

# Annual Research Review: Does late-onset attention-deficit/hyperactivity disorder exist?

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Attention-deficit/hyperactivity disorder (ADHD) is conceptualized as an early onset childhood neurodevelopmental disorder. Prevalence in adults is around two-thirds that in childhood, yet longitudinal outcome studies of children with ADHD found a minority continue to meet full criteria in adulthood. This suggests that not all adult cases meet ADHD criteria as children, a conclusion supported by earlier studies relying on retrospective recall in adolescent and adult samples. More recently prospective follow-up of population and control samples suggest that adolescent and young adult ADHD is not always a continuation of childhood ADHD. Here, we review the literature on age of onset, to explore whether late-onset ADHD exists, and if so, examine the evidence for whether this should be considered the same or a different disorder as childhood onset ADHD. We conclude that current evidence supports the view that a significant proportion of young adults meeting criteria for ADHD would not have met full diagnostic criteria for ADHD as children. However, many in the late-onset group show some ADHD symptoms in childhood, or an externalizing disorder such as oppositional defiant disorder. Furthermore, the current studies suggest that most (but not all) cases of late-onset ADHD develop the disorder between the ages of 12–16 and can therefore be considered adolescent or early adult onset ADHD. There is a relative lack of data spanning young to older adulthood to address the question of adult-onset. Currently, there is insufficient data to clarify the extent to which early and late onset ADHD reflect a different balance of genetic and environmental risks or share the same underlying neural mechanisms. Clinicians should be aware that significantly impairing forms of ADHD can emerge beyond the age of 12 years, although perhaps rarely in the context of a complete absence of precursors. The current evidence on treatment responses is limited. **Keywords:** ADHD; developmental psychopathology; longitudinal studies; developmental epidemiology.

## Introduction

Attention-deficit/hyperactivity disorder (ADHD) is classified as a childhood onset neurodevelopmental disorder defined by the presence of a persistent pattern of inattention and/or hyperactivity-impulsivity that interferes with functioning or development (American Psychiatric Association, 2013). Cross-sectional epidemiological surveys find that 5%–6% of children and 3%–4% of adults meet DSM-IV criteria for ADHD (Fayyad et al., 2007; Polanczyk, de Lima, Horta, Biederman, & Rohde, 2007; Simon, Czobor, Balint, Mészáros, & Bitter, 2009; Willcutt, 2012), with slightly higher prevalence when DSM-5 criteria are applied. Meta-analysis of follow-up studies of children with ADHD found that 15% retain the full diagnostic criteria by the age of 25 years, with a further 50% meeting subthreshold criteria with persistence of some ADHD symptoms causing continued impairments (Faraone, Biederman, & Mick, 2006). This suggests that not all adult ADHD cases would have met full criteria for ADHD as children, although other studies report persistence rates of 50%–80% (Cheung et al., 2015; Lara et al., 2009; Van Lieshout et al., 2016), perhaps related to the

focus on severe combined type ADHD cases in European child mental health services. These findings raise the possibility that ADHD may arise later in life, and certainly beyond the age of 7 years as defined in DSM-IV criteria, and now amended to age 12 in DSM-5. The DSM-5 scientific committee decided to change the criterion to several symptoms before age 12, based on evidence that this threshold would capture most cases of ADHD, although there was limited data available at the time on later onsets.

Initial studies using retrospective recall to evaluate the validity of the DSM-IV age 7 criterion found that age of onset did not predict clinical severity, comorbidity profiles or treatment response (Applegate et al., 1997; Faraone, Biederman, Doyle, et al., 2006; Faraone, Biederman, Spencer, et al., 2006; Guimaraes-da-Silva et al., 2012; Hesslinger, Tebartz van Elst, Mochan, & Ebert, 2003). These studies suggested that a proportion of cases have emerging ADHD symptoms and impairment between the ages of 7–16. More recently this conclusion was confirmed using prospective data collection for ADHD symptoms at different ages, in individuals who did not meet ADHD criteria as children (Caye et al., 2016; Cooper et al., 2018; Odgers et al., 2012; Riglin et al., 2016; Sibley et al., 2017). However, providing accurate estimates of age of onset has proven difficult due to

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limitations in each of the studies to date, and different approaches to defining what is meant by onset of ADHD. For example, do we mean onset of the full syndrome, or onset of several symptoms with or without impairment. Furthermore, it has been questioned whether ADHD symptoms arising for the first time in later adolescence or young adulthood reflect the same condition as early onset (neurodevelopmental type) ADHD (Moffitt et al., 2015). Here, we review the literature on age of onset of ADHD the evidence for later onset forms of the disorder and discuss potential explanations.

### ADHD as a childhood onset neurodevelopmental disorder

The perspective of ADHD as an early onset neurodevelopmental disorder is strongly embedded in the literature from the earliest descriptions of ADHD-like syndromes. Perhaps the first formal description of a disorder of inattention was from Alexander Crichton (1798) who considered the condition to be 'evident at a very early period of life' and to have a detrimental impact on education due to being 'incapable of attending with constancy'. He considered the disorder to run a benign course for most people as the disorder 'generally diminished with age'. This idea of ADHD-like disorders being childhood onset and restricted conditions was reflected in subsequent writings. George Still referred to children who had 'defects of moral control', while Franz Kramer and Hans Pollnow referred to a hyperkinetic disorder of infancy. Subsequently, several alternative terms were used to describe conditions like ADHD, including hyperactivity, hyperkinesis, minimal brain damage and minimal brain dysfunction. These conditions were generally considered to be childhood syndromes that are outgrown during adolescence.

Among the first authors to challenge the concept of ADHD-like disorders being restricted to childhood were Wood, Wender, Reimherr and colleagues (Wood, Reimherr, Wender, & Johnson, 1976). They noted that several longitudinal and adoption studies suggested that minimal brain dysfunction (MBD) persisted into adult life, where its existence was masked by the application of a variety of alternative diagnostic labels. To evaluate this hypothesis, they investigated a small sample of adults with MBD-like symptoms who gave a retrospective account of similar symptoms in childhood, supported by parent ratings of childhood hyperactivity. In a randomized controlled trial of methylphenidate, they found that 8 out of 11 showed a significant clinical response. They concluded that MBD may persist into adult life, with a lessening or reduction of symptoms in the 20s and 30s rather than the teens.

The idea of ADHD as a childhood onset disorder was included in DSM-II (1968) which described Hyperkinetic Disorder of Childhood, seen in childhood and usually diminishing by adulthood. DSM-III

(1980) provided for the first time more formal operational diagnostic criteria, including age of onset of symptoms before 7 years. The introduction of the age-7 criteria was not however based on empirical research but on clinical consensus at the time, and the view that hyperactive, impulsive and inattentive symptoms later in life might reflect stress related problems, such as starting school. The age-7 onset criterion was subsequently retained within DSM-IV which required 'some symptoms with impairment before the age of 7 years', although they did not specify that the full diagnostic criteria should be present before age 7. More recently, DSM-5 has for the first time applied a later age of onset criterion, requiring that 'several symptoms were present prior to age 12', but specifically not requiring impairment, indicating that people can be diagnosed with ADHD who would not have met criteria for ADHD before the age of 12 years. The reason for this change in age of onset from age 7 to age 12, and loss of the childhood impairment criteria, was in part related to recognition of the inaccuracy of retrospective recall, and research that highlighted that age of onset did not appear to predict clinical characteristics or treatment response. However, it is only more recently that age of onset beyond the age of 12 years has been widely discussed and remains a controversial question that is not yet fully resolved.

Regarding age of onset, several authors noted that not all children met the DSM-IV criteria for some symptoms with impairment before age 7. This was highlighted in a study using retrospective parent reports in children meeting DSM-IV ADHD criteria (Applegate et al., 1997). Age of onset of symptoms with impairment beyond age 7 was reported in 18% of youths meeting criteria for combined type ADHD, and 43% of those with inattentive type ADHD. The Great Smoky Mountain Study using data collected on a representative community sample, came to similar conclusions (Willoughby, Curran, Costello, & Angold, 2000). They collected data in 4 annual waves on 9 to 16 year-olds and found that 13% and 26% of children meeting criteria for combined and inattentive type ADHD respectively had onset of symptoms beyond age 7 years, with a small group reporting onset of symptoms after the age of 12 years. Studies of adults using retrospective reporting came to similar conclusions. For example, a study of 50 adults meeting all ADHD criteria apart from age of onset, found that 28% reported onset of symptoms beyond age 6, and that there was no difference in ADHD symptom severity or comorbidity between early and later onset groups (Hesslinger et al., 2003). This finding was confirmed in a study that compared a sample of 127 adults meeting full DSM-IV ADHD criteria including symptoms and impairment by age 7, and a sample of 79 adults presenting with all criteria but reporting the emergence of impairing symptoms beyond 7 years. In the late onset group 83% reported first emergence of symptoms and

impairments between 7 and 12 years, and 17% after the age of 12 years (Faraone, Biederman, Spencer, et al., 2006). Their comparisons found no differences in patterns of psychiatric comorbidity, functional impairment, familial risk and neurocognitive deficits between the early and later onset groups (Faraone, Biederman, Doyle, et al., 2006; Faraone, Biederman, Spencer, et al., 2006). Similar findings regarding neurocognitive deficits were reported in a study of 415 adult ADHD patients from Brazil, 50% of whom reported onset of impairing symptoms between ages 7–12 (Guimaraes-da-Silva et al., 2012). Critical to clinical decision making, the validity of the DSM-IV age 7 criteria was further challenged as no significant differences in response to methylphenidate were identified comparing early (by 7 years of age) and later onset cases in an evaluation of 180 children aged 4–17 years and 111 adults with ADHD (Reinhardt et al., 2007).

