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Attention-Deficit/Hyperactivity Disorder persistence from childhood into young adult age: A 10-year longitudinal study

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Conflict of interest

We have no conflict of interest.

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Ethical approval

This study was prospectively reviewed and approved by the Regional Committee for Medical Research Ethics in Eastern Norway (REK 6-2009-24, 2018/1611) and the Privacy Ombudsman for Research at Innlandet Hospital Trust. The studies were conducted in accordance with the Helsinki Declaration of the World Medical Association Assembly.

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Data availability statement

The datasets presented in this article are not readily available because the data serving as the basis for the article submitted is stored in a secured repository at Innlandet Hospital Trust (Norway). Due to ethical restrictions on access to the data pursuant to the consent statements participants signed upon collecting the data, the authors are not permitted to upload a data set to sites outside of the repository. Access to the data, however, is available upon request to all serious researchers by contacting the following persons at Innlandet Hospital Trust: Erik Winther Skogli. Requests to access the datasets should be directed to erik.winther.skogli@sykehuset-innlandet.no.

Author contributions

ES contributed to conceptualization, methodology, investigation, formal analysis, funding acquisition, supervision, project administration, and wrote the original draft. SO contributed to

the conceptualization, data curation, formal analysis, and writing. IF contributed to data investigation, data curation and writing – reviewing and editing. PA contributed to methodology, investigation, supervision, and writing – reviewing and editing. MØ contributed to the methodology, investigation, funding acquisition, supervision, and writing – reviewing and editing. All authors approved the final manuscript for submission.

Abstract

Introduction: The aim of this study was to estimate ADHD persistence in a European clinical sample of children diagnosed with ADHD and followed prospectively for 10 years into young adulthood. **Methods:** We assessed 85 children with ADHD at baseline (M_{age} = 11.6, SD = 2.1, 54% male) and re-assessed 59 at 10-year follow-up (M_{age} = 21.4, SD = 2.3, 54% male). ADHD symptoms at baseline were assessed with a semi-structured clinical interview (Kiddie-Schedule for Affective Disorders and Schizophrenia/Present and lifetime version) and parent rating scales (ADHD Rating Scale IV, Child Behavior Checklist). ADHD symptoms at 10-year follow-up were assessed with a semi-structured clinical interview (MINI-Plus) and self-report scales (ADHD Self-Report Scale version 1.1 screener, Adult Self Report). Functional impairment at 10-year follow-up was assessed with the Global Assessment of Functioning scale. **Results:** At 10-year follow-up, 39% met ADHD symptom thresholds based on clinical evaluation using MINI-Plus or the ADHD Self-Report Scale version 1.1 screener or the Adult Self Report together with clinicians' rating of functional impairment. **Conclusion:** ADHD persistence rates in this European clinical sample match previous estimates and indicate that a significant proportion of those diagnosed with ADHD as children still exhibit clinical levels of ADHD symptoms in adulthood.

Keywords: Attention-Deficit/Hyperactivity Disorder, Persistence, Adults, European.

Introduction

Growing consensus holds that Attention-Deficit/Hyperactivity Disorder (ADHD) is a chronic health problem, associated with lower academic achievement, increased risk of unemployment, substance abuse, comorbid disorders, and reduced quality of life in adult age (Caye et al., 2016). Even though ADHD is considered to represent a neurodevelopmental disorder, with clear genetic underpinnings and stable endophenotypic traits, persistence rates show considerable variability into adult age, ranging from 4% to 78% (Di Lorenzo et al., 2021; Sibley et al., 2021). Longitudinal studies show that ADHD symptoms may wane with age (Hartman, Geurts, Franke, Buitelaar, & Rommelse, 2016), and this symptom diversity may cause substantial variability in ADHD persistence rates with age (Di Lorenzo et al., 2021; Sibley et al., 2021). Divergent persistence rates from childhood to adulthood could also be explained by differences in sample characteristics, methodological issues (i.e., the use of DSM-based symptom count criteria or a norm-based symptom threshold), and different sources of information among studies (i.e., self-report, informant reports, clinical interviews) (Sibley, Mitchell, & Becker, 2016). Higher rates of comorbidity in clinical samples relative to participants in cohort studies may be one factor driving persistence rates in adult age (Sibley et al., 2016). Further, studies requiring a rigorous DSM-based symptom count threshold typically report lower ADHD persistence rates compared to studies using a norm-based threshold in the assessment (Caye et al., 2016; Sibley et al., 2016). Sole reliance on self-report may also result in lower persistence rates compared to studies using multiple information sources (i.e., informant reports and clinical interviews). Likewise, requiring functional impairment to be present while evaluating an ADHD diagnosis lowers the likelihood of persistence in adulthood (Sibley et al., 2016).

