Postnatal Trajectories of Maternal Depressive Symptoms: Postpartum Antecedents and Differences in Toddler Adjustment

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Abstract

Infants are uniquely vulnerable to maternal depression's noxious effects, but few longitudinal studies have tried to identify discrete postnatal trajectories of maternal depressive symptoms (MDS) beginning in infancy. This study extends evidence of heterogeneous change in postnatal MDS by examining their cross-contextual antecedents in infancy and their consequences for children's early behavior problems and language skills in late toddlerhood. A community sample of mother–child dyads (N = 235, 72% Caucasian) was assessed when children were 7, 15, and 33 months old. Mothers reported their socioeconomic status (SES), social support, marital relationship quality, family dysfunction, parenting stress, and infants' functional regulatory problems at 7 months postpartum, and children's internalizing and externalizing symptoms at 33 months. Children completed a receptive vocabulary assessment at 33 months in the lab. Latent class growth analysis identified three postnatal MDS trajectory classes that fit the data best: low-decreasing, moderate, and increasing. Psychosocial measures at seven months postpartum primarily predicted membership to these postnatal trajectory classes, which subsequently differed in children's internalizing, externalizing, and receptive vocabulary in late toddlerhood, controlling for family SES and functional regulatory problems in infancy. We discuss salient antecedents and consequences of postnatal depression for mothers and their offspring.

Keywords: maternal depression, infancy, internalizing, externalizing, language

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About 13% of women in the U.S. develop postpartum or postnatal depression (Kessler et al., 2003; O'Hara & Swain, 1996). Although the terms *postpartum* and *postnatal* are often used synonymously, we refer to the first 12 months after birth as the postpartum period and the first three years after birth as the postnatal period. Infancy is a key developmental phase in which to examine the heterogeneous progression of mothers' postnatal symptoms and its consequences for young children. Extensive time with and dependence on parents for physical care and cognitive and socioemotional stimulation make infants especially vulnerable to the deleterious effects of maternal depression (Bagner, Pettit, Lewinsohn, & Seeley, 2010). Associations between mothers' depression and children's adjustment problems vary by the timing and length of exposure such that early and/or chronic experiences are most strongly related to maladjustment (Campbell, Matestic, von Stauffenberg, Mohan, & Kirchner, 2007; Goodman, Rouse, Connell, Broth, Hall, & Heyward, 2011). Maternal depression assessed with clinical interviews or symptom ratings has been linked to children's cognitive and socioemotional problems, such as self-regulatory difficulties (Choe, Shaw, Brennan, Dishion, & Wilson, 2014; Choe, Sameroff, & McDonough, 2013), early conduct problems (Shaw, Gilliom, Ingoldsby, & Nagin, 2003), and poor language skills (McManus & Poehlmann, 2012; Sohr-Preston & Scaramella, 2006). Studies indicate the utility of conceptualizing maternal depression along a continuum, as we do here, in contrast to clinical status, because even subthreshold levels of symptoms are disruptive to children's health and development (for a review, see Meaney, 2018). Consequently, we use the terms maternal depression and maternal depressive symptoms (MDS) interchangeably throughout this paper.

Studies repeatedly show that exposure to maternal depression increases young children's

risks of early externalizing and internalizing symptoms that often precede more serious behavior problems (Bagner et al., 2010; Goodman et al., 2011), but relatively little longitudinal research examines postnatal changes in MDS in relation to young children's emerging language skills that are critical for school readiness (Sohr-Preston & Scaramella, 2006). Exposure to postpartum depression in infancy is related to poor language skills and low IQ scores in school-age children (O'Hara & McCabe, 2013), but a dearth of longitudinal studies examines these effects prior to the preschool years. Although studies have examined changes in MDS from the prenatal period to early childhood (Mora, Bennett, Elo, Mathew, Coyne, & Culhane, 2009; Parade et al., 2014) and across childhood (Campbell et al., 2007; Gross, Shaw, Burwell, & Nagin, 2009; Gump et al., 2009), little work has explored effects of their distinct postnatal changes on toddlers' behavioral functioning (Goodman & Gotlib, 1999). Studies showing harmful effects of maternal depression on young children's functioning tend to target families of low socioeconomic status (SES; e.g., Brennan et al., 2000; Kiernan & Huerta, 2008; Shaw et al., 2003) that typically yield relatively large effect sizes (Goodman et al., 2011). To complement this literature, we examine mothers' heterogeneous changes in postnatal depressive symptoms, their postpartum antecedents, and their prediction of child behavior problems and language skills in late toddlerhood among mostly two-parent, middle-class families considered to be at low risk for suboptimal child outcomes. Identifying dissociable postnatal trajectories of MDS in a community sample can promote public and professional awareness of the potential noxious effects of subclinical levels of depressive symptoms and inform programs that safeguard families from all walks of life after a child's birth.

Heterogeneous Changes in Mothers' Postnatal Depressive Symptoms

Longitudinal research has increasingly attended to heterogeneity in the onset, timing, severity, and course of MDS, primarily using growth curve and group-based trajectory modeling

to assess individual differences in their initial levels and functional forms of change (e.g., Gross et al., 2009). We are aware of only three studies in the U.S. that have used group-based trajectory modeling to identify discrete trajectory classes of MDS and their predictors across infancy and toddlerhood, of which just one examined the effects of MDS trajectories on child outcomes (Campbell et al., 2007; McCall-Hosenfeld, Phiri, Schaefer, Zhu, & Kjerulff, 2016; Mora et al., 2009). Mora and colleagues (2009) found five MDS trajectories in low-income women from Philadelphia from 15 weeks before giving birth to 25 months postpartum (i.e., *chronic*, *never*, *antepartum*, *postpartum*, *late*) that were predicted by sociodemographic background (e.g., race, parity, nativity, education), emotional and physical health, alcohol use, and objective stress. McCall-Hosenfeld et al. (2016) most recently found six MDS trajectory classes from the third trimester to 12 months postpartum in first-time mothers in Pennsylvania that were predicted by a history of depression or anxiety, marital status, and social support. Campbell and colleagues (2007) analyzed data from NICHD's Study of Early Child Care and Youth Development (SECCYD) and found *high-chronic*, *increasing*, *high-decreasing*, *intermittent*, *moderate-stable*, and *low-stable* MDS trajectories from age 1 month to 7 years that were related to maternal sensitivity and sociodemographic indices in infancy (e.g., maternal education, family income, ethnicity, marital status). Children's behavior problems and cognitive skills in first grade differed among MDS trajectories, but postpartum sociodemographic factors explained most differences.

There is one additional study from the U.S. (i.e., Gross et al., 2009) and several from Western Europe (Cents et al., 2012; Luoma, Korhonen, Salmelin, Helminen, & Tamminen, 2015; Sutter-Dallay, Cosnefroy, Glatigny-Dallay, Verdoux, & Rascle, 2012; van der Waerden et al., 2015a, 2015b) that examined growth in MDS during pregnancy and/or childhood with group-based trajectory modeling, but most did not examine mothers' postnatal trajectories in relation to

child outcomes (Luoma et al., 2015; Sutter-Dallay et al., 2012; van der Waerden et al., 2015b) or they focused on phases of development after infancy (e.g., Gross et al., 2009). These studies and those reviewed above collectively show that group-based trajectory modeling yields distinct classes of growth in MDS across pregnancy and childhood, such as persistently low, moderate, or high levels of depressive symptoms, intermittent symptoms, or symptoms only elevated in the postpartum or preschool period. We use this form of modeling to identify trajectories of mothers' postnatal depressive symptoms to more strongly predict child outcomes as studies have found trajectory classes better explain children's behavior problems than static measures of depression severity or predefined chronicity variables (Cents et al., 2012; van der Waerden et al., 2015a).

We refrain from further contrasting U.S. and Western European studies of postnatal MDS trajectories because of stark differences between these nations in a mother's social ecology after childbirth. The U.S. is the only industrialized country without a national policy for paid maternal leave, with most mothers restricted to no more than 12 weeks of unpaid leave after giving birth (Ruhm, 2017), despite evidence of an inverse relation between length of maternity leave and MDS (Baird, Bingenheimer, & Markus, 2016) up to six months postpartum (Dagher, McGovern, & Dowd, 2014). In France (Sutter-Dallay et al., 2012; van der Waerden et al., 2015b), Finland (Luoma et al., 2015), and the Netherlands (Cents et al., 2012), mothers are entitled to paid maternal leave, extended periods of unpaid maternal leave, and/or childcare subsidies after giving birth (Ruhm, 2017). Most industrialized nations also provide fathers with paid parental leave, which again suggests most mothers in the U.S. are relatively under-resourced during the postpartum period and at greater risk for postnatal depression than mothers in other nations.

Although marital status and SES are related to distinct patterns of postnatal change in MDS, the quality of marital and family relationships are also key factors to consider, especially

when examining maternal depression's effects on children. The longitudinal studies reviewed above did not assess family process variables closely linked to maternal depression, such as marital relationship quality (Cummings & Davies, 1994; Parade et al., 2014). For example, McCall-Hosenfeld et al. (2016) examined general social support but not qualities of specific relationships. Campbell et al. (2007) merely inferred marital quality via stability in marital status. Initial study of the SECCYD sample showed that mothers with chronic depressive symptoms (i.e., who repeatedly scored above cut-off on a clinical screen) reported the least social support, followed by mothers with occasional symptoms, while mothers with no symptoms reported the most social support (NICHD Early Child Care Research Network [ECCRN], 1999). Proximal psychosocial factors may have stronger effects than marital status or SES on postnatal depression and child functioning, but there is no way to know from these prior longitudinal studies.

