

Trajectories of maternal depressive symptoms across the birth of a child: associations with toddler emotional development

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Received: 4 January 2015 / Accepted: 5 July 2015
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Abstract Depression during the perinatal period is common and impacts the physical and psychological well-being of those who experience it. One area of particular significance is the course of maternal depression across time, including the differential effects of depression trajectories during the perinatal period on early child development. The current study explored trajectories of maternal depressive symptoms from pregnancy through 2 years postpartum and their relation to toddler emotional development. Participants included 120 primarily low-income, ethnically diverse women and their toddlers. Depression was assessed during pregnancy, at 3 months postpartum, and at 1 and 2 years postpartum. Toddler emotional development was assessed at age 2 via video observations and mother report. Results indicated a four-class model that best fits the data: low-decreasing (47.5 %), stable-low (22.5 %), stable-moderate (21.7 %), and increasing (8.3 %) trajectories of maternal depressive symptoms. Women in the increasing group reported significantly more toddler social and emotional problems at age 2 than women in all other groups, and women in the stable-moderate group reported significantly more toddler social and emotional problems at age 2 than women in the stable-low group. No associations between trajectories and observed toddler affect expression were found. Results highlight variable courses of depressive symptoms for women across the birth of a child as well as the importance of reducing depression for the benefit of both mother and child. It is important for clinicians working with

pregnant and postpartum mothers to assess for depressive symptoms over time and not just at a single time point.

Keywords Maternal depression · Trajectories · Pregnancy · Postpartum · Toddler emotional development

Maternal depression during the perinatal period (i.e., pregnancy and the years immediately after giving birth) is highly prevalent and has been shown to negatively affect the developing fetus as well as the mother's parenting resources. For example, maternal depression has been associated with numerous deleterious impacts on the health and well-being of the mother such as an increased risk for suicidal ideation, lower maternal self-esteem, and greater parenting stress as well as negative developmental outcomes of the fetus and growing child (see Diego et al. 2009; Field 1995; Field et al. 2010; Luoma et al. 2001; O'Hara 2009; Paris et al. 2009). Even mild levels of maternal depression have been shown to impact psychosocial functioning and parenting in ways similar to chronic or higher levels of depression (Fleming et al. 1988; Goodman and Tully 2009; Weinberg et al. 2001).

Maternal depression has also been associated with problematic infant and toddler social and emotional development such as the expression of more negative and less positive facial expressions and greater general negative emotionality (Forbes et al. 2004). Recent studies have begun to examine trajectories of maternal depressive symptoms in order to better understand how different courses, or patterns, of maternal depressive symptoms across time affect developing children. Given the prevalence of maternal depression and its associations with problematic parenting very early in a child's life, further examination regarding the effects of maternal depression on infant and toddler development is warranted. The current study aims to identify trajectories of maternal

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depressive symptoms from pregnancy through 2 years following the birth of a child. Possible differences in toddler emotional development at age 2 between groups based on different maternal depression trajectories are also explored.

Maternal depression during the perinatal period

The Centers for Disease Control and Prevention's National Center for Health Statistics estimates prevalence rates of major depressive disorder to be 5.4 % across adults and 6.7 % among US women (Pratt and Brody 2008). A postpartum onset specifier can be assigned when the onset of a major depressive episode is during pregnancy or within 4 weeks following the birth of a child according to the Diagnostic and Statistical Manual for Mental Disorders, fifth edition (American Psychiatric Association 2013). However, the term *postpartum depression* is often used to refer to clinical diagnoses of depression or significant symptom levels of depression that occur throughout the first several years after birth, as will be done in the current paper. Likewise, the term *prenatal depression* in this paper will refer to significant symptom levels of depression, as well as diagnoses of depression, that occur during pregnancy.

Research indicates that the prevalence rate of prenatal depression ranges from 1.7 to 20.8 %, depending on outcome measures and criteria used (Banti et al. 2011; Bennett et al. 2004). Reported prevalence rates of minor to severe depression in the postpartum period range from 5.7 to 19.2 % (Gavin et al. 2005; O'Hara and Swain 1996). Furthermore, studies examining prevalence rates of problematic symptom levels of maternal depression anytime during the perinatal period report rates as high as 40 % (Chaudron et al. 2004). Thus, rates of depressive symptoms throughout the perinatal period are quite high and exceed rates reported for the general population (Kessler et al. 2005).

Patterns of maternal depression

Past research has suggested that rates of prenatal depression tend to be higher than postpartum depression, indicating that, for most women, there may be a decline in depression across the perinatal period and beyond (Banti et al. 2011). For example, Wu and colleagues (2011) examined maternal depression from 1 to 36 months postpartum, using cutoff scores on a self-report measure to indicate probable (or risk of) depression at multiple time points. They reported that depressive symptoms decrease over time for the whole sample, on average. Additionally, they noted that, while symptoms initially decreased rather quickly between 1 and 6 months, the rate of decline slowed from 6 to 36 months.

However, there is evidence to suggest that many women experience different patterns or trajectories of depression before and after giving birth. For instance, Luoma and colleagues (2001) noted variability in symptom levels of maternal depression from pregnancy through 8–9 years after giving birth, suggesting that many women experience recurring episodes rather than a steady decline or a stable trajectory. Depression peaked during pregnancy and again at 6 months postpartum, followed by a decline throughout the following years. Therefore, rather than an overall decline in reported symptoms over time, Luoma and colleagues found support for a different, but common, pattern characterized by variability.

