

The Delinquency Outcomes of Boys with ADHD with and Without Comorbidity

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Abstract This study examined the association between childhood ADHD and juvenile delinquency by examining data from the Pittsburgh ADHD Longitudinal Study (PALS), a follow-up study of individuals diagnosed with ADHD in childhood (ages 5–12) and recontacted in adolescence and young adulthood for yearly follow-up (age at first follow-up interview $M=17.26$, $SD=3.17$). Participants were 288 males with childhood ADHD and 209 demographically similar males without ADHD who were recruited into the follow-up study. Delinquency information gathered yearly during the second through eighth follow-up provided a comprehensive history of juvenile delinquency for all participants. Four childhood diagnostic groups [ADHD-only ($N=47$), ADHD+ODD ($N=135$), ADHD+CD ($N=106$), and comparison ($N=209$)] were used to examine group differences on delinquency outcomes. Analyses were conducted across three dimen-

sions of delinquency (i.e., severity, age of initiation, and variety). Individuals with childhood ADHD+CD displayed significantly worse delinquency outcomes than the other three groups, across almost all indices of offending. When compared to comparison participants, boys with ADHD-only and ADHD+ODD in childhood displayed earlier ages of delinquency initiation, a greater variety of offending, and higher prevalence of severe delinquency. These findings suggest that although childhood ADHD+CD creates the greatest risk for delinquency, boys with ADHD-only and ADHD+ODD also appear at a higher risk for later offending. The patterns of offending that emerged from the PALS are discussed in the context of the relationship between ADHD, comorbidity, and delinquency.

Keywords ADHD · Delinquency · Conduct disorder

Every year thousands of individuals fall victim to criminal acts committed by juveniles in the United States. In 2006, 19.1% of property crimes and 12.1% of violent crimes involved only juveniles (U.S. Department of Justice, 2007). The young individuals who commit these crimes are at a high risk of continuing this criminality into adulthood (Loeber 1982; Moffitt et al. 2002), which also incurs a high economic cost to society. By one estimate, a lifetime criminal costs the public between \$1.3 million and \$1.5 million (Cohen 1998). In addition to the increased risk of adult criminality, delinquent adolescents are also more likely to experience multiple negative personal outcomes in adulthood, ranging from substance abuse to work-related problems (Loeber et al. 1999; Moffitt et al. 2002).

Given the gravity of juvenile offending, much attention has been directed toward identifying developmental pathways to serious delinquency in order to identify children who are most at risk for this costly outcome. Although

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minor delinquency appears to be somewhat normative and transient in adolescence, a subset of offenders display a pattern of severe and persistent offending that begins in childhood (Loeber 1988; Moffitt 1993, 2003). These individuals are most troublesome as they are more likely to continue their criminal behavior into adulthood, commit more severe and violent crimes, and experience a variety of poor personal outcomes (Moffitt and Caspi 2001; Stouthamer-Loeber and Loeber 2002). There is currently consensus that the progression to serious delinquency begins early, with problems at school, at home, and with peers. Most agree with the hypothesis that this troubling path begins with impulsivity, ADHD, undercontrolled temperament, or some variant thereof (Loeber 1988; McMahon and Kotler 2006; Moffitt 1993; Patterson et al. 2000). Negative environmental factors (e.g., poor parenting, life stressors) are thought to lead to an escalation of antisocial behavior that qualifies many for a comorbid diagnosis of Oppositional Defiant Disorder (ODD) and, eventually, Conduct Disorder (CD; Burke et al. 2005; Lahey and Loeber 1994; Patterson et al. 2000). By one estimate, the progression to comorbid ODD develops in 59% of school-aged children with ADHD (Barkley 2006). In about two-thirds of these children diagnosed with ADHD+ODD, CD later develops (Greene 2005). In these children, antisocial behavior often becomes chronic and evolves into a pattern of problematic delinquency.

Data from many longitudinal samples of children with ADHD support the hypothesis that these children are at an increased risk of qualifying for CD in adolescence (Gittelman et al. 1985; Lambert 1988; Mannuzza et al. 2004). However, few studies examine the relation between childhood ADHD and subsequent delinquent offending (Lee and Hinshaw 2004; Loeber et al. 1990; Molina et al. 2007a; Satterfield et al. 1982, 1994). The distinction between these outcomes is important as the overlap between CD and delinquency is only partial. The CD criteria include non-criminal acts such as lying, staying out past curfew, and bullying (APA 2000), and they do not provide a comprehensive list of delinquent behaviors. As such, delinquency is present in a minority of children with CD (Burke et al. 2002), and many children who commit delinquent acts fail to qualify for a diagnosis of CD (Molina et al. 2007a). The studies cited above provide evidence that children with ADHD are more likely than those without ADHD to offend in adolescence; however, most data suggest that this relationship is influenced by the development of childhood conduct problems subsequent to the onset of ADHD (Biederman et al. 2001; Lee and Hinshaw 2004; Lilienfeld and Waldman 1990; Loeber et al. 2000). This repeated finding is consistent with the hypothesis that many children with ADHD follow a maladaptive

pathway to serious delinquency, but that only those who develop childhood CD become severe and persistent offenders.

