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Trajectories of Maternal Depressive Symptoms in the Early Childhood Period and Family-Wide Clustering of Risk

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Abstract

Background:

Previous research on individual differences in the course of maternal depressive symptoms has yielded inconsistent findings, with significant variation in the number and pattern of trajectories identified. In addition, missing from the literature is a comprehensive examination of predictors and longitudinal consequences of particular depression trajectories.

Method:

Participants in this study included a community cohort of 501 women assessed for depression using the Center for Epidemiologic Depression Scale at infant age 2, 18, 36, and 54 months. A multi-informant approach was used to examine predictors and outcomes of trajectory membership.

Results:

Using growth mixture modeling, three distinct trajectories emerged: 84% of the sample demonstrated low-stable levels of depressive symptoms, 9.5% had high-decreasing scores, and 6.5% had moderate-increasing scores. While socioeconomic status and marital conflict differentiated the low-stable group from the high-decreasing and moderate-increasing group, neighborhood collective efficacy differentiated the latter two groups. At 54 months, a clustering of family risks was prevalent for the moderate-increasing depression group, including higher marital conflict and household chaos, lower parental positivity, and heightened levels of child psychopathology.

Limitations:

Limitations include reliance on self-reports to assess maternal depression and the relatively small sample size of certainly trajectory classes.

Conclusions:

The onset and course of maternal depression in the early childrearing period is heterogeneous, with distinct subgroups in the population. Comprehensive assessment of individual, family, and neighborhood stressors augments our understanding of the predictors and consequences of trajectory membership over this critical period of child and family adaptation.

Keywords: maternal depressive symptoms, growth mixture modeling, family-wide risk

Depression is one of the most common psychiatric illnesses, and is considered to be the leading cause of disease-related disability worldwide among women (Kessler, Berglund, Demler, & et al., 2003). Maternal depressive symptoms are common in the early childrearing period, with meta-analytic estimates suggesting that 19.2% of women experience a depressive episode within 3 months of childbirth (Gavin et al., 2005). Exposure to maternal depression during the first few

years of life may be particularly problematic for the child, as they are undergoing a period of rapid brain and biobehavioral organization (Shonkoff et al., 2012; Teicher et al., 2003). Indeed, increased severity and chronicity of maternal depression has been shown to be an especially potent predictor of deleterious child outcomes (Ashman, Dawson, & Panagiotides, 2008; Campbell, Matestic, von Stauffenberg, Mohan, & Kirchner, 2007).

A growing body of research suggests that the course and severity of maternal depression is heterogeneous. In a comprehensive review of the literature, Vliegen, Casalin, and Luyten (2014) determined that the number of subgroups of maternal depression likely depends on how depression was defined. When depression was measured diagnostically, a group of chronically depressed and remitting mothers most commonly characterized the literature. However, when the severity of depression was taken into account, a third group of mothers with stable-minor depression was identified. These results suggest that there are both qualitative (i.e., course) and quantitative (i.e., severity) differences to consider when examining trajectories of maternal depression.

At present, there is considerable variability in the number and pattern of maternal depression trajectories identified over the early childhood period (Ashman et al., 2008; Campbell et al., 2007; Cents et al., 2013; van der Waerden et al., 2015). These inconsistent findings create difficulty in planning prevention and intervention efforts and targeting sub-groups at greatest risk of psychosocial maladaptation. Although cross-study differences may be attributed to sampling and measurement factors, one critical difference among existing trajectory studies is the methodology used to derive the trajectories. Two methods are often used. The first is latent class growth analysis (LCGA), which assumes that individual differences in symptom course are entirely accounted for by qualitative differences – that is, they are accounted for by distinct

trajectories and there is no variability in severity among individuals within each trajectory.

Because this method assumes that individual differences are entirely accounted for by qualitative differences, it has a tendency to extract a relatively larger number of trajectories. To date, studies using LCGA have generally identified 4 to 6 depression trajectories (e.g., Campbell et al., 2007; Cents et al., 2013; van der Waerden et al., 2015). The second method is growth mixture modeling (GMM), which assumes that individual differences in symptom course are accounted for by both distinct trajectories (i.e., qualitative differences between classes) as well as variability among individuals within each trajectory (i.e., quantitative differences in severity within each class). GMM is particularly appropriate for describing the course of depressive symptoms as it accounts for both symptom course and severity (Vliegen et al., 2014). Despite its advantages, only one study to date has used GMM to describe maternal depression across early childhood (Ashman et al., 2008). This study identified three trajectories: 30% of the sample experienced decreasing symptoms, 8% chronic symptoms, and 62% stable-mild symptoms. However, the sample size for this study was small, and non-depressed participants were not included in the analyses. As a result, it is unclear if the number and pattern of trajectories is generalizable to community samples. Moreover, studies examining risk and protective factors of trajectory membership have commonly examined whether membership in the elevated trajectory groups is associated with greater risk for child psychopathology. In the current study, we extend this literature by comprehensively examining individual and family-wide downstream consequences of trajectory membership, including marital conflict, caregiving behavior, family chaos, and child psychopathology.

