RESEARCH ARTICLE

Belg J Paediatr. 2026;28(2): p.141-150

Patient and Disease Characteristics of ADHD in Clinical Practice: A Retrospective Study in a Population- based Cohort of Children and Adolescents

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Keywords

Attention Deficit Hyperactivity Disorder (ADHD); Children/Adolescents; Comorbidity; Neurodevelopmental disorders; Psychosocial factors

Abstract

Background
Attention deficit hyperactivity disorder (ADHD) is a neurodevelopmental disorder that frequently co-occurs with various developmental, medical and psychosocial conditions. This study profiled children assessed for ADHD in a tertiary care setting.

Methods
Records of 164 children (3–18 years) assessed in 2023, resulting in 55 children suspected of and 109 diagnosed with ADHD, were retrospectively reviewed. Developmental, medical and psychosocial characteristics were analysed descriptively.

Results
Developmental coordination disorder (19.5%), learning disorders (13.4%) and language impairments (12.2%) were commonly associated. Medical comorbidities included atopic (14.6%), neurological (13.4%) and respiratory disorders (12.2%). Prematurity (21.3%) was also a notable risk factor for ADHD. Parental separation (31.1%) and family history of neurodevelopmental disorders (38.4%) were prevalent.

Conclusions
The clinical profile of children referred for ADHD assessment largely reflects patterns described in literature, underscoring the complexity of ADHD as a neurodevelopmental condition and highlighting the need for increased awareness, context-sensitive assessment and multidisciplinary collaboration.

Introduction

Definition

Attention deficit hyperactivity disorder (ADHD) is a common neurodevelopmental childhood disorder characterized by persistent inattention and/or hyperactivity-impulsivity across multiple settings such as personal, social, academic or occupational environments. Symptoms emerge during the developmental period and impair functioning and/or development. Clinical presentation can be predominantly inattentive, predominantly hyperactive impulsive or combined, depending on symptom pattern. Diagnostic classification is primarily guided by the International Classification of Diseases and Related Health Problems 10th revision (ICD-10) and the Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition, Text Revision (DSM-5-TR) which provide standardized criteria for assigning a diagnostic label and forming the basis for multidisciplinary care and support. (1-3).

TABLE 1: List of included and analysed variables

Variables
Medical history
Gender
Term
Birth weight
Maternal usus during pregnancy
Medical history
Family history
Psychosocial background
Education level of both parents
Household composition
Language spoken with parents
Type of education
Professional guidance involved at time of assessment
Functional status
Course of development perceived by parents
Age at moment of diagnosis/suspicion ADHD
Referrer and reason for referral to the Centre for Developmental Disorders
Diagnosis after assessment (past and present)
Total intelligent quotient
Neurologic examination

Prevalence

Over recent decades, substantial efforts have been made to accurately estimate ADHD prevalence. An umbrella review of systematic reviews and meta-analyses by Ayano et al. reported a pooled global prevalence of 8.0% in children and adolescents with higher rates in boys (10%) compared to girls (5%). The included studies represented diverse populations across developed and developing regions showing broadly consistent prevalence worldwide with only modest variations among Black, White and Asian American groups and in samples from India and the Middle East (4).

Causes

The exact mechanisms underlying ADHD remain unclear. Strong genetic influences are well established with twin studies estimating heritability at around 76% (5). Although no single gene for ADHD has been detected, large genome-wide association studies have identified several loci in constrained genomic regions, loss-of-function genes and brain-expressed regulatory regions (6). ADHD risk is also increased in several genetic syndromes including fragile X syndrome, tuberous sclerosis and other microdeletion syndromes such as Smith-Magenis and velocardiofacial (VCFS; 22q11 microdeletion) syndrome (3). Observational and epidemiological studies link various prenatal and perinatal factors (such as very low birth weight, prematurity and smoking) as well as environmental toxins, diet and psychosocial factors to increased ADHD prevalence (2, 3). However, because genetic and environmental influences interact in complex ways establishing clear causal pathways remains challenging.