Some evidence also suggests that children with ADHD who do not have serious conduct problems in childhood are also at a higher risk for later delinquent offending. Several studies have found elevated rates of later delinquency in children with ADHD who were not diagnosed with comorbid ODD or CD (Loeber et al. 1990; Farrington et al. 1990; Satterfield et al. 1994; Molina et al. 2007a). There are also established links between the core symptoms of ADHD and delinquent offending (Carroll et al. 2006; Kagan and Zentner 1996; Klinteberg 1997; Loeber et al. 2007; White et al. 1994), even after controlling for conduct problems (Babinski et al. 1999; Pardini et al. 2006), although exceptions to these findings exist (Lahey et al. 2000; Satterfield and Schell 1997). Mixed findings on the relationship between ADHD and delinquency highlight the need for further studies with more exhaustive techniques for examining this association.

Notably, a number of questions remain about the relationship between childhood ADHD and delinquency. For example, although studies have examined the presence of offending within the ADHD population (Biederman et al. 2001; Satterfield et al. 1982, 1994), there has been less emphasis on delinquency severity (Lee and Hinshaw 2004; Molina et al. 2007a) and variety (Loeber et al. 1990). Delinquency severity is an important characteristic of the persistent offender (Loeber 1988) and delinquency variety shows associations with lower self-control and a greater propensity to offend repeatedly (Mazerolle et al. 2000). Furthermore, examinations of severity and variety outcomes in ADHD samples have involved very young adolescents who have not likely reached their offending peak (Lee and Hinshaw 2004; Loeber et al. 1990; Molina et al. 2007a). Variety of offending (i.e., the number of different delinquent acts that a participant endorses in the lifetime) is also likely to increase with age simply due to the passage of time and increased opportunity. Consequently, follow-up studies that span adolescence are needed to investigate the timing of delinquency initiation in ADHD samples. In addition, almost no research examines risk for delinquency among children with ADHD and comorbid ODD (Satterfield et al. 1994). Given the important role of ODD in the progression from ADHD to CD (Burke et al. 2005), better understanding of this association may elucidate the relative contributions of ADHD, ODD, and CD toward the later development of delinquency.

The current study seeks to address the questions raised above by examining the delinquent behavior of the males in the Pittsburgh ADHD Longitudinal Study (PALS; Molina et al. 2007b). The PALS is a study of individuals diagnosed

with and treated for ADHD in childhood (baseline) and recontacted in adolescence and young adulthood for yearly follow-up visits. In the current study, we examined the contribution of childhood diagnosis (ADHD-only, ADHD+ODD, ADHD+CD, and no diagnosis) to the prediction of later lifetime delinquency severity and variety as well as to the age of initiation at each delinquency severity level (i.e., mild, moderate, severe). We hypothesized the following: 1) that overall prevalence of severe offending would increase incrementally with the severity of childhood diagnostic group, but mild and moderate offending would not due to the more normative nature of these lesser offense categories (Junger-Tas et al. 1994), 2) that across delinquency severity levels, earlier ages of initiation would correspond with the severity of childhood diagnosis, and (3) that variety of offending would also increase in a stepwise fashion along with the severity of childhood diagnosis.

Method

Participants

Probands At the start of the follow-up study, probands were recruited from a pool of 466 study-eligible adolescent and young adult males who were previously diagnosed with DSM-III-R or DSM-IV ADHD and treated at the ADD clinic at the Western Psychiatric Institute and Clinic in Pittsburgh, PA in childhood (baseline). In the current study, probands were 288 males in the PALS who were age 12 or younger at baseline. Of the 466 study eligible adolescent and young adult males, 23 could not be located at follow-up, 129 refused or failed to participate, and 26 were older than 12 at initial referral to the clinic (baseline). Age at baseline evaluation ranged from 5.0 to 12.83 years ($M=8.92$, $SD=1.79$).

In childhood (baseline), all probands participated in the Summer Treatment Program (STP) for children with ADHD, an 8-week intervention that included behavioral modification, parent training, and psychoactive medication trials where indicated (Pelham and Hoza 1996). Children were referred to the STP from across Allegheny County, PA by several large public sources, such as Pittsburgh Public Schools. Diagnostic information for probands was collected at baseline using parent and teacher DSM-III-R and DSM-IV symptom ratings scales (DBD; Pelham et al. 1992) and a semi-structured diagnostic interview administered to parents by a Ph.D. level clinician. The interview consisted of the DSM-III-R or DSM-IV descriptors for ADHD, ODD, and CD with supplemental probe questions regarding situationality and severity. It also included queries about other comorbidities to determine whether

additional assessment was needed (instrument available at <http://ccf.fiu.edu>). Following DSM guidelines, diagnoses of ADHD, ODD, and CD were made if a sufficient number of symptoms were endorsed (considering information from both parents and teachers) to result in diagnosis. Two Ph.D. level clinicians independently reviewed ratings and interviews to confirm diagnoses and when disagreement occurred, a third clinician reviewed the file and the majority decision was used. Exclusion criteria for probands were assessed at this baseline assessment and included a full-scale IQ<80, a history of seizures or neurological problems, and/or a history of pervasive developmental disorder, schizophrenia, or other psychotic or organic mental disorders.

Probands began participation in the follow-up study an average of 8.35 ($SD=2.79$) years after baseline assessment and treatment at the ADD clinic. They were recontacted and admitted to the study on a rolling basis as adolescents and young adults (11–28 years of age; all but three <25) and completed their first follow-up interview upon enrollment. Participants in the follow-up study were compared with the eligible individuals who did not enroll on demographic (i.e., age at first treatment, race, parental education level, and marital status) and diagnostic (i.e., parent and teacher ratings of ADHD and related symptomatology) variables collected at baseline. Only one of 14 comparisons was statistically significant at the $p<0.05$ significance level. Participants had a slightly lower average CD symptom rating on a four point scale as indicated by a composite of parent and teacher ratings (participants $M=0.43$, non-participants $M=0.53$).