Putative Psychosocial Stressors Associated with Depression Trajectories

Etiological models of depression often focus on eventful changes that occurs as a function of stress or life events (Yim, Tanner Stapleton, Guardino, Hahn-Holbrook, & Dunkel Schetter, 2015). It has been suggested that changes associated with the birth of a child explicitly pull for individual and family re-adjustment, which can intensify psychological stress and create vulnerability for depression or exacerbate pre-existing difficulties (O'Hara, Rehm, & Campbell, 1982; Pearlin, Menaghan, Lieberman, & Mullan, 1981). Several antecedent psychosocial stressors have been shown to predict elevated levels of maternal depression (Boyce & Hickey, 2005). Lower maternal age and educational attainment, single parenthood, and poverty have been associated with persistent depressive symptoms in mothers, suggesting that socioeconomic disadvantage exacerbates the risk of depression (O'Hara & Swain, 1996; Pascoe, Stolfi, & Ormond, 2006). Moreover, the accumulation of traumatic childhood events has been shown to have life-long consequences for adaptation and psychological functioning (Felitti et al., 1998). Another putative psychological stressor for depression is marital conflict, wherein heightened discord often coincides with elevated levels of depressive symptoms (Cox, Paley, Burchinal, & Payne, 1999; Yim et al., 2015). Separate lines of evidence have pointed to pre/perinatal problems as a source of increased depression (O'Hara & Swain, 1996). Specifically, mothers of low birth weight children are at an increased risk of depression, possibly due to enhanced stress associated with suboptimal pregnancy and the demands of caring for a medically vulnerable child (Field et al., 1985; Vigod, Villegas, Dennis, & Ross, 2010). Finally, the absence of psychological resources or social support networks may impinge on one's capacity to effectively manage stress in several domains (Cohen & Wills, 1985; Pearlin et al., 1981), and this may include neighborhood-wide factors (Sampson, 1997). In sum, several theoretically and empirically derived individual and family stressors may serve as antecedent risks for maternal depression. To

date, however, no study has examined such a wide range of risks as predictors of maternal depression trajectories in the early postnatal period.

The Current Study

The current study examined trajectories of maternal depressive symptoms in a large, community-based sample of mothers assessed at four times over the first five years following the birth of their child. The goals were to: (1) identify heterogeneous trajectories of depressive symptoms, wherein we hypothesized the number and nature of the trajectories would coincide with previous research reflecting chronic, remitting, and low-stable groups (Ashman et al., 2008; Vliegen et al., 2014); (2) examine various psychosocial and ecological factors at infant age 2 months that putatively differentiate among trajectory groups. Here, it was hypothesized that belonging to a trajectory group characterized by higher initial levels and/or higher chronicity would be associated with more psychosocial problems; and (3) validate the existence of trajectory groups by examining family-wide consequences of group membership at child age 5. It was expected that trajectories characterized by relatively higher levels of depressive symptoms over the study period would demonstrate more clustering of family dysfunction compared to those with consistently low or less chronic levels of depression.

Method

Participants

Multiparous women giving birth to infants in the cities of Toronto and Hamilton between 2006 and 2008, who had been contacted by the *Healthy Babies Healthy Children (HBHC)* public health program (run by Public Health Units), were considered for participation. Inclusion criteria were: (1) English-speaking mother; (2) a newborn weighing $\geq 1500\text{g}$; (3) one or more children less than 4 years old in the home; and (4) agreement to the collection of observational and

biological data. Thirty-four percent of mothers whose information was passed by HBHC consented to participate. Reasons for non-enlistment included inability to contact families, ineligibility once contacted, and refusals. The research questions were examined using the enlisted sample of 501 mothers and their target newborns. Families were followed at 2 (Time 1; T1, $N = 501$), 18 (Time 2; T2, $N = 397$, 79% of original sample), 36 (Time 3; T3, $N = 385$, 77% of original sample), and 54 months (Time 4; T4, $N = 323$, 65% of original sample). Attrition analysis showed that dropout was related to lower maternal education, family income, and teenage pregnancy. As detailed elsewhere (Meunier et al., 2013), families in our sample were similar to 2006 Census data on family size, income, immigration status, and marital status. However, education levels of mothers (53.3% vs. 30.6% earned a bachelor degree or higher), and the proportion of Canadian-born versus immigrants to Canada were higher in our sample (57.7% vs. 47.6%) compared to the general population.

Procedure

At each of the four time points, families participated in a 2-hour home interview conducted by trained interviewers and completed several questionnaires about their family life, neighborhood, and each participating child.

Measures

Depressive symptoms.

The Center for Epidemiologic Depression Scale (CES-D) was collected from T1 to T4. The CES-D is a 20-item self-report instrument that is widely used and validated measure to assesses the presence of depressive symptoms (Radloff, 1977). Higher scores represent higher levels of depression and the clinical cutoff score is 16. Average Cronbach alpha was .84.

Predictors of Class Membership at Time 1

Income/assets (SES):

SES was a composite of: (i) annual family income, assessed on a scale from 1 ('no income') to 16 ('\$105,000 or more'); (ii) number of rooms in the family's residence; (iii) whether the family owns/co-owns their current home; and (iv) vehicle ownership status (yes/no variables for the latter two). These four variables were rescaled, standardized, and averaged to create a composite for income/assets. Higher values represented higher SES ($\alpha = .68$).

