

# Latent class profiles of depressive symptoms from early to middle childhood: predictors, outcomes, and gender effects

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**Background:** There has been little available data to inform the predictors and outcomes of latent class trajectories of depressive symptoms beginning during preschool and continuing throughout school age. Further, the extant literature in this domain has been limited by the use of parent report checklists of nonspecific ‘internalizing’ psychopathology rather than diagnostic interviews for depression. **Methods:** To address these gaps in the literature, this study applied growth mixture modeling to depressive symptom severity endorsed by children and/or their caregivers ( $N = 348$ ) during a structured clinical interview in a 10-year longitudinal dataset spanning from preschool into late school age. **Results:** Three distinct trajectories of depressive symptom severity were found in boys and girls. For boys, but not girls, the high depression severity latent class increased in depressive symptoms from preschool through school age, followed by a decline in depressive symptom severity during later school age. For girls, the high depression severity latent class remained stable across time. Early childhood social adversity, familial history of affective disorder, preschool-onset ODD/CD, and school age functional impairment differentiated high-risk trajectory classes among both boys and girls. **Conclusions:** Extending the literature on trajectories of depressive symptoms to the preschool period, these findings incorporate structured clinical interviews of depressive symptom severity and indicate gender differences as well as psychosocial predictors and functional outcomes among children in high severity latent classes. The findings from this study suggest that increased attention to screening for depressive symptoms in early childhood is of significant public health importance. **Keywords:** Depression; longitudinal; childhood; growth mixture modeling.

## Introduction

Research on the course of childhood depression is extensive; yet, longitudinal studies are frequently limited by the assumption that the time course of depressive symptoms is similar for all children. By contrast, latent class growth analysis (LCGA; Nagin, 1999) or growth mixture modeling (GMM; Muthén & Muthén, 2000) approaches can: (a) create unique trajectories of depressive symptoms for groups of children and (b) highlight the differences in trajectories between children who are at early and/or sustained risk for chronic depression versus children whose depressive symptoms represent relatively short-lived, single clinical episodes. Little is known about the latent classes of depressive symptoms that begin in early childhood, as well as the predictors and longitudinal outcomes of membership in specific trajectories. However, much evidence exists for the clinical importance and chronicity associated with early-onset psychopathology (Dougherty et al., 2015), particularly early-onset depression (Luby, 2010; Luby, Gaffrey, Tillman, April, & Belden, 2014; Luby, Si, Belden, Tandon, & Spitznagel, 2009). Preschool depression has been shown to have content and discriminant validity, homotypic continuity into school-age and early

adolescence, higher rates of familial affective disorders compared with healthy subjects, as well as numerous biological correlates including alterations in the function and structure of the brain (Barch, Gaffrey, Botteron, Belden, & Luby, 2012; Gaffrey, Barch, Singer, Shenoy, & Luby, 2013; Luby, 2010; Luby et al., 2003; Luby, Si, et al., 2009; Luby et al., 2014). Thus, identifying the unique trajectories and functional implications of depressive symptoms that onset in early childhood may elucidate groups at the greatest risk for a chronic, impairing, and recurrent course.

The existing LCGA/GMM analyses of depressive and internalizing symptoms in youth provide evidence for both specific (e.g. gender) and general risk factors (e.g. social adversity) that predict membership in a high-risk latent class (Dekker et al., 2007; Mezulis, Salk, Hyde, Priess-Groben, & Simonson, 2013; Stoolmiller, Kim, & Capaldi, 2005). Below, we review the evidence for specific predictors and outcomes of class membership focused mostly on prepubertal depression, including gender, social adversity, and functional outcomes later in life.

## Influence of gender on class membership

Gender appears to exert a different influence on both class membership and trajectory shapes depending

Conflict of interest statement: See Acknowledgements section.

on age and depression assessment method. By early adolescence and continuing throughout adulthood, girls are more likely than boys to have membership in latent classes with more severe symptoms of depression (Brendgen, Wanner, Morin, & Vitaro, 2005; Costello, Swendsen, Rose, & Dierker, 2008; Mezulis et al., 2013). However, results are not as consistent during earlier childhood. Two studies have created latent class trajectories of depressive symptoms beginning during the preschool period (Carter et al., 2009; Dekker et al., 2007). One study assessed youth from ages 4 to 18 and results indicated a high, adolescent-increasing trajectory of depressive symptoms for girls and a high, childhood peak trajectory for boys (Dekker et al., 2007). These trajectories, along with a high, increasing trajectory found for both genders, differed the most significantly from other trajectories and predicted negative outcomes in young adulthood (Dekker et al., 2007). In work including younger samples (ages 4–8), however, boys and girls showed equal rates of change in depressive symptoms across early development (Carter et al., 2009). Thus, additional research is needed to clarify whether gender differences exist in depressive symptom trajectories with symptom onset occurring during early childhood. Furthermore, no study of which we are aware has created latent class trajectories of depression symptom severity using structured clinical interviews that incorporate symptom endorsement from both parents and children, as compared to just parents. This is particularly important for symptoms of disorders like depression that may not always be directly observed by parents.