In conclusion, these earlier studies suggested there may be limited value in clinicians working with older children, adolescents and young adults focusing on age of onset, as no clinically meaningful differences were found between those reporting early and later onset of ADHD. These studies focused on challenging the DSM-IV criteria, and defined late onset as beyond 7 years, with most late onset cases presenting with emerging symptoms and impairment by age 12. However, they also found that a proportion of cases reported onset of symptoms beyond age 12. A limitation of these studies from the perspective of determining age of onset of ADHD was the reliance on retrospective recall, which led to the view that older adolescents or adults reporting late onset of ADHD may have met the criteria for early emerging ADHD symptoms and impairments, if only data had been collected prospectively at the time.

One study that addressed the issue of biased reporting of age of onset supported this view. The authors identified cases of ADHD based on a representative population sample of twins assessed at ages 7–19, and followed up 5 years later (Todd, Huang, & Henderson, 2008). The key finding was that of the initial sample of ADHD individuals (who met the onset by age 7 criteria and continued to meet all other ADHD criteria) 46% failed the age of onset criterion 5 years later according to parent or self-report. Change in reported age of onset from time 1 to time 2 ranged from 0.6 to 2.4 years for parent-report, and 1.0 to 2.9 years for self-report. Similar findings were also found for other disorders including oppositional defiant disorder, conduct disorder and major depressive disorder, so biased recall of age of onset did not appear to be specific to ADHD. Overall, around 10% of the sample reported onset of ADHD between the ages of 7–16, consisting of a combination of cases under-reporting early onset of symptoms, and new onset cases occurring between 7–16 years.

### Later emerging ADHD

In summary, the earlier studies of ADHD suggested that during childhood and adolescence, the majority show onset of some symptoms with impairment before age 7, with a significant proportion of cases reporting onset between 7–16 years of age. DSM-5 reflected these findings by raising the onset of ADHD symptoms (regardless of impairment) to age 12, but still does not account for individuals reporting onset of ADHD beyond 12 years. However, until recently there has been limited data following up individuals prospectively with and without childhood ADHD into early or late adult life, to infer more accurately the rate of later emerging ADHD.

Clues that later onset of ADHD might be a more frequent occurrence than previously thought, comes from examination of estimates for the prevalence of ADHD in adults, and estimates of the persistence of early onset ADHD. The persistence of ADHD into adulthood had been hotly debated. An early initial review of nine prospective follow-up studies suggested a 50% decline in prevalence of ADHD every 5-years (Hill & Schoener, 1996). The authors argued that assuming a 4% prevalence of ADHD in childhood, this suggested prevalence of ADHD by age 20 of 0.8%, and by age 40 of only 0.05%. Although based on limited data, this led many people to believe that most people grew out of ADHD by young adulthood. These early findings were however based on relatively few studies and are not reflected in subsequent reports.

A subsequent meta-analysis, based on a much larger dataset, also found a rapid decline of childhood ADHD during the transition from adolescence to adulthood, with an estimated 15% of childhood cases retaining full diagnostic criteria by the age of 25 years (Faraone, Biederman, & Mick, 2006). Assuming prevalence of childhood ADHD to be 7.2% (95% confidence interval 6.7–7.8), from a recent meta-analysis (Thomas, Sanders, Doust, Beller, & Glasziou, 2015), and that all ADHD starts in childhood, this suggests a prevalence of ADHD of 1.08% (95% CI 1.01–1.17) by age 25. This last study did however find that up to 65% of childhood cases had persistence of some ADHD symptoms still causing impairment, even though they did not meet full diagnostic criteria for ADHD. On this basis, around 4.68% (95% CI 4.36–5.07) are still impaired by persistence of ADHD symptoms, even though they do not all meet full diagnostic thresholds.

These estimates of prevalence of ADHD in adulthood from follow-up studies of children with ADHD contrast with prevalence estimates from cross-sectional epidemiological surveys, which from meta-analysis suggests rates of ADHD in adults in the range 2.5% to 3.4% (Fayyad et al., 2007; Simon et al., 2009). Most of these epidemiological surveys required full symptom criteria as adults, but only evidence of some symptoms (not the full diagnostic

criteria) as children. The discrepancies between these two ways of estimating ADHD prevalence in adults therefore raises the possibility that some cases of adult ADHD would not have met full criteria for ADHD as children. The epidemiological surveys generally applied weak criteria, reliant on retrospective recall, for the early childhood onset of ADHD symptoms, and are therefore consistent with the general conclusion that the adult ADHD population may consist of two groups of individuals: one with onset of the full ADHD diagnosis during early childhood that persists into adulthood, and a second with emergence of the full diagnostic criteria as older children or adolescents. However, differences in the way ADHD is assessed in clinical follow-up versus epidemiologic survey-based studies may also help explain discrepancies in prevalence, as clinical follow-up studies are more likely to use clinical interviews to identify cases while large epidemiologic studies more often use rating scales. Additionally, given the lower base rate of ADHD in the general population, epidemiological studies are more likely to identify false positives in a community-based setting where the disorder is less common than in a clinical setting.

### Prospective studies

Until recently there was limited information to clarify more precisely the range of ADHD age of onset past childhood, particularly emerging after age 12. A potential limitation of earlier studies assessing ADHD only in adulthood was the reliance on retrospective reporting of ADHD symptoms and impairments; and among clinical longitudinal studies there was a relative lack of prospective data on ADHD in people who did not present with ADHD as children.

To address these limitations, at the time of writing, there are nine published studies that examine the presence of late-onset ADHD based on prospective assessments of ADHD symptoms from childhood into later life. The majority provide information into adolescence or young adulthood with only two studies providing information on older adults. Below we provide an overview of these studies (see Table 1 for summary of studies). Since there is only limited data on onset in older adults, we consider separately the question of adult onset, before focusing on the question of later-onset during the adolescent/young adult years.

### Adult-onset ADHD

*New York ADHD cohorts comparison subjects.* Two New York based cohort studies longitudinally followed up boys with hyperactivity and behavioral problems, as well as matched comparison groups. Controls were recruited at the age 18 follow-up, from among individuals who received medical attention at the same medical center as the

hyperactivity/behavioral cases, but for routine physical exams or other acute physical issues. Potential comparison subjects had medical records that noted only unremarkable school behavior, and their parents were contacted and queried as to whether elementary teachers had ever expressed concern about their child's behavior. Children of parents who answered negatively were matched to probands on race (all were white), age and parental occupation (Klein 2012).

Follow-up of both probands and controls occurred at several ages in young and middle adulthood. At young adult follow-up in the first cohort (mean age of 25.6, range 23–29), one of the 95 controls (1.1%) met DSM III-R criteria for ADHD, compared with 7 of the 91 (7.7%) childhood ADHD probands. These diagnoses were based on a semi-structured psychiatric interview given to the participants by a doctoral level clinical psychologist and psychiatric social worker blinded to the participants' childhood ADHD group status (Mannuzza, Klein, Bessler, Malloy, & LaPadula, 1993). At a similar follow-up age in the second cohort (mean age 23.5 years) using a similar diagnostic approach as the first cohort, none of the control subjects met DSM-III-R ADHD criteria, compared to 4% of the childhood ADHD cases at follow-up (Mannuzza, Klein, Bessler, Malloy, & LaPadula, 1998).

Combining both cohorts, at the age 41-year follow-up seven (5.1%) of the control subjects met DSM-IV ADHD criteria. Of these seven individuals, only one had met ADHD criteria at the age 18 follow-up assessment. Furthermore, the prevalence of late-onset ADHD was higher at age 41 than age 25, suggesting an increase in prevalence into mid-life. While the comparison subjects were all considered to be free of ADHD and related behavior problems based on parent and teacher report in adolescence, all seven comparison participants who met ADHD criteria at age 41 reported the presence of impairing ADHD symptoms before age 12. Because this comparison group was not identified until after age 12 (they were identified at age 18), it cannot be ruled out that these individuals may have presented with childhood ADHD symptoms if they had been assessed prospectively in childhood (Klein 2012). Nevertheless, the longitudinal nature of this study's follow-up into midlife suggests there may be some individuals with no history of childhood ADHD who develop the full ADHD syndrome between the ages 18 to 41.

*Dunedin Multidisciplinary Health and Development Study.* The first study to examine the prevalence of late-onset ADHD by applying prospective data collection of childhood ADHD diagnoses was the Dunedin Multidisciplinary Health and Development Study. This study concluded that at the age of 38 years, most cases of adult ADHD did not begin as childhood ADHD (Moffitt et al., 2015). The study was