Given the broad and multifaceted influences of context theorized to drive human development (Bronfenbrenner & Morris, 2006), we extend the literature and increase the ecological validity of this investigation by including multiple family process variables and simultaneously testing sociodemographic, psychosocial, and infant predictors of postnatal MDS trajectory classes and offspring functioning to elucidate their differential effects on mothers' symptom changes and children's development. As previous studies of postnatal trajectories of maternal depression have found predictive effects of past anxiety or depression (Sutter-Dallay et al., 2012; McCall-Hosenfeld et al., 2016; van der Waerden et al., 2015b), objective stress (Mora et al., 2009), and family stress (Cents et al., 2012), psychosocial resources and stressors during the postpartum period may be particularly robust influences on mothers' depressive symptoms.

Psychosocial Risk Factors of Postnatal Depression in Mothers

Various interpersonal factors within the social milieu of new motherhood are believed to

influence the developmental course of MDS and directly impact infant mental health (Cummings & Davies, 1994; Goodman & Gotlib, 1999). Among these are psychosocial risk factors for both maternal depression and child maladjustment, such as parental conflict, mothers' loss of social contacts, lack of intimate relationships, and poor social support (Dodge, 1990; Parade et al., 2014). An interpersonal model of maternal depression emphasizes the fit between mothers' desires for social support and the support they receive after childbirth (O'Hara & McCabe, 2013). For example, mothers whose spouses provide little help with infant care are at elevated risk for postnatal depression (Boyce, Hickie, & Gordon, 1991). Meta-analyses show postpartum depression has moderate to strong associations with marital quality and social support, and only modest links to sociodemographic factors (O'Hara & McCabe, 2013). Psychosocial factors may strongly influence postpartum depression, independent of family SES, because all mothers need more social support following childbirth. To maximize the ecological validity of this study, we consider mothers' need for social support, marital relationship quality, and family dysfunction as key predictors of their postnatal MDS trajectories. Similarly, we consider parenting stress, because mothers with recurrent depression report more overall stress than depressed women with no children, a difference largely attributable to child-related stressors (Feske et al., 2001).

Infant-Centered Risk Factors of Mothers' Postnatal Depression

A mother who perceives her infant to have a difficult temperament is at increased risk of postnatal depression (Dodge, 1990; Cummings & Davies, 1994; O'Hara & McCabe, 2013; Sohr-Preston & Scaramella, 2006). An infant's difficult temperament may reflect frequent crying, fussiness, waking, or other behavioral signs of functional dysregulation in crying, sleep, or feeding, but mothers report a difficult temperament chiefly based on frequent fussing and crying (Bates, 1980). Young children's early regulatory problems can exacerbate mothers' depressive

symptoms, children's risk of maladjustment, and their shared risk correlates (Choe et al., 2013; Shaw et al., 2003). Yet, relatively few studies test for child evocative effects of infant regulatory problems on MDS despite evidence of their bidirectional associations with each other and with child adjustment problems that reflect transactional processes across early childhood (Bagner, Pettit, Lewinsohn, Seeley, & Jaccard, 2013; Choe et al., 2014). Because a difficult temperament in infancy is an established risk factor for MDS, examining the evocative effects of infant regulatory problems may demonstrate their antecedent role in mothers' postnatal depression.

The frequency of infants' night waking, duration of wakefulness, and daytime sleep correlate with the same sleep behaviors in their mothers, especially during the first six months postpartum when mothers face considerable reductions in sleep duration and quality (Sinai & Tikotzky, 2012). Difficulties attending to infants' sleep, as well as crying and feeding, may prolong mothers' postpartum depressive symptoms, and distinct forms of functional regulatory problems may independently add to the postnatal progression of mothers' depressive symptoms and infants' mental health problems. Prior study of this sample found that infants' functional regulatory problems at seven months of age correlated positively with mothers' concurrent depressive symptoms and infants' externalizing problems across toddlerhood (Choe et al., 2013). The current longitudinal study tests whether mothers' perceptions of their 7-months-old infants' functional regulatory problems in crying, sleep, and feeding in combination or separately predict growth in their postnatal depression and infants' mental health problems in toddlerhood.

The Current Study

This study investigates discrete changes in mothers' postnatal depressive symptoms, their postpartum antecedents, and differences in offspring's emerging behavior problems and vocabulary skills in late toddlerhood. While studies of maternal depression are often limited by

retrospective data, small samples, short-term follow-ups, and a lack of data on parent–child relationships (Campbell et al., 2007), this prospective longitudinal study includes multimethod data from a relatively large community sample of mother–child dyads assessed at ages 7, 15, and 33 months. Mothers completed the Center for Epidemiological Studies-Depression Scale (CES-D) at each assessment (Radloff, 1977). When infants were seven months old, mothers reported on five sociodemographic indices (family income, both parents' education and occupation), four psychosocial variables (social support, marital adjustment, family dysfunction, parenting stress), and three infant variables (crying, sleep, and feeding problems). Measures of internalizing and externalizing symptoms and a test of receptive vocabulary were administered at 33 months, which to our knowledge is one of the earliest language assessments in the MDS literature.

We first hypothesized that a single latent growth model would insufficiently capture heterogeneous changes in mothers' postnatal depressive symptoms, yielding inadequate model fit to the data and indicating significant variability in the level and change of MDS. Second, using group-based trajectory modeling, we hypothesized finding discrete MDS trajectories of persistently low, moderate, or high levels of depressive symptoms and changing symptoms. We third hypothesized that, consistent with an interpersonal model of maternal depression and while considering family SES in infancy, unfavorable levels of social support, marital relationship quality, family dysfunction, parenting stress, and infant functional regulatory problems would predict atypical MDS trajectories (i.e., elevated symptom trajectories demonstrated by small subgroups of mothers). We hypothesized that young children exposed to atypical trajectories of MDS would show more behavior problems and poorer language skills in late toddlerhood.

Method

Participants

We drew families from a longitudinal study of 252 mother–child dyads (54.0% female) recruited during well-child visits at pediatric clinics near a large university in the Midwest (McDonough, 1994). According to mothers at seven months postpartum, 73.8% of infants were Caucasian, 13.1% were African American, and 11.5% were biracial or belonged to other racial-ethnic groups (1.6% of infants had no reported race or ethnicity data). Approximately 81.3% of mothers were married, 9.5% never married, 7.5% were cohabitating with infants' biological fathers, and 1.6% were separated, divorced, or otherwise not residing with biological fathers. In terms of employment, 40.9% of mothers stayed at home with their baby, 26.6% worked part-time, 25.8% worked full-time, and 6.7% did not report this information. The current study's final sample included 235 offspring (54.0% female) and mothers who rated their depressive symptoms at least once during the study period. Selective attrition analyses showed that the final sample had fathers with more occupational prestige ($M = 6.43$, $SD = 2.24$) than the attrition group ($M = 4.73$, $SD = 2.49$) excluded from subsequent analyses, $t(220) = 2.83$, $p = 0.005$.

Procedure and Measures

A trained graduate student visited homes when children were 7 (T1, $N = 252$), 15 (T2, $N = 218$), and 33 months old (T3, $N = 196$). Mothers completed questionnaires about their family and were compensated modestly. Data from T2 were only used for group-based trajectory modeling of MDS. At T3, most toddlers ($n = 185$) completed lab tasks a week after home visits. This study followed APA ethical standards and received institutional review board approval.

Maternal depressive symptoms. Mothers reported their depressive mood and somatic symptoms, such as hopelessness, poor appetite, and restless sleep, using the 20-item CES-D at each assessment (Radloff, 1977). Mothers indicated the average number of days per week they experienced symptoms using a 4-point response scale from 0 (*less than one day*) to 3 (*5–7 days*).

Items were summed into MDS scores at each assessment (mean α = 0.88). The CES-D is used as a clinical screening device with a cut-off score of 16. About 19% of mothers in the sample exceeded this cut-off at T1, 18% at T2, and nearly 14% of mothers at T3. These estimates are similar to national prevalence rates of postpartum and major depression (Kessler et al., 2003; O'Hara & Swain, 1996), as well as those of community samples (e.g., Gump et al., 2009).

Sociodemographic background. Mothers reported their annual family income on a 21-point response scale ranging from 1 (*less than $5,000*) to 21 (*more than $100,000*) with an average of $50,000 to $54,999 per year ($M$ = 11.16, SD = 5.71). Mothers reported their and their partners' (if applicable) educational attainment on a 7-point response scale ranging from 1 (*less than 7th grade*) to 7 (*graduate or professional training*), although mothers only reported scores from 3 (*partial high school*) to 7. Mothers (M = 5.60, SD = 1.08) and fathers (M = 5.63, SD = 1.12) on average completed partial college or at least one year of specialized training. Mothers reported their occupational prestige on a 9-point response scale ranging from 1 (*farm laborers, service workers*) to 9 (*higher executives, major professionals*). Mothers most frequently reported clerical or sales worker occupations for themselves (M = 5.21, SD = 2.51) and technicians or semiprofessionals for fathers (M = 6.29, SD = 2.31). Response scales for parental education and occupation were adopted from Hollingshead (1975). Because parent educational attainment, occupational prestige, and family income were highly correlated with each other (r's = 0.39–0.72, p's < 0.001, see Table 1), we standardized and mean averaged these variables to create a family SES variable (α = 0.84). We also examined unique effects of family income and separate mean average scores of parental education and occupation called mother SES (α = 0.76) and father SES (α = 0.84), because these aspects of SES are related to child and parent outcomes differently (Duncan & Magnuson, 2003), including with postpartum depression (O'Hara &

McCabe, 2013).