Comparison Group Comparison participants were 209 males without ADHD. Comparison participants were recruited for the PALS from the greater Pittsburgh community at the same time as probands were recontacted to enroll in the follow-up study. These individuals were recruited from several sources including pediatric practices in Allegheny County (40.8%), advertisements in local newspapers (27.5%), local universities and colleges (20.8%), and other methods (10.9%) such as Pittsburgh Public Schools and word of mouth. Like probands, comparison participants were recruited on a rolling basis. Comparison recruitment lagged 3 months behind proband enrollment in order to facilitate efforts to obtain demographic similarity (discussed below). A telephone screening interview was administered to parents of potential comparison participants to gather basic demographic characteristics, history of diagnosis or treatment for ADHD and other behavior problems, presence of exclusionary criteria as previously listed for probands, and a full checklist of ADHD symptoms. Older individuals (age 18+) also

provided self-report. ADHD symptoms were counted as present if reported by either the parent or the young adult. Individuals who met DSM-III-R criteria for ADHD, either currently or historically, were immediately excluded from study consideration. Although a history of ODD and CD were not exclusion criteria for comparison participants, parent and self-report indicated that only one comparison participant had a history of ODD-like behaviors in childhood and no comparison participants displayed a history of CD-like behaviors. At recruitment, average ADHD symptom severity for the comparison group was 0.65 (0–3 scale).

If a potential comparison participant passed the initial phone screen, senior research staff members met to determine whether he was demographically appropriate for the study. Four demographic characteristics were examined for each potential comparison participant: 1) age, 2) gender, 3) race, and 4) parent education level. A comparison participant was deemed study-eligible if his enrollment increased the comparison group's demographic similarity to the probands. At the end of the recruitment process, the proband and comparison groups were equivalent on the four demographic variables noted above. An unsuccessful attempt was made to obtain equivalence on the proportion of parents who were married (see Table 1).

Procedure

As noted, baseline diagnoses were gathered for probands at initial referral to the clinic during childhood. Follow-up interviews in adolescence and young adulthood were conducted by post-baccalaureate research staff. All questionnaires (paper and pencil or web-based) in the current study were completed privately. During informed consent, participants were assured of the confidentiality of disclosed materials. In cases where distance prevented participant travel to WPIC, information was collected through mail, telephone correspondence, and home visits. PALS follow-up interviews were conducted yearly beginning in the year of enrollment. As a result, the year (e.g., 2000) in which a participant completed a given interview (e.g., follow-up interview 1) varied across individuals. The collection of lifetime delinquency data began at the second annual interview. Data for the current study were from the second through the eighth annual interviews. By the 8th interview, all participants had turned 18 years old which provided a cumulative record of delinquency through age 18 for all participants.

Measures of Delinquency

Delinquency ratings were calculated from data collected by the Self-Reported Delinquency questionnaire (SRD; Elliot

Table 1 Characteristics of the Sample at Baseline and First Follow-up Visit

	Comparison (<i>N</i> =209)	ADHD-only (<i>N</i> =47)	ADHD+ODD (<i>N</i> = 135)	ADHD+CD (<i>N</i> = 106)
Diagnostic Variables at Baseline				
ADHD				
Symptoms Endorsed	–	11.23(1.90)	12.88(1.60)	13.09(1.34)
Severity Score	–	2.05 (0.44)	2.28(0.41)	2.40(0.36)
ODD				
Symptoms Endorsed	–	2.57 (1.17)	7.08(1.35)	7.82(1.20)
Severity Score	–	0.83 (0.32)	1.93(0.51)	2.23(0.44)
CD				
Symptoms Endorsed	–	0.38 (0.61)	1.13(0.76)	4.14(1.39)
Severity Score	–	0.15 (0.11)	0.32(0.18)	0.72(0.27)
Demographics at First Follow-up				
Age (M, SD)	17.00 (3.15)	17.68 (3.02)	16.84(3.04)	17.59(3.38)
Symptom endorsed is total number of symptoms reported by either parent or teacher on the DBD rating scale or DBD interview. Severity score is the higher score reported by either parent or teacher on the DBD rating scale, calculated by taking the average symptom level on a scale from 0 “not at all present” to 3 “very much present” † <i>p</i> <0.25				
Racial Minority (%)	14.4	15.6	21.2	15.5
African–American (%)	8.1	11.1	14.4	5.8
Other (%)	6.3	4.5	6.8	9.7
Highest Parent Education [†]				
High School Grad or GED (%)	9.1	4.9	8.3	9.1
Partial College (%)	29.9	46.3	31.7	47.7
College or University Grad (%)	26.4	19.5	31.7	25.0
Graduate Training (%)	34.5	29.3	28.3	18.2
% Single Parent Household [†]	24.7	31.7	36.3	32.6

et al. 1985). During the second (age $M=18.11$, $SD=3.18$), third (age $M=19.15$, $SD=3.16$), and fourth (age $M=20.22$, $SD=3.23$) annual interviews, all participants and parents were asked to provide information about lifetime engagement in 37 delinquent acts (e.g., Have you ever snatched someone's purse or wallet?), including initiation age (e.g., How old were you when you first snatched someone's purse or wallet?), setting (e.g., Did any of these occur at school?), and the value of damages (e.g., What was the dollar value?). At least three lifetime reports were available for most participants (88.7%). A minority provided lifetime delinquency information at only two interviews (6.5%) or at one interview (4.8%). At the fifth follow-up interview, only participants who were still under 18 at the previous interview (18%) were administered the SRD. These individuals were asked to report on delinquency during the past year until the follow-up interview at which they reached the age of 18. Past-year reporting continued for 12.3% of the sample at the sixth follow-up interview, 7.8% at the seventh follow-up interview, and 3.2% at the eighth follow-up interview.