Maternal education:

Measured by calculating the total year of formal education, excluding kindergarten ($M = 15.3$, $SD = 2.7$).

Marital conflict.

Marital conflict was rated by mothers using the Conflicts and Problem-solving Scale (CPS-Scale; (Kerig, 1996). Mothers that had been cohabitating with their partner for at least 3 months rated two items describing the frequency at which they have minor and major disagreements with their partner. This scale demonstrates good inter-rater reliability, internal consistency and test-retest reliability (Kerig, 1996). The internal consistency of this scale was good, $\alpha_{\text{standardized}} = .70$ to $.74^1$.

Pre/perinatal problems:

Mothers reported on their own pregnancy complications and a variety of perinatal problems. A single item was used to assess the presence/absence (0 = absent; 1 = present) of each of the following: (1) gestational diabetes; (2) hypertension; (3) thyroid problems; (4) loss of fetal movement; (5) injury to abdomen; infant need for (6) intensive care after birth; (7) oxygen/ventilation; and (8) transfer to a specialized hospital. Two additional continuous perinatal

¹ Because it is a two-item scale, the internal consistency was investigated using the standardized Cronbach's alpha (Eisinga, Grotenhuis, & Pelzer, 2013).

risk factors were dichotomized based on pre-defined cut-off points: (9) low birth weight (< 2500 g) and (10) short gestation (< 37 weeks). A count of these risks was computed².

Neighborhood collective efficacy.

Mothers and fathers rated neighborhood collective efficacy using two scales: informal social control and social cohesion (Sampson et al., 1997). There were five items related to informal social control, rated on a Likert scale of 1 (very unlikely) to 5 (very likely). Social cohesion and trust contained five questions, rated on a five-point scale from 1 (strongly agree) to 5 (strongly disagree). Cronbach's alphas were $\alpha = .82$ and $.85$ for social cohesion/trust, and $\alpha = .74$ and $.76$ on the informal social control scale, for mothers and fathers respectively. Scores for each parent were combined into a composite reflecting 'collective efficacy'. Maternal and paternal composite scores were highly correlated ($r = .62, p < .001$), and thus averaged into a single composite. Higher scores indicated higher collective efficacy.

Adverse childhood experiences (ACEs).

Mothers were asked to answer a series of questions pertaining to family dysfunction and victimization prior to the age of 16. *Family Dysfunction*: Mothers were asked about the presence of verbal and physical conflict in their childhood home, whether their family unit was intact or separated, whether a parent had alcohol and/or drug problems, and finally, whether a parent had been arrested or jailed (Byles, Byrne, Boyle, & Offord, 1988). *Victimization experience*: Sexual and physical victimization were assessed using an adapted version of a self-report measure of childhood exposure to violence for adults, which shows good reliability and validity (Walsh, MacMillan, Trocmé, Jamieson, & Boyle, 2008). Similar to all other studies on adverse childhood

² As few individuals existed in the upper tail of the distribution, we combined 4-6 problems into a category of '4 or more' problems' (1.4% of the sample).

experiences (ACEs; Felitti et al., 1998), ACEs were scored as present versus absent. Scores were summed and a cumulative adversity index was used in analyses³.

Validation Outcome at Time 4⁴

Maternal positivity and negativity.

Mothers completed the widely used and validated positivity and negativity scale from the National Longitudinal Survey of Children and Youth (NLSCY, 1995), which were originally adapted from the Parenting Practices Scale (Strayhorn & Weidman, 1988). Mothers rated five items for each of positivity and negativity, on a five-point scale ranging from ‘never’ (1) to ‘almost always’ (5) and the mean across items was used. Internal consistency was good (α 's $>.82$).

Household chaos:

Trained interviewers rated the quality of the home environment using an adapted version of the HOME scale (Bradley & Caldwell, 1981). In total, observers rated 12 items on a 3- or 4-point scale. Observer inter-rater reliability was strong ($\alpha = .83$). Preliminary factor analysis revealed two factors with eigenvalues greater than 1, which explained 44% of the variance. The first factor (including 4 items) represented order, cleanliness, and safety of the physical environment. This factor score was reverse-coded to represent the underlying construct of household chaos ($\alpha = .83$).

Child psychopathology.

Mothers and fathers rated the frequency of attention (6 questions), conduct (6 questions), and emotional (7 questions) problems on 3-point scales (‘never’, ‘sometimes’, or ‘often’).

³ As few individuals existed in the upper tail of the distribution, we combined 7-10 problems into a category of ‘7 or more’ problems’ (0.7% of the sample).

⁴ Marital conflict was also used as a validation outcome at T4. Methods for assessing marital conflict paralleled those described in the predictors of class membership section.

Reliability and validity of the scales are well-established (Boyle et al., 2004). Maternal and paternal ratings were averaged into a composite score of each problem in order to reduce rater bias. Internal consistency was good (maternal $\alpha = .71$ to $.81$; paternal $\alpha = .69$ to $.82$). Father and mother reports were positively associated for each category (r 's = $.49$ to $.56$).