Recently, researchers have begun examining individual differences in symptom change over time using a person-centered approach, rather than the more typical variable-centered approach. The person-centered approach allows for the examination of unique and meaningful subgroups defined by symptom change over time, whereas the variable-centered approach aims to identify global across-sample trends (Bergman and Magnusson 1997). This person-centered approach has gained popularity in developmental and clinical research. For example, Vänskä and colleagues (2011) examined trajectories of self-reported maternal mental health symptoms (depression, anxiety, sleeping difficulties, and social dysfunction) from pregnancy through 1 year postpartum as well as the effects of these trajectories on child health and development 7–8 years later. The researchers uncovered five distinct trajectories of composite mental health profiles, which they labeled as follows: stable-low (75 %), prenatal (7 %), early postpartum (9 %), late postpartum (6 %), and chronic high (5 %) trajectories. The women in the prenatal class reported the highest number of symptoms during pregnancy; the women in the early postpartum class reported a high amount of symptoms at 2 months postpartum, but little to no symptoms during pregnancy or at 1 year postpartum; and the late postpartum group reported few symptoms during pregnancy and at 2 months postpartum but reported a high level of symptoms at 1 year postpartum. Children of the women in the early postpartum and chronic high groups had higher reported internalizing symptoms compared to children of women in the stable-low group. Children of women in the chronic high group also demonstrated more executive functioning and memory problems than children of women in the other groups.

Campbell and colleagues (2007) identified six different trajectories of maternal depression from 1 to 7 years following the birth of a child: low-stable (45.6 %), moderate-stable (36.4 %), intermittent (3.6 %), moderate-increasing (6.2 %), high-decreasing (5.6 %), and chronic (high stable; 2.5 %) trajectories. They concluded that stable patterns of depression, especially of a low to moderate severity level, characterize most women's experiences. This is in contrast with previous

variable-centered research, which has suggested that a decreasing trajectory characterizes most women's experience. Furthermore, this study found that, by first grade, children of mothers in the low-stable, moderate-stable, and intermittent groups had fewer internalizing and externalizing symptoms than children of mothers in the moderate-increasing, high-decreasing, and high-chronic groups. Children of mothers in the low- and moderate-stable groups also demonstrated better cognitive skills than children of mothers in the intermittent depression group. Campbell and colleagues (2009) then expanded their findings by examining trajectories of maternal depression from 1 to 12 years following the birth of a child while incorporating contextual risk in order to better understand the course of maternal depressive symptoms and the impact on child development. The authors identified five latent classes: never depressed (48.5 %), stable subclinical (30.8 %), early decreasing (5.1 %), moderately elevated (10.9 %), and chronic (4.7 %). In regards to contextual risk, being married, having higher education, and being in better physical health were related to lower depressive symptoms. The authors again found evidence that maternal depression is associated with later behavioral problems, this time stretching into adolescence (i.e., age 15). Thus, recent research suggests that there are important individual differences in depression trajectories among women from pregnancy through the first several years after birth; however, what is less well known is how different trajectories of maternal depression, beginning in pregnancy, may affect women and their young children. In particular, few studies have examined the effects of trajectories of maternal depressive symptoms on toddler emotional development, specifically. The examination of trajectories and subsequent early developmental outcomes has important implications for assessment and intervention for women and their young children.

The effects of maternal depression on infant and toddler development

As noted earlier, prior research has indicated that maternal depression has a negative effect on the affect expression, and more general emotional development, of infants and toddlers. These associations may be partially explained through the context of the bonds that infants share with caregivers. Young children learn about the world and how to respond to it through relationships with others, and maternal depression is believed to disrupt the central relational connection between a mother and her infant because of how it limits the mother's parenting resources and impairs mother–infant interactions (Beebe et al. 2012; Field 2010; Tronick and Weinberg 1997). Studies have found, for example, that maternal depression negatively impacts maternal sensitivity, responsivity, and engagement with the infant, and mother–child interactions

tend to be characterized by greater negativity, less facial empathy, and poor communication (Albright and Tamis-LeMonda 2002; Beebe et al. 2012; Murray 1992; O'Hara 2009). Infants also learn how to regulate their emotions from the affective messages they receive from their mothers, and it has been suggested that the relay of negative feelings through facial expressions and verbal and non-verbal behaviors may impede healthy emotional development (Albright and Tamis-LeMonda 2002; Gravener et al. 2012). In fact, research shows that infants and toddlers of depressed mothers display more negative and less positive affect themselves (Albright and Tamis-LeMonda 2002; Feldman et al. 2009; Hart et al. 1998; Righetti-Veltema et al. 2002). Thus, there is evidence that maternal depressive symptoms have an effect on various forms of infant emotional development; however, the mechanisms of exposure over time that explain how young children are affected have yet to be fully understood. Although some researchers have begun to examine trajectories of maternal depressive symptoms and associations with developmental outcomes of school-aged children, researchers have yet to examine the effects of trajectories of maternal depressive symptoms on the emotional development of toddlers.

The current study

A person-centered framework has become an increasingly important approach to understand individual differences as well as to identify and examine developmental pathways of adjustment (Muthen and Muthen 2000; Nesselroade 1991). Therefore, the current study takes a person-centered approach to address two primary aims: (1) to explore trajectories of maternal depressive symptoms beginning in pregnancy through 2 years following the birth of a child and (2) to examine how these trajectories affect toddler emotional development. It was hypothesized that

1. Different trajectories of maternal depressive symptoms would emerge. Specifically, trajectories characterized by increasing, decreasing, and stable symptoms of depressive symptoms would be identified.
2. Trajectories of maternal depressive symptoms would have differential effects on toddler emotional development at age 2. More specifically, a trajectory characterized by consistently high or increasing levels of maternal depressive symptoms would be related to generally negative toddler emotionality and more mother-reported toddler emotional problems. In contrast, a trajectory characterized by consistently low or decreasing levels of maternal depressive symptoms would be related to generally positive toddler emotionality and less mother-reported toddler emotional problems.