**Table 1** Published studies that examine the presence of late-onset ADHD based on prospective assessments

Study	Cohort	<i>N</i>	Childhood ADHD assessment	Age at childhood ADHD assessment	Childhood ADHD reporter	Adolescent/adult ADHD assessment	Period of onset	Age at adult ADHD assessment	Adult ADHD reporter	Total adult ADHD N (% total pop)	<i>N</i> late onset (% total pop)
Gittelman et al. 1985, Mannuzza et al. 1991, 1993, 1998, Klein et al. 2012	New York longitudinal ADHD cohorts, comparison subjects	178 (136 to age 41 follow-up)	Medical records; parents queried whether teachers had expressed concern about child's behavior	Participants visited same hosp. as cases at ages 5-12; parents contacted when participants age 18	Medical report, parent, teacher (via parent)	Schedule for the Assessment of Conduct, Hyperactivity, Anxiety, Mood, and Psychoactive Substances DSM-III/DSM-III-R at age 25, Structured Clinical Interview for DSM-IV Axis I Disorders at age 41	18-41	18, 25, 41	Participant	NA (control not population-based sample)	7 (5.1%) of 136 control subjects at age 41 with no childhood ADHD
Moffitt et al. 2015	Dunedin Multidisciplinary Health and Development Study	1,007	DISC-Child version; DSM-III criteria	11, 13, 15	Participant (via child psychiatrist ages 11, 13; trained interviewer age 15)	Structured diagnostic interview, DSM-5 criteria	16-38	38	Participant	31 (3.1%)	28 (2.8%)
Agnew-Blais et al. 2016	E-Risk Longitudinal Twin Study	2,040	Structured diagnostic interview, DSM-IV criteria	5, 7, 10, 12	Mother and teacher	Structured diagnostic interview, DSM-5 criteria	13-18	18	Participant	166 (8.1%)	112 (5.5%)
Caye et al. 2016	1993 Pelotas Birth Cohort	5,249	SDQ hyperactivity subscale (cut-off $\geq 8$ ) and impairment supplement	11	Parent (self-report in sensitivity analyses)	Structured interview, DSM-5 criteria	12-18/19	18/19	Participant	492 (12.2%) <sup>a</sup>	416 (10.3%)
Riglin et al. 2016	ALSPAC	4,824	SDQ hyperactivity subscale (childhood ADHD cut-off $\geq 7$ , borderline $6-7$ )	7	Parent	SDQ hyperactivity subscale (cut-off $\geq 7$ )	8-17	17	Parent	261 (5.4%)	122 (2.5%) (late-onset defined as $SDQ \geq 7$ at age 17 and $< 6$ at age 7)
Cooper et al. 2018	ALSPAC	4,953	SDQ hyperactivity subscale classified as close to average (0-5), slightly raised (6-7), high (8) and very high (9-10)	7, 8, 9, 12	Parent	SDQ hyperactivity subscale (cut-off $\geq 8$ )	13-17	17	Parent	142 (2.9%)	87 (1.8%) 'apparent late-onset'; 19 (0.4%) late-onset w/ average-to-below average childhood ADHD symptoms

(continued)

**Table 1** (continued)

Study	Cohort	N	Childhood ADHD assessment	Childhood ADHD reporter	Adolescent/adult ADHD assessment	Period of onset	Age at adult ADHD assessment	Adult ADHD reporter	Total adult ADHD N (% total pop)	N late onset (% total pop)
Sibley et al. 2017	Multimodal Treatment Study of ADHD, local normative comparison cohort	239	Baseline ADHD diagnosis via the DISC; ADHD symptoms at childhood follow-ups via the SNAP Rating Scale	Parent and Teacher	ADHD symptoms Adolescence: SNAP; Adulthood: CAARS, Impairment Adolescence: CIS; Adulthood: IRS	12- mean 24.4 years	Mean = 24.4	Adolescence: Parent, teacher, participant; Adulthood: Parent, participant	NA (total adult ADHD not assessed as did not included persistent ADHD)	8 (3.3%) late-onset (1.7% continuing past age 20) among a control cohort without childhood ADHD
Manfro et al. 2018	Brazilian High-Risk Study	924	DAWBA	Parent	DAWBA	13–17 years	Age range 13–17	Parent	54 (5.8%) (subthreshold childhood/adult ADHD excluded)	28 (3.0%) (subthreshold childhood/adult ADHD excluded)
Taylor et al. 2018	CATSS	15,436	Swedish National Patient Register, A-TAC	Clinical diagnosis (National Pat. Register), parent (A-TAC)	Clinical diagnosis (National Patient Register)	Over age 12	Adolescent-diagnosed 12–18, adult-diagnosed 18+	Clinical diagnosis (National Register)	NA (persistence of childhood ADHD cases to adulthood not established)	cases = 74 (0.48%), adolescent-diagnosed cases = 394 (2.55%)

ALSPAC, Avon Longitudinal Study of Parents and Children; A-TAC, Autism-Tics, AD/HD, and other Comorbidities (A-TAC) inventory; CAARS, Conner's Adult ADHD Rating Scale; CATSS, Child and Adolescent Twin Study; CIS, Columbia Impairment Scale; DAWBA, Development and Well-Being Assessment; DISC, Diagnostic Interview Schedule for Children; DSM, Diagnostic and Statistical Manual; IRS, Impairment Rating Scale; NA, not available; SDQ, Strengths and Difficulties Questionnaire; SNAP Rating Scale, Swanson, Nolan and Pelham Rating Scale.

<sup>a</sup>Demoninator is 4,039, the number of individuals with ADHD information at the age 17/18 follow-up.

based on data from a population-representative birth cohort from New Zealand and took a follow-forward and a follow-back approach to understanding the course of ADHD from childhood to middle adulthood. Childhood ADHD was assessed at ages 11, 13 and 15 with the Diagnostic Interview Schedule for Children – Child version, administered by a child psychiatrist at ages 11 and 13, and by trained interviewers at age 15 using DSM-III criteria. Adult ADHD was assessed when study participants were aged 38 and was based on self-report gathered using structured diagnostic interviews administered by trained interviewers who had tertiary mental health-related qualifications. Participants reported on ADHD symptoms (including example behaviors relevant to adult life) to which DSM-5 diagnostic criteria were applied except for the requirement of childhood onset of ADHD symptoms.

Among those who met ADHD criteria at age 38 ( $n = 31$ , 3% of the cohort), 90% did not meet criteria for ADHD at any of the childhood ADHD assessments (age 11, 13 and 15). The adult ADHD group, consisting of three individuals with childhood ADHD and 28 without, was characterized by a more even sex distribution than the childhood group (61.3% male in adulthood vs. 78.7% male in childhood), consistent with the sex distribution observed in epidemiological surveys of adult ADHD. The adult ADHD group was rated as having higher mean co-informant-rated ADHD symptoms compared with those who did not meet ADHD criteria in childhood or adulthood. Interestingly, the group who met ADHD criteria as children (but most no longer as adults) had similarly high co-informant ADHD ratings compared to the adult ADHD group, and continued to show functional and cognitive impairments, suggesting they may not have outgrown the disorder despite not meeting diagnostic criteria as adults based on their self-reports.

ADHD medication use was rare at the age 38 follow-up (and non-existent in childhood given the rarity of ADHD medication in the 1970–1980s in New Zealand): of the adult ADHD cases, at age 38 one individual with persistent ADHD and two with late-onset were taking ADHD medication. In childhood, the adult ADHD group was more likely to have had a diagnosis of conduct disorder than the comparison group (although less likely than the childhood ADHD group), but did not differ from the comparison group on rates of childhood depression or anxiety diagnoses. The adult ADHD group did not differ from the comparison group on measures of full-scale IQ at ages 7–11, but did show poorer reading achievement at ages 7–11 (although again they were less impaired than the childhood ADHD group).

In summary, this study estimated a population prevalence for ADHD in adults of 3%, and prevalence of 'late-onset' ADHD of 2.8%. However, the study included no assessments of ADHD between the ages of 15 to 38, so it is not possible to infer whether the

reported adult onset of ADHD reflects later-adolescent/young-adult onset, or later onset during the middle adult years. This study raised for the first time the idea that many adult ADHD cases may not have met ADHD criteria as children, but unfortunately lacked more detailed information to define more precisely the age of onset or stability of ADHD symptoms. After these findings from the Dunedin study were reported, other cohorts sought to examine this question. However, these further studies do not yet report beyond the mid-20s.

### *Adolescent/young adult-onset ADHD*

Several studies have examined the prevalence of late-onset ADHD during the adolescent or young adult years. These studies define late-onset ADHD as having an age of onset later than the age 12 cut-off specified by the DSM-5, at some point in adolescence or young adulthood.

### *Environmental Risk (E-Risk) Longitudinal Twin Study*

The E-Risk study is a longitudinal cohort of 2,232 British children drawn from a larger birth register of twins born in England and Wales from January 1, 1994, to December 4, 1995 (Trouton, Spinath, & Plomin, 2002). Study assessments occurred at ages 5, 7, 10, 12 and most recently age 18. At follow-up, the study sample represented the full range of socioeconomic conditions in the UK, as reflected in families' distribution on a neighborhood-level socioeconomic index (Odgers et al., 2012). Childhood-onset ADHD was assessed at ages 5, 7, 10 and 12 based on mother and teacher reports of 18 symptoms of inattention and hyperactivity-impulsivity and applied DSM-IV diagnostic criteria (Polanczyk et al., 2010). ADHD was again assessed at age 18 based on participant self-report gathered during private structured interviews. Adult ADHD diagnoses were made based on DSM-5 criteria, including 5 or more inattentive and/or 5 or more hyperactivity-impulsivity symptoms. These symptoms had to interfere with the participants' 'life at home or with family and friends' and 'life at school or work' (rated 3 or higher on a scale from 1, mild interference to 5, severe interference). Full DSM-5 criteria were met if parents or teachers also reported three or more ADHD symptoms at age 5, 7, 10, or 12 years, in line with the requirement for several symptoms by age 12.

Among those who met DSM-5 diagnostic criteria for ADHD at age 18 ( $n = 166$ , 8.1% of the entire cohort), 67.5% ( $n = 112$ ) did not meet full diagnostic criteria for ADHD at any of the four childhood assessments (Agnew-Blais et al., 2016). The DSM-5 age of onset criterion of several ADHD symptoms prior to age 12 was applied to all the adult ADHD cases in E-Risk, including the late-onset cases. This is in contrast to other studies that did not include

this criterion, or excluded late-onset cases if they had elevated but subthreshold childhood ADHD symptoms. However, it should be noted that more than 2 childhood ADHD symptoms reported at any childhood assessment by mothers or teachers is not a particularly stringent criterion, with over 63% of the E-Risk study sample meeting this threshold. Furthermore, among those with this level of childhood ADHD symptoms only 10.7% went on to develop late-onset ADHD. Also, among the 12.6% of the E-Risk study sample who had zero ADHD symptoms across childhood, 7% went on to develop symptoms and impairment consistent with late-onset ADHD (i.e. they would have met full DSM-5 ADHD criteria for ADHD except for the criterion requiring onset of several symptoms during childhood).

