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Developmental Trajectories of Pediatric Obsessive–Compulsive Symptoms

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Abstract

Children who experience obsessive–compulsive symptoms (OCS) may be at risk for developing Obsessive–Compulsive Disorder (OCD). The current study aimed to investigate developmental trajectories of OCS, as well as possible predictors, within a community-based sample of children. Children (N = 1147) from the longitudinal NICHD Study of Early Child Care and Youth Development (SECCYD) were assessed for OCS, via the Child Behavioral Checklist – Obsessive–Compulsive Scale (OCS-8), eight times between Pre-Kindergarten (54 months; Pre-K) and High School (15 years of age; HS.) Participants were recruited within the United States and included only maternal caregivers. Preliminary analyses indicated that approximately 3% of the sample was above the diagnostic cutoff score on the OCS-8 at the High School time-point. Latent growth models tested symptom trajectories. Findings demonstrated three groups of OCS trajectories. Most children fell within a low symptomatology group (the No Peak group) with low OCS across all time points. Two additional OCS trajectories were also demonstrated: Pre-K Peak (high to low OCS across time) and HS Peak (low to high OCS across time). Both higher attention problems and greater depression/anxiety symptoms at the Pre-K time point predicted children's membership in the Pre-K Peak or HS Peak groups compared to the No Peak group. Membership within the HS Peak group predicted a high likelihood of children's OCS being above previously established cutoff scores for an OCD diagnosis at age 15 years. Membership within either the Pre-K Peak or No Peak groups predicted a low likelihood. This study provides new evidence for the existence of different developmental trajectories for youth with OCS. From a clinical perspective, these results may have important implications when considering the identification and early intervention of childhood OCS and OCD within the community.

Keywords OCD · Obsessive–compulsive symptoms · Latent growth · Developmental trajectories

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Obsessive Compulsive Disorder (OCD) is a chronic psychiatric disorder that affects up to 2–3% of children and adolescents (Douglass et al. 1995; Zohar et al. 1993). Obsessions are reoccurring images, thoughts, and impulses that are intrusive and unwanted, while compulsions are repetitive, ritualized behaviors or mental acts implemented in an attempt to control or alleviate obsessional distress (Krebs and Heyman 2015). In contrast to developmentally typical ritualistic behaviors often seen in children (e.g., bedtime rituals), OCD-related behaviors must be considered impairing and/or distressing or persist beyond typical development (American Psychiatric Association [APA] 2013). Additionally, given the critical development (e.g., cognitive, creative, physical) which takes place throughout childhood, the onset of OCD during this time may result in additional developmental disruptions (Fineberg et al. 2019). Symptoms may wax and wane in severity but, if left untreated, can persist

continuously throughout the lifespan causing significant academic, occupational, and social impairment and reducing quality of life (Coluccia et al. 2016; Stewart et al. 2004). OCD demonstrates a bimodal (i.e., child and adult) onset (Anholt et al. 2014; Dell'Osso et al. 2016). Juvenile OCD typically emerges before puberty and appears to have more frequently remitting symptoms (Bloch et al. 2009; Freeman et al. 2014; Mancebo et al. 2014; Micali et al. 2010). Additionally, in contrast to adult onset OCD, pediatric OCD tends to affect a greater number of males than females (Geller et al. 1998; Taylor 2011). Previous research has found that while OCD symptom severity increases with age among school-aged children (Canals et al. 2012), earlier age of onset is predictive of greater symptom severity and chronicity (Taylor 2011). However, the generalizability of these results is limited by the use of cross-sectional designs, retrospective recall, and patient samples from specialist clinics. Thus, despite the clear and negative impact of pediatric OCD, relatively little is known about its developmental trajectory (i.e., onset and progression of symptoms over time). It has been hypothesized that the development of OCD may follow stage models commonly seen across multiple psychological disorders (Fineberg et al. 2019). Specifically, researchers propose that prior to the onset of full symptoms, affected individuals may experience subthreshold symptoms. Those individuals with additional risk factors (e.g., family history of related disorders) may be characterized as being at high risk (Fineberg et al. 2019). The present study seeks to, in part, further investigate the development of OCD over time.

In addition to clinical pediatric OCD, research has also focused on subclinical levels, often referred to as obsessive–compulsive symptoms (OCS), during childhood. An early meta-analysis of 16 follow-up studies (*M* time = 5.7 years) by Stewart et al. (2004) found symptom persistence rates of 60% for full + subclinical OCD and 41% for clinical OCD among child and adolescent samples (Stewart et al. 2004). Notably, across studies included in the review, gender was not predictive of symptom persistence (Stewart et al. 2004). Even in the absence of an OCD diagnosis, childhood OCS are highly prevalent, similarly chronic, and can present an increased risk of developing OCD (Arnold et al. 2018; Bryńska and Wolańczyk 2005; Canals et al. 2012; Fineberg et al. 2019; Monzani et al. 2014). For example, a prospective study by Fullana et al. (2009) found that among a large sample (N = 1,037), 21–25% endorsed specific obsessions and compulsions at age 11; further, children who reported subclinical OCS at this age were more likely to have a clinical OCD diagnosis at follow-up assessments that occurred at 26 and 32 years (Fullana et al. 2009). Alvarenga and colleagues (2015) found that parent-reported OCS among school-aged children gradually increased with age (Alvarenga et al. 2015), and a similar pattern was found by Stavropoulos et al. (2017) in self-reported OCS among adolescents aged 16–18 (Stavropoulos et al. 2017). While these studies indicate that OCS fluctuate throughout development, they fail to examine trajectories of OCS throughout childhood. Given that OCS are known to occur in children as young as four (National Institute for Clinical Excellence 2005), additional research is needed to clarify if early-childhood OCS are predictive of symptom severity in adolescence, a common period for OCD diagnosis (Stavropoulos et al. 2017). As such, investigating OCS dimensionally (versus only tracking diagnosis course) through a prospective, longitudinal design may allow for a better understanding of the developmental trajectory of OCD-related behaviors.