At each follow-up interview, parent report was compared to self-report and an act was counted if endorsed by either reporter. In a few cases ($N=12$), follow-up interviews were not conducted with parents and youth report alone was used. Because the current study concerns itself only with juvenile delinquency, acts reported as being committed after the age of 18 (according to SRD follow-up questions) were not included in analyses. All available reports were integrated to provide a comprehensive lifetime history of juvenile offending for all participants.

Severity Lifetime severity ratings were coded according to the scheme developed by Wolfgang et al. (1985) and used extensively in the Pittsburgh Youth Study (Loeber et al. 1991). Three levels of delinquency severity were coded at each follow-up interview based on whether or not a participant or his parent reported an act at a given level: mild=minor delinquency outside of the home (e.g., vandalism with damages less than \$100, avoiding payment, theft of less than \$5); moderate=moderately serious delinquency (e.g., credit card fraud, theft of \$5 or more, arson with damages over \$100, joyriding); severe=serious delinquency (e.g., breaking and entering, vehicle theft, attacking someone with a weapon with the intent to seriously hurt or kill, rape). For each participant, codes from each available follow-up interview were integrated to indicate the presence of offending (yes/no) and age of initiation (up to age 18) for each severity level of delinquency (based on the SRD follow-up questions).

Variety A lifetime estimate of delinquency variety was obtained by summing the total number of types of acts (out

of 34) that a participant or his parent endorsed as occurring before age 18 (Loeber et al. 1990; Mazerolle et al. 2000). Three acts are routinely omitted from coding due to deviation from the delinquency construct (i.e., arrest, carrying a concealed weapon, drug selling). The variety categorization did not account for the number of times each act was committed, rather served as a measure of variety across category. A participant's variety score consisted of the total number of acts a participant endorsed across all follow-up interviews.

Analytic Plan

Prior to the analyses all demographic characteristics were examined by the four childhood diagnostic subgroups [ADHD-only ($N=47$), ADHD+ODD ($N=135$), ADHD+CD ($N=106$), no diagnosis ($N=209$)]. Single parent household and parental education tended toward group differences but were not statistically significant ($p<0.25$). Nevertheless, these variables were included as covariates in all models to ensure that they were not contributing to subgroup differences in delinquency outcomes. The three proband diagnostic groups did not significantly differ in their average age at baseline [$F(2,285)=0.60$, $p=0.55$]; however, given the wide age range (11–28) at enrollment into the follow-up study, age at the first follow-up interview was also entered into all models to control for any differential recall that may have occurred as a result of the participant's age at follow-up.

Severity Three survival analyses were conducted to examine potential childhood diagnostic group differences (ADHD-only, ADHD+ODD, ADHD+CD, no diagnosis) in the prevalence of offending at each severity level (mild, moderate, severe). Survival rates were expressed as percentages of youth who had offended at a given severity level through age 18 calculated using the Cox regression method. Cox regression curves and log-likelihood tests were used to test the difference between the groups' offending curves. For severe delinquency, additional planned comparisons (ADHD-only vs. ADHD+ODD; ADHD-only vs. ADHD+CD; ADHD+ODD vs. ADHD+CD) were conducted in order to further examine the relative risk of childhood diagnosis in predicting this most clinically significant variable. A Bonferroni correction for three planned comparisons set a pre-established alpha-level of 0.02 for this analysis.

Age of Initiation A Generalized Linear Model using a normal distribution and an identity link function was employed to compare the four childhood diagnostic groups on age of initiation for mild, moderate, and severe delinquency. Comparison participants were used as a reference group and childhood diagnosis dummy codes

(ADHD-only: yes vs. no; ADHD+ODD: yes vs. no; ADHD+CD: yes vs. no) as the independent variable. Additional planned comparisons (ADHD-only vs. ADHD+ODD; ADHD-only vs. ADHD+CD; ADHD+ODD vs. ADHD+CD) were conducted to examine the relative risk of comorbid ODD and CD diagnosis. A Bonferroni correction for three planned comparisons set a pre-established alpha-level of 0.02 for this analysis. Generalized Linear Modeling has been shown to be a powerful method of detecting relationships involving normally and non-normally distributed variables (McCullagh and Nelder 1989).

Variety A Generalized Linear Model using a normal distribution and an identity link function was employed to compare the four childhood diagnostic groups on delinquency variety. Comparison participants were used as a reference group and childhood diagnosis dummy codes (ADHD-only: yes vs. no; ADHD+ODD: yes vs. no; ADHD+CD: yes vs. no) as the independent variable. Additional planned comparisons (ADHD-only vs. ADHD+ODD; ADHD-only vs. ADHD+CD; ADHD+ODD vs. ADHD+CD) were conducted in order to further examine the relative risk of comorbid ODD and CD diagnosis. A Bonferroni correction for three planned comparisons set a pre-established alpha-level of 0.02 for this analysis.