Those with late-onset ADHD had a female preponderance (44.6% male) compared with the childhood ADHD group (71.3% male). Co-informants rated participants on an 8-item ADHD symptom scale in which they were asked to rate problems the participant may have had over the past 12 months, including 3 items relating to inattention ('is easily distracted', 'can't concentrate, mind wanders' and 'lacks self-discipline') and 5 items relating to hyperactivity/impulsivity ('impulsive, rushes into things without thinking what might happen', 'makes "snap" decisions', 'is uncomfortable sitting still', 'always on the go in a hurry, fast paced', and 'fidgety, restless'). Those with late-onset ADHD had significantly more co-informant-rated ADHD symptoms than those who never had ADHD (mean 1.37 among late-onset vs. 0.42 among those who never had ADHD). In childhood, the late-onset group was more likely than controls to meet criteria for a diagnosis of conduct disorder, and had higher externalizing and internalizing behavior scores. They also had lower total IQ and poorer function on executive functioning performance tests (Mazes Task, Day-Night Task, Sentence Working Memory Task at age 5). The late-onset group was more likely to have grown up in households that were of lower social class, where a parent abused substances, and were more likely to be exposed to domestic violence and child maltreatment than those who never had ADHD. Among those with ADHD at age 18, only 13 individuals (7.8% of those with adult ADHD) reported taking ADHD medication within the last year.

### 1993 Pelotas Birth Cohort

Published concurrently with the E-Risk ADHD study was a study examining late-onset ADHD in the 1993 Pelotas Cohort, which follows children born in the city of Pelotas, Brazil in 1993 ( $n = 5,249$ ) (Caye et al., 2016). Follow-up visits with the full study population were conducted at ages 11, 15 and 18 (Gonçalves et al., 2014). At the age 11 assessment study

participants and their parents were administered the Brazilian Portuguese Version of the Strengths and Difficulties Questionnaire (SDQ) (Goodman, 1997), and a subset of the study population ( $n = 280$ ) was administered the Development and Well-Being Assessment (DAWBA) (Anselmi, Fleitlich-Bilyk, Menezes, Araujo, & Rohde, 2010). The DAWBA was used to estimate an optimal cut-off for ADHD on the SDQ of 8 or more on the parent-rated SDQ hyperactivity scale. Childhood ADHD was defined as a score of 8 or more on this scale plus at least 1 point in the impact supplement, yielding a sensitivity of 85.7% and specificity of 67.4%. While this specificity is relatively low, we would not expect this to lead to many false positive late-onset cases; if anything, more individuals would be classified as false positive childhood ADHD cases, which would remove them from the pool of potential late-onset cases.

At age 18/19 study participants were initially screened with an instrument based on the WHO Adult ADHD Self-Report Scale Screener (Kessler et al., 2005). Participants who answered positively to two or more questions were asked 12 additional ADHD symptom questions as part of a structured interview performed by trained psychologists. In accordance with DSM-5 criteria, a 5-item cut-off was applied, and subjects were considered a positive diagnosis if they endorsed symptoms in at least two of three settings (home, social and/or work/school) and stated that symptoms impaired their lives at least 'fairly' or 'a lot'. Among those with ADHD at ages 18/19 ( $n = 492$ , 12.2% of the cohort), 84.6% ( $n = 416$ ) did not meet criteria for ADHD at the age 11 assessment. The young adult ADHD group had a female preponderance (39% male), while the childhood ADHD group ( $n = 393$ , 8.9% of the cohort) showed the traditional male preponderance (63.9% male). Ten individuals were using ADHD medication at the age 18/19 follow-up. In summary, this study estimated a population prevalence for ADHD in adults of 12.2%, and prevalence of late-onset ADHD of 10.3% (Caye et al., 2016).

### Avon Longitudinal Study of Parents and Children (ALSPAC) 2016

Following the publication of the E-Risk and Pelotas late-onset ADHD studies, a study from the Avon Longitudinal Study of Parents and Children (ALSPAC), focusing on polygenic risk and ADHD across development, also assessed the possibility of late-onset ADHD (Riglin et al., 2016). ALSPAC is a prospective birth cohort study that included 14,541 expectant mothers in Avon, England in 1990, of which 13,988 offspring of these pregnancies were alive at 1 year, and an additional 713 children were enrolled when the oldest children were about age 7 years, resulting in total sample size of 14,701 children at 1 year.

ADHD symptoms were assessed using the parent-rated 5-item Strengths and Difficulties Questionnaire (SDQ) (Goodman, 1997) hyperactivity subscale (scale score range from 0–10). High ADHD symptom levels were defined as 7 or higher. At age 7, the SDQ was found to have high sensitivity (0.86) and specificity (0.90) compared to ADHD diagnoses made based on parent reports on the DAWBA (Goodman, Heiervang, Collishaw, & Goodman, 2011). Latent growth curve analysis examining repeated measures of the SDQ subscale did not empirically identify a late-onset group. Therefore, late-onset ADHD was defined as those who had less than borderline ADHD symptoms (defined as a score of 5 or less on the SDQ subscale) at age 7, but fell above the symptom cut-off (score of 7 or more) at age 17 ( $n = 122$ , 2.5% of the entire sample). Overall, the estimated prevalence of ADHD at age 17 was 5.4%, of which 2.2% were persistent cases from childhood, 0.7% were late-onset cases with borderline levels of ADHD symptoms at age 7 (SDQ score = 6 symptoms), and 2.5% were late-onset cases with less than borderline ADHD symptoms (SDQ score < 6) at age 7 (Riglin et al., 2016).

### ALSPAC 2018

A follow-up study to the earlier ALSPAC report further explored the childhood ADHD symptoms of those who met study criteria for late-onset ADHD to better understand whether: (a) some late-onset individuals may have been misclassified and actually had elevated childhood ADHD symptoms, and (b) the profile of neurodevelopmental impairments of those with 'genuine' late-onset ADHD differed from those with childhood-onset of elevated ADHD symptoms (Cooper et al., 2018).

To investigate these hypotheses, this study defined an 'apparent late-onset' group who fell below a score of 8 on the SDQ-hyperactivity scale at age 12, and at or above a score of 8 at age 17. This group was further subdivided based on childhood ADHD symptoms gathered at ages 7, 8, 9 and 12 years. A group was classified as 'genuine late-onset' if they had 'close to average score' (0–5) at ages 7, 8, 9 and 12 and 'high or very high' (8–10) at age 17. Another group was classified as potentially 'misclassified', if they had slightly raised (6–7), high (8), or very high (9–10) ADHD symptoms at ages 7, 8, 9, or slightly raised (6–7) at age 12, and then very high (8–10) at age 17, consistent with the DSM-5 criterion of several symptoms by age 12.

Among the original apparent late-onset group ( $n = 87$ ), reflecting 1.8% of the population, 12 individuals were missing earlier childhood ADHD information. Among the remaining 75 individuals,  $n = 56$  (74.7%) showed evidence of elevated childhood ADHD symptoms at least at one age and were classified as 'potentially misclassified late-onset' cases. Nineteen (25.3%) had only lower or average

ADHD symptoms at each childhood assessment, with onset of elevated symptoms between ages 12–17, and were therefore classified as 'genuine late-onset'. Using this approach, the estimated rate of genuine late-onset ADHD was around 0.4% of the population, with an additional 1.1% in the potentially misclassified late-onset group.

In childhood, the 'genuine late-onset' group did not differ from those with consistently low ADHD symptoms on SDQ-rated emotional, conduct, or peer problems or on prosocial behavior. However, at age 17 this group was rated more poorly across each of these scales. The 'potentially misclassified late-onset' group generally performed at an intermediate level between the genuine late-onset group and the childhood-persistent group on childhood and young adult assessments (Cooper et al., 2018).

### Multimodal Treatment Study of ADHD local normative comparison group

More recently, the control group of a treatment study of ADHD with longitudinal follow-up was used to examine potential late-onset ADHD. The Multimodal Treatment Study of ADHD (MTA) compared the effects of different ADHD treatments among children diagnosed with combined-type ADHD. Classmates of study participants were recruited to represent a local normative comparison group (LNCG) 2 years after study baseline ( $n = 289$ ): children were randomly selected from study participant classrooms and group-matched for sex.

Individuals were included in this study if they did not receive a diagnosis of ADHD at baseline with the Diagnostic Interview Schedule for Children ( $n = 239$ ). Follow-up assessments were then conducted 2, 3, 6, 8, 10, 12, 14 and 16 years after baseline, allowing for a detailed longitudinal profile of study participants (Sibley et al., 2017). ADHD symptoms in childhood were assessed using the SNAP Rating Scale (Swanson, 1992) based on parental, teacher and (in adolescence) self-report. ADHD in adulthood was assessed with the Conners' Adult ADHD Rating Scale (Conners, Erhardt, & Sparrow, 1999) based on parent and self-report (Sibley et al., 2017).