### *Influence of social adversity on class membership*

Not surprisingly, stressful life events and family adversity have been shown to predict youths' membership in a high/chronic depressive trajectory (Brendgen et al., 2005; Ge, Conger, & Elder, 2001). More recently, the influence of life events was found to differ with regard to gender, such that in boys, but not girls; the number of life events influenced the level of symptoms (Castelao & Kröner-Herwig, 2012). However, little work has focused on the impact of cumulative social adversity occurring relatively early in the child's life as a predictor of latent class membership for depressive symptoms. Rather than looking at the unique effect of a single risk factor, cumulative adversity scores combine social risks, such as neighborhood disadvantage, family income, maternal psychopathology, and related factors within a single variable. This approach has several advantages since risk factors tend to cluster together and the impact of cumulative adversity is often much larger than the impact of any single risk factor (Evans, 2003; Slopen, Koenen, & Kubzansky, 2014). Thus, we aimed to explore the influence of cumulative social adversity in predicting children's

trajectories of depressive symptom severity from early to middle childhood, a time when social adversity can have powerful effects (Slavich & Irwin, 2014).

### *Influence of family history of affective disorders*

In four studies with participants spanning infancy through adolescence, maternal depressive symptoms predicted a child's membership in higher risk trajectories of internalizing symptoms (Côté et al., 2009; Davis, Votruba-Drzal, & Silk, 2015; Fanti & Henrich, 2010; Sterba, Prinstein, & Cox, 2007). However, trajectories for depression apart from other internalizing symptoms were not modeled, and the presence of affective disorders found more broadly at the family level were not assessed. In other work, parental mood disorders predicted baseline symptoms of depression in boys and girls (Burstein, Ginsburg, Petras, & Jalongo, 2009) and significantly increased the probability of membership in the higher risk trajectories of depressive symptoms (Castelao & Kröner-Herwig, 2012). While these results show interesting relations between parental affective disorder and youth's depressive symptoms trajectories, additional research is needed to further clarify whether familial history of affective disorders, including all first- and second-degree relatives, also predicts depressive symptoms trajectories in younger youth.

### *Outcomes of class membership*

LCGA/GMM studies indicate that distinctions between classes or groups of children with depressive symptoms offer longitudinal predictive power for several negative outcomes. For example, several studies have found that in boys and girls, membership in any of the high and/or chronic classes of depressive symptom predicts depressive symptoms and rates of MDD later in adolescence (Dekker et al., 2007; Mezulis et al., 2013; Toumbourou, Williams, Letcher, Sanson, & Smart, 2011). Membership in a high-risk class of chronic comorbid internalizing and externalizing problems during childhood has also been shown to predict risk taking behaviors and peer exclusion during adolescence (Fanti & Henrich, 2010).

Despite this available data, it is difficult to draw firm conclusions about the predictors and outcomes of depressive symptoms trajectories starting early in childhood. The studies reviewed above used children of varying ages and different assessments of depressive and internalizing symptoms with different informants. As such, there is a great need to examine the predictors and outcomes of latent class profiles created using diagnostic interviews that incorporate both parent and child endorsement of symptoms. Furthermore, little work has focused on latent class profiles that begin as early as the preschool period, the earliest developmental period that clinical depression has been validated. The purpose of this

study was to apply GMM to depressive symptoms endorsed by children and/or their caregivers during a structured clinical interview, in a 10-year longitudinal dataset spanning from preschool into school age. Informed by findings from the extant literature and based on the age-range of our sample, we chose to separate boys and girls when identifying class trajectories. After creating these trajectories, we examined the predictive power of early social adversity and family history of affective disorders on trajectory class membership for boys and girls separately. Finally, we investigated functional impairment outcomes at later school age as related to these specific trajectories.

Based on prior LCGA/GMM analyses in older samples of children, we anticipated at least three distinct trajectories: those with stable, low symptoms, those with lower, yet increasing symptoms, and those with stable, high symptoms of depression. We anticipated that girls' trajectories would show steeper increases over time than boys' trajectories even in early childhood. Also based on past work, we hypothesized that early social adversity and family history of affective disorders would predict higher risk trajectory class memberships. Finally, we hypothesized that membership in trajectories with more depressive symptoms would predict greater functional impairment at school age.

## Methods

### Participants

Participants were from the Preschool Depression Study (PDS), a prospective longitudinal investigation of preschoolers and their families conducted at the Washington University School of Medicine (WUSM; Luby, Si et al., 2009). This study reports on 348 children from the PDS, who across a 10-year period completed at least three behavioral assessments out of a possible eight assessments (due to the grant funding cycle, a gap occurred between the third and fourth possible assessment). Parental written consent and child assent were obtained prior to participation and the WUSM Institutional Review Board approved all procedures. Details of recruitment have been previously reported (Luby, Si, et al., 2009; Luby et al., 2014). In brief, from 2003 to 2005, 3- to 6-year-olds were recruited from primary care practices and preschools/day-cares throughout the Saint Louis metropolitan region using a validated screening checklist (Preschool Feelings Checklist; Luby, Heffelfinger, Koenig-McNaught, Brown, & Spitznagel, 2004) to oversample preschoolers with symptoms of depression and healthy controls.

