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Research paper

Prenatal stress from the COVID-19 pandemic predicts maternal postpartum anxiety as moderated by psychological factors: The Australian BITTOC Study

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ARTICLE INFO

Keywords:

Prenatal maternal stress
 COVID-19
 Anxiety
 Resilience
 Tolerance of uncertainty
 Cognitive appraisal

ABSTRACT

Background: While there have been reports of increased perinatal anxiety during the COVID-19 pandemic (Stepowicz et al., 2020), there has been a lack of research on the relative importance of objective hardship and subjective distress. In this study, we explored the extent to which resilience, tolerance of uncertainty, and cognitive appraisal of the pandemic's consequences moderate the effect of prenatal objective hardship and subjective distress due to the pandemic on 2-month postpartum anxiety.

Methods: Data were collected as part of the Birth in the Time of COVID (BITTOC) study. We measured objective hardship and subjective distress, mental health, and potential psychological moderators in 419 pregnant women residing in Australia, and at two months postpartum. Hierarchical multiple regressions were used.

Results: Objective hardship and subjective distress independently predicted postpartum anxiety. All three psychological factors moderated the effect of objective hardship on anxiety. For women with low/neutral resilience, or low/moderate tolerance of uncertainty, or a negative cognitive appraisal, greater objective hardship predicted higher postpartum anxiety. Conversely, for women with high resilience, or high tolerance of uncertainty, or neutral/positive cognitive appraisal, there was no association. Only a neutral/positive cognitive appraisal significantly buffered the effect of subjective distress on anxiety.

Limitations: Participants self-selected themselves into the study. The generalizability of our results could be restricted to women of higher socio-economic status.

Conclusions: These findings help us better understand options for intervention and assessment of vulnerable women during times of stress, along with the mechanisms by which COVID-related stress during pregnancy contributes to postpartum anxiety.

1. Introduction

The first reported case of the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) appeared on Dec 31st, 2019 in Wuhan, China (World Health Organization, 2020). The virus quickly spread around the world resulting in a global pandemic from 2020, continuing into 2022. In general, pregnant women are a particularly vulnerable population group at risk of severe disease and poor mental health during

pregnancy and postnatally. However, a subset of women will experience less severe mental health concerns from the pandemic as a function of personal protective factors (Khoury et al., 2021a; Kinser et al., 2021). In this paper, we report on the extent to which three personal characteristics buffer pregnant women from elevated post-partum anxiety in the face of varying levels of hardship associated with the COVID-19 pandemic.

Postpartum anxiety is common, with 15 % of postnatal women

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<https://doi.org/10.1016/j.jad.2022.06.055>

Received 28 January 2022; Received in revised form 1 June 2022; Accepted 20 June 2022

Available online 24 June 2022

0165-0327/© 2022 Published by Elsevier B.V.

reporting significant anxiety symptoms (Dennis et al., 2017). Anxiety in the postpartum period has been associated with excessive worry, panic attacks, trouble breathing, difficulties in parenting and bonding, reduced breastfeeding, and difficult temperament in infants (Field, 2017; Wardrop and Popadiuk, 2013). Risk factors for postpartum anxiety include lower socio-economic status (Leach et al., 2017), primiparity (Martínez-Galiano et al., 2019), past history of mental health issues, and “adverse circumstances around the pregnancy and birth” (Leach et al., 2017, p. 1). Major stressors in pregnancy, such as the death/illness of a friend or family member, financial problems, or conflicts with loved ones, can increase a woman's risk for postpartum anxiety (Aris-Meijer et al., 2019; Yelland et al., 2010). However, many stressful life events are not randomly distributed in the population (Malhi et al., 2000); for example, twin studies of depression suggest that the propensity to experience adverse life events may be genetically influenced as a function of heritable traits (Kendler, 1998). The possibility of genetic confounds makes it difficult to disentangle the relative effects of objective hardship (i.e., level of exposure to an external stressor) and subjective distress from these events; understanding their respective roles for the development of maternal postnatal anxiety can guide prevention and intervention efforts.

Many natural disasters distribute hardship in the population in a quasi-random manner, independent of an individual's actions or personal characteristics. Moreover, disasters offer the opportunity to study large numbers of women with varying degrees of objective hardship from the disaster; the researcher can measure the individual's subjective distress associated with the event and tease this apart from their objective levels of threat, loss, and change. However, few studies have examined the association between objective hardship and post-partum anxiety. The value of this approach was seen in the QF2011 study which found that both greater objective hardship and subjective distress from the Queensland floods during pregnancy independently predicted greater maternal anxiety at 6-weeks postpartum (Kildea et al., 2018).

The COVID-19 pandemic is a major global disaster on a different scale than a local disaster, and which has led to higher levels of subjective distress and anxiety in pregnant women compared to similar samples before the pandemic (Chmielewska et al., 2021; Hessami et al., 2020; Tomfohr-Madsen et al., 2021). This includes an increase in feelings of social isolation, concerns regarding changes to prenatal care, and worries about threat to themselves or their unborn child (Lebel et al., 2020). Lebel et al. (2020) found that 57 % of perinatal women during the pandemic reported clinically significant anxiety. Furthermore, experiencing greater objective hardship during the pandemic, such as having family members infected with COVID-19 (Zeng et al., 2020), being at risk of infection (Khoury et al., 2021a), pandemic-related financial strain (Cameron et al., 2020), and changes to prenatal care (Zeng et al., 2020), have all been associated with greater perinatal anxiety.

Protective psychological factors, such as a woman's resilience, tolerance of uncertainty, and positive cognitive appraisal of an event, may buffer pregnant women from disaster-related distress. Resilience is a well-recognized and multi-faceted personality factor that encapsulates the concept of positive, healthy, and adaptive functioning over time after the experience of an adverse event (Southwick et al., 2014). This paper focuses on one particular aspect of this construct: a person's ability to bounce back after a stressor (Smith et al., 2008). Higher levels of resilience have been associated with lower levels of anxiety during the pandemic in the general population (Barzilay et al., 2020; Havnen et al., 2020; Hou et al., 2021), and in pregnant women (Kinser et al., 2021). Another psychological factor, tolerance of uncertainty, can be defined as an individual's ability to endure situations that appear to lack adequate information without experiencing undue distress (Carleton, 2016). Lower tolerance of uncertainty during pregnancy predicts worsening postpartum anxiety (Furtado et al., 2019). During the COVID-19 pandemic, greater tolerance of uncertainty has been associated with lower levels of anxiety in the general population (Korkmaz and Güloğlu,

2021; Rettie and Daniels, 2021), although one study found no association (Sauer et al., 2020). Finally, a positive cognitive appraisal of a life event, or using a positive reframing of a potentially stressful event, has been found to buffer the association between subjective distress and postpartum anxiety in a sample of disaster-exposed pregnant women (Paquin et al., 2021b) and among quarantined adults during the COVID-19 pandemic (Xu et al., 2020). Similarly, a negative cognitive appraisal of the pandemic has been related to higher scores on a composite of depression and anxiety symptoms in pregnant women (Khoury et al., 2021a).

1.1. The present study

There are no reports to date that demonstrate whether individual variability in psychological factors moderate associations between prenatal maternal stress (PNMS; i.e., objective hardship or subjective distress) from the COVID-19 pandemic and postpartum anxiety. The Birth in the Time of COVID (BITTOC) study is a longitudinal cohort study of child-bearing women from across Australia recruited during the pandemic. The study assessed their experiences, their mental health, and psychosocial factors during pregnancy and again in the post-partum. Australia managed the pandemic through stringent public health directives and closed borders. Although these strategies kept COVID deaths relatively low (2253 deaths by January 1st 2022) (Australian Government Department of Health, 2022), there were increased levels of personal restrictions, enforced isolation, changes to maternity services and everyday activities (Beck and Hensher, 2020).

Thus, the goal of the present study is to determine the extent to which psychological factors, including resilience, tolerance of uncertainty, and a positive cognitive appraisal, moderate the association between objective hardship or subjective distress from the COVID-19 pandemic during pregnancy and anxiety at two-months postpartum. We hypothesized that a positive association between objective hardship or subjective distress during pregnancy and 2-month postpartum anxiety would be stronger (1) the lower the woman's resilience score, (2) the lower the woman's tolerance of uncertainty, and (3) for women with a negative cognitive appraisal of the COVID-19 pandemic, all while controlling for socioeconomic status, parity, history of poor mental health, and gestation timing at first survey completion.

