The chronicity and timing of prenatal and antenatal maternal depression and anxiety on child outcomes at age 5

Rochelle F. Hentges,[1,2]

Susan A. Graham,[1,2]

Pasco Fearon,[3,4]

Suzanne Tough,[2,5,6*]

Sheri Madigan[1,2*]

Affiliations:
[1]Department of Psychology, University of Calgary, Calgary, Canada;
[2]Owerko Centre, Alberta Children's Hospital Research Institute, Calgary, Canada;
[3]Research Department of Clinical, Educational and Health Psychology, University College London, London, UK;
[4]The Anna Freud National Centre for Children and Families, London, UK;
[5]Department of Community Health Sciences, University of Calgary, Calgary, Canada; [6]Department of Pediatrics, University of Calgary, Calgary, Canada
*Shared senior authorship

Corresponding Authors: Rochelle F. Hentges, Owerko Centre, Third Floor – CDC Building, c/o 2500 University Drive NW, Calgary, AB T2N 1N4. e-mail: Rochelle.hentges@ucalgary.ca; and Sheri Madigan, Department of Psychology, University of Calgary, 2500 University Ave., Calgary, AB, T2N 1N4, Canada, Phone: (403) 220-5561; Fax: (403) 282-8249; email: sheri.madigan@ucalgary.ca

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Abstract

Background: Maternal depression and anxiety have been associated with deleterious child outcomes. It is, however, unclear how the chronicity and timing of maternal mental health problems predict child development outcomes. The aim of the current study was to assess the effect of both chronicity and timing of maternal anxiety and depression in pregnancy, infancy, and the toddler period on children's internalizing and externalizing symptoms, as well as social and communication skills at age 5. **Method:** Participants were 1,992 mother-child pairs drawn from a large prospective pregnancy cohort. Mothers reported on anxiety and depression symptoms with clinical screening tools at six time points between <25 weeks gestation and 3 years postpartum. Child outcomes were assessed at age 5. **Results:** Effect sizes were small for brief incidents of depression/anxiety and increased for intermittent and chronic problems (i.e., 3 or more timepoints) compared to mothers who had never experienced clinical-level anxiety or depression. Maternal anxiety/depression during pregnancy, infancy, and toddlerhood predicted all child outcomes, even after controlling for depression/anxiety during the other timepoints. However, maternal anxiety and depression during toddlerhood had a stronger association with child internalizing/externalizing symptoms and communication skills than either prenatal or postpartum depression/anxiety. **Conclusions:** Increasing number of exposures to clinical-level anxiety and depression is related to poorer child outcomes. Neither prenatal nor postpartum periods emerged as "sensitive" periods. Rather, maternal depression and anxiety during toddlerhood was more strongly associated with child outcomes at age 5. Results highlight the need for continued support for maternal mental health across early childhood.

Keywords: Depression, Anxiety/anxiety disorders, Child/Adolescent, pregnancy and postpartum, maternal-child

Approximately 10% to 15% of women experience mood disorders, such as depression, and/or anxiety in a given year (Ertel, Rich-Edwards, & Koenen, 2011; O'Donnell, Vanderloo, McRae, Onysko, Patten, & Pelletier, 2016; Reupert, Maybery, & Kowalenko, 2013), while perinatal mood disorders affect approximately 16% of mothers (Fairbrother, Janssen, Antony, Tucker, & Young, 2016). It is well-established that maternal mental health has wide-ranging implications for children's social, emotional, and cognitive development (Barker, Jaffee, Uher, & Maughan, 2011; Goodman et al., 2011; Grace, Evindar, & Stewart, 2003; O'Connor, Heron, Glover, & Team, 2002). Moreover, postpartum maternal mental illness has been regarded as particularly deleterious for maternal health and child development, with calls to consider it a major public health problem (Wisner, Chambers, & Sit, 2006). Research, however, has generally been constrained to examining the consequences of maternal mental health for children's development at a single time point, typically during the prenatal or acute postpartum period, and predicting child outcomes either concurrently or longitudinally. Accordingly, a paucity of research exists examining the role of chronicity and timing of maternal mental health problems in relation to child outcomes. Through repeated measurement of maternal mental health from pregnancy to age 3, this study seeks to attain a more nuanced understanding of the role of chronicity and timing of maternal depression and anxiety on child outcomes at age 5 to help inform preventative programs and intervention research.

