

Kyle S. Wiley, Department of Anthropology, UCLA, Los Angeles, CA, USA.

Email: [kyleswiley@ucla.edu](mailto:kyleswiley@ucla.edu)

## Funding information

Dartmouth College; National Institute of Diabetes and Digestive and Kidney Diseases, Grant/Award Number: DK105110-01 and DK125524-01; National Institute on Minority Health and Health Disparities, Grant/Award Number: 1F32MD015201; Wenner-Gren Foundation, Grant/Award Number: 9687

## Abstract

Infant social–emotional development may be impacted by the COVID-19 pandemic. This study investigated associations between maternal pre- and postnatal pandemic-related concerns and social–emotional developmental risk. Data, collected in 2020–2021, came from 220 mothers (87% white, 6% Hispanic, 1% Black, 3% Asian, 1% American Indian,  $M_{\text{age}} = 32.46$  years), and infants (53.18% male,  $M_{\text{age}} = 12.98$  months) in the United States. Maternal postnatal pandemic-related concerns were associated with total risk scores ( $B = 6.09$ ,  $p$ -value  $< .001$ ) and offspring risk of scoring positive for problems related to inflexibility ( $B = 4.07$ ,  $p$ -value  $= .006$ ). The total score association was moderated by self-reported social support. Infants may be detrimentally impacted by the pandemic via maternal pandemic-related concerns. Maternal social support may buffer infants.

The spread of the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) and subsequent global coronavirus disease (COVID)-19 pandemic has disrupted the lives of almost all segments of society in the U.S. and elsewhere. Pregnant people and parents of infants and young children may be particularly vulnerable to challenges posed by the pandemic (Gildner & Thayer, 2020b). Pregnant and postpartum individuals have been shown to have severe burdens of psychological distress during the pandemic, including symptoms of depression and anxiety (Berthelot et al., 2020; Chmielewska et al., 2021; King et al., 2021). Several studies have also shown high levels of pandemic-related concerns reported by pregnant and postpartum people (Pope et al., 2022), resulting from factors ranging from job loss, financial insecurity, changes to birthing plans, disruption of exercise routines, social isolation, and childcare and school closures (Gildner et al., 2020; Ollivier et al., 2021; Sherin et al., 2021; Thayer & Gildner, 2021). In addition to consequences for the

health and well-being of the mother, stressors encountered during pregnancy may affect the developing fetus (Davis & Narayan, 2020), and postnatal stressors may affect the infant (Oyetunji & Chandra, 2020). Thus, researchers and healthcare providers have called for more research on the immediate and long-term effects of the COVID-19 pandemic on pregnant and postpartum mothers and infants (Buekens et al., 2020; Semaan et al., 2020).

Few studies have examined associations between mothers' COVID-19 pandemic-related concerns and infant development. In one of the first studies of the impact of the pandemic on infants, the authors found that pandemic-related maternal stress experienced during pregnancy was positively associated with infants' levels of DNA methylation of the serotonin transporter gene *SLC6A4* at 3 months of age, which was negatively correlated with infants' positive affect (Provenzi, Mambretti, et al., 2021). These authors also reported an



association between postnatal maternal psychological distress and infant regulatory capacity, which was mediated by postnatal social support (Provenzi, Grumi, et al., 2021). Prenatal psychological distress during the pandemic was also associated with social–emotional development of 6–13 week-old infants, and this association was mediated by postnatal distress (Duguay et al., 2022). Others reported that high levels of maternal postnatal pandemic-related concerns were negatively associated with dimensions of infant temperament at 6 months, including positive affect and orienting/regulatory behaviors (Bianco et al., 2022). Previous work has largely focused on how mothers' postnatal psychological distress mediates the consequences of prenatal pandemic stress (Provenzi, Grumi, et al., 2021). Few have examined how ongoing concerns related to the pandemic or positive factors such as social support may moderate associations between pandemic-related concerns and infant social–emotional development.

Social support is a predictor of maternal psychological well-being in the pre- and postnatal period and support from partners and family may buffer women and infants from the adverse consequences of prenatal stress (Feldman et al., 2000; Tani & Castagna, 2017; Xie et al., 2010). Studies have shown that lack of social support, both across the peripartum and during delivery has impacted women during the pandemic and is associated with depression and anxiety (Grumi et al., 2021). Due to social distancing, expectant mothers may have had reduced access to traditional types of social support (Gildner et al., 2021; Gildner & Thayer, 2020a; Zhou et al., 2021) and experiences that deviated from expected normative experiences of pregnancy (Kolker et al., 2021). Father or partner's absence from prenatal care visits or delivery may have also impacted maternal well-being during the pandemic (Lista & Bresesti, 2020; Meaney et al., 2022; Morris et al., 2022). Perceived support may not closely map to receive support as pregnant and postpartum women may not be able to access traditional support resources during periods of social distancing (Adhikari et al., 2021; Blebu et al., 2022). However, few studies have examined how social support in the postnatal period may buffer maternal stress and infant development from pandemic-related concerns.

Here, we examine associations between COVID-19 pandemic-related concerns in the prenatal and postnatal periods and their associations with infant social–emotional developmental risk. Our analysis uses data from the COVID-19 Reproductive Effects (CARE) study—a longitudinal online survey of pregnant and postpartum people and infants living in the United States (U.S.) during the first wave of the COVID-19 pandemic. We examined infant social–emotional development risk because previous studies indicate that it is impacted by elevated maternal psychological stress during the COVID-19 pandemic (Duguay et al., 2022; Madigan et al., 2018). We first investigated (1) if prenatal

or postnatal pandemic-related concerns, or both, were associated with infant social–emotional developmental risk. As social support may buffer women and infants from the negative developmental consequences of prenatal and postnatal stress (Davis & Narayan, 2020), we also examined (2) if social support received by the mother was associated with her pandemic-related concerns and (3) if it moderated the association between pandemic concerns and infant social–emotional developmental risk. We hypothesized that prenatal and postnatal pandemic-related concerns would be positively associated with infant social–emotional developmental risk and negatively associated with reported levels of social support. Furthermore, we hypothesized a moderation effect such that the predicted positive association between pandemic-related concerns and infant social–emotional developmental risk would be stronger among women who received lower levels of social support and weaker or absent among women who received higher levels of social support. These analyses are exploratory as they test novel hypotheses about the effects of pandemic-related concerns in the prenatal and postnatal periods on infant social–emotional developmental risk. However, they contribute to an established literature investigating the effects of prenatal and postnatal stress on infant development and the buffering role of social support for maternal and child health.