2. Methods

2.1. Participants and procedure

Pregnant women were recruited from August 2nd to November 29th, 2020 through social media, mother and baby websites, consumer organisations, and the snowball method, where recruited women referred new participants to the study. To be eligible, participants must have either been pregnant or given birth during the pandemic, living in Australia, over 18 years of age, able to answer questions in English, and had access to the internet. We administered questionnaires through Qualtrics at recruitment and again at two-months postpartum. The follow-up questionnaire contained all the questions from the recruitment questionnaire, with additional questions relating to childbirth and to the participants' infants. After the exclusion of incomplete (<50 % items completed) and invalid surveys, 1343 pregnant women responded at recruitment and 439 of these women completed the 2-month follow-up questionnaire; of these, 419 participants reported on their postpartum mental health. This project received ethical approval by the Human Research Ethics Committee (HREC) of the University of Western Sydney in Australia (#H13825). All women who participated in the study provided informed consent. They were also entered into a raffle with the chance to win a \$30 gift voucher.

2.2. Measures

2.2.1. Maternal postpartum anxiety

The Anxiety scale of the Depression, Anxiety and Stress Scales (DASS-21; Lovibond and Lovibond, 1995) was used to measure the participants' level of anxiety at two-months postpartum. The Anxiety scale asks seven questions to assess the participant's level of physiological arousal, feelings of fear or panic, and situational anxiety over the past week. Each item is scored from 0 (*did not apply to me at all*) to 3 (*applied to me very much, or most of the time*). To create a total score, the participant's responses are summed and then multiplied by 2. Scores of 8–9, 10–14, 15–19, and 20 or greater represent either mild, moderate, severe or extremely severe anxiety, respectively (Lovibond and Lovibond, 1995). The DASS-21–Anxiety Scale has good internal consistency (Cronbach alpha = 0.87) and high concurrent validity with the Beck Anxiety Inventory ($r = 0.85$) (Antony et al., 1998).

2.2.2. Objective Hardship

We developed the BITTOC Assessment of Stress due to COVID-19 (BASC) Scale to assess the participants' level of objective hardship due to the pandemic. At two-months postpartum, the scale asked women to report their hardship throughout their entire pregnancy. We patterned this new scale after questionnaires our group (www.mcgill.ca/spiral) has developed in the past to capture objective events occurring during environmental crises such as the 1998 Quebec ice storm (Laplante et al., 2007), the 2008 Iowa floods (Yong Ping et al., 2015), the 2011 flooding in Queensland (King et al., 2015), the 2016 Fort McMurray, Alberta wildfires (Olson et al., 2019), and the 2017 floods in Houston, Texas following Hurricane Harvey (Paquin et al., 2021a). Each scale must be tailor made to reflect the typical experiences of those exposed to the particular event. Items are designed to tap into at least three categories of hardship from disasters (threat, loss, and change; (Bromet and Dew, 1995)), and are pre-tested to improve face validity, as needed. A team of researchers then works together to weight the responses to individual items to reflect the relative hardship imposed by each, and to make each category worth the same potential maximum number of points. The objective hardship scales from these previous disaster studies have predictive validity for maternal outcomes such as post-partum depression (Brock et al., 2014; Kildea et al., 2018; Paquin et al., 2021a) and anxiety (Kildea et al., 2018; Paquin et al., 2021a). For the pandemic in Australia, the measure has three subscales: Threat50 (e.g., the extent to which a participant or their friends and family members suffered from COVID-19 symptoms), Loss50 (e.g., financial loss), and Change50 (e.g., change in daily routines, employment, and pregnancy plans). The total Objective Hardship score (the BITTOC Assessment of Stress from COVID; BASC150) is calculated by summing all three subscales (see items and scoring in supplemental material). A participant can obtain a score from –6 to 150, where a higher score indicates a greater level of objective hardship; a negative score indicates that the participant's situation improved during the pandemic.

2.2.3. Subjective Distress

We developed the SubjectiveDistress200 scale to measure a woman's overall experience of subjective distress due to the pandemic at recruitment during pregnancy. Two subscales addressed Non-Pregnancy Subjective Distress and Pregnancy-related Subjective Distress, each with a maximum total score of 100 (see items and scoring in supplemental material). The Non-Pregnancy subscale measures the participant's level of distress due to such things as COVID-19-related symptoms or potential for infection, and disruption of routine. The Pregnancy subscale measures distress related to prenatal care, the birth, postnatal care, and the baby's well-being. The research team discussed the relative importance of each distress item and allotted point values for each item, and for options within each item, until consensus was reached about the relative weightings. The total score is calculated by summing the two subscales, and can range from –15 to 200, with a higher score indicating

a greater level of subjective distress and a negative score signifying an improved sense of belonging, sleep and/or energy levels. This total score has good internal consistency (Cronbach alpha = 0.89).

2.2.4. Resilience

We measured the participant's level of resilience at recruitment through a single item adapted from the 6-item Brief Resilience Scale (BRS; Smith et al., 2008): “When things go wrong in my life it generally takes me a long time to get back to normal”. Response options range from 1 (*strongly agree*) to 5 (*strongly disagree*). The higher the participant's score, the higher their level of resilience. The internal consistency of the full BRS is excellent (alpha = 0.90), and correlates well ($r = 0.59$) with the gold-standard CD-RISC scale of resilience (Connor and Davidson, 2003).

2.2.5. Tolerance of Uncertainty

We assessed Tolerance of Uncertainty at recruitment using one item: “Uncertainty makes me uneasy, anxious, stressed, vulnerable, unhappy, or sad”. Response options included scores between 0 (*not at all characteristic of me*) and 2 (*entirely characteristic of me*). Thus, the higher the score, the lower the person's tolerance of uncertainty. This item was created by combining two items from the 27-item Intolerance of Uncertainty Scale (IUS; Freeston et al., 1994): “Uncertainty makes me uneasy, anxious, stressed” and “Uncertainty makes me vulnerable, unhappy, or sad”. In the English-language validation of the IUS, these two items had the highest correlation with the total score ($r = 0.71$ and $r = 0.77$, respectively). The IUS has excellent internal consistency, 5-week test-retest reliability, and convergent and divergent validity (Buhr and Dugas, 2002; Dugas et al., 1997; Freeston et al., 1994).

2.2.6. Cognitive Appraisal

At recruitment, we assessed the women's cognitive appraisal of the pandemic: “Overall, what would you say have been the consequences of COVID-19 on you and your household?” Response options ranged from a score of 1 (*extremely positive*) to a score of 7 (*extremely negative*). The higher the score, the less positive their cognitive appraisal. Our group has used this same item in every prenatal disaster study to date. The variable tends to have low correlations with objective hardship and subjective distress, but independently predicts maternal postpartum depression (Kildea et al., 2018) and offspring outcomes such as obesity (Dancause et al., 2012), immune function (Veru et al., 2015), insulin secretion (Dancause et al., 2013), and DNA methylation (Cao-Lei et al., 2014).

2.2.7. Covariates

The recruitment questionnaire asked about maternal age, highest level of education, yearly household/family income, ethnic background, number of children (parity), and relationship status. Income was recoded into two categories: ‘below \$100,000 AUD’ or ‘greater than or equal to \$100,000 AUD’. Parity was also recoded into multiparity and primiparity. Education was recoded into four categories: Secondary (High School Certificate or <12 years of education), Vocational (TAFE or Diploma), Undergraduate university education, and Postgraduate (e.g., graduate diploma, masters or doctorate). Highest level of education, yearly household/family income, parity, number of weeks pregnant at recruitment, and past mental health treatment were all included as covariates in the analyses as described below.

2.3. Statistical analyses

Statistical analyses were conducted using IBM SPSS Statistics v26. We ran descriptive analyses and correlations on our dependent variable (DASS-21– Anxiety at two-months postpartum), our independent variables (Subjective Distress and Objective Hardship), our potential moderators (resilience, tolerance of uncertainty, and cognitive appraisal), and our covariates (see Tables 1–2).

Table 1
Sample characteristics.