Social support. Mothers completed 12 questions assessing their need for social support across domains (Social Support Scale, unpublished). Mothers were asked to circle responses that best described the extent to which they have or feel a need for any help or assistance in emotional (e.g., "Someone to talk to about things that worry you;" "to encourage or keep you going when things seem hard") and instrumental domains (e.g., "Someone to help take care of your child;" "who loans you money when you need it;" "to help with household chores") using a 5-point response scale (1 = *never* to 5 = *quite often*). Items were summed to create a total score with higher scores indicating mothers' greater need for social support ($\alpha = 0.82$).

Marital relationship quality. Mothers completed the 32-item Dyadic Adjustment Scale (Spanier, 1976). Mothers selected responses reflecting the extent of agreement or disagreement with their partner (e.g., about finances, recreation, religion, chores) using either a *yes* or *no* scale or a 6-point response scale (0 = *always disagree* to 5 = *always agree*). Mothers indicated how often specific events occurred (e.g., showing affection, discussing separation or divorce) using a 6-point response scale (0 = *never* to 5 = *more often*). Items reflected dyadic consensus, satisfaction, cohesion, and affectional expression and were summed into an overall scale of dyadic adjustment ($\alpha = 0.92$) with higher scores indicating better marital adjustment.

Family dysfunction. Mothers rated 12 items about social support, acceptance, connectedness, and decision making among family members with the Family Assessment Device (Epstein, Baldwin, & Bishop, 1983). Mothers indicated how closely statements described their family using a 4-point response scale (1 = *strongly agree* to 4 = *strongly disagree*). Items were summed into a total score with higher values indicating greater family dysfunction ($\alpha = 0.91$).

Parenting stress. Mothers rated 26 items on the child's reinforcement of the parent,

acceptability of the child to the parent, demandingness of the child, sense of competence in the parenting role, and parent health using an abbreviated version of the Parenting Stress Index (Abidin, 1997). For the initial 22 items, mothers were asked to mark the degree to which they agreed or disagreed with statements by circling responses best describing how they felt using a 5-point response scale (1 = *strongly agree* to 5 = *strongly disagree*). For the last four items, mothers were asked to circle responses that best described their situation using a similar 5-point response scale. Items were summed to create a total score of parenting stress ($\alpha = 0.84$), which we reversed-coded and divided by 10 so that higher scores indicated greater stress.

Infant functional regulatory problems. Mothers completed questionnaires about infant behavior in the past week that reflected functional regulation problems more than poor quality caregiving. Mothers rated infants' total crying times on the Crying Patterns Questionnaire (St. James-Roberts & Halil, 1991). A 5-item crying scale ($\alpha = 0.81$) captured total time in minutes the infant cried throughout the day (morning, afternoon, evening, night) and the total crying time in minutes the day before. Mothers rated infants' appetite, picky eating habits, and difficulty to feed using a 3-point response scale (1 = *no problems* to 3 = *definite problems*), which we summed into a 3-item feeding problems scale ($\alpha = 0.54$). Mothers rated whether infants slept too little, the right amount (reverse-coded), and the same amount each day (reverse-coded) using a 3-point response scale (1 = *rarely* to 3 = *usually*) on the sleep duration scale of the Children's Sleep Habits Questionnaire, which has shown adequate item reliability in both control ($\alpha = 0.69$) and clinic samples ($\alpha = 0.80$; Owens, Spirito, & McGuinn, 2000). We summed responses into a 3-item sleep problems scale ($\alpha = 0.63$). Crying was correlated with sleep ($r = 0.34$, $p < 0.001$) and feeding problems ($r = 0.28$, $p < 0.001$), which also correlated with one another ($r = 0.13$, $p = 0.043$). We mean averaged standardized scores for crying, feeding, and sleep problems into a

total score in which higher scores indicated more infant functional regulatory problems (scale-level $\alpha = 0.50$), which we used in a previous study of the sample (Choe et al., 2013). We also examined unique effects of each subscale of infant functional regulatory problems on postnatal depression, because perceptions of infant difficultness increase risk for maternal depression (Dodge, 1990) and are chiefly based on frequent fussing and crying (Bates, 1980). Considering the relatively low internal consistency of two of these scales, examining their independent effects on postnatal MDS trajectories may elucidate whether they have predictive value beyond their composite scale, the effects of which may be reduced because of its constituents' low reliability.

Toddler adjustment problems. Mothers completed the Child Behavior Checklist for Ages 2–3 (CBCL/2–3; Achenbach, 1992). The externalizing broadband scale included 26 items ($\alpha = 0.86$) assessing destructive and aggressive behaviors. The internalizing broadband scale included 25 items ($\alpha = 0.78$) assessing anxious, depressed, and withdrawn behaviors. Mothers rated children's behavior over the last two months using a 3-point response scale (0 = *not true* to 2 = *very true or often true*). Mothers rated 25 toddlers in the borderline clinical range (10.6%; $T = 60–63$) and five in the clinical range (2.1%; $T > 63$) of the externalizing scale. Mothers rated 15 toddlers in the borderline clinical range (6.4%; $T = 60–63$) and 11 in the clinical range (4.7%; $T > 63$) of the internalizing scale. *T*-scores were used in analyses to account for sex and age.

Toddler receptive vocabulary. Children completed the Peabody Picture Vocabulary Test–3rd Edition (PPVT–III) in the laboratory (Dunn & Dunn, 1997). An examiner directed the children to select one image from arrays of four that best represented a word said aloud. Initial items were determined by toddler age. Raw scores were converted to standard scores for age norm-referencing and interpretation. Standard scores ranged from 65 to 143 ($M = 103.68$, $SD = 17.17$) with age equivalents of less than 1.09 years old to 6.03 years old.

Data Analysis Plan

We used SPSS 22 to examine descriptive statistics and missing data, and we used M*plus* 7.2 to test study hypotheses (Muthén & Muthén, 2017). We estimated an unconditional latent growth model of all mothers' postnatal depressive symptoms to approximate their rate of change from infancy through toddlerhood. After verifying sample heterogeneity in growth parameters, we used latent class growth analysis (LCGA) to approximate one through six postnatal MDS trajectory classes and then used growth mixture modeling (GMM) to estimate separate within-class variances. Once we identified a trajectory class solution with the best balance in model fit and parsimony, we simultaneously tested sociodemographic, psychosocial, and infant predictors of membership to postnatal MDS trajectory classes with a multinomial logistic regression model that accounted for uncertainty in class assignment. We then estimated a simpler model with only significant predictors of trajectory class membership and correlates of missing data and attrition to ensure systematic missingness did not bias results. Lastly, we examined differences among postnatal MDS trajectory classes simultaneously on T3 internalizing, externalizing, and receptive vocabulary while accounting for class uncertainty, and then re-ran the analysis with only significant T1 covariates of T3 outcomes and correlates of non-random missingness and attrition.

Results

Preliminary Analyses

Table 1 presents descriptive statistics and correlations. We found no problems with non-normality in variables (absolute skewness < 1.61, absolute kurtosis < 3.54) or multicollinearity among predictors (tolerance > 0.30, variance inflation factor < 2.70). We tested whether missing data were at random, an assumption of full information maximum likelihood (FIML) estimation. Little's (1988) missing completely at random (MCAR) test with expectation maximization,

$\chi^2(648) = 806.23$, $p < 0.001$, indicated that missing data were not MCAR and that conditions were not ideal for using FIML unless accounting for variables related to missing data.

Among the full sample, missing T2 MDS data (15.1%) were unrelated to study variables, but families with T3 MDS data differed from families without T3 MDS data (24.2%) on T1 father occupation, $p = 0.041$, mother education, $p = 0.015$, father education, $p = 0.022$, T3 internalizing symptoms, $p = 0.013$, externalizing problems, $p = 0.043$, and receptive vocabulary, $p = 0.029$. Within only the final sample, 16.6% of mothers did not report T3 externalizing or internalizing symptoms. These mothers reported significantly fewer T1 infant sleep problems than mothers with T3 ratings, $p = 0.004$. In addition, 21.3% of toddlers did not participate in T3 vocabulary assessments. These children were from lower income families ($p = 0.008$) and had less educated fathers ($p = 0.044$) than children with vocabulary data. We included family income, mother SES, father SES, and infant sleep problems as covariates in final predictive models to account for their associations with nonrandom missing data and attrition.