Depression and anxiety symptoms are moderately stable over time (Lovibond, 1998), suggesting that some mothers experience chronic mental health problems, while others have either brief or intermittently recurring episodes, or no mental health difficulties at all. Although it has been proposed that chronic maternal depression is more problematic for early child development compared to brief or intermittent depression (Brennan et al., 2000; Giles, Davies, Whitrow, Warin, & Moore, 2011; Van Der Waerden et al., 2015),

research supporting this notion is very limited. More recently, attention has shifted to research suggesting that antenatal anxiety and depression "program" adverse health outcomes, including child mental health and cognitive development (Madigan et al., 2018; Tarabulsy et al., 2014). However, many of these studies ignore the potential importance of maternal depression and anxiety during early childhood on child development. Yet, women who experience postpartum depression are six times more likely to experience subsequent depressive episodes during the first four years of the child's life than women without postpartum depression (Josefsson & Sydsjo, 2007). Further, it has been posited that the accumulation of adversity over time (e.g., number of stressors exposed to or number of times exposed to adversity) is particularly detrimental to child development (Sameroff & Seifer, 1995).

While both prenatal and postpartum depression and anxiety have been associated with adverse child outcomes, only recently have studies begun controlling for prior (in the case of postpartum) or future (in the case of prenatal) maternal mental health. Importantly, while some studies continue to find an effect of maternal depression or anxiety at one time period, controlling for the other (Barker et al., 2011; O'Connor et al., 2002), to our knowledge, no previous studies have directly compared the strength of the effect sizes between different time periods. In addition, maternal mental health during the toddler years has received scarce attention relative to the prenatal and postpartum periods. During the toddler years, children experience rapid growth in social, emotional, and cognitive development, and maternal depression and anxiety during this time period may have profound implications for child development across these domains. Thus, without controlling for maternal depression during toddlerhood, it is unclear if the prenatal or postpartum periods are truly "sensitive" periods for linking maternal mental health to child outcomes.

To date, one study has examined the chronicity and timing of maternal depression (Brennan et al., 2000). This study demonstrated that chronicity of depression measured at four time points (during pregnancy, immediately after birth, 6 months, and 5 years) predicted both higher behavior problems and lower vocabulary sizes. They further found that concurrent maternal depression was a stronger predictor of child behavior problems than depression during either pregnancy or immediately post-partum. There are, however, limitations of this study, including a restricted examination of maternal mental health (i.e., depression only) and large gaps between maternal depression assessment periods (i.e., from 6 to 60 months postpartum), which limits conclusions regarding the role of timing on child outcomes.

With six assessments of maternal depression and anxiety across pregnancy (<25 and 35 weeks gestation), infancy (4 and 12 months), and toddlerhood (24 and 36 months), the current large-scale epidemiological study is designed to effectively address the role of chronicity and timing of maternal mental health on a range of critical child development domains at age 5, including child social skills, mental health, and communication abilities.

Method

Participants

Participants were drawn from a larger, on-going prospective pregnancy cohort in western Canada. Pregnant women were recruited through community advertising and at local primary health care offices and Laboratory Services. Women were eligible to participate if: they were > 18 years of age, could communicate in English, < 25 weeks gestation, and receiving prenatal care. Women with known multiple pregnancies were excluded. Between August 2008 and July 2011, 3387 women were enrolled in the study. The

original study was funded for three waves: < 25 weeks gestation, 34-36 weeks gestation, and 4 months postpartum. Subsequent

funding allowed for further follow-up assessments at 12, 24, 36, and 60 months of age. Due to delays in funding acquisition, some

participants had aged out of eligibility at these follow-up timepoints, resulting in smaller sample sizes (see Tough et al., 2017). Only

participants with data available at age 5 (N = 1992) were included in the current study. Sample characteristics can be found in Table 1.

As this was a community cohort study with anonymized data, participants who screened high on anxiety or depression were not

referred to treatment. However, all participants were provided with a list of mental health resources during administration of the

questionnaire. All procedures were approved by the institutional research ethics board.

Measures

  Maternal anxiety. Maternal anxiety was assessed with the Spielberger State Anxiety Inventory (SAI; Spielberger, Gorsuch, &

Lushene, 1970) at six time points: < 25 and 34-36 weeks gestation, and 4, 12, 24, and 36 months postpartum. Internal reliabilities were

satisfactory at all timepoints (αs from .91 to .93). Participant scores were coded as 0 = non-clinical or 1 = clinical-level anxiety

symptoms (scores of $\geq$ 40; Addolorato et al., 1999; Benediktsson, McDonald, & Tough, 2016) at all six timepoints (see Table 1 for

prevalence at each timepoint), which were then summed to create a measure of chronicity of clinical-level anxiety exposure ranging

from 0 to 6 times.