Statistical Analyses

All analyses were conducted using MPlus version 7.2 (Muthén & Muthén, 2012). Trajectories of maternal depression were modeled using GMM (Muthén & Muthén, 2000). First, the best fitting model was selected based on models that excluded covariates. The appropriate number of subgroups is established by comparing models with an increasing number of subgroups and stopping when the fit indices became statistically inferior (Nylund, 2007). We used the following fit indices: AIC (Akaike's Information Criteria) and BIC (Bayesian Information Criteria), wherein lower numbers indicated better model fit. The BIC is given priority given its performance at identifying the correct number of classes (Nylund, 2007). We also report the Lo-Mendell-Rubin Likelihood Ratio Test (LMR-LRT), with a significant p -value indicating that the $k-1$ class model should be rejected in favor of the k class model. Entropy, which indexes classification accuracy, is also reported ($>.80$ indicates excellent classification accuracy) (Lubke, 2007). Finally, after selecting the best-fitting model, starts and optimizations were increased to avoid practical problems such as local optima, and the parametric Bootstrapped Likelihood Ratio Test (BLRT) was used to replicate the best solution.

Once the best fitting model was selected, we investigated the association between psychosocial predictors at T1 and the identified trajectories. This was done in a 1-step model in which covariates were allowed to both predict class membership and within-class intercept. Finally, we examined how class membership in the best-fitting model predicted validation

outcomes at T4 while controlling for T1 predictors (see Figure 1). Thus, differences between subgroups in the outcomes are over and above the effects of the T1 covariates. To do so, we used the manual 3-step approach with unequal residual variances between groups (Asparouhov & Muthén, 2014).

-----[Insert Figure 1]-----

Participants with missing data on maternal depression due to attrition were incorporated in the analyses by using maximum likelihood under the missing at random assumption (Graham, 2009). Participants with missing data on the predictors are typically excluded when using maximum likelihood. However, missing data on the T1 predictors was low on any single variable (0-3%) and a single imputation procedure was employed (Graham, 2009) which allowed us to retain the complete sample of 501 participants.

Results

Descriptive statistics for all study variables are presented in Table 1. In a preliminary analysis, no significant variations in the linear and quadratic slopes were observed in the GMM models. Constraining these parameters to zero in the GMM 1-class model did not significantly reduce model fit, $\Delta\chi^2(2) = 2.47, p > .05$. For this reason, all subsequent GMMs constrained the linear and quadratic slope variances to zero and only the within-class variation on the intercept was modeled⁵.

-----[Insert Table 1]-----

Regarding the number of trajectory groups identified, a model with 3 classes fit the data best based on an array of fit statistics (Table 2). Although the BIC improved when adding the

⁵ Constraints on variance were based on Mplus' default, i.e., intercept variance was constrained to equality across classes and occasion-level residuals were free to vary over time but constrained to be equal across classes at each time-point.

fourth class, the LMR-LRT suggested that this offered no statistically significant improvement over a 3-class model. In addition, the 4-class model had a class that was deemed too small (six individuals, or 1.2% of the sample). Given these results, the GMM 3-class model was chosen as the best fitting model. The BLRT confirmed the preference of the 3-class solution over the 2-class solution as it was significant across 10 successful bootstrap draws, $2*Loglikelihood = 113.0$, $p < .0001$. The three groups were as follow as: (1) low-stable (representing 84.0% of the sample); (2) high-decreasing (9.5%); and (3) moderate-increasing (6.5%; see Figure 2).

-----[Insert Table 2]-----

On average, scores in the low-stable class consistently remained below the clinically depressed range (≤ 16) on the CES-D. The high-decreasing class scored well above the clinical cut-off at T1, at the clinical cut-off at T2, and then dropped below the cut-off at T3 and T4. Finally, the moderate-increasing group had average initial depression levels at the clinical cut-off, and these levels increased well into the clinical range by the final assessment point.

-----[Insert Figure 2]-----

We then examined which T1 covariates (entered simultaneously) predicted both within-class variations on the intercept as well as class membership. Regarding within-class variation, higher income/assets (β [SE] = $-.25$ [.07], $p < .001$), maternal education (β [SE] = $-.18$ [.07], $p = .005$), and neighborhood collective efficacy (β [SE] = $-.15$ [.07], $p = .03$) were associated with lower initial levels of depression, while higher levels of marital conflict were associated with higher initial levels of depression (β [SE] = $.19$ [.06], $p = .001$). Neither pre/perinatal problems (β [SE] = $-.04$ [.06], $p = .52$) nor maternal ACEs (β [SE] = $.07$ [.06], $p = .25$) were significantly associated with initial levels of depression.

In terms of covariates that differentiated between the classes (i.e., predicted membership in one class versus another), it was observed that low SES (income/assets) and high levels of marital conflict increased the risk of belonging in the high-decreasing group compared to the low-stable group. High levels of marital conflict also increased the risk of belonging in the moderate-increasing group compared to the low-stable group. Finally, lower levels of collective efficacy increased the risk of belonging to the moderate-increasing group compared to the high-decreasing group. Said differently, the high-decreasing group had higher levels of collective efficacy at T1 than the moderate-increasing group (see Table 3).