Results

Severity

Figures 1a–c display prevalence of offending for the childhood diagnostic groups across mild, moderate, and severe delinquency. Only 23.9% of comparison participants, 29.8% of ADHD-only, 25.9% of ADHD+ODD, and 17.8% of ADHD+CD completely abstained from delinquent offending at any severity level. For mild delinquency, the overall test of the model was non-significant [$X^2(8)=6.55$, $p=0.59$], indicating that all four groups showed a similar prevalence of mild offending (see Table 2). For moderate delinquency, the overall test of the model was significant [$X^2(58)=46.99$, $p<0.01$], and after controlling for the covariates, only probands with a childhood diagnosis of ADHD+CD displayed a pattern of moderate offending that was significantly different from that of comparison participants (see Table 2). For severe delinquency, the overall test of the model was also significant [$X^2(5)=37.35$, $p<0.01$], and after controlling for the covariates, probands with childhood ADHD+CD and ADHD+ODD displayed a prevalence of severe offending that was significantly higher than comparison participants.

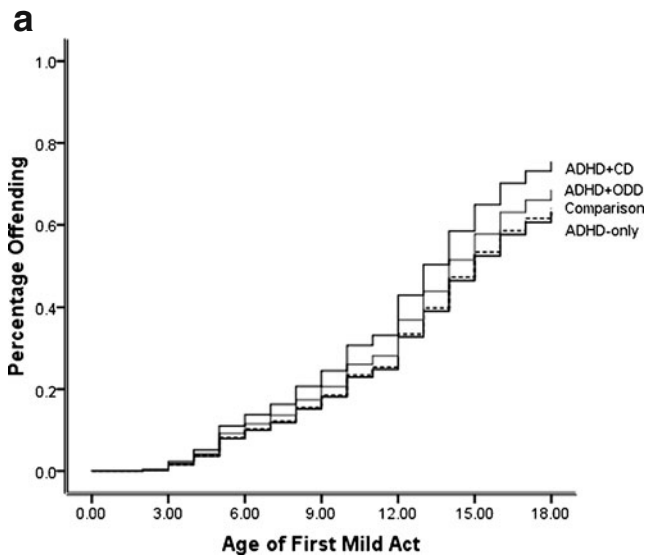
ADHD-only probands did not significantly differ from comparison participants ($p=0.12$), despite displaying a nearly identical pattern of severe offending to the ADHD+ODD group (see Table 2 and Fig. 1c). Planned comparisons revealed that risk for severe offending did not differ significantly between the ADHD-only and the ADHD+ODD groups ($OR=1.63$, $p=0.36$) or between the ADHD+ODD and the ADHD+CD groups ($OR=1.58$, $p=0.22$); however, individuals with a childhood diagnosis of ADHD+CD ($OR=2.57$, $p=0.07$) were more likely than individuals with a childhood diagnosis of ADHD-only to engage in severe delinquency.

Age of Initiation

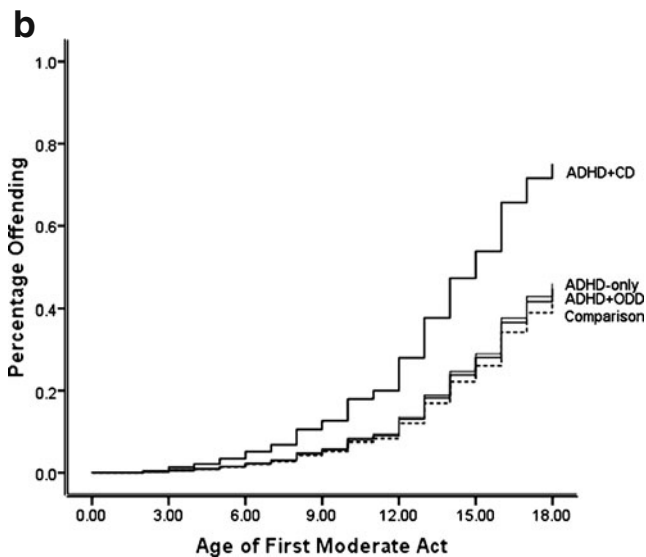
Table 2 displays diagnostic group differences in age of initiation. For mild delinquency, the overall test of the model was significant [$X^2(8)=388.42$, $p<0.01$]. Results revealed that after controlling for the covariates, the ADHD-only (*Estimated M*=11.42, *SE*=0.21, *b*=-1.04, *SE*=0.22, *Wald*=22.38, $p<0.01$), ADHD+ODD (*Estimated M*=10.96, *SE*=0.12, *b*=-1.50, *SE*=0.15, *Wald*=105.76, $p<0.01$), and ADHD+CD (*Estimated M*=10.36, *SE*=0.14, *b*=-2.10, *SE*=0.16, *Wald*=175.53, $p<0.01$) groups initiated mild delinquency at significantly earlier ages than the comparison group (*Estimated M*=12.46, *SE*=0.10). Additional planned comparisons revealed that after controlling for the covariates, the ADHD+CD group also initiated mild delinquency at significantly earlier ages than the ADHD+ODD and ADHD-only groups.

For moderate delinquency, the overall test of the model was significant [$X^2(8)=258.27$, $p<0.01$] and after controlling for the covariates, the ADHD-only (*Estimated M*=13.36, *SE*=0.24, *b*=-1.14, *SE*=0.26, *Wald*=19.03, $p<0.01$), ADHD+ODD (*Estimated M*=13.43, *SE*=0.14, *b*=-1.08, *SE*=0.18, *Wald*=35.37, $p<0.01$), and ADHD+CD (*Estimated M*=11.99, *SE*=0.14, *b*=-2.52, *SE*=0.17, *Wald*=218.82, $p<0.01$) groups initiated moderate delinquency at significantly earlier ages than comparisons (*Estimated M*=14.50, *SE*=0.12). Additional planned comparisons revealed that after controlling for the covariates, the ADHD+CD group initiated moderate delinquency at significantly earlier ages than the ADHD+ODD and ADHD-only groups.