  Maternal depression. At < 25 and 34-36 weeks gestation, as well as 4 and 12 months postpartum, mothers completed the

Edinburgh Postnatal Depression Scale (EDPS; Cox, Holden & Sagovsky, 1987). At 24 and 36 months, the Center for Epidemiological

Studies Depression Scale (CES-D; Radloff, 1977) was used. Established cut-off points of 10 and 16 on the EDPS and CES-D,

respectively, were used as indicators of clinically significant depression. The EDPS and CES-D were moderately correlated and the magnitude of the correlation was similar to the stability estimates within measures. In addition, the percent of individuals who met the clinical cut-points was similar across both measures (see Table 1). Thus, both measures were retained in the study. Internal reliabilities were satisfactory at all timepoints, αs = .80 to .89. As with maternal anxiety, the number of times a mother met the clinical threshold for depressive symptoms were summed to create a measure of chronicity, ranging from 0 to 6.

Child mental health. At age 5, mothers completed the Behavior Assessment System for Children-Second Edition (BASC-2), a widely-used assessment of child psychological problems with established reliability and validity (Reynolds & Kamphaus, 2007). The current study used the Externalizing (α = .86) and Internalizing (α = .88) scales of the BASC. All analyses were conducted using combined-sex standardized T-scores (norm-referenced M = 50, SD = 10).

Child social skills. Child social skills were assessed with the BASC Social Skills scale. *Lower* T-scores on the Social Skills scale reflect greater problems in peer relations and prosocial behavior. The scale demonstrated satisfactory internal reliability, α = .84.

Child communication skills. At age 5, mothers completed the Children's Communication Checklist (CCC-2; (Bishop, 2006), a 70-item measure that assesses language (e.g., syntax, speech) and social communication skills (e.g., nonverbal communication, social relations). We used the standardized Global Communication scale, a composite of all 10 subscales on the measure, to assess the child's general communication skills (norm-referenced M = 100, SD = 15). Internal reliability was satisfactory, α = .76.

Covariates. We controlled for child sex (male = 1; female = 2), maternal education, and family income in all analyses. Maternal education was assessed on a scale of 1 (did not complete high school) to 6 (completed graduate school), while income was

reported in increments of $10,000 (1 = ≤$10,000; 11 = ≥$100,000). In addition, we controlled for maternal age and gestational age at birth, as well as maternal health risk during pregnancy using data collected from pregnancy medical records. Maternal health risk was assessed with the Antepartum Risk Score (APRS; Alberta Perinatal Health Program, 2009), which was completed by the attending physician at the time of delivery. Risk scores were based on a number of pre-existing risk factors (e.g., obesity), past pregnancy history (e.g., stillbirths), current pregnancy complications (e.g., gestational diabetes), and other risk factors (e.g., substance use). A weighted value is assigned to each condition based on the severity of the condition, and all values are summed to create a total risk score.

Statistical Analyses

To address chronicity of maternal anxiety and depression on child outcomes, we conducted analyses of covariance (ANCOVAs) in SPSS 25 to determine group differences amongst children as a function of the number of exposures to clinically-significant maternal depression or anxiety. As few mothers reported clinically significant levels of anxiety or depression at five (n = 28 for both anxiety and depression) or all six (n = 18 for anxiety, n = 11 for depression) assessment periods, we conducted analyses with five exposure groups: 0 times, 1 time, 2 times, 3 times, and 4 or more times.

To address timing of anxiety and depression on child outcomes, we aggregated the six assessment points into three developmental periods: prenatal (i.e., < 25 weeks gestation; 34-36 weeks gestation; rs= .61 and .62 for depression and anxiety, respectively), postpartum (i.e., 4 and 12 months; rs = .58 and .60), and toddlerhood (i.e., 24 and 36 months; rs = .57 and .62). Only a very small portion of the sample met the clinical cut-off criteria for depression or anxiety during only one developmental period.

Therefore, to increase power, we used the full continuous scores of maternal anxiety and depression. Because mothers completed two assessments during each developmental period, the two scores were averaged together to create a composite of maternal anxiety or depression during each developmental period. Two path analysis models (one for maternal depression and one for maternal anxiety) were conducted in AMOS 25 using maternal depression/anxiety scores at each of the three developmental periods to simultaneously predict the four child outcomes. Path analysis is a form of multiple regression that models directional effects between one or more predictor variables (e.g., maternal depression) and one of more dependent variables (e.g., child outcomes at age 5) (see Supplemental Figure 1 for the structural model). Thus, regression estimates for maternal depression and anxiety during each developmental period controls for the effects of maternal depression or anxiety during the other two developmental periods. To retain the full sample size of 1992, path analysis models used full information maximum likelihood (FIML) estimation to handle missing data. FIML is a widely accepted technique and is considered superior to listwise and pairwise deletion procedures because it optimally maintains the original structural association between variables in the model. (Enders, 2001).