Comorbidities

ADHD frequently co-occurs with a wide range of neurodevelopmental and psychiatric conditions including autism spectrum disorder (ASD), learning or intellectual disabilities, motor disorders and behavioural problems such as oppositional defiant disorder and conduct disorder (2, 3, 7). Less common, yet still more prevalent than in the general population, are anxiety disorders, major depressive disorder, obsessive–compulsive disorder and intermittent explosive disorder (2). Besides psychiatric and neurodevelopmental conditions individuals with ADHD exhibit increased prevalence of several medical conditions particularly allergies, autoimmune disorders, epilepsy and sleep-related difficulties (2, 8). Additional factors such as visual or hearing impairments, metabolic abnormalities and nutritional deficiencies may influence ADHD symptom expression or severity and warrant careful consideration in clinical assessment (2).

Diagnosis

Because no specific laboratory tests exist for ADHD and given its broad range of potential comorbidities and contributing factors assessment must be comprehensive and extend beyond evaluating core symptoms. A thorough diagnostic process includes interviews, observations, symptom rating scales and input from multiple informants to assess functioning across different settings (9). Missed diagnoses may compromise academic, social or occupational outcomes and may result in inappropriate or unnecessary pharmacological interventions. Therefore detailed clinical history covering developmental and medical background, as well as family dynamics and psychosocial context, is essential to ensure accurate diagnosis and appropriate treatment planning (3).

Aims

This article aims to elucidate how the diagnostic complexities of ADHD manifest in clinical practice. Using a cohort of children and adolescents from a tertiary care centre, we retrospectively analysed a broad range of patient and disease characteristics to evaluate the extent to which real-world observations align with existing literature. This investigation addresses key gaps in ADHD research: underrepresentation of children from ethnically diverse backgrounds, limited consideration of ADHD heterogeneity and multiple comorbidities and limited research conducted in real-world clinical settings. By incorporating a comprehensive set of patient and disease characteristics the study aims to provide a more complete and clinically relevant understanding of ADHD.