### Measures

**Depressive symptom severity.** Symptoms of depression were assessed at each behavioral assessment and covered the preceding 6 months, using the Preschool Age Psychiatric Assessment (PAPA; Egger et al., 2006; Egger, Ascher, & Angold, 2003) and the Child and Adolescent Psychiatric Assessment (CAPA; Angold et al., 1995; Angold & Costello, 2000). The PAPA and CAPA consist of a series of developmentally appropriate questions covering the DSM-IV criteria for disorders of childhood, with parental reports used

exclusively before age 9. For the purpose of the present report, symptoms of depression were used to create latent class trajectories. The depressive symptom severity score was created by summing the total number of core DSM-IV MDD symptoms (out of 9 possible) endorsed by the caregiver and/or child about the child during each assessment. In order to meet diagnostic criteria for MDD, a child needed to endorse anhedonia or depressed mood/irritability, as well as at least four additional symptoms. Thus, a severity score of 5 or above typically indicates meeting clinical diagnostic criteria for depression. MDD symptoms ranged from 0 to 9. Inter-rater reliability was high for a diagnosis of depression ( $\kappa = 1.0$ ; ICC = 0.98).

**Preschool-onset ODD/CD diagnoses.** Diagnoses of ODD and CD were assessed at each behavioral assessment using the PAPA and CAPA (described above). For the purpose of the present report, meeting DSM-IV diagnostic criteria between ages 3 and 6 for either ODD or CD was coded as '0' *not present*, and '1' *present* and included as a predictor in our analyses.

**Cumulative social adversity/risk.** Seven social risk factors (described below) were assessed during the baseline assessment (e.g. prior to age 5). Cumulative social adversity/risk scores (occurring prior to age 5) were created by summing the dichotomous indicators (0 '*not present*,' or 1 '*present*') of each of the seven social risk factors below (Slopen et al., 2014). The cumulative social adversity/risk score could range from 0 to 7. This variable was used as a predictor of latent class trajectory membership in later analyses. Adversity risk variables included: (a) living in a single caregiver household, (b) maternal psychopathology (excluding eating disorders), (c) parental arrest, (d) foster care placement, (e) physical abuse, (f) sexual abuse, and (g) caregiver report of being unable to meet the families' financial needs.

**Family history of affective disorders.** The Family Interview for Genetic Studies (FIGS; Maxwell, 1992) assessed for the presence of affective disorders (e.g. depression and/or bipolar disorder) in first and second degree relatives. This is a widely used and well-validated fully structured measure of family history of psychiatric disorders. A senior psychiatrist (J.L., second author), blind to the child's diagnostic status, reviewed questions about the diagnostic status of family members. For the purpose of the present report, family history of affective disorder was coded as '0' *not present*, and '1' *present*.

**Functional impairment.** The child's functional impairment was rated by the primary caregiver on a 0–14 scale using the functional impairment subscale of the MacArthur Health and Behavior Questionnaire (HBQ; Armstrong & Goldstein, 2003). The HBQ functional impairment subscale assesses the amount of impairment children exhibit across several domains of functioning, such as school, home/family, and social. This subscale includes eight items each rated using a likert scale (0 = none, 1 = a little, and 2 = a lot). For the purpose of the present report, an average functional impairment score from each assessment is included in Table 3. In our analyses, functional impairment from the most recent assessment during later childhood (ages 13–15) was used.

### Data analytic plan

Beginning during the preschool period, participants were classified into subgroups based on depressive symptom severity scores across the longitudinal study using growth mixture modeling (Muthén & Muthén, 2000) in Mplus version

7.3 (Muthén & Muthén, 2012). Mplus utilizes full information maximum likelihood (FIML) estimation under the assumption of data missing at random (MAR) with robust standard errors (called the MLR estimator in Mplus). Specifically, depressive symptom severity score was calculated at each of the eight annual assessment waves as the number of core MDD symptoms (9 possible) endorsed at each wave. Quadratic growth mixture models with these severity scores as the dependent variables were used to determine categorical latent class variables for grouping participants with similar depressive symptom severity trajectories. Separate growth mixture models were conducted for males and females. In each of these models, the participants' probability of belonging to each of the latent classes was evaluated, and participants were assigned to the latent class with the greatest probability. Participants were assigned to pseudoclasses and then class membership was treated as an observed categorical variable in regression analyses, otherwise known as modal class assignment.

To be included in the quadratic growth mixture models, participants needed to have completed at least three annual assessments (out of a possible eight). Thirty-eight of the study participants completed fewer than three assessments and were excluded from analyses. Two hundred and eleven (68%) of the study participants completed at least six of the eight possible assessments. Growth mixture modeling was conducted on  $N = 310$  participants. For each subset of the sample (male and female), several growth mixture models with varying numbers of classes (1–5 classes) for depressive symptoms severity were compared. The model with the best fit according to a combination of the Bayesian Information Criterion (BIC), the Lo-Mendell-Rubin adjusted likelihood ratio test (LRT), and sample size of the resulting classes was selected (Jung & Wickrama, 2008; Nylund, Asparouhov, & Muthén, 2007).

We then used multinomial logistic regressions and ANOVA to determine whether early social adversity, preschool-onset ODD/CD, familial history of affective disorder, and later childhood functional impairment were differentially associated with latent class membership. These analyses compare latent classes (e.g. high vs. medium) on the predictors and outcomes of interest.