Variable	n	M (SD)	Potential range
Objective Hardship	419	25.51 (15.63)	[-6 to 150]
Subjective Distress	419	70.25 (29.94)	[-15 to 200]
Resilience	419	3.55 (1.04)	[1 to 5]
Tolerance of Uncertainty	419	1.12 (0.61)	[0 to 2]
Cognitive Appraisal	419	4.69 (1.45)	[1 to 7]
DASS-21 Anxiety (2-month)	419	2.91 (4.95)	[0 to 42]

	n	Valid %
Resilience		
(1) Strongly Agree (Low resilience)	9	2.1
(2) Somewhat Agree	75	17.9
(3) Neither Agree nor Disagree (neutral)	86	20.5
(4) Somewhat Disagree	176	42.0
(5) Strongly Disagree (High resilience)	73	17.4
Tolerance of Uncertainty		
(0) High Tolerance	54	12.9
(1) Moderate Tolerance	260	62.1
(2) Low Tolerance	105	25.1
Cognitive Appraisal		
(1) Extremely Positive	6	1.4
(2) Moderately Positive	47	11.2
(3) Slightly Positive	33	7.9
(4) Neither Positive nor Negative	64	15.3
(5) Slightly Negative	127	30.3
(6) Moderately Negative	121	28.9
(7) Extremely Negative	21	5.0
DASS-21 Anxiety (2-month)		
Normal (0–7)	362	86.4
Mild (8–9)	13	3.1
Moderate (10–14)	29	6.9
Severe (15–19)	8	1.9
Extremely Severe (20+)	7	1.7
Maternal Age		
21–24	12	2.9
25–29	90	21.5
30–34	185	44.2
35–39	117	27.9
40 or over	15	3.6
Gestational Age (at recruitment)		
0–20 weeks	80	19.1
21–30 weeks	163	38.9
31–41 weeks	176	42.0
Parity		
0	123	29.4
1	197	47.0
2	67	16.0
3+	32	7.6
Marital Status		
Single	3	0.7
Married	310	74.0
De-facto/Long Term Relationship	105	25.1
Separated, divorced, widowed	0	0
Other	1	0.2
Education		
Secondary (High school Certificate or lower)	30	7.2
Vocational (TAFE or Diploma)	83	19.8
Undergraduate or University	160	38.2
Postgraduate	146	34.8
Income		
<\$100,000 AU	100	24.9
≥\$100,000 AU	301	75.1
Data not reported	18	4.3
Ethnicity		
Australian	84	77.8
Non-Australian	24	22.2
Data not reported	311	74.2
Past Mental Health Treatment?		
No	218	52.0
Yes	201	48.0

Hierarchical multiple regressions were conducted to determine the magnitude of any association between subjective distress or objective hardship during pregnancy and anxiety at two-months postpartum, and the extent to which resilience, tolerance of uncertainty, or cognitive appraisal could moderate the association. Each moderation was studied using a separate model, leading to six interactions: Objective Hardship X psychological factor, and Subjective Distress X psychological factor.

For models studying the interaction between objective hardship and a psychological factor, the hierarchical multiple regressions were conducted with variables added as follows: in step 1, Objective Hardship was added; in step 2, the moderator was added; in step 3, the interaction between Objective Hardship and the moderator was added; and in step 4, the covariates were added. For models studying the interaction between subjective distress and a psychological factor, Objective Hardship was added in step 1 and Subjective Distress was added in step 2; the sequence continued as for the objective hardship models. Statistically significant interactions were probed using the PROCESS Macro (Hayes, 2017) in SPSS. This extension was used to run observed-variable moderation process analysis to study the predictor's coefficient at various levels of the moderator while controlling for co-variables (Hayes, 2017). Each significant model was assessed separately and ran twice. Firstly, postpartum anxiety was set as the outcome variable Y, objective hardship or subjective distress (depending on the model) was set as the predictor variable X, and each moderator was set as variable W. Secondly, for each model the variables X and W were then switched to study the Johnson-Neyman region of significance.

3. Results

3.1. Sample description

Recruitment questionnaires were completed, on average, at 28 weeks of pregnancy (SD = 6.51). All sample characteristics are reported in Table 1. A majority of the women in the sample were 30–34 years old, had a university education, an annual household/family income above \$100,000 AUD per year, and at least one child. In addition, most of these women were in a long-term relationship or married. On average, the sample reported a degree of anxiety considered “normal” on the DASS-21 during the postpartum period, although 13.6 % scored above the clinical cut-off for mild anxiety of 7.

3.2. Correlations

Correlations are shown in Table 2. Total Objective Hardship and Subjective Distress due to the pandemic were positively correlated with 2-month postpartum anxiety, and moderately correlated with each other. Both resilience and tolerance of uncertainty were correlated with postpartum anxiety, while cognitive appraisal was not: the more resilient and the greater the tolerance of uncertainty, the less severe the postpartum anxiety symptoms. Among our control variables, only education, income, and past history of mental health treatment were significantly associated with anxiety symptoms at two-months postpartum.

3.3. Regression models

3.3.1. Objective Hardship and Resilience

Our first model studied resilience as a potential moderator of objective hardship. As reported in Table 3, step 1 showed a significant main effect of Objective Hardship on postpartum anxiety, explaining 4.3 % of the variance; in step 2 resilience explained 9.9 % of additional, unique variance. Results from step 3 showed that the interaction between Objective Hardship and resilience had a significant effect on anxiety explaining an additional 2.0 % of variance. As illustrated in Fig. 1a, for mothers with low or neutral resilience (score below 3.7), the effect of Objective Hardship on 2-month postpartum anxiety was

Table 2
Correlations between 2-month postpartum anxiety, prenatal stress, psychological factors, and potential covariates.

	1	2	3	4	5	6	7	8	9	10	11
1 Anxiety at 2 months	–										
2 Objective Hardship	0.21**	–									
3 Subjective Distress	0.22**	0.48**	–								
4 Resilience	–0.34**	–0.15**	–0.35**	–							
5 Tolerance of Uncertainty	0.29**	0.06	0.32**	–0.42**	–						
6 Cognitive Appraisal	0.08	0.25**	0.44**	–0.20**	0.18**	–					
7 Education	–0.23**	–0.08	–0.05	0.10*	–0.07	0.01	–				
8 Income	–0.15**	–0.24**	–0.11*	0.12*	–0.04	–0.04	0.27**	–			
9 Parity	0.08	–0.01	–0.01	–0.04	0.10*	0.05	0.05	–0.00	–		
10 Gestation	–0.05	–0.02	–0.04	0.11*	–0.03	0.06	0.05	0.15**	0.18**	–	
11 Past Mental Health Treatment	0.14**	0.07	0.10*	–0.18**	0.30**	–0.02	0.01	–0.04	0.03	–0.02	–

Note: Correlation was computed pairwise ($n = 401$ to 419). Statistical significance: * $p < 0.05$, ** $p < 0.01$. Anxiety at 2 months: 2-months postpartum anxiety as measured by the Depression, Anxiety and Stress Scales (DASS-21). Gestation: Number of weeks pregnant at recruitment.

Table 3
Hierarchical multiple regression of objective hardship predicting two-month post-partum anxiety with resilience as moderator.

Predictor variables	B	SE	β	Coefficient p-value	R ²	ΔR^2	F	ΔF	ΔF p-value
Step 1					0.043	0.043	17.992**	17.992	< 0.001
(Constant)	1.266	0.468		0.007					
Objective Hardship	0.066	0.016	0.208	< 0.001					
Step 2					0.142	0.099	32.892**	45.772	< 0.001
(Constant)	7.083	0.968		< 0.001					
Objective Hardship	0.051	0.015	0.160	0.001					
Resilience	–1.527	0.226	–0.318	< 0.001					
Step 3					0.162	0.020	25.616**	9.639	0.002
(Constant)	3.248	1.563		0.038					
Objective Hardship	0.196	0.049		< 0.001					
Resilience	–0.424	0.420		0.313					
Objective Hardship X Resilience	–0.043	0.014		0.002					
Step 4					0.213	0.051	13.285**	5.093	< 0.001
(Constant)	5.434	1.856		0.004					
Objective Hardship	0.189	0.048		< 0.001					
Resilience	–0.246	0.419		0.556					
Objective Hardship X Resilience	–0.043	0.014		0.002					
Education	–1.025	0.260		< 0.001					
Income	–0.291	0.560		0.603					
Parity	0.969	0.507		0.057					
Weeks pregnant at recruitment	–0.004	0.036		0.903					
Past Mental Health Treatment	0.932	0.461		0.044					

Note: Statistical significance: ** $p < 0.01$.

significant, where an increase in objective hardship was associated with an increase in postpartum anxiety (e.g., moderately low resilience: $B = 0.10$; $SE = 0.02$; $p < 0.001$). However, for participants with high resilience scores (scores of 4 or 5), objective hardship was not significantly associated with postpartum anxiety. Additionally, a region of significance was found at an Objective Hardship value above 9.00 (~1 SD below the mean) in which the lower the resilience the greater the anxiety; only 13.47 % ($n = 55$) of participants scored below this level of Objective Hardship and for this group resilience was not associated with anxiety.

