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Disruptive Mood Dysregulation Disorder at Age Six and Clinical and Functional Outcomes Three Years Later

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Abstract

Background—Little is known about the predictive validity of disruptive mood dysregulation disorder (DMDD). This longitudinal, community-based study examined associations of DMDD at age six with psychiatric disorders, functional impairment, peer functioning, and service use at age nine.

Methods—473 children were assessed at ages six and nine. Child psychopathology and functional impairment were assessed at age six with the Preschool Age Psychiatric Assessment (PAPA) with parents and at age nine with the Kiddie-Schedule of Affective Disorders and Schizophrenia (K-SADS) with parents and children. At age nine, mothers, fathers and youth completed the Child Depression Inventory (CDI) and the Screen for Anxiety Related Disorders (SCARED), and teachers and K-SADS interviewers completed measures of peer functioning. Significant demographic covariates were included in all models.

Results—DMDD at age six predicted a current diagnosis of DMDD at age nine. DMDD at age six also predicted current and lifetime depressive disorder and attention-deficit/hyperactivity disorder (ADHD) at age nine, after controlling for all age six psychiatric disorders. In addition, DMDD predicted depressive, ADHD, and disruptive behavior disorder (DBD) symptoms on the

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K-SADS, and maternal and paternal reports of depressive symptoms on the CDI, after controlling for the corresponding symptom scale at age six. Lastly, DMDD at age six predicted greater functional impairment, peer problems, and educational support service use at age nine, after controlling for all psychiatric disorders at age six.

Conclusions—Children with DMDD are at high risk for impaired functioning across childhood, and this risk is not accounted for by comorbid conditions.

Keywords

Disruptive mood dysregulation disorder; DMDD; Irritability; Longitudinal

Introduction

Disruptive mood dysregulation disorder (DMDD) was added to the DSM-5 as a new diagnosis for children and adolescents (APA, 2013). DMDD is characterized by severe temper tantrums and persistently angry/irritable mood that are present for at least 12 months and across contexts. DMDD cannot be diagnosed in children before age six and must be observed by age 10. The disorder was added to DSM-5 given accumulating evidence supporting the clinical distinction between nonepisodic and episodic irritability (Leibenluft, 2011). Yet, much of this research was based on severe mood dysregulation (SMD), a condition characterized by severe and chronic irritability but which also required the presence of hyperarousal symptoms, which overlap with symptoms of mania and attention-deficit/hyperactivity disorder (ADHD) (Leibenluft et al., 2003). SMD was originally conceptualized as a possible phenotype for bipolar disorder, but this has not been supported (Leibenluft et al., 2011). Not surprisingly, the inclusion of DMDD in DSM-5 has been controversial given that little empirical data exist on the disorder. Moreover, there has been debate as to whether the disorder affords clinical utility over and above comorbid disorders, particularly co-occurring depression and oppositional defiant disorder (ODD) (Copeland et al., 2013).

Emerging research shows that although DMDD appears to be relatively common in clinical settings (26.0–30.5%) (Axelson et al., 2012; Margulies et al., 2012), it is fairly uncommon in community samples with three-month prevalence rates ranging from 0.8–3.3% in 2–17 year-old children from the Great Smoky Mountain Study (Copeland et al., 2013) and 8.2% in 6 year-old children from the Stony Brook Temperament Study (Dougherty et al., 2014). Both community-based studies demonstrate that DMDD frequently co-occurs with another disorder; rates of co-occurrence ranged from 60.5–92.0%, and the highest rates of co-occurrence were with depression and ODD (Copeland et al., 2013; Dougherty et al., 2014). DMDD was also concurrently associated with elevated rates of psychosocial impairment, difficult child temperament, family and peer problems, school suspension, service use, and poverty (Copeland et al., 2013; Dougherty et al., 2014). Dougherty et al. (2014) also provided the first data on early childhood predictors of DMDD, which included age three diagnoses of ADHD and ODD, difficult child temperament, and environments characterized by problematic parenting and parental psychopathology.

Community-based longitudinal studies of DMDD are sparse. A few studies have examined the long-term adult psychiatric outcomes of SMD and chronic irritability (Brotman et al., 2006; Leibenluft et al., 2006; Stringaris et al., 2009). These findings generally support that SMD and/or chronic irritability in youth ages 10–13 years increase risk for depression, anxiety, and functional impairment in adulthood. Using the same sample reported in Brotman et al. (2006), Copeland and colleagues (2014) applied the DSM-5 DMDD criteria to children ages 10–16 years and examined adult outcomes. Relative to non-case and psychiatric comparison subjects, youth with DMDD were at higher risk for meeting criteria for adult depressive and anxiety disorders, and having poorer health, legal, financial, educational, and social functioning than non-case comparison subjects. Rather strikingly, the high rate of comorbidity in youth with DMDD persisted into adulthood, with rates of comorbidity five and seven times higher than non-case and psychiatric comparison subjects, respectively. These initial findings provide compelling evidence that youth with DMDD have a poor long-term course. However, a number of issues require further exploration.

