Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

Journal of Affective Disorders Reports 6 (2021) 100287

Contents lists available at ScienceDirect

Journal of Affective Disorders Reports

journal homepage: www.sciencedirect.com/journal/journal-of-affective-disorders-reports

Research Paper

Mediating Mechanisms for Maternal Mental Health from Pre- to during the COVID-19 Pandemic
Mediators of maternal mental illness during COVID-19

Nicole Racine [a], Sheila McDonald [b,c], Suzanne Tough [b,1], Sheri Madigan [a,1,*,1]

[a] Department of Psychology, University of Calgary, Calgary, Alberta, Canada
[b] Department of Community Health Sciences, University of Calgary, Calgary, Alberta, Canada
[c] Alberta Health Services, Canada

ARTICLE INFO

Keywords:
COVID-19
Depression
Anxiety
Mothers

ABSTRACT

Background: Mothers have experienced a near doubling of depression and anxiety symptoms pre- to during the COVID-19 pandemic. The identification of mechanisms that account for this increase can help inform specific targets for mental health recovery efforts. The current study examined whether women with higher levels of depression and anxiety symptoms pre-pandemic, reported higher levels of depression and anxiety symptoms during the pandemic, and whether these increases were mediated by perceived stress, strained relationships, coping attitudes, participation in activities, alcohol use, and financial impact.

Methods: Mothers (n = 1,333) from an ongoing longitudinal cohort (All Our Families; AOF) from Calgary, Alberta, Canada, completed online questionnaires prior to (2017–2019) and during the COVID-19 pandemic (May-July 2020). Mothers reported on depressive and anxiety symptoms pre- and during the pandemic, as well as perceived stress, engagement in physical and leisure activities, coping, alcohol use, and financial impact of the pandemic.

Results: In unadjusted analyses, maternal depression and anxiety symptoms pre-pandemic were strongly associated with COVID-19 depressive (r = 0.57, p<.01) and anxiety symptoms (r = 0.49, p<.01). Significant indirect effects between maternal depressive symptoms pre- and during COVID-19 were found for coping behavior (ab_{cs}=0.014, 95%CI=0.005, 0.022, p=.001), perceived stress (ab_{cs}=0.22, 95%CI=0.179, 0.258, p<.001), and strained relationships (ab_{cs}=0.013, 95%CI= 0.005, 0.022, p=.003). For maternal anxiety symptoms pre- and during COVID-19, significant indirect effects were observed for perceived stress (ab_{cs}=0.012, 95%CI=0.077, 0.154, p=.003) and strained relationships (ab_{cs}=0.010, 95%CI=0.001, 0.018, p=.03).

Conclusions: Perceived stress, coping attitudes, and interpersonal relationships are three potential intervention targets for mitigating COVID-19 related mental distress in mothers.

1. Introduction

A pernicious consequence of the COVID-19 pandemic has been its impact on mental health across the globe (Holmes et al., 2020). Social isolation and increased financial stress associated with the COVID-19 pandemic have created a ripe context for increases in mental illness (Brooks et al., 2020), particularly for parents who have also endured stress related to homeschooling responsibilities, loss of childcare, and significant disruptions in daily routines (Cameron et al., 2020; Racine et al., 2020; Wade et al., 2021). Indeed, longitudinal research has highlighted that during COVID-19, parents are demonstrating sharper increases in mental distress compared to individuals without children (Pierce et al., 2020). Specifically, from pre- to during the COVID-19 pandemic, mothers have experienced a near doubling of clinically-significant depression (19% to 35%) and anxiety (18% to 31%) symptoms (Racine et al., 2021). The rapid rise in maternal mental distress during the COVID-19 pandemic is concerning, as it is well established that maternal mental illness is adversely associated with developmental outcomes in offspring (Rogers et al., 2020; Wall-Wieler et al., 2020). Thus, there is urgency in identifying mechanisms, both

* Corresponding author.
E-mail address: sheri.madigan@ucalgary.ca (S. Madigan).
[1] Shared Senior Authorship.

https://doi.org/10.1016/j.jadr.2021.100287
Received 12 October 2021; Received in revised form 1 November 2021; Accepted 24 November 2021
Available online 29 November 2021

unique to COVID as well as though that have been shown previously, that account for why these increases in maternal mental illness have occurred. Understanding the mechanisms that may account for the association between mental health difficulties before and during the COVIID-19 pandemic can inform the mobilization of intervention and recovery efforts.

There are several candidate mechanisms that may account for the association between maternal mental illness prior to, and during, the COVID-19 pandemic. First, perceived stress is a well-established catalyst for mental health difficulties (Harkness, 2020), and may be playing a critical role in the observed increase in mental health difficulties in mothers. Indeed, parents, but especially mothers, have reported higher levels of stress exposure, including financial disruption and increased household and childcare responsibilities during the pandemic (Wade et al., 2021). Second, according to transactional interpersonal theories of mental illness, individuals with pre-existing symptoms of depression or anxiety may act in ways that promote conflict or strain relationships, which subsequently perpetuate mental health difficulties (Rudolph et al., 2009). As a result of public health measures imposed during the pandemic, including home confinement, loss of social support, and increased demands, mothers may have experienced increased relational strain with partners and children (Pietromonaco and Overall, 2020; Russell et al., 2020), and these relational challenges may be contributing to worsening mental health symptoms. Other potential COVID-19 specific mechanisms accounting for the association between symptoms of mental illness from pre- to during the pandemic include poor coping strategies, increased alcohol consumption, and due to various restrictions (e.g., closing of fitness centres), deceased physical and recreational activities (Rettie and Daniels, 2020). Finally, there is also evidence to suggest that financial strain during the pandemic is associated with increased depressive symptoms and may propel feelings of hopelessness and worry that could exacerbate pre-existing mental distress (Hertz-Palmor et al., 2020).