## Results

Fit statistics for the growth mixture models with latent class variables with 1, 2, 3, 4, and 5 classes were compared (Table 1). For males, the 3-class model had the lowest BIC and fit significantly better than the 2-class model according to the Lo-Mendell-Rubin adjusted LRT, so the 3-class model was chosen for analyses. For females, the 3-class model had the lowest BIC and offered marginal ( $p = .0575$ ) improvement over the 2-class

model. While the 4-class model offered statistically significant improvement over the 3-class model according to the Lo-Mendell-Rubin adjusted LRT, we elected to use the 3-class model for further analyses to avoid having a latent class with fewer than 10 children. For males, the probabilities of being included in each latent class were: low 0.92 (0.13), medium 0.86 (0.14), and high 0.95 (0.10). For females, the probabilities of being included in each latent class were: low 0.85 (0.15), medium 0.83 (0.14), and high 0.96 (0.11).

Details of the growth mixture models are shown in Table 2 and the trajectories of latent classes are graphed in Figure 1. For the growth mixture model of males, one latent class had an intercept significantly different from zero, indicating differences in depressive symptom severity at the first assessment, as well as significant linear and quadratic slope components, indicating significant changes in the course of symptoms across time. The other two classes had intercepts, but not slopes that differed significantly from zero, suggesting no differences in the rate of change in symptom severity across time. For males, the high depression severity latent class evidenced a significant linear and quadratic slope indicating an increase from preschool through mid-school age in depressive symptom severity, followed by a decline in depressive symptom severity during late school age. The low and midlatent classes of boys were stable across time in depressive symptom severity. For females, on the other hand, all three latent classes in the growth mixture model had intercepts that significantly differed from zero, but did not have significant linear or quadratic slope components. Thus, among females, no depression severity latent classes exhibited increasing (or decreasing) symptoms; instead, symptoms appeared to remain stable across time. Of note, the intercept (i.e. mean severity score) in the high depression severity latent class of females (5.05) was close to two times higher than the intercept in the high depression severity latent class of males (2.797).

Descriptive statistics for participants are presented in Table 3. Rates of clinical depression were relatively high in this young sample, as 6–24% of children met DSM-IV criteria for depression at each assessment.

**Table 1** Fit statistics of growth mixture models with one to five latent classes

N Latent classes	Male ( $N = 160$ )			Female ( $N = 150$ )		
	BIC	L-M-R ALRT $p$	Class $N$ 's	BIC	L-M-R ALRT $p$	Class $N$ 's
1	3,869.8	–	160	3,594.8	–	150
2	3,627.2	0.0006	53, 107	3,455.6	0.3603	18, 132
3	3,568.9	0.0002	27, 50, 83	3,409.9	0.0575	13, 53, 84
4	3,593.9	0.0221	12, 22, 45, 81	3,432.1	0.0253	7, 16, 24, 103
5	3,601.8	0.1224	4, 12, 22, 47, 75	3,439.6	0.4634	7, 14, 21, 41, 67

BIC, Bayesian Information Criterion; L-M-R ALRT  $p$  = Lo-Mendell-Rubin Adjusted Likelihood Ratio Test  $p$ -value.

**Table 2** Estimates from growth mixture models of depression severity

	Estimate	SE	Estimate/SE	Two-tailed <i>p</i>
<b>Model 1: Males</b>				
Low MDD severity: Intercept	1.309	0.115	11.420	<.0001
Medium MDD severity: Intercept	2.901	0.193	15.066	<.0001
High MDD severity: Intercept	2.797	0.305	9.165	<.0001
High MDD severity: Linear Slope	0.618	0.075	8.202	<.0001
High MDD severity: Quadratic Slope	-0.033	0.005	-7.351	<.0001
<b>Model 2: Females</b>				
Low MDD severity: Intercept	1.325	0.308	4.298	<.0001
Medium MDD severity: Intercept	2.634	0.442	5.955	<.0001
High MDD severity: Intercept	5.050	0.386	13.098	<.0001

### *Influence of cumulative early social adversity on class membership within males versus females*

**Male.** Results from the multinomial logistic regression indicated that in males, the amount of social adversity experienced by age 5 was a significant predictor of latent class,  $\chi^2(2) = 14.60$ ,  $p = .001$ . Specifically males in the high depression severity latent class experienced significantly more social adversity by age 5 than boys in the mid, Wald  $\chi^2(1) = 4.31$ ,  $p = .04$ , or low, Wald  $\chi^2(1) = 12.36$ ,  $p < .0001$ , latent classes. The amount of social adversity experienced by age 5 did not significantly differentiate the low and mid latent classes within males, Wald  $\chi^2(1) = 3.51$ ,  $p = .06$ .

**Females.** Consistent with findings in males, the amount of social adversity experienced by age 5 significantly predicted latent class membership in females,  $\chi^2(2) = 21.35$ ,  $p < .0001$ . Females in the high depression severity latent class experienced significantly greater social adversity by age 5 than females in the low depression severity latent class, Wald  $\chi^2(1) = 15.53$ ,  $p < .0001$ , but only approached significance compared to the mid depression severity latent class, Wald  $\chi^2(1) = 3.98$ ,  $p = .046$ . Females in the mid latent class experienced significantly more social adversity by age 5 compared to same age females in the low latent class, Wald  $\chi^2(1) = 9.77$ ,  $p = .002$ .