Materials and methods

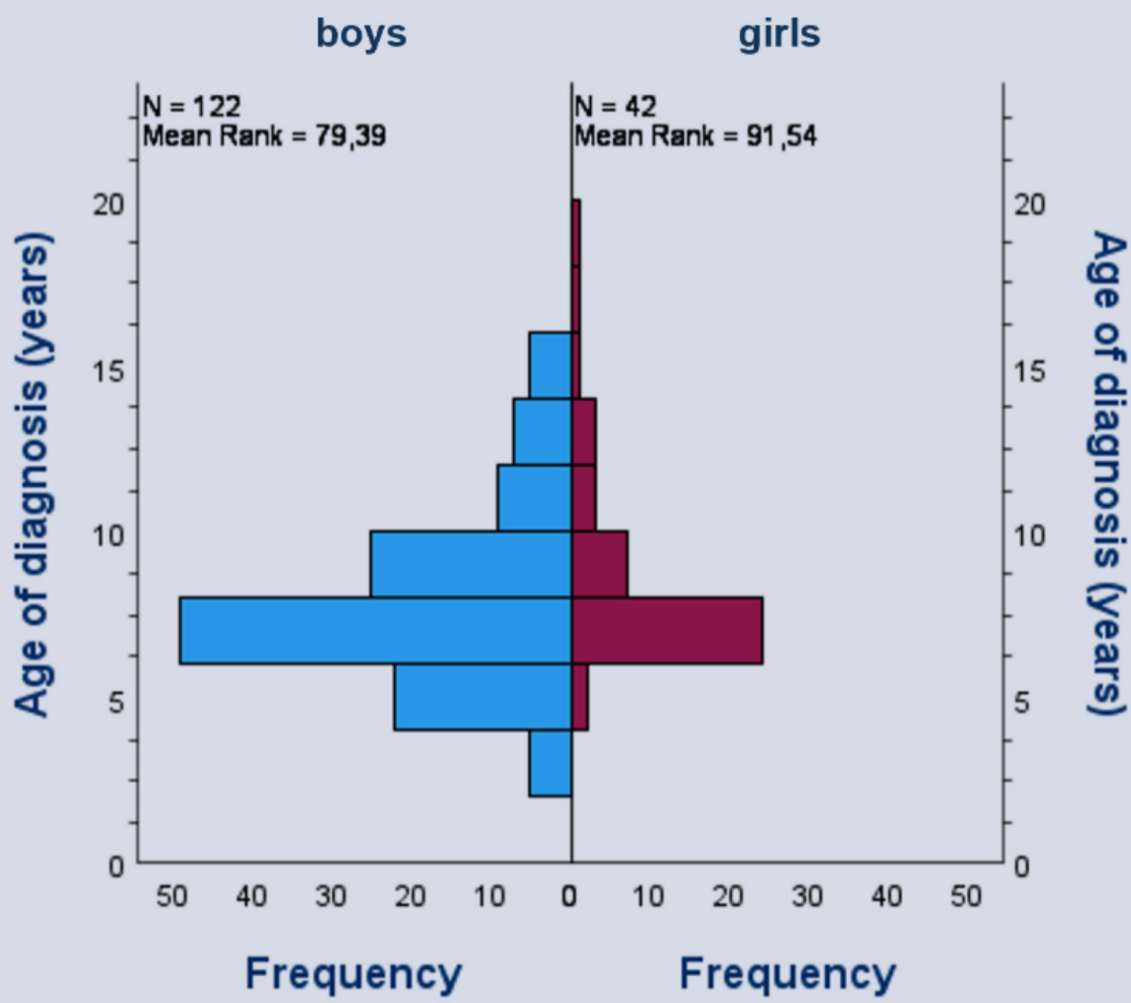
Literature search

We searched PubMed and Google Scholar using the MeSH terms: "Attention Deficit Disorder with Hyperactivity/epidemiology", "Risk Factors" and "Comorbidity". The search was restricted to systematic reviews and meta-analyses published in English within the last ten years focusing on children (6–12 years) and adolescents (13–18 years). After screening titles and abstracts, 81 articles were retained, of which 23 articles were included based on relevance.

Data collection

For this retrospective study we compiled a patient list from the database of the Centre for Developmental Disorders (CDD) at UZ Brussel. Inclusion required proficiency in Dutch, as evidenced by its use at home or in school. Patients assessed in 2023 who received

FIGURE 1: Distribution of the age at the time of ADHD diagnosis/suspicion in relation to sex.



a diagnosis or clinical suspicion of ADHD according to DSM-5-TR criteria were selected, yielding 204 records. After removing duplicates, 164 children remained. These were categorized into two groups: children younger than 6 years with suspected ADHD and children who reach 6 years of age or older during the year of assessment with either suspected or confirmed ADHD. The age threshold of 6 years is widely employed in ADHD research. This convention is supported by evidence indicating that in younger children behavioural symptoms are less readily distinguishable from typical developmental variation, psychometric reliability is reduced due to rapid developmental changes and the absence of a standardized school context may limit assessment validity and multi-informant information (2, 10). Despite these methodological considerations younger children were included in the present study to capture early developmental manifestations of the disorder. Medical records including the intake questionnaire, registration form, CDD assessment report and consultation notes from other healthcare disciplines were reviewed retrospectively. Table 1 summarizes the extracted variables.

Data analysis

Dichotomous variables were analysed and graphically represented using Microsoft Excel. Continuous and categorical variables were analysed using IBM SPSS Statistics 29.0 to generate descriptive statistics, no inferential statistical analyses were implemented. Missing data were not imputed as the primary aim of the study was descriptive. Instead, missing values were explicitly reported to ensure transparency. In the absence of inferential objectives no further adjustment for missing data were applied.