In the current study, we report on findings from a cohort of mothers with children aged 9–11 years who have been followed longitudinally. We examined whether women who had higher levels of depression and anxiety symptoms pre-pandemic (2017 to 2019), reported higher levels of depression and anxiety symptoms during the pandemic (May-June 2020), and whether these increases were mediated by *a priori defined* candidate mechanisms. We expected that pre-pandemic depression and anxiety symptoms would be associated with COVID-19 depression and anxiety symptoms through perceived stress, strained relationships, coping attitudes, participation in activities, alcohol use, and financial impact.

2. Methods

2.1. Participants and study design

Participants in the current study are part of an ongoing longitudinal cohort from Calgary, Alberta, Canada, the All Our Families study (AOF; (McDonald et al., 2015; Tough et al., 2017)) examining longitudinal associations of maternal-child health and wellbeing. The AOF study started in 2008 and recruited women in pregnancy from medical laboratory offices, primary care clinics, and public locations that pregnant women frequent. To date, 2445 women have participated in data collection consistently over time, through eight data waves including prior to 25 weeks gestation, between 34- and 36-weeks gestation, and when their child was 4-months, 1-year, 2-years, 3-years, 5-years, and 8-years of age. In the current study we include data collected immediately prior to the COVID-19 pandemic (child age 8-years; collected 2017–2019), to directly examine associations with COVID-19 mental illness.

In March 2020, a state of emergency was declared in the province of Alberta as a result of the COVID-19 pandemic. A COVID-19 impact survey was emailed to AOF mothers and completed between May 20th and July 15th, 2020. Eligible mothers were those who have remained in the study over time (i.e., had not discontinued, were not lost to follow-up, and had an email address available on file; $n = 2445$, 72% retention). A total of 1333 women (54.5% of eligible women) consented to participate in the COVID-19 impact survey. Mothers who have been retained in the study across time are generally of higher education, higher income, older, more likely to be in a stable relationship, and more likely to be born in Canada (Tough et al., 2017). Patterns were similar when comparing women who were initially enrolled in the study ($n = 3387$) with those who participated in the COVID-19 impact survey ($n = 1333$). Specifically, women who participated in the COVID-19 impact survey had higher income ($t = -6\bullet53$, $p < \bullet0001$), were older ($t = -4\bullet44$, $p < \bullet0001$), and had higher education levels ($t = -5\bullet82$, $p < \bullet0001$) than women initially enrolled at baseline into the AOF study. Analyses that weighted for non-response (Racine et al., 2021) found similar rates of depression and anxiety symptoms during the pandemic for mothers who participated at the COVID-19 time point, indicating that mental health rates of mothers who did and didn't respond were likely similar.

2.2. Procedures and variables

Data at the COVID-19 timepoint was collected using the Research Electronic Data Capture (REDCap) platform and was linked with the most recent pre-COVID-19 timepoint when the child was 8 years of age, which was collected from February 2017 to October 2019. Both the 8-year and COVID-19 impact surveys included questions about demographic information (i.e., race/ethnicity, household income, maternal age, maternal education), maternal mental health and well-being, and family functioning. All demographic information for the sample is reported in Table 1. The University of Calgary Institutional Review Board approved all data collection for this study (REB13–0868).

Mental health variables. Maternal depressive and anxiety symptoms were obtained via maternal self-report at the pre-COVID-19 and COVID-19 timepoints. Depressive symptoms in the past week were assessed using the 10-item Center for Epidemiological Studies of Depression Short Form (CES-D-10), with scores ranging from 0 to 30. The CES-D-10 includes questions that map on to the diagnostic criteria for depression including low mood, depressed affect, and anhedonia. The CES-D-10 has good psychometric properties (Andresen et al., 1994; Bjorgvinsson et al., 2013). Internal consistency for the CESD-10 in the AOF study ranges from 0.81 to 0.87, demonstrating good internal consistency. Anxiety symptoms were assessed using the 6-item Spielberger

Table 1
Socio-demographic characteristics of sample of mothers during COVID-19 (May – July 2020), $N = 1333$.

Variable	Mean (SD)
Maternal age	41.56 (4.35)
Child age	9.66 (0.81)
	% (N)
One child family	11.7 (156)
Single parent family	6.8 (91)
Family had COVID-19 exposure	8.7 (116)
Family income >$80,000 per year	81.2 (1083)
Highest level of maternal education	
Less than high school	1.4 (18)
Graduated high school	5.0 (66)
Some college, trade school, university	13.1 (174)
Graduated college, trade school, university	64.3 (857)
Some graduate school	2.6 (35)
Completed graduate school	13.5 (180)
Race/Ethnicity	
Asian	11.1 (148)
Black	0.80 (10)
First Nations, Inuit, Metis	0.50 (7)
Latin	1.5 (20)
Mixed/Other	2.9 (39)
White	82.7 (1102)

State-Trait Anxiety Inventory Short Form (STAI-SF)(Marteau and Bekker, 1992), with scores ranging from 6 to 24. The SSAI-SF, which has previously been validated for use with mothers (Bayrampour et al., 2014), has demonstrated good psychometric properties (Tluczek et al., 2009). Good internal consistency for the SSAI-SF has been demonstrated across study waves in the AOF cohort (0.81 to 0.86).