## METHOD

### Cohort and demographics

Data for this analysis come from the first and third waves of the CARE study, which has been described in detail elsewhere (Gildner et al., 2020; Thayer & Gildner, 2021). In brief, a convenience sample of pregnant persons living in the U.S. was recruited for the first round of data collection from April 16, 2020 to December 27, 2020 (wave 1) through advertising study information on social media and sharing study information with research collaborators in maternal and child health. A total of 2027 participants completed the questionnaire via an online survey. All participants who completed the questionnaire and consented to be re-contacted ( $N=1880$ ) were emailed a follow-up questionnaire 4 weeks after their listed due date (wave 2, May 2020–February 2021). A subset ( $N=941$ ) agreed to be re-contacted for a third study wave, which occurred in July 2021 (wave 3). Wave 3 data were collected from July 14, 2021 to September 12, 2021. The wave 3 survey was completed by 287 participants. We excluded 24 that did not complete the infant development questionnaire and an additional 43 that were missing data for one or more covariates. Complete longitudinal data were, therefore, available for 220 participants. This large rate of attrition was unfortunately common among online surveys during the COVID-19

pandemic and factors such as changes in employment or increased work hours as lockdowns lifted may be associated with increased odds of attrition (Yu et al., 2022). In this analytic sample, 87% of participants self-identified as white, 6% as Hispanic/Latino, 1% as Black, 3% as Asian, and 1% as American Indian. Participants were relatively high-income (63% of participants self-reported their household income as \$100,000+, 31% as \$50,000–\$99,000, and 6% as <\$49,999) and well-educated (88% reported having a bachelor's degree or more advanced education). This sample is not representative of the general U.S. population, likely reflective of the structural barriers to research participation among participants from low-income communities and communities of color that create extra barriers to research participation.

Demographic covariates included maternal age, education (less than, earned, or greater than a bachelor's degree), parity (primiparous or multiparous), household income (<\$49,999, \$50,000–\$99,999, or \$100,000+), infant age, and infant sex.

## Measures

### Pandemic-related concerns

Prenatal pandemic-related concerns were measured at the prenatal interview using a seven-item original questionnaire. Participants answered each question on a five-item Likert scale ranging from 1-strongly disagree to 5-strongly agree. Three of the items were about fears related to contracting COVID-19 and the effects of infection on the baby's development and health in utero, potential transmission to their baby, and the long-term effects of infection in utero on their baby. Two items assessed fears related to labor and delivery, including not having support in the delivery room due to the ongoing pandemic and the baby being taken away at birth if the participant had a positive COVID-19 diagnosis upon hospital admission. The remaining two items were about specific concerns related to financial worries due to the pandemic and fears about being treated poorly by others after receiving a positive COVID-19 diagnosis. An average score was created by taking the mean of responses to the seven items. Reliability of this composite was adequate (Cronbach's  $\alpha = .65$ ).

Postnatal pandemic-related concerns were assessed at the postpartum interview via responses to five questions answered on a five-item Likert scale ranging from 1-strongly disagree to 5-strongly agree. The first three questions reflected concerns that were similar to the prenatal concerns and included questions about COVID-19 infection: “How concerned are you that your infant will become infected with COVID-19? If your infant has already had COVID-19, how concerned are you about reinfection?”, “How concerned are you that someone else in your household will become infected with

COVID-19?”. The fourth question was about financial worries: “How worried are you about your financial situation due to the COVID-19 crisis?”. This fourth question was a modified version of the social isolation and parenting question published by Lee et al. (2022): “In the last three months, have you felt that social isolation/social distancing makes it difficult to parent your child(ren)?”. The fifth question was: “Are you concerned that social isolation/social distancing has affected your infant's development?” An average score was created by taking the mean of the response to the five items. Reliability of this composite was adequate (Cronbach's  $\alpha = .63$ ).

### Social support

Social support in the last 3 months was measured at the second postpartum interview using an original five-item questionnaire of common sources of social support and answered on a five-item Likert scale ranging from 1-strongly disagree to 5-strongly agree. The questions addressed whether the participant had felt emotionally supported by their partner (if applicable), family, and friends, whether they had someone they could reach out to when they felt anxious or upset, and whether their support system had helped them reduce their stress levels. A composite score was generated by averaging responses to the five items. The social support composite had good reliability (Cronbach's  $\alpha = .84$ ).

### Infant social–emotional development

Infant social–emotional developmental risk was quantified using the Baby Pediatric Symptom Checklist (BPSC) from the Survey of the Wellbeing of Young Children study (Sheldrick et al., 2013). The BPSC is a 12-item comprehensive and free social–emotional screening instrument that is validated for children up to 18 months of age. It assesses social–emotional developmental risk in three domains: irritability, inflexibility, and difficulty with routines, and has good reliability when compared to longer paid instruments such as the Ages and Stages Questionnaire (Sheldrick et al., 2013). Parents respond to each question with either 0-not at all, 1-somewhat, or 2-very much. The responses are summed for each subscale and a score of 3 or more is indicative of potential developmental risk for social–emotional problems, creating a binary variable for each subscale, which we refer to as high=scoring at or above 3 and low=scoring below 3 (Sheldrick et al., 2013). The dimensional total score, with a higher score reflecting more risk for social–emotional developmental risk, was also used in our analysis. Hereafter, we refer to the total BPSC score as “social-emotional developmental risk score.” Cronbach's  $\alpha$  for the BPSC in our sample was .80, suggesting good internal consistency.



## Statistical analysis

Statistical analyses were performed in R statistical programming language and environment, version 1.3. Pearson correlations were used to test for associations between continuous study variables. Multivariable hierarchical linear and logistic regression were used to test associations between predictors of interest (pre- and postnatal pandemic-related concerns) and the social-emotional developmental risk score (continuous) and subscales (binary), respectively, and calculate unstandardized coefficients. Variables were entered into the models in the following steps: (Step 1) pre- and postnatal pandemic-related concern scores and covariates; (Step 2) social support scores; (Step 3) interaction term between significant pandemic-related concerns from Step 1 and social support scores. Multicollinearity was not detected for any variables in Step 1 or 2 between any variables; all GVIF values were in the range of 1.01–1.25. Multicollinearity was detected in Step 3 with the addition of the interaction term, which is due to collinearity between the interaction term and the main effects comprising the interaction term. Ablative Testing and the Akaike information criterion (AIC) were used to evaluate whether the addition of social support (Step 2) or an interaction term (Step 3) meaningfully impacted the association between stressors and infant outcomes and to select the most parsimonious model. An interaction plot was generated using the *Interaction* and *jtools* packages (Long & Long, 2017, 2019). McFadden's pseudo- $R^2$  was calculated for the logistic regression models using the *pscl* package (Jackman et al., 2015).

## RESULTS

Descriptive statistics for the dependent and independent variables are reported in Table 1. Only 28 of the participants (13%) and 18 of their infants (8%) reported having tested positive for COVID-19 or having had COVID-19-like symptoms during the study period. As these rates were very low, we elected to not include them in the statistical models. Mean maternal prenatal pandemic-related concerns were 3.72 ( $SD=0.63$ , on a 1–5 scale), while mean postnatal pandemic-related concerns were 3.19 ( $SD=0.97$ , on a 1–5 scale). Average social-emotional developmental risk scores ranged from 0–18, on a 0–24 scale, with a mean score of 5.07 ( $SD=3.94$ ). Sixty percent of the infants scored above the BSPC cutoffs for at least one of the subscales. The number varied considerably by subscale with 12% of infants scoring above the cutoff for irritability, 40% for inflexibility, and 33% for difficulty with routines.

## Correlations between study variables

Correlations between continuous variables are shown in Table 2. Social support was negatively correlated

TABLE 1 Participant Characteristics ( $n=220$ ).