As described above, the pattern of differences across trajectories in terms of social adversity differed for males and females. Thus, in order to test whether there were gender differences in the amount of social adversity experienced by children in the high and mid latent class, two logistic regressions were conducted with either high or mid latent class females as the reference group. High latent class females experienced more social adversity than low/medium males ( $B = -6.80$ ,  $p < .000$ ) and females ( $B = -6.29$ ,  $p < .000$ ). However, there were no significant differences between high latent class males and females on early social adversity ( $B = -2.02$ ,  $p = .30$ ). Similarly, mid latent class females experienced more social adversity than low males ( $B = -4.31$ ,  $p < .01$ ) and females ( $B = -5.18$ ,  $p < .000$ ). However, there were no significant differences between mid latent class males and females on early social adversity ( $B = -1.55$ ,  $p = .28$ ).

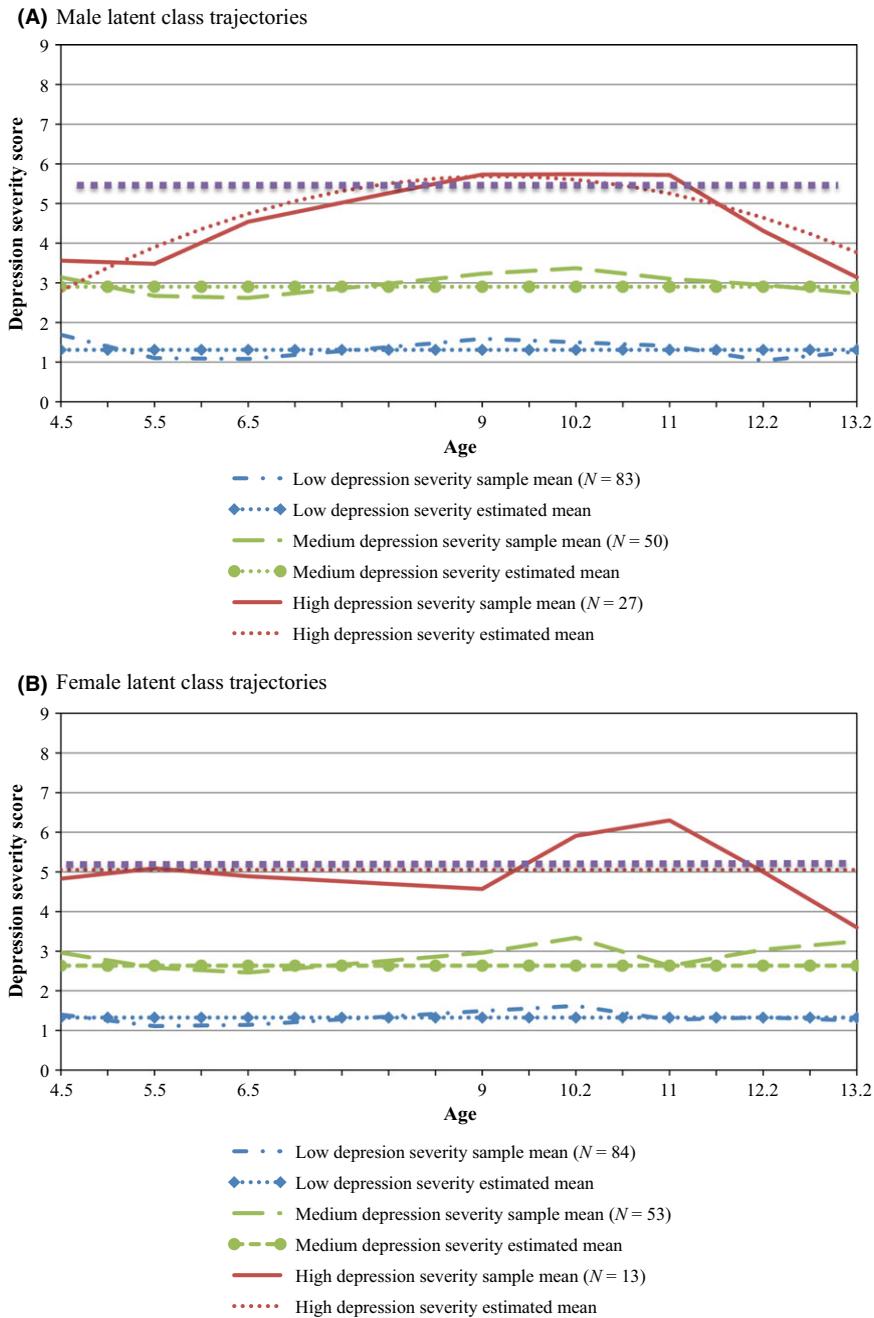
### *Influence of family history of affective disorder on class membership within males versus females*

**Male.** The overall model indicated that having a first or second degree relative with an affective disorder (depression and/or bipolar disorder) significantly predicted boys latent class assignment,  $\chi^2(2) = 13.96$ ,  $p < .01$ . Males in the high depression severity class were significantly more likely to have a first or second-degree relative with an affective disorder compared to males in the low group, Wald  $\chi^2(1) = 10.23$ ,  $p < .01$ , but not compared to the mid group, Wald  $\chi^2(1) = 3.81$ ,  $p = .05$ . Family history of affective disorder did not significantly predict latent class membership in the low versus mid depression severity groups, Wald  $\chi^2(1) = 3.24$ ,  $p = .07$ .