The pathogenesis and course of OCD remains unclear, with a complex interplay of neurobiological, genetic, and behavioral factors implicated. OCD appears to have a clear genetic component (Arnold et al. 2018; Monzani et al. 2014). Although several environmental and psychosocial risk factors have been posited to play a role in the etiology of the disorder (e.g., brain injury, perinatal and stressful/traumatic events; Tanidir et al. 2015), a meta-analytic review conducted by Brander and colleagues (2016) found no clear evidence in support of any one risk factor linked to the development of OCD (Brander et al. 2016). The authors noted that this lack of evidence relates to a lack of well-controlled, longitudinal examinations of the course and long-term trajectory of the disorder. However, the presence of co-occurring psychopathology is one factor consistently associated with worsened symptom severity for both clinical and subclinical OCD. An estimated 50% of children with OCD exhibit at least one co-occurring diagnosis, which is commonly an anxiety-based disorder (Berman et al. 2016; Farrellet al. 2012). Concurrent depression and attention-deficit/hyperactivity disorder (ADHD) are also highly common comorbidities associated with increased severity and persistence of OCD symptoms when compared to OCD alone (Abramovitch et al. 2015; Farrell et al. 2012; Storch et al. 2012). This also appears to be true for OCS. For example, among a sample of children ages 6–12 (N = 2512), Saad et al. (2017) found that higher self-reported rates of OCS were associated with co-occurring anxiety disorders, ADHD, and mood and disruptive disorders (Saad et al. 2017). Similarly, Barzilay et al. (2019) found that OCS endorsement was linked to increased risk of experiencing psychopathology, including depression and suicide, in a large community-based sample of children and adolescents aged 11–21 (Barzilay et al. 2019). In addition, comorbidities appear to vary by gender. Specifically, males with OCD appear to experience more behavioral comorbidities (e.g., oppositional defiant disorder; Tanidir et al. 2015) while females may be more likely to have a comorbid depressive disorder than males (Storch et al., 2012). In addition to comorbidities, gender may also play a role in determining the course of the disease. While gender does not appear to influence the type or severity

of OCS (Geller et al. 1998), it may have other impacts. In a meta-analytic review, Stewart and colleagues (2004) reported that previous research has demonstrated an association between males and experiencing a chronic disease course (Wewetzer et al. 2001) while others demonstrated a relationship between being female and experiencing an episodic course of the disease (Wewetzer et al. 2001). Given that both co-occurring diagnoses and gender identity can influence the clinical presentation, the symptom severity, and the developmental trajectory of OCD, these additional, contextual factors are important to examine in prospective studies of OCS fluctuation.

OCS can be assessed through a variety of self- and parent- report measures that are time-efficient and thus advantageous for large-scale longitudinal examinations (Piqueras et al. 2015).The Child Behavior Checklist (CBCL; Achenbach 1991) is a widely-used research instrument to assess a variety of externalizing behaviors, internalizing disorders, and adaptive functioning. Particularly germane to the present investigation is the derivation of the Obsessive–Compulsive Scale (i.e., CBCL-OCS), consisting of several items from disparate subscales of the CBCL (Hudziak et al. 2006). While multiple iterations of the CBCL-OCS exist, the most often utilized is an 8-item version (the OCS-8) developed by Nelson and colleagues (2001) from a factor analysis of 11 items believed to predict OCD (Nelson et al. 2001). Use of the OCS-8 has been shown to differentiate between children with OCD and the general population as well as clinical controls (Nelson et al. 2001). Additionally, previous research suggests that using a cutoff score of 5 on this scale is optimal for differentiating between children with OCD and the general population. Compared to other iterations of the scale, the OCS-8 has been shown to have the highest sensitivity rate (Andersen and Bilenberg 2012); however, a more recent study utilizing a Brazilian cohort (Saad et al. 2017) noted that the OCS-8 exhibited a low PPV. This latter finding is in contrast to the preponderance of prior literature establishing the use of the OCS-8 as a useful screening tool. Collectively, while not without its limitations, the OCS-8 is widely accepted as being an acceptable screening tool for identifying OCS.

Although existing literature has added to our knowledge about the risk factors and developmental course of pediatric OCS and OCD, significant gaps remain related to the developmental trajectory of OCS as measured by well-controlled studies. The existence of parent-report measures such as the CBCL-OCS-8 provides researchers with an opportunity to more thoroughly examine the progression of OCS from early childhood to late adolescence. Research of this nature may inform science's understanding of not only the course of OCS over childhood but also aid in the identification of subgroups of youths who may benefit most from tailored, developmentally sensitive prophylactic interventions. Consequently, the primary objective of the current study was to identify and characterize developmental trajectories of subgroups of OCS within a general population sample of youths from 54-months (Pre-Kindergarten) to 15 years of age (High School), assessed over eight time points. We aimed to examine these developmental trajectories within the context of clinically relevant variables (i.e., gender, co-occurring psychiatric symptoms) that may serve as predictors as well as in relation to a dichotomous outcome representing clinical versus non-clinical symptom levels.

Method

Participants

Data for this analysis came from the Study of Early Child Care and Youth Development (SECCYD), a multi-phased, longitudinal study supported by the National Institute of Child Health and Human Development (NICHD). The study examined the effects of early childcare on human emotional, social, and physical development among 1,364 families recruited from 10 US regions in accordance with ethical standards. Consent was obtained from all participants and assent was obtained from children at the later time points. The sample, while diverse, had higher education and income levels and was not designed to be nationally representative. Specifically, 79% of children included in the study were Caucasian, 24% were children of color, and 14% of mothers were single mothers. Approximately half of the children were male. For full demographic details please see: NICHD Early Child Care Research Network 2002. Relevant to the current study, participants completed the CBCL in-person either at home or during a lab visit depending on the phase of data collection. While the CBCL was completed by the child's mother, father, and daycare/after-school caregiver across timepoints, the current study only utilizes the mother report of the CBCL. Details about study recruitment and procedures are presented elsewhere (NICHD Early Child Care Research Network (2002), and study data is accessible to researchers at (http://www.icpsr.umich.edu/icpsrweb/ICPSR/series/00233).