First, no study to date has examined DMDD, or even SMD, from early childhood to pre-adolescence. This is particularly important as DMDD can be diagnosed in children as young as age six years, and the persistent irritability and angry affect that characterize DMDD likely contribute to significant impairment in children's expanding social and academic success, two fundamental domains of childhood. Moreover, DMDD may play a role in the development and course of other forms of child and adolescent psychopathology. Hence, longitudinal studies beginning in early childhood are needed to illuminate these processes.

Second, given the high rates of comorbidity observed for DMDD, a major critique of the new diagnosis is that DMDD may merely be a category for diagnostically complex children with multiple comorbid conditions. Thus, it is unknown whether a diagnosis of DMDD affords any clinical utility in predicting the longitudinal course of psychopathology over and above comorbid disorders. Nevertheless, previous findings demonstrate that DMDD is associated with significant concurrent functional impairment even after accounting for comorbid conditions, suggesting that DMDD may contribute additional prognostic information over and above other diagnoses (Dougherty et al., 2014).

The present study investigated DMDD in six-year old children using data from the Stony Brook Temperament Study (Olino et al., 2010), a large community-based study of young children followed from age three to age nine. Previously, we reported on the concurrent correlates and early childhood predictors of DMDD at age six (see Dougherty et al., 2014). In this report, we extended these findings and tested the longitudinal associations between DMDD at age six and clinical and functional outcomes at age nine. We examined whether DMDD assessed at age six predicts psychiatric disorders and symptoms, functional impairment, peer relations, and psychiatric and educational service use at age nine, both in models adjusting for demographic covariates only and in models adjusting for demographic covariates and all psychiatric disorders at age six. Based on the limited longitudinal research on DMDD and the broader literature on SMD and chronic irritability, we hypothesized that DMDD at age six would predict DMDD, depressive and anxiety disorders, greater functional impairment, peer problems, and psychiatric and educational service use at age nine, even after accounting for demographic covariates and psychiatric disorders at age six.

In addition, we hypothesized that DMDD would predict childhood externalizing disorders, given the frequent co-occurrence between DMDD and externalizing psychopathology (Copeland et al., 2013; Dougherty et al., 2014). Lastly, to provide a highly stringent test of the specificity and clinical utility of DMDD, we examined whether associations between age six DMDD and age nine outcomes persisted after controlling for demographic covariates, all psychiatric disorders at age six, and concurrent diagnoses at age nine.

Method

Participants

The Stony Brook Temperament Study is a longitudinal study investigating the role of early temperament on the development of psychiatric disorders (Olino et al., 2010). We recruited families with a three-year-old child living within 20 contiguous miles of Stony Brook University. Potential participants were identified via a commercial mailing list; eligible families had a child between 3–4 years of age with no significant medical conditions or developmental disabilities, and at least one English-speaking biological parent. Of the 815 families who were identified as potentially eligible, 559 entered the study and 541 (96.8%) provided child diagnostic information (see Bufferd et al., 2011). There were no significant differences between families who did and did not participate on demographic variables. The study was approved by the human subjects review committee. Informed consent was obtained from parents, and child assent was obtained at age nine.

Participants were assessed at ages three, six and nine years. At the age six assessment, an additional 50 minority/non-White participants were recruited to increase the diversity of the sample. Findings on the age three predictors of DMDD assessed at age six have been reported previously (Dougherty et al., 2014). The current report focuses on the age nine outcomes of DMDD assessed at age six. At age six, 516 parents were interviewed regarding their six-year-old child ($M=6.1$, $SD=0.4$ years). Of the 516 families, 473 (91.7%) participated in the age nine wave ($M=9.2$ years, $SD=0.4$): 470 parents and children completed a diagnostic clinical interview; 467 families completed questionnaires about the child's depressive and anxiety symptoms; and 300 teachers completed peer functioning measures. Families who participated at ages six and nine did not differ from those who participated at age six but not at age nine on any of the variables in this paper. See Table 1 for sample characteristics and Supplementary Material for attrition analyses.

Age Six Assessment

Disruptive Mood Dysregulation Disorder—Primary caregivers were interviewed regarding their child's psychopathology using the Preschool Age Psychiatric Assessment (PAPA; Egger et al., 1999). A three-month primary period was used to enhance recall, but symptom onset dates were obtained for all criteria. Although the PAPA was not designed to assess DMDD, consistent with Copeland et al. (2013) it contained information needed to rate DSM-5 DMDD criteria. As described elsewhere (Dougherty et al., 2014), Criterion A and B (recurrent/severe temper outbursts) were defined using items from the ODD section assessing temper tantrums/outbursts occurring at least three times per week (criterion C). Chronically irritable/angry mood between temper outbursts (criterion D) was coded using

items from the depression section on whether the child was prone to feelings of anger, irritability, annoyance or low frustration tolerance more days than not (45 times in the past three months). Based on age of onset questions, we determined whether frequent temper outbursts and chronically irritable/angry mood had been present for 12 months or more (criterion E). Based on setting information, temper outbursts and chronically irritable/angry mood had to occur in at least two settings (criterion F). Children were assessed at age six; thus age-of-onset criteria were met (criteria G and H). Criteria I and J involve exclusions for a history of mania, bipolar disorder, and intermittent explosive disorder. Based on the K-SADS (described below), no child met criteria for lifetime bipolar spectrum disorders or for lifetime mania or hypomania. Using these criteria, 36 (7.6%) six-year old children met criteria for DMDD.