Among this pool of LNCG participants, potential cases of ADHD developing in adolescence and adulthood were identified using a multi-step procedure. The authors identified many potential late-onset ADHD cases using a liberal symptom cut-off, and then applied additional criteria sequentially to exclude individuals. The steps were as follows. To identify a large pool of potential cases, ADHD symptoms at each assessment were summed if endorsed by any informant after age 12 as assessed by the SNAP (rated by parent, teacher or the participant) in adolescence, and by the CAARS (rated by parent or the participant) in adulthood. If the number of symptoms exceeded the DSM cut off for that age, the individual was considered a potential late-onset

case. To this pool a series of exclusionary steps were applied. First, those in the potential case pool were excluded if they did not show impairment at the time of elevated ADHD symptoms, defined as a score of 3 or higher (out of 4) on the 'getting along with kids own age', 'schoolwork', 'behavior at home' or 'behavior at school' domains of the parent rated Columbia Impairment Scale (Bird, Shaffer, & Fisher, 1993) in adolescence, or a response of 3 or higher out of 6 on the parent or self-rated versions of the Impairment Rating Scale in adulthood (Fabiano, Pelham, & Waschbusch, 2006). Second, individuals were excluded if childhood SNAP assessments showed symptom levels exceeding the DSM cut-off at any point before age 12, since they would meet the DSM-5 age of onset criterion of several symptoms by age 12. Third, remaining cases were excluded if ADHD symptoms occurred exclusively in the context of heavy substance use, defined as self-reported marijuana or other drug use more than twice per week. Fourth, remaining cases with a pre-existing or concurrent mental health disorder identified by the Diagnostic Interview Schedule for Children (Shaffer, Fisher, & Lucas, 2000) were reviewed by a clinical panel that determined whether ADHD symptoms or impairment were 'better explained by another mental disorder'. If so, these individuals were excluded as potential cases of ADHD. Fifth, symptoms were determined to be cross-situational if at least two symptoms were reported, by both the parent and teacher, or by both the participant and another informant. Symptoms endorsed by self, parent or teacher report were additionally assessed to be sure they did not refer to the same setting; those whose symptoms were situation-specific were excluded.

In the LNCG, above DSM-5 threshold ADHD symptoms and impairment were seen in 13.4% ( $n = 32$ ) of the sample during adolescence (aged 12–17), and 16.7% ( $n = 40$ ) during young adulthood (aged > 17). Of these, 27 had SNAP ratings reported by at least one source that met the DSM-5 symptoms count criteria before age 12 and were therefore excluded as potential late onset cases, leaving 45 (18.8% of LNCG) cases of apparent adolescent or adult onset ADHD. Of those remaining, 17 participants were excluded because they were determined to only meet ADHD symptom and impairment criteria in the context of heavy substance use. A further 12 were excluded based on the conclusions of the panel that another disorder better explained ADHD symptoms or impairment, leaving 16 cases (6.7% of LNCG). Of the 16 remaining potential cases with full information at follow-up, eight were excluded due to lack of cross-sectional symptoms (i.e. they had elevated symptoms reported by only one source or symptoms reported by multiple sources that referred to the same setting). After these exclusions, eight individuals (3.3% of the study population) were found to have late-onset ADHD: 6 individuals (2.5% of the control sample) with adolescent-onset defined

as 12–17 years, and 2 (0.8%) individuals with adult-onset.

Among the final group of eight late-onset ADHD individuals, 3 (1.2% of LNCG) of the adolescent-onset group potentially met the DSM-5 criteria of several ADHD symptoms by age 12, since there was evidence for 'three or more childhood symptoms of inattention and hyperactivity/impulsivity', leaving a group of 5 (2.1% of LNCG) with no evidence of even subthreshold symptoms during childhood. Four of the adolescent onset group also exhibited an adolescent/young-adult limited course of the disorder, with a remission of symptoms before age 20. The two individuals with adult-onset of ADHD both met criteria for ADHD at only one timepoint (Sibley et al., 2017).

Overall, using a rather conservative approach was unable to remove all potential cases of late onset ADHD. Although only four individuals were identified who showed an adult-onset or persistent adolescent-onset course following late onset of ADHD, this still reflected 1.7% of the LNCG sample.

### *Brazilian High-Risk Cohort*

The Brazilian High-Risk Cohort is a school-based community cohort of 2,511 children (1,554 high-risk and 957 randomly selected (Salum et al., 2015)) who received psychiatric evaluations at baseline and after three-year follow-up with the DAWBA administered to parents. Restricting to participants who were less than age 12 at baseline and older than age 12 at follow-up, this study identified community comparisons ( $n = 806$ ) who had no more than two ADHD symptoms at baseline or follow-up (and no other psychiatric disorder at baseline), childhood-limited ADHD ( $n = 64$ ) who met ADHD diagnostic criteria at baseline and had no more than two ADHD symptoms at follow-up, persistent ADHD ( $n = 26$ ) who met ADHD criteria both in childhood and at follow-up, and youth-onset ADHD ( $n = 28$ ) who had no more than two ADHD symptoms at baseline and met ADHD criteria at follow-up (Manfro et al., 2018). The mean age at baseline for these groups ranged from 9.8–10.1 years and at follow-up from 13.1–13.6 years.

While late-onset individuals in this study did not meet ADHD criteria or have subthreshold ADHD symptoms before age 12, they exhibited a higher number of other psychiatric symptoms reported by parents and teachers on the SDQ before the age of 12, compared to community controls. However, the late-onset group did not show high rates of meeting *full* criteria for other disorders (three had oppositional defiant disorder and one had depression). This study found the youth-onset ADHD group had a higher *p*-factor (the shared variance in psychiatric symptomatology) score compared to the community comparison group, especially for the externalizing factor. This youth-onset group also showed poorer

global executive functioning, lower reading and writing scores, and worse academic performance than comparison study participants at childhood baseline.

In order to create unambiguous ADHD diagnostic groups in this study (e.g. late-onset ADHD with no evidence of elevated childhood symptoms), sub-threshold ADHD cases were excluded entirely. This means that the late-onset group is more distinctly late-onset, as they did not have evidence of the 'several' childhood ADHD symptoms required by the DSM-5, and the remitted group is distinctly remitted, as they did not show subthreshold symptoms after childhood. Using these criteria, the persistent and late-onset groups are of about equal size: about half of the adult ADHD group is late-onset which accounts for 2.9% of the overall study population. However, the exclusion of any subthreshold cases also means that extrapolation to a more naturalistic young adult ADHD population is somewhat limited, as those individuals who were subthreshold in childhood and went on to meet full ADHD criteria in young adulthood are not included in the young adult ADHD population. Therefore, we cannot determine the exact proportion of the total young adult ADHD group that is late-onset as we do not know what proportion of this group may have been subthreshold in childhood.

#### *Child and Adolescent Twin Study in Sweden (CATSS)*

A recent study used data from the Child and Adolescent Twin Study in Sweden (CATSS), in combination with the Swedish National Patient Register, to identify participants diagnosed with ADHD in childhood, adolescence and adulthood (Taylor, Larsson, Gillberg, Lichtenstein, & Lundström, 2018). This study included all CATSS birth cohorts between 1992 and 1999 and identified three ADHD groups: an 'adult diagnosed' group, who received an ADHD diagnosis in the National Register after age 18 ( $n = 74$ , 0.48%), an 'adolescent diagnosis' group, who were diagnosed between the ages of 12–18 ( $n = 394$ , 2.55%), and a 'childhood diagnosis' group, diagnosed prior to age 12 ( $n = 194$ , 1.26%). The remaining 14,474 participants were the non-ADHD comparison group. In Sweden, childhood diagnoses of ADHD are made by child and adolescent psychiatry specialists with a recommended five-step process that includes an interview with the patient, parents and other relatives; a survey of the patient's daily function; a psychological assessment; and a medical evaluation. When CATSS participants were ages 9/12 parents were administered the Autism-Tics, AD/HD, and other Comorbidities (A-TAC) inventory (Hansson et al., 2005), a fully structured interview that broadly assesses neuropsychiatric symptoms.

ADHD diagnosed groups had higher mean A-TAC ADHD scores than the comparison group, with the childhood diagnosed group showing the highest

average symptom level (9.86) followed by the adolescent diagnosed group (6.14) and the adult diagnosed group (5.18) compared to controls (1.73). They also had higher scores on the ASD, motor functioning, learning, tics, conduct and ODD scales, of a similar pattern in which the childhood diagnosed group had the highest scores, followed by the adolescent and adult diagnosed groups. Additionally, 50% of the adult-diagnosed group received another diagnosis (other than ADHD) as children in the National Register, as did 63.5% of those in the adolescent-diagnosed group and 73.2% in the childhood-diagnosed group, compared with 20.1% in the comparison group. This study also investigated whether those who did not receive an ADHD diagnosis until adulthood showed 'no discernible evidence of earlier impairments'. Among the 74 individuals diagnosed with ADHD in adulthood, 21 scored below the population mean for the ADHD scale on the A-TAC at age 9/12. Among this subset, mean scores on the other subscales of the A-TAC did not differ from controls; however 57.1% of these 21 participants received a childhood psychiatric diagnosis other than ADHD. Therefore, nine cases (six female), representing 12.2% of those with ADHD diagnosed with adulthood, did not show any evidence of childhood mental health problems.

#### **Possible explanations for late-onset ADHD**

In conclusion, the more recent follow-forward prospective studies of ADHD in population or control cohorts are in general consistent with conclusions drawn from the earlier studies that relied on retrospective recall. Both sets of studies establish that ADHD can emerge between the ages of 7–12 years, and that in at least some cases onset of the disorder (meeting full current diagnostic criteria for ADHD) occurs beyond age 12. Among the late-onset cases there appears to be a mix of those that would meet the DSM-5 criterion of several ADHD symptoms by age 12, as well as a group that would not meet this criterion.