	Mean ( $SD$ )
Maternal characteristics	$N$ (%)
Age (Years)	32.46 (3.78)
Previous Birth (Yes)	115 (52.27%)
Self-identified race or ethnicity	
White	192 (87.27%)
Hispanic, Latino, or Spanish Origin	13 (5.91%)
Black or African American	3 (1.36%)
Asian	6 (2.73%)
American Indian or Alaska Native	3 (1.36%)
Other	3 (1.36%)
Yearly Household Income (U.S. Dollars)	
<\$49,999	14 (6.36%)
\$50,000–\$99,999	68 (30.91%)
\$100,000+	138 (62.73%)
Highest Level of Education Completed	
No Bachelor's Degree	26 (11.82%)
Bachelor's Degree	78 (35.45%)
Beyond Bachelor's Degree	116 (52.73%)
Relationship Status (Married)	211 (95.91%)
Prenatal Pandemic-Related Concerns	3.72 (0.63)
Postnatal Pandemic-Related Concerns	3.19 (0.97)
Infant characteristics	
Age (Months)	12.98 (2.22)
Sex (Male)	117 (53.18%)
Birthweight (Ounces)	120.9 (20.22)
Gestational Age at Birth (Weeks)	38.92 (1.66)
Hospitalized at Birth (Yes)	34 (15.45%)
BPSC Scores	5.07 (3.94)

with both prenatal ( $r=-.15$ ,  $p$ -value=.026) and postnatal pandemic-related concerns ( $r=-.37$ ,  $p$ -value<.001). Postnatal pandemic-related concerns scores were positively correlated with infants' social-emotional developmental risk scores ( $r=.31$ ,  $p$ -value<.001) while mothers' social support was negatively correlated with infants' social-emotional developmental risk scores ( $r=-.19$ ,  $p$ -value=.006). There was no significant relation observed between mothers' prenatal pandemic-related concerns and infants' social-emotional developmental risk.

## Pandemic-related concerns and infant social-emotional development

Associations between maternal prenatal and postnatal pandemic-related concerns and infant social-emotional developmental risk scores after adjusting for covariates are shown in Table 3. Mothers' prenatal concerns were not associated with infants' social-emotional

**TABLE 2** Pearson correlations between study variables.

	Prenatal pandemic concerns	Postnatal pandemic concerns	Social support
Postnatal Pandemic Concerns	0.30***		
Social Support	−0.15*	−0.37***	
BPSC Total	0.03	0.31***	−0.19**

Note: BPSC: Baby Pediatric Symptom Checklist from the Survey of the Wellbeing of Young Children study (Sheldrick et al., 2013).

\* $p$ -value < .05; \*\* $p$ -value < .01; \*\*\* $p$ -value < .001.

developmental risk in any of the models. Because there was no significant relation observed between mothers' prenatal pandemic-related concerns and infants' social-emotional developmental risk, the hypothesized moderating effect of social support was not tested.

Mothers' postnatal pandemic-related concerns were significant predictors of infants' social-emotional developmental risk in all three models. Ablative testing ( $F(6.80)$ ,  $p$ -value = .01) and AIC comparison suggested that the third-step model was the most parsimonious. In this model, infants' social-emotional developmental

**TABLE 3** Multivariable hierarchical regression of total Baby Pediatric Symptom Checklist scores.

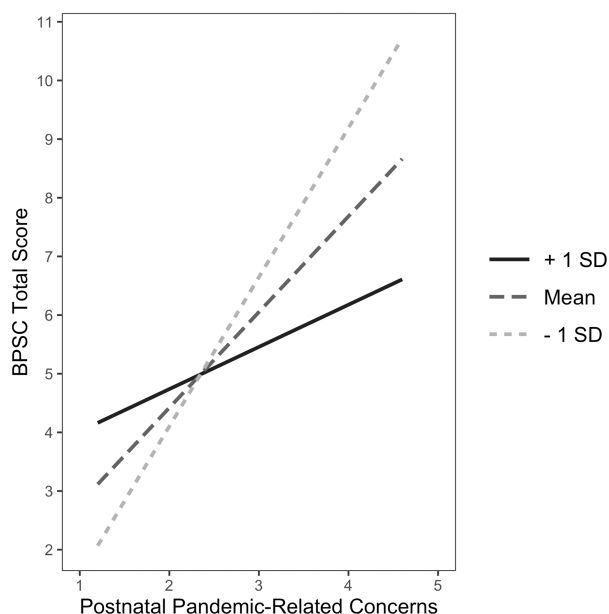
	<i>B</i>	<i>SE</i>	<i>p</i> -value	Adj. $R^2$	AIC
Step 1				0.137	580.546
Prenatal Pandemic Concerns	−0.496	0.425	0.244		
Postnatal Pandemic Concerns	1.930	0.398	<0.001		
Infant Sex (ref: Male)	0.696	0.498	0.164		
Infant Age (Months)	−0.047	0.113	0.681		
Mother Age (Years)	0.029	0.068	0.675		
Income (ref: <\$49,999)	−1.227	0.451	0.007		
Education (Bachelor's Degree; ref: <Bachelor's Degree)	−1.034	0.882	0.242		
Education (>Bachelor's Degree)	−1.267	0.871	0.147		
Parity	0.313	0.510	0.540		
Step 2				0.144	574.853
Prenatal Pandemic Concerns	−0.560	0.427	0.192		
Postnatal Pandemic Concerns	1.792	0.422	0.000		
Social Support	−0.356	0.337	0.292		
Infant Sex (ref: Male)	0.732	0.500	0.145		
Infant Age (Months)	−0.039	0.114	0.736		
Mother Age (Years)	0.018	0.069	0.791		
Income (ref: <\$49,999)	−1.303	0.453	0.004		
Education (Bachelor's Degree; ref: <Bachelor's Degree)	−0.924	0.881	0.295		
Education (>Bachelor's Degree)	−1.074	0.874	0.221		
Parity	0.417	0.513	0.417		
Step 3				0.167	569.768
Prenatal Pandemic Concerns	−0.598	0.422	0.158		
Postnatal Pandemic Concerns	6.094	1.701	<0.001		
Social Support	2.702	1.218	0.028		
Infant Sex (ref: Male)	0.850	0.495	0.087		
Infant Age (Months)	−0.031	0.112	0.785		
Mother Age (Years)	−0.002	0.068	0.981		
Income (ref: <\$49,999)	−1.212	0.448	0.007		
Education (Bachelor's Degree; ref: <Bachelor's Degree)	−1.098	0.872	0.209		
Education (>Bachelor's Degree)	−1.207	0.864	0.164		
Parity	0.531	0.507	0.296		
Postnatal Pandemic Concerns × Social Support	−1.109	0.425	0.010		



risk was positively associated with mothers' postnatal pandemic-related concerns ( $B=6.09$ ,  $p\text{-value}<.001$ ) and with social support the mother received ( $B=2.70$ ,  $p\text{-value}=.03$ ). The association between maternal postnatal pandemic-related concerns and infant social-emotional developmental risk was moderated by social support (interaction term  $B=-1.11$ ,  $p\text{-value}=.01$ ; Figure 1) such that there was a stronger positive relation between mothers' postnatal pandemic-related concerns and infant social-emotional developmental risk for those mothers who reported low levels of social support.