Results

Chronicity of Maternal Anxiety and Depression

The main effects of chronicity of maternal anxiety and depression were significant for all four child outcomes, Fs(4) = 9.04-27.98, ps < .001, partial etas squared = .02-.07. Results of these analyses are presented in Figures 1 and 2. Post-hoc analyses, using a Bonferroni adjustment for multiple comparisons, suggested that being exposed to maternal anxiety or depression at even one time point was related to significantly worse child externalizing, internalizing, social skills, and general communication skills (see Figures

1 and 2). However, being exposed at two time points was not significantly worse than being exposed at only one assessment point. Generally, three or more exposures was worse than being exposed at only one time period. Pairwise comparisons suggested there were no differences between children exposed to either maternal anxiety or depression at three versus four or more time points on any of the child outcomes.

Timing of Maternal Anxiety and Depression

Controlling for maternal anxiety in the postpartum and toddlerhood periods, prenatal anxiety was associated with greater child internalizing symptoms, and lower communication and social skills, but did not significantly predict child externalizing problems (see Table 2). Controlling for prenatal anxiety, maternal anxiety during both the postpartum period and toddlerhood was associated with all four child outcomes at age 5. Results for maternal depression were similar (see Table 2), with the exception that postpartum depression did not predict child communication skills at age 5.

To determine if maternal anxiety or depression during one developmental period had a stronger effect on child outcomes than anxiety or depression during a different time period, we compared the model fit when paths were constrained to be equal versus free to vary. Chi-square difference tests revealed that maternal anxiety during the toddler years (ages 2 and 3) had a stronger effect on child internalizing and externalizing symptoms at age 5 than either prenatal or postnatal anxiety (see Table 3). The strength of effects on child communication or social skills at age 5 did not significantly differ according to the developmental period of maternal anxiety. Maternal depression during toddlerhood had a stronger effect on child internalizing and externalizing symptoms and communication

skills than either prenatal or postnatal depression. There were no significant differences in effect sizes of maternal depression across the prenatal, postpartum, and toddlerhood periods for child social skills.

Follow-Up Sensitivity Analyses

We conducted follow-up sensitivity analyses estimating missing data using Expectation-Maximization (EM) analyses prior to running ANCOVA analyses in SPSS 25.Chronicity of both maternal depression and anxiety predicted all four child outcomes, Fs(4) = 9.72-32.22, ps < .001. In addition, the same general pattern of follow-up group differences were replicated: maternal depression/anxiety at even one time point was related to significantly worse child outcomes than no maternal depression/anxiety, and chronic mental health problems (i.e., 4 or more times) predicted worst child outcomes than intermittent mental health problems (i.e., one or two time points). Estimated means are presented in Supplemental Table 1.

We also conducted follow-up analyses with additional covariates to provide a rigorous test of our models. In addition to the six covariates selected a priori and described in the methods section, we re-ran all analyses while controlling for (a) ethnic minority status; (b) maternal perceived social support; (c) perceived support from partner; (d) psychotropic medication use during pregnancy; (e) prior suicidal thoughts or actions; (f) number of cigarettes smoked per day during pregnancy; and (g) maternal binge-drinking (i.e., 5 or more drinks in one sitting) during infancy. Chronicity of maternal depression and anxiety continued to predict all four child outcomes at age 5, Fs(4) = 2.80-14.81, ps < .05. In addition, the finding that maternal depression/anxiety during toddlerhood had a stronger effect than either prenatal or postpartum depression/anxiety on child internalizing and externalizing symptoms and general communication skills at age 5 was replicated (see Supplemental Table 2 for effect sizes).

Discussion

The current study's aims were two-fold: first, to examine how chronicity of maternal depression and anxiety affects child outcomes across a range of important developmental domains; and second, to examine how the timing of exposure to maternal anxiety and depression differentially predicted child outcomes. In line with the accumulation hypothesis of adversity (Sameroff & Seifer, 1995), chronicity of maternal depression heightened the risk of child psychopathology symptoms (i.e., internalizing and externalizing) and predicted lower communication skills. Extending previous findings (Brennan et al., 2000), we found that chronicity of maternal depression was associated with lower social skills at age 5, an age at which social skills become increasingly important as children make the transition into formal schooling. These results were replicated for maternal anxiety. This study makes a novel contribution by demonstrating that chronicity of maternal depression and anxiety in early childhood is associated with poorer outcomes across the domains of children's mental health, social skills, and communication abilities.