Although the Dunedin study identified a very large proportion of adults meeting current criteria for ADHD at age 38 who did not meet ADHD criteria during childhood, they lacked data on ADHD between the ages of 15–38; therefore the age at which the participant first met ADHD criteria within that range is not clear. Some evidence for the idea that ADHD might arise in some cases during middle adulthood is also supported by the earlier New York studies. However, the relative dearth of data on later-adult onset of ADHD means that no firm conclusions can be drawn on these figures, and further data are required to address the idea of ADHD emerging beyond the adolescent/young adult years. The other studies provide information on childhood versus middle to late-adolescent onset, and here there is far more data to consider, with repeated reports of

later-onset of ADHD from different study designs. We therefore focus most of our discussion on the occurrence of ADHD onset during the adolescent and young adult years.

There have been several explanations put forth to account for late-onset ADHD in the studies reported to date. Each of these explanations could account for possible false positive cases of late-onset ADHD. We discuss each below as well as the extent to which the studies that have been done so far support or refute the potential explanation.

### *Change of informant reporting ADHD symptoms*

One potential explanation for cases of ADHD that appear after childhood is that a change in the reporter of ADHD symptoms from childhood to adulthood identifies different individuals as having ADHD. In two of the population-based studies, the E-Risk and Pelotas cohorts, childhood ADHD was assessed by either mother, or mother and teacher, report and young adult ADHD by self-report, so this change in rater could potentially explain the emergence of ADHD cases in young adulthood in these studies. The Dunedin study also relied on self-report of ADHD symptoms in adulthood, although childhood ADHD was assessed via clinician interview at several assessments. To offer some insight as to whether others corroborate self-report of ADHD symptoms in young adulthood, the E-Risk and Dunedin studies collected information from co-informants regarding study participants' ADHD symptoms. In both studies, co-informants rated late-onset cases as having significantly more ADHD symptoms than non-ADHD controls (Agnew-Blais et al., 2016; Moffitt et al., 2015).

However, many studies have identified a relative lack of agreement between parent- and self-report of ADHD symptoms (Sibley et al., 2012). In one follow-up study of children with combined type ADHD into young adulthood, persistence of ADHD was found to be 79% using parent-reported ADHD, and 44% using self-reported ADHD, with a stronger association of parent-reported ADHD with neurocognitive impairments (Du Rietz et al., 2016). Much of the research in this area suggests individuals with childhood ADHD tend to underreport their own ADHD symptoms compared to parent-reported ADHD. While this could account for the relatively low persistence rates of childhood ADHD reported in some studies, it is unlikely to account for over-reporting that would be necessary to generate a 'false-positive' late-onset ADHD population.

Studies from the ALSPAC cohort offer convincing evidence that change of ADHD symptom informant does not entirely explain the presence of a late-onset ADHD group. In this cohort ADHD was assessed by parent report both in childhood and young adulthood. Nearly half of the young adult ADHD group, as identified by parent report, did not meet borderline

criteria for ADHD at age 7 (Riglin et al., 2016); and 25.3% of late-onset individuals had low to average ADHD symptoms across all childhood assessments up through age 12 (Cooper et al., 2018). Additionally, in the Brazilian High-Risk Study parent-report was used both in childhood and adolescence and found about half of those who met full ADHD criteria in young adulthood were late-onset (Manfro et al., 2018). Therefore, it seems we can safely conclude that the change in rater from parent to self does not completely account for those individuals with apparent onset of ADHD after childhood.

However, the question remains: how do adults without childhood ADHD report their ADHD symptoms? A recent study by Sibley et al. found self-report resulted in a more frequent endorsement of ADHD symptoms compared with parent-report among 18–28 year old controls without ADHD. However, this study did not include controls who met symptom criteria for adult ADHD, was 85% male and did not report a full clinical diagnostic assessment (Sibley et al 2012). While a higher rate of endorsement of symptoms by self- versus parent report is suggestive that self-report may lead to more ADHD diagnosis than parent-report, future research should further examine this question in the context of a full ADHD diagnosis in a representative population. One study in a population referred for adult ADHD assessments compared co-informant, self and clinician symptom reports. They also found that co-informant report resulted in fewer symptoms endorsed than self-report, but that self-report resulted in fewer symptoms endorsed compared with clinician report. They concluded that 'if patients underreport the severity of their symptoms, partners do so even more' (Kooij et al., 2008). This and other studies support the use of self-report of ADHD symptoms in treatment seeking and referred populations. More work is needed to understand how individuals without childhood ADHD self-report their ADHD symptoms compared to co-informants *and* compared with clinical assessments, as well as to establish the accuracy of self-report of pervasiveness and impairment, especially in general population samples.

Assuming that self-report identifies at least some different individuals as having late-onset ADHD than parent-report, does this imply self-report is inherently inaccurate? Parent report may become less appropriate as individuals age, move out of the home and may no longer be in daily contact with parents. Additionally, studies have found that the ADHD symptoms that are most likely to continue into adulthood are those which tap into more internal processes; for example what may have presented as fidgetiness or inability to sit still in childhood may be experienced as feelings of internal restlessness in adulthood and consequently, be less apparent to outside observers (Asherson, 2005; Asherson, Buitelaar, Faraone, & Rohde, 2016). Whether a change

from parent-report to self-report in adulthood may appropriately reflect changes in the nature of ADHD symptoms into adulthood remains to be fully explored. Most research comparing self- and parent-report of ADHD symptoms has been conducted among individuals who had childhood ADHD, but this question has yet to be investigated among individuals with apparent late-onset ADHD. Studies have found self-report to have high agreement with clinical interview in both non-clinical and clinical populations, suggesting that self-report can also provide an acceptable source of ADHD symptoms (Ustun et al., 2017).

### *Not ADHD but other disorders*

Another explanation for the late emergence of ADHD symptoms is that these are not symptoms originating from ADHD itself, but rather reflect one or more other mental health disorders. ADHD symptoms may be viewed as relatively non-specific, and a myriad of other disorders could potentially present with ADHD symptoms: depression is associated with difficulty focusing on tasks, anxiety may cause distractibility, substance use may lead to low arousal levels and lack of motivation, and so on. From the first paper identifying a large apparent late-onset ADHD population, the possibility that late-onset ADHD symptoms might be better explained by another disorder has been grappled with. The Dunedin study notes that although 'it is tempting to conclude that adult ADHD is secondary to substance abuse', further analyses revealed that 55% of participants with adult ADHD had no other concurrent diagnosis at age 38, so the ADHD symptom picture appeared to be present alone in many late-onset cases (Moffitt et al., 2015). Similarly, the E-Risk and Pelotas studies addressed the possibility that late-onset ADHD is better explained by symptoms of other disorders by excluding from the late-onset ADHD group anyone with another common comorbidity: in the case of E-Risk anyone with diagnoses of anxiety, depression, and marijuana and alcohol dependence; and in Pelotas anyone with major depressive disorder, bipolar disorder, generalized anxiety disorder, social anxiety disorder or regular use of illicit drugs. This resulted in the exclusion of two-thirds of the E-Risk late-onset population and about half of the late-onset group in Pelotas (Agnew-Blais et al., 2016; Caye et al., 2016). However, these are necessarily crude ways to exclude this possibility, as ADHD has been found time and again to be highly comorbid with other disorders (Faraone et al., 2015), and simply the presence of a comorbid mental health problem does not negate the possibility of an ADHD diagnosis.

The MTA Study had more detailed information regarding comorbidities to make decisions about differential diagnosis. Rather than necessarily excluding individuals with one of the commonly

comorbid diagnoses, potential late-onset cases were considered for a differential diagnosis by an author panel of psychiatrists and clinical psychologists if they had at least one comorbid mental health diagnosis over follow-up on the DISC (Sibley et al., 2017). Members of the panel reviewed onset and chronicity of all mental health symptoms of comorbid disorders at each follow-up assessment to determine whether a case should be excluded based on ADHD symptoms being attributable to another disorder. Of the 28 potential late-onset ADHD cases, 10 were excluded due to the determination that other disorders accounted for ADHD symptoms or impairment and two were missing data on comorbidities at one follow-up point, so were summarily excluded. Their results point to a similar percentage as identified by the population-based cohort studies of the late-onset ADHD group who had significant comorbid disorders that may contribute to ADHD symptoms. Furthermore, even after excluding all these comorbid cases they report that 3.3% of their control sample met late-onset ADHD criteria (1.7% with adolescent-persistent or adult-onset course).

In our view, the very high rate of comorbid mental health problems, and the lack of evidence that other conditions commonly generate above threshold levels of ADHD symptoms among those with apparent childhood-onset ADHD, suggests it may be premature to apply strong exclusionary criteria to the ADHD diagnosis in the presence of comorbidity, even in the case of late-onset ADHD. For example, it has also been argued that ADHD itself often mimics other common mental health conditions (Asherson et al., 2016), leading to under diagnosis of ADHD in clinical practice. Furthermore, it is to be expected that at least some of the excluded cases in the MTA study could be ADHD presenting with comorbid conditions or drug use, which are common in ADHD. In our own study of adults meeting criteria for ADHD and drug dependency, although we did find that severity of ADHD reduced once drug taking had ceased, the individual cases still met criteria for ADHD (Huntley et al., 2012). We also found that adults with ADHD score highly on interview assessments of general psychopathology even in the absence of concurrent mental health conditions or drug use (Skirrow & Asherson, 2013). Overall, these findings do not exclude the possibility that other disorders can account for apparent late-onset of ADHD, but caution is needed in making the strong assumption that all comorbid late-onset ADHD cases are better accounted for by the other disorder.