Participants were recruited from hospitals across the United States following the birth of a child (NICHD Early Child Care Research Network 2002). Children were followed from birth to 15 years of age, with data collected using objective and subjective assessment tools at four phases. The present study includes data from phases II (54 months – 1st grade), III (2nd – 6th grade), and IV (7th – 9th grade). Within these phases, eight time points were available: Pre-Kindergarten (Pre-K; 54 months, age four), kindergarten (ages 4–6; M age = 5.11, SD = 0.32), first grade (ages 6–8; M age = 6.45, SD = 0.50), third grade (ages 8–10; M age = 8.42, SD = 0.51), fourth grade (ages 9–11; M age = 9.32, SD = 0.48), fifth

grade (ages 9–12; *M* age = 10.16, *SD* = 0.38), sixth grade (ages 11–13; *M* age = 11.36, *SD* = 0.49), and High School (ages 14–15; *M* age = 14.44, *SD* = 0.50). Any participants who provided CBCL data were included in analyses, resulting in a sample of 1,147 participants.

Materials

Child Behavior Checklist (CBCL; Achenbach 1991). The CBCL utilized in the current study is a parent-report measure which assesses a wide range of emotional and behavioral symptoms in children. The CBCL provides overall externalizing, internalizing, and total problems scores. In addition to these composite scales, the CBCL provides several symptom-specific scales which allow for a more specific analysis of child symptoms. The current study utilized the 8-item Obsessive–Compulsive Scale as a measure of OCS (OCS-8; Nelson et al. 2001). Children with an OCS-8 score of five or higher are considered "at-risk" for later developing OCD. The reliability and specificity of the OCS-8 was demonstrated by Geller and colleagues (2006), and the scale was later found to have moderate specificity and high sensitivity by Andersen and Bilenberg (2012). The inclusion of multiple symptoms and syndrome subscales as part of the CBCL simultaneously allows for the identification of commonly occurring clinical correlates (i.e., anxiety, inattention; Saad et al. 2017). Thus, the CBCL provides an excellent, research-based tool for examining the trajectory of OCS. For the purposes of the current study, the OCS-8 subscale included the items: "Can't get mind off certain thoughts," "Fears he/she might think/do something bad," "Feels he/she has to be perfect," "Feels too guilty," "Repeats certain acts over and over," "Strange Behavior," "Strange Ideas," and "Worries." An item level review of the OCS-8 at each time point indicates that the construct represented by the eight included items is relatively stable over the time measured, with some deviation in the Pre-K time point when compared to later time points. Across time, items with the largest frequency of somewhat or very true responses (scored as 1 or 2, respectively) were "Feels he/she has to be perfect" and "Worries." To a lesser extent, "Can't get mind off certain thoughts" and "Fears might do or think something bad" also had larger frequencies of elevated responses. Other items had more consistently high frequencies of not true responses (scored as 0.)

Additionally, the anxious/depressed subscale of the CBCL as well as the attention problems subscale were considered as covariates, along with gender. The anxious/depressed subscale of the CBCL consists of 13 items assessing behaviors characteristic of anxiety/depressive symptoms (e.g., "Cries a lot," "Fears certain animals, situations, or places," "Fears going to school," "Fears he/she might do something bad," "Feels he/she has to be perfect," "Feels or complains that no one loves him/her," "Feels worthless or inferior," "Nervous, high-strung, or tense," "Too fearful or anxious," "Feels too guilty," "Self-conscious or easily embarrassed," "Talks about killing self," "Worries;" Achenbach 1991). The anxious/depressed subscale has been shown to be clinically useful in classifying youths as having an anxiety disorder as well as ruling out the presence of an anxiety disorder (Aschenbrand et al. 2005). Additionally, this subscale has been shown to be associated with clinical interviews assessing similar constructs (Birmaher et al. 2009). Three items from the anxious/depressed subscale that overlapped with the OCS-8 subscale were removed before creating a total anxious/depressed score.

The attention problems subscale of the CBCL consists of 10 items (i.e., "Acts too young for his/her age," "Fails to finish things he/she starts," "Can't concentrate, can't pay attention for long," "Can't sit still, restless, hyperactive," "Confused, seems to be in a fog," "Daydreams or gets lost in his/her thoughts," "Impulsive or acts without thinking," "Poor schoolwork," "Inattentive or easily distracted," "Stares blankly;" Achenbach 1991). The attention problems subscale has been identified as an accurate screening tool for ADHD (Chen et al. 1994; Eiraldi et al. 2000).

Data Analytic Plan

Developmental Trajectories. The planned analyses investigating the developmental trajectories of OCD symptoms had two steps. First, the best model of latent growth was identified in the full sample using Mplus 8 (Muthén and Muthen 2017) with OCS-8 total scores obtained from maternal report at each time point serving as observed variables in the models. The time points included were the eight time points listed in the participants section: Pre-K, Kindergarten, first grade, third grade, fourth grade, fifth grade, sixth grade, and high school. The four models tested were intercept only (no growth), linear growth, quadratic growth, and latent basis (Berlin et al. 2014). All models were tested using maximum likelihood estimation with robust standard errors (MLR), which accounts for missingness on OCS-8 total scores and multivariate kurtosis (Berlin et al. 2014). Once the best model was identified for the full sample, latent groups were investigated through testing a series of models: latent class growth models (no within class variability), growth mixture models with fixed parameters across groups, and growth mixture models with freed parameters across groups. These represent the most to least parsimonious model frameworks, respectively. In each framework, two to six latent classes were investigated. Models were compared based on Bayesian Information Criteria (BIC), (Schwarz 1978) the Bootstrap Likelihood Ratio (BLRT) test (McLachlan and Peel 2000),

and the Lo-Mendell-Rubin (LMR) test (Lo et al. 2001). For the BIC, lower values are indicative of better model fit, and for the BLRT and LMR tests, which compare the current class solution to the previous class solution (e.g., 3-class compared to 2-class), significant p-values are indicative of a statistically superior model solution with the inclusion of an additional class (Berlin et al. 2013). Along with these measures of comparative fit, groups were also reviewed qualitatively to ensure that group memberships and trajectories were sensible relative to current knowledge about OCD symptoms in children and adolescents.