Method

Participants

Participants included a community sample of 120 primarily low-income pregnant women (mean age=26.2 years, SD=5.7) who participated in a five-panel longitudinal study on parenting that began in pregnancy and extended through the child's third birthday (November 2007 to April 2012). Twenty-five percent of the sample was first-time mothers. Detailed demographic information is presented in Table 1. Data from the first four panels are used in the current study; data from the fifth wave did not include relevant child outcomes. The first panel (T1) was completed when the women were in their third trimester of pregnancy, the second (T2) panel was completed when their infants were 3 months old ($n=119$; 99 % retention), the third (T3) panel was completed at 1 year postpartum ($n=114$; 95 % retention), and the fourth (T4) panel was completed at 2 years postpartum ($n=99$; 83 % retention). In terms of reasons for attrition, at T2, one participant was unable to be located at the time of the interview. At

T3, three participants were unable to be located, two participants withdrew from the study, and one participant moved out of the country. At T4, 10 participants were unable to be located, 4 were too busy (but agreed to be contacted for future waves), 6 withdrew from the study, and 1 had moved out of the country. No evidence for differential attrition was found. Bivariate analyses revealed that participants who completed the assessments at T2, T3, and T4 did not differ in terms of maternal age, family income, maternal race, marital status, and education from those who were lost due to attrition.

Procedures

Participants were recruited via flyers advertising a study about parenting placed in areas serving primarily low-income families. Eligible women were enrolled into the study if they were currently pregnant, at least 18 years of age, and able to speak fluent English. Interested participants were scheduled for the pregnancy interview once they were in their third trimester of pregnancy. The interviews were conducted in the participant's home (81 %) or at a research office (19 %) based on the preference of the participant. Interviews were conducted by teams of two research assistants and lasted approximately 2.5 to 3 h.

The pregnancy interview included a battery of questionnaires and other assessments. Questionnaires were administered in the same predetermined order for each participant, which was strategically determined to build rapport with the participants by initially asking less sensitive questions before querying more sensitive topics. Research assistants read the questions aloud and circled the response of the participant in order to minimize random responding and protect against possible literacy difficulties. Participants were given a copy of the questionnaire packet to follow along. At the end of the interview, participants were asked for their permission to stay in contact in order to continue with the ongoing longitudinal study. Upon completion, participants were given a referral list of area community resources and compensated with a \$25.00 gift card.

The second interview (T2) was conducted over the phone when the participants' infants were approximately 3.2 months old (SD=1.0 month). This interview typically lasted 30 to 45 min, with the purpose of obtaining information about the infants' first 3 months of life, such as their crying, feeding, and sleeping routines, as well as information about the health and well-being of the mother and her infant. Upon completion, participants were given a referral list of area community resources and compensated with a \$10.00 gift card.

The 1- and 2-year interviews each lasted approximately 3 to 3.5 h. The interviews took place primarily in the participant's home (92 % both times); however, some were conducted in a research office (4 %) or over the phone (4 %). Both interviews consisted of a battery of questionnaires as well as

Table 1 Demographic information for study participants

Variable	<i>M</i> (SD) or % (<i>n</i>)
Family income (per month)	2143.1 (2107.7)
Mothers' ethnicity	
Black, African American	46.7 (56)
Caucasian, White	35.8 (43)
Biracial	12.5 (15)
Asian American/Pacific Islander	2.5 (3)
Arab American	1.7 (2)
Native American	0.8 (1)
Mothers' education	
Did not complete high school	4.2 (5)
High school diploma or GED	15.8 (19)
Some college	44.2 (53)
Associate's degree	12.5 (15)
Bachelor's degree	14.2 (17)
Some graduate school	1.7 (2)
Graduate degree	7.5 (9)
Marital status	
Single, never married	63.3 (76)
Married	27.5 (33)
Divorced	5 (6)
Separated	4.2 (5)
Social services received	
Women, infants, and children (WIC)	73.3 (88)
Public health insurance	75 (90)
Food stamps	51.7 (62)
Supplemental income	16.7 (20)

other assessments similar to the pregnancy interview. In addition, the women were asked to engage in a 10-min free play and 2-min cleanup interaction task with their child at both interviews. These interactions were videotaped and later coded by trained research assistants (more details about this procedure are located in the “Measures” section). Participants were compensated with \$50.00 and an infant/toddler gift at the end of both interviews.

To ensure retention of participants, those who agreed to continue in the longitudinal study following each interview were asked to provide contact information for themselves as well as the names and contact information of up to three “recontact people” who could provide information on the location of the study participant in the event that she could not be reached directly at a given tracking interval. In between interviews, research assistants contacted each participant every 3 months to update their contact information.

Measures

Demographic questionnaire

A brief demographic questionnaire was used to assess background characteristics such as age, marital status, ethnicity, educational level, and total family monthly income, among other things, at study entry.

Maternal depression

Maternal depression was measured at T1 and T2 using the Edinburgh Postnatal Depression Scale (EPDS; Cox et al. 1987; Wisner et al. 2002). The EPDS is a 10-item questionnaire designed to assess the frequency of prenatal and postpartum depressive symptoms. Possible scores range from 0 to 30, with higher scores indicating more depressive symptoms. The psychometric properties of the EPDS have been reported by Cox and colleagues (1987). The EPDS demonstrated good internal consistency in the current sample at T1 ($\alpha=0.76$) and T2 ($\alpha=0.84$). Maternal depression at T3 and T4 was assessed using the Beck Depression Inventory-II (BDI-II; Beck et al. 1996). The BDI-II is a 21-item self-report questionnaire that measures the severity of depression in adults. Possible scores range from 0 to 63, with higher scores indicating greater severity of depressive symptoms. The psychometric properties of the BDI-II have been reported by Beck and colleagues (1996) and Beck and Steer (1987). The BDI-II demonstrated good internal consistency in the current sample at T3 ($\alpha=0.90$) and T4 ($\alpha=0.94$). Scores for both depression measures were converted to z-scores for trajectory analyses to allow for comparisons across measures. The decision to use two different measures of depression was based on the significant overlap between symptoms of depression and more typical symptoms of pregnancy such as fatigue, sleep difficulties, appetite

changes, and somatic complaints that makes it difficult to accurately assess depressive symptoms during the perinatal period (Matthey and Ross-Hamid 2011). These effects may be minimized by the use of well-designed and validated self-report measures such as the EPDS, which take into account symptom overlap and provide more accurate assessments of depression during the perinatal period than the BDI-II (Su et al. 2007).