### *Childhood and subthreshold ADHD that was not captured by population-based studies*

Another possible explanation for late-onset ADHD is that these population-based studies simply missed cases of ADHD in childhood. The Pelotas

and ALSPAC studies have the limitation of using the 5-item hyperactivity scale of the SDQ, which given its brevity, could miss childhood ADHD cases. However, the sensitivity of the SDQ hyperactivity scale reported in these two cohorts is relatively good (about 85%) estimated using diagnostic interviews given to subsamples of the study population. The E-Risk study assessed the full set of 18 DSM ADHD symptoms for hyperactive-impulsive and inattentive symptoms at four time points across childhood, which likely increased the ability to identify childhood ADHD cases. In the Dunedin study, ADHD at ages 11 and 13 was assessed based on interviews with child psychiatrists, which is the gold standard for diagnosis, suggesting it would be unlikely that many childhood ADHD cases were missed in the adult ADHD group. Additionally, rates of childhood ADHD identified in each of these population-based studies are similar, or in some cases on the high end, of estimated prevalence rates for ADHD, suggesting it is unlikely that late-onset ADHD was identified because these studies simply missed large numbers of childhood ADHD cases.

Relatedly, late-onset ADHD could arise from individuals who fell just below the threshold for meeting ADHD criteria in childhood who then crossed over the threshold in adulthood. The Dunedin study addressed this question by providing the distribution of teacher-reported childhood ADHD symptoms at ages 5, 7, 9 and 11 and found that while most childhood ADHD cases had at least one symptom rated as 'certainly' present by teachers, few individuals in the adult ADHD group exhibited symptoms as 'certainly' present in childhood. Furthermore, the mean childhood ADHD symptom score of the adult ADHD group as prospectively rated by parents did not differ from controls without ADHD (Moffitt et al., 2015). Supplemental tables in the E-Risk study also point to the low number of childhood ADHD symptoms exhibited in the late-onset group: the majority of the late-onset ADHD group had zero or one symptom of inattention or hyperactivity/impulsivity at age 12, suggesting those with late-onset ADHD were not hovering just below the ADHD symptom cut-off, even by the beginning of adolescence (Agnew-Blais et al., 2016). In sensitivity analyses in the Pelotas cohort, the SDQ cutoff score for childhood ADHD was lowered from 8 to 5, to assess whether children with ADHD just below the threshold were being erroneously categorized as late-onset; however even after excluding these additional sub-threshold childhood ADHD cases, 51% of the young adult ADHD group still did not meet the childhood ADHD diagnostic threshold using this lower cut off (Caye et al., 2016).

One recent study that interrogated the question of whether those with late-onset ADHD exhibited sub-threshold ADHD symptoms in childhood is the most recent late-onset study from the ALSPAC cohort

(Cooper et al., 2018). This study found that excluding individuals who scored as having slightly elevated ADHD symptoms at any of several childhood time points reduced the number of late-onset individuals. More specifically, of those with 'apparent late-onset ADHD', nearly 75% showed evidence of elevated childhood ADHD symptoms in childhood (slightly raised, high or very high symptoms at ages 7, 8, 9, or slightly raised at age 12) and were considered by the study to be 'potentially misclassified'. Additionally, in the MTA study, potential cases were excluded if they had elevated symptoms reported by at least one reporter at any childhood ADHD assessment on the SNAP (although they did meet criteria for a full ADHD diagnosis based on the DISC at baseline). Additionally, the study in CATSS using Swedish Register data found that 28.4% of those diagnosed with ADHD in adulthood fell below the population mean on the parent rated A-TAC ADHD Scale (Taylor et al., 2018). The Brazilian High-Risk Study only included individuals as late-onset cases if they had two or fewer childhood ADHD symptoms as rated by parents on the DAWBA, thereby excluding subthreshold childhood ADHD cases (Manfro et al., 2018). This approach of excluding those without a childhood diagnosis, but elevated or subthreshold childhood symptoms, is in contrast to several of the population-based cohort studies that only excluded potential late-onset cases if they met full childhood ADHD criteria at any point in childhood.

It remains an open question what level of childhood ADHD symptoms and/or impairment should constitute an exclusion from a 'late-onset ADHD' categorization. The DSM-5 offers relatively vague guidance as to what is considered childhood onset, by specifying 'several symptoms prior to age 12' (American Psychiatric Association, 2013). Whether the vagueness of this guideline was intentional, to reflect potential issues with recall of childhood ADHD symptoms, or rather recognition that some individuals with ADHD in adulthood may not have met full diagnostic criteria in childhood, is unclear. Overall, the weight of the evidence from population-based studies indicates that while some late-onset cases fall just below the symptom cut off in childhood and would meet DSM-5 criteria for ADHD (i.e. 3–5 symptoms in either symptom domain, with or without impairment), there remains a group with few if any symptoms who do not fall just below the symptom cut off in childhood. It is also possible that there are some individuals who exhibited few ADHD symptoms, but had clinically significant impairment and may have received an ADHD diagnosis in a clinical setting, but would not have been identified as ADHD cases or subthreshold cases based on symptom count only. However, it is important to consider that most individuals with 'several' ADHD symptoms at any point in childhood do not go on to develop late-onset ADHD, as supported by data from the E-

Risk study that only about 11% of children with 3 or more ADHD symptoms would later meet criteria for ADHD at age 18.

It has also been suggested that evidence of onset prior to age 12 need not be based only on elevated ADHD symptoms, per se, but rather also based on the presence of externalizing disorders such as oppositional defiant disorder or conduct disorder, or any deviation from a neurotypical childhood profile that could constitute evidence of childhood onset. Indeed, several of the studies converge in the finding that those who have later onset of ADHD exhibit elevated mental health problems in childhood as evidenced by for example, higher p-factor scores, higher A-TAC scores, more frequent diagnosis of other mental health problems in clinical settings, and more parent reported CD/ODD. So, it seems that while this late-onset group does not meet ADHD diagnostic criteria in childhood, they may exhibit higher rates of other disorders and mental health problems, especially externalizing problems, that may place them at higher risk to later meet full ADHD criteria after age 12.

#### *Childhood ADHD that was masked by the family environment or high IQ*

It has also been suggested that late-onset ADHD may be accounted for by individuals who have a similar biologic predisposition for ADHD, but for whom the disorder was not apparent in childhood because it was masked, for example by a particularly protective family environment or high childhood IQ. While this explanation has obvious intuitive appeal and is consistent with the experience of many clinicians, so far there is limited evidence for this hypothesis.

Regarding those with late-onset ADHD having high IQ, while several studies find those with late-onset ADHD do not show neuropsychological impairment to the extent of those with childhood ADHD, there is less evidence for particularly high IQ in this group on average. The Dunedin study found that those with late-onset ADHD had IQ at ages 7–11 that was slightly lower, although not significantly so, than controls without ADHD, and had scores on reading achievement tests that were significantly lower than controls (Moffitt et al., 2015). The E-Risk study found those with late-onset ADHD had lower IQ at age 5 than controls who never had ADHD (101.4 in the control group and 96.91 in the late-onset group) as well as significantly lower scores on a measure of executive functioning at age 5 (Agnew-Blais et al., 2016). Additionally, in the ALSPAC study late-onset individuals had slightly lower IQ in childhood and adolescence compared to those with consistently low symptoms (Cooper et al., 2018). However, some supportive evidence of this pattern comes from the MTA study, which identified two individuals with late-onset ADHD who showed high IQ (Sibley et al., 2017).

The population-based studies that have examined this high IQ explanation have so far only examined mean IQ in the late-onset group, which does not rule out the possibility that this could account for a subset of late-onset cases, even if it does not appear to explain the phenomenon overall. We examined data in the E-Risk study to determine whether there might be a subgroup of late-onset individuals who exhibited high IQ in childhood. We identified 5 individuals (4.5% of those with late-onset ADHD) whose IQ was 115 or above at both age 5 and age 12. So, while it seems the protective effect of high IQ might mask ADHD in childhood among some individuals with late-onset ADHD, this pattern does not seem to describe the majority of those with late-onset ADHD and cannot be considered as a general explanation for later emerging ADHD.

Evidence is also lacking regarding the kind of protective family environment that might scaffold children who would otherwise present with ADHD. The E-Risk study provides some information about the childhood environments of those who developed late-onset ADHD (Agnew-Blais et al., 2016). Overall the family home environment of those with late-onset ADHD was more like those with childhood ADHD than controls without the disorder. Compared with non-ADHD controls, those with late-onset ADHD were more likely to be low SES in childhood, to have a parent with a history of substance use problems, and to be exposed to domestic violence and childhood maltreatment. While these characteristics don't paint a picture of a particularly supportive family environment, what is not available are questions more specific to a parent buffering children from the impact of ADHD, such as whether parents focus on consistency and routine, or frequently remind children to complete tasks in daily life. This hypothesis of the childhood scaffolding of late-onset cases can also be considered in the context of the experience of many families of children with ADHD, in which parents expend significant time and effort attempting to scaffold children with ADHD, and yet are not able to completely mask their child's ADHD. It may be that this explanation is more applicable to individuals who exhibit milder forms of ADHD that are more amenable to being masked or buffered by protective family environments, but as yet there is no empirical data evaluating this question.

#### *'Late'-onset but how late? Adolescent versus adult onset of ADHD*

Unfortunately, most of the studies examining the question of late-onset ADHD have data only to a limited age of follow-up, as the E-Risk and Pelotas cohorts, and the MTA control study, only include follow-up to young adulthood. The Dunedin study, while providing information about a later age of follow-up (age 38) does not have ADHD information available between age 15 and 38 (Moffitt et al.,

2015), leaving a large age gap for which information about ADHD onset is not available. The MTA study suggests that for some individuals with an adolescent onset of ADHD, symptoms will resolve by early adulthood (Sibley et al., 2017), and adult onset of ADHD may not reflect a persistent condition. Very little is therefore known about the long-term course of late-onset ADHD, and whether some late-onset individuals persist beyond the young adult years into older adult life, whether the majority of these cases are adolescent-limited, or whether those with late-onset ADHD reflect a more fluctuating course of the disorder that vacillates above and below the diagnostic threshold as environmental challenges wax and wane across the life course.