Potential mediator variables. All mediator variables were assessed as part of the COVID-19 Impact Survey completed by mothers May-July 2020.

Increased activities. Mothers were asked to report on activities they are doing more of since COVID-19 (1=yes, 0=no) for each of the following: domestic/household projects, hobbies, educational activities, physical fitness/self-care, and spending time with family. A total sum score ranging from 0 to 5 was obtained.

Coping Behaviors. Coping was assessed using the Brief Resilient Coping Scale (Sinclair and Wallston, 2004), which is a 4-item questionnaire with a 5-point response scale that captures tendencies to cope with stress in an adaptive way, such as being flexible or problem solving. A total score from 4 to 20 was obtained for each participant.

Perceived stress. Assessed using the Perceived Stress Scale (Cohen et al., 1983), a well-validated and reliable (Andreou et al., 2011) 10-item instrument that assess the degree to which individuals perceive their lives to be unpredictable, uncontrollable, and overwhelming. Total scores range from 0 to 40.

Strained relationships. Assessed by asking mothers how the COVID-19 pandemic has affected their relationship with their partner, AOF target child, and friends/family outside the household. Sum scores from 0 to 3 were obtained adding together the score for each relationship (0=not strained, 1=strained).

Financial impact. Mothers were asked to self-report on the financial impact of the COVID-19 pandemic on their family. Scores from 1 to 4 were obtained where 1=no financial impact or too soon to tell, 2=mild financial impact, 3=moderate financial impact, and 4=major financial impact.

Alcohol Use. Mothers were asked to report on the number of occasions in the last month where they had consumed 4 or more alcoholic beverages. Women who did not drink alcohol in the last month received a score of zero.

Covariates. Maternal age at the COVID-19 Impact Survey and household family income prior to COVID-19 were entered in the path model as covariates.

2.3. Statistical analyses

All analyses were conducted in SPSS 25.0 and MPlus Version 8.0. First, descriptive statistics and correlations among study variables were explored. Second, we tested two paired sample-tests to demonstrate a significant change in levels of depression and anxiety symptoms from pre to during the COVID-19 pandemic. Third, we tested study hypotheses using a mediation framework in the context of path analysis (MacKinnon et al., 2007). We used a multivariable path model that estimated the effects of maternal depression and anxiety symptoms pre-COVID (at child age 8, 2017–2019) on maternal depression and anxiety symptoms at the COVID-19 wave via increased activities, coping, perceived stress, strained relationships, financial impact, and alcohol use. We controlled for maternal age and household family income prior to COVID-19 in our multivariable model. Maternal depressive and anxiety symptoms pre-COVID were considered the independent variables, depressive and anxiety symptoms at the COVID-19 timepoint were considered the dependent variables, and activities, coping, perceived stress, relationship strain, financial impact, and alcohol use were the hypothesized mediators.

Mediators were regressed onto maternal depressive and anxiety symptoms pre-COVID (*a*-pathways), and the dependent variables were regressed onto the mediators (*b*-pathways), controlling for the direct effects of the independent variables on the dependent variables (i.e., *c*′-pathways). Indirect effect sizes were evaluated using completely standardized indirect effect (ab_{cs}), which represent the impact of depression and anxiety symptoms pre-COVID on depression and anxiety symptoms at the COVID-19 timepoint *through* the mediators. Associations between maternal depression and anxiety pre-COVID to during COVID-19 were included in the model. We used a bootstrapping method (5000 bootstrap draws) to obtain 95% confident intervals around the indirect effect estimates. All analyses were conducted using Full Information Maximum Likelihood (Graham, 2009) and thus all data for participants that did not have complete missing data were included in the path analysis (n = 1332).

3. Results

3.1. Descriptive characteristics and associations among variables

Descriptive statistics and correlations are presented in Table 2. There were strong positive associations among depression and anxiety symptoms from pre- to during COVID-19 with correlations ranging from 0.42 to 0.72. Increased uptake of activities and coping were negatively associated with depressive and anxiety symptoms at both timepoints, while perceived stress, strained relationships, financial impact, and alcohol use were positively associated with mental health symptoms pre- and during COVID-19.

3.2. Increases in maternal depression and anxiety symptoms from pre to during COVID-19

Using a paired sample *t*-test, we found a significant difference in maternal depression symptoms from pre (M = 5.45, SD=4.66) to during the COVID-19 pandemic (M = 7.97, SD=5.72) (Mean difference= −2.52, SD=4.90, 95% CI=−2.80 to −2.24, t=−17.84, df=1203, p<.001), with higher depressive symptoms during the COVID-19 pandemic. Using a paired sample *t*-test, we found a significant difference in maternal anxiety symptoms from pre (M = 10.12, SD=3.54) to during the COVID-19 pandemic (M = 11.73, SD=4.03) (Mean difference= −1.62, SD=3.85, 95% CI=−1.83 to −1.40, t=−14.68, df=1231, p<.001).

3.3. Mediation model

The full mediation model with statistically significant associations is presented in Fig. 1. The fit statistics for the model were adequate with RMSEA=0.07, CFI=0.97, TLI=0.89, SRMR=0.03, which are deemed acceptable.

Examining the *a*-pathways, higher maternal depressive symptoms pre-COVID-19 were associated with lower engagement in activities and less coping behavior during the COVID-19 pandemic, while higher depressive symptoms pre-COVID-19 were associated with increased stress, relational strain, and financial impact during COVID-19. Higher maternal anxiety pre-pandemic was associated with lower coping behavior, as well as increased strained relationships and alcohol use during COVID-19. Examining the *b*-pathways, lower levels of coping behavior, as well as higher perceived stress, strained relationships, and alcohol use, were associated with higher depressive symptoms at COVID-19. Higher stress, strained relationships, and greater COVID-19 financial impact was associated with increased anxiety symptoms at the COVID-19 timepoint. All *a* and *b* paths are presented in Table 3.