Predictors of Group Membership. To investigate predictors of developmental trajectory subgroups, three covariate predictors, measured at the Pre-K timepoint, were added to the best fitting model identified in the previous analytic step. These covariates included gender, attention problems, as determined by the attention problems subscale of the CBCL, and depression/anxiety symptoms, as determined by the anxious/depressed subscale of the CBCL. As recommended (Asparouhov and Muthén 2014), these variables were investigated using the R3Step procedure in Mplus 8. Because MLR does not accommodate missingness on covariates, multiple imputation was used for covariate variables (Little et al. 2013). Data were imputed 100 times in Mplus 8 to impute missing values for both attention problems and anxiety/depression symptoms. As with the previous modeling steps, missingness on OCS-8 variables was handled through MLR estimation.

Group Membership Predicting Diagnostic Outcomes. To investigate developmental trajectory subgroups predicting probable clinical levels of OCD symptoms in adolescence, a dichotomous variable was created from the OCS-8 at the High School time point; based on previous research, scores of 4 or below were assigned a value of zero, for non-clinical levels, and scores of 5 or above were assigned a value of one, for probable clinical OCD symptoms (Andersen and Bilenberg 2012; Hudziak et al. 2006; Nelson et al. 2001; Saad et al. 2017). This new variable was then entered into the final model as an auxiliary dichotomous outcome, using the DCAT procedure in Mplus 8, as recommended for latent groups predicting binary outcomes (Asparouhov and Muthén 2014). Because MLR does not accommodate missingness on auxiliary outcome variables, multiple imputation was used for the outcome variable (Little et al. 2013). Data were imputed 100 times in Mplus to impute missing values for the dichotomous variable of presence or absence of clinical levels of OCD symptoms. As with the previous modeling steps, missingness on OCS-8 variables was handled through MLR estimation.

Results

In terms of descriptive statistics and missingness, there was some missingness present on all included variables. Given the use of MLR estimation in all models tested, "full information" methods were used to estimate missingness on the OCS-8 at all time points. This means that participants with information on any of the OCS-8 time points were included in the models (n = 1,147) and that some participants had information on later OCS-8 time points who did not have information at the first, Pre-K timepoint. Descriptive statistics for each time point of the OCS-8 are included in Table 1 along with descriptives for the covariates of attention problems and anxiety/depression symptoms. For gender, all 1,147 participants had information available, with 49% (564 participants) identifying with a female gender. For the dichotomous outcome, data were missing at the same rate as for the OCS-8 at the High School time-point. Of the 965 participants with available outcome data, 3% (32 participants) were above the cutoff indicating probable clinical OCD symptoms while the remainder (933 participants) were below the cutoff. Data appear to be missing at random (MAR) and thus the use of both full information and imputation methods of handling missing data are appropriate and all 1,147 participants with present data were included in all models tested. Further expanding on OCS-8 missingness across time points, dropout analysis indicates 1% dropout

Table 1 Descriptive Statistics for OCS-8, Attention problems, and anxiety/depression symptoms

	Mean	SD	N present	Percent Missing
OCS-8 Pre-K	1.11	1.44	1,057	7.8%
OCS-8 K	1.05	1.35	1,042	9.2%
OCS-8 1st	1.22	1.47	1,018	11.2%
OCS-8 3rd	1.35	1.57	1,015	11.5%
OCS-8 4th	1.23	1.47	1,010	11.9%
OCS-8 5th	1.31	1.52	1,009	12.0%
OCS-8 6th	1.14	1.42	1,011	11.9%
OCS-8 HS	1.10	1.38	965	15.9%
Attention Problems Pre-K	2.73	2.39	1,057	7.8%
Anxiety/Depression Symptoms Pre-K	1.54	1.86	1,057	7.8%

Table 2 Fit Statistics for OCS-8 Growth Models (n = 1,147 for all models tested)

	χ^2	*df*	χ^2 *p*	RMSEA [90% CI]	SRMR	CFI	BIC
Intercept only	266.09	34	<.001	0.08 [.07, .09]	0.09	0.88	26165
Linear growth	203.85	31	<.001	0.07 [.06, .08]	0.07	0.91	26079
Quadratic growth	92.54	27	<.001	0.05 [.04, .06]	0.04	0.97	25930
Latent basis	125.82	25	<.001	0.06 [.05, .07]	0.05	0.95	25964

from Pre-K to Kindergarten, 1% dropout from Kindergarten to first grade, 3% dropout from first grade to third grade, 1% dropout from third grade to fourth grade, 1% dropout from fourth grade to fifth grade, 2% dropout from fifth grade to sixth grade, and 6% dropout from sixth grade to high school.

Among models of growth tested in the full sample, a quadratic growth model demonstrated the best model fit (see Table 2 for model fit across growth models) and was investigated across the latent group frameworks described in the analytic plan. Given errors in the least parsimonious framework (growth mixture models (GMMs) with freed variance) across all models, analyses proceeded comparing latent class growth models (LCGMs) to growth mixture models (GMMs) with fixed variance across groups. As seen in Table 3, BLRT *p* values favored a larger number of classes while the LMR suggested a two class solution in the LCGMs and a single class solution in the GMMs with fixed variance. The three class model was chosen as the optimal solution, as the BLRT tends to perform better than the LMR (Nylund et al. 2007), and an otherwise appropriate solution for the three class model was agreed upon by the research team (e.g., reasonable trajectories, appropriate class sizes). When the two three class models were compared with one another, GMM with free variance demonstrated superior fit based on BIC comparison and, while less parsimonious, offers a more realistic picture of children and adolescents across the time points under investigation. Results for the three class GMM are depicted in Fig. 1, which includes both the model implied trajectories and the trajectories implied by the means of each latent group. While these are largely identical, depiction of both trajectories demonstrates that actual group means reflect model implied group means.