For severe delinquency, the overall test of the model was significant [$X^2(8)=88.99$, $p<0.01$] and the analysis revealed that after controlling for the covariates, the ADHD+CD group (*Estimated M*=12.87, *SE*=0.18, *b*=-0.89, *SE*=0.27, *Wald*=10.75, $p<0.01$) initiated severe delinquency at significantly earlier ages than the comparison group (*Estimated M*=13.76, *SE*=0.22). The ADHD+ODD (*Estimated M*=14.59, *SE*=0.19, *b*=0.83, *SE*=0.29, *Wald*=8.13, $p<0.01$) group initiated severe delinquency at significantly later ages than the comparison group. The ADHD-only group (*Estimated M*=13.99, *SE*=0.34, *b*=-0.23, *SE*=0.40, *Wald*=0.33, $p=0.57$) was not

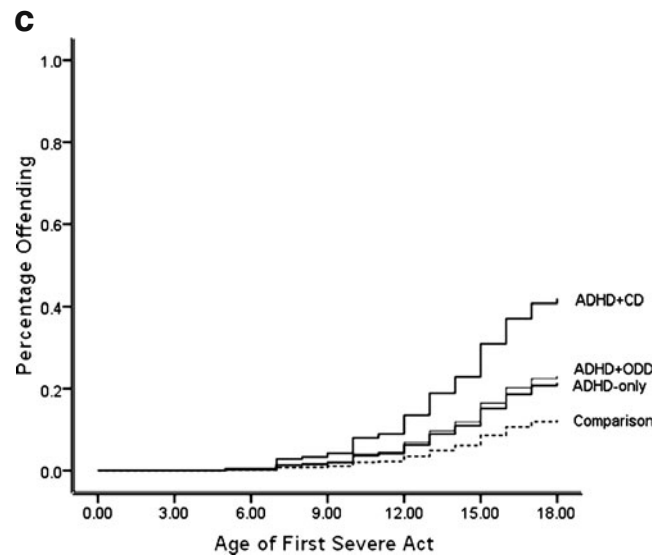


Note. Y-axis represents % initiating mild delinquency at the mean of the covariates (single parent status, parental education, and age at follow-up).



Note. Y-axis represents % initiating moderate delinquency at the mean of the covariates (single parent status, parental education, and age at follow-up).

Fig. 1 **a** Mild Delinquency. Note. Y-axis represents % initiating mild delinquency at the mean of the covariates (single parent status, parental education, and age at follow-up). **b** Moderate Delinquency Pattern. Note. Y-axis represents % initiating moderate delinquency at the mean of the covariates (single parent status, parental education,



Note. Y-axis represents % initiating severe delinquency at the mean of the covariates (single parent status, parental education, and age at follow-up).

and age at follow-up). **c** Severe Delinquency Pattern. Note. Y-axis represents % initiating severe delinquency at the mean of the covariates (single parent status, parental education, and age at follow-up)

significantly different from the comparison group on age of severe delinquency initiation. Additional planned comparisons revealed that after controlling for the covariates, the ADHD+CD group initiated severe delinquency at significantly earlier ages than the ADHD+ODD and ADHD-only groups.

Variety

The overall model was significant [$\chi^2(5)=644.32, p<0.01$] and the analysis revealed that after controlling for the

covariates, the ADHD-only (*Estimated M*=6.19, *SE*=0.16, *b*=0.82, *SE*=0.17, *Wald*=22.33, *p*<0.01), ADHD+ODD (*Estimated M*=6.72, *SE*=0.10, *b*=1.35, *SE*=0.12, *Wald*=129.58, *p*<0.01), and ADHD+CD (*Estimated M*=8.69, *SE*=0.12, *b*=3.32, *SE*=0.13, *Wald*=630.30, *p*<.01) groups committed a significantly higher variety of delinquent acts than the comparison group (*Estimated M*=5.37, *SE*=0.08). In addition, all planned comparisons were significant indicating that the three proband groups also significantly differed from each other.

Table 2 Group Differences in the Initiation of Mild, Moderate, and Severe Delinquency

	Age of Initiation ^a	b	SE	Wald	Sig.	OR
Mild Acts						
Comparison	12.46	–	–	–	–	–
ADHD-only	11.42	–0.03	0.22	0.01	0.91	0.98
ADHD+ODD	10.96	0.12	0.15	0.72	0.40	1.13
ADHD+CD	10.36	0.32	0.16	3.97	0.05	1.37
Moderate Acts						
Comparison	14.50	–	–	–	–	–
ADHD-only	13.36	0.08	0.26	0.10	0.75	1.09
ADHD+ODD	13.43	0.12	0.18	0.48	0.49	1.13
ADHD+CD	11.99	0.94	0.17	29.11	<0.01	2.55
Severe Acts						
Comparison	13.76	–	–	–	–	–
ADHD-only	13.99	0.61	0.39	2.39	0.12	1.84
ADHD+ODD	14.59	0.70	0.28	6.23	0.01	2.01
ADHD+CD	12.87	1.42	0.27	27.33	<0.01	4.13

Mild offenses include: property damage <\$100, minor fire-setting, theft <\$5, avoiding payment, cheating others. Moderate offenses include: gang fighting, property damage >\$100, fire-setting with major damage, theft >\$5, purse snatching, picking pocket, stealing from a car, dealing stolen goods, joyriding, check fraud, credit card fraud, counterfeiting. Severe offenses include: forcible theft, breaking and entering, vehicle theft, rape, attacking someone with the intent to seriously injure or kill, attack with a weapon. ^a Represents the estimated marginal mean age of initiation for participants who offended at a given level after controlling for demographic covariates