Toddler affect expression

Toddler behaviors and affect expression were assessed at T4 (age 2) by videotaped observations during a 10-min free play task and a 2-min cleanup task. A standard set of developmentally appropriate toys were brought to the interview and used for the interaction task. At a later time, trained coders viewed the entire 10-min free play segment and the entire 2-min cleanup segment and provided separate, global toddler behavioral and affect expression ratings for each task. The current study utilized only the codes from the 10-min free play task in analyses because the free play task provided a longer, less structured sample of behavior that is presumably more characteristic of the dyad’s daily interactions.

The resulting coding scheme included 11 scales (three behavioral scales, four affect scales, and four dyadic scales) of toddler affect expression and behavior. The behavioral scales included *compliance*, or the degree to which the toddler complied with or responded to the mother’s bids; *object engagement*, or the degree to which the toddler was engaged with toys; and *social engagement*, or the degree to which the toddler engaged with the mother or initiated social interaction. The affect scales included *positive affect*, or the frequency, intensity, and duration of displays of positive affect such as smiles, upbeat vocal tones, laughter, and exuberant vocal utterances; *negative affect*, or the frequency, intensity, and duration of displays of general fussiness such as brief or mild facial expression of sadness or anger, brief negative vocalizations, limb flailing, intermittent crying, sustained crying, or temper tantrums; *aggression*, or the frequency, intensity, and duration of displays of instrumental aggression such as throwing toys or instances of low physical aggression directed towards the mother such as swatting or yelling at the mother and high physical aggression directed towards the mother such as hitting, shoving, or biting; and *withdrawn/flat*, or the frequency and duration of displays of withdrawn/flat affect such as disinterest, lack of facial animation, or little or slowed movement. Dyadic codes included *reciprocity/fluency*, or the degree of similarity, rhythm, or matching of the mother’s and toddler’s energy, interest, and engagement in the interaction, and three *shared affective valence* codes that assessed the degree of similarity between the mother’s and toddler’s affect states including the duration of shared positive, flat, and negative affect expression. All codes were assigned using a five-point,

anchored rating system: 1 (*none or very little*), 2 (*some*), 3 (*moderate*), 4 (*much*), and 5 (*very much*). Higher scores indicate more of the given construct.

Following extensive training, each individual coder's reliability was established with the first author of this study using a random subset of the mother–toddler interaction tapes ($n=24$; approximately 27 % of the sample). Reliability was calculated using intra-class correlation coefficients (ICCs; single, absolute), which ranged from 0.60 for the object engagement subscale to 0.93 for the positive affect subscale. Following the establishment of initial inter-rater reliability, each of the coders was randomly assigned interactions to code independently. Final reliabilities reflect a combination of the initial and ongoing reliability calculations and ranged from 0.67 for the withdrawn/flat affect subscale to 0.91 for the shared positive affect subscale. These final reliability estimates are more than adequate (Cicchetti and Sparrow 1981).

Three composites were created due to significant inter-correlations among the individual codes. As a result, social engagement, compliance, reciprocity/fluency, toddler positive affect, and shared positive affect were summed to create a positive affect and behavior composite, with possible scores ranging from 5 to 25. Toddler aggressive behavior, toddler negative affect, and shared negative affect were summed to create a negative affect and behavior composite, with possible scores ranging from 3 to 15. Toddler withdrawn/flat affect and shared flat affect were summed to create a flat composite, with possible scores ranging from 2 to 10. An exploratory factor analysis conducted in SPSS version 22.0 confirmed that the five subscales in the positive affect and behavior composite accounted for 68 % of the variance in the higher-order factor. All factor loadings exceeded 0.76. The three subscales in the negative affect and behavior composite accounted for 60 % of the variance in the higher-order factor; factor loadings exceeded 0.76. Last, the two subscales in the flat composite accounted for 77 % of the variance in the higher-order factor; factor loadings exceeded 0.87. Object engagement was not included in the composites due to poor factor loadings. Subsequent analyses were done using only the three theoretically and empirically derived composites.

Toddler social–emotional development

The Brief Infant-Toddler Social and Emotional Assessment (BITSEA; Briggs-Gowan and Carter 2006) was used to assess mothers' perceptions of toddler social–emotional problems at age 2. The BITSEA is a 42-item parent-reported, screening questionnaire designed to assess social–emotional and behavior problems or delays and social–emotional competence in young children aged 12 to 36 months old. Items are rated on a three-point scale (0=*not true/rarely*, 1=*somewhat true/sometimes*, and 2=*very true/often*) in regard to the child's behavior over the last month. The BITSEA is composed of

two broad scales labeled the problem scale (31 items) and competence scale (11 items); the problem scale is further broken down into an externalizing scale (6 items) and internalizing scale (8 items). Higher scores indicate more social–emotional or behavior problems or greater social–emotional competence, respectively. Various studies have assessed the psychometric properties of the BITSEA and found that it has strong reliability and validity (Briggs-Gowan and Carter 2007; Briggs-Gowan et al. 2004; Karabekiroglu et al. 2010). In the current study, the BITSEA total problem scale, as well as the internalizing and externalizing subscales, were used in analyses. The coefficient alphas were 0.83 for the total scale, 0.63 for the internalizing scale, and 0.65 for the externalizing scale.

Data analysis plan

Missing data

Of the 119 retained participants at T2, one participant was missing a depression score due to an incomplete interview. Maximum likelihood ratio (MLR), a type of full-information maximum likelihood (FIML) estimation, was used in the current study to handle missing data on the depression scales (including missing data due to attrition as well as due to incomplete records for retained participants). Therefore, model estimation procedures in *Mplus* to test hypothesis 1 (trajectories of depressive symptoms) were based on all 120 participants.