As seen in Fig. 1, the largest group is the No Peak group, representing no peak in OCS symptoms across time. The No Peak group represented over 85% (n = 984) of the sample with estimated sample average scores at or below one across time points. At the item level, the No Peak group largely reflects the patterns observed in the full sample, with a higher amount of positive responses for "Worries," "Feels has to be perfect," and, to a lesser extent, "Can't get mind off certain thoughts" and "Fears might think or do something bad." The next largest group, with just over 9% of the sample (n = 105), was the Pre-K Peak group. This group, with average scores starting at just above four at the Pre-K timepoint and falling to just above two at the high school (HS) timepoint, represents a decrease in OCS symptoms across time. This group demonstrates a different pattern at the item level than the full sample, most notably higher frequencies of positive responses across time points for "Can't get mind off certain thoughts" and "Fears might think or do something bad" when compared to both the full sample and the No Peak group. The last group, with 5% of the sample (n = 58), was the High School Peak group. This group, with scores starting under two at Pre-K but nearing five at High School, represents an increase in OCS symptoms over time and experiences a large spike in symptoms

Table 3 Fit statistics for LCGMs and GMMs (n = 1,147 for all models tested)

	Free parameters	BIC	BLRT	BLRT *p*	LMR	LMR *p*	n of Smallest Class	Model Errors
LCGM								
2 Class	15	26745.14	14545.56	<.001	2367.70	0.007	251 (21.88%)	
3 Class	19	26095.83	13319.73	<.001	654.28	0.16	49 (4.27%)	
4 Class	23	25814.75	12981.00	<.001	298.65	0.40	12 (1.10%)	
5 Class	27	25647.53	12826.36	<.001	188.71	0.17	9 (0.79%)	
GMM Fixed								
2 Class	21	25659.14	12905.31	<.001	289.17	0.06	126 (10.99%)	Nonpositive definite
3 Class	25	25479.32	12754.60	<.001	200.87	0.06	58 (5.06%)	
4 Class	29	25364.50	12651.60	<.001	138.10	0.10	11 (0.96%)	Nonpositive definite
5 Class	33	25293.95	12580.10	<.001	95.35	0.35	31 (2.70%)	

For models with non-positive definite errors, fit indices should be interpreted with caution

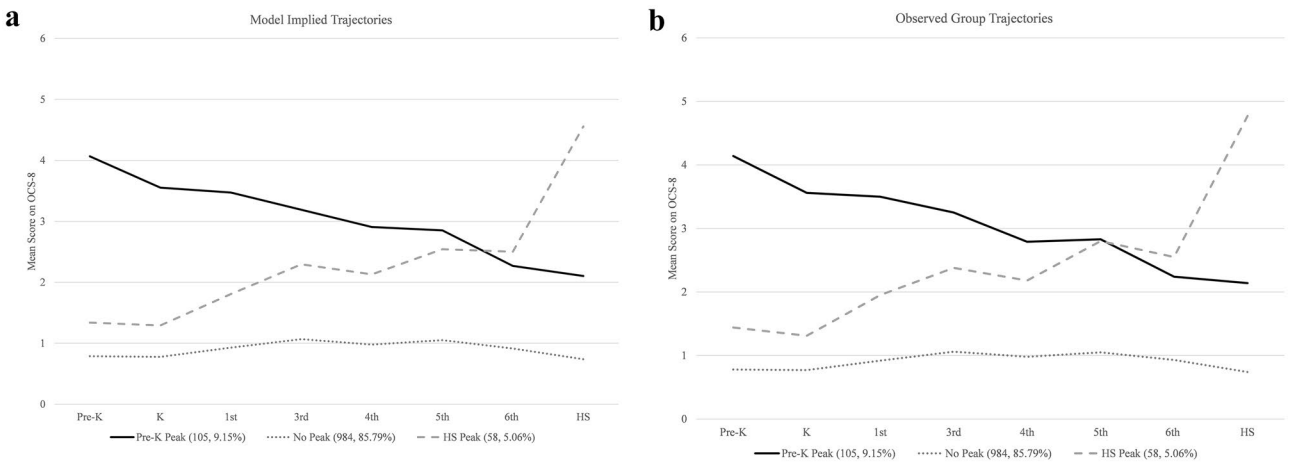

Fig. 1 Modeled Implied and Observed Trajectories

between the sixth grade and High School time points. At the item level, this group also demonstrates differences from the full sample, especially at later time points. Notably, the High School Peak group demonstrates higher frequencies of positive response for "Repeats certain acts over and over," especially at the high school time point, along with higher frequencies of positive responses for the items which are elevated in the other groups. Figure 2 depicts the observed group means from Fig. 1 along with standard deviation error bars. This figure demonstrates that the groups differentiate most at the Pre-K and high school time points, with a good deal of overlap in error bars at many of the middle time points. In addition, item level information by group is available upon request.

When adding covariate predictors to the three-class GMM model, gender did not predict differences between groups, but both attention problems and anxious/depressed scores did predict group differences. Table 4 presents results of the covariate predictors. Compared to the No Peak group, increases in attention problems increased the likelihood of participant membership in either the Pre-K Peak group or the High School Peak group. A similar pattern was observed for increases in anxious/depressed scores, where increases increased the likelihood of participant membership in Pre-K Peak group when compared to the No Peak group. In addition, anxious/depressed scores distinguished between the High School Peak and Pre-K Peak groups such that an increase in anxious/depressed scores predicted greater likelihood of participant membership in the Pre-K Peak group when compared to both other groups.

When considering differences in diagnostic outcomes in the three-class model, the No Peak group had 100% probability of being below the cutoff for clinical levels of OCD symptoms at the high school time point (e.g., no members of this group had scores at or above the cutoff). The Pre-K Peak group also had a very high probability of being below cutoff (0.95, 0.03 S.E.) while the High School Peak group had a similarly high probability of being above cutoff (0.96, 0.91 S.E.) at the high school time point. Of those participants whose outcome variable was not imputed, the following outcome patterns were observed across the groups: no participants in the No Peak group fell above cutoff (with 822 falling below the cutoff and 162 with missing data); five participants in the Pre-K Peak group fell above cutoff (with 85 falling below the cutoff and 15 with missing data); and 27 participants in the High School Peak group fell above cutoff (with 26 falling below the cutoff and five with missing data). To better describe the three groups, descriptive statistics are presented in Table 5 for each of the three groups observed in the final mixture models for present data only (imputed values not included and missingness reported includes those participants for whom values were imputed). Descriptives include means and standard deviations for covariate predictors and the OCS-8 at each time point. In addition, Table 6 presents frequencies for each group for both gender (as measured at the Pre-K time point) and for being above or below diagnostic criteria on the OCS-8 at each time point, including at the high school time point as described in the previous section on diagnostic outcome differences. Notably, while there are participants in the No Peak group who are above cutoff before the high school measurement, these participants are not missing at the high school time point nor are they consistently above cutoff prior to high school measurement.