In step 4, with the addition of the covariates, the interaction remained significant. In this, and all other models, education was a significant predictor with higher educational attainment being associated with lower postpartum anxiety, all else being equal. History of mental health treatment significantly predicted greater anxiety. There was a non-significant ($p = 0.057$) trend for greater parity to be associated with more severe anxiety. The full model explained 21.3 % of the variance in anxiety symptoms at two-months postpartum.

3.3.2. Objective Hardship and Tolerance of Uncertainty

We tested the extent to which tolerance of uncertainty moderated the association between objective hardship and postpartum anxiety. As shown in Table 4, step 2 showed a significant main effect of Tolerance of Uncertainty on postpartum anxiety, explaining an additional 7.7 % of variance, indicating that less tolerance was associated with greater

anxiety when controlling for objective hardship. In step 3, the interaction between Objective Hardship and Tolerance of Uncertainty was significant and explained an additional 1.2 % of variance. The interaction remained significant with the addition of the covariates. As illustrated in Fig. 1b, for participants with either low Tolerance (score of 2; top 84th percentile; $B = 0.09$; $SE = 0.02$; $p < 0.001$) or moderate Tolerance of Uncertainty (score of 1; bottom 16th percentile; $B = 0.04$; $SE = 0.02$; $p = 0.008$) as Objective Hardship increased, so did postpartum anxiety. However, for those with high Tolerance of Uncertainty (score of 0; $B = -0.01$; $SE = 0.03$; $p = 0.810$) the association between objective hardship and anxiety was not significant. There also was a region of significance above an Objective Hardship value of 6.88 in which the lower the tolerance of uncertainty the greater the postpartum anxiety; only 7.23 % ($n = 30$) of the sample scored below this value. The final model explained 18.0 % of variance in postpartum anxiety.

3.3.3. Objective Hardship and Cognitive Appraisal

Table 5a presents the results of the interaction between objective hardship and cognitive appraisal. In step 2, the main effect of Cognitive Appraisal was not significant. As seen in step 3, the interaction was significant, and explained an additional 1.9 % of the variance. In step 4, the interaction remained significant following the addition of covariates; lower education, a history of prior mental health treatment, and multiparity were significantly associated with greater anxiety. As shown in Fig. 1c, for participants scoring above 4.33 on Cognitive Appraisal,

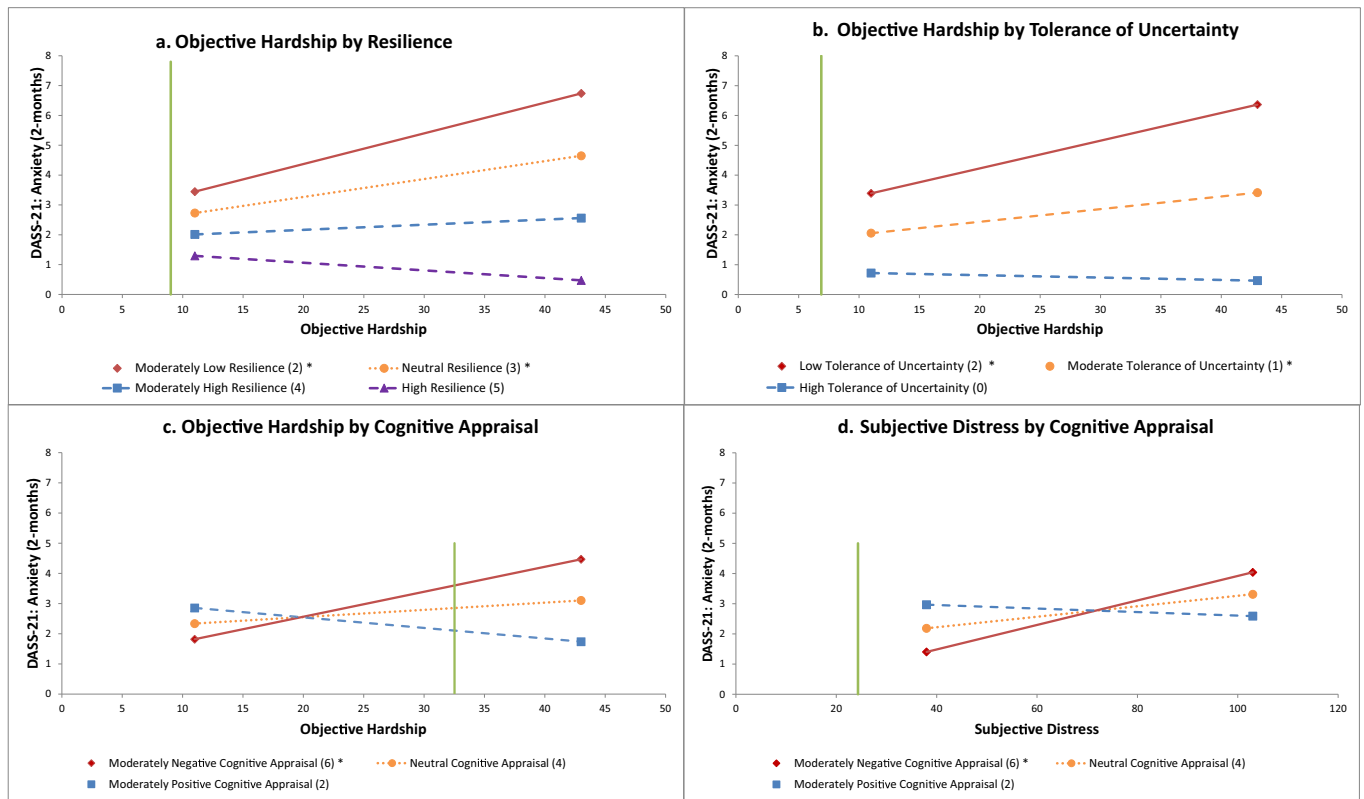


Fig. 1. Two-month postpartum anxiety as a function of Objective Hardship or Subjective Distress at different levels of resilience, tolerance of uncertainty, and cognitive appraisal.

Note: Each star (*) indicates that the association between objective hardship or subjective distress and postpartum anxiety is significant ($p < 0.05$) at that level of the moderator. The vertical green lines represent the Johnson-Neyman region of significance: the region where the moderator has a significant association with postpartum anxiety on the objective hardship/subjective distress scale. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

Table 4

Hierarchical multiple regression of objective hardship predicting two-month post-partum anxiety with tolerance of uncertainty as moderator.

Predictor variables	B	SE	β	Coefficient p-value	R ²	ΔR^2	F	ΔF	ΔF p-value
Step 1					0.043	0.043	17.99**	17.99	< 0.001
(Constant)	1.266	0.47		0.007					
Objective Hardship	0.066	0.02	0.208	< 0.001					
Step 2					0.120	0.077	27.17**	34.81	< 0.001
(Constant)	-1.190	0.61		0.053					
Objective Hardship	0.062	0.02	0.192	< 0.001					
Tolerance of Uncertainty	2.290	0.39	0.278	< 0.001					
Step 3					0.132	0.012	20.08**	5.31	0.022
(Constant)	0.411	0.92		0.657					
Objective Hardship	-0.007	0.03		0.824					
Tolerance of Uncertainty	0.935	0.70		0.184					
Objective Hardship X Tolerance of Uncertainty	0.058	0.03		0.022					
Step 4					0.180	0.048	10.73**	4.58	< 0.001
(Constant)	4.067	1.27		0.001					
Objective Hardship	-0.008	0.03		0.810					
Tolerance of Uncertainty	0.780	0.71		0.269					
Objective Hardship X Tolerance of Uncertainty	0.050	0.03		0.041					
Education	-1.067	0.27		< 0.001					
Income	-0.412	0.57		0.470					
Parity	0.741	0.52		0.155					
Weeks pregnant at recruitment	-0.023	0.04		0.528					
Past Mental Health Treatment	0.609	0.48		0.207					

Note: Statistical significance: ** $p < 0.01$.

higher Objective Hardship was significantly associated with greater two-month postpartum anxiety (e.g., for a score of 6, $B = 0.08$; $SE = 0.02$; $p < 0.001$). However, for participants with a neutral or positive cognitive appraisal, (e.g., for a score of 2, $B = -0.03$; $SE = 0.03$; $p = 0.304$), there

was no association between objective hardship and postpartum anxiety. Additionally, the effect of Cognitive Appraisal on two-month postpartum anxiety was significant for participants with Objective Hardship above 32.52 ($\sim 1/2$ SD below the mean): the more negative the appraisal

Table 5

Hierarchical multiple regression of prenatal maternal stress (5a. Objective Hardship; 5b. Subjective Distress) predicting two-month post-partum anxiety with cognitive appraisal as moderator.