Discussion

The findings of this study suggest that regardless of comorbidity, all children with ADHD are at some type of increased risk for delinquency. Specific findings were that: (a) compared to the other three childhood diagnostic subgroups (no diagnosis, ADHD-only, ADHD+ODD), children with ADHD+CD were at a higher risk for all but one index of delinquency examined in this study (prevalence of mild delinquency); b) children with ADHD-only and ADHD+ODD displayed a slightly elevated prevalence of severe offending, were at risk for earlier initiation of mild and moderate delinquency, and committed a greater variety of acts than the comparison group; and (c) the risks exhibited by the ADHD-only and ADHD+ODD groups were very similar, only differing on variety of offending. We shall discuss each of these findings in turn.

The clearest finding that emerged from this study was that children diagnosed with ADHD+CD were at the highest risk for delinquent offending across measures of severity, variety, and age of initiation. This finding is consistent with most if not all studies that examine the relationship between childhood ADHD, childhood conduct problems, and adolescent delinquency (Loeber et al. 1990, 2000). The pervasiveness of this finding highlights the grave trajectory shared by these individuals. Most of these boys ($\approx 70\%$) initiated mild and moderate delinquency, doing so early (mild *Estimated M* = 10.36, moderate *Estimated M* = 11.99). A subset of the boys with ADHD+

CD (45.3%) also initiated severe delinquency, again doing so at earlier ages than offenders in the other groups (*Estimated M* = 12.87). These boys also committed a greater variety of acts than the other subgroups. Although these results implicate childhood CD as a precursor to severe delinquent offending, at least when it co-occurs with ADHD, only half (51.6%) of severe offenders with childhood ADHD were diagnosed with CD at baseline, despite the high rate of CD in our sample. Thus, something other than CD appears to account for the development of severe delinquency in about half of the PALS severe offenders. Of course, it is possible that some of these boys developed CD after baseline assessment (Lahey et al. 1995).

The only exception to the elevated risk displayed by ADHD+CD probands was prevalence of mild delinquency. Our data show a high prevalence of mild delinquency in all four childhood diagnostic groups, which suggests that mild offending may be normative in adolescence. In fact, a high proportion of participants in all four childhood diagnostic groups committed at least one delinquent act (Range = 70.2–82.2%). This finding is consistent with cross-national prevalence rates that suggest that most adolescents will self-report at least one criminal act during their youth (Junger-Tas et al. 1994). Thus, group differences did not emerge on mild delinquency because of prevalent normative offending in the comparison group.

Our data also revealed that boys with childhood ADHD-only and childhood ADHD+ODD showed elevated risks for delinquent offending by age 18. Specifically, these two

groups were more likely to offend earlier, commit a greater variety of crimes, and initiate severe delinquency than comparison participants (see Table 2). These findings suggest that boys with ADHD who are low on antisocial behaviors in elementary school are still at risk for later delinquent offending. This risk is concerning given that early offending and varied offending are both associated with non-normative offending trajectories (Mazerolle et al. 2000; Moffitt 2003). This claim is also consistent with other studies showing that adolescents with ADHD begin offending earlier than those without this disorder (Forehand et al. 1991; Moffitt 1990). With respect to severe delinquency, boys with ADHD-only (23.4%, $OR=1.84$) and with ADHD+ODD (25.4%, $OR=2.01$) were at a similar risk (see Fig. 1c); however, this risk was non-significant in the ADHD-only group ($p=0.12$). Despite this non-significance—perhaps because the sample size was about 1/3 of that for the ADHD+ODD group—both groups were about twice as likely as comparison participants to engage in severe delinquency, such as forcible theft, breaking and entering, vehicle theft, rape, or murder.

Only delinquency variety displayed the stepwise risk that we predicted would occur in correspondence with childhood diagnostic severity. This finding was consistent with the only other study of ADHD and delinquency variety (Loeber et al. 1990), which reported that variety scores in youth with ADHD+CD were higher than those possessed by youth with ADHD-only, which in turn were higher than the comparison group. Studies of delinquency volume draw a similar conclusion. These findings suggest that ADHD is related to overall volume of crime, but not any particular type of crime, with high rates of offending across a wide variety of crimes (Barkley et al. 2007; Dalteg and Levander 1998; Torgersen et al. 2006). It is not surprising that the variety variable displayed our hypothesized incremental risk, as delinquency variety is an index that is conceptualized by some to reflect low self-control (Hirschi and Gottfredson 1993), which is also a hallmark feature of ADHD (Barkley 2006). Indeed, one characteristic of the PALS sample was that baseline ADHD severity increased with the severity of one's childhood diagnosis (see Table 1), which may account for some of the relative increased delinquency variety.

While it came as no surprise that boys with ADHD+CD offended at the highest rates, the similar pattern of offending displayed by boys with ADHD-only and ADHD+ODD was somewhat unexpected (see Table 2 and Fig. 1a–c). A full understanding of this finding requires careful consideration of the composition of these groups. Although as discussed above, the ADHD+ODD group showed somewhat elevated levels of baseline ADHD symptomatology, compared to the ADHD-only group, they differed vastly on ODD symptomatology (see Table 1). Furthermore, the ADHD+ODD and ADHD+CD shared

very similar levels of baseline ODD symptoms, but displayed disparate risks for later offending (see Tables 1 and 2 and Fig. 1b–c). Consequently, these data seem to suggest that elevations in ODD symptomatology do not increase the risk for most of the delinquency indices examined in this study. Although theory heavily implicates coercive family processes and subsequent ODD in the development of conduct problems and later delinquency (Moffitt 1990; Patterson et al. 2000; Snyder et al. 2005), our data suggest that oppositional behavior may carry a limited risk for non-normative delinquency if this disorder does not evolve into symptoms of CD. However, given the finding that about two-thirds of children with ADHD+ODD develop CD (Greene 2005), it may be particularly effective to intervene with boys with ADHD+ODD in order to prevent the especially severe offending trajectory demonstrated by boys with ADHD+CD.