**Females.** Family history significantly predicted latent class membership in females,  $\chi^2(2) = 11.80$ ,  $p < .01$ . Girls with a family history of affective disorders were more likely to be in the high compared to low depression severity class, Wald  $\chi^2(1) = 5.25$ ,  $p = .02$ . However, the likelihood of being in the mid versus high depression severity classes did not differ in relation to family history of affective disorders, Wald  $\chi^2(1) = 2.31$ ,  $p = .13$ . Females in the mid depression severity group were significantly more likely than females in the low depression severity group to have a first or second degree relative who had been diagnosed with an affective disorder, Wald  $\chi^2(1) = 4.56$ ,  $p = .03$ .

### *Influence of preschool-onset ODD/CD diagnosis on class membership within males versus females*

**Males.** Results from multinomial logistic regression indicated that the presence of preschool-onset ODD/CD predicted membership in latent classes. Specifically, males in the medium ( $\chi^2(1) = 10.92$ ,  $p = .001$ ) and high ( $\chi^2(1) = 16.74$ ,  $p = .000$ ) latent classes



**Figure 1** Latent class trajectories in male ( $N = 160$ ) and female ( $N = 150$ ) participants: (A) male latent class trajectories (B) female latent class trajectories. Note: 5 designates severity score needed for a clinical diagnosis of depression

were more likely than males in the low latent class to meet criteria for ODD/CD during preschool. Preschool-onset ODD/CD did not distinguish between the medium and high classes ( $\chi^2(1) = 1.52$ ,  $p = .22$ ).

*Females.* Similar to what was found in males, preschool-onset ODD/CD significantly predicted membership in latent classes. Specifically, females in the medium ( $\chi^2(1) = 11.80$ ,  $p = .001$ ) and high ( $\chi^2(1) = 22.42$ ,  $p = .000$ ) latent classes were more likely than females in the low latent class to meet criteria for ODD/CD during preschool. Preschool-onset ODD/CD did not distinguish between the medium and high classes ( $\chi^2(1) = 0.03$ ,  $p = .87$ ).

### Later school age functional impairment

*Males.* Results indicated a significant main effect of boys' class membership on their school age functional impairment scores as rated by their parent ( $F_{(2, 110)} = 32.19$ ,  $p < .0001$ , effect size of .61). Pairwise comparisons demonstrated that boys in the high depression severity class ( $M = .71$ ,  $SD = .06$ ) had significantly higher parent reported functional impairment scores than boys in the mid ( $M = .32$ ,  $SD = .05$ ),  $p < .0001$ , and low ( $M = .14$ ,  $SD = .04$ ),  $p < .0001$ , classes. The mid and low depression severity latent classes also differed significantly in school age functional impairment,  $p = .009$ .

**Table 3** Descriptive characteristics of participants

	Males														
	Low depression severity (N = 83)				Medium depression severity (N = 50)				High depression severity (N = 27)						
Age	N	Mean	SD	Min	Max	N	Mean	SD	Min	Max	N	Mean	SD	Min	Max
First Assessment	83	5.43	2.48	3.03	12.85	50	4.70	1.20	3.08	11.25	27	4.96	0.75	3.46	5.87
Social Adversity	N	Mean	SD	Min	Max	N	Mean	SD	Min	Max	N	Mean	SD	Min	Max
At age 5	66	0.47	0.61	0.00	2.00	48	0.79	0.85	0.00	3.00	25	1.28	1.14	0.00	5.00
Functional Impairment	N	Mean	SD	Min	Max	N	Mean	SD	Min	Max	N	Mean	SD	Min	Max
Mean across waves	83	0.12	0.12	0.00	0.50	50	0.37	0.25	0.00	1.13	27	0.63	0.28	0.15	1.38
MDD Diagnosis	Total N	%	N			Total N	%	N			Total N	%	N		
Lifetime	83	13.25	11			50	86.00	43			27	100.00	27		
ODD/CD Diagnosis	Total N	%	N			Total N	%	N			Total N	%	N		
Preschool	83	21.69	18			50	50	25			27	59.26	16		
Family History Affective Disorder	Total N	%	N			Total N	%	N			Total N	%	N		
Lifetime	83	83.13	69			49	89.80	44			27	96.30	26		

	Females														
	Low depression severity (N = 84)				Medium depression severity (N = 53)				High depression severity (N = 13)						
Age	N	Mean	SD	Min	Max	N	Mean	SD	Min	Max	N	Mean	SD	Min	Max
First Assessment	84	5.11	2.23	3.02	12.95	53	4.70	1.36	3.07	10.37	13	4.87	1.37	3.42	8.76
Social Adversity	N	Mean	SD	Min	Max	N	Mean	SD	Min	Max	N	Mean	SD	Min	Max
At age 5	70	0.44	0.71	0.00	3.00	49	1.00	1.12	0.00	4.00	11	1.82	0.98	1.00	4.00
Functional Impairment	N	Mean	SD	Min	Max	N	Mean	SD	Min	Max	N	Mean	SD	Min	Max
Mean across waves	84	0.13	0.15	0.00	0.70	53	0.24	0.20	0.00	0.94	13	0.58	0.38	0.00	1.25
MDD Diagnosis	Total N	%	N			Total N	%	N			Total N	%	N		
Lifetime	84	13.10	11			53	77.36	41			13	100.00	13		
ODD/CD Diagnosis	Total N	%	N			Total N	%	N			Total N	%	N		
Preschool	84	13.10	11			53	39.62	21			13	76.92	10		
Family History Affective Disorder	Total N	%	N			Total N	%	N			Total N	%	N		
Lifetime	84	77.38	65			53	98.11	52			13	92.31	12		