## Pandemic-related concerns and subscales of social-emotional developmental risk

Associations between pandemic-related concerns and infant BPSC subscale scores are shown in Tables 4–6. Mothers' prenatal pandemic-related concerns were not associated with any of the BPSC subscale scores. Mothers' postnatal pandemic-related concerns were associated with infants exhibiting high Irritability in Step 1 ( $B=1.23$ ,  $p\text{-value}=.001$ , Table 4). Step 1 and 3 had similar AICs and did not significantly differ as indicated by ablative testing ( $\chi^2(4.12)$ ,  $p\text{-value}=.13$ ). In the Step 3 model, postnatal pandemic-related concerns were associated with a greater risk of high Irritability ( $B=3.83$ ,  $p\text{-value}=.01$ ). Contrary to our hypothesis, social support did not moderate the association between postnatal pandemic-related concerns and high Irritability ( $B=-0.72$ ,  $p\text{-value}=.06$ ).



**FIGURE 1** Interaction plot of moderation of Baby Pediatric Symptom Checklist scores by social support. A graphical plot depicting the interaction between postnatal pandemic-related concerns and social support in predicting total scores on the Baby Pediatric Symptom Checklist.

Mothers' postnatal pandemic-related concerns were a significant predictor of infants' likelihood of scoring high in Inflexibility Step 1 ( $B=1.21$ ,  $p\text{-value}<.001$ ) and Step 2 ( $B=1.35$ ,  $p\text{-value}<.001$ , Table 5). Ablative testing ( $\chi^2(4.17)$ ,  $p\text{-value}=.04$ ) and AIC comparison suggested that the Step 3 model was the most parsimonious. In this model, greater postnatal pandemic-related concerns were associated with a greater risk of high Inflexibility ( $B=4.07$ ,  $p\text{-value}=.006$ ), as was social support ( $B=2.24$ ,  $p\text{-value}=.03$ ). However, social support did not significantly moderate the association between postnatal pandemic-related concerns and Inflexibility ( $B=-0.68$ ,  $p\text{-value}=.06$ ).

Mothers' postnatal pandemic-related concerns were not a significant predictor of infants' likelihood of scoring high in Difficulties with Routines in Step 1 ( $B=0.40$ ,  $p\text{-value}=.10$ , Table 6). Ablative testing ( $\chi^2(3.91)$ ,  $p\text{-value}=.048$ ) and AIC comparison suggested that the Step 2 model was the most parsimonious. In this model, only social support received by the mother was significantly associated with the infant's risk of high Difficulty with Routines ( $B=0.39$ ,  $p\text{-value}=.048$ , Table 6). Of note, the difficulties with routines model explained the least amount of variance of all models tested.

## DISCUSSION

In this longitudinal cohort study of pregnant women and their infants, we examined associations between maternal pre- and postnatal pandemic-related concerns and risk of developmental problems in three domains of infant social-emotional development: irritability, inflexibility, and difficulty with routines. We detected significant associations between mothers' postnatal pandemic-related concerns and infant social-emotional developmental risk scores, as well as scoring in at-risk categories for infant irritability and inflexibility. We found limited evidence that a mother's social support attenuated the associations between her postnatal concerns and infant development. Social support was marginally related to infants' risk of scoring above the Difficulties with Routines cut-off. It also significantly moderated the associations with the infant's total social-emotional developmental risk scores, such that infants of mothers with greater social support were less likely to score higher on the social-emotional measure. Our sample had a high prevalence of potential developmental delays relative to other samples using the Baby Pediatric Symptom Checklist, particularly those related to Inflexibility (40% scored above the cut-off) and Difficulty with Routines (33% scored above the cut-off). This is slightly higher than the validation study which reported that 10%–30% fell above the cut-off for Inflexibility across infancy (Sheldrick et al., 2013). It is similar to the rates of 10%–30% for Difficulty with Routines (Sheldrick et al., 2013). This is also higher than other studies reported for pre-pandemic samples using

**TABLE 4** Multivariable hierarchical regression of Irritability subscale.

	<i>B</i>	<i>SE</i>	<i>p</i> -value	Pseudo <i>R</i> <sup>2</sup>	AIC
Step 1				0.111	165.640
Prenatal Pandemic Concerns	−0.656	0.359	0.067		
Postnatal Pandemic Concerns	1.233	0.379	0.001		
Infant Sex	0.609	0.442	0.168		
Infant Age	−0.029	0.100	0.773		
Mother Age	0.001	0.060	0.990		
Income	−0.387	0.379	0.308		
Education 1	0.228	0.734	0.756		
Education 2	−0.252	0.753	0.738		
Parity	−0.531	0.461	0.249		
Step 2				0.113	166.780
Prenatal Pandemic Concerns	−0.674	0.361	0.062		
Postnatal Pandemic Concerns	1.144	0.398	0.004		
Social Support	−0.196	0.282	0.487		
Infant Sex	0.615	0.444	0.166		
Infant Age	−0.030	0.101	0.766		
Mother Age	−0.005	0.060	0.938		
Income	−0.410	0.385	0.287		
Education 1	0.262	0.737	0.722		
Education 2	−0.193	0.759	0.799		
Parity	−0.487	0.463	0.293		
Step 3				0.136	165.140
Prenatal Pandemic Concerns	−0.681	0.367	0.063		
Postnatal Pandemic Concerns	3.827	1.532	0.013		
Social Support	1.959	1.188	0.099		
Infant Sex	0.701	0.455	0.123		
Infant Age	−0.028	0.102	0.786		
Mother Age	−0.018	0.062	0.775		
Income	−0.338	0.396	0.393		
Education 1	0.182	0.745	0.807		
Education 2	−0.249	0.768	0.746		
Parity	−0.492	0.476	0.302		
Postnatal Pandemic Concerns × Social Support	−0.720	0.384	0.061		

the Ages & Stages: Social–Emotional screener, a comparable instrument, where 22.4% scored at or above the risk cut-off (Briggs et al., 2012).

These results are largely consistent with other studies that have reported detrimental effects of pre- and postnatal pandemic-related concerns on infants, particularly in the temperament domain of Orienting/Regulation (Bianco et al., 2022; Duguay et al., 2022; Provenzi, Grumi, et al., 2021; Provenzi, Mambretti, et al., 2021), parallel with our findings of postnatal pandemic concerns predicting infants' risk of scoring positive on the Inflexibility and Irritability subscales. The association between postnatal pandemic-related concerns and inflexibility is notable as infants' regulatory

skills may be particularly vulnerable to environmental conditions (Gartstein & Skinner, 2018; Provenzi, Grumi, et al., 2021). Regulatory skills are associated with the development of similar temperament characteristics, such as effortful control, that emerge in toddlerhood (Putnam et al., 2008), as well as behavioral problems in childhood (Toffol et al., 2019).