Child Psychiatric Disorders—As described elsewhere (Bufferd et al., 2012), DSM-IV-TR disorders in the previous three months were assessed with the PAPA at age six and included: any depressive disorder (major depressive disorder [MDD] using modified criteria for preschoolers [Luby et al., 2003], dysthymic disorder, or depression not otherwise specified); any anxiety disorder (specific phobia, separation anxiety disorder, social phobia, generalized anxiety disorder [GAD], agoraphobia, selective mutism); ADHD; and ODD. Interrater reliability for all diagnoses was good ($\kappa=.64-.89$).

Age Nine Assessment

Child Psychiatric Disorders—470 parents and their children were interviewed using the Kiddie-Schedule for Affective Disorders and Schizophrenia—Present and Lifetime (K-SADS-PL; Axelson et al., 2009). Doctoral students in clinical psychology and a master's-level clinician administered the K-SADS first to the parent and then to the child. Summary ratings for each symptom were derived based on the combination of parent and child reports. Interviewers were unaware of the age six data. All cases with a K-SADS diagnosis were reviewed in a case conference co-led by a child psychiatrist and a clinical psychologist. Current and lifetime disorder (MDD, dysthymic disorder, depressive disorder-NOS); any anxiety disorder (specific phobia, social phobia, separation anxiety, GAD, panic, agoraphobia, obsessive compulsive, post-traumatic stress, acute stress, anxiety disorder-NOS); any ADHD (ADHD-inattentive, hyperactivity or combined type, ADHD-NOS); and any DBD (ODD, conduct disorder, DBD-NOS). Current symptoms of any depression ($\alpha=.84$), anxiety ($\alpha=.85$), ADHD ($\alpha=.86$), and DBD ($\alpha=.73$) were rated on a 3-point scale (0=not present; 1=subthreshold; 2=threshold) and were summed to create dimensional scores. A second rater derived ratings from 74 videotaped interviews to assess inter-rater reliability. Inter-rater reliability for lifetime diagnoses ($\kappa=.58-.85$) and dimensional scores ($\text{ICC}=.77-.97$) were acceptable.

The DMDD diagnosis was not proposed at the time of the K-SADS interviews; however, Axelson et al. (2012) previously operationalized a current DMDD diagnosis using items from the K-SADS (see Supplementary Material).

Child Depressive and Anxiety Symptoms—At age nine, 467 mothers ($\alpha=.79$, 17 items), 405 fathers ($\alpha=.76$, 17 items), and 463 children ($\alpha=.74$, 27 items) completed the Child

Depression Inventory (CDI; Kovacs, 1992), and 467 mothers ($\alpha=.90$), 404 fathers ($\alpha=.88$), and 463 children ($\alpha=.73$) completed the 41-item Screen for Child Anxiety Related Disorders (SCARED; Birmaher et al., 1999) to assess children's current depressive and anxiety symptoms, respectively. Correlations between maternal and paternal-reported CDI and SCARED scores were .44 and .58, respectively. Correlations ranged from .09 to .22 between either maternal or paternal and youth reports.

Functional Impairment—The K-SADS interviewer completed the Children's Global Assessment Scale (CGAS) following the administration of the K-SADS. The CGAS is a global measure of children's level of functioning (Shaffer et al., 1983). Scores range from 0–100, where 0 indicates the worst functioning and 100 indicates superior functioning. The interrater reliability (ICC) for the CGAS was .56.

Service Use—The K-SADS interviewer assessed whether the child ever received psychotherapy or was prescribed psychotropic medication for a mental health problem. In addition, the interviewer assessed whether the child currently receives educational support services, which included emotional or learning support in the classroom, a full or part-time classroom aid, special education accommodations, reading room resources, and/or tutoring.

Peer Functioning—The K-SADS interviewer rated the child's peer relationships at school on a 4-point scale from 1 (excellent) to 4 (poor) and how often the child is victimized or bullied by peers on a 4-point scale from 1 (never) to 4 (very often). In addition, 300 teachers reported on children's peer aggression using two subscales from the Children's Social Behavior Scale-Teacher Version (CSBS-T; Crick, 1996). The CSBS-relational aggression scale (5 items, $\alpha=.89$) assesses whether the child excludes or socially manipulates peers by using his/her relationship with the victim as the vehicle for harm (e.g., "When mad at a peer, this child ignores the peer"). The CSBS-overt aggression scale (4 items, $\alpha=.86$) assesses whether the child attempts or threatens to harm another child's physical well-being (e.g., "This child initiates physical fights with peers"). Each item was rated on a 5-point scale ranging from 1 (never true) to 5 (almost always true). 299 teachers also completed the Excluded by Peers scale (7 items, $\alpha=.94$) from the Child Behavior Scale (CBS; Ladd & Profilet, 1996), which assesses whether the child is ignored, avoided, or excluded by peers. Each item was rated on a 3-point scale from 1 (doesn't apply) to 3 (certainly applies).