5a. Objective Hardship by Cognitive Appraisal									
Predictor variables	B	SE	β	Coefficient p-value	R ²	ΔR ²	F	ΔF	ΔF p-value
Step 1									
(Constant)	1.266	0.468		0.007	0.043	0.043	17.992**	17.992	< 0.001
Objective Hardship	0.066	0.016	0.208	< 0.001					
Step 2									
(Constant)	0.921	0.865		0.287	0.044	0.001	9.091**	0.224	0.636
Objective Hardship	0.065	0.016	0.202	< 0.001					
Cognitive Appraisal	0.083	0.176	0.024	0.636					
Step 3									
(Constant)	4.28	1.465		0.004	0.063	0.019	8.832**	7.995	0.005
Objective Hardship	-0.082	0.054		0.131					
Cognitive Appraisal	-0.628	0.306		0.041					
Objective Hardship X Cognitive Appraisal	0.03	0.011		0.005					
Step 4									
(Constant)	7.785	1.694		< 0.001	0.139	0.076	7.904**	6.95	< 0.001
Objective Hardship	-0.094	0.053		0.077					
Cognitive Appraisal	-0.583	0.297		0.05					
Objective Hardship X Cognitive Appraisal	0.029	0.01		0.004					
Education	-1.168	0.271		< 0.001					
Income	-0.53	0.586		0.366					
Parity	1.111	0.529		0.036					
Weeks pregnant at recruitment	-0.035	0.037		0.348					
Past Mental Health Treatment	1.209	0.473		0.011					
5b. Subjective Distress by Cognitive Appraisal									
Predictor variables	B	SE	β	Coefficient p-value	R ²	ΔR ²	F	ΔF	ΔF p-value
Step 1									
(Constant)	1.266	0.468		0.007	0.043	0.043	17.992**	17.992	< 0.001
Objective Hardship	0.066	0.016	0.208	< 0.001					
Step 2									
(Constant)	-0.023	0.636		0.971	0.064	0.021	13.556**	8.77	0.003
Objective Hardship	0.041	0.018	0.129	0.020					
Subjective Distress	0.027	0.009	0.164	0.003					
Step 3									
(Constant)	0.403	0.873		0.645	0.065	0.001	9.196**	0.509	0.476
Objective Hardship	0.042	0.018	0.130	0.019					
Subjective Distress	0.03	0.01	0.180	0.003					
Cognitive Appraisal	-0.135	0.189	-0.039	0.476					
Step 4									
(Constant)	3.947	1.819		0.031	0.076	0.011	8.195**	4.921	0.027
Objective Hardship	0.04	0.018		0.024					
Subjective Distress	-0.027	0.028		0.332					
Cognitive Appraisal	-0.907	0.396		0.022					
Subjective Distress X Cognitive Appraisal	0.012	0.005		0.027					
Step 5									
(Constant)	7.444	1.983		< 0.001	0.148	0.071	7.543**	6.561	< 0.001
Objective Hardship	0.03	0.017		0.089					
Subjective Distress	-0.029	0.027		0.278					
Cognitive Appraisal	-0.832	0.384		0.031					
Subjective Distress X Cognitive Appraisal	0.012	0.005		0.025					
Education	-1.16	0.27		< 0.001					
Income	-0.501	0.583		0.391					
Parity	1.111	0.527		0.036					
Weeks pregnant at recruitment	-0.031	0.037		0.415					
Past Mental Health Treatment	1.081	0.474		0.023					

Note: Statistical significance: **p < 0.01.

the higher the postpartum anxiety. The final model explained 13.9 % of variance in postpartum anxiety.

3.3.4. Subjective distress and cognitive appraisal

Only cognitive appraisal significantly moderated the association between subjective distress during pregnancy and postpartum anxiety, as shown in Table 5b. Step 2 showed a significant main effect of Subjective Distress on postpartum anxiety when controlling for Objective Hardship, explaining an additional 2.1 % of variance. The addition of Cognitive Appraisal in step 3 was not significant; however, step 4 showed a significant interaction between Subjective Distress and

Cognitive Appraisal, explaining an additional 1.1 % of the variance. The interaction remained significant after the addition of the covariates. As illustrated in Fig. 1d, higher Subjective Distress was associated with higher postpartum anxiety when Cognitive Appraisal was negative (score above 4.23, e.g., moderately negative appraisal; B = 0.04; SE = 0.01; p < 0.001). However, for participants with a neutral (score of 4; B = 0.02; SE = 0.01; p = 0.103) or positive appraisal, there was no effect. There was also a region of significance below a Subjective Distress value of 24.33, such that among women with very low levels of distress the more positive the appraisal the higher the postpartum anxiety; only 4.99 % (n = 21) of the sample scored below this value. The full model

explained 7.1 % of variance in postpartum anxiety.

Neither resilience nor tolerance of uncertainty had significant interactions with subjective distress; these results can be found in Supplemental Tables 1–2.

4. Discussion

As part of our ongoing, prospective, longitudinal study examining the effects of COVID-19 on pregnant women and their unborn children in Australia, women in BITTOC reported on their prenatal maternal stress, mental health, and psychological factors during pregnancy and at two-months postpartum. Recent studies report great variability in the extent to which pregnant women experience distress from the pandemic (Ostacoli et al., 2020; Perzow et al., 2021). Here, we aimed to determine whether individual psychological factors might explain these differences in their response to prenatal maternal stress as suggested in the recent literature.

Our results showed that the greater women's objective hardship (e.g., threat of infection, loss of income, change to routine or prenatal care) and subjective distress from the pandemic in pregnancy, the greater their anxiety at two-months postpartum. We also found that the greater the women's self-reported resilience and tolerance of uncertainty, the less severe their postpartum anxiety. All three psychological variables (including a positive cognitive appraisal of the pandemic) buffered the impact of objective hardship during pregnancy on postpartum anxiety, while only a positive cognitive appraisal significantly buffered the effect of subjective distress. These results remained even after adjustment by covariates, of which education was the only consistently significant factor: higher levels of education were protective against anxiety. Previous births (that is, older children likely in the home) and a history of treatment for mental health issues were found to be risk factors in some analyses.

The concept of resilience implies an interplay between life's difficulties and one's ability to withstand them. Our study goes further than previous studies that have found main effects of resilience (Barzilay et al., 2020; Kinser et al., 2021). We demonstrate that resilience, even assessed with a single item, can moderate the association between the severity of the women's objective hardship from the pandemic and their postpartum anxiety: for low or neutral resilience, an increase in objective hardship was associated with an increase in two-month postpartum anxiety, while for high resilience there was no association. Thus, this self-reported resilience item could be useful in identifying the most vulnerable women during the COVID-19 pandemic or following any disaster, and could even be considered in routine psychosocial perinatal screening to determine which women may benefit from interventions.

One of the mechanisms by which resilience may have moderated this association is through individual coping styles whereby women with high resilience tend to focus on the positives or seek social support, as opposed to negative coping styles, such as avoidance which has been associated with postpartum depression (Yu et al., 2020). Resilient individuals have a tendency to use optimism, social support, and humor to deal with stressful events, all characteristics associated with lower levels of stress and better mental health (Bonanno, 2004; Wu et al., 2013). Positive coping styles often associated with higher resilience may have led to lower levels of anxiety, even despite high levels of objective hardship, in our study (Khoury et al., 2021b).

The novelty and fast moving pace of the SARS-Cov-2 virus and the gradual evolution of scientific knowledge and public health directives have challenged individuals who find uncertainty difficult to tolerate during the pandemic in the general population (Bottesì et al., 2021; del Valle et al., 2020) and in pre-pandemic pregnant women (Furtado et al., 2019). Our results confirm that the greater pregnant women's tolerance of uncertainty the lower their postpartum anxiety. We delved into nuances of this association further, and found that for women with low and moderate levels of tolerance of uncertainty, greater objective hardship predicted higher postpartum anxiety, while for those with high

tolerance there was no association.