Single Latent Growth Model of Postnatal Depressive Symptoms

Our first hypothesis was that a single latent growth model would inadequately capture the heterogeneous changes in mothers' postnatal depressive symptoms, such that a unitary growth model would yield poor fit indices and indicate significant variance in level and change of MDS. Following Preacher, Wichman, MacCallum, and Briggs' (2008) model building guidelines, we conducted latent growth modeling with repeated measures of MDS and iteratively tested more complex models of growth until we found an optimal balance of model fit and parsimony. Figure 1 shows a thick black line with triangles that represents the final sample's postnatal trajectory of MDS, which adequately fit the data when we estimated an intercept, slope (loadings of 0, 1, and 3.25 corresponding to 7, 15, and 33 months), and a covariance between growth parameters fixed

to a null value; however, the root mean square error of approximation's 90% confidence interval crossed 1.00, suggesting possible model misfit. Intercept ($\alpha_i = 11.15$, $p < 0.001$) and slope ($\alpha_s = -0.20$, $p = 0.275$) means indicated mothers' initial depressive symptoms differed from zero but did not change over time. Intercept ($\sigma^2_i = 36.05$, $p < 0.001$) and slope ($\sigma^2_s = 4.38$, $p = 0.007$) variances indicated heterogeneity in growth parameters. Mothers varied in their initial depressive symptoms and their rates of postnatal change in a single latent growth model that yielded one concerning fit index, supporting use of group-based trajectory modeling and our first hypothesis.

Latent Class Growth Analysis of Postnatal Depressive Symptoms in Mothers

Our second hypothesis was that group-based trajectory modeling would identify discrete trajectories of persistently low, moderate, or high levels of depressive symptoms and changing symptoms across the postnatal period. We conducted LCGA to find an optimal number of MDS trajectory classes with the requisite assumption of zero variance in growth parameters within latent classes (Nagin & Odgers, 2010). According to Jung and Wickrama (2008), an optimal number of classes can be identified by the lowest Bayesian information criterion (BIC), entropy close to 1.0, class membership posterior probabilities close to 1.0, and a significant Lo-Mendell-Rubin adjusted likelihood ratio test (LMR-LRT) and bootstrap likelihood ratio test (BLRT). We estimated a 1-class solution that produced similar means and variances in the intercept and slope of MDS as the latent growth model. Model fit indices for the 1-class solution (BIC = 4603.50) did not indicate improvement over more complex solutions estimating more than one trajectory class, which further supported use of LCGA and our first two hypotheses.

As shown in Table 2, all LCGA solutions had significant BLRTs and acceptable entropy values, except the 6-class solution. BIC values decreased with each additional class. Only 2-, 3-, and 6-class solutions had significant LMR-LRTs, which indicate improvements over solutions

with one fewer class. The 3-class solution of postnatal trajectories of MDS best fit the data based on fit indices, improvements over simpler solutions, and parsimony. Models with four or more trajectory classes produced poor membership probabilities, classes with too few cases for cross comparison, entropy lower than 0.80, or growth parameters that were discordant with individual trajectories. Because of GMM's increased complexity over LCGA, estimating within-class variances and covariances among growth parameters repeatedly produced non-converging and untrustworthy solutions, so we used the 3-class LCGA solution for all subsequent analyses.

Figure 1 shows a thin solid line with squares that represents the postnatal trajectory of 163 mothers (69.4%) who reported fewer depressive symptoms across early childhood. This *low-decreasing* MDS trajectory class had a significant intercept ($M = 7.72$, $SE = 0.45$, $p < 0.001$) and negative slope ($M = -0.47$, $SE = 0.16$, $p = 0.003$), such that mothers' postnatal depressive symptoms diminished over time. The average latent class probability for most likely group membership was 95.7%. The low-decreasing class included the majority of mothers in this study who demonstrated what we describe as a typical postnatal trajectory of depressive symptoms.

A thin dashed line with diamonds in Figure 1 represents the postnatal trajectory of 60 mothers (25.5%) with heightened depressive symptoms across time. This *moderate* MDS trajectory class had a significant intercept ($M = 18.45$, $SE = 1.70$, $p < 0.001$) but a nonsignificant slope ($M = -0.55$, $SE = 0.68$, $p = 0.422$). Mothers continually reported depressive symptoms two times greater than the low-decreasing MDS trajectory class. The average latent class probability for most likely group membership was 84.1%. The moderate class represented a medium-sized group of mothers with an atypical trajectory of heightened depressive symptoms across time.

Figure 1 shows a thin dotted line with dots that represents the postnatal trajectory of 12 mothers (5.1%) with the highest initial depressive symptoms that continually increased over

time. This *increasing* MDS trajectory class had a significant intercept ($M = 22.57$, $SE = 4.20$, $p < 0.001$) and positive slope ($M = 4.55$, $SE = 1.37$, $p = 0.001$). The average latent class probability for most likely group membership was 91.7%. The increasing class included the smallest group of mothers with an atypical trajectory of chronically-high and worsening depressive symptoms.

Predicting Membership to Postnatal Trajectories Classes of Maternal Depressive Symptom

Our third hypothesis was that unfavorable levels of social support, marital adjustment, family dysfunction, parenting stress, and infant functional regulatory problems would predict membership to atypical trajectories of MDS while accounting for family SES in infancy. We regressed postnatal MDS trajectory class on these six T1 variables in a multinomial logistic regression model with an automatic R3STEP approach that treats auxiliary variables as latent class predictors and accounts for uncertainty in class assignment (Asparouhov & Muthén, 2014). The last two columns in Table 3 displays log odds, standard errors, and *p*-values with the low-decreasing MDS trajectory class as the reference group. Only mothers' high need for social support and parenting stress predicted an increased likelihood of being in the moderate MDS trajectory class. For every one unit increase in need for social support or parenting stress, there was a 0.12 or 0.92 respective increase in log odds of being in the moderate MDS trajectory class. High need for social support, high parenting stress, and low marital adjustment predicted mothers' increased likelihood of being in the increasing MDS trajectory class. For every one unit increase in need for social support or parenting stress, there was a respective increase of 0.16 or 0.85 in log odds of being in the increasing MDS trajectory class than the low-decreasing class. For every one unit increase in marital adjustment, there was a 0.07 decrease in log odds of an increasing postnatal trajectory. No T1 predictor differentiated the increasing and moderate MDS trajectories. The final multinomial logistic regression included only significant predictors and all

correlates of nonrandom missing data and attrition to account for potential spurious effects.

Family income, mother SES, father SES, and infant sleep problems were associated with nonrandom missing data and attrition, so we regressed postnatal MDS trajectory class on these covariates, need for social support, marital adjustment, and parenting stress in a final multinomial logistic regression that accounted for class uncertainty. The right half of Table 4 displays estimates with the low-decreasing MDS trajectory class as the reference. Mothers' high need for social support, parenting stress, and father SES predicted assignment to the moderate MDS trajectory class, while low mother SES and marital adjustment also emerged as significant predictors. For every one unit increase in maternal SES or marital adjustment, there was a 1.42 or 0.05 decrease respectively in log odds of being in the moderate MDS trajectory class than the low-decreasing class. High need for social support and low marital adjustment continued to predict mothers' assignment to the increasing MDS trajectory class, but parenting stress was no longer significant. Again, no predictor differentiated the increasing and moderate MDS trajectory classes. We partially confirmed the third hypothesis, such that high need for social support, low marital adjustment, and high parenting stress predicted assignment to atypical MDS trajectories while accounting for infant sleep problems and multiple components of family SES.

Postnatal Trajectories of Maternal Depressive Symptom Differ in Toddler Adjustment

Our fourth hypothesis was that infants exposed to atypical MDS trajectories would show more behavior problems and poorer vocabularies in late toddlerhood. We examined differences in T3 externalizing, internalizing, and receptive vocabulary among postnatal MDS trajectories with an automatic DU3STEP method that accounts for class uncertainty and unequal variances among dependent variables (Asparouhov & Muthén, 2014). Table 5 shows mothers in the low-decreasing MDS trajectory class rated toddlers as showing fewer externalizing and internalizing

symptoms than mothers in the moderate or increasing class, with some differences as large as one standard deviation. Mothers in the increasing MDS trajectory class rated toddlers as having more internalizing symptoms than mothers in the moderate class, and their children scored a standard deviation below children of mothers with a moderate or low-decreasing trajectory on vocabulary. Mothers in the low-decreasing MDS class had toddlers with the fewest behavior problems and mothers in the increasing class had toddlers with the smallest vocabularies.

We next used a manual 3-step approach to test for differences among postnatal MDS trajectory classes on T3 outcomes while accounting for T1 family SES, psychosocial predictors, infant functional regulatory problems, and class uncertainty (Asparouhov & Muthén, 2014). The analysis estimated covariates' regression coefficients and three dependent variables' covariances held constant across trajectory classes, but it required repeated use of Wald chi-square (χ^2) tests and reduced the analytic sample to 218 cases because of missing T1 data. Across MDS trajectory classes: family SES and infant functional regulatory problems predicted externalizing symptoms; family SES, infant regulatory problems, and parenting stress predicted internalizing symptoms; and only family SES predicted receptive vocabulary (see Table 6). Externalizing and internalizing symptoms were related to each other ($r = 0.64$, $p < 0.001$) but not to vocabulary. Wald χ^2 tests yielded only a significant difference in receptive vocabulary: children of mothers in the increasing MDS trajectory class scored almost one standard deviation below children of mothers in the low-decreasing MDS trajectory class (see Table 7). Differences in receptive vocabulary between the increasing and moderate classes approached significance, $p = 0.060$.