Data Analyses

Binary logistic regression analyses were conducted to examine longitudinal associations between DMDD at age six and psychiatric diagnoses at age nine (DMDD, any depressive disorder, any anxiety disorder, DBD, and ADHD). Odds ratios (OR) provide the effect size estimate. Separate models were run for each of the current and lifetime diagnoses. DMDD diagnosis was entered as the independent variable. Models included child's current age, gender, and parental education as covariates if they were significantly associated with the outcome variable.² Linear regression analyses were used to examine longitudinal associations between DMDD at age six and symptoms scales at age nine. We report models

²Results were similar when marital status at age 6 was included as an additional covariate.

adjusted for significant demographic covariates only and models adjusted for significant demographic covariates and all psychiatric disorders at age six (any depressive disorder, any anxiety disorder, ODD, and ADHD). Finally, as the most stringent and conservative test of the predictive validity of a DMDD diagnosis at age six on outcomes at age nine, all models were rerun adjusting for significant demographic covariates, all age six psychiatric disorders, and age nine comorbid psychiatric disorders to account for prior diagnoses and comorbid diagnoses on age nine outcomes.³ When the outcome was a current age nine diagnosis or symptom scale, we controlled for current age nine comorbid diagnoses, and when the outcome was a lifetime diagnosis assessed at age nine, we controlled for comorbid lifetime diagnoses.

Linear regression analyses were used to examine longitudinal associations between DMDD at age six and functional impairment and peer functioning at age nine. Logistic regression analyses were used to examine longitudinal associations between DMDD and educational support services, outpatient treatment, and medication use. We report models adjusted for significant demographic covariates only and models adjusted for significant demographic covariates and all age six psychiatric disorders. Lastly, all models were rerun adjusting for significant demographic covariates, all age six psychiatric disorders, and all age nine current psychiatric disorders on children's functional impairment, peer functioning, and service use at age nine.

Results

Child gender and age and parental education were examined as covariates. Boys were more likely to meet criteria for current and lifetime ADHD and DBD, receive educational services, and have greater maternal, paternal, and youth-reported CDI scores, higher teacher-rated overt aggression, and lower CGAS scores at age nine than girls; girls had greater maternal-rated SCARED scores than boys. If neither parent had a four-year college degree, children were more likely to meet criteria for current and lifetime DBD and receive educational services, and have greater maternal-rated CDI and SCARED scores, youth-reported SCARED scores, poorer peer relations at school, and lower CGAS scores at age nine than children with at least one parent with a four-year college degree. No significant associations were observed for child current age.

DMDD Stability

At age six, 36 (7.6%) met criteria for DMDD using the PAPA. At age nine, 6 (1.3%) met criteria for DMDD using the K-SADS. Five children (13.9%) who had a DMDD diagnosis at age six continued to meet criteria for DMDD at age nine; thus, 83.3% of children who met criteria for DMDD at age nine also met criteria for DMDD at age six. DMDD at age six significantly predicted DMDD at age nine (OR=69.84, 95% CI=7.91–616.42, $p<.001$); controlling for significant demographic covariates and all psychiatric disorders at age six, there was a marginally significant association between DMDD at age six and DMDD at age nine (OR=14.97, 95% CI=1.00–218.22, $p=.05$).

³See Supplementary Material for rates of psychiatric disorders at ages six and nine in children with and without DMDD at age six.

DMDD at Age Six as Predictor of Psychiatric Disorders at Age Nine

Table 2 shows associations between DMDD at age six and current and lifetime disorders at age nine. In models adjusted for demographic covariates, DMDD at age six significantly predicted current and lifetime ADHD and DBD at age nine. After controlling for demographic covariates and all age six psychiatric disorders, DMDD at age six significantly predicted current and lifetime depressive disorder and current and lifetime ADHD at age nine. After controlling for demographic covariates, all age six psychiatric disorders, and all age nine comorbid psychiatric disorders, DMDD at age six continued to predict current (OR=21.81, 95% CI=1.36–349.30, $p=.03$) and lifetime (OR=20.40, 95% CI=2.08–200.49, $p=.01$) depressive disorder, and there were trends for current (OR=2.87, 95% CI=.95–8.65, $p=.06$) and lifetime (OR=2.78, 95% CI=.95–8.10, $p=.06$) ADHD.

DMDD at Age Six as Predictor of Psychiatric Symptoms at Age Nine

Table 3 shows associations between DMDD at age six and children's current psychiatric symptoms at age nine. In models adjusted for demographic covariates only and for models adjusted for demographic covariates and all age six psychiatric disorders, DMDD at age six predicted K-SADS depressive, ADHD, and DBD symptom scales and maternal and paternal-reported CDI scores at age nine. In models adjusted for demographic covariates, all age six psychiatric disorders, and all age nine current comorbid disorders, DMDD at age six continued to predict K-SADS depressive ($B=.73$, $SE=.33$, $\beta=.12$, $p=.03$), ADHD ($B=.78$, $SE=.32$, $\beta=.11$, $p=.02$), and DBD symptoms ($B=1.56$, $SE=.48$, $\beta=.16$, $p=.001$), and maternal-reported CDI scores ($B=3.43$, $SE=.85$, $\beta=.19$, $p<.001$) at age nine.