*Females.* The ANOVA results indicated that school age functional impairment as rated by their parent differed significantly in relation to female's class membership ( $F_{(2, 104)} = 19.06, p < .0001$ , effect size of .52). Follow-up pairwise comparisons indicated that girls in the high ( $M = .69, SD = .09$ ) depression severity latent class differed significantly from girls in the mid ( $M = .20, SD = .04, p < .0001$ ), and low ( $M = .13, SD = .03, p < .0001$ ), depression severity classes. Results indicated that school age functional impairment scores in females did not differ between the low and mid classes,  $p = .50$ .

## Discussion

There has been little available data to inform the predictors and outcomes of latent class trajectories of depressive symptoms in early childhood beginning during preschool and continuing throughout school age. To address these gaps in the literature, this study applied GMM to depressive symptoms endorsed by children and/or their caregivers during a structured clinical interview in a 10-year longitudinal dataset spanning from preschool into late school age. As hypothesized, we found three distinct trajectories of depressive symptom severity, high, medium, and low in boys and girls. Contrary to our hypothesis, girls did not evidence a class that demonstrated increases in their depressive symptom severity across time. For boys, the high depression severity latent class increased in depressive symptoms from preschool through school age, followed by a decline in depressive symptom severity during later school age. Early childhood social adversity, familial history of affective disorder, preschool-onset ODD/CD diagnosis, and school age functional impairment differentiated high-risk trajectory classes among boys and girls.

For boys and girls, similar to past work, the three-class solution provided the best balance between statistical indices of fit and number of children in each trajectory class (Castelao & Kröner-Herwig, 2012). More similarities than differences were noted in the overall trajectories for males and females with each having a high, medium, and low latent class. However in boys, the high severity latent class showed a significant quadratic slope signifying a faster rate of increase in symptoms during preschool and early childhood followed by a decline during later school age in depressive symptom severity. For girls in the high latent class, depressive symptoms remained stable and high from preschool through later school age. Furthermore, these results show clear differences in the starting intercepts of high severity latent classes between boys and girls. Thus, during the preschool period, girls in the high severity latent class were reporting almost twice the number of symptoms as the boys in a similar high severity latent class. This finding is notable as rates of MDD

in school age children are generally reported to be the same for boys and girls. Thus in this study, the relative severity of depressive symptoms was higher in the most symptomatic preschool girls when compared to boys. However, boys quickly 'caught up' to girls in the number of symptoms that were endorsed by mid childhood, but were showing declining depression rates by later childhood. These trajectories offer unique insights into gender differences in early-onset depressive symptoms and the continuation of these early-onset symptoms into school age, extending the literature by creating latent trajectories with structured clinical interviews of depressive symptom severity rather than relying on self/parent-report questionnaires. Additional, planned follow-up assessments of the sample into adolescence will be important to investigate continuity and changes in trajectories.

Overall, our findings suggest that early childhood social adversity, occurring prior to age 5, is predictive of greater depression symptom severity across preschool and into school age in both boys and girls. However, the predictive impact of early childhood social adversity on latent class trajectory membership was somewhat different for boys and girls. For boys, greater early childhood social adversity predicted membership in the high latent trajectory class over both the medium and low classes, with the influence of early childhood social adversity being equivalent in the medium and low classes. By contrast, for girls, greater early childhood social adversity predicted membership in the high latent trajectory class over the low class, but not the medium class. In girls, the medium class also experienced significantly more childhood social adversity than the low class. When compared directly, the high and mid latent trajectory class of boys evidenced equal amounts of early childhood adversity as the high and mid latent trajectory class of girls. It may be that, in boys, early social adversity exerts influence in a 'dose-response' fashion, where the greatest social adversity predicts the greatest symptom severity. In girls, heightened early social adversity appears to be more generally predictive of trajectory memberships with any depressive symptoms (high or medium) as opposed to none (low). This finding could be consistent with the hypothesis that girls are more sensitive to the effects of early childhood social adversity leading to (even moderately) heightened symptom levels during preschool and throughout childhood (St Clair et al., 2015).