## Other issues

### *Polygenic risk and late-onset ADHD*

Three studies of late-onset ADHD assessed the association between an ADHD polygenic risk score (PRS) derived from predominantly childhood onset cases, and late-onset ADHD. The Dunedin study found that the group with childhood ADHD had a significantly elevated ADHD PRS compared to the non-ADHD comparison group, whereas the average PRS was not elevated among the adult (predominant late-onset) ADHD group (Moffitt et al., 2015). Although this might seem to indicate that childhood-onset ADHD is not strongly genetically linked with late-onset ADHD in this study, low power limits interpretation of this finding (only  $n = 28$  individuals were analyzed in the adult ADHD group). The Brazilian High-Risk Study also did not find an elevated ADHD PRS in their youth-onset ADHD group, although again the sample size was small ( $n = 28$ ) (Manfro et al. 2018). In the ALSPAC cohort, the ADHD PRS was investigated among those with persistent, remitted and late-onset ADHD. This study found that only those with persistent ADHD (from child to adult) had significantly elevated ADHD PRS compared to those with low symptoms levels across development (Riglin et al., 2016). Although the childhood-restricted, and adolescent-onset groups also showed elevated but lower PRS intermediate between the persistent and low symptom groups, these differences were not statistically significant, possibly related to low power of these analyses. Questions therefore remain as to how genetic risk influences the emergence of ADHD over the life course. Although firm conclusions cannot be drawn from the current findings, this could suggest that late-onset individuals have some (lower level) of genetic risk for ADHD susceptibility, perhaps combining with environmental challenges in adolescence and young adulthood to lead to the emergence of ADHD. These findings are also consistent with twin studies, which show that ADHD is influenced by both stable genetic effects as well as newly emerging

genetic influences at different developmental stages from childhood to adulthood (Chang, Lichtenstein, Asherson, & Larsson, 2013). This suggests that genetic variation contributes to the onset, persistence and remission of ADHD, presumably via both stable neurobiological deficits as well as maturational or compensatory processes influencing development (Faraone et al., 2015). The findings from twin studies indicating that only a subset of the genetic influences on ADHD are stable effects through development, are consistent with the finding of higher genetic loading for the current PRS in the group with persistent child to adult ADHD.

### *Cognitive deficits*

Evidence for an aetiological distinction between the childhood versus later-onset of ADHD was reported in the Dunedin study, investigating cognitive deficits. They found that children with ADHD showed a range of cognitive performance deficits both as children and as adults, regardless of whether their ADHD had persisted or not (Moffitt et al., 2015). The finding that some cognitive functions associated with childhood ADHD persist into adulthood regardless of the persistence of ADHD symptoms is well-established; particularly relating to cortical control functions (Cheung et al., 2016; Mattfeld et al., 2014). However, the late-onset ADHD group in the Dunedin cohort lacked case-control differences for the same cognitive functions suggesting that the late-onset group might reflect a different etiopathology. However, the sample size was small, and there is as yet no similar dataset for comparison. The E-Risk and ALSPAC studies suggest that those with late-onset ADHD may show a slightly lower IQ than those who never had the disorder, but have significantly higher IQ than those with childhood ADHD (both in childhood and in adulthood). Previous studies focusing on the distinction in onset of ADHD before or after the age 7 years did not identify significant differences in cognitive performance between early and later onset groups (Faraone, Biederman, Doyle, et al., 2006; Guimaraes-da-Silva et al., 2012; Lin & Gau, 2017). Overall these findings suggest a similar etiopathology for child and adolescent onset forms of ADHD, with only very limited information informing about potential later (adult) onset ADHD.

## Conclusions

The weight of the current evidence supports the view that among those who meet criteria for ADHD in adolescence and young adulthood, a significant proportion would not have met full diagnostic criteria for the disorder as children. While studies so far find a range of prevalence estimates for late-onset ADHD depending on the method of diagnosis used, current evidence appears to converge on prevalence

around 1%–2% of those without childhood ADHD developing late-onset ADHD. While this is a relatively small prevalence, given that the adult ADHD prevalence is estimated at around 3%–4%, late-onset ADHD could account for around half of the overall adult ADHD population.

There is however evidence that many in the late-onset group show some ADHD symptoms in childhood, another externalizing disorder such as ODD, or some evidence of neurodevelopmental impairment such as slightly lower IQ or lower scores on reading and spelling measures. For example, the ALSPAC sample estimated that around 75% of their apparent late-onset cases had some symptoms as a child. In the MTA study, 3 out of 8 (38%) late-onset cases had several symptoms by age 12. Furthermore, the current studies suggest that most (but not all) cases of late-onset ADHD develop the disorder between the ages of 12–16 and can therefore be considered adolescent or early adult onset ADHD. Indeed, strict application of the current DSM-5 criteria of ‘several’ ADHD symptoms in childhood (with or without impairment) is largely consistent with these findings. Some of the late-onset cases may have had three or more symptoms by age 12. However, this level of ADHD symptoms at any point across childhood is relatively normative and does not clearly identify a group who will later develop full ADHD in adulthood. More work needs to be done to identify what factors increase risk for meeting criteria for ADHD after childhood among those who do not meet full childhood ADHD criteria.

Of the nine study samples with information on late-onset ADHD, six do not follow participants past young adulthood, therefore we know little about the potential onset of ADHD after young adulthood, or about the longitudinal course of late-onset ADHD into later life. The MTA study suggests that some cases of late-onset ADHD may be adolescent limited. It is therefore possible that late adolescence/young adulthood represents a particularly fraught transition period during which ADHD symptoms may be particularly elevated and impairing. Future studies should examine the long-term course of ADHD among the late-onset group to better understand whether ADHD symptoms are limited to young adulthood, persist into mid- and later-life, or fluctuate across the life span depending on environmental stressors.

Regardless of age of onset, both recent and earlier studies point to the impairment and distress experienced by those meeting current criteria for ADHD. Whether individuals with late-onset ADHD had above or below average childhood ADHD symptoms (Cooper et al., 2018), or did or did not have comorbidities in adulthood (Caye et al., 2016), they experience a wide range of functional problems in adulthood, including poorer education and occupational outcomes, lower self-satisfaction, elevated

self-reported cognitive problems, and more risky health behaviors (Agnew-Blais et al., 2018; Caye et al., 2016; Moffitt et al., 2015). So, while there are many open questions as to the nature of late-onset ADHD, these individuals clearly require support and possible clinical interventions.

Among the most fundamental questions raised by these findings is the extent to which late-onset ADHD reflects the same underlying liability as the traditional early childhood onset form of ADHD. Should late onset of ADHD be considered the same or a different disorder? Whether ADHD in general should be understood as a disorder that strictly reflects only a limited set of ‘valid’ etiologic factors, or as a complex disorder including multiple possibly disparate etiologies, is a continuing controversy (Caye, Sibley, Swanson, & Rohde, 2017). Late-onset ADHD could represent a different, potentially milder form of ADHD, one that is perhaps more influenced by environmental factors than an early onset neurodevelopmental type. An analogy might be type I and type II diabetes with later onset forms being more related to acquired factors accumulating throughout development. Alternatively, late-onset of ADHD symptoms and impairment could reflect emerging neurodevelopmental problems in adolescence due to later developing genetically driven failings of maturational processes. Although twin studies suggest that ADHD has similar heritability at different ages, it is influenced by both stable genetic effects as well as newly emerging genetic influences at different developmental stages from childhood to adulthood (Chang et al., 2013). Genes therefore contribute to the onset, persistence and remission of ADHD, presumably via stable neurobiological deficits as well as maturational or compensatory processes influencing brain development at different developmental stages (Faraone et al., 2015). The age of onset of other ‘neurodevelopmental’ disorders such as schizophrenia varies considerably, and the same could be the case for ADHD.

From the perspective of clinicians working with adults with ADHD these data suggest that an insistence that ADHD is only diagnosed in those with a clear account of childhood symptoms and impairment is not appropriate. First, there is the practical problem that retrospective recall by both individuals and families can be poor, with good evidence from prospective data for changes in the recall of age of onset. However, this does not appear to account for the emergence of late-onset data as evidenced by the prospectively collected datasets. Clearly clinicians should pay regard to exacerbating factors that could be modified such as ongoing drug abuse, stress, anxiety, depression, head injury and so on. However, there is yet no data to suggest that later-onset forms of ADHD respond any less well to stimulants or other ADHD medications. Indeed, preliminary evidence enquiring from retrospectively

collected data suggests that response to drug treatments are predicted by the presence of ADHD symptoms and impairments regardless of age of onset (Reinhardt et al., 2007; Surman et al., 2010). Further work is required to clarify this point, but in the meantime, clinicians would be advised to consider treatment as usual for ADHD in adult patients with onset of chronic trait-like ADHD symptoms emerging out of childhood or adolescence, and meeting both the symptom and impairment criteria for the disorder.

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## Key points

- Conservatively, about 1–2 % of those without childhood ADHD may have onset of the full syndrome after the age of 12 years.
- Some (but not all) cases of late-onset ADHD meet the DSM-5 age of onset criterion of 'several symptoms present by age 12', or presented with an externalising or developmental disorder as children.
- Current evidence does not distinguish early and late-onset forms of ADHD as aetiologically discrete disorders, but likely reflects a different balance of genetic and environmental risks. Clinicians are advised to treat ADHD as usual in adult patients meeting current symptom and impairment thresholds for the disorder with onset of chronic trait-like ADHD symptoms emerging out of childhood or adolescence, regardless of the precise reported age of onset.

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