The indirect effects are presented in Table 4. Significant indirect effects between maternal depressive symptoms pre- and during COVID-19 were found for coping behavior (ab_{cs}=0.014, 95%CI=0.006, 0.023, p=.001), perceived stress (ab_{cs}=0.22, 95%CI=0.178, 0.258, p<.001), and strained relationships (ab_{cs}=0.013, 95%CI= 0.006, 0.023, p=.003), suggesting that the effects of depression pre- to during-COVID-19 operated through perceived stress, strained relationship, and coping. The indirect effects were small, albeit statistically significant. This

Table 2
Descriptive statistics and correlation matrix ($N = 1333$).

	2	3	4	5	6	7	8	9	10	11	12	M	SD	Min-Max
1.COVID-Dep	.72**	.57**	.45**	−0.16**	−0.40**	.80**	.40**	.22**	.15**	−0.01	−0.09**	8.06	5.75	0–29
2.COVID-Anx	1	.42**	.49**	−0.18**	−0.35**	.74**	.35**	.22**	.14**	−0.01	−0.05	11.76	4.04	6–24
3.Pre-Dep		1	.61**	−0.13**	−0.27**	.48**	.26**	.14**	.09**	−0.05	−0.14**	5.43	4.66	0–29
4.Pre-Anx			1	−0.10**	−0.27**	.41**	.26**	.13**	.13**	−0.01	−0.08**	10.14	3.55	6–23
5.Increased activities				1	.24**	−0.17**	−0.13**	.02	−0.10**	−0.03	.01	3.27	1.12	0–5
6.Coping					1	−0.39**	−0.20**	.001	−0.10**	.04	.03	14.90	2.62	4–20
7.Perceived Stress						1	.38**	.24**	.10**	−0.04	−0.05	16.16	6.76	0–39
8.Strained Relationships							1	.17**	.11**	.03	−0.01	0.42	0.66	0–3
9.Financial Impact								1	.06	−0.01	−0.27**	1.69	0.91	1–4
10.Alcohol Use									1	−0.05	.02	1.37	3.27	0–30
11.Maternal age										1	.12**	41.56	4.35	29–54
12.Income before COVID-19											1	6.33	1.73	1–8

Note. Pre-Dep: Depressive symptoms prior to the COVID-19 pandemic, Pre-Anx: Anxiety symptoms prior to the COVID-19 pandemic, COVID-Dep: Depressive symptoms during the COVID-19 pandemic, COVID-Anx: Anxiety symptoms during the COVID-19 pandemic. ** $p < .01$.
* $p < .05$.

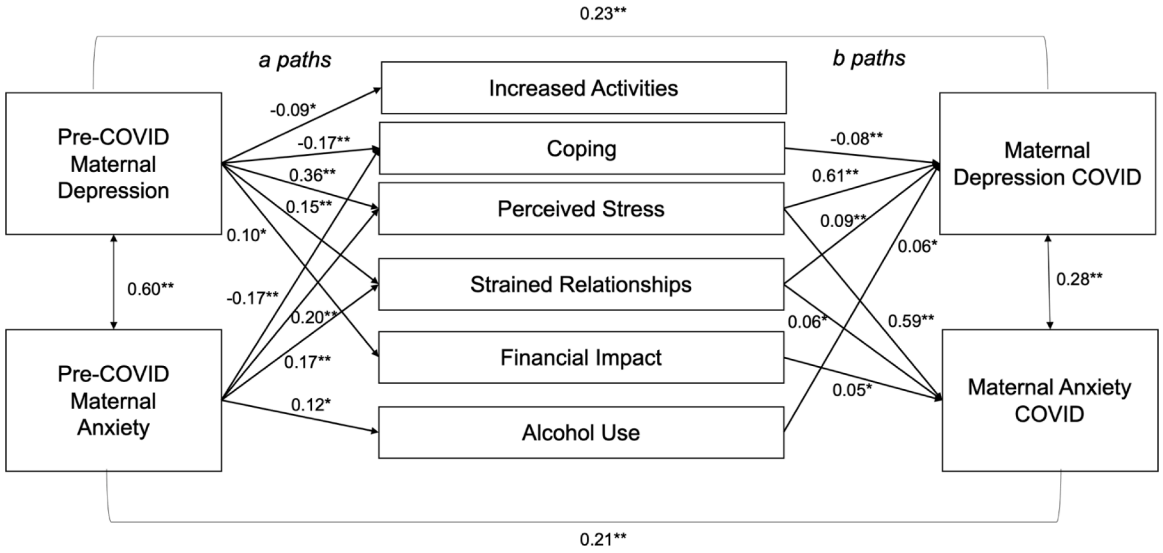

Fig. 1. *Path model of association between maternal mental health prior to and during the COVID-19 pandemic.*
Fig. 1. Complete standardized estimates are presented. *p<.05, **p<.001. Lines represent statistically significant paths. A total of 70.1% of the variance in maternal depression and 59.2% of the variance in anxiety at the COVID-19 time point were accounted for by these models. Maternal age and income prior to COVID-19 timepoint were included as covariates.