In the final model, we removed nonsignificant predictors to maximize the analytic sample size and disaggregated family SES and infant functional regulatory problems because their components were related to nonrandom missing data and attrition (i.e., family income, mother

SES, father SES, infant sleep problems). Table 8 presents seven T1 covariates' effects on T3 outcomes for children in the final model ($N = 224$). Only parenting stress predicted externalizing symptoms, albeit modestly. Infant sleep problems were the sole predictor of internalizing symptoms. Both infant feeding and crying problems predicted receptive vocabulary scores but in opposite ways such that feeding problems and crying problems predicted better and worse vocabularies, respectively. Table 9 shows that while accounting for class uncertainty and covariates in infancy, offspring of mothers with an increasing postnatal trajectory of depressive symptoms showed more internalizing symptoms and smaller vocabularies than offspring with mothers in the low-decreasing class. Offspring of mothers in the increasing MDS trajectory class showed poorer receptive vocabularies than offspring of mothers in the moderate class. Although only the overall Wald χ^2 test was statistically significant, means of externalizing symptoms for the increasing and moderate MDS trajectory classes were higher than the low-decreasing class. Consistent with our fourth hypothesis, children exposed to atypical MDS trajectories across early childhood showed more behavior problems and poorer vocabularies in late toddlerhood.

Discussion

This longitudinal study of mostly middle-class two-parent families found distinct changes in mothers' postnatal depressive symptoms from infancy through toddlerhood, their antecedents across socioeconomic and interpersonal contexts in infancy, and their consequences for infants' adjustment in late toddlerhood. We leveraged a prospective longitudinal design with a relatively large community sample, wide survey of mothers' resources and stressors, and multimethod measurement of infant outcomes in late toddlerhood to uncover three sets of novel findings.

First, as we hypothesized, a unitary model of growth in all mothers' depressive symptoms from when children were 7 to 33 months old did not fit the data better than more complex

models estimating multiple postnatal trajectories of MDS. To extend evidence of heterogeneity in postnatal depression (e.g., Campbell, Morgan-Lopez, Cox, McLoyd, & NICHD ECCRN, 2009; NICHD ECCRN, 1999; O'Hara & McCabe, 2013), we used group-based trajectory modeling to test the hypothesis that we would identify discrete MDS trajectory classes.

In support of our second hypothesis that we would find persistently low, moderate, high, or changing levels of depressive symptoms, three postnatal trajectories best represented distinct patterns of change in MDS. The postnatal trajectories were similar in size and pattern of change as Campbell et al.'s (2007) three largest classes. Though larger than the low-stable trajectory in the SECCYD sample (Campbell et al., 2007) but similar in size to Mora and colleagues' (2009) lowest symptom group, over two-thirds (70%) of mothers in the current study showed a low-decreasing postnatal trajectory of depressive symptoms. Our moderate postnatal MDS trajectory class included 26% of mothers with slightly elevated depressive symptoms that were stable across time, similar to Campbell et al.'s (2007) moderate-stable MDS trajectory and McCall-Hosenfeld et al.'s (2016) moderate-level trajectory of first-time mothers. The increasing MDS trajectory class in the current study included 5% of mothers with the most depressive symptoms that increased over time, which is consistent in size and form as trajectory classes reported in these other longitudinal studies from the U.S. (Campbell et al., 2007; McCall-Hosenfeld et al., 2016; Mora et al., 2009). Though our sample likely included too few single-parent or low-SES families to replicate the smallest and intermittent trajectories from other studies, we identified dissociable trajectories of postnatal MDS that meaningfully differ in a largely low-risk sample.

Predictors of Membership to Postnatal Depressive Symptom Trajectory Classes

Our third hypothesis was partially supported with findings showing that poor social support, marital adjustment, and high parenting stress predicted elevated risks of increasing and

moderate postnatal MDS trajectories relative to the low-decreasing trajectory, while considering family SES and dysfunction, infant functional regulatory problems, and uncertainty in trajectory class membership, which was not accounted for in previous studies (Campbell et al., 2007; Cents et al., 2012; Gross et al., 2009; Luoma et al., 2015; McCall-Hosenfeld et al., 2016; Mora et al., 2009; Sutter-Dallay et al., 2012; van der Waerden et al., 2015b). After disaggregating family SES and infant regulatory problems into their constituents, high need for social support, poor marital adjustment, and high parenting stress continued to predict mothers' risk of atypical MDS trajectories above all other covariates, except for low maternal education. Although research has linked maternal depression separately to education, social support, marital conflict, and parenting stress (Cummings, Keller, & Davies, 2005; Manuel, Martinson, Bledsoe-Mansori, & Bellamy, 2012; McCall-Hosenfeld et al., 2016), we considered these variables simultaneously to predict postnatal MDS trajectories. Consistent with meta-analyses and interpersonal and family process models of maternal depression (Cummings et al., 2005; O'Hara & McCabe, 2013; O'Hara & Swain, 1996), our findings show that interpersonal processes, especially family stressors and support, more strongly predict postpartum depression than socioeconomic and infant factors.

Mothers' social support when infants were seven months old repeatedly predicted postnatal trajectories, consistent with past studies of postpartum depression (Cutrona & Troutman, 1986; Howell, Mora, & Leventhal, 2006). Instrumental and emotional support are both implicated in mothers' postpartum symptoms (Manuel et al., 2012), but mothers report that their postpartum depression mainly results from poor instrumental support with basic needs related to household chores and self-care, such as eating, showering, and getting sleep (Negron, Martin, Almog, Balbierz, & Howell, 2014). Our social support measure included twice as many items on instrumental than emotional support, so the former likely played a greater role in

predicting mothers' postnatal MDS trajectories. Mothers view infants' fathers and grandmothers as key sources of instrumental and emotional support, but partners are the main source of the latter (Negron et al., 2014) and the overall social support they provide is a key predictor of postnatal depression (Milgrom et al., 2008). Because our marital adjustment questionnaire captured dyadic affectional expression, its modest correlation with social support may reflect consideration of partners' emotional support in ratings of marital quality. Hence, both forms of social support were assessed across our significant predictors of postnatal MDS trajectories.

Family dysfunction and infant functional regulatory problems unexpectedly failed to predict postnatal trajectories, despite correlating with MDS and their risk factors. While family stress (Cents et al., 2012) and infant dysregulation have been linked to postnatal depression (Howell et al., 2006; Sidor, Fischer, & Cierpka, 2017), overlap and low reliability of some scales in the current study likely reduced predictive effects of family dysfunction and infant regulatory problems. Further consideration of infant dysregulation when examining maternal depression and infant mental health is warranted, despite this study's lack of child evocative effects, because infants' regulatory problems strongly predicted their later behavior problems and language skills.

Postnatal Depressive Symptom Trajectory Class Differences in Late Toddlerhood

In support of our last hypothesis, children showed more behavior problems and smaller receptive vocabularies in late toddlerhood when mothers experienced elevated or worsening depressive symptoms across early childhood. When just accounting for significant covariates, only toddlers of mothers with increasing MDS trajectories showed more internalizing and poorer vocabularies than offspring of mothers with mild symptoms, as well as smaller vocabularies than toddlers of mothers with moderate symptoms. These findings expand on studies that linked early MDS to internalizing and cognitive problems in kindergarteners and first graders (Campbell et

al., 2007; Cummings et al., 2005), which could be rooted in or at least exacerbated by children's poor language skills. Although MDS have been shown to predict behavior problems in toddlers (e.g., Weinfield, Ingerski, & Moreau, 2009), this study may be one of the first to find differences in toddler functioning among postnatal MDS trajectories. Children of mothers with moderate or mild depressive symptoms did not differ from one another in late toddlerhood when accounting for all possible covariates. After accounting for covariates, postnatal MDS trajectories did not differ in externalizing symptoms, contrary to studies linking early MDS to behavioral problems in toddlers, preschoolers, and school-age children (Bagner et al., 2010; Campbell et al., 2007; Goodman et al., 2011; Weinfield et al., 2009), but their means followed the expected pattern.

When controlling for family income, parent SES, and mothers' need for social support, high infant sleep problems at 7 months predicted more internalizing symptoms at 33 months, which is consistent with recent work linking infant sleep difficulties at 6 months old to internalizing symptoms at 36 months (Sidor et al., 2017). Although we expected postnatal MDS trajectories to differ in offspring internalizing symptoms, internalizing symptoms were more closely related to infant sleep problems and parenting stress than other regulatory problems or SES. Because postnatal MDS are exacerbated by infants' and mothers' sleep problems (Negron et al., 2014; Sidor et al., 2017), sleep disturbances likely added to mothers' parenting stress and its inconsistent prediction of internalizing and externalizing symptoms across analyses.

The most robust difference in offspring among postnatal MDS trajectories was in receptive vocabulary in late toddlerhood. Although some studies have found no link between MDS and preschoolers' cognitive skills (e.g., Kiernan & Huerta, 2008), a recent meta-analysis reported negative associations between maternal depression and child cognitive scores across early childhood, detectable even in early infancy (Liu et al., 2017). We found that children of

mothers with worsening depressive symptoms scored lowest in receptive vocabulary at 33 months across all analyses, which extends Brennan and colleagues' (2000) finding that only chronically severe MDS predict children's receptive vocabularies. As far as we know, the only other evidence linking MDS to toddlers' vocabularies came from a study of vocabulary production trajectories from age 1 to 3 years (Pan, Rowe, Singer, & Snow, 2005). In this study, mothers' literacy, language skills, depressive symptoms (assessed only at the first time point), and their interaction predicted vocabulary growth, such that mothers with high MDS and low literacy and language skills had toddlers with the smallest gains in vocabulary production. The findings encourage further consideration of the severity, timing, and chronicity of MDS and the language used in parent–child interactions in relation to infant development and mental health.