The predictive impact of preschool-onset ODD/CD and family history of affective disorders on latent class trajectory membership was similar across gender. Preschool-onset ODD/CD predicted membership in the high and medium latent classes over and above the low latent class in both boys and girls. However, preschool-onset ODD/CD did not distinguish between the medium and high

latent classes. These findings suggest that although preschool-onset ODD/CD may predict the trajectories of elevated depressive symptoms in youth, these early occurring diagnoses do not predict the severity of such trajectories. The high depression severity latent classes of boys and girls were more likely than the low severity class to have family members diagnosed with an affective disorder. For girls, but not boys, family history of affective disorders also predicted membership in the middle depression severity latent class over and above the lower class. Similar to findings examining early social adversity, in girls, family history of affective disorder appears to be more predictive of trajectory memberships with any depressive symptoms (high or medium) as opposed to none (low). These findings fit with evidence from large twin studies suggesting increased heritability of depression in females than males (Kendler & Gardner, 2014). Taken together, these findings suggest that both preschool-onset ODD/CD and family history of affective disorders differentiate youth with depressive symptoms, but cannot distinguish between the most severe youth and those with subclinical symptom severity.

Importantly, later school age functional impairment was predicted by early childhood depression severity trajectories among boys and girls. In boys and girls, membership in the high depression severity latent class predicted the greatest functional impairment in school age, even above the impairment reported for youth in the medium latent class. These findings imply that even if children did not meet diagnostic criteria for depression at each assessment wave, membership in a latent class with more depressive symptoms predicted greater functional impairment during school age. As such, study findings underscore the need for identification and intervention in moderate, subclinical depressive symptoms during early childhood. Findings also provide additional evidence for the continuity of early-onset depressive symptoms through school age.

While this study has strength in the use of both parent- and child- structured interviews on a sample ascertained at preschool age, it could be improved by the inclusion of additional reporters, such as the child's other caregiver and/or teacher. Indeed, past work has found differences in the reporting of children's symptoms as a function of parental psychopathology. Thus, this possibility cannot be ruled out in this study, as approximately 40% of the mothers in this study had a history of depression. Furthermore, temperament during early childhood was not assessed in this study and therefore, the influence of temperament, above and beyond diagnostic severity, remains open for inquiry. Disentangling the longitudinal influences of temperament and diagnostic symptoms on childhood functional impairment and psychopathology remains an impor-

tant area for future work. Rather than including a single predictor of social risk, such as parental education or income, this study is strengthened from creating a cumulative variable encompassing seven indicators of social risk. The inclusion of additional predictive and outcome variables, such as social, familial, and/or biological indices, could further elucidate trajectories of low, medium, and high depressive symptom severity throughout childhood. For example, as mentioned above, a large percentage of mothers in this study had a history of depression and may have been receiving treatment throughout the course of the study. Future work may want to investigate the impact of treatment for parental psychopathology on trajectories of childhood depression severity.

Due to the relatively small sample size for conducting the GMM, this study has reduced power to detect differences between gender and latent classes. Specifically, strong conclusions cannot be drawn regarding gender differences in the medium depression latent class, as  $p$  values of these comparisons generally ranged from 0.04 to 0.07. For example, the  $p$  values differentiating males in the high latent trajectory from those in the mid (0.04) or low (0.06) trajectories were very similar; yet, only one is below the standard significance threshold. The differences between the mid and low groups found (or not found) in this study will need to be replicated in larger samples before strong conclusions can be drawn.

The findings from this study suggest that increased attention to screening for depressive symptoms in *early* childhood is of significant public health importance, as prior work highlights the functional impairment (Luby, Belden, Pautsch, Si, & Spitznagel, 2009), significant risk for later DSM-5 depression (Luby et al., 2014), evidence of brain change (Barch et al., 2012; Gaffrey et al., 2013), and most importantly, the poor overall efficacy of treatments for depression in later childhood (Chorpita et al., 2011). In addition, preschool-onset depression shows discriminant validity and specificity from other disorders. These findings taken together suggest earlier interventions, and specific interventions for depression, during periods of greater developmental change, and higher neuroplasticity may be an important treatment opportunity. Results from this study indicate that early childhood social adversity predicts and differentiates the latent class trajectory membership of depressive symptom severity throughout childhood. Therefore, interventions for these children may need to occur earlier in development, even if the child has not yet met diagnostic criteria for depression. For example, in boys, those in the mid depression severity class experienced significantly greater functional impairment during school age than boys in the low class, even though both groups had average symptom counts well below the cut off needed for a clinical diagnosis. Furthermore, among

girls in the high latent class, depressive symptoms remained high and stable from preschool through school age. Early intervention in these cases may decrease the likelihood that heightened symptom severity is maintained throughout development and lessen the functional impairment resulting from trajectory membership over time. Such interventions will likely need to take a multipronged approach that target several areas including increasing social support (Kaufman et al., 2006), building children's self-concept and self-control (Miller-Lewis, Searle, Sawyer, Baghurst, & Hedley, 2013), and enhancing parent-child relationship quality and family functioning (Luby, Lenze, & Tillman, 2012).

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## Key points

- Little is known about the latent classes of depressive symptoms that begin in early childhood, as well as the predictors and longitudinal outcomes of membership in these specific trajectories.
- Three distinct trajectories of depressive symptom severity were found in boys and girls. For boys, the high MDD severity latent class increased in depressive symptoms from preschool through school age, followed by a decline in depressive symptom severity during later school age.
- Early childhood social adversity, familial history of affective disorder, preschool-onset ODD/CD, and school age functional impairment differentiated high-risk trajectory classes among boys and girls.
- Findings suggest that increased attention to screening for depressive symptoms in early childhood is of significant public health importance.

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