Previous studies have established that trajectories of chronically high depression are related to poorer child outcomes than persistently low depressive symptoms (Campbell, Matestic, von Stauffenberg, Mohan, & Kirchner, 2007; Van Der Waerden et al., 2015). However, the current study builds on these findings by more fully examining group differences in the number of times children were exposed to clinical-level maternal mental health problems from the prenatal to toddler period. Results suggest that exposure to clinical-level maternal anxiety or depression at even one time point was related to poorer child outcomes compared to children of non-depressed mothers. However, the effect sizes were small, with mean differences falling in the range of .15 and .29 normed standard deviations. In contrast, the differences between those exposed to either maternal anxiety or depression at 0 compared to 4 or more

timepoints were in the range of .38 and .89 normed standard deviations, representing medium to large effect sizes. There were no significant differences between those exposed to maternal mental health problems at 3 versus 4 or more assessment points. Together, these results indicate that brief and isolated periods of maternal depression or anxiety may constitute small risk factors, but that intermittent (e.g., 3 of 6 assessment periods) or chronic (4 or more assessment periods) maternal depression and anxiety represent stronger risk factors for poorer child development outcomes. Notably, the pattern of results was highly similar across exposure to maternal anxiety and depression, suggesting that, at least in this sample, chronicity of maternal anxiety imparts similar effects on child outcomes as chronicity of maternal depression.

In regard to the second aim, the current study, to our knowledge, is the first to compare the unique predictive power of maternal depression and anxiety during the prenatal, postpartum, and toddler years. Results suggest that higher maternal anxiety during any of these early developmental periods is related to higher child internalizing symptoms and poorer child communication and social skills, controlling for maternal anxiety levels during the other developmental periods. Results were similar for maternal depression, with the exception that postpartum depression was unrelated to child communication skills after controlling for depression during pregnancy and toddlerhood.

These results counter the notion that the prenatal or immediate postpartum period are the most "sensitive periods" for child exposure to maternal anxiety of depression (Bagner, Pettit, Lewinsohn, & Seeley, 2010; Glover, 2014; Kingston & Tough, 2014; Thapar & Rutter, 2009). Rather, our results indicate that maternal anxiety or depression during the toddler years (ages 2-3) had a stronger effect on child internalizing and externalizing symptoms as well as communication skills at age 5 than either prenatal or

postpartum maternal mental health. Toddlerhood is a period of rapid growth in emotional, behavioral, and communicative development. Thus, this could represent a sensitive period for the effects of maternal depression and anxiety on these key developmental tasks. Another possibility is that these findings reflect a "recency" effect. Indeed, previous research has found that increasing maternal depression (i.e., low initial levels that rise during the investigative period) has similar effects on child outcomes as high-chronic depression (Campbell et al., 2007). Future research should extend into the early school years to help further disentangle these timing effects.

Two other findings related to the developmental timing of maternal anxiety and depression on child outcomes are noteworthy. First, maternal depression during the prenatal and toddler periods was related to child communication skills at age 5, but postpartum depression was not. While some previous studies have found that postpartum depression predicts lower child communication and language skills (Kawai et al., 2017; Valla, Wentzel-Larsen, Smith, Birkeland, & Slinning, 2016), others have not (Cornish et al., 2005; Paulson, Keefe, & Leiferman, 2009; Piteo, Yelland, & Makrides, 2012). Prior research has almost exclusively examined the effects of postnatal depression on child communication and language during infancy or toddlerhood. In addition, to our knowledge, none of these studies have controlled for maternal depressive symptoms during both pregnancy and the toddler years. Thus, it is possible that postpartum maternal depression, independent of depression during pregnancy and the toddler years, does not have an effect on child communication abilities during the kindergarten period. Future research should attempt to replicate this finding. Second, while maternal depression and anxiety during the postpartum and toddler years were related to child externalizing symptoms, prenatal depression and anxiety were not. One possible explanation is that maternal depression and anxiety are related to child behavior

problems through social learning processes (Bandura & Walters, 1977) as opposed to a programming effect in utero (Barker, 1990). This is in line with recent findings that prenatal mental health was only indirectly related to externalizing problems in early childhood through its effects on maternal mental health and harsh parenting during infancy (Hentges, Graham, Plamondon, Tough, & Madigan, 2019).