As longitudinal studies on ADHD persistence rates are scarce and extremely heterogeneous in methodology, longitudinal research assessing ADHD persistence based on a transparent and replicable norm-based approach is warranted. Furthermore, there are few longitudinal studies

investigating ADHD persistence in Europe (Di Lorenzo et al., 2021). Different social and cultural factors, as well as variations in the organization of health care services in Europe and the United States, may all play a role in the progression of ADHD over time (Faraone, Sergeant, Gillberg, & Biederman, 2003; Sayal, Prasad, Daley, Ford, & Coghill, 2018; van Lieshout et al., 2016). To address these limitations, this study used a well-powered Norwegian clinical sample to evaluate ADHD persistence in individuals who were diagnosed with ADHD as children and followed prospectively for 10 years into young adulthood. We assessed ADHD persistence rates by combining established norm-based symptom criteria and multiple information sources (clinical interview and self-reports) together with clinician ratings of functional impairment, in line with the recommendations by Sibley et al. (2016).

Material and methods

Procedure and Participants

This study is part of the Lillehammer Neurodevelopmental Follow-up Study (LINEUP), a longitudinal study of individuals with neurodevelopmental disorders followed prospectively for 10 years (Fossum, Andersen, Oie, & Skogli, 2021). At baseline, participants between 8 and 17 years of age were recruited upon consecutive referrals from child and adolescent psychiatric outpatient clinics at Innlandet Hospital, Norway, in 2008-2009. Exclusion criteria were prematurity (< 36 weeks), having a disease affecting the central nervous system, IQ < 70 and a history of stimulant treatment. Eighty-five children fulfilling the DSM-IV criteria for ADHD (M_{age} = 11.6, SD = 2.1, 46 males) were included in the study at baseline.

Baseline assessment

At baseline, all participants underwent a comprehensive assessment according to common clinical practice for an evaluation of ADHD. Semi-structured clinical interviews using the Kiddie-Schedule for Affective Disorders and Schizophrenia/Present and lifetime version (Kiddie-SADS; Kaufman et al., 1997) were conducted separately for children/adolescents and

parents to assess psychopathology. Kiddie-SADS has demonstrated good inter-rater reliability (93-100%), test-retest reliability (.77-1.00), and validity (Kaufman et al., 1997). The diagnostic evaluation with Kiddie-SADS was supplemented with information from the ADHD Rating Scale IV (ARS-IV; DuPaul et al., 1998), and the Child Behavior Checklist (CBCL; Achenbach & Rescorla, 2001), which cover the *DSM-IV-TR* symptoms for ADHD. The ARS-IV rating scale completed by the parents has been reported to have good internal consistency (Cronbach's alpha $\geq$ 0.87) and intraclass correlation ($\geq$0.87) (DuPaul et al., 1998; Wyrwich et al., 2014). Acceptable reliability and validity of the Norwegian version of the CBCL are reported by Nøvik and colleagues (Nøvik, 1999, 2000). Additional information about academic and social school functioning, which is mandatory on referral, was incorporated into the diagnostic evaluation.

If both parents could not report on Kiddie-SADS and rating scales together, information from mothers was used. In cases of disagreement between parents, information from mothers was emphasized. When information on the Kiddie-SADS was not consistent with rating scales, Kiddie-SADS was emphasized in the assessment. Diagnoses were considered positive if, based on a comprehensive evaluation of Kiddie-SADS, teacher information and rating scales, *DSM-IV-TR* criteria were met (American Psychiatric Association, 2000). Diagnostic assessment at baseline was conducted by experienced clinicians and supervised by a clinical neuropsychologist specialised in neurodevelopmental disorders. The project manager, who is a specialised psychologist in clinical neuropsychology, independently reviewed all diagnostic judgements set by the interviewers. Disagreements were discussed to arrive at a consensus diagnosis. For a detailed description of recruitment strategy and diagnostic assessment at baseline see Skogli, Egeland, Andersen, Hovik, & Oie (2014).