Of the 99 participants retained at T4, four participants were not able to provide information regarding their toddler's social and emotional development or participate in the free play interaction task because they no longer had contact with their child. Seven additional participants were not able to participate in the free play interaction task because interviews were done over the phone ($n=4$), toddlers were not at home during the interview ($n=2$), and one participant's child was asleep during the interview. Missing data on the toddler outcomes were handled using multiple imputation so that analyses testing hypothesis 2 (trajectory group differences) were based on the full sample of 120 participants. Currently, SPSS version 22.0 does not support pooled results for multiple imputation at the post hoc level for ANOVAs. Therefore, planned post hoc comparisons were performed using *t* tests and pooled results are reported.

Trajectory analyses

Trajectories of maternal depressive symptoms were identified using latent class growth analysis (LCGA) in *Mplus* version 6.0, which is a person-centered, latent growth modeling approach used to identify underlying heterogeneity in a sample

(Wang and Bodner 2007). LCGA is a commonly used person-centered statistical technique for modeling trajectories of various constructs across time and, therefore, is optimal for longitudinal data. In LCGA, unobserved heterogeneity of a variable across time within a given sample is captured by categorical latent variables (i.e., trajectory classes; Wang and Bodner 2007). The unequal time intervals between assessments were retained by coding time scores in months, anchoring at zero, such as T1@0, T2@3, T3@12, and T4@24, which is an appropriate sequencing for unequal time intervals (Jung and Wickrama 2008).

Models for two, three, four, and five trajectories were examined after testing the univariate growth curve model. The final, optimal model was chosen based on an evaluation of fit statistics. The most commonly used and recommended fit statistic is the Bayesian information criterion (BIC) statistic (Jung and Wickrama 2008; Wang and Bodner 2007). The model with the lowest BIC value is considered to be the best-fitting model. The current study also considered entropy values, the bootstrap likelihood ratio test (BLRT), and the Lo–Mendell–Rubin likelihood ratio test (LMR-LRT) to identify the model that best fits the data. Entropy values are based on posterior probabilities and, therefore, reflect how neatly and exclusively subjects are classified into each trajectory group (Wang and Bodner 2007). Entropy values exceeding 0.80 indicate good classification (Wang and Bodner 2007). The BLRT and LMR-LRT statistics reflect the relative fit of a k class model compared to a $k-1$ class model, where k indicates the number of latent classes. For example, when testing a three-class model, the BLRT and LMR-LRT statistics indicate whether a three-class model has a better fit than a two-class model. Statistical significance ($p < 0.05$) indicates that the k class model exceeds the $k-1$ model. The BLRT statistic has been shown to outperform the LMR-LRT; however, it is recommended that both be used and compared (Jung and Wickrama 2008). Since there are competing opinions about which fit indices best determine the appropriate number of classes, it is recommended that a combination of factors be used beyond these fit statistics such as considerations of parsimony, theoretical justification, and interpretability (Jung and Wickrama 2008).

Hypothesis 2 was examined in SPSS 22.0 using ANOVA tests to examine between-group (trajectory) contrasts on the BITSEA and toddler affect and behavior codes at age 2.

Results

Descriptive statistics and correlations between study variables

Overall, the women in the current study reported relatively low levels of depressive symptoms at each time point (see

Table 2). Average levels of depressive symptoms were the highest during pregnancy and continued to decrease throughout the second year following birth. Correlation coefficients for study variables are also presented in Table 2. As expected, depression scores were significantly, positively correlated across all time points for the entire sample. Depressive symptoms at all waves were unrelated to the toddler affect and behavior composites based on free play codes; however, there were several significant associations between depressive symptoms and the BITSEA problem scales. In particular, depressive symptoms at T1 and T3 were significantly, positively correlated with total mother-reported toddler social and emotional problems and internalizing problems. Depressive symptoms at T4 were significantly, positively correlated with all BITSEA scales.

Trajectory analysis

Hypothesis 1 was tested by examining a univariate growth curve model using all four waves of maternal depression scores to determine whether the data were optimally explained by a single growth curve. The univariate model was a poor fit for the data when compared to more complex models, supporting hypothesis 1. Therefore, model testing was continued in order to determine the optimal number of trajectory classes. Maternal age, education, and family income-to-needs ratio at study entry were significantly correlated with maternal depressive symptoms, such that younger age, lower educational attainment, and greater economic disadvantage were correlated with higher depressive symptoms (correlations ranged from -0.19 to -0.30 , all $p < 0.05$). Therefore, these three demographic characteristics were entered into trajectory analyses as covariates. The fit indices of the models examined in the current study are presented in Table 3. The three- and four-class models emerged as good fitting models with equal BIC values and entropy above 0.80. Significant BLRT values also indicated that a three-class model was better than a two-class model and a four-class model improved upon a three-class model. Although the LMR-LRT statistic was significant for the three-class model, but not the four-class model, it has been suggested that the BLRT statistic performs better and should be followed above the LMR-LRT (Jung and Wickrama 2008). Furthermore, posterior probabilities improved from the three- to the four-class model, indicating that women were more exclusively and decisively classified into their respective groups. For these important reasons, the four-class model was chosen as the best fitting model. Posterior probabilities and descriptive statistics for the four-class model are presented in Table 4.