Implications

The results of the current study underscore the importance of assessing maternal mental health and well-being in order to intervene early to support child healthy development across a range of domains. Increasing evidence and awareness about the effects of maternal mental health on the developing child has led to calls to develop wide-spread screening and prevention programs for mothers during the prenatal and postpartum periods (Glover, 2014; Murray, Fearon, & Cooper, 2015). However, implementation of universal screening has lagged, with providers citing a lack of knowledge about mental health diagnoses and community resources as prime barriers (Wakida et al., 2018). Furthermore, physician screening for mental health problems, when it exists, is almost exclusively tied to the prenatal and early postpartum period. Yet, the current study highlights that maternal depression and anxiety during the toddler years may be just as important for healthy child development as perinatal depression and anxiety. Thus, screening for maternal mental health should start early *and* continue into the childhood period.

Given the widespread implications for child health and development, an integrated approach to maternal and pediatric primary care could be particularly beneficial for families. For example, with appropriate training, pediatricians or family nurses/health visitors should inquire about mothers' (and fathers') existing or past psychological problems and provide mental health screeners for parents at

well-baby visits. Screening need not be onerous, as two- and three-item screening tools have been implemented and report good sensitivity and specificity for detecting depressive and anxiety disorders (Cuijpers, Smits, Donker, Have, de Graaf, 2009). Mothers who report positive symptoms can be provided with follow-up screening or assessment by their primary care practitioners and, if necessary, referrals to mental health services should be made. Future research should also attempt to capture how treatment of mood disorders (e.g., anti-depressant and anti-anxiety medications; psychotherapy) may disrupt the trajectory and course of both maternal mental health symptoms over time and their relation to later child outcomes.

Strengths and Limitations

There are a number of strengths of the current study, including the use of well-validated instruments of maternal mental health and child development in a prospective design that assesses maternal mental health from pregnancy through the toddler years. The results should also be interpreted within the context of several limitations. First, the sample was predominantly white with middle to high socio-economic backgrounds. Depression and anxiety tend to be higher in low SES and minority women (Myers et al., 2002); therefore results may not generalize to higher risk samples. Second, maternal mental health and child outcomes were both assessed via maternal report, and mothers experiencing depression or anxiety may view their child's behavior and development more negatively. However, this limitation is mitigated by the lapse in time between the last assessment of maternal mental health at age 3 and the assessment of child outcomes at age 5. In addition, a systematic review found no clear evidence that depressed mothers have distorted perceptions of their children's development (Richters, 1992). Third, the current study only assessed maternal mental health problems, and future research should also examine paternal psychiatric problems. Fourth, while appropriate for large-scale population-based

studies, the screening tools used in the current study have a number of limitations, including that they are not diagnostic and only ask about symptoms within the last 7 days. In addition, in order to maximize power to detect group differences in the first set of analyses, we used a threshold of 10 on the EDPS, which is generally described as the threshold for "minor" depression. While this cut-off criterion is commonly used in community cohort research and has been found to have specificity and sensitivity rates above 80% (Benvenuti, Maurizio, Niccolai, Valoriani, & Cox, 1999; Murray & Carothers, 1990), findings may differ when considering more severe cases of depression.

Conclusions

This study suggests that exposure to maternal anxiety or depression at even one time point between the prenatal and toddler period is associated with small effects on child socio-emotional, mental health, and cognitive functioning, while exposure to intermittent or chronic depression and anxiety (i.e., 3 or more time points) represents a larger risk factor for child development. Maternal depression and anxiety during all three developmental periods (prenatal, postpartum, toddlerhood) generally continued to predict child outcomes at age 5 after controlling for symptoms during the other developmental periods. However, maternal depression and anxiety during the toddler period had stronger effects on child mental health outcomes at age 5 than either prenatal or postpartum depression or anxiety. These results support recent calls to consider maternal mental health a public health concern (Wisner et al., 2006), and highlight the need for continuing maternal mental health support that spans developmental periods from pregnancy through early childhood (and potentially beyond). This study also highlights the need for longitudinal studies of child development to account for the effects of both prior (e.g., at birth) and on-going maternal mental health problems on child development.

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Figure Legends

Figure 1. Effect of chronicity of maternal depression on child externalizing (a), internalizing (b), social skills (c), and communication skills (d).

Notes. Error bars represent 95% confidence intervals. Columns that share subscripts are not significantly different from each other. Sample sizes vary slightly across analyses due to missing data.

Figure 2. Effect of chronicity of maternal anxiety on child externalizing (a), internalizing (b), social skills (c), and communication skills (d).

Notes. Error bars represent 95% confidence intervals. Columns that share subscripts are not significantly different from each other. Sample sizes vary slightly across analyses due to missing data.

Supporting Information

Supplemental Figure 1. Structural Path Analysis Model. Covariates, described in the methods section, were also included in the analytical models but are not shown for clarity of presentation.