-----[Insert Table 3]-----

Finally, we examined how class membership was associated with a range of family-level outcomes at T4 (the final assessment period), controlling for the contribution of T1 predictors. Results are presented in Table 4. Results revealed between-groups differences on all outcomes except for maternal negativity. Compared to the low-stable class, the high-decreasing class did not differ significantly except for one outcome: they had higher levels of maternal positivity. Compared to the low-stable group, the moderate-increasing group fared worse on all but one outcome: they had higher levels of marital conflict, lower maternal positivity, higher household chaos, and children had more emotional, conduct, and attention/hyperactivity problems. Finally, compared to the high-decreasing group, the moderate-increasing group had higher levels of marital conflict and lower levels of maternal-reported positivity, and their children were reported to have higher levels of conduct and emotional problems.

-----[Insert Table 4]-----

Discussion

The current study examined longitudinal trajectories of maternal depressive symptoms from 2 to 54 months following the birth of their youngest child. Results supported three trajectory classes: 84% of the sample had low-stable levels of depression, 9.5% reported clinically-elevated levels of depressive symptoms at 2 months that remitted by 54 months, and 6.5% showed moderate levels of depression at 2 months that increased up to 54 months. One explanation for the desisting trajectory is that these mothers may be particularly reactive to the stressors associated with the addition of a newborn child into the family unit. This could result from specific dysfunctions of the hypothalamic-pituitary-adrenal (HPA) axis, which appears to confer greater vulnerability to stress in some women (Kammerer, Taylor, & Glover, 2006). With time, these mothers may be able to successfully adapt, resulting in symptom decline across childhood. With regard to the moderate-increasing group, it is notable that these mothers obtained scores at or above the clinical cut-off at all periods of assessment. It is possible that depression may be etiologically distinct for this group of women, either as a function of preexisting conditions and associated biobehavioral regulatory mechanisms, or due to disparities in present environmental conditions that heighten or exacerbate the risk of depression.

Although previous research suggests that there are heterogeneous trajectories of maternal depressive symptoms in the early childhood period, the number and pattern of those trajectories has varied considerably across studies. In the current study, we found that individual differences in maternal depression were due to a combination of qualitative (i.e., course of depression), as well as quantitative differences (i.e., within-class variations in the level of depression). Previous models using community-based samples which ignored quantitative differences (such as those using LCGA) may have extracted an unreliably large number of classes (i.e., 4-6 classes), thus explaining replication difficulties across studies. Our GMM analysis was not only more

parsimonious than LCGA, but also replicated previous findings in several ways. First, the majority (84%) of the women in our sample did not experience clinically-elevated depressive symptoms at any stage of early childhood. However, 16% of mothers obtained scores at or above the cut-off for depression, a prevalence rate that aligns with meta-analytic estimates of postpartum depression rates within three months of childbirth (Gavin et al., 2005). Second, our results are consistent with Vleigen et al.'s (2014) review that included chronically high (and increasing), remitting, and low-stable groups. Notwithstanding these findings, continued replication that spans the prenatal period and extends into later childhood are needed to better characterize the heterogeneous patterns of maternal depression over the childbearing years.

The current study also sought to identify stressors that predicted membership in different trajectory groups. We found that lower SES was associated with membership in the high-decreasing group compared to low-stable group. This finding is consistent with previous research documenting associations between socio-demographic risk and depressive symptoms in mothers (O'Hara & Swain, 1996). Interestingly, SES was only associated with one of the two elevated classes (i.e., the high-decreasing group). One explanation for this finding is that socioeconomically disadvantaged mothers may be particularly vulnerable to the acute stressors that accompany the birth of a new child, resulting in an increased risk of depression that wanes over time as mothers become more adept at handling these stressors.

The high-decreasing group and moderate-increasing group had more marital conflict than the low-stable group at 2 months. Interestingly, results from the validation analysis showed that at 54 months the high-decreasing group had lower levels of conflict than the moderate-increasing group. Thus, while marital conflict at 2 months predicted membership in either elevated depression trajectory groups, those on a desisting trajectory may experience less chronic levels of

marital conflict than those who go on to experience continued difficulties with depression. Indeed, previous research has shown that stable levels of marital conflict may serve to maintain or reinforce negative family processes over time (Gerard, Buehler, Franck, & Anderson, 2005), and this may apply to mothers' experience of chronic depressive symptoms. Thus, marital conflict may be both a cause and consequence of high/increasing levels of depression, and future research incorporating reciprocal models may be helpful to untangle the directional relations between these related constructs over time (Whisman, Davila, & Goodman, 2011).

Neighborhood collective efficacy, an indirect metric of the availability of psychological resources, differentiated the high-decreasing and moderate-increasing groups, with lower collective efficacy in the latter. Since collective efficacy, like poverty, is relatively stable over time (Schmidt et al., 2014), these results may index poor social support networks among mothers who experience moderate-increasing levels of depression in the early childhood period. Alternatively, high levels of social support and control may espouse feelings of security, trust, order and connectedness with others, and this may be protective for high-decreasing mothers, enabling them to better cope with mood problems and experience a net decline in depressive symptoms over time.