10-year follow-up

Diagnostic assessment at 10-year follow up was based on information from clinical interviews, self-reported rating scales, and clinicians' evaluation of functioning. We used the MINI

International Neuropsychiatric Interview Plus (MINI-Plus), which is a semi-structured diagnostic interview for DSM-IV disorders (Sheehan, Lecrubier, Sheehan, & al., 1998). This was supplemented with information from the Adult ADHD Self-Report Scale version 1.1 screener (ASRSv1.1; Kessler, Adler, Barkley, et al., 2005), the Adult Self Report - ADHD Problems Scale (ASR; Achenbach & Rescorla, 2003), and assessment of impairment level with the Global Assessment of Functioning Scale (GAF; Luborsky, 1962).

The MINI-Plus was conducted with the participants, and current ADHD symptoms were assessed with the adult ADHD current symptoms module (W7). The ADHD current symptoms module includes 14 questions, and the participants' responses were assessed according to established criteria requiring that the participants to display at least 9 of 14 symptoms (Sheehan et al., 1998). Therefore, cut-off for clinical significant ADHD symptoms based on the MINI-Plus was defined as ≥ 9 symptoms on the ADHD module current symptoms according to the scoring protocol (Sheehan et al., 1998).

A clinical level of ADHD symptoms on the ASRSv1.1 screener was defined as ≥4 symptoms in clinical area on the first 6 items (Kessler et al., 2007). The ASRSv1.1 screener was used because this short version is reported to out-perform the ASRSv1.1. full version in terms of sensitivity, specificity, and total classification accuracy (Kessler, Adler, Ames, et al., 2005). The ASRSv1.1 screener has demonstrated acceptable internal reliability (.63-.72) and test-retest reliability (.58-.77) (Kessler et al., 2007).

A clinical level of ADHD symptoms on the ASR was defined as T-scores ≥ 65 on the DSM-IV oriented ADHD subscale according to the ASR manual (Achenbach & Rescorla, 2003). The ASR has demonstrated good reliability ($\alpha \geq .81$) and validity (Achenbach, Ivanova, & Rescorla, 2017; de Vries, Verdam, Prins, Schmand, & Geurts, 2018; Guerrero, Hoffmann, & Pulkki-Råback, 2020).

At the end of each examination, the interviewing clinicians used the split version of the Global Assessment of Functioning scale (GAF-F) to assess functional impairment (criteria E in DSM-IV and criteria D in DSM-V) (Pedersen, Hagtvet, & Karterud, 2007). GAF-F scores ≤70 indicate clinically significant functional impairment (Luborsky, 1962), and was set as cut-off for impairment level in the current study.

Diagnostic assessment at 10-year follow-up was conducted by experienced clinicians and supervised by a clinical neuropsychologist specialised in neurodevelopmental disorders. ADHD persistence was set for participants scoring above clinical levels on the MINI-Plus ADHD module (≥ 9 symptoms) OR above cut-off on the ASRSv1.1 screener (≥ 4 symptoms) OR above cut-off on the ASR-ADHD Problem Scale (T-scores ≥ 65) AND displayed impaired functioning (≤70) on the GAF-F scale. Clinical characteristics for the ADHD remittent and persistent groups at follow-up are presented in Table 1.

Co-occurring symptoms at 10-year follow-up was assessed with the Adult Self-Report from the Achenbach System of Empirically Based Assessment (Achenbach & Rescorla, 2003) and clinical interviews with the MINI-Plus (Sheehan et al., 1998). The Wechsler Abbreviated Scale of Intelligence (WASI) was administered to estimate participants' intellectual abilities at each assessment (Wechsler, 1999).

[Insert Table 1 around here].

Data analyses

Data analyses were conducted using the statistical package SPSS for Windows, version 26. Differences between participants re-assessed at follow-up and those not re-assessed, were investigated using Chi-square test for independence and *t-tests*. When estimating persistence rates at follow-up, we calculated the percentage fulfilling criteria for ADHD based on the different measures and our diagnostic algorithm, including bootstrapped (1000 samples), bias and accelerated 95% confidence intervals (CI).

Results

Sample retention

The number of participants at follow-up was 59, yielding a retention rate of 69% from the baseline sample of 85 participants. Results indicated no statistically significant differences between those re-assessed at 10-year-follow-up and the drop-out group in terms of the T1 characteristics mother's education (p = .683), FSIQ (p = .535) or gender (p = .949). Independent samples *t-tests* indicated that the re-assessed group was significantly older than the dropout group (p = .032, re-assessed M_{age} = 11.7, SD = 2.2, dropout M_{age} = 11.3, SD = 1.8).