Discussion

While previous literature has looked at the relationship between OCS and age, no other study to date has examined whether trajectories of OCS in childhood can differentially

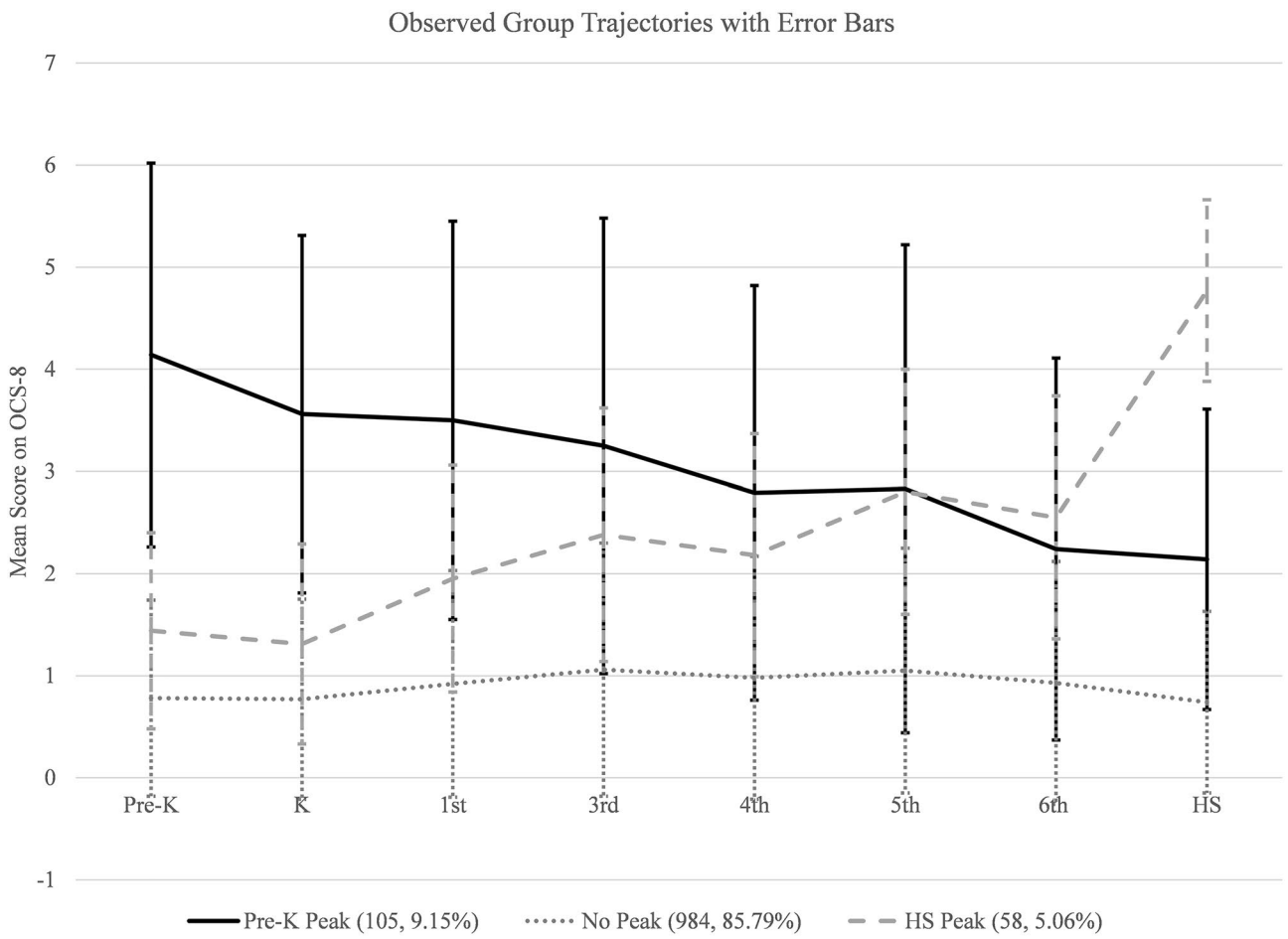

Fig. 2 Observed group trajectories across all timepoints

predict OCS in adolescence. Thus, the current study is among the first to address this gap by investigating OCS and their potential predictors using the NICHD SECCYD longitudinal data set. The results suggest the presence of three overall OCS trajectories, grouped by symptoms that were: always low (No Peak Group), started high and ended low (Pre-K Peak Group), or started low and ended high (High School Peak Group). In the current study, the prevalence rates of the group of children closest to at-risk OCS (i.e., score of 5 or above) at Pre-K was the Pre-K Peak group

Table 4 Covariate Predictors of Latent Classes (n = 1,147)

Reference Class	Comparison Class	Predictor	Unstandardized Estimate (log odds)	SE	*p* value	Odds Ratio
No Peak	Pre-K Peak	Gender	-0.11	0.35	.74	0.89
		Attention problems	0.30	0.08	<.001	1.35
		Depression/anxiety problems	0.69	0.10	<.001	1.99
	HS Peak	Gender	0.51	0.34	0.14	1.66
		Attention problems	0.22	0.08	0.01	1.25
		Depression/anxiety problems	0.23	0.12	0.05	1.86
Pre-K Peak	HS Peak	Gender	0.62	0.44	0.16	1.86
		Attention problems	-.09	0.10	0.38	0.91
		Depression/anxiety problems	-.45	0.12	<.001	0.64

Table 5 Descriptive Statistics by Group for OCS-8, Attention problems, and anxiety/depression symptoms