In order to validate the identified trajectory profiles, we also examined how these related to a collection of family-wide factors shown to be associated with maternal depression⁶. First, the low-stable group had lower household chaos than the two heightened profiles, although it only significantly differed from the moderate-increasing group. This is consistent with studies showing that higher chaos is associated with higher maternal depression (Pike, Iervolino, Eley, Price, & Plomin, 2006). Household chaos can include noise in the home due to overcrowding,

⁶ Differences in outcomes across trajectory groups were observed after controlling for Time 1 predictors (see Figure 1), thereby resulting in relatively conservative estimates of differences between subgroups.

household traffic, or a lack of structure and predictability (Coldwell, Pike, & Dunn, 2006), and mothers experiencing depressed mood may experience less motivation or an inability to control their environmental surroundings (Goodman & Gotlib, 1999). One unexpected finding from the validation analysis was that mothers in the high-decreasing group reported more positive parenting practices than mothers in the moderate-increasing group *and* the low-stable group. The former effect is consistent with models positing that persistently high levels of maternal depression are more deleterious with respect to parenting than transient or intermittent levels (NICHD, 1999); and the heightened level of mother-reported negative parenting in the moderate-increasing group parallels this notion. The latter finding was somewhat surprising, however. One possibility is that mothers with initially high but desisting levels of depression unreasonably attribute more positive caregiving to themselves (i.e., a case of rater bias). Another possibility is that mothers on a downward depression trajectory follow such a path as a result of improvements in parenting or parent-child relationships, which act in a protective manner. As with the link between depression and marital conflict, further research documenting the temporal relationship between depression and parenting over time, including mediators of this relationship, will clarify the nature and mechanism(s) of this association.

We also found that children of mothers in the moderate-increasing group had the highest levels of psychopathology, including conduct, attention, and emotional difficulties compared to the low-stable and high-decreasing groups. This is consistent with meta-analytic research suggesting that children of depressed parents are at greater risk of developing psychological problems compared to children of non-depressed parents (Goodman & Gotlib, 1999). However, the current study extends this research by suggesting that child outcomes might differ as a function of the longitudinal course of maternal depression, rather than specific levels of

depression at any single point in time. There are several possible mechanisms to explain why chronically elevated (and increasing) levels of maternal depressive symptoms would be associated with children's behavioral problems. The first is the familial transmission of psychopathology through genetic factors (Plomin, 1990). Indeed, the often non-specific, generalizable transmission of psychopathology (Caspi et al., 2014) suggests that maternal depression may confer risk for many childhood psychopathologies, and chronically elevated (or increasing) levels of depression may represent a particularly strong risk. Second, the psychological and physical unavailability of a parent during depressive episodes may influence child expectations of the caregiver as accessible and responsive (Davies & Cummings, 1994). Third, children of depressed mothers are more likely to experience a variety of additional socio-ecological stressors associated with maternal depression, such as marital conflict and household chaos, and the accumulation of these risks can increase a child's susceptibility to psychopathology (Evans, Li, & Whipple, 2013; Goodman & Gotlib, 1999).

Study Limitations

These results should be considered in the context of several limitations. The first was reliance on maternal reports of depressive symptoms, as symptomatology can vary based on methodological approach (self-report versus clinical interview (Eaton, Neufeld, Chen, & Cai, 2000)). However, self-report instruments for assessing depression, considered the most cost-effective methodology, are deemed particularly appropriate when examining levels of depressive symptoms versus the presence or absence of a specific diagnosis (Eaton et al., 2000). Second, the relatively small sample size in certain classes raises the question of whether some effects failed to emerge due to inadequate power. That we demonstrated several effects on both the T1 predictors (2 months) and T4 validation outcomes (54 months) suggests that these results are

likely an under- rather than over-estimation of effects. Finally, trajectory analyses are by nature descriptive, and thus do not examine specific mechanisms or processes that could account for the association between maternal depressive symptoms and outcomes of trajectory class membership. Thus, we are unable to determine the extent to which our findings are due to genetic and/or social-environmental processes operating within the mother-child dyad or the spousal relationship.