Limitations, Future Directions, and Implications

Caveats of the current investigation warrant cautious interpretation of its findings. One concern is that mothers reported most data. Potential biases from a single informant or mothers' depressive symptoms (Connell & Goodman, 2002) were offset by lab assessments of receptive vocabulary that repeatedly differed among postnatal MDS trajectories. Mother-reported behavior problems did not differ as consistently among postnatal trajectories, which is unexpected if there were strong reporter biases. Furthermore, overlap and/or low internal consistency across mother-reported variables in infancy likely reduced predictive effects of family dysfunction and infant regulatory problems, leading to their unexpected failure to predict MDS trajectories in this study.

We also lacked data on prenatal and postpartum depression until infants were seven months old, which limits inferences about symptom continuity. Prenatal depression is a major risk factor of postpartum depression, partly because onset of a depressive episode markedly increases risk of later depression (Field, 2011; O'Hara & McCabe, 2013). Milgrom et al. (2008)

found prenatal depression, depression history, and poor social support from a partner were the strongest predictors of postnatal depression, which suggests some of our predictive effects reflect vulnerabilities established prior to childbirth or pregnancy. Evidence linking prenatal depression to pregnancy and birth complications and infant functional regulatory problems encourages further longitudinal study of the heterogeneous course of pre- and postnatal depression and their effects on infant mental health (Field, 2011). Because postpartum depression is more closely related to child maladjustment than depression before or during pregnancy (Bagner et al., 2010), we are less concerned of a lack of prenatal data for analyses predicting toddlerhood outcomes.

Further research is needed to clarify the mechanisms underlying effects of MDS on infant development and mental health. Parenting styles and practices are often examined as proximal mechanisms through which maternal depression influences child outcomes, but few studies empirically test for mediators of postpartum depression on caregiving (Cummings & Davies, 1994; O'Hara & McCabe, 2013). Meta-analytic results indicate strong links between diagnosed and self-reported MDS and negative maternal behavior that are moderated by timing, such that current depression demonstrates the largest effects on caregiving; moreover, negative effects of MDS on positive maternal behavior appear strongest in studies of disadvantaged mothers and mothers of infants (Lovejoy, Graczyka, O'Hare, & Neumana, 2000). The greater malleability of mother–infant interactions compared to later in childhood implicates the postpartum period as a window of opportunity through which to serve mother–infant dyads and study growth in MDS (Sohr-Preston & Scaramella, 2006). Improvements in maternal depression and parenting are also shown to mediate family intervention effects on child mental health outcomes, even when not directly targeted (Hutchings, Bywater, Williams, Labe, & Whitaker, 2012; Shaw, Connell, Dishion, Wilson, & Gardner, 2009). Because a continuum of MDS severity and chronicity is

shown to impair functioning in mothers and their offspring (Meaney, 2018), it is imperative that future work include mothers representing the entire spectrum of depressive symptom trajectories.

The findings from this longitudinal study support recent recommendations from the U.S. Preventive Services Task Force (USPSTF) for the implementation of universal depression screenings for the adult population, especially pregnant and postpartum women, with proper support services in place for accurate diagnosis, effective treatment, and follow-up (Siu & USPSTF, 2016). The report indicates that early screening contributes minimal to no harm, and that cognitive-behavioral therapy improves clinical outcomes in pregnant and postpartum women with depression. Early identification and treatment of affected mothers and mother–infant dyads are needed to curb adverse consequences of postpartum and postnatal depression (O'Hara & McCabe, 2013). Services that concentrate on mothers with probable depression or subthreshold levels of depressive symptoms can help reach the majority of vulnerable mothers, many of whom go undiagnosed and untreated despite experiencing some functional impairments and distress. Further investments in all mothers' postpartum health may yield innumerable benefits to the development of their offspring and subsequent generations of children and parents, ultimately helping to prevent depression and the intergenerational transmission of psychopathology.

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Table 1.

Descriptive Statistics and Correlations of Main Study Variables

Variables		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1.	T1 MDS	–																	
2.	T2 MDS	**.53*****	–																
3.	T3 MDS	**.44*****	**.62*****	–															
4.	T1 Family Income	**-.27*****	**-.21****	**-.19****	–														
5.	T1 Mother Occupation	-.13	**-.14***	**-.19***	**.51*****	–													
6.	T1 Father Occupation	-.11	**-.21****	-.14	**.47*****	**.39*****	–												
7.	T1 Mother Education	**-.17***	**-.20****	**-.28*****	**.51*****	**.62*****	**.58*****	–											
8.	T1 Father Education	-.09	-.12	**-.18***	**.46*****	**.45*****	**.72*****	**.68*****	–										
9.	T1 Social Support Need	**.34*****	**.35*****	**.33*****	**-.18****	-.08	-.04	**-.15***	-.10	–									
10.	T1 Marital Adjustment	**-.48*****	**-.38*****	**-.35*****	**.18****	.08	**.21****	**.15***	**.22****	**-.17***	–								
11.	T1 Family Dysfunction	**.38*****	**.31*****	**.29*****	**-.19****	-.11	**-.26*****	**-.26*****	**-.24*****	.13	**-.57*****	–							
12.	T1 Parenting Stress	**.43*****	**.28*****	**.31*****	-.11	-.04	-.01	-.01	-.04	**.15***	**-.46*****	**.33*****	–						
13.	T1 Crying Problems	.12	.05	.02	-.10	-.05	-.11	-.09	-.09	**.13***	-.05	.06	.11	–					
14.	T1 Feeding Problems	**.20****	.04	.01	-.07	-.04	.05	-.07	.01	.02	-.08	.07	.12	**.28***	–				
15.	T1 Sleep Problems	**.20****	.03	.05	.01	.12	.06	.07	.04	.11	-.11	.04	**.24*****	**.34*****	**.13***	–			
16.	T3 Externalizing	**.31*****	**.26*****	**.44*****	-.12	-.14	-.11	-.14	**-.16***	**.24****	**-.19****	**.20****	**.30*****	.10	**.16***	**.21****	–		
17.	T3 Internalizing	**.27*****	**.22****	**.39*****	**-.23****	**-.16***	-.06	**-.16***	**-.14***	**.22****	**-.16***	**.18***	**.29*****	**.15***	**.18***	**.23****	**.69*****	–	
18.	T3 Vocabulary	**-.22****	**-.25****	**-.25****	**.37*****	**.29*****	**.28*****	**.33*****	**.36*****	-.11	.06	-.14	-.06	-.12	.10	-.06	-.11	**-.22****	–
M		11.06	11.03	10.33	11.16	5.25	6.42	5.65	5.67	31.23	112.19	1.70	-10.48	145.00	3.96	4.09	49.40	49.80	103.69
SD		8.18	9.13	8.89	5.71	2.48	2.23	1.04	1.12	7.56	15.52	.51	1.06	144.20	1.15	1.39	7.77	8.73	17.15

Note: T1 = infant age 7 months. T2 = age 15 months. T3 = age 33 months. MDS = maternal depressive symptoms.

*$p < .05$. **$p < .01$. ***$p < .001$.

Table 2.

Comparison of Fit Among Latent Class Growth Analysis Solutions for Postnatal Trajectories of Maternal Depressive Symptoms from Infancy through Toddlerhood (N = 235)

Fit Statistic	*2-Class*	***3-Class***	*4-Class*	*5-Class*	*6-Class*
1. AIC BIC adjusted BIC	4419.36 4447.03 4421.68	**4359.35** **4397.40** **4362.54**	4333.98 4382.42 4338.04	4317.53 4376.35 4322.46	4310.09 4379.29 4315.89
2. Entropy	0.85	**0.84**	0.86	0.87	0.78
3. % of Participants in Classes Based on Estimated Posterior Probabilities	20.43% 79.57	**5.40%** **24.81%** **69.79%**	4.89% 5.27% 21.05% 68.80%	2.65% 3.54% 3.65% 22.86% 67.29%	2.98% 2.98% 3.83% 13.19% 21.70% 55.32%
4. Probability of Membership	92.0% - 96.5%	**84.1% - 95.7%**	82.4% - 95.7%	76.5% - 95.2%	72.3% - 99.2%
5. LMR-LRT	$p = 0.002$	$\boldsymbol{p = 0.044}$	$p = 0.568$	$p = 1.000$	$p < 0.001$
6. BLRT	$p < 0.001$	$\boldsymbol{p < 0.001}$	$p < 0.001$	$p < 0.001$	$p = 0.030$

Note: AIC = Akaike information criterion. BIC = Bayesian information criterion. LMR-LRT = Lo-Mendell-Rubin adjusted likelihood ratio test. BLRT = bootstrap likelihood ratio test. The column with bold text is the solution with the best balance in overall fit indices and parsimony.