These trends suggest that while individuals without ADHD are mostly at risk for committing delinquent acts of mild to moderate severity during adolescence, individuals with childhood ADHD are at an earlier and unremitting risk for offending at all delinquency severity levels and across a wider variety of crimes (see Table 2). Unfortunately, earlier and more severe offending would seem to suggest that children with ADHD, and especially with comorbid CD, are also at risk for offending that persists into adulthood (Moffitt 1993, 2003). Our data also indicate that clinically significant levels of childhood conduct problems propel the risk for earlier, more severe, and more varied delinquency. However, given the incremental gains in ADHD symptomatology as one moves to a more severe childhood diagnosis (see Table 1; Waschbusch 2002), it is also possible that some of the risk accrued by comorbidity may be attributable to more severe ADHD symptoms. Unfortunately, without childhood measures on the comparison group, we were unable to fully investigate the contribution of childhood symptom severity to the development of later delinquency. This is an important limitation to our study.

There are other limitations as well. As a clinic-referred sample, the outcomes found in the PALS may not generalize to epidemiological samples of children with ADHD. Thus, there is a need to replicate these results using a community sample. Another limitation to our study is that our baseline data represents a diagnostic snapshot of each proband in childhood. Therefore, it is also possible that some of the probands without a baseline diagnosis of comorbid CD (age range: 5–12 years; $M=8.92$, $SD=1.79$) might have developed CD between baseline and follow-up. It is also possible that some participants who met criteria for ODD or CD during baseline may have experienced a remission of these symptoms after the baseline assessment. In addition, eligible participants who did not enroll in the study possessed slightly higher baseline CD severity scores

than enrollees. It is possible that had these eligible participants enrolled, delinquency estimates in the proband groups could have been different. For probands with a comorbid diagnosis of CD, delinquent acts committed prior to initial assessment may have actually been the cause of a CD diagnosis. Although we attempted to reduce this possibility by excluding participants who were over age 12 at baseline, we were regrettably unable to completely remove these acts from our analyses due to the nature of the SRD questionnaire (Elliot et al. 1985). It is also the case that some of the delinquency history collected from our sample was based on retrospective report. We attempted to safeguard against the complications associated with retrospective report of delinquency (Kazemian and Farrington 2005) by asking participants and parents to report lifetime delinquency three times and using age at follow-up as a covariate. However, it is possible that we were unable to identify all acts ever committed by the participants. Given that our delinquency measure did not assess for the number of times each act was committed, we were also unable to examine differential patterns in delinquency volume.

Given the small number of boys in our sample who qualified for diagnosis of ADHD-Predominantly Inattentive Subtype, we were also unable to examine whether offending patterns differed amongst the subtypes of ADHD. In addition, while our sample was demographically representative of the county in which the study occurred, it is important to note that many of our participants came from middle-class families. As a result, our findings may be most generalizable to middle-class, racial-majority males with parents who are high school graduates. For example, evidence suggests that females display different normative and non-normative patterns of offending than males (Silverthorn and Frick 1999).

Future Directions

An important future line of research is the investigation of symptom clusters and child characteristics that give rise to non-normative delinquency. For example, Callous-Unemotional (CU) traits show evidence of a unique pathway to severe offending (Frick 2004); however, no study has examined the role of these traits in predicting delinquency outcomes in a childhood ADHD sample. Future research must also address influences, such as parenting, that occur between childhood and adolescence and likely influence whether or not a child with ADHD initiates or maintains an antisocial pathway. Additionally, future work should address the adulthood persistence of criminal offending within the ADHD population, thereby extending the patterns examined in the current study and addressing whether the early-onset offending found in the ADHD group represents life-course persistent criminality.

Clinical Implications

For children with ADHD, an elevated risk for non-normative delinquency is just one of a slew of probable negative life outcomes, including school drop-out, interpersonal difficulties, substance use, and unemployment (Barkley et al. 2007; Mannuzza et al. 1993; Molina et al. 2007b; Weiss and Hechtman 1993). These outcomes highlight the intense need for treatment in individuals diagnosed with ADHD. All PALS probands participated in an 8-week intensive Summer Treatment Program and their parents received a standard course of behavioral parent training (Pelham and Hoza 1996). They also received an average of 6 years of pharmacological intervention. However, the findings of this study and others from this same sample (Molina et al. 2007b; Kent et al. 2010) suggest that these interventions were not sufficient to prevent the negative outcomes that are common for children with ADHD. This is especially true for children with comorbid CD. Our findings suggest that in individuals with ADHD, there is a need for chronic treatment that begins early in childhood and persists into adolescence (Eyberg et al. 2008; Pelham and Fabiano 2008). For many children with ADHD, antisocial behavior begins in childhood but peaks in adolescence. However, treatment for adolescents with ADHD (Smith et al. 2000) is not well-researched and scarcely offered in most communities. Further work is sorely needed to develop prevention and intervention efforts in childhood and effective interventions for adolescents with ADHD.

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