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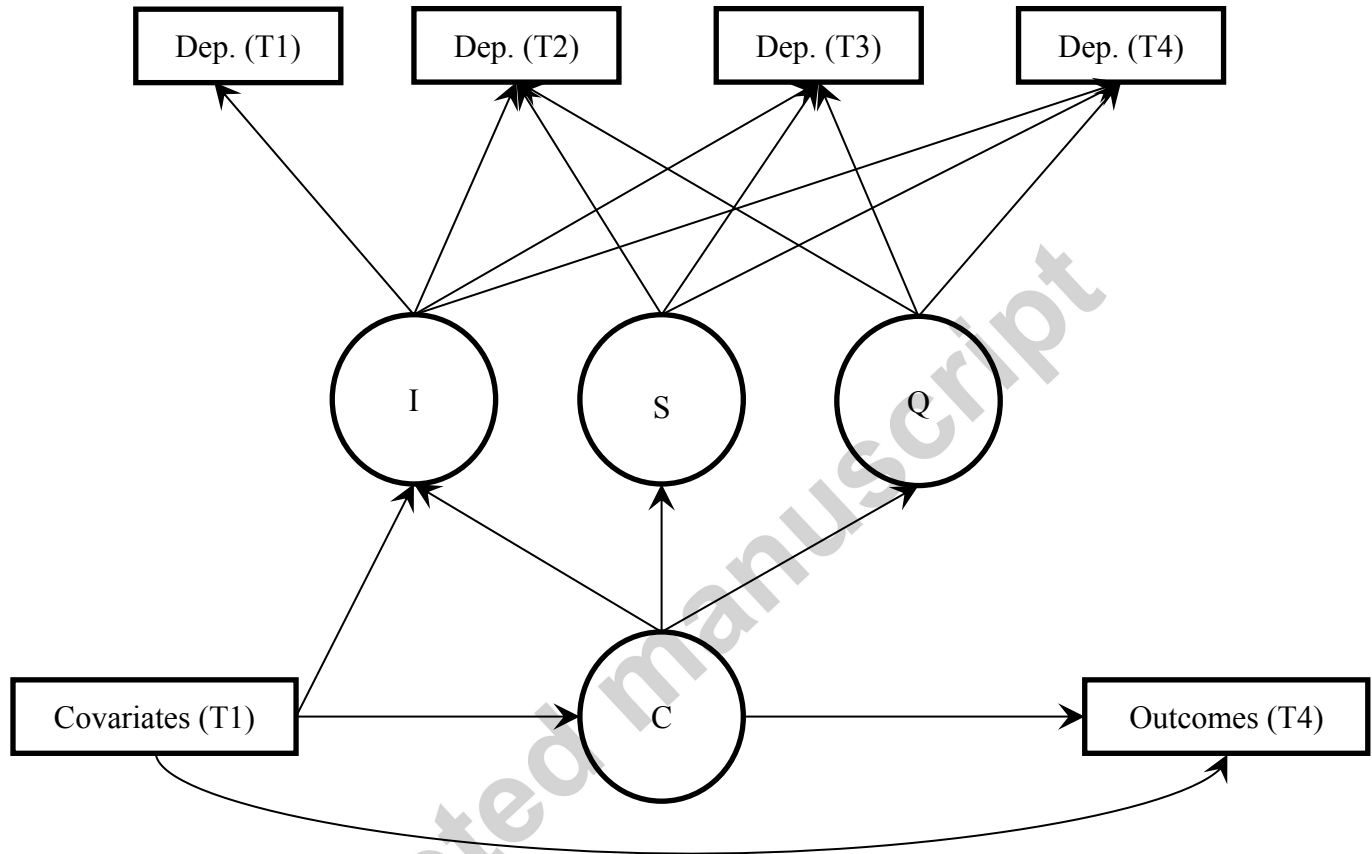


Figure 1. Conceptual model tested for the growth mixture model. I = intercept. S = linear slope. Q = Quadratic Slope. C = Latent class grouping.