We found that postnatal pandemic-related concerns were associated with scores on the subscales related to inflexibility and irritability, but not on the difficulty with routines, of the social–emotional developmental measure. While it is unclear why this is the case, it may partially reflect the items that make up this subscale. Three of the four questions on this subscale are

**TABLE 5** Multivariable hierarchical regression of Inflexibility subscale.

	<i>B</i>	<i>SE</i>	<i>p</i> -value	Pseudo <i>R</i> <sup>2</sup>	AIC
Step 1				0.096	288.530
Prenatal Pandemic Concerns	−0.331	0.258	0.199		
Postnatal Pandemic Concerns	1.207	0.275	<0.001		
Infant Sex	0.375	0.296	0.206		
Infant Age	0.069	0.068	0.314		
Mother Age	−0.030	0.041	0.468		
Income	−0.175	0.264	0.508		
Education 1	−0.477	0.518	0.357		
Education 2	−0.303	0.508	0.551		
Parity	0.139	0.302	0.646		
Step 2				0.107	285.310
Prenatal Pandemic Concerns	−0.331	0.263	0.208		
Postnatal Pandemic Concerns	1.352	0.297	<0.001		
Social Support	0.317	0.206	0.123		
Infant Sex	0.418	0.300	0.164		
Infant Age	0.094	0.070	0.179		
Mother Age	−0.020	0.042	0.626		
Income	−0.238	0.268	0.374		
Education 1	−0.492	0.523	0.347		
Education 2	−0.264	0.516	0.609		
Parity	0.134	0.307	0.662		
Step 3				0.121	283.130
Prenatal Pandemic Concerns	−0.347	0.264	0.188		
Postnatal Pandemic Concerns	4.073	1.495	0.006		
Social Support	2.243	1.030	0.029		
Infant Sex	0.459	0.303	0.129		
Infant Age	0.103	0.071	0.145		
Mother Age	−0.031	0.043	0.475		
Income	−0.197	0.271	0.467		
Education 1	−0.553	0.529	0.296		
Education 2	−0.295	0.521	0.572		
Parity	0.170	0.310	0.584		
Postnatal Pandemic Concerns × Social Support	−0.675	0.352	0.055		

related to sleep routines. Previous studies have shown that pandemic lockdowns and work-from-home routines are positively associated with parents', infants', and children's sleep duration (Aishworiya et al., 2021; Cellini et al., 2021; Conroy et al., 2021; Trakada et al., 2020). Furthermore, infants have been reported to sleep more during the pandemic when their mothers get more sleep (Trakada et al., 2020), a relation also observed prior to the pandemic (Tikotzky et al., 2015). It is possible that these sleep-related factors buffer infant scores on the difficulty with routines subscale.

While concerns related to the COVID-19 pandemic may negatively impact infant development, these associations may be attenuated by positive factors such as

social support. The results of our study also suggest that mothers reported social support may buffer the negative effects of pandemic-related concerns on infant developmental risk. Social support moderated the associations between postnatal pandemic-related concerns and infants' total scores on the social-emotional developmental risk scale. Social support was positively associated with higher scores on the social-emotional developmental risk scale in the moderation models. It could be because mothers of infants with social-emotional developmental risk or with greater levels of stress are seeking out social support. Other studies have found that social support may reduce detrimental consequences of the COVID-19 pandemic on infants indirectly by exerting

**TABLE 6** Multivariable hierarchical regression of Difficulty with Routines subscale.

	<i>B</i>	<i>SE</i>	<i>p</i> -value	Pseudo <i>R</i> <sup>2</sup>	AIC
Step 1				0.040	288.430
Prenatal Pandemic Concerns	−0.055	0.253	0.828		
Postnatal Pandemic Concerns	0.403	0.241	0.095		
Infant Sex	−0.050	0.297	0.867		
Infant Age	−0.116	0.067	0.085		
Mother Age	−0.006	0.041	0.877		
Income	−0.532	0.261	0.042		
Education 1	0.100	0.519	0.848		
Education 2	0.133	0.514	0.797		
Parity	0.062	0.304	0.838		
Step 2				0.054	284.860
Prenatal Pandemic Concerns	−0.076	0.258	0.769		
Postnatal Pandemic Concerns	0.236	0.256	0.356		
Social Support	−0.392	0.199	0.048		
Infant Sex	−0.073	0.301	0.808		
Infant Age	−0.120	0.069	0.079		
Mother Age	−0.015	0.041	0.722		
Income	−0.564	0.266	0.034		
Education 1	0.183	0.528	0.729		
Education 2	0.248	0.524	0.636		
Parity	0.139	0.309	0.654		
Step 3				0.056	286.530
Prenatal Pandemic Concerns	−0.078	0.258	0.763		
Postnatal Pandemic Concerns	0.802	1.014	0.429		
Social Support	0.018	0.735	0.981		
Infant Sex	−0.057	0.303	0.851		
Infant Age	−0.120	0.069	0.081		
Mother Age	−0.017	0.042	0.677		
Income	−0.553	0.267	0.038		
Education 1	0.157	0.529	0.767		
Education 2	0.229	0.525	0.663		
Parity	0.153	0.311	0.621		
Postnatal Pandemic Concerns × Social Support	−0.149	0.257	0.563		

beneficial effects on parental mental health (Provenzi, Grumi, et al., 2021). However, several studies have found that social support may be positively associated with stress when perceived support does not map on to received support (Adhikari et al., 2021; Blebu et al., 2022). Social distancing and concern about infection, for example, may limit access to traditional support networks even when individuals perceive high levels of support from their networks. Better parental mental health may also impact infant social–emotional outcomes.

The precise pathways by which pandemic-related concerns influence infant social–emotional development may include both social and biological mechanisms. The

pandemic and related concerns have been associated with social factors such as suboptimal parent–infant bonding (Mayopoulos et al., 2021; Morris & Saxbe, 2021), parenting stress (Babore et al., 2021; Ben-Yaakov & Ben-Ari, 2021), and less sensitive or harsh parenting practices (Chung et al., 2022; Lee et al., 2022; van den Heuvel et al., 2022). These factors have been associated with infant social–emotional development and parenting stress may be a particularly salient pathway through which pandemic stressors influence child regulatory capacities (Spinelli et al., 2021). Biological mechanisms that may be influenced both by pandemic- and parenting stressors may include hormonal and epigenetic pathways.

Pandemic-related concerns have been associated with infant DNA methylation, specifically of the serotonin receptor *SLC6A4* (Provenzi, Mambretti, et al., 2021). It has also been associated with maternal and child hair cortisol (Hastings et al., 2021; Perry et al., 2022). However, it should be noted that there are few studies providing evidence for the impact of the COVID-19 pandemic on such biological processes, and, therefore, such pathways require further investigation.

The results of our study should be considered in light of several limitations. First, the sample size is relatively small and due to convenience sampling is not representative of the broader U.S. birthing population; the sample is majority white, with high-income and education levels. Therefore, it is unclear how our results may generalize to the U.S. birthing population and infants. We also experienced substantial attrition across our survey waves, consistent with other online studies (Yu et al., 2022). However, we detected significant risks for infants in this sample, suggesting an urgent need for studies in populations with less resource access and those facing higher risks for developmental delays. Future studies are needed to evaluate the impact of pandemic-related concerns in other populations. Second, the pre- and postnatal pandemic and social support questionnaires were developed ad hoc for this study. A benefit of this approach is that it allowed us to develop questions more specific to the emergent and ongoing public health crisis than would have been captured by more general existing instruments. The use of these targeted ad hoc measures—in place of multiple, long preexisting instruments—also reduced the burden placed on study participants. However, the measures lack formal validation and are based on self-report. Third, a subset of analyses was cross-sectional and preclude causal inference. Thus, additional studies are needed to determine if these associations are evident across more representative samples and to determine causal relations between pandemic-related concerns, social support, and infant social–emotional development. Fourth, the child social–emotional measure was based on maternal report and our study does not include direct assessment of infants' behavior. While the BPSC is reported to have good construct validity based on correlations with related measures, such as the Ages & Stages Questionnaire (Sheldrick et al., 2013), additional work is needed to see how this measure maps on to infant behavior.