DMDD at Age Six as Predictor of Functional Impairment, Service Use, and Peer Functioning at Age Nine

DMDD at age six significantly predicted lower CGAS scores at age nine both in models adjusted for demographic covariates only and models adjusted for demographic covariates and all psychiatric disorders at age six (Table 4). In addition, in models controlling for demographic covariates, children with DMDD at age six were more likely to receive educational support services, outpatient treatment and psychotropic medication at age nine. After controlling for demographic covariates and all age six psychiatric disorders, DMDD at age six remained a significant predictor of educational services at age nine. DMDD at age six also predicted interviewer-rated poorer peer relations at school and more frequent peer victimization, and greater teacher-reported greater relational aggression and peer exclusion both in models adjusted for demographic covariates only and in models adjusted for demographic covariates and all psychiatric disorders at age six. Lastly, we reran models adjusting for demographic covariates, all age six psychiatric disorders, and all age nine current psychiatric disorders, DMDD at age six continued to predict lower CGAS scores ($B=-6.56$, $SE=1.81$, $\beta=-.16$, $p<.001$), poorer interviewer-rated peer relations at school ($B=.40$, $SE=.12$, $\beta=.15$, $p=.002$) and greater peer victimization ($B=.30$, $SE=.11$, $\beta=.14$, $p=.007$), and greater teacher-reported relational aggression ($B=2.21$, $SE=.87$, $\beta=.16$, $p=.01$) and peer exclusion ($B=1.66$, $SE=.52$, $\beta=.18$, $p<.01$); there was also a trend level association between DMDD and use of educational services (OR=2.40, 95% CI=.96–5.97, $p=.06$).

Discussion

Using data from a large, community-based sample, we examined the longitudinal associations between the DSM-5 diagnosis of DMDD assessed at age six and clinical and functional outcomes at age nine. We found that DMDD at age six predicted current DMDD at age nine and predicted any current and lifetime depressive disorder and ADHD, after controlling for demographic covariates and all age six psychiatric disorders. In addition, DMDD at age six predicted depressive, ADHD and DBD symptoms on the K-SADS, and maternal and paternal reports of depressive symptoms on the CDI, after controlling for demographic covariates and all age six psychiatric disorders. DMDD at age six also predicted greater functional impairment, poorer peer relations, and educational support service use, even after accounting for demographic covariates and psychiatric disorders at age six. Lastly, as a particularly stringent test of the predictive validity of DMDD, we examined the specificity of the longitudinal associations by controlling for age nine psychiatric disorders, in addition to demographic covariates and all age six psychiatric disorders. In these models, DMDD at age six continued to predict any depressive disorder; depressive, ADHD, and DBD symptoms on the K-SADS; maternal reports of depressive symptoms on the CDI; greater functional impairment; and poorer peer functioning.

The course and stability of DMDD across childhood is largely unknown. We found that DMDD at age six significantly predicted DMDD at age nine; however, the rates decreased from 7.6% at age six to 1.3% at age nine. Five children (13.9%) who had a DMDD diagnosis at age six continued to meet criteria for DMDD at age nine; thus, 83.3% of children who met criteria for DMDD at age nine also met criteria for DMDD at age six. It is unclear whether this decline in DMDD at age nine was due to methodological differences in the clinical assessments (PAPA vs. K-SADS) or to a substantive decrease in DMDD across this developmental period. Nevertheless, having the diagnosis at age six increased a child's risk for persistent DMDD. Similarly, cross-sectional data on the rates of DMDD across childhood (Copeland et al., 2013) and longitudinal data on normative irritability across childhood (Wiggins et al., 2014) demonstrate similar decreases in irritability after early childhood. In the only other study examining the stability of SMD and DMDD, Deveney and colleagues (2015) reported that in a clinical sample, 48.7% and 39.5% of youth (ages 7–17) with SMD continued to meet criteria for SMD at two- and four-year follow-ups, respectively. Of those children with DMDD at baseline, 51.3% and 36.4% continued to meet criteria for DMDD at two and four years, respectively. Consistent with our findings, Deveney and colleagues demonstrate that the majority of children with SMD or DMDD no longer meet criteria for the diagnosis four years later, and that children with DMDD or SMD are a high risk for continued impairment and other forms of psychopathology over time as discussed below.

Our findings that DMDD at age six uniquely predicted any depressive disorder and interviewer-rated and maternal-rated depressive symptoms at age nine are consistent with Copeland et al.'s (2014) longitudinal study that found that children with DMDD were at increased risk for developing depression in adulthood compared to non-case and psychiatric comparison subjects, and the broader literature linking SMD and chronic irritability to depression in adults (Brotman et al., 2006; Leibenluft et al., 2006; Stringaris et al., 2009).

These results are also consistent with evidence for shared genetic influences between irritability and depression in adolescents (Stringaris et al., 2012). Nevertheless, it is important to acknowledge that even though the odds ratios are significant, the estimates are based on a small number of children with depressive disorders. Likewise, the findings for depressive disorders were only significant in models adjusting for earlier and/or concurrent psychopathology. Thus, these findings require replication. Interestingly, in contrast to findings reported by Copeland et al. (2014), we did not find evidence for longitudinal associations between DMDD and any anxiety disorder or symptoms at age nine, suggesting that these associations may not emerge until later in development.