Table 1

Sample Characteristics

Characteristic	%
Maternal age, mean (SD)	30.87 (4.36)
Race/ethnicity	
White	81.9
Asian	10.7
Hispanic	1.6
Black	1.2
Indigenous	.5
Mixed or other	4.1
Maternal education	
Less than high school diploma	1.8
High school diploma	5.7
Some college or trade school	13.0
Completed college or trade school	63.4
Some or completed graduate school	16.2
Annual family income, CAD	
< 40,000	5.8
40,000-80,000	21.0
> 80,000	73.2
Depression prevalence	
< 25 weeks gestation	14.7
34-36 weeks gestation	13.8
4 months	10.2
12 months	11.1
24 months	12.1
36 months	11.7
Anxiety prevalence	
< 25 weeks gestation	14.1
34-36 weeks gestation	18.1
4 months	13.1
12 months	16.0

24 months	14.8
36 months	14.6
Antepartum Risk Score[a]	
Low risk	68.0
Moderate risk	28.8
High risk	3.2

[a] Based on prior validation (Parboosingh, 1986), scores of 0 to 2 are considered low risk, scores of 3 to 6 indicate moderate risk, and scores of 7 or more reflect high risk.

Note. CAD = Canadian dollars.

Table 2

Standardized Effects of Maternal Depression/Anxiety During Pregnancy, Infancy, and Toddlerhood on Child Outcomes at Age 5

	Externalizing	Internalizing	General Communication	Social Skills
Model 1: Anxiety[a]				
Family Income	-.01	.00	**.07****	-.01
Maternal Education	**-.06****	.01	**.12*****	.02
Maternal Age	-.01	**-.09*****	-.01	**-.08****
APRS	.00	.00	.02	**.06***
Gestational Age	.03	.03	.03	-.01
Child Sex	**-.19*****	.03	**.14*****	**.18*****
Prenatal Anxiety	.01	**.06***	**-.07***	**-.08***
Postpartum Anxiety	**.08****	**.08****	**-.07***	**-.09****
Toddlerhood Anxiety	**.19*****	**.19*****	**-.15*****	**-.08***
Model 2: Depression[a]				
Family Income	-.01	.02	**.06****	-.01
Maternal Education	**-.06***	.02	**.12*****	.02
Maternal Age	.01	**-.08****	-.02	**-.09*****
APRS	-.01	.00	.02	.05
Gestational Age	.04	.03	.02	-.01
Child Sex	**-.19*****	.03	**.14*****	**.18*****
Prenatal Depression	.03	**.12*****	**-.09****	**-.07***
Postpartum Depression	**.06***	**.07***	-.04	**-.07***

Toddlerhood Depression	**.22*****	**.21*****	**-.19*****	**-.08****

Note. Child Sex: 1 = Male, 2 = Female. Bolded values represent significant effects. $^*p \leq .05$; $^{**}p \leq .01$; $^{***}p \leq .001$.

[a] All possible predictive pathways between exogenous and endogenous variables were estimated, as were covariances between predictors assessed at the same time point, resulting in a saturated model, which by definition fits the data perfectly, χ^2 (0, $N = 1992$) = 0.00, RMSEA = .00, CFI = 1.00, TLI = 1.00).

Table 3

Comparison of Effect Sizes According to Timing of Maternal Anxiety and Depression on Child Outcomes at Age 5

	Model 1: Anxiety		Model 2: Depression	
	$\Delta\chi^2$ $(df = 1)$	*p*-value	$\Delta\chi^2$ $(df = 1)$	*p*-value
Externalizing				
Prenatal vs. Postpartum	2.07	.15	.43	.51
Prenatal vs. Toddlerhood	**13.47**	**<.001**	**17.34**	**<.001**
Postpartum vs. Toddlerhood	**5.06**	**.02**	**10.60**	**.001**
Internalizing				
Prenatal vs. Postpartum	.11	.74	1.21	.27
Prenatal vs. Toddlerhood	**4.79**	**.03**	**3.77**	**.05**
Postpartum vs. Toddlerhood	**6.13**	**.01**	**8.60**	**.003**
General Communication				
Prenatal vs. Postpartum	.01	.92	1.14	.29
Prenatal vs. Toddlerhood	2.19	.14	**4.85**	**.03**
Postpartum vs. Toddlerhood	2.62	.11	**9.87**	**.002**
Social Skills				
Prenatal vs. Postpartum	.01	.92	.01	.92

Prenatal vs. Toddlerhood	.02	.89	.05	.82
Postpartum vs. Toddlerhood	.05	.82	.02	.89

Note. Bolded values represent significant differences in effect sizes between developmental periods, $p \leq .05$.