## CONCLUSIONS

The results of this study suggest that infants' social–emotional development is vulnerable to the consequences of the ongoing COVID-19 pandemic via maternal postnatal pandemic-related concerns. These results are particularly striking as this effect can be observed in our relatively low-risk, high-income population. Studies of populations at higher risk are urgently needed. Such

disruptions to infant social–emotional development may confer risk for later suboptimal or adverse development outcomes. This suggests the promotion of the health and well-being of mothers, infants, and families should be a priority for public health during and after the pandemic (Provenzi et al., 2020). Our results also highlight social support for mothers as a protective factor which may offer an opportunity for interventions that buffer infants and mothers from stressors related to the pandemic. Longitudinal observation of the development of children born during the pandemic is needed to assess whether such associations impact later developmental outcomes.

## ACKNOWLEDGMENTS

We would like to thank Nadia Clement for her assistance in building the online survey and designing the recruitment flyers. We would also like to thank Margaret Sherin and Chlöe Sweetman for their valuable feedback on the questionnaire during development.

## FUNDING INFORMATION

Kyle Wiley was supported by an NIH NRSA F32 funded by the National Institute on Minority Health and Health Disparities (5F32MD015201). Molly Fox was supported by NIH K01 DK105110-01 and R03 DK125524-01. Zaneta Thayer was funded by the Wenner Gren Hunt Fellowship (grant #9687) during this project. Participant compensation was provided through the Claire Garber Goodman Fund in the Department of Anthropology at Dartmouth College.

## DATA AVAILABILITY STATEMENT

This analysis was not preregistered. The data and code used to reproduce this analysis are not publicly available but are accessible upon reasonable request to the CARE study team.

## ETHICS STATEMENT

This study received ethical approval from Dartmouth College (STUDY00032045).

## ORCID

Kyle S. Wiley  <https://orcid.org/0000-0003-0233-9561>

## REFERENCES

- Adhikari, R. P., Shrestha, M. L., Satinsky, E. N., & Upadhaya, N. (2021). Trends in and determinants of visiting private health facilities for maternal and child health care in Nepal: Comparison of three Nepal demographic health surveys, 2006, 2011, and 2016. *BMC Pregnancy and Childbirth*, 21(1), 1. <https://doi.org/10.1186/s12884-020-03485-8>
- Aishworiya, R., Lim, M. T. C., Ramamurthy, M. B., Tran, A. P., Rajgor, D. D., & Goh, D. Y. T. (2021). Impact of work routines on parents' and children's sleep during the COVID-19 pandemic lockdown. *Sleep Medicine*, 88, 61–67. <https://doi.org/10.1016/j.sleep.2021.10.005>
- Babore, A., Trumello, C., Lombardi, L., Candelori, C., Chirumbolo, A., Cattelino, E., Baiocco, R., Bramanti, S. M., Viceconti, M. L., Pignataro, S., & Morelli, M. (2021). Mothers' and Children's mental