DMDD at age six also predicted current and lifetime ADHD, and ADHD and DBD symptoms in models controlling for all psychiatric disorders at age six. These associations persisted even after further controlling for concurrent comorbid disorders at age nine, but with trend level associations for current and lifetime ADHD diagnoses. Consistent with our results, Leibenluft et al. (2006) found that chronic irritability in early adolescence predicted ADHD in mid-adolescence after accounting for earlier ADHD. Taken together, the association between DMDD and later ADHD is consistent with current conceptualizations of ADHD as a disorder characterized by attentional, behavioral, *and* emotional dysregulation (Martel, 2009). Furthermore, given that DMDD predicted later ADHD after accounting for earlier ADHD, these findings suggest that the emotional dysregulation/irritability in children with DMDD may influence the developmental trajectory of ADHD. Thus, investigating how DMDD influences the development, phenomenology, course, and treatment of ADHD warrants further attention. Also consistent with previous findings that irritability is concurrently (Stringaris et al., 2009) and longitudinally (Leibenluft et al., 2006) associated with both emotional and behavioral disorders in adolescence, we found that DMDD predicted both externalizing (ADHD and DBD) and depressive symptoms in all adjusted models. These findings suggest that DMDD is a shared risk factor for both internalizing and externalizing symptoms in childhood, perhaps increasing risk for each as well as their co-occurrence.

DMDD at age six predicted greater functional impairment at age nine, even after controlling for all psychiatric disorders at age six and concurrent psychiatric disorders at age nine, demonstrating that the link between DMDD and subsequent psychosocial impairment cannot be entirely explained by earlier or concurrent comorbid psychopathology. These findings strongly argue for the clinical utility and predictive validity of DMDD in childhood, and do not support the contention that DMDD is merely a new category for comorbid diagnoses. DMDD at age six also predicted a greater likelihood of using psychological (outpatient psychosocial and pharmacological) and educational services, and the association with later educational services persisted after accounting for all age six psychiatric disorders. The link between DMDD and academic problems is consistent with longitudinal findings demonstrating that DMDD and chronic irritability in older youth predicted lower educational attainment in adults (Copeland et al., 2014; Stringaris et al., 2009). Studies have found that children with SMD perform poorly on tasks of cognitive flexibility (Adleman et al., 2011; Leibenluft & Stoddard, 2013); this may contribute to the educational problems observed in children with DMDD. Future research is needed to further characterize the

cognitive deficits in DMDD that play a role in emotional dysregulation and academic difficulties.

Both interviewer- and teacher-rated measures identified significant peer problems in children with DMDD. Controlling for all psychiatric disorders at ages six and nine, DMDD at age six uniquely predicted interviewer-rated poorer peer relations at school and more frequent peer victimization, and teacher-reported greater relational aggression toward peers and peer exclusion at age nine. Interestingly, children with DMDD were rated as being more likely to be both victimized by peers and engage in peer victimization via relational aggression. Likewise, evidence suggests that irritable youth have atypical attentional biases toward hostile social and/or affective stimuli, perhaps making them more prone to anger and aggression toward peers (Leibenluft & Stoddard, 2013). Youth with SMD also show aberrations in labeling facial emotions both in their behavioral (Guyer et al., 2007; Rich et al., 2008) and neural responses (Brotman et al., 2010; Tseng et al., in press). These findings suggest that children with DMDD may show neurocognitive deficits in emotional and social-information processing that contribute to their poor peer functioning, but more research is sorely needed in this area.

This study had several strengths, including being the first investigation of pre-adolescent outcomes of early childhood DMDD, the use of structured clinical interviews to assess child psychopathology, and the inclusion of reports from multiple informants. However, the study also had a number of limitations. First, the relatively small number of cases ($n=36$) of DMDD at age six may have limited the values that could be observed in our dependent variables (i.e., range restriction), which may affect the power to detect significant longitudinal effects. Second, we did not correct for multiple testing. We view our analyses as exploratory, providing hypotheses for future testing given the limited research on DMDD. Third, we assessed child psychopathology at ages six and nine using different measures (PAPA and K-SADS), and the concordance between these measures is unknown. Fourth, DMDD diagnosis relied on psychiatric interviews that were not designed to assess DSM-5 DMDD. Fifth, assessments of psychiatric diagnoses were largely based on parent-report; however, our findings do not seem to be due to shared method variance because psychopathology at age nine was assessed by interviewing both the parent and child and because we found meaningful associations between DMDD and maternal, paternal, and teacher-reported measures. Nevertheless, there were discrepancies in results between parent and child informants, suggesting that child and parent report capture different aspects of the youth's emotions and behavior. Lastly, the sample was largely white and middle class. Future research should extend this research to more diverse samples.