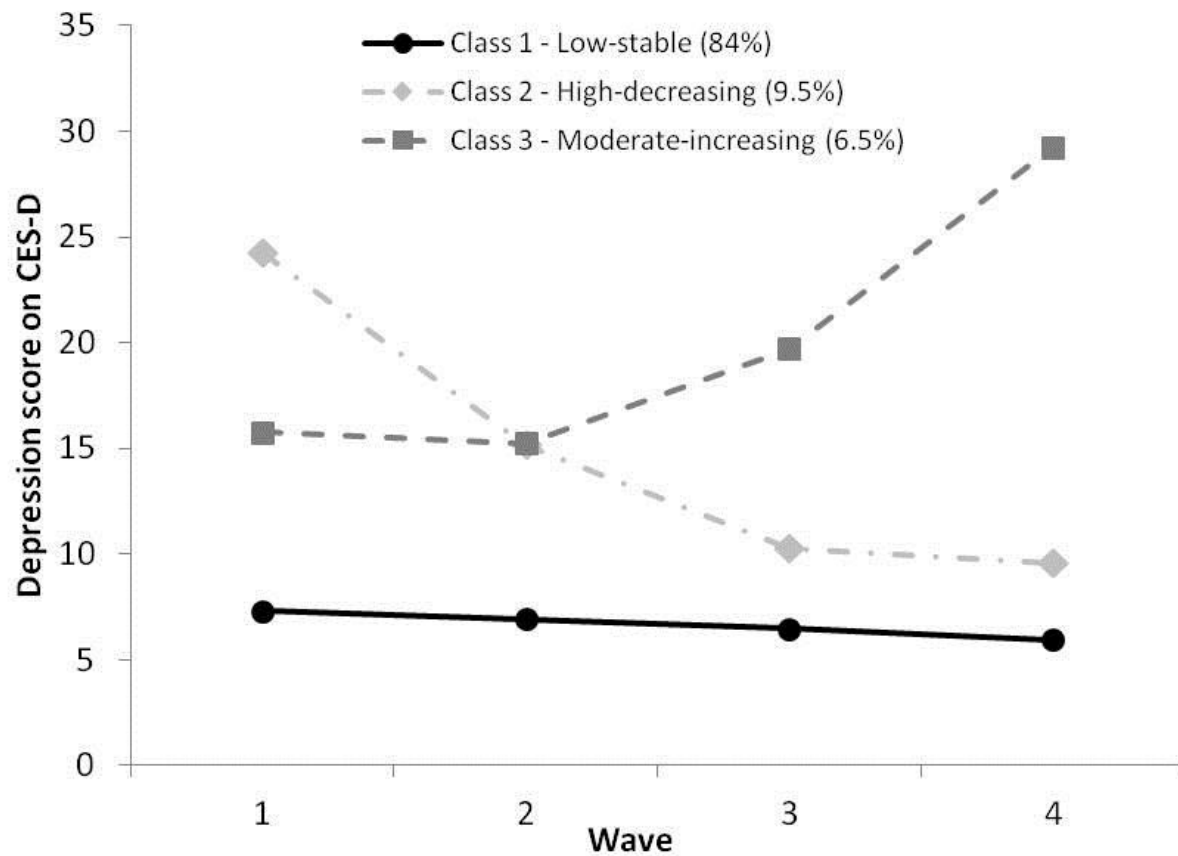


Figure 2. Heterogeneous trajectories of maternal depression across early childhood. Class 1 – Low-stable depression class; Class 2 – High-decreasing depression class; Class 3 – Moderate-increasing depression class. Predictors of class membership, and outcomes predicted by the classes, are presented in-text.

Table 1 Descriptive statistics for all study variables

	<i>M</i>	<i>SD</i>	<i>Range</i>
Depression			
T1	9.46	7.29	0-40
T2	7.85	6.42	0-33
T3	7.36	6.62	0-37
T4	7.54	7.62	0-42
Covariates (T1)			
Income/assets	3.49	.96	.71-5.59
Maternal education	15.3	2.69	8-22
Pre/perinatal problems	.43	.76	0-4
Marital conflict	7.14	3.24	.44-18.0
Collective efficacy	3.79	.67	1.5-5.0
ACEs	1.32	1.81	0-9
Validation Outcomes (T4)			
Marital conflict	6.84	3.19	3-16
Maternal positivity	4.46	.45	2.8-5.0
Maternal negativity	2.82	.52	1.2-4.0
Household chaos	1.33	.26	1.0-2.0
Child attention problems	1.41	.25	1.0-2.29
Child conduct problems	1.50	.36	1.0-2.58
Child emotional problems	1.57	.41	1.0-3.00

Table 2 Fit indices for the growth mixture models of maternal depression with different number of subgroups, excluding covariates.

Model	# Par.	LLCorrection			AIC	BIC	aBIC	Entropy	LMR-
		LL	Factor						LRT
GMM 1C	8	-5007.044	1.9755		10030.088	10063.805	10038.413	NA	NA
GMM 2C	12	-4933.434	1.776		9890.869	9941.444	9903.355	.91	.001
GMM 3C	16	-4885.124	1.8333		9802.248	9869.682	9818.897	.88	.04
GMM 4C	20	-4865.165	1.6127		9770.33	9854.622	9791.141	.90	.07

Note. AIC = Akaike's Information Criteria. BIC = Bayesian Information Criteria. aBIC = sample size adjusted

BIC. LMR-LRM = Lo-Mendell-Rubin adjusted LRT test (*p*-value).

Table 3 Predictors of class-membership

Covariate (T1)	High-decreasing vs. Low-stable (ref)		Moderate-increasing vs. Low- stable (ref)		Moderate- increasing vs. High-decreasing (ref)	
	OR	95% CI	OR	95% CI	OR	95% CI
Income/assets	.56*	.36-.86	.89	.54-1.48	1.60	.84-3.30
Maternal education	.98	.87-1.11	.91	.73-1.13	.92	.73-1.17
Pre/perinatal problems	1.27	.92-1.75	1.21	.74-1.98	.96	.59-1.56
Marital conflict	1.28***	1.15-1.41	1.24**	1.11-1.40	.97	.85-1.11
Collective efficacy	1.57	.91-2.69	.59	.34-1.02	.38*	.18-.79
ACEs	1.08	.92-1.26	1.13	.93-.38	1.05	.84-1.31

* $p < .05$;** $p < .01$;*** $p < .001$ **Table 4.** Differences in means across class membership

	Adjusted means			Differences in mean	
	Low- Stable	High- Decreasing	Moderate- Increasing	Wald's test	p - value
Marital conflict	-0.01 _a	-0.57 _a	0.73 _b	7.69	.02
Maternal positivity	0.04 _a	0.77 _b	-0.92 _c	20.70	.00
Maternal negativity	-0.06	-0.14	0.53	3.65	.16
Household chaos	-0.15 _a	0.33 _{a,b}	0.94 _b	9.04	.01
Child attention problems	-0.06 _a	0.49 _{a,b}	0.53 _b	7.00	.03
Child conduct problems	-0.12 _a	0.00 _a	1.13 _b	8.69	.01
Child emotional problems	-0.05 _a	-0.05 _a	0.71 _b	11.08	.00

Note. Adjusted means with different subscripts are different at $p < .05$. Adjusted means represent the mean for each outcome when T1 covariates are at the sample mean values. Outcomes were standardized prior to analysis to facilitate interpretation of between-group differences. The Wald's test was used to test if means were equal across all groups for each outcomes ($df = 2$).

Highlights

- Onset and course of maternal depression is examined from child age 2-54 months.
- Trajectories: low-stable (84%), high-decreasing (9.5%), moderate-increasing (6.5%).
- Elevated trajectory groups were in the clinical range for depression at 2 months.
- The moderate-increasing group was associated with significant family-wide risk.