No Peak Group (n=984)				
	Mean	SD	N present	Percent Missing
OCS-8 Pre-K	0.78	0.96	908	7.7%
OCS-8 K	0.77	0.98	890	9.6%
OCS-8 1st	0.92	1.11	867	11.9%
OCS-8 3rd	1.06	1.24	862	12.4%
OCS-8 4th	0.98	1.19	862	12.4%
OCS-8 5th	1.05	1.20	860	12.6%
OCS-8 6th	0.93	1.19	858	12.8%
OCS-8 HS	0.74	0.89	822	16.5%
Attention Problems Pre-K	2.39	2.12	905	8.0%
Anxiety/Depression Symptoms Pre-K	1.22	1.43	908	7.7%
Pre-K Peak Group (n=105)				
	Mean	SD	N present	Percent Missing
OCS-8 Pre-K	4.14	1.88	92	12.4%
OCS-8 K	3.56	1.75	94	10.5%
OCS-8 1st	3.50	1.95	93	11.4%
OCS-8 3rd	3.25	2.23	97	7.6%
OCS-8 4th	2.79	2.03	92	12.4%
OCS-8 5th	2.83	2.39	94	10.5%
OCS-8 6th	2.24	1.87	97	7.6%
OCS-8 HS	2.14	1.47	90	14.3%
Attention Problems Pre-K	5.59	3.04	92	12.4%
Anxiety/Depression Symptoms Pre-K	4.43	2.89	92	12.4%
HS Peak Group (n=58)				
	Mean	SD	N present	Percent Missing
OCS-8 Pre-K	1.44	1.13	57	1.7%
OCS-8 K	1.31	1.22	58	0.0%
OCS-8 1st	1.95	1.79	58	0.0%
OCS-8 3rd	2.38	1.90	56	3.4%
OCS-8 4th	2.18	1.87	56	3.4%
OCS-8 5th	2.80	1.72	55	5.2%
OCS-8 6th	2.55	2.00	56	3.4%
OCS-8 HS	4.77	1.22	53	8.6%
Attention Problems Pre-K	3.54	2.04	57	1.7%
Anxiety/Depression Symptoms Pre-K	1.98	1.62	57	1.7%

and constituted approximately 9% of our sample (*M* score at Pre-K = 4.07; M teen score = 2.10). At the high school timepoint, those children within the High School Peak group exhibited the highest scores and constituted approximately 5% of our sample (*M* score at Pre-K = 1.34; *M* score at age 15 = 4.56). While estimates of the prevalence of elevated OCS are inconsistent due to differences in study methodology, OCS definition, and measured time-points (Saad et al. 2017), results herein are within the 2% (Bryńska and Wolańczyk 2005) to 19% (Alvarenga et al. 2015) found in previous studies, with the majority reporting roughly 10% (Canals et al. 2012; Fullana et al. 2010). In addition, when compared to the No Peak group, inclusion in the Pre-K Peak and High School Peak groups was predicted by greater attention problems and anxious/depressed scores (approaching significance ($p = 0.05$) when referring to the comparison between the No Peak and High School Peak groups), and the latter was also more predictive of inclusion in the Pre-K Peak group when compared to the High School Peak group. These findings contribute to literature characterizing the trajectory of OCS and by extension OCD.

Findings from this study suggests a pattern of at least three different pediatric OCS trajectories. These differences in developmental sequelae may have clinical implications for identifying and intervening on childhood OCS. In our study, two patterns of development were associated with a low probability of developing high OCS later in adolescence. The No Peak group, which consisted of children with

Table 6 Frequencies by Group for Gender and OCS-8 diagnostic status (above or below diagnostic criteria)

No Peak Group (n=984)				
	Male	Female	N present	Percent Missing
Gender	504	480	984	0.0%
	Above Criteria	Below Criteria	N present	Percent Missing
OCS-8 Pre-K	1	907	908	7.7%
OCS-8 K	2	888	890	9.6%
OCS-8 1st	7	860	867	11.9%
OCS-8 3rd	17	845	862	12.4%
OCS-8 4th	12	850	862	12.4%
OCS-8 5th	14	846	860	12.6%
OCS-8 6th	14	844	858	12.8%
OCS-8 HS	0	822	822	16.5%
Pre-K Peak Group (n=105)				
	Male	Female	N present	Percent Missing
Gender	55	50	105	0.0%
	Above Criteria	Below Criteria	N present	Percent Missing
OCS-8 Pre-K	28	64	92	12.4%
OCS-8 K	26	68	94	10.5%
OCS-8 1st	27	66	93	11.4%
OCS-8 3rd	17	80	97	7.6%
OCS-8 4th	19	73	92	12.4%
OCS-8 5th	20	74	94	10.5%
OCS-8 6th	12	85	97	7.6%
OCS-8 HS	5	85	90	14.3%
HS Peak Group (n=58)				
	Male	Female	N present	Percent Missing
Gender	24	34	58	0.0%
	Above Criteria	Below Criteria	N present	Percent Missing
OCS-8 Pre-K	0	57	58	0.0%
OCS-8 K	1	57	58	0.0%
OCS-8 1st	4	54	58	0.0%
OCS-8 3rd	9	47	56	3.4%
OCS-8 4th	4	52	56	3.4%
OCS-8 5th	10	45	55	5.2%
OCS-8 6th	11	45	56	3.4%
OCS-8 HS	27	26	53	8.6%

consistently low OCS, was the largest. This was not surprising given that many children never experience OCS beyond that which may occur as part of normal development (i.e., normative repetitive or ritualistic behaviors; Chacon et al. 2018). The second largest group was the Pre-K Peak group. Interestingly, while children in this group initially appeared akin to children considered to have early onset OCD, our study found a very low likelihood that they would later develop levels of elevated OCS during mid-adolescence. These findings are consistent with previous evidence that, for many children who exhibit OCS, severity does not remain stable over time, and most are unlikely to later develop levels high enough to constitute an OCD diagnosis (Black and Gaffney 2008; Fullana et al. 2009). Symptom remittance could possibly be explained by factors not measured in the current study, such as receiving mental health services or a lack of ancillary OCD risk factors (e.g., parent with OCD, maladaptive parenting practices; Suñol et al. 2018). It is also possible that within the Pre-K Peak group, co-occurring psychopathology symptoms worsened over time, thus making OCS less salient and/or prominent and impacting maternal report of OCS. In contrast, the third group – the High School Peak group – exhibited a very high likelihood of nearing the at-risk cut-off score likely to predict OCD in adolescence. Several studies have found that OCS and OCD onset is most likely to occur during late adolescence (16–18; Stavropoulos et al. 2017). This time is considered a 'critical time' for the development of OCD, as associated developmental changes