- health during the COVID-19 pandemic lockdown: The mediating role of parenting stress. *Child Psychiatry & Human Development*, 54, 134–146. <https://doi.org/10.1007/s10578-021-01230-6>
- Ben-Yaakov, O., & Ben-Ari, O. T. (2021). COVID-19-related anxieties and parenting stress among first-time mothers and fathers in their first year of parenthood. *Psychology & Health*, 37, 1327–1341. <https://doi.org/10.1080/08870446.2021.1942875>
- Berthelot, N., Lemieux, R., Garon-Bissonnette, J., Drouin-Maziade, C., Martel, É., & Maziade, M. (2020). Uptrend in distress and psychiatric symptomatology in pregnant women during the coronavirus disease 2019 pandemic. *Acta Obstetrica et Gynecologica Scandinavica*, 99(7), 848–855. <https://doi.org/10.1111/aogs.13925>
- Bianco, C., Sania, A., Kyle, M. H., Beebe, B., Barbosa, J., Bence, M., Coskun, L., Fields, A., Firestein, M. R., Goldman, S., Hane, A., Hott, V., Hussain, M., Hyma, S., Lucchini, M., Marsh, R., Mollicone, I., Myers, M., Ofray, D., ... Amso, D. (2022). Pandemic beyond the virus: Maternal COVID-related postnatal stress is associated with infant temperament. *Pediatric Research*, 93, 253–259. <https://doi.org/10.1038/s41390-022-02071-2>
- Blebu, B. E., Tesfalul, M., Karasek, D., McCulloch, C. E., Fontenot, J., Lessard, L., & Kuppermann, M. (2022). Perceived stress and COVID-19-related stressors: The moderating role of social support during pregnancy. *Women & Health*, 62(8), 720–730. <https://doi.org/10.1080/03630242.2022.2125139>
- Briggs, R. D., Stettler, E. M., Silver, E. J., Schrag, R. D. A., Nayak, M., Chinitz, S., & Racine, A. D. (2012). Social-emotional screening for infants and toddlers in primary care. *Pediatrics*, 129(2), e377–e384. <https://doi.org/10.1542/peds.2010-2211>
- Buekens, P., Alger, J., Bréart, G., Cafferata, M. L., Harville, E., & Tomasso, G. (2020). A call for action for COVID-19 surveillance and research during pregnancy. *The Lancet. Global Health*, 8(7), e877–e878. [https://doi.org/10.1016/S2214-109X\(20\)30206-0](https://doi.org/10.1016/S2214-109X(20)30206-0)
- Cellini, N., Di Giorgio, E., Mioni, G., & Di Riso, D. (2021). Sleep and psychological difficulties in Italian school-age children during COVID-19 lockdown. *Journal of Pediatric Psychology*, 46(2), 153–167. <https://doi.org/10.1093/jpepsy/jsab003>
- Chmielewska, B., Barratt, I., Townsend, R., Kalafat, E., van der Meulen, J., Gurol-Urganci, I., O'Brien, P., Morris, E., Draycott, T., Thangaratinam, S., Le Doare, K., Ladhani, S., von Dadelszen, P., Magee, L., & Khalil, A. (2021). Effects of the COVID-19 pandemic on maternal and perinatal outcomes: A systematic review and meta-analysis. *The Lancet Global Health*, 9(6), e759–e772. [https://doi.org/10.1016/s2214-109x\(21\)00079-6](https://doi.org/10.1016/s2214-109x(21)00079-6)
- Chung, G., Lanier, P., & Wong, P. Y. J. (2022). Mediating effects of parental stress on harsh parenting and parent-child relationship during coronavirus (COVID-19) pandemic in Singapore. *Journal of Family Violence*, 37(5), 801–812. <https://doi.org/10.1007/s10896-020-00200-1>
- Conroy, D. A., Hadler, N. L., Cho, E., Moreira, A., MacKenzie, C., Swanson, L. M., Burgess, H. J., Arnedt, J. T., & Goldstein, C. A. (2021). The effects of COVID-19 stay-at-home order on sleep, health, and working patterns: A survey study of US health care workers. *Journal of Clinical Sleep Medicine*, 17(2), 185–191. <https://doi.org/10.5664/jcsm.8808>
- Davis, E. P., & Narayan, A. J. (2020). Pregnancy as a period of risk, adaptation, and resilience for mothers and infants. *Development and Psychopathology*, 32(5), 1625–1639. <https://doi.org/10.1017/S0954579420001121>
- Duguay, G., Garon-Bissonnette, J., Lemieux, R., Dubois-Comtois, K., Mayrand, K., & Berthelot, N. (2022). Socioemotional development in infants of pregnant women during the COVID-19 pandemic: The role of prenatal and postnatal maternal distress. *Child and Adolescent Psychiatry and Mental Health*, 16(1), 28. <https://doi.org/10.1186/s13034-022-00458-x>
- Feldman, P. J., Dunkel-Schetter, C., Sandman, C. A., & Wadhwa, P. D. (2000). Maternal social support predicts birth weight and fetal growth in human pregnancy. *Psychosomatic Medicine*, 62(5), 715–725.
- Gartstein, M. A., & Skinner, M. K. (2018). Prenatal influences on temperament development: The role of environmental epigenetics. *Development and Psychopathology*, 30(4), 1269–1303. <https://doi.org/10.1017/S0954579417001730>
- Gildner, T. E., Laugier, E. J., & Thayer, Z. M. (2020). Exercise routine change is associated with prenatal depression scores during the COVID-19 pandemic among pregnant women across the United States. *PLoS ONE*, 15(12), e0243188. <https://doi.org/10.1371/journal.pone.0243188>
- Gildner, T. E., & Thayer, Z. M. (2020a). Birth plan alterations among American women in response to COVID-19. *Health Expectations*, 23(4), 969–971. <https://doi.org/10.1111/hex.13077>
- Gildner, T. E., & Thayer, Z. M. (2020b). Maternal and child health during the COVID-19 pandemic: Contributions in the field of human biology. *American Journal of Human Biology*, 32(5), e23494. <https://doi.org/10.1002/ajhb.23494>
- Gildner, T. E., Uwizeye, G., Milner, R. L., Alston, G. C., & Thayer, Z. M. (2021). Associations between postpartum depression and assistance with household tasks and childcare during the COVID-19 pandemic: Evidence from American mothers. *BMC Pregnancy and Childbirth*, 21(1), 828. <https://doi.org/10.1186/s12884-021-04300-8>
- Grumi, S., Provenzi, L., Accorsi, P., Biasucci, G., Cavallini, A., Decembrino, L., Falcone, R., Fazzi, E. M., Gardella, B., Giaccherio, R., Guerini, P., Grossi, E., Magnani, M. L., Mariani, E. M., Nacinovich, R., Pantaleo, D., Pisoni, C., Prefumo, F., Sabatini, C., ... Borgatti, R. (2021). Depression and anxiety in mothers who were pregnant during the COVID-19 outbreak in northern Italy: The role of pandemic-related emotional stress and perceived social support. *Frontiers in Psychiatry*, 12, 716488. <https://doi.org/10.3389/fpsy.2021.716488>
- Hastings, P. D., Partington, L. C., Dajani, R., & von Suchodoletz, A. (2021). Adrenocortical and psychosocial responses of families in Jordan to the COVID-19 pandemic. *Child Development*, 92(5), e798–e816. <https://doi.org/10.1111/cdev.13662>
- Jackman, S., Tahk, A., Zeileis, A., Maimone, C., Fearon, J., Meers, Z., Jackman, M. S., & Imports, M. (2015). Package 'pscl'. *Political Science Computational Laboratory*, 18(04.2017).
- King, L. S., Feddoes, D. E., Kirshenbaum, J. S., Humphreys, K. L., & Gotlib, I. H. (2021). Pregnancy during the pandemic: The impact of COVID-19-related stress on risk for prenatal depression. *Psychological Medicine*, 1–11, 170–180. <https://doi.org/10.1017/S003329172100132X>
- Kolker, S., Biringer, A., Bytautas, J., Blumenfeld, H., Kukan, S., & Carroll, J. C. (2021). Pregnant during the COVID-19 pandemic: An exploration of patients' lived experiences. *BMC Pregnancy and Childbirth*, 21(1), 851. <https://doi.org/10.1186/s12884-021-04337-9>
- Lee, S. J., Ward, K. P., Lee, J. Y., & Rodriguez, C. M. (2022). Parental social isolation and child maltreatment risk during the COVID-19 pandemic. *Journal of Family Violence*, 37(5), 813–824. <https://doi.org/10.1007/s10896-020-00244-3>
- Lista, G., & Bresesti, I. (2020). Fatherhood during the COVID-19 pandemic: An unexpected turnaround. *Early Human Development*, 144, 105048. <https://doi.org/10.1016/j.earlhumdev.2020.105048>
- Long, J. A., & Long, M. J. A. (2017). Package 'jtools'.
- Long, J. A., & Long, M. J. A. (2019). Package 'interactions'. <https://interactions.jacob-long.com>
- Madigan, S., Oatley, H., Racine, N., Fearon, R. M. P., Schumacher, L., Akbari, E., Cooke, J. E., & Tarabulsy, G. M. (2018). A meta-analysis of maternal prenatal depression and anxiety on child socioemotional development. *Journal of the American Academy of Child & Adolescent Psychiatry*, 57(9), 645–657.e648. <https://doi.org/10.1016/j.jaac.2018.06.012>
- Mayopoulos, G. A., Ein-Dor, T., Dishy, G. A., Nandru, R., Chan, S. J., Hanley, L. E., Kaimal, A. J., & Dekel, S. (2021). COVID-19 is associated with traumatic childbirth and subsequent mother-infant