ADHD persistence

Of the 59 participants at follow up, 25% (n = 15, 95% CI [15%, 36%]) met the criteria for an ADHD diagnosis based on the clinical interview (MINI-Plus), whereas 29% (n = 17, 95% CI [20%, 39%]) met the cut-off at the ASRSv1.1 screener, and 37% (n = 22, 95% CI [27%, 49%]) met the cut-off at the ASR. In total, 48% (n = 28, 95% CI [36%, 58%]) met either the criteria based on MINI-Plus or the cut-off at ASRSv1.1 screener or ASR, whereas 15% (n = 9, 95% CI [9%, 22%]) met the criteria on both MINI-Plus and ASRSv1.1 screener and 19% (n = 11, 95% CI [12%, 27%]) met the criteria on both MINI-Plus and ASR. When adding the impairment criterion (GAF-F ≤70), 39% of the participants who met ADHD symptom criteria also displayed functional impairment at follow up (n = 23, 95% CI [27%, 51%]).

Co-occurring symptoms

Independent samples t-tests indicated that the ADHD remission group had significantly less Internalizing co-occurring symptoms (t (57)=5.177, <.001), less Externalizing co-occurring symptoms (t (57)=6.864, <.001) and less Total problems (t (57)=7.199, <.001) than the persistence group based on the Adult Self-Report from the Achenbach System of Empirically Based Assessment (see Table 1). Based on the clinical evaluation with MINI-Plus at 10 year

follow-up, independent samples t-tests indicated that the ADHD remission group in average had significantly more comorbid disorders (t (57)=6.681, <.002) relative to the remittent group.

Discussion

The primary goal of this study was to investigate ADHD persistence in individuals who were diagnosed with ADHD in childhood and followed prospectively for 10 years into young adulthood. As the diagnostic assessment of ADHD primarily is based on behavioural symptoms, diagnostic procedures applied in the clinical evaluation may have a considerable impact on estimated persistence rates (Sibley et al., 2016). Consequently, when assessing ADHD persistence rates, we based our evaluation on a diagnostic algorithm combining clinical interviews (MINI-Plus) with rating scales (ASRSv1.1. screener, ASR) and a clinical assessment of impairment level using GAF. Using this diagnostic algorithm, results from our study indicate that 39% of the individuals still met symptom threshold and displayed functional impairment at follow-up. ADHD persistence rates found in this European clinical sample appear thus to correspond with previous estimates (40-50%) (Di Lorenzo et al., 2021; Sibley et al., 2016). As the diagnosis of ADHD is based on behavioral symptoms (American Psychiatric Association, 2013), social and cultural factors might influence how symptoms are evaluated (Hinshaw et al., 2011; Sibley et al., 2016). Consequently, ADHD persistence rates may be biased by contextual factors affecting clinician judgments when assessing ADHD symptoms. Our findings, which mirror persistence rates from US studies, may highlight the value of utilizing a diagnostic algorithm in the assessment of ADHD that integrates norm-based symptom criteria and multiple information sources with clinician ratings of functional impairment.

Our findings suggest that a substantial proportion of those being diagnosed with ADHD in childhood still display clinical levels of ADHD symptoms in young adult age. For a significant proportion of individuals with ADHD, enduring ADHD symptoms can potentially have negative clinical and social consequences into young adulthood. Higher levels of co-

occurring symptoms in the ADHD persistent group compared to the remission group highlight the potentially negative outcome of persistent ADHD throughout young adulthood. Previous findings from the LINEUP-study have reported a link between co-occurring symptoms and ADHD symptomatology throughout young adulthood, implying that treatment should not just target ADHD core symptoms or adaptive functioning, but also co-occurring symptoms (Orm, Øie, Fossum, Andersen, & Skogli, 2021). The need for treatment of co-occurring disorders may be of particular concern for those individuals with persistent ADHD.