and transitions (e.g., school, family) may be potential risk factors for triggering or exacerbating OCS (Stavropoulos et al. 2017). However, the increase in OCS seen herein suggests that this intensification in symptoms may be evident even earlier than late adolescence, and that children who present with initially low but gradually increasing OCS may benefit from early intervention services. Interestingly, item-level analyses at the group level indicated differences between both the Pre-K Peak group and the High School Peak group as compared to the full sample and the No Peak group. It is possible that frequently endorsed items among the full sample and No Peak groups (e.g., 'Worries," "Feels has to be perfect") may reflect a higher frequency and normality of these behaviors in the general population. In contrast, items endorsed at a higher frequency in the Pre-K Peak group (e.g., Can't get mind off certain thoughts" and "Fears might think or do something bad") and the High School Peak group (e.g., "Repeats certain acts over and over") may represent behaviors more specific to OCS and which are less common in the general population.

These results summarized above also lead to additional questions related to the clinical applicability of measuring OCS over time. Early childhood is characterized, generally speaking, by increased ritualistic/repetitive behavior. As such, the clinical meaningfulness of the elevations in OCS demonstrated by the Pre-K Peak group may be of somewhat questionable utility – caveats noted in the preceding paragraph not withstanding; however, the course of OCS over childhood and, in particular, the elevation in symptoms noted within the HS Peak group during adolescence may be more meaningful due to a peak in the onset of pre-adolescent cases frequently noted during this time period (Freeman et al. 2014). It is this potentiality that leads to perhaps the most intriguing downstream question pertaining to the clinical applicability of these findings. Can the classes of youths identified herein be reliably identified, during early to middle-childhood as being likely to develop symptoms characteristic of clinical OCD during adolescence? Such early identification could allow for early treatment, and prevention for these children. Likewise, determining the minimal number of time points that may be necessary in order to correctly classify a child within either of these groups may enhance the efficiency of prevention and early intervention efforts. This study's finding in relation to predictors of developmental trajectories of OCS may help to expedite this process.

The current study also examined several predictors of the discussed trajectories. The finding that anxious/depressed and attention problems scores predicted group membership for both the Pre-K Peak and High School Peak groups is in line with previous evidence that co-occurring psychopathology is linked to worsened outcomes among children with OCD (Storch et al. 2008, 2010), and that OCS are associated with pathological features more generally (Alvarenga et al. 2016; Canals et al. 2012). In addition, an association between the presence of OCS (as measured by the CBCL-OCS-8 scale) and anxiety and depression disorders was also found by Saad and colleagues (2017), who noted that "at-risk" children (i.e., those with OCS-8 scores of five or higher) exhibited similar patterns of functional impairment and psychiatric comorbidity with those seen in clinical pediatric OCD (Saad et al. 2017). The finding that inclusion in the Pre-K Peak group was predicted by greater anxious/depressed scores when compared the High School Peak group was somewhat surprising, as there is evidence to suggest that anxiety may be a prodromal risk factor of OCD development (Juckel et al. 2014). However, as mentioned above, it is possible that for a sub-set of children, co-occurring depression and anxiety symptoms may become more distressing and/or impairing than OCS over time. Additionally, research has shown that among children with OCS, children of parents with OCD are more likely to later develop clinically high levels of OCS and other internalizing disorders (Black and Gaffney 2008). Thus, while the current study did not assess for parental OCD diagnosis, genetic factors (i.e., having a parent with OCD) may predict inclusion in the High School Peak group. Finally, the current study did not find gender to be a significant predictor of group membership. Although some research has found gender differences related to age of OCS onset and the presence of comorbidities (Alvarenga et al. 2016), our results are in line with others from community based (i.e., non-clinical) samples that have found no associations between gender and OCS (Stavropoulos et al. 2017). However, our study exclusively examined class membership based on symptoms at present at Pre-K, and not later timepoints. While our study found significant associations between OCS severity and co-occurring psychopathology at Pre-K, this may vary across time-points. As such, more longitudinal research is needed to examine how these, and other risk factors may impact OCS over time.

Strengths and Limitations

The current study examined OCS over childhood using a longitudinal design, making it possible to cover a large developmental range. A notable strength of the study is the longitudinal growth framework. Investigating latent growth trajectories rather than cross-sectional latent groups allowed a more nuanced picture of how OCS might change over time in subgroups of children, rather than simply what differences exist between children at a singular point in time. This study was limited, however, in that it used only maternal parent-report of OCS, and also in that an OCD diagnosis was not measured. Future research may benefit from multi-informant

(e.g., child, peer) reports, as well as validated, diagnostic measures of OCD. Another limitation was that the NICHD SECCYD sample was primarily Caucasian and not nationally representative; however, previous work has noted the sample illustrates economical, ethnic, and geographical diversity (National Institute of Child Health and Human Development Early Child Care Research Network and Duncan 2003; Vandell et al. 2010).

Conclusions

This study provides new evidence for the existence of different developmental trajectories for youth with OCS and provided further evidence that the course of OCS may be influenced by co-occurring psychopathology. These results may have important clinical implications. Given the debilitating nature of OCD symptoms, longitudinal studies are needed in order to further characterize trajectories of OCS and OCD, and such future research is necessary to better differentiate those children who are or are not at risk for the development of OCD-related symptoms. Further identification of risk factors and course of OCS would help inform the development of possible prophylactic interventions for these youths. Research of this nature may significantly impact the long-term outcomes of youths (and their families) exhibiting OCS by helping inform early identification and intervention of at-risk children.

Compliance with Ethical Standards

Conflict of Interest The authors declare they have no conflicts of interest.

Ethical Approval All procedures were performed in accordance with the standards of the national research committee and the 1964 Helsinki declaration and its later amendments.

Informed Consent Informed consent was obtained from all adult participants and assent was obtained from children when applicable.

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