- bonding problems. *Journal of Affective Disorders*, 282, 122–125. <https://doi.org/10.1016/j.jad.2020.12.101>
- Meaney, S., Leitao, S., Olander, E. K., Pope, J., & Matvienko-Sikar, K. (2022). The impact of COVID-19 on pregnant women's experiences and perceptions of antenatal maternity care, social support, and stress-reduction strategies. *Women and Birth*, 35(3), 307–316. <https://doi.org/10.1016/j.wombi.2021.04.013>
- Morris, A. R., Herzig, S. E., Orozco, M., Truong, V., Campuzano, V., Sridhara, S., Sellery, P., & Saxbe, D. E. (2022). Delivering alone in a pandemic: Anticipated changes to partner presence at birth are associated with prenatal distress. *Families, Systems & Health*, 40, 126–131. <https://doi.org/10.1037/fsh0000679>
- Morris, A. R., & Saxbe, D. E. (2021). Mental health and prenatal bonding in pregnant women during the COVID-19 pandemic: Evidence for heightened risk compared with a Prepandemic sample. *Clinical Psychological Science*, 10, 846–855. <https://doi.org/10.1177/21677026211049430>
- Ollivier, R., Aston, D. M., Price, D. S., Sim, D. M., Benoit, D. B., Joy, D. P., Idue, D., & Nassaji, N. A. (2021). Mental Health & Parental Concerns during COVID-19: The experiences of new mothers amidst social isolation. *Midwifery*, 94, 102902. <https://doi.org/10.1016/j.midw.2020.102902>
- Oyetunji, A., & Chandra, P. (2020). Postpartum stress and infant outcome: A review of current literature. *Psychiatry Research*, 284, 112769. <https://doi.org/10.1016/j.psychres.2020.112769>
- Perry, N. B., Donzella, B., Troy, M. F., & Barnes, A. J. (2022). Mother and child hair cortisol during the COVID-19 pandemic: Associations among physiological stress, pandemic-related behaviors, and child emotional-behavioral health. *Psychoneuroendocrinology*, 137, 105656. <https://doi.org/10.1016/j.psyneuen.2021.105656>
- Pope, J., Olander, E. K., Leitao, S., Meaney, S., & Matvienko-Sikar, K. (2022). Prenatal stress, health, and health behaviours during the COVID-19 pandemic: An international survey. *Women and Birth*, 35(3), 272–279. <https://doi.org/10.1016/j.wombi.2021.03.007>
- Provenzi, L., Baroffio, E., Ligabue, S., & Borgatti, R. (2020). The little professor and the virus: Scaffolding children's meaning making during the COVID-19 emergency. *Frontiers in Psychiatry*, 11, 817. <https://doi.org/10.3389/fpsy.2020.00817>
- Provenzi, L., Grumi, S., Altieri, L., Bensi, G., Bertazzoli, E., Biasucci, G., Cavallini, A., Decembrino, L., Falcone, R., Freddi, A., Gardella, B., Giaccherio, R., Giorda, R., Grossi, E., Guerini, P., Magnani, M. L., Martelli, P., Motta, M., Nacinovich, R., ... Borgatti, R. (2021). Prenatal maternal stress during the COVID-19 pandemic and infant regulatory capacity at 3 months: A longitudinal study. *Development and Psychopathology*, 1–9, 35–43. <https://doi.org/10.1017/S0954579421000766>
- Provenzi, L., Mambretti, F., Villa, M., Grumi, S., Citterio, A., Bertazzoli, E., Biasucci, G., Decembrino, L., Falcone, R., Gardella, B., Longo, M. R., Nacinovich, R., Pisoni, C., Prefumo, F., Orcesi, S., Scelsa, B., Giorda, R., & Borgatti, R. (2021). Hidden pandemic: COVID-19-related stress, SLC6A4 methylation, and infants' temperament at 3 months. *Scientific Reports*, 11(1), 15658. <https://doi.org/10.1038/s41598-021-95053-z>
- Putnam, S. P., Rothbart, M. K., & Gartstein, M. A. (2008). Homotypic and heterotypic continuity of fine-grained temperament during infancy, toddlerhood, and early childhood. *Infant and Child Development*, 17(4), 387–405. <https://doi.org/10.1002/icd.582>
- Semaan, A., Audet, C., Huysmans, E., Afolabi, B., Assarag, B., Banke-Thomas, A., Blencowe, H., Caluwaerts, S., Campbell, O. M. R., Cavallaro, F. L., Chavane, L., Day, L. T., Delamou, A., Delvaux, T., Graham, W. J., Gon, G., Kascak, P., Matsui, M., Moxon, S., ... Benova, L. (2020). Voices from the frontline: Findings from a thematic analysis of a rapid online global survey of maternal and newborn health professionals facing the COVID-19 pandemic. *BMJ Global Health*, 5(6), e002967. <https://doi.org/10.1136/bmjgh-2020-002967>
- Sheldrick, R. C., Henson, B. S., Neger, E. N., Merchant, S., Murphy, J. M., & Perrin, E. C. (2013). The baby pediatric symptom checklist: Development and initial validation of a new social/emotional screening instrument for very young children. *Academic Pediatrics*, 13(1), 72–80. <https://doi.org/10.1016/j.acap.2012.08.003>
- Sherin, M., Gildner, T. E., & Thayer, Z. M. (2021). COVID-19-related changes to pregnant People's work-plans increase prenatal depression. *Frontiers in Global Women's Health*, 2, 639429. <https://doi.org/10.3389/fgwh.2021.639429>
- Spinelli, M., Lionetti, F., Setti, A., & Fasolo, M. (2021). Parenting stress during the COVID-19 outbreak: Socioeconomic and environmental risk factors and implications for children emotion regulation. *Family Process*, 60(2), 639–653. <https://doi.org/10.1111/famp.12601>
- Tani, F., & Castagna, V. (2017). Maternal social support, quality of birth experience, and post-partum depression in primiparous women. *The Journal of Maternal-Fetal & Neonatal Medicine*, 30(6), 689–692. <https://doi.org/10.1080/14767058.2016.1182980>
- Thayer, Z. M., & Gildner, T. E. (2021). COVID-19-related financial stress associated with higher likelihood of depression among pregnant women living in the United States. *American Journal of Human Biology*, 33(3), e23508. <https://doi.org/10.1002/ajhb.23508>
- Tikotzky, L., Sadeh, A., Volkovich, E., Manber, R., Meiri, G., & Shahar, G. (2015). Infant sleep development from 3 to 6 months postpartum: Links with maternal sleep and paternal involvement. *Monographs of the Society for Research in Child Development*, 80(1), 107–124. <https://doi.org/10.1111/mono.12147>
- Toffol, E., Rantalainen, V., Lahti-Pulkkinen, M., Girchenko, P., Lahti, J., Tuovinen, S., Lipsanen, J., Villa, P. M., Laivuori, H., Hämäläinen, E., Kajantie, E., Pesonen, A.-K., & Räikkönen, K. (2019). Infant regulatory behavior problems during first month of life and neurobehavioral outcomes in early childhood. *European Child & Adolescent Psychiatry*, 28(6), 847–859. <https://doi.org/10.1007/s00787-018-1243-8>
- Trakada, A., Nikolaidis, P. T., Andrade, M. D. S., Puccinelli, P. J., Economou, N. T., Steiropoulos, P., Knechtel, B., & Trakada, G. (2020). Sleep during “lockdown” in the COVID-19 pandemic. *International Journal of Environmental Research and Public Health*, 17(23), 9094. <https://doi.org/10.3390/ijerph17239094>
- van den Heuvel, M. I., Vacaru, S. V., Boekhorst, M. G. B. M., Cloin, M., van Bakel, H., Riem, M. M. E., de Weerth, C., & Beijers, R. (2022). Parents of young infants report poor mental health and more insensitive parenting during the first Covid-19 lockdown. *BMC Pregnancy and Childbirth*, 22(1), 302. <https://doi.org/10.1186/s12884-022-04618-x>
- Xie, R.-H., Yang, J., Liao, S., Xie, H., Walker, M., & Wen, S. W. (2010). Prenatal family support, postnatal family support and postpartum depression. *Australian and New Zealand Journal of Obstetrics and Gynaecology*, 50(4), 340–345. <https://doi.org/10.1111/j.1479-828X.2010.01185.x>
- Yu, T., Chen, J., Gu, N. Y., Hay, J. W., & Gong, C. L. (2022). Predicting panel attrition in longitudinal HRQoL surveys during the COVID-19 pandemic in the US. *Health and Quality of Life Outcomes*, 20(1), 104. <https://doi.org/10.1186/s12955-022-02015-8>
- Zhou, J., Havens, K. L., Starnes, C. P., Pickering, T. A., Brito, N. H., Hendrix, C. L., Thomason, M. E., Vatalaro, T. C., & Smith, B. A. (2021). Changes in social support of pregnant and postnatal mothers during the COVID-19 pandemic. *Midwifery*, 103, 103162. <https://doi.org/10.1016/j.midw.2021.103162>

**How to cite this article:** Wiley, K. S., Fox, M. M., Gildner, T. E., & Thayer, Z. M. (2023). A longitudinal study of how women's prenatal and postnatal concerns related to the COVID-19 pandemic predicts their infants' social-emotional development. *Child Development*, 00, 1–12. <https://doi.org/10.1111/cdev.13934>