Tolerance of uncertainty may have buffered the effect of objective hardship on anxiety through worry. Intolerance of uncertainty has been found to create and maintain worry in ambiguous situations (Dugas et al., 2004, 1998; Freeston et al., 1994). Participants with high objective hardship but low tolerance of uncertainty may have worried more about the unpredictable events of the pandemic, thus increasing their anxiety. Furthermore, similar to resilience, tolerance of uncertainty could have affected the women's ability to cope. Rettie and Daniels, 2021 found that people with greater intolerance of uncertainty were more likely to use maladaptive coping strategies, which were related to greater levels of generalized anxiety during the pandemic.

Cognitive appraisal was the only psychological variable studied that buffered the effect of both objective hardship and subjective distress on postpartum anxiety. These results support the idea that the way one thinks about an event could affect the amount of anxiety experienced when subjected to high levels of prenatal stress, which is consistent with the Folkman and Lazarus (1984) transactional model of negative stress. The model suggests that when individuals experience an event, they first engage in a primary appraisal to determine if the event is a threat, and if so, they engage in a secondary appraisal where they compare the threat with their perceived ability to cope. Negative stress is experienced when a person believes they do not have the necessary ability to deal with the threat. Participants in this study with a neutral or more positive cognitive appraisal may have believed more in their ability to cope when faced with the demands of the pandemic and, thus, experienced low levels of postpartum anxiety. More generally, cognitive appraisal of hardships, including studies of multiple pandemics and natural disasters, has been shown to influence stress levels and mental health, including anxiety (Cheng et al., 2004; Kim et al., 2021; Paquin et al., 2021b).

Objective hardship and subjective distress had roughly equivalent main effects on postpartum anxiety as seen in their correlations with the DASS of 0.21 (Objective) and 0.22 (Subjective). However, objective hardship, which was assessed in ways that reflect relatively external, observable events and conditions due to the pandemic, was found to be more amenable to moderation by psychological factors than was the level of internally-generated subjective distress about the pandemic. Among the psychological factors, resilience had the strongest main effect on anxiety followed closely by tolerance of uncertainty. As for their buffering effects, interactions between objective hardship and resilience or cognitive appraisal explained similar amounts of variance while tolerance of uncertainty moderated objective hardship to a slightly lesser degree. We note, however, that the magnitude of the main effects and moderations were relatively small. Furthermore, compared to two recent studies of mental health during the COVID-19 pandemic, our sample had relatively low rates of severe anxiety: only 14 % of women in our sample scored above the "normal" range on the DASS-Anxiety, which is lower than the 41 % of Australians, with similar socio-economic status to our study, and 44 % of Iranian pregnant women who scored above this range (Effati-Daryani et al., 2020; Rossell et al., 2021). Objective hardship and subjective distress, together, explained only 6.4 % of the variation in post-partum anxiety, while the psychological factors explained up to 10 % additional variance, with the interactions explaining only an additional 1–2 % of variance. As such, further research is required to better predict vulnerability to postpartum anxiety among pregnant women during population-level crises.

This study is not without limitations. Firstly, online social media recruitment strategies led to participants self-selecting themselves into the study which could have introduced some biases, although this sample was not biased towards a very anxious group since only 14 % scored above the cut-off for even mild anxiety. Secondly, the majority of the women in our study have a university education, and an annual household income of over \$100,000. While this may be representative of the general Australian population (Australian Bureau of Statistics, 2019), our results might not be generalizable to lower-middle income

Australians, ethnically diverse populations, or to other countries. Additionally, there are certain limitations in relation to our measurements. For example, the psychological variables were measured during, not before, the pandemic. Thus, the strength of the main effects and interactions may not be predictive, per se, but could reflect the women's evaluation of their resilience and tolerance of uncertainty with respect to the ongoing pandemic. Furthermore, our psychological factors were measured by single items, which could have reduced the reliability and the validity of our measurements. Finally, the participation rate at two months postpartum was relatively low (31.1 %), most likely due to the demands of parenting infants that age; among this same cohort, response rates at 6 months have been 74.6 % of the original cohort.

This study had a number of strengths. For one, this study has a large sample size and, thus, sufficient power to detect significant main effects and interactions among variables. In addition, this study is among the only perinatal COVID studies that considers the effects of objective hardship and subjective distress from the pandemic separately. We also recruited participants during a short four-month span, such that the data collected were not influenced by large variations in the duration of the pandemic at the time they completed recruitment surveys. Finally, the longitudinal, prospective nature of the study is a strength as it allowed us to predict two-month postpartum anxiety using subjective distress during pregnancy, rather than using retrospective reports, minimising risk of recall bias.

These results have implications for mental health care in the perinatal period. Our findings suggest that resilience, tolerance of uncertainty, and cognitive appraisal, could be screened in routine assessments to identify at-risk women, along with being the focus of interventions aimed at reducing distress during pregnancy. Psychological intervention, including targeting positive reappraisal and reframing with cognitive behavioral therapy (Bourdon et al., 2019), would not only be beneficial for the mother, but also for her unborn child as high levels of stress in pregnancy are associated with offspring neurodevelopment, cognitive development, and temperament (Van den Bergh et al., 2017). Further research on other psychological factors such as coping styles and social support, could be studied as personal and environmental factors that may mitigate in the relationship between prenatal stress due to the pandemic and postpartum anxiety.

In conclusion, this study found that higher levels of objective hardship and subjective distress during pregnancy predicted higher levels of two-month postpartum anxiety, and that resilience, tolerance of uncertainty, and cognitive appraisal buffered the effects of pandemic stress on postpartum anxiety.

Funding sources

This work was supported by the Sydney Partnership for Health, Education, Research and Enterprise (SPHERE) Maternal, Newborn and Women's Clinical Academic Group (MNW CAG to Dr. Hannah Dahlen). Additional funding was received from Charles Darwin University Rainmaker Readiness Grant (Pregnant During the Pandemic Grant # 33377286). Funding sources had no involvement in the study design, in the collection, analysis and interpretation of data, in the writing of the paper, or in the decision to submit the article for publication. Guillaume Elgbeili was supported by a grant from the Canadian Institutes of Health Research (CIHR # PJT-148903) awarded to S. King and colleagues.

CRedit authorship contributor statement

H. Dahlen, B. Lequertier, M.A. McLean, S. King, and S. Kildea all helped to design and manage the study and write the protocol. A. Di Paolo conducted the literature searches, statistical analyses, and wrote the first draft of the manuscript under the supervision of S. King and M. A. McLean. All authors made significant contributions to the writing of the manuscript and revisions. G. Elgbeili curated the data with assistance from B. Lequertier, and supervised statistical analyses. All authors

contributed to the development of the COVID survey, and S. King and G. Elgbeili created the scoring algorithm for the BASC. All authors contributed to the review, edit, and approved the final manuscript.

Conflict of Interest

None of the authors have conflicts of interest to declare.

Acknowledgements

This work could not have been accomplished without the participation of the pregnant women in the BITTOC study. We would like to thank all participants for their contribution. Thanks to Hazel Keedle, Jaqueline Boyle and Yu Gao for their participation in the project and their support.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.jad.2022.06.055>.