Supplemental Table 1
Estimated means of child outcomes, controlling for covariates, according to number of times mothers reported clinical levels of depression/anxiety

	0 times	1 time	2 times	3 times	4 or more times
Maternal Anxiety	($n = 1253$)	($n = 337$)	($n = 154$)	($n = 98$)	($n = 148$)
Externalizing	48.16$_a$	50.17$_b$	49.53$_{a,b}$	53.01$_c$	53.41$_c$
Internalizing	49.06$_a$	51.49$_b$	51.92$_{b,c}$	54.80$_{c,d}$	56.03$_d$
General Communication	109.75$_a$	106.67$_b$	104.86$_{b,c}$	103.24$_{b,c}$	101.38$_c$
Social Skills	55.04$_a$	52.90$_b$	52.51$_b$	51.72$_b$	50.65$_b$
Maternal Depression	($n = 1334$)	($n = 332$)	($n = 153$)	($n = 70$)	($n = 101$)
Externalizing	48.26$_a$	50.15$_b$	50.84$_b$	52.29$_b$	54.54$_c$
Internalizing	49.12$_a$	51.34$_b$	53.41$_b$	56.48$_{b,c}$	57.21$_c$
General Communication	109.70$_a$	105.59$_b$	104.53$_b$	103.00$_b$	100.16$_c$
Social Skills	54.77$_a$	53.07$_b$	52.52$_b$	50.81$_b$	51.21$_b$

Notes. Estimated means with different subscripts across rows are significantly different from each other, using Bonferroni adjustments for multiple comparisons. The final sample using EM to estimate missing data is 1990, and not 1992, because 2 participants were missing gender data from medical records and mom reports at all data assessment periods, and EM does not estimate categorical data.

Supplemental Table 2

Follow-Up Sensitivity Analyses Examining the Timing of Maternal Anxiety and Depression on Child Outcomes, with Additional Covariates

	Externalizing	Internalizing	General Communication	Social Skills
Model 1: Anxiety[a]				
Family Income	-.02	.03	.04	-.02
Maternal Education	-.04	.02	**.12*****	.02
Maternal Age	.00	**-.09*****	-.01	**-.08****
APRS	-.01	.00	.02	**.06***
Gestational Age	.02	.04	.01	-.01
Child Sex	**-.19*****	.03	**.14*****	**.18*****
Psychotropic Medication	-.02	-.02	-.04	**-.05***
Prior Suicidal Ideation	**-.08*****	**-.10*****	**.05***	.01
Ethnic Minority	**-.05***	**.06****	**-.10*****	.02
Social Support	-.03	-.03	.04	**.10*****
Partner Support	.02	-.03	-.01	.02
Prenatal Smoking	**.05***	.03	-.03	.04
Binge Drinking	.03	.01	-.03	-.03
Prenatal Anxiety	-.01	**.06***	-.04	-.05
Postpartum Anxiety	**.07***	**.07***	-.05	**-.07***
Toddlerhood Anxiety	**.18*****	**.17*****	**-.14*****	**-.08***
Model 2: Depression[a]				
Family Income	-.01	.03	.04	-.02
Maternal Education	-.04	.02	**.11*****	.02
Maternal Age	.02	**-.07****	-.02	**-.08****
APRS	-.01	.00	.02	**.06***
Gestational Age	.03	.04	.01	-.01
Child Sex	**-.19*****	.02	**.14*****	**.18*****
Psychotropic Medication	-.01	-.02	-.04	**-.05***
Prior Suicidal Ideation	**-.07****	**-.07****	.03	.01
Ethnic Minority	**-.06***	**.05***	**-.09*****	.03

Social Support	-.02	-.01	.03	**.12*****
Partner Support	.02	-.04	-.01	.02
Prenatal Smoking	**.05*****	.03	-.03	.04
Binge Drinking	.03	.01	-.03	-.03
Prenatal Depression	.03	**.12*****	**-.06*****	-.03
Postpartum Depression	.05	**.06*****	-.03	-.05
Toddlerhood Depression	**.21*****	**.20*****	**-.18*****	**-.08*****

Note. Child Sex: 1 = Male, 2 = Female. Bolded values represent significant effects. *$p \le .05$; **$p \le .01$; ***$p \le .001$.

[a] All possible predictive pathways between exogenous and endogenous variables were estimated, as were covariances between predictors assessed at the same time point, resulting in a just-identified model, which by definition fits the data perfectly, χ^2 (0, $N = 1992$) = 0.00, RMSEA = .00, CFI = 1.00, TLI = 1.00).