Table 3
Completely Standardized Effects for all a and b paths from mediation analyses.

a paths	Estimate	95%CI	*p*	b paths	Estimate	95%CI	*p*
Pre-Dep→ Activities	−0.094	−0.166,−0.022	0.011	Activities→COVID-Dep	0.007	−0.028,0.040	0.684
Pre-Dep → Coping	−0.173	−0.241,−0.107	<0.001	Coping→ COVID-Dep	−0.078	−0.116, −0.04	<0.001
Pre-Dep → Perceived stress	0.358	0.295,0.420	<0.001	Perceived stress→ COVID-Dep	0.611	0.572, 0.649	<0.001
Pre-Dep → Strained relationships	0.149	0.074,0.23	<0.001	Strained relations→ COVID-Dep	0.089	0.048, 0.132	<0.001
Pre-Dep → Financial impact	0.104	0.027,0.178	0.007	Financial impact→ COVID-Dep	0.020	−0.015,0.054	0.272
Pre-Dep → Alcohol use	0.031	−0.047, 0.115	0.448	Alcohol use→ COVID-Dep	0.057	0.02, 0.095	0.003
Pre-Anx → Activities	−0.048	−0.121,0.022	0.193	Activities→ COVID-Anx	−0.032	−0.07, 0.006	0.093
Pre-Anx → Coping	−0.166	−0.235, −0.098	<0.001	Coping→ COVID-Anx	−0.043	−0.09,0.001	0.053
Pre-Anx → Perceived stress	0.196	0.129,0.261	<0.001	Perceived stress→ COVID-Anx	0.589	0.54,0.63	<0.001
Pre-Anx → Strained relationships	0.170	0.097,0.241	<0.001	Strained relations→ COVID-Anx	0.056	0.013, 0.099	0.009
Pre-Anx → Financial impact	0.065	−0.005,0.135	0.069	Financial impact→ COVID-Anx	0.051	0.012, 0.090	0.011
Pre-Anx → Alcohol use	0.124	0.04, 0.21	0.004	Alcohol use→ COVID-Anx	0.034	−0.016,0.083	0.174

Note: Confidence intervals were derived from bootstrapping across 5000 draws. Covariates included in the model were maternal age and income prior to COVID-19. Pre-Dep: Depressive symptoms prior to the COVID-19 pandemic, Pre-Anx: Anxiety symptoms prior to the COVID-19 pandemic, COVID-Dep: Depressive symptoms during the COVID-19 pandemic, COVID-Anx: Anxiety symptoms during the COVID-19 pandemic.

Table 4
Completely standardized indirect effects (ab_{cs}) of maternal mental health prior to and during COVID-19.

Independent Variable		Mediator		Outcome	ab_{cs}	95% CI	p	
Pre-Dep	→	Activities	→	COVID-Dep	−0.001	−0.004,0.003	0.711	
	→	Coping	→		0.014	0.006, 0.023	0.001	**
	→	Perceived stress	→		0.218	0.178, 0.258	<0.001	***
	→	Strained relationships	→		0.013	0.006, 0.023	0.003	**
	→	Financial impact	→		0.002	−0.002, 0.007	0.332	
	→	Alcohol use	→		0.002	−0.002, 0.008	0.50	
Pre-Anx	→	Activities	→	COVID-Anx	0.002	−0.001, 0.006	0.353	
	→	Coping	→		0.007	0.000, 0.016	0.09	
	→	Perceived stress	→		0.115	0.077, 0.154	<0.001	**
	→	Strained relationships	→		0.010	0.002, 0.019	0.03	*
	→	Financial impact	→		0.003	0.000, 0.009	0.170	
	→	Alcohol use	→		0.004	−0.002, 0.012	0.223	

***$p < .001$.
** $p < .01$.
*$p < .05$.
Note: Confidence intervals were derived from bootstrapping across 5000 draws. Covariates included in the model were maternal age and income prior to COVID-19. Pre-Dep: Depressive symptoms prior to the COVID-19 pandemic, Pre-Anx: Anxiety symptoms prior to the COVID-19 pandemic, COVID-Dep: Depressive symptoms during the COVID-19 pandemic, COVID-Anx: Anxiety symptoms during the COVID-19 pandemic.

model accounted for 70.1% of the variance in maternal depression at the COVID-19.

For maternal anxiety symptoms pre- and during COVID-19, significant indirect effects were observed for perceived stress (ab_{cs}=0.012, 95%CI=0.077, 0.154, p<.001.003) and strained relationships (ab_{cs}=0.010, 95%CI=0.002, 0.019, p=.03), suggesting that the effects of anxiety pre-to during the COVID-19 pandemic operated through perceived stress and strained relationships. The indirect effects were small, albeit statistically significant. This model accounted for 59.2% of the variance in maternal anxiety at the COVID-19.

Lastly, the direct effect of maternal depressive symptoms pre-COVID-19 on depressive symptoms during COVID-19 remained statistically significant, irrespective of the mediators tested (c'=0.23, 95% CI=0.19, 0.28). Similarly, the direct effect of maternal anxiety symptoms pre-COVID-19 on anxiety symptoms during COVID-19 remained statistically significant, irrespective of the mediators tested (c'=0.21, 95% CI=0.17, 0.25). These findings suggest that the effects of maternal mental health from pre- to during COVID-19 are not fully captured by the mediators included in the current model.