References

- Aris-Meijer, J., Bockting, C., Stolk, R., Verbeek, T., Beijers, C., van Pampus, M., Burger, H., 2019. What if pregnancy is not seventh heaven? The influence of specific life events during pregnancy and delivery on the transition of antenatal into postpartum anxiety and depression. *Int. J. Environ. Res. Public Health* 16, 2851.
- Australian Bureau of Statistics, 2019. Household Income And Wealth, Australia. <https://www.abs.gov.au/statistics/economy/finance/household-income-and-wealth-australia/latest-release#key-findings>.
- Australian Government Department of Health, 2022. Coronavirus (COVID-19) at a glance – 1 January 2022. January 2. <https://www.health.gov.au/resources/publications/coronavirus-covid-19-at-a-glance-1-january-2022>.
- Barzilay, R., Moore, T.M., Greenberg, D.M., DiDomenico, G.E., Brown, L.A., White, L.K., Gur, R.C., Gur, R.E., 2020. Resilience, COVID-19-related stress, anxiety and depression during the pandemic in a large population enriched for healthcare providers. *Transl. Psychiatry* 10, 1–8.
- Beck, M.J., Hensher, D.A., 2020. Insights into the impact of COVID-19 on household travel and activities in Australia—the early days under restrictions. *Transp. Policy* 96, 76–93.
- Bonanno, G.A., 2004. Loss, trauma, and human resilience: have we underestimated the human capacity to thrive after extremely aversive events? *Am. Psychol.* 59, 20.
- Bottesi, G., Marino, C., Vieno, A., Ghisi, M., Spada, M.M., 2021. Psychological distress in the context of the COVID-19 pandemic: the joint contribution of intolerance of uncertainty and cyberchondria. *Psychol. Health* 1–18.
- Bourdon, D.-É., El-Baalbaki, G., Girard, D., Lapointe-Blackburn, É., Guay, S., 2019. Schemas and coping strategies in cognitive-behavioral therapy for PTSD: a systematic review. *Eur. J. Trauma Dissociation* 3, 33–47.
- Brock, R.L., O'Hara, M.W., Hart, K.J., McCabe, J.E., Williamson, J.A., Laplante, D.P., Yu, C., King, S., 2014. Partner support and maternal depression in the context of the Iowa floods. *J. Fam. Psychol.* 28, 832.
- Bromet, E., Dew, M.A., 1995. Review of psychiatric epidemiologic research on disasters. *Epidemiol. Rev.* 17, 113–119. <https://doi.org/10.1093/oxfordjournals.epirev.a036166>.
- Buhr, K., Dugas, M.J., 2002. The intolerance of uncertainty scale: psychometric properties of the English version. *Behav. Res. Ther.* 40, 931–945.
- Cameron, E.E., Joyce, K.M., Delaquis, C.P., Reynolds, K., Protudjer, J.L.P., Roos, L.E., 2020. Maternal psychological distress & mental health service use during the COVID-19 pandemic. *J. Affect. Disord.* 276, 765–774. <https://doi.org/10.1016/j.jad.2020.07.081>.
- Cao-Lei, L., Massart, R., Suderman, M.J., Machnes, Z., Elgbeili, G., Laplante, D.P., Szyf, M., King, S., 2014. DNA methylation signatures triggered by prenatal maternal stress exposure to a natural disaster: project ice storm. *PLoS One* 9, e107653.
- Carleton, R.N., 2016. Into the unknown: a review and synthesis of contemporary models involving uncertainty. *J. Anxiety Disord.* 39, 30–43.
- Cheng, S.K.W., Wong, C.W., Tsang, J., Wong, K.C., 2004. Psychological distress and negative appraisals in survivors of severe acute respiratory syndrome (SARS). *Psychol. Med.* 34, 1187–1195. <https://doi.org/10.1017/S0033291704002272>.
- Chmielewska, B., Barratt, I., Townsend, R., Kalafat, E., van der Meulen, J., Gurol-Urganci, I., O'Brien, P., Morris, E., Draycott, T., Thangaratinam, S., 2021. Effects of the COVID-19 pandemic on maternal and perinatal outcomes: a systematic review and meta-analysis. *Lancet Glob. Health* 9 (6), e759–e772.
- Connor, K.M., Davidson, J.R., 2003. Development of a new resilience scale: the Connor-Davidson resilience scale (CD-RISC). *Depress. Anxiety* 18, 76–82.
- Dancause, K.N., Laplante, D.P., Fraser, S., Brunet, A., Ciampi, A., Schmitz, N., King, S., 2012. Prenatal exposure to a natural disaster increases risk for obesity in 5½-year-old children. *Pediatr. Res.* 71, 126–131. <https://doi.org/10.1038/pr.2011.18>.