Table 3.
Multinomial Logistic Regression Model (R3STEP): Sociodemographic, Psychosocial, and Infant Predictors of Postnatal Trajectory Class of Maternal Depressive Symptoms (N = 218)

T1 Predictors	*Increasing* (*n* = 9)†			*Moderate* (*n* = 53)††			*Increasing* (*n* = 9)††		
	b	*SE*	*p*	*b*	*SE*	*p*	*b*	*SE*	*p*
1. Family SES	-.82	.53	.125	.11	.33	.740	-.71	.55	.198
2. Social Support Need	.04	.04	.347	**.12**	**.04**	**.007**	**.16**	**.05**	**.000**
3. Marital Adjustment	-.04	.04	.234	-.03	.02	.098	**-.07**	**.03**	**.030**
4. Family Dysfunction	-1.34	1.2	.262	.76	.50	.132	.59	1.13	.605
5. Parenting Stress	-.07	.41	.869	**.92**	**.37**	**.013**	**.85**	**.42**	**.042**
6. Infant Functional Regulatory Problems	-.52	.40	.190	.51	.35	.149	-.02	.11	.972

Note: T1 = infant age 7 months. SES = socioeconomic status. Bold text indicates statistically significant log odds that represent likelihoods of membership to postnatal trajectory classes of maternal depressive symptom (MDS) relative to the reference group. Loglikelihood = -2168.67. Bayesian information criterion = 4397.40. Entropy = 0.84. † Moderate MDS trajectory class is the reference group. †† Low-Decreasing MDS trajectory class (*n* = 156) is the reference group.

Table 4.

Final Multinomial Logistic Regression Model (R3STEP): Sociodemographic, Psychosocial, and Infant Predictors of Postnatal Trajectory Class of Maternal Depressive Symptoms (N = 218)

T1 Predictors	*Increasing* (*n* = 9)†			*Moderate* (*n* = 53)††			*Increasing* (*n* = 9)††		
	b	*SD*	*p*	*b*	*SD*	*p*	*b*	*SD*	*p*
1. Family Income	-.24	.16	.149	.02	.09	.810	-.22	.15	.146
2. Mother SES	.95	.70	.175	**-1.42**	**.54**	**.008**	-.47	.55	.391
3. Father SES	-.51	.48	.288	**1.08**	**.51**	**.036**	.57	.41	.166
4. Social Support Need	.04	.05	.430	**.12**	**.05**	**.009**	**.16**	**.04**	**.000**
5. Marital Adjustment	-.02	.03	.367	**-.05**	**.02**	**.008**	**-.07**	**.02**	**.003**
6. Parenting Stress	-.41	.38	.273	**1.11**	**.36**	**.002**	.69	.41	.087
7. Infant Sleep Problems	.03	.22	.901	.24	.20	.239	.27	.22	.225

Note: T1 = infant age 7 months. SES = socioeconomic status. Bold text indicates statistically significant log odds that represent likelihoods of membership to postnatal trajectory classes of maternal depressive symptom (MDS) relative to the reference group. Loglikelihood = -2168.67. Bayesian information criterion = 4397.40. Entropy = 0.84. † Moderate MDS trajectory class is the reference group. †† Low-Decreasing MDS trajectory class (*n* = 156) is the reference group.

Table 5.

Differences in Toddlerhood among Postnatal Trajectory Classes of Maternal Depressive Symptoms: Equality Tests of Means with Automatic DU3STEP Approach (N = 235)

Dependent Variables	Trajectory Class of Maternal Depressive Symptoms		
	Low-Decreasing $n = 163$	*Moderate* $n = 60$	*Increasing* $n = 12$
T3 externalizing broadband scale *T*-scores	$M = 47.70$ $SE = 0.69$	$M = 53.16$ $SE = 1.46$	$M = 54.53$ $SE = 1.68$
Overall $\chi^2(2) = 20.69$, $p < 0.001$	***Low-Decreasing < Moderate*:** **$\chi^2(1) = 9.65$** ***p* = 0.002**	*Moderate* vs. *Increasing*: $\chi^2(1) = 0.35$ $p = 0.554$	***Increasing > Low-Decreasing*:** **$\chi^2(1) = 14.24$** ***p* < 0.001**
T3 internalizing broadband scale *T*-scores	$M = 48.27$ $SE = 0.75$	$M = 52.45$ $SE = 1.42$	$M = 57.67$ $SE = 1.88$
Overall $\chi^2(2) = 24.66$, $p < 0.001$	***Low-Decreasing < Moderate*:** **$\chi^2(2) = 6.11$** ***p* = 0.013**	***Moderate < Increasing*:** **$\chi^2(1) = 4.64$** ***p* = 0.031**	***Increasing > Low-Decreasing*:** **$\chi^2(1) = 21.54$** ***p* < 0.001**
T3 receptive vocabulary standard scores	$M = 106.06$ $SE = 1.59$	$M = 100.80$ $SE = 2.61$	$M = 85.81$ $SE = 4.83$
Overall $\chi^2(2) = 17.18$, $p < 0.001$	*Low-Decreasing* vs. *Moderate*: $\chi^2(1) = 2.59$ $p = 0.107$	***Moderate > Increasing*:** **$\chi^2(1) = 6.92$** ***p* = 0.009**	***Increasing < Low-Decreasing*:** **$\chi^2(1) = 15.90$** ***p* < 0.001**

Note: T3 = infant age 33 months. Bold text indicates statistically significant mean differences between trajectory classes, $p < 0.05$. Loglikelihood = -2168.67. Bayesian information criterion = 4397.40. Entropy = 0.84.

Table 6.

Differences in Toddlerhood among Postnatal Trajectory Classes of Maternal Depressive Symptoms with Covariates: Summary of Regression Coefficients across the Low-Decreasing (n = 156), Moderate (n = 52), and Increasing (n = 10) Trajectory Classes.

	T3 Externalizing Symptoms				T3 Internalizing Symptoms				T3 Receptive Vocabulary			
T1 Covariates	*B*	*SE B*	*β*	*p*	*B*	*SE B*	*β*	*p*	*B*	*SE B*	*β*	*p*
Family SES	**-1.56**	**0.75**	**-0.16**	**0.037**	**-2.00**	**0.79**	**-0.17**	**0.011**	**9.07**	**1.66**	**0.41**	**0.000**
Social Support Need	0.12	0.09	0.11	0.200	0.13	0.09	0.11	0.177	-0.02	0.14	-0.01	0.918
Marital Adjustment	0.00	0.05	0.00	0.975	0.03	0.05	0.06	0.550	-0.04	0.08	-0.04	0.646
Family Dysfunction	0.29	1.46	0.02	0.844	0.24	1.42	0.02	0.865	0.11	2.55	0.00	0.965
Parenting Stress	1.26	0.69	0.19	0.069	**1.86**	**0.90**	**0.24**	**0.038**	-0.10	1.25	-0.01	0.936
Infant Functional Regulatory Problems	**1.64**	**0.73**	**0.18**	**0.024**	**2.57**	**0.79**	**0.24**	**0.001**	-0.17	1.45	-0.01	0.907
R^2	0.11 / 0.14 / 0.12				0.15 / 0.19 / 0.17				0.18 / 0.17 / 0.13			

Note: T1 = infant age 7 months. T3 = age 33 months. SES = socioeconomic status. R^2 values are listed in order of *Low-Decreasing*, *Moderate*, and *Increasing* trajectory classes. Bold text indicates statistically significant regression coefficients, $p < 0.05$. Regression coefficients were estimated in the same analysis as estimates reported in Table 7.

Table 7.

Differences in Toddlerhood among Postnatal Trajectory Classes of Maternal Depressive Symptoms with Covariates: Wald χ^2 Tests of Means with Manual 3-Step Approach (N = 218)

	Trajectory Class of Maternal Depressive Symptoms		
Dependent Variables	*Low-Decreasing* $n = 156$	*Moderate* $n = 52$	*Increasing* $n = 10$
T3 externalizing broadband scale *T*-scores	$M = 57.06$ $SD = 10.68$	$M = 60.68$ $SD = 10.72$	$M = 61.76$ $SD = 11.30$
Overall $\chi^2(2) = 3.90$, $p = 0.142$	*Low-Decreasing* vs. *Moderate*: $\chi^2(1) = 1.64$ $p = 0.201$	*Moderate* vs. *Increasing*: $\chi^2(1) = 0.03$ $p = 0.859$	*Increasing vs. Low-Decreasing*: $\chi^2(1) = 1.06$ $p = 0.304$
T3 internalizing broadband scale *T*-scores	$M = 60.54$ $SD = 9.63$	$M = 61.78$ $SD = 9.11$	$M = 69.21$ $SD = 11.50$
Overall $\chi^2(2) = 2.88$, $p = 0.237$	*Low-Decreasing* vs. *Moderate*: $\chi^2(1) = 0.14$ $p = 0.713$	*Moderate* vs. *Increasing*: $\chi^2(1) = 0.74$ $p = 0.389$	*Increasing vs. Low-Decreasing*: $\chi^2(1) = 1.74$ $p = 0.188$
T3 receptive vocabulary standard scores	$M = 108.02$ $SD = 15.44$	$M = 103.82$ $SD = 15.30$	$M = 95.83$ $SD = 15.49$
Overall $\chi^2(2) = 8.77$, $p < 0.013$	*Low-Decreasing* vs. *Moderate*: $\chi^2(1) = 1.36$ $p = 0.243$	*Moderate* vs. *Increasing*: $\chi^2(1) = 3.54$ $p = 0.0598$	***Increasing < Low-Decreasing*: $\chi^2(1) = 8.77$ $p = 0.003$**

Note: T3 = infant age 33 months. Bold text indicates statistically significant mean differences between trajectory classes, $p < 0.05$. Loglikelihood = -2089.93. Bayesian Information Criterion = 4368.31. Entropy = 0.78. Covariates include family socioeconomic status, need for social support, marital adjustment, family dysfunction, parenting stress, and infant functional regulatory problems. Mean differences were tested in the same analysis as estimates reported in Table 6.