4. Discussion

This study found increases in maternal depression and anxiety symptoms from pre- to post-COVID19 and strong positive association between maternal-reported symptoms of depression and anxiety prior to and those experienced during the COVID-19 pandemic. The strength of these associations is consistent with those reported in prior longitudinal research before the COVID-19 pandemic (Paulson et al., 2016). This is not entirely surprising as one of the best predictors of current mental health symptoms is past mental health symptoms (Rudolph et al., 2009). These findings are also consistent with studies from previous natural disasters (e.g., Hurricane Katrina) that show that those who had clinically significant depression and/or anxiety symptoms were most at risk for screening positive for mental illness (Sullivan et al., 2013). Ultimately, our results suggest that consideration of previous mental health history should be considered when assessing or triaging mothers for mental health support.

Consistent with other general population studies (Asmundson et al., 2020a), we also found that mothers who self-reported pre-existing struggles with mental health up to 2-years prior to the COVID-19 pandemic, were more susceptible to the social, financial, and relational stressors and disruptions caused by COVID-19. These stressors were in turn precipitants of increases in mental health symptoms during COVID-19 (Kessler, 1997; Monroe et al., 2019). Individuals with pre-existing anxiety-related and mood disorders have been shown to exhibit higher stress during the COVID-19 pandemic and to generally perceive the consequences of the pandemic, such as financial impacts, as worse compared to individuals without mental health conditions (Asmundson et al., 2020b). Thus, for mothers with pre-existing mental health concerns, elevations in perceived stress and increased financial impact may play an important role in the perpetuation of mental health difficulties during the pandemic.

In the current study we identify three important modifiable factors that partially mediated the association between mental illness symptoms from pre- to during the pandemic: perceived stress, strained relationships, and coping attitudes. That is, individuals who felt the most overwhelmed with the shifts in daily life activities and extra demands that were placed upon them during the COVID-19 pandemic appeared to struggle the most with anxious and depressive symptoms. Experiencing strain in relationships with their spouse, children, and/or friends also partially accounted for the association between depression and anxiety symptoms from pre- to during the pandemic. Mental health difficulties may trigger conflict or strain in interpersonal relationships further perpetuating feelings of frustration, sadness, and/or worry (Russell et al., 2020). Optional relational functioning across the entire family (Prime et al., 2020), especially during COVID-19 when external social supports are limited, are critical for well-being.

Finally, a mediator unique to depressive symptoms, was poor coping behaviors. Those who lacked coping skills (i.e., flexibility and problem solving in the face of stress) had higher depressive symptoms, but not anxiety symptoms. Indeed, evidence-based psychological interventions, such as Cognitive-Behaviour Therapy (CBT)(Sheeber et al., 2012), specifically increase coping strategies and decrease negative thought patterns, which have been shown to decrease maternal depressive symptomatology (Cuijpers et al., 2015).

Maternal mental illness was a glaring public health concern pre-COVID-19, with nearly 50% of children being exposed to maternal mental illness before 16 years of age (Abel et al., 2019). Emerging research suggesting a doubling of maternal mental illness estimates during COVID-19 (Racine et al., 2021), and therefore, a greater likelihood that many more children will be exposed to maternal mental illness. In addition to health consequences for mothers (Witt et al., 2011), maternal mental illness has been associated with decreased cognitive, socio-emotional, and motor outcomes in children (Rogers et al., 2020). Mediation findings from the current study, albeit small in effect, indicate that reducing stress, increasing coping strategies, and increasing relational functioning for mothers are key targets to reduce mental health difficulties. Services and opportunities that decrease stress for mothers are critical components of recovery efforts. For mothers where symptoms of depression and anxiety persist, targeted

interventions, such as Cognitive-Behaviour Therapy (CBT), should be made available. CBT specifically targets stress reducing, improved coping, and problem solving that can improve relational functioning (Ammerman et al., 2011). Given that mothers have primarily accessed mental health resources online during the pandemic (Cameron et al., 2020), web-based or app-based psychoeducational materials and treatment (Hermann et al., 2021) should be prioritized.

4.1. Limitations

The women recruited into the All Our Families cohort are generally representative of those living in the city and province from which they were recruited (Tough et al., 2017). Consequently, risk estimates for marginalized populations may be underestimated. A recent study using longitudinal non-response weights in the All Our Families Cohort showed that complete case analysis and a weighted analyses (full sample) produced similar maternal mental health estimates (Racine et al., 2021). Thus, the impact of attrition is hypothesized to be small. Second, given the time sensitivity for gathering data during the COVID-19 pandemic, measurement was single informant and self-report in nature. This means that we cannot preclude single-informant bias in our findings. Third, although the inclusion of pre-pandemic data is a strength of the current study, both mediators and COVID-19 mental health outcomes were collected at the same timepoint. Thus, we are limited in our ability to make causal inferences related to the timing of variables.

5. Conclusions

Our findings indicate that perceived stress, coping attitudes, and strained interpersonal relationships are three potential intervention targets for mitigating the association between mental health symptoms from pre- to during the COVID-19 pandemic. As mental health services and interventions adapt both during and in the aftermath of the pandemic (Moreno et al., 2020), consideration to evidence-based approaches that address stress reduction, increased perceived coping, and provide strategies for managing in interpersonal relationships both in and outside the home are needed. Ongoing research to examine the trajectory of maternal mental health during the recovery phase of the pandemic will inform long-term implications for maternal and parent mental health.

Contributors

Racine and Madigan contributed to conceptualization, formal analysis, writing-original draft, and writing-review and editing. McDonald and Tough contributed to methodology, investigation, data curation, writing-review and editing, project administration, and funding acquisition.

Data sharing

The All Our Families meta-data are available online https://sage-metadata.policywise.com/nada/index.php/catalog/1. Investigators can submit a proposal that has been approved by an independent ethics and scientific review committee to obtain de-identified individual participant data. Data requestors will need to sign confidentiality and access agreements. The study protocol for the current study is available upon request to stough@ucalgary.ca. Data are also available from the principal investigator of the All Our Families study, Suzanne Tough, through University of Calgary processes.