According to hypothesis 1, it was expected that trajectories that depict relatively low-stable and relatively high-stable levels of symptoms across time, as well as increasing or decreasing patterns, would emerge. Results support the viability of a four-class model. The four trajectories that emerged were labeled

Table 2 Bivariate correlations and descriptive statistics among study variables

Variable	1	2	3	4	5	6	7	8	9	10
1 T1 EPDS	1.0									
2 T2 EPDS	0.46***	1.0								
3 T3 BDI-II	0.32**	0.34***	1.0							
4 T4 BDI-II	0.28*	0.31**	0.60***	1.0						
5 Positive composite	-0.19 [†]	0.02	0.03	0.11	1.0					
6 Negative composite	0.19 [†]	-0.05	-0.06	0.01	-0.44*	1.0				
7 Flat composite	0.18 [†]	-0.04	-0.02	0.01	-0.43*	0.07	1.0			
8 BITSEA total problems	0.29*	0.18	0.30**	0.49***	-0.09	0.11	-0.08	1.0		
9 BITSEA internalizing problem	0.28*	0.21 [†]	0.25*	0.43***	-0.03	0.04	-0.02	0.79***	1.0	
10 BITSEA externalizing problem	0.23 [†]	0.05	0.41**	0.41**	-0.08	0.15	-0.13	0.77***	0.48***	1.0
<i>M</i>	12.77	5.08	10.78	10.83	16.10	3.88	2.38	11.62	2.46	2.70
<i>SD</i>	3.60	4.46	8.53	10.14	4.09	1.37	0.94	6.27	1.94	1.96
Range	7–23	0–21	0–51	0–57	6–24	3–10	2–7	1–36	0–13	0–9

All bivariate correlations presented in this table are between variables included in study analyses (including some that have been transformed and imputed as described earlier). All descriptive statistics in this table are based on raw data before transformations and imputation. Composites reflect observed toddler affect and behavior free play codes

EPDS Edinburgh Postnatal Depression Scale, BDI-II Beck Depression Inventory-II, BITSEA Brief Infant-Toddler Social Emotional Assessment

[†] $p < 0.10$; * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

stable-moderate depressive symptoms (21.7 %, $n=26$), low-decreasing symptoms (47.5 %, $n=57$), stable-low depressive symptoms (22.5 %, $n=27$), and increasing symptoms (8.3 %, $n=10$; see Fig. 1). Women in the increasing group had significantly lower educational attainment than all other groups, and women in the stable-low group were significantly older in age than women in the increasing group. Otherwise, trajectory groups did not significantly differ on the covariates.

Maternal depression trajectories: relations with toddler emotional development

Hypothesis 2 stated that mothers reporting chronically high or increasing levels of depression across time would report that their toddlers were exhibiting more social and emotional problems and would have toddlers who displayed more generally negative or flat affect and behavior while interacting with them. Conversely, mothers reporting stable-low or decreasing levels of depression across time would report that their

toddlers were exhibiting less social and emotional problems and would have toddlers who displayed more generally positive affect and behavior.

Contrary to expectations, there were no significant differences in observed toddler affect expression and behavior from the free play codes between the depression trajectory groups (see Table 5). In regard to total mother-reported social and emotional problems on the BITSEA at age 2, however, significant differences were found between trajectory groups ($F[3, 116]=8.54, p < 0.001$). Specifically, women in the increasing group reported significantly more social and emotional problems than women in all other groups. Additionally, women in the stable-moderate group reported significantly more social and emotional problems than women in the low-decreasing group. There were also significant differences between trajectory groups and mothers' reports of internalizing ($F[3, 116]=6.41, p < 0.001$) and externalizing ($F[3, 116]=5.96, p < 0.01$) toddler problems. Specifically, in regards to internalizing problems, women in the increasing group reported significantly more toddler internalizing problems than women in the low-decreasing and stable-low groups. In regards to externalizing problems, women in the increasing group reported significantly more toddler externalizing problems than women in all other groups.

Discussion

Maternal depression during the perinatal period has been shown to have numerous deleterious effects on the mother,

Table 3 Fit indices for latent classes

Model	Entropy	BIC	LMR-LRT	<i>p</i>	BLRT	<i>p</i>
Class 2	0.84	1226	-632.265	<0.01	-632.265	<0.0001
Class 3	0.88	1207	-577.548	<0.17	-577.548	<0.0001
Class 4 ^a	0.90	1214	-567.229	0.06	-567.229	<0.0001
Class 5	0.87	1228	-553.035	0.33	-553.035	0.12

BIC Bayesian information criterion, LMR-LRT Lo-Mendell-Rubin likelihood ratio test, BLRT bootstrap likelihood ratio test

^a The best fitting model

Table 4 Posterior probabilities and descriptive statistics for four-class model

	Class 1	Class 2	Class 3	Class 4	<i>n</i> (proportion of sample)	Slope	Intercept
Class 1	0.951	0.088	0.008	0.008	26 (21.7 %)	0.001, ns	0.697, $p < 0.001$
Class 2	0.042	0.977	0.016	0.000	57 (47.5 %)	-0.016, $p < 0.01$	-0.354, $p < 0.001$
Class 3	0.008	0.006	0.974	0.017	27 (22.5 %)	-0.005, ns	-0.150, ns
Class 4	0.021	0.016	0.015	0.893	10 (8.3 %)	0.073, $p < 0.01$	0.491, ns

ns no significance

the developing child, and the mother's ability to care for her child following birth (Albright and Tamis-LeMonda 2002; Diego et al. 2009; Field 1995; Field et al. 2010; O'Hara 2009). Past research has shown that levels of depressive symptoms are typically highest during pregnancy and decrease across the postpartum period. However, not all women follow a decreasing course of symptoms. Thus, the current study sought to identify trajectories of maternal depressive symptoms from pregnancy to 2 years after birth and to examine the differential effects of trajectories of maternal depressive symptoms on toddler emotional development at age 2.