At the same time, a significant proportion of those being diagnosed with ADHD in childhood no longer display clinical levels of ADHD symptoms in adult age. This may underline the relevance of a diagnostic re-assessment in adult age for most individuals with ADHD. For some individuals, diagnoses may have a negative impact by contributing to unwarranted concerns, treatment burden, and stigmatization (Lea & Hofmann, 2021). However, it is important to recognize that diagnoses such as ADHD are linked to social welfare rights and treatment support, which must be taken into account when conducting re-assessments (Lea & Hofmann, 2021). Many people with ADHD may find that having access to treatment and social benefits is crucial to achieve adequate adaptive functioning. When removing an ADHD diagnosis, there is a risk of losing social welfare rights and treatment assistance (Lea & Hofmann, 2021; Turgay et al., 2012). Furthermore, having ADHD may for some individuals be closely linked to their personal identity, and a re-assessment of ADHD in young adulthood may result in a problematic reorientation of the person's self-experience. Consequently, the re-evaluations of an ADHD diagnosis should only be done in close collaboration with the person with ADHD, and preferably with their approval and consent.

ADHD persistence rates in young adulthood have also been associated with lower perseverance than in adolescence or adulthood (Sibley et al., 2016). As ADHD symptoms seem to wane and wax through age (Hartman et al., 2016; Sibley et al., 2021), precautions should be

taken when identifying low persistence rates in young adult age, as reported in this study. Furthermore, our results show that persistence rates dropped significantly when relying solely on MINI-Plus clinical interview (25%) or the ASRSv1.1. screener (29%). Interestingly, the norm-based ASR scale persistence rate (37%) corresponded more closely with estimated persistence rates based on our diagnostic algorithm (clinical interviews, self-report, and impairment level). Sole reliance on MINI-Plus or ASRSv1.1 self-report scales may thus result in a bias toward lower persistence rates (Sibley et al., 2016), and this points out the importance of including several measures when assessing persistence rates in longitudinal studies. ADHD persistence rates (39%) in this study were comparable to that of previous studies using similar diagnostic methodology (i.e., the Milwaukee study, 40-44%, combining norm-based symptom threshold, and impairment level) (Barkley, Murphy, & Fischer, 2010). The lack of collateral reports at 10-year follow-up may nevertheless constitute one clear limitation in this study, as self-report may lead to an underestimation of ADHD symptoms (Sibley et al., 2016). Barkley and colleagues (2002) reported persistence rates to increase from 5% to 46% when parent report was considered instead of self-report only. Similar findings were reported from the Pittsburg longitudinal ADHD study where parent report increased persistence rates with 8% in adolescents (Sibley et al., 2012). Another potential limitation of this study is that we did not acquire detailed information regarding any treatment the participants may have received between assessment points. Consequently, we cannot rule out that participants have received different types of treatment that may have affected outcome at 10-year follow-up. Taking these limitations into account, one should exercise caution when drawing firm conclusions or broad generalizations from our study.

The findings of our study, which used a transparent and replicable norm-based approach, indicate that a meaningful proportion of those diagnosed with ADHD as children no longer exhibit clinical levels of ADHD symptoms in adulthood. Our study underscores the

importance of longitudinal studies that use empirically and theoretically sound diagnostic methods and may provide important guidance for future research on the stability and nature of ADHD throughout development. More longitudinal research focusing on determinants of ADHD persistence into early adulthood is needed. Findings from such research may provide important information about long-term changes in individuals with ADHD, as well as helping clinicians identifying key treatment factors to improve long-term outcomes.

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Conflict of interest

No potential conflict of interest was reported by the authors.

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Table 1.

ADHD symptoms, co-occurring symptoms and IQ across ADHD remittent and ADHD persistent group at 10-year follow-up. Means, standard deviations and group comparisons.

	Remitted (*n=36*)		Persistent (*n=23*)		Group comparisons		
	M	*SD*	*M*	*SD*	*t*	*p*	Hedges' *g*
ASRSv1.1 screen[a]	1.7	1.6	3.6	1.3	4.632	<.001	-1.22
ASR ADHD subscale[b]	55.9	7.4	72.6	9.3	7.261	<.001	-2.01
ASR Internalizing[b]	48.1	10.6	62.6	10.4	5.177	<.001	-1.36
ASR Externalizing[b]	45.4	9.2	61.1	7.4	6.864	<.001	-1.81
ASR Total problems[b]	47.9	10.4	65.4	6.6	7.199	<.001	-1.90
FSIQ[c]	102.4	15.0	104.1	12.1	.460	.647	-0.12

Note. ADHD: Attention-Deficit/Hyperactivity Disorder; [a]Adult ADHD Self-Report Scale version 1.1 screener; [b]Adult Self-Report, Achenbach System of Empirically Based Assessment (T-scores); [c] Full-Scale IQ (WASI).