Role of the funding source

The funding source had no role in data collection, analysis, interpretation, or the decision to submit for publication.

Declaration of Competing Interest

None to declare.

Acknowledgements

The AOF study has been funded by an Alberta Innovates Health Solutions Interdisciplinary Team grant #200700595 and the Alberta Children's Hospital Foundation. Funding for the data collection for the COVID-19 wave was provided by the Canadian Institutes of Health Research and Alberta Innovates, through the COVID-19 Rapid Research Response Operating Grant.

References

Abel, K.M., Hope, H., Swift, E., Parisi, R., Ashcroft, D.M., Kosidou, K., Osam, C.S., Dalman, C., Pierce, M., 2019. Prevalence of maternal mental illness among children and adolescents in the UK between 2005 and 2017: a national retrospective cohort analysis. Lancet Public Health 4, e291–e300.

Ammerman, R.T., Putnam, F.W., Stevens, J., Bosse, N.R., Short, J.A., Bodley, A.L., Van Ginkel, J.B., 2011. An open trial of in-home CBT for depressed mothers in home visitation. Matern. Child Health J. 15, 1333–1341.

Andreou, E., Alexopoulos, E.C., Lionis, C., Varvogli, L., Gnardellis, C., Chrousos, G.P., Darviri, C., 2011. Perceived stress scale: reliability and validity study in Greece. Int. J. Environ. Res. Public Health 8, 3287–3298.

Andresen, E.M., Malmgren, J.A., Carter, W.B., Patrick, D.L., 1994. Screening for depression in well older adults: evaluation of a short form of the CES-D (Center for Epidemiologic Studies Depression Scale). Am. J. Prev. Med. 10, 77–84.

Asmundson, G.J.G., Paluszek, M.M., Landry, C.A., Rachor, G.S., McKay, D., Taylor, S., 2020a. Do pre-existing anxiety-related and mood disorders differentially impact COVID-19 stress responses and coping? J. Anxiety Disord., 102271

Asmundson, G.J.G., Paluszek, M.M., Landry, C.A., Rachor, G.S., McKay, D., Taylor, S., 2020b. Do pre-existing anxiety-related and mood disorders differentially impact COVID-19 stress responses and coping? J. Anxiety Disord. 74, 102271.

Bayrampour, H., McDonald, S., Fung, T., Tough, S., 2014. Reliability and validity of three shortened versions of the State Anxiety Inventory scale during the perinatal period. J. Psychosom. Obstet. Gynaecol. 35, 101–107.

Bjorgvinsson, T., Kertz, S.J., Bigda-Peyton, J.S., McCoy, K.L., Aderka, I.M., 2013. Psychometric properties of the CES-D-10 in a psychiatric sample. Assessment 20, 429–436.

Brooks, S.K., Webster, R.K., Smith, L.E., Woodland, L., Wessely, S., Greenberg, N., Rubin, G.J., 2020. The psychological impact of quarantine and how to reduce it: rapid review of the evidence. Lancet 395, 912–920.

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.

Cohen, S., Kamarck, T., Mermelstein, R., 1983. A global measure of perceived stress. J. Health Soc. Behav. 24, 385–396.

Cuijpers, P., Weitz, E., Karyotaki, E., Garber, J., Andersson, G., 2015. The effects of psychological treatment of maternal depression on children and parental functioning: a meta-analysis. Eur. Child Adolesc. Psychiatry 24, 237–245.

Graham, J.W., 2009. Missing data analysis: making it work in the real world. Annu. Rev. Psychol. 60, 549–576.

Harkness, K., Hayden, E., 2020. Introduction, In: Harkness, L., Hayden, E. (Eds.), The Oxford Handbook of Stress and Mental Health. Oxford University Press, New York, New York.

Hermann, A., Fitelson, E.M., Bergink, V., 2021. Meeting Maternal Mental Health Needs During the COVID-19 Pandemic. JAMA Psychiatry 78, 123–124.

Hertz-Palmor, N., Moore, T., Gothelf, D., DiDomenico, G., Dekel, I., Greenberg, D., Brown, L., Matalon, N., Visoki, E., White, L., Himes, M., Schwartz-Lifshitz, M., Gross, R., Gur, R., Pessach, I., Barzilay, R., 2020. Association among income loss, financial strain, and depressive symptoms during COVID-19: evidence form two longitudinal studies. medRxiv.

Holmes, E.A., O'Connor, R.C., Perry, V.H., Tracey, I., Wessely, S., Arseneault, L., Ballard, C., Christensen, H., Cohen Silver, R., Everall, I., Ford, T., John, A., Kabir, T., King, K., Madan, I., Michie, S., Przybylski, A.K., Shafran, R., Sweeney, A., Worthman, C.M., Yardley, L., Cowan, K., Cope, C., Hotopf, M., Bullmore, E., 2020. Multidisciplinary research priorities for the COVID-19 pandemic: a call for action for mental health science. Lancet Psychiatry 7, 547–560.

Kessler, R.C., 1997. The effects of stressful life events on depression. Annu. Rev. Psychol. 48, 191–214.

MacKinnon, D.P., Fairchild, A.J., Fritz, M.S., 2007. Mediation analysis. Annu. Rev. Psychol. 58, 593–614.

Marteau, T.M., Bekker, H., 1992. The development of a six-item short-form of the state scale of the Spielberger State-Trait Anxiety Inventory (STAI). Br. J. Clin. Psychol. 31, 301–306.