For the sample as a whole, higher levels of depressive symptoms were found during pregnancy compared to later postpartum waves. For example, following pregnancy, a tapering off of symptoms from pregnancy through the postpartum period was observed based on an examination of mean and cutoff scores from each respective scale. This decreasing pattern is similar to what has been reported in other variable-centered research. However, in the current study, a univariate (one-class) growth curve model demonstrated a poor fit, indicating heterogeneity in the sample for depression trajectories. Instead, trajectory analyses indicated that four distinct trajectories of maternal depressive symptoms best fit the data and explained well the experiences of subgroups of women in the

sample. One trajectory group was composed of women who continued to report consistently moderate levels of depressive symptoms from pregnancy through 2 years postpartum, and another trajectory was composed of women who continued to report consistently low symptoms of depression across time. These two stable groups represented 44 % of women in the sample. The other two trajectory groups were composed of women with increasing or decreasing symptoms. The increasing group initially reported a moderate level of depressive symptoms during pregnancy but continued to report increases throughout the postpartum period. By 2 years postpartum, this group was reporting a high, clinical level of depressive symptoms. Conversely, the decreasing group initially reported the lowest levels of depressive symptoms during pregnancy and their symptoms decreased throughout the postpartum period. This decreasing group differs from past studies that have identified a decreasing group characterized by initially high symptoms followed by decreases over time. The present study, in contrast, did not find evidence for a class of women with initially high levels of depressive symptoms that later decreased. Instead, women in the present study who initially reported moderate to high levels of symptoms either continued to report moderate levels or reported increasingly higher levels of depressive symptoms after the birth of their child.

Fig. 1 Trajectories of maternal depressive symptoms from pregnancy through 2 years postpartum

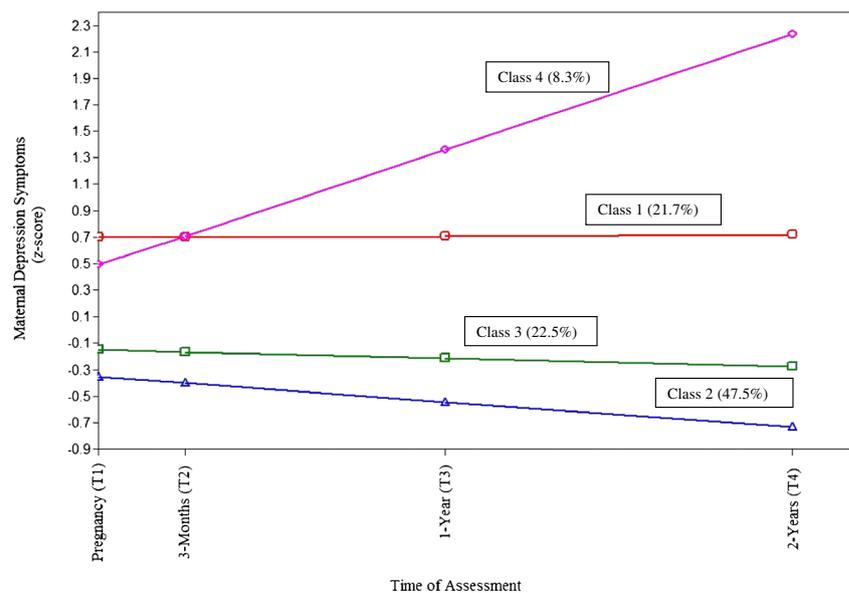


Table 5 Between-group comparisons on toddler emotional development by maternal depression trajectory class

	Class 1		Class 2		Class 3		Class 4		F	p	Post hoc level
	Stable-moderate (n=26)		Low-decreasing (n=57)		Stable-low (n=27)		Increasing (n=10)				
	M	SD	M	SD	M	SD	M	SD			
Toddler affect and behavior											
Positive composite	12.67	–	12.54	–	11.95	–	13.57	–	0.59	0.62	
Negative composite	3.91	–	3.77	–	4.00	–	4.00	–	0.16	0.92	
Flat composite	2.62	–	2.28	–	5.00	–	2.29	–	0.62	0.60	
T4 BITSEA											
Total problems	13.46	–	9.21	–	10.57	–	20.88	–	8.54	<0.001	4>1* 4>2*** 4>3*** 1>2*
Internalizing problems	2.87	–	1.86	–	2.29	–	4.88	–	6.41	<0.01	4>2** 4>3***
Externalizing problems	2.75	–	2.21	–	2.33	–	5.63	–	5.96	<0.001	4>1* 4>2*** 4>3***

Multiple imputation does not provide pooled results for standard deviation; therefore, these values are not presented above

BITSEA Brief Infant-Toddler Social Emotional Assessment

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

These findings are somewhat similar to those reported by several researchers who have assessed trajectories of depression over time (Ashman et al. 2008; Campbell et al. 2007, 2009); however, the current study is the first to take a person-centered approach to examine trajectories of maternal depressive symptoms *beginning in pregnancy* and extending across several years after birth. Although several studies mentioned earlier did report symptom levels from pregnancy throughout the postpartum period (Banti et al. 2011; Gotlib et al. 1989; Wu et al. 2011), they focused on the sample, as a whole, rather than identifying subgroups within the sample. Examining depressive symptom levels across time in an entire sample likely mischaracterizes many women's experiences. For instance, 30 % of women in the present study continued to report at least moderate levels of depressive symptoms over time. Thus, using a person-centered approach to understanding depression trajectories leads to a very different conclusion about women's experiences compared to a variable-centered approach, suggesting that future research needs to more closely examine possible heterogeneity in mental health profiles among childbearing women.

Another aim of the current study was to examine differences in toddler affect and emotional development between groups based on maternal depression trajectories. Surprisingly, results revealed no differences between trajectory groups on observations of toddler affect and behavior at age 2 based on mother-child free play interactions. One possible

explanation for the lack of group differences may be that the 10-min interaction task did not provide a large enough sample of behavior to accurately reflect the toddler's general emotional functioning. It may be beneficial for future research to observe children on more than one occasion on different days at each wave to obtain a larger sample of behaviors. Furthermore, the task used was an unstructured free play interaction with very interesting, novel toys brought by the researchers. Given that the families in this sample were mostly economically disadvantaged, the standard set of toys used to conduct the play interactions may have created a scenario where the children behaved differently than is typical (i.e., better than usual). Alternatively, the lack of findings between maternal depressive symptom trajectories and observed toddler emotionality could, in fact, indicate no real associations. That is, there may be no differences in the observed toddler emotionality between groups of mothers reporting different courses of depressive symptoms from pregnancy through the first years following birth; however, this seems unlikely given consistent findings in past research demonstrating that infants of mothers reporting depressive symptoms show less positive and more negative affect during interactions with their mothers (Feldman et al. 2009; Hart et al. 1998).