- Dancause, K.N., Veru, F., Andersen, R.E., Laplante, D.P., King, S., 2013. Prenatal stress due to a natural disaster predicts insulin secretion in adolescence. *Early Hum. Dev.* 89, 773–776.
- Dennis, C.-L., Falah-Hassani, K., Shiri, R., 2017. Prevalence of antenatal and postnatal anxiety: systematic review and meta-analysis. *Br. J. Psychiatry* 210, 315–323.
- Dugas, M.J., Freeston, M.H., Ladouceur, R., 1997. Intolerance of uncertainty and problem orientation in worry. *Cogn. Ther. Res.* 21, 593–606. <https://doi.org/10.1023/A:1021890322153>.
- Dugas, M.J., Gagnon, F., Ladouceur, R., Freeston, M.H., 1998. Generalized anxiety disorder: a preliminary test of a conceptual model. *Behav. Res. Ther.* 36, 215–226.
- Dugas, M.J., Schwartz, A., Francis, K., 2004. Brief report: intolerance of uncertainty, worry, and depression. *Cogn. Ther. Res.* 28, 835–842.
- Effati-Daryani, F., Zarei, S., Mohammadi, A., Hemmati, E., Ghasemi Yngyknd, S., Mirghafourvand, M., 2020. Depression, stress, anxiety and their predictors in Iranian pregnant women during the outbreak of COVID-19. *BMC Psychol.* 8, 99. <https://doi.org/10.1186/s40359-020-00464-8>.
- Field, T., 2017. Postpartum anxiety prevalence, predictors and effects on child development: a review. *J. Psychiatr. Psychiatr. Disord.* 1, 86–102.
- Folkman, S., Lazarus, R.S., 1984. *Stress, Appraisal, And Coping*. Springer Publishing Company, New York.
- Freeston, M.H., Rhéaume, J., Letarte, H., Dugas, M.J., Ladouceur, R., 1994. Why do people worry? *Personal. Individ. Differ.* 17, 791–802.
- Furtado, M., Van Lieshout, R.J., Van Ameringen, M., Green, S.M., Frey, B.N., 2019. Biological and psychosocial predictors of anxiety worsening in the postpartum period: a longitudinal study. *J. Affect. Disord.* 250, 218–225.
- Havnen, A., Anyan, F., Hjemdal, O., Solem, S., Gurigard Riksfjord, M., Hagen, K., 2020. Resilience moderates negative outcome from stress during the COVID-19 pandemic: a moderated-mediation approach. *Int. J. Environ. Res. Public Health* 17, 6461.
- Hayes, A.F., 2017. *Introduction to Mediation, Moderation, And Conditional Process Analysis: A Regression-based Approach*. Guilford publications.
- Hessami, K., Romanelli, C., Chirazzi, M., Cozzolino, M., 2020. COVID-19 pandemic and maternal mental health: a systematic review and meta-analysis. *J. Matern. Fetal Neonatal Med.* 1–8.
- Hou, W.K., Tong, H., Liang, L., Li, T.W., Liu, H., Ben-Ezra, M., Goodwin, R., Lee, T.M.-C., 2021. Probable anxiety and components of psychological resilience amid COVID-19: a population-based study. *J. Affect. Disord.* 282, 594–601.
- Kendler, K., 1998. Major depression and the environment: a psychiatric genetic perspective. *Pharmacopsychiatry* 31, 5–9.
- Khoury, Jennifer E., Atkinson, L., Bennett, T., Jack, S.M., Gonzalez, A., 2021. COVID-19 and mental health during pregnancy: the importance of cognitive appraisal and social support. *J. Affect. Disord.* 282, 1161–1169.
- Khoury, Jennifer E., Atkinson, L., Bennett, T., Jack, S.M., Gonzalez, A., 2021. Coping strategies mediate the associations between COVID-19 experiences and mental health outcomes in pregnancy. *Arch. Womens Ment. Health* 24, 1007–1017. <https://doi.org/10.1007/s00737-021-01135-2>.
- Kildea, S., Simcock, G., Liu, A., Elgbeili, G., Laplante, D.P., Kahler, A., Austin, M.-P., Tracy, S., Kruske, S., Tracy, M., O'Hara, M.W., King, S., 2018. Continuity of midwifery carer moderates the effects of prenatal maternal stress on postnatal maternal wellbeing: the Queensland flood study. *Arch. Womens Ment. Health* 21, 203–214. <https://doi.org/10.1007/s00737-017-0781-2>.
- Kim, J.H., Shim, Y., Choi, I., Choi, E., 2021. The role of coping strategies in maintaining well-being during the COVID-19 outbreak in South Korea. *Soc. Psychol. Personal. Sci.* 13 (1), 320–332.
- King, S., Kildea, S., Austin, M.-P., Brunet, A., Cobham, V.E., Dawson, P.A., Harris, M., Hurrion, E.M., Laplante, D.P., McDermott, B.M., 2015. QF2011: a protocol to study the effects of the Queensland flood on pregnant women, their pregnancies, and their children's early development. *BMC Pregnancy Childbirth* 15, 1–24.
- Kinsler, P.A., Jallo, N., Amstadter, A.B., Thacker, L.R., Jones, E., Moyer, S., Rider, A., Karjane, N., Salisbury, A.L., 2021. Depression, anxiety, resilience, and coping: the experience of pregnant and new mothers during the first few months of the COVID-19 pandemic. *J. Women's Health* 30, 654–664.
- Korkmaz, H., Güloğlu, B., 2021. The role of uncertainty tolerance and meaning in life on depression and anxiety throughout COVID-19 pandemic. *Personal. Individ. Differ.* 179, 110952.
- Laplante, D.P., Zelazo, P.R., Brunei, A., King, S., 2007. Functional play at 2 years of age: effects of prenatal maternal stress. *Infancy* 12, 69–93.
- Leach, L.S., Poyser, C., Fairweather-Schmidt, K., 2017. Maternal perinatal anxiety: a review of prevalence and correlates. *Clin. Psychol.* 21, 4–19.
- Lebel, C., MacKinnon, A., Bagshawe, M., Tomfohr-Madsen, L., Giesbrecht, G., 2020. Elevated depression and anxiety symptoms among pregnant individuals during the COVID-19 pandemic. *J. Affect. Disord.* 277, 5–13.
- Lovibond, S.H., Lovibond, P.F., 1995. *Manual for the Depression Anxiety Stress Scales*, Second edition. Psychology Foundation of Australia.
- Malhi, G.S., Moore, J., McGuffin, P., 2000. The genetics of major depressive disorder. *Curr. Psychiatry Rep.* 2, 165–169. <https://doi.org/10.1007/s11920-000-0062-y>.
- Martínez-Galiano, J.M., Hernández-Martínez, A., Rodríguez-Almagro, J., Delgado-Rodríguez, M., Gómez-Salgado, J., 2019. Relationship between parity and the problems that appear in the postpartum period. *Sci. Rep.* 9, 1–8.
- Olson, D., Brémault-Phillips, S., King, S., Metz, G., Montesanti, S., Olson, J., Hyde, A., Pike, A., Hoover, T., Linder, R., 2019. Recent Canadian efforts to develop population-level pregnancy intervention studies to mitigate effects of natural disasters and other tragedies. *J. Dev. Orig. Health Dis.* 10, 108–114.
- Ostacoli, L., Cosma, S., Bevilacqua, F., Berchiolla, P., Bovetti, M., Carosso, A.R., Malandrone, F., Carletto, S., Benedetto, C., 2020. Psychosocial factors associated with postpartum psychological distress during the COVID-19 pandemic: a cross-sectional study. *BMC Pregnancy Childbirth* 20, 703. <https://doi.org/10.1186/s12884-020-03399-5>.
- Paquin, V., Bick, J., Lipschutz, R., Elgbeili, G., Laplante, D.P., Biekman, B., Brunet, A., King, S., Olson, D., 2021a. Unexpected effects of expressive writing on post-disaster distress in the Hurricane Harvey Study: a randomized controlled trial in perinatal women. *Psychol. Med.* 1–9.
- Paquin, V., Elgbeili, G., Laplante, D.P., Kildea, S., King, S., 2021b. Positive cognitive appraisal “buffers” the long-term effect of peritraumatic distress on maternal anxiety: the Queensland Flood Study. *J. Affect. Disord.* 278, 5–12.
- Perzow, S.E.D., Hennessey, E.-M.P., Hoffman, M.C., Grote, N.K., Davis, E.P., Hankin, B. L., 2021. Mental health of pregnant and postpartum women in response to the COVID-19 pandemic. *J. Affect. Disord. Rep.* 4, 100123. <https://doi.org/10.1016/j.jadr.2021.100123>.
- Rettie, H., Daniels, J., 2021. Coping and tolerance of uncertainty: predictors and mediators of mental health during the COVID-19 pandemic. *Am. Psychol.* 76 (3), 427–437.
- Rossell, S.L., Neill, E., Phillipou, A., Tan, E.J., Toh, W.L., Van Rheenen, T.E., Meyer, D., 2021. An overview of current mental health in the general population of Australia during the COVID-19 pandemic: results from the COLLATE project. *Psychiatry Res.* 296, 113660.
- Sauer, K.S., Jungmann, S.M., Withöft, M., 2020. Emotional and behavioral consequences of the COVID-19 pandemic: the role of health anxiety, intolerance of uncertainty, and distress (in) tolerance. *Int. J. Environ. Res. Public Health* 17, 7241.
- Smith, B.W., Dalen, J., Wiggins, K., Tooley, E., Christopher, P., Bernard, J., 2008. The brief resilience scale: assessing the ability to bounce back. *Int. J. Behav. Med.* 15, 194–200.
- Southwick, S.M., Bonanno, G.A., Masten, A.S., Panter-Brick, C., Yehuda, R., 2014. Resilience definitions, theory, and challenges: interdisciplinary perspectives. *Eur. J. Psychotraumatol.* 5, 25338.
- Tomfohr-Madsen, L.M., Racine, N., Giesbrecht, G.F., Lebel, C., Madigan, S., 2021. Depression and anxiety in pregnancy during COVID-19: a rapid review and meta-analysis. *Psychiatry Res.* 300, 113912. <https://doi.org/10.1016/j.psychres.2021.113912>.
- del Valle, M., Andrés, M.L., Urquijo, S., Yerro Avincetto, M.M., López Morales, H., Canet Juric, L., 2020. Intolerance of uncertainty over COVID-19 pandemic and its effect on anxiety and depressive symptoms.
- Van den Bergh, B.R., van den Heuvel, M.I., Lahti, M., Braeken, M., de Rooij, S.R., Entringer, S., Hoyer, D., Roseboom, T., Räikkönen, K., King, S., 2017. Prenatal developmental origins of behavior and mental health: the influence of maternal stress in pregnancy. *Neurosci. Biobehav. Rev.* 117, 26–64.
- Veru, F., Dancause, K., Laplante, D.P., King, S., Luheshi, G., 2015. Prenatal maternal stress predicts reductions in CD4+ lymphocytes, increases in innate-derived cytokines, and a Th2 shift in adolescents: project ice storm. *Physiol. Behav.* 144, 137–145.
- Wardrop, A.A., Popadiuk, N.E., 2013. Women's experiences with postpartum anxiety: expectations, relationships, and sociocultural influences. *Qual. Rep.* 18, 6.
- World Health Organization, 2020. Novel coronavirus (2019-nCoV) Situation report – 1. https://www.who.int/docs/default-source/coronaviruse/situation-reports/20200121-sitrep-1-2019-ncov.pdf?sfvrsn=20a99c10_4.
- Wu, G., Feder, A., Cohen, H., Kim, J., Calderon, S., Charney, D., Mathé, A., 2013. Understanding resilience. *Front. Behav. Neurosci.* 7, 10. <https://doi.org/10.3389/fnbeh.2013.00010>.
- Xu, C., Xu, Y., Xu, S., Zhang, Q., Liu, X., Shao, Y., Xu, X., Peng, L., Li, M., 2020. Cognitive reappraisal and the association between perceived stress and anxiety symptoms in COVID-19 isolated people. *Front. Psychiatry* 11.
- Yelland, J., Sutherland, G., Brown, S.J., 2010. Postpartum anxiety, depression and social health: findings from a population-based survey of Australian women. *BMC Public Health* 10, 1–11.
- Yong Ping, E., Laplante, D.P., Elgbeili, G., Hiller, K.M., Brunet, A., O'Hara, M.W., King, S., 2015. Prenatal maternal stress predicts stress reactivity at 2½ years of age: the Iowa Flood Study. *Psychoneuroendocrinology* 56, 62–78.
- Yu, M., Gong, W., Taylor, B., Cai, Y., Xu, D.R., 2020. Coping styles in pregnancy, their demographic and psychological influences, and their association with postpartum depression: a longitudinal study of women in China. *Int. J. Environ. Res. Public Health* 17, 3654. <https://doi.org/10.3390/ijerph17103654>.
- Zeng, X., Li, W., Sun, H., Luo, X., Garg, S., Liu, T., Zhang, J., Zhang, Y., 2020. Mental health outcomes in perinatal women during the remission phase of COVID-19 in China. *Front. Psychiatry* 11, 977. <https://doi.org/10.3389/fpsy.2020.571876>.