McDonald, S.W., Lyon, A., Benzies, K., McNeil, D., Lye, S., Dolan, S., Pennell, C., Bocking, A., Tough, S.C., 2015. The All Our Babies pregnancy cohort: design, methods, and participant characteristics. BMC Pregnancy Childbirth 13.

Monroe, S.M., Anderson, S.F., Harkness, K.L., 2019. Life stress and major depression: the mysteries of recurrences. Psychol. Rev. 126, 791–816.

Moreno, C., Wykes, T., Galderisi, S., Nordentoft, M., Crossley, N., Jones, N., Cannon, M., Correll, C.U., Byrne, L., Carr, S., Chen, E.Y.H., Gorwood, P., Johnson, S., Karkkainen, H., Krystal, J.H., Lee, J., Lieberman, J., Lopez-Jaramillo, C., Mannikko, M., Phillips, M.R., Uchida, H., Vieta, E., Vita, A., Arango, C., 2020. How mental health care should change as a consequence of the COVID-19 pandemic. Lancet Psychiatry 7, 813–824.

Paulson, J.F., Bazemore, S.D., Goodman, J.H., Leiferman, J.A., 2016. The course and interrelationship of maternal and paternal perinatal depression. Arch. Womens Ment. Health 19, 655–663.

Pierce, M., Hope, H., Ford, T., Hatch, S., Hotopf, M., John, A., Kontopantelis, E., Webb, R., Wessely, S., McManus, S., Abel, K.M., 2020. Mental health before and during the COVID-19 pandemic: a longitudinal probability sample survey of the UK population. Lancet Psychiatry 7, 883–892.

Pietromonaco, P.R., Overall, N.C., 2020. Applying relationship science to evaluate how the COVID-19 pandemic may impact couples' relationships. Am. Psychol.

Prime, H., Wade, M., Browne, D.T., 2020. Risk and resilience in family well-being during the COVID-19 pandemic. Am. Psychol. 75, 631–643.

Racine, N., Birken, C., Madigan, S., 2020. Supporting the mental health of parents and children during and after coronovirus. J. Dev. Behav. Pediatr. 41, 508–510.

Racine, N., Hetherington, E., McArthur, B., McDonald, S., Edwards, S., Tough, S., Madigan, S., 2021. Maternal depressive and anxiety symptoms before and during COVID-19: longitudinal findings from the all our families cohort, Canada. Lancet Psychiatry 8 (5), 405–415. https://doi.org/10.1016/S2215-0366(21)00074-2.

Rettie, H., Daniels, J., 2020. Coping and tolerance of uncertainty: predictors and mediators of mental health during the COVID-19 pandemic. Am. Psychol.

Rogers, A., Obst, S., Teague, S.J., Rossen, L., Spry, E.A., Macdonald, J.A., Sunderland, M., Olsson, C.A., Youssef, G., Hutchinson, D., 2020. Association between maternal perinatal depression and anxiety and child and adolescent development: a meta-analysis. JAMA Pediatr.

Rudolph, K.D., Flynn, M., Abaied, J.L., Groot, A., Thompson, R., 2009. Why is past depression the best predictor of future depression? Stress generation as a mechanism of depression continuity in girls. J. Clin. Child. Adolesc. Psychol. 38, 473–485.

Russell, B.S., Hutchison, M., Tambling, R., Tomkunas, A.J., Horton, A.L., 2020. Initial challenges of caregiving during COVID-19: caregiver burden, mental health, and the parent-child relationship. Child Psychiatry Hum. Dev. 51, 671–682.

Sheeber, L.B., Seeley, J.R., Feil, E.G., Davis, B., Sorensen, E., Kosty, D.B., Lewinsohn, P. M., 2012. Development and pilot evaluation of an Internet-facilitated cognitive-behavioral intervention for maternal depression. J. Consult. Clin. Psychol. 80, 739–749.

Sinclair, V.G., Wallston, K.A., 2004. The development and psychometric evaluation of the Brief Resilient Coping Scale. Assessment 11, 94–101.

Sullivan, G., Vasterling, J.J., Han, X., Tharp, A.T., Davis, T., Deitch, E.A., Constans, J.I., 2013. Preexisting mental illness and risk for developing a new disorder after hurricane Katrina. J. Nerv. Ment. Dis. 201, 161–166.

Tluczek, A., Henriques, J.B., Brown, R.L., 2009. Support for the reliability and validity of a six-item state anxiety scale derived from the State-Trait Anxiety Inventory. J. Nurs. Meas. 17, 19–28.

Tough, S.C., McDonald, S.W., Collisson, B.A., Graham, S.A., Kehler, H., Kingston, D., Benzies, K., 2017. Cohort profile: the all our babies pregnancy cohort (AOB). Int. J. Epidemiol. 46, 1389–1390k.

Wade, M., Prime, H., Johnson, D., May, S., Jenkins, J., Browne, T., 2021. The disparate impact of COVID-19 on the mental health of female and male caregivers. Soc. Sci. Med.

Wall-Wieler, E., Roos, L.L., Gotlib, I.H., 2020. Maternal depression in early childhood and developmental vulnerability at school entry. Pediatrics 146.

Witt, W.P., Wisk, L.E., Cheng, E.R., Hampton, J.M., Creswell, P.D., Hagen, E.W., Spear, H.A., Maddox, T., Deleire, T., 2011. Poor prepregnancy and antepartum mental health predicts postpartum mental health problems among US women: a nationally representative population-based study. Womens Health Issues 21, 304–313.