Unlike findings with observed toddler affect and behavior, trajectory groups did differ on *mother-reported* toddler social and emotional problems. In general, women in the increasing trajectory group reported significantly more problems than did

women in the stable-low, stable-moderate, and decreasing groups. Women in the stable-moderate group reported significantly more problems than did women in the stable-low group. These expected results are consistent with past research, which suggests that women experiencing patterns of depressive symptoms across time that are characterized by worsening of symptoms or stable-high symptoms perceive their children to have more social and emotional problems (Campbell et al. 2007; Vänskä et al. 2011). It may be that women experiencing these types of depressive symptoms may be more likely to notice and be negatively impacted by their toddler's emotionality and report it as problematic. Over time, this may contribute to a strained parent-child relationship, which eventually gives rise to observable impaired child adjustment.

Strengths and limitations of the study

The current study has a number of noteworthy strengths. This was the first known study to use a person-centered approach to examine maternal depressive symptoms beginning in pregnancy, yielding a considerably different picture of women's experiences of depression over time than past studies examining sample-level trends. The longitudinal nature of the current study allowed for this examination of trajectories across four time points. Few studies examining the effects of maternal depression on child emotional development begin during pregnancy, which is a very important time for both maternal and child adjustment. Second, the sample was composed of predominantly economically disadvantaged women who were diverse in terms of age, race, and family structure. Many other studies in this area have been done using predominantly Caucasian, middle-class families. It is important to focus on high-risk samples (defined by minority status and/or economic status, for example) because these mothers have higher rates of depression and may be in greater need of services than women who are classified as lower risk (Blazer et al. 1994). Last, the current study used a multi-method approach to assess toddler social and emotional outcomes, which provided two unique perspectives on toddler emotional development.

Several limitations are also evident in the current study. First, the sample size was relatively small, which restricts the number of possible trajectories that can be detected and limits statistical power using latent class growth analysis. Also, smaller samples result in smaller groups, which may impede the ability to detect differences between groups. Although the increasing class contained a small proportion of the sample (8.3 %), past research has suggested that classes containing at least 5 % are viable, interpretable classes (Jung and Wickrama 2008). Furthermore, the studies reviewed earlier by Campbell and colleagues (2007, 2009), and Vänskä and colleagues (2011) both had classes containing smaller proportions of the sample (e.g., 2.5–6.2 %). No extracted class

contained less than 6 % of the sample in the current study; however, it is still possible that between-group differences were not detected due to lower statistical power. Second, given that the reliability for the internalizing and externalizing subscales for the BITSEA was on the low end of acceptable in our sample, the findings using these subscales should be interpreted cautiously. Third, the very small window of observation of toddler affect and behavior (10 min) on a single occasion may not have been sufficient to gather the data needed to detect differences in the emotionality of children with mothers reporting different trajectories of depressive symptoms across time. More than one assessment for longer periods of time may be necessary, along with the addition of different paradigms that are specifically designed to elicit toddler emotionality. Fourth, due to the episodic nature of depression, more frequent assessment of depressive symptoms may be preferable. Assessing depressive symptoms every 9–12 months, as was the case at certain times in this study, may not be sufficient to accurately detect changes in levels of depressive symptoms across time, particularly since most depression questionnaires assess only a short, recent time frame, such as the last 2 to 4 weeks.

Conclusion

The current study used a person-centered approach to identify maternal depressive symptom trajectories beginning in pregnancy across 2 years postpartum and to examine the influence of different courses of depressive symptoms on toddler emotional development. Four distinct trajectories of maternal depressive symptoms were found: stable-low, stable-moderate, increasing, and low-decreasing trajectories. Despite an overall decreasing pattern for the sample as a whole, 30 % of women in the present study experienced stable-moderate or increasing courses of depressive symptoms across the assessment period. Although trajectories were not related to observations of toddler affect and behavior at age 2, they were related to mothers' perceptions of their toddlers' emotional development. A growing body of literature indicates that subgroups of mothers experience distinct courses of depressive symptoms before and after giving birth that impact how they view their toddlers' emotional development. Future studies should be conducted in order to further understand how trajectories of depression, as well as other types of caregiver psychopathology, are associated with toddler emotional development; future studies should also consider obtaining multiple-informant reports of child social-emotional problems, rather than relying solely on mothers' reports.

Finally, results from such studies will have critical implications for interventions with women and young children during this important developmental period. Being able to identify and understand the many distinct patterns of depressive

symptoms over time holds powerful implications for the development of medical and psychosocial interventions aimed at assessing and reducing the risk for maternal depression across the perinatal period. For example, the results of this study indicate the need for frequent assessment of symptoms during pregnancy and several years thereafter. If depression is assumed to decrease following the birth of a child, providers may be less likely to assess for or recognize possible cases of maternal depression in the following years. Also, the results indicate a need for interventions aimed at reducing symptoms of depression beginning in pregnancy because many women will not experience a decrease in symptoms following the birth of a child and, subsequently, may view their child as more difficult or problematic than non-depressed mothers. As a result of taking a more person-centered approach in both research and practice, the likelihood of initiating more adaptive developmental trajectories will be increased for both mothers and young children.

Acknowledgments This research was supported by grants from the American Psychoanalytic Association, the International Psychoanalytic Association, the Psi Chi International Honor Society, and Eastern Michigan University. The authors would like to thank the Parenting Project research assistants for their invaluable help with data collection and the families who participated in the study. The authors also appreciate the meticulous coding efforts of Alicia Totten, Jamie King, and Alicia Burditt.

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