In summary, our findings underscore the clinical significance of DMDD in childhood. Our results suggest that a diagnosis of DMDD identifies a group of children who are at high risk for continued psychopathology and impairment, including DMDD, depression, externalizing problems, and academic and peer problems. Importantly, associations between DMDD and later psychopathology and impairment cannot be explained by comorbidity with other disorders. Further scientific investigation is critically needed to advance our understanding of DMDD, including its epidemiology, clinical features, development, long-term course, genetics, and pathophysiology. This information is necessary to inform the development of

targeted therapeutic interventions that can be applied with young children, with the hope of improving the long-term prognosis of children with DMDD.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Table 1**Characteristics of the Study Sample (*N*=473)**

	Age 6 Assessment	Age 9 Assessment
Child mean age: years (SD)	6.10 (.43)	9.21 (.38)
Child sex: female <i>n</i> (%)	215 (45.5)	
Child race: <i>n</i> (%)		
White	419 (88.6)	
Black/African-American	40 (8.5)	
Asian	13 (2.7)	
Other	1 (.2)	
Child Hispanic ethnicity: <i>n</i> (%)	60 (12.7)	
Biological parents' marital status: <i>n</i> (%)		
Married	405 (85.6)	
Divorced, separated, or widowed	35 (7.4)	
Never married	33 (7.0)	
Parents' education: graduated college <i>n</i> (%)		
Mother	259 (55.7)	
Father	205 (45.4)	
<i>Child psychopathology n (%)</i>		
Current DMDD	36 (7.6)	6 (1.3)
Current Depressive Disorder	22 (4.7)	4 (.9)
Lifetime Depressive Disorder		10 (2.1)
Current Anxiety Disorder	70 (14.8)	91 (19.4)
Lifetime Anxiety Disorder		109 (23.4)
Current ADHD	30 (6.3)	64 (13.6)
Lifetime ADHD		64 (13.6)
Current ODD	40 (8.5)	13 (2.8)
Lifetime ODD		16 (3.4)
Current DBD		20 (4.3)
Lifetime DBD		23 (4.9)
<i>Mean child symptom scales at age 9</i> (SD; range)		

	Age 6 Assessment	Age 9 Assessment
Maternal-reported CDI	7.28 (4.92)	0–29
Paternal-reported CDI	7.27 (4.36)	0–23
Child-reported CDI	4.89 (4.20)	0–22
Maternal-reported SCARED	7.93 (7.96)	0–55
Paternal-reported SCARED	6.62 (6.42)	0–36
Child-reported SCARED	19.68 (11.17)	1–61
<i>Child functioning and social behavior at age 9</i>		
Child mean CGAS (SD; range)	78.61 (11.07)	45–99
Peer relationships at school (SD; range)	1.60 (.71)	1–4
Peer victimization (SD; range)	1.33 (.59)	1–4
Overt aggression-Teacher (SD; range)	4.32 (1.27)	4–17
Relational aggression-Teacher (SD; range)	7.27 (3.31)	5–22
Peer exclusion-Teacher (SD; range)	.82 (2.23)	0–14
Educational support services, <i>n</i> (%)	100 (21.3)	
Outpatient treatment services, <i>n</i> (%)	89 (18.9)	
Psychotropic medication use, <i>n</i> (%)	36 (7.7)	

Note. SD=standard deviation; DMDD=disruptive mood dysregulation disorder; ADHD=attention-deficit/hyperactivity disorder; ODD=oppositional defiant disorder; DBD=disruptive behavior disorder; CDI=Child Depression Inventory; SCARED=Screen for Child Anxiety Related Disorders; CGAS=Children's Global Assessment Scale.

Table 2

DMDD at Age 6 as Predictor of DSM-IV Disorders at Age 9

Age 6 DMDD						
	No DMDD Diagnosis (n=434)	DMDD Diagnosis (n=36)	Adjusted for Demographic Covariates	Adjusted for All Age 6 Psychiatric Disorders and Demographic Covariates		
<i>Disorder at Age 9, n(%)</i>			<i>Odds Ratio</i>	<i>95% CI</i>	<i>Odds Ratio</i>	<i>95% CI</i>
Current Depressive Disorder	3 (.7)	1 (2.8)	4.10	.42 – 40.41	16.71 *	1.32 – 211.21
Lifetime Depressive Disorder	8 (1.8)	2 (5.6)	3.13	.64 – 15.30	12.95 *	1.72 – 97.54
Current Anxiety Disorder	85 (19.5)	6 (16.7)	.82	.33 – 2.03	.82	.28 – 2.42
Lifetime Anxiety Disorder	101 (23.5)	8 (22.2)	.93	.41 – 2.10	1.06	.40 – 2.84
Current ADHD	52 (12.0)	12 (33.3)	3.94 **	1.79 – 8.64	2.89 *	1.05 – 7.95
Lifetime ADHD	52 (12.0)	12 (33.3)	3.94 **	1.79 – 8.64	2.89 *	1.05 – 7.95
Current DBD	12 (2.8)	8 (22.2)	10.74 ***	3.83 – 30.12	2.30	.58 – 9.06
Lifetime DBD	15 (3.5)	8 (22.2)	8.56 ***	3.15 – 23.23	2.23	.61 – 8.24

Note. † $p < .10$;* $p < .05$;** $p < .01$;*** $p < .001$.

N=470; CI=Confidence Interval; DMDD=disruptive mood dysregulation disorder; ADHD=attention-deficit/hyperactivity disorder; DBD=disruptive behavior disorder. Demographic variables (age, gender, parental education) were included as covariates only if they were significantly associated with the outcome variable.