Table 8.

Final Differences in Toddlerhood among Postnatal Trajectory Classes of Maternal Depressive Symptoms with Covariates: Summary of Regression Coefficients across the Low-Decreasing (n = 159), Moderate (n = 55), and Increasing (n = 10) Trajectory Classes.

	T3 Externalizing Symptoms				T3 Internalizing Symptoms				T3 Receptive Vocabulary			
T1 Covariates	*B*	*SE B*	*β*	*p*	*B*	*SE B*	*β*	*p*	*B*	*SE B*	*β*	*p*
Family Income	0.02	0.13	0.02	0.865	-0.22	0.14	-0.15	0.105	0.47	0.28	0.16	0.098
Mother SES	-0.32	0.96	-0.04	0.735	-1.20	0.98	-0.13	0.222	2.69	1.85	0.15	0.147
Father SES	-1.15	0.76	0.15	0.130	0.38	0.85	0.04	0.656	3.08	1.74	0.18	0.077
Parenting Stress	**1.32**	**0.63**	**0.21**	**0.037**	1.53	0.78	0.22	0.050	0.18	1.30	0.01	0.891
Infant Feeding Problems	0.79	0.46	0.14	0.088	0.91	0.54	0.14	0.095	**2.34**	**0.92**	**0.19**	**0.011**
Infant Sleep Problems	0.69	0.39	0.15	0.073	**0.85**	**0.40**	**0.16**	**0.032**	-0.52	0.90	-0.05	0.562
Infant Crying Problems	0.00	0.00	-0.01	0.919	0.00	0.00	0.04	0.434	**-0.01**	**0.01**	**-0.09**	**0.037**
R^2	0.10 / 0.13 / 0.11				0.14 / 0.19 / 0.13				0.19 / 0.19 / 0.19			

Note: T1 = infant age 7 months. T3 = age 33 months. SES = socioeconomic status. R^2 values are listed in order of *Low-Decreasing*, *Moderate*, and *Increasing* trajectory classes. Bold text indicates statistically significant regression coefficients, $p < 0.05$. Regression coefficients were estimated in the same analysis as estimates reported in Table 9.

Table 9.

Final Differences in Toddlerhood among Postnatal Trajectory Classes of Maternal Depressive Symptoms with Covariates: Wald χ^2 Tests of Means with Manual 3-Step Approach (N = 224)

	Trajectory Class of Maternal Depressive Symptoms		
Dependent Variables	*Low-Decreasing* $n = 159$	*Moderate* $n = 55$	*Increasing* $n = 10$
T3 externalizing broadband scale *T*-scores	$M = 55.82$ $SD = 7.21$	$M = 60.41$ $SD = 6.84$	$M = 60.08$ $SD = 6.99$
Overall $\chi^2(2) = 7.56$, $p = 0.023$	*Low-Decreasing* vs. *Moderate*: $\chi^2(1) = 3.64$ $p = 0.056$	*Moderate* vs. *Increasing*: $\chi^2(1) = 0.01$ $p = 0.922$	*Increasing vs. Low-Decreasing*: $\chi^2(1) = 3.52$ $p = 0.061$
T3 internalizing broadband scale *T*-scores	$M = 60.02$ $SD = 8.38$	$M = 62.29$ $SD = 7.41$	$M = 66.35$ $SD = 8.29$
Overall $\chi^2(2) = 5.93$, $p = 0.052$	*Low-Decreasing* vs. *Moderate*: $\chi^2(1) = 0.77$ $p = 0.382$	*Moderate* vs. *Increasing*: $\chi^2(1) = 1.00$ $p = 0.317$	***Increasing > Low-Decreasing*: $\chi^2(1) = 4.77$ $p = 0.029$**
T3 receptive vocabulary standard scores	$M = 96.62$ $SD = 14.96$	$M = 92.36$ $SD = 13.71$	$M = 81.44$ $SD = 14.53$
Overall $\chi^2(2) = 19.81$, $p < 0.001$	*Low-Decreasing* vs. *Moderate*: $\chi^2(1) = 1.51$ $p = 0.219$	***Moderate > Increasing*: $\chi^2(1) = 7.51$ $p = 0.006$**	***Increasing < Low-Decreasing*: $\chi^2(1) = 19.75$ $p < 0.00001$**

Note: T3 = infant age 33 months. Bold text indicates statistically significant mean differences between trajectory classes, $p < 0.05$. Loglikelihood = -2128.25. Bayesian information criterion = 4462.14. Entropy = 0.77. Covariates include family income, mother socioeconomic status (SES), father SES, parenting stress, and infant crying, feeding, and sleep problems. Mean differences were tested in the same analysis as estimates reported in Table 8.

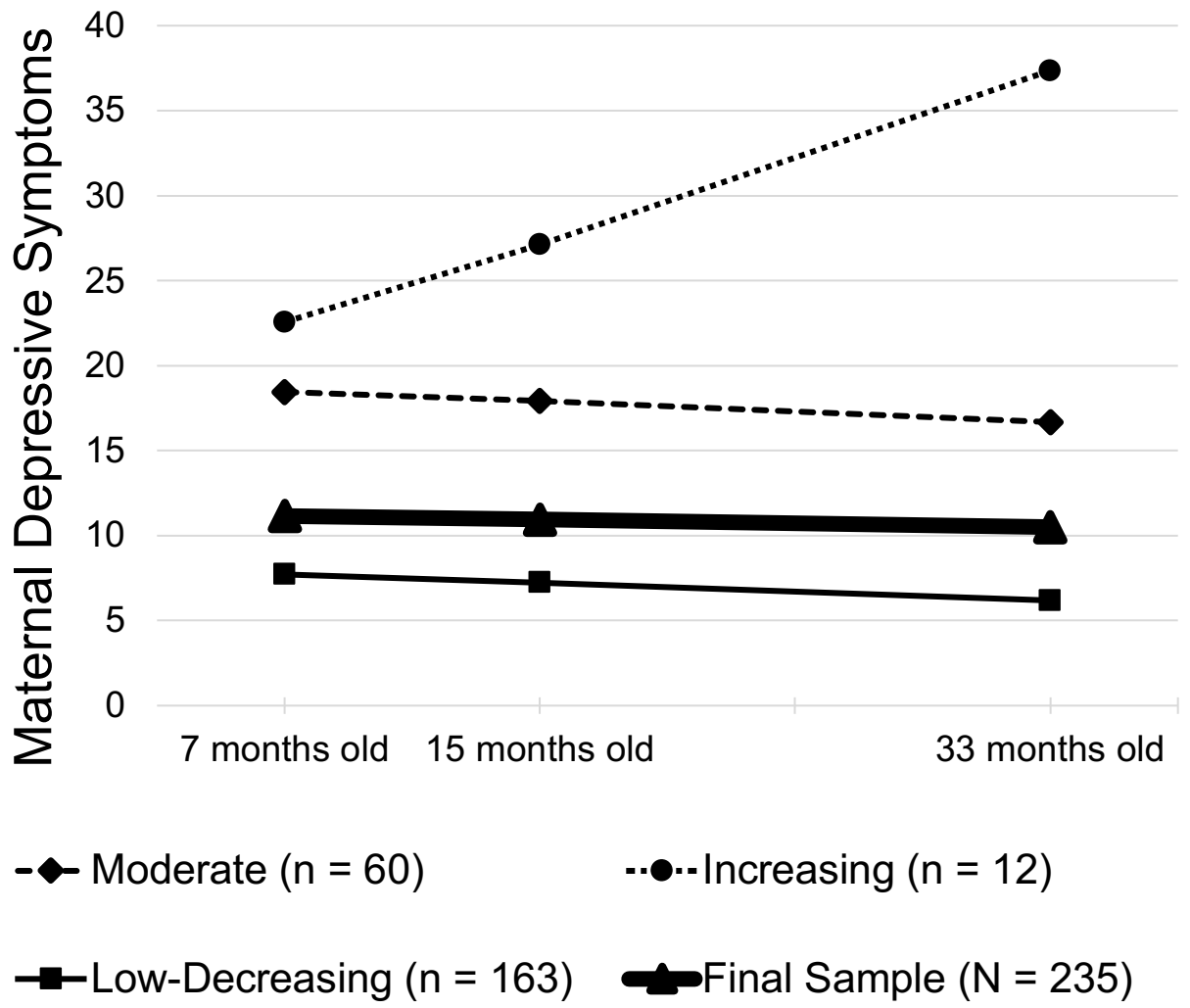

Figure 1. **(a)** The thick black line with triangle-shaped markers represents a single latent growth model of maternal depressive symptoms with an intercept, slope, and their covariance fixed to a null value: $\chi^2(2, N = 235) = 2.89$, $p = 0.236$; confirmatory fit index = 0.99; root mean square error of approximation (RMSEA) = 0.04, RMSEA 90% confidence interval [0.00, 0.14]; standardized root mean square residual = 0.03. **(b)** Three thin black lines with distinct patterns and markers are the postnatal trajectories estimated from the latent class growth analysis' 3-class solution: Bayesian information criterion = 4397.40; entropy = 0.84; Lo-Mendell-Rubin adjusted likelihood ratio test, $p = 0.044$; bootstrap likelihood ratio test, $p < 0.001$.