Table 3

DMDD at Age 6 as Predictor of Symptom Scores at Age 9

Symptoms at age 9, mean (SD)	Age 6 DMDD					
	No DMDD Diagnosis (n=434)	DMDD Diagnosis (n=36)	Adjusted for Demographic Covariates		Adjusted for All Age 6 Psychiatric Disorders and Demographic Covariates	
			β	B(SE)	β	B(SE)
Depressive symptom scale	.48 (1.62)	1.14 (2.22)	.10 *	.66 (.29)	.12 *	.75 (.33)
Anxiety symptom scale	3.70 (5.40)	4.25 (5.15)	.03	.55 (.93)	.02	.37 (1.02)
ADHD symptom scale	1.24 (1.75)	2.42 (2.18)	.17 ***	1.17 (.30)	.13 **	.91 (.32)
DBD symptom scale	.88 (2.29)	4.14 (4.87)	.32 ***	3.26 (.44)	.17 ***	1.74 (.48)
Maternal-reported CDI	6.94 (4.61)	11.42 (6.50)	.24 ***	4.33 (.82)	.22 ***	3.96 (.88)
Paternal-reported CDI	7.11 (4.34)	9.13 (4.23)	.12 *	1.97 (.80)	.11 *	1.78 (.87)
Child-reported CDI	4.86 (4.23)	5.29 (3.85)	.03	.41 (.74)	-.004	-.07 (.84)
Maternal-reported SCARED	7.82 (8.00)	9.33 (7.48)	.05	1.36 (1.38)	.01	.20 (1.50)
Paternal-reported SCARED	6.75 (6.48)	5.13 (5.54)	-.07	-1.62 (1.20)	-.06	-1.55 (1.33)
Child-reported SCARED	19.60 (11.14)	20.71 (11.66)	.02	1.02 (1.96)	.05	2.01 (2.26)

Note. † $p < .10$;* $p < .05$,** $p < .01$,*** $p < .001$.

DMDD=disruptive mood dysregulation disorder; ADHD=attention-deficit/hyperactivity disorder; DBD=disruptive behavior disorders; CDI=Child Depression Inventory; SCARED=Screen for Child Anxiety Related Disorders. K-SADS scales $N=470$ (434 No DMDD, 36 DMDD); Maternal-reported CDI and SCARED $N=467$ (431 No DMDD, 36 DMDD); Paternal-reported CDI $N=405$ (374 No DMDD, 31 DMDD); Paternal-reported SCARED $N=404$ (373 No DMDD, 31 DMDD); Child-reported CDI and SCARED $N=463$ (428 No DMDD, 35 DMDD). Demographic variables (age, gender, parental education) were included as covariates only if they were significantly associated with the outcome variable.

Table 4
DMDD at Age 6 as Predictor of Functional Impairment and Service Use at Age 9

	Age 6 DMDD					
	No DMDD Diagnosis	DMDD Diagnosis	Adjusted for Demographic Covariates		Adjusted for All Age 6 Psychiatric Disorders and Demographic Covariates	
	(n=434)	(n=36)	β	B(SE)	β	B(SE)
Functional impairment at age 9						
CGAS (mean, SD)	79.34 (10.79)	69.90 (10.73)	-.22 ^{***}	-9.06 (1.84)	-.19 ^{***}	-8.04 (2.01)
Peer relationships at school	1.55 (.67)	2.17 (.85)	.23 ^{***}	.62 (.12)	.21 ^{***}	.55 (.14)
Peer victimization	1.31 (.57)	1.58 (.69)	.12 ^{**}	.27 (.10)	.18 ^{**}	.39 (.11)
Overt aggression-Teacher	4.33 (1.31)	4.21 (.42)	-.02	-.12 (.30)	-.01	-.05 (.34)
Relational aggression-Teacher	7.11 (3.06)	9.63 (5.51)	.19 ^{***}	2.53 (.77)	.18 ^{**}	2.41 (.88)
Peer exclusion-Teacher	.70 (2.01)	2.53 (4.03)	.20 ^{***}	1.83 (.52)	.21 ^{***}	1.94 (.57)
			Odds Ratio	95% CI	Odds Ratio	95% CI
Educational services <i>n</i> (%)	86 (19.8)	14 (38.9)	2.51 [*]	1.22–5.15	3.07 [*]	1.29–7.31
Outpatient service <i>n</i> (%)	73 (16.9)	16 (44.4)	3.95 ^{***}	1.95 – 7.98	2.23 [†]	.92 – 5.41
Psychotropic medication <i>n</i> (%)	30 (6.9)	6 (16.7)	2.69 [*]	1.04 – 6.96	1.01	.24 – 4.30

Note. [†] $p < .10$.

* $p < .05$.

** $p < .01$.

*** $p < .001$.

DMDD=disruptive mood dysregulation disorder; CGAS=Children's Global Assessment Scale; OR=Odds Ratio; CI=Confidence Interval; SE=Standard Error. C-GAS, peer relationships at school, peer victimization, educational services, outpatient service and psychotropic medication $N=470$ (434 No DMDD, 36 DMDD); Teacher-reported relational and overt aggression $N=300$ (281 No DMDD, 19 DMDD); Teacher-reported peer exclusion $N=299$ (280 No DMDD, 19 DMDD). Demographic variables (age, gender, parental education) were included as covariates only if they were significantly associated with the outcome variable.