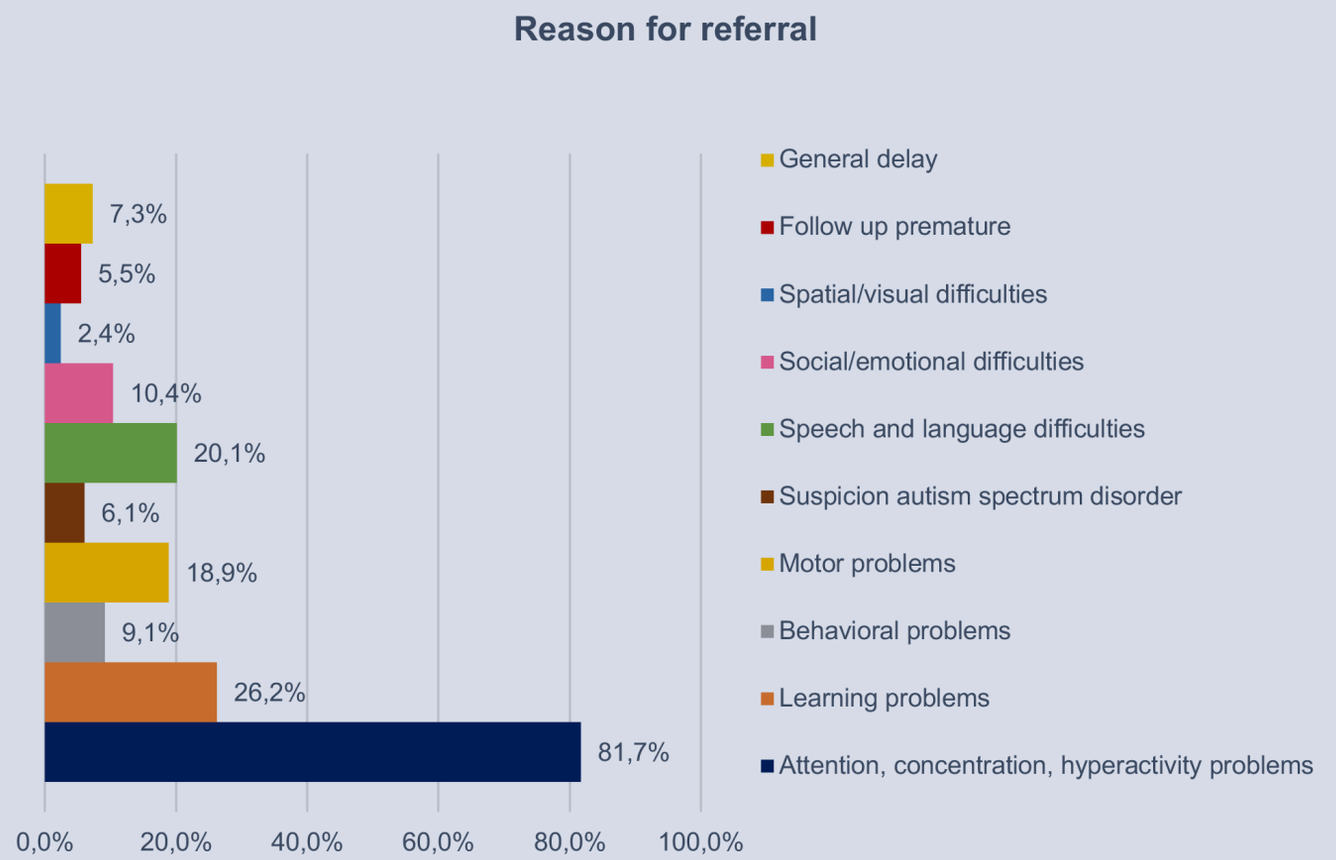
Ethical considerations

This study was reviewed and approved by the Medical Ethics Committee of UZ Brussel / VUB under protocol number EC-2024-205.

Results

The profiles of 164 children who underwent a diagnostic assessment in 2023 of whom 109 received a diagnosis of ADHD and 55 were suspected of having ADHD were analysed. The sample contained 122 boys (74.4%). Eight individuals had previously been diagnosed with ADHD and were reassessed in 2023 because of suspected comorbid developmental disorders. Most of the children (74.4%) were diagnosed between the age of 5 and 9 years, with a mean age of 7 years for boys and 8 years for girls. While girls were generally diagnosed at a later age than boys the peak age of diagnosis for both sexes was 7 years (Figure 1).

FIGURE 2: Overview of reasons for referral.



1. Referral patterns and functioning

A total of 145 children were referred of whom 24 indicated they were referred by a healthcare professional but also came on their own initiative. A total of 19 children presented solely on their own initiative, 12 of them were already receiving some form of professional support (as discussed further below) and 6 had a positive family history. An examination of language spoken at home within the cohort of children who self-referred (n = 43) revealed the following distribution: 6 were multilingual and did not speak Dutch at home, 19 were multilingual and Dutch-speaking, 17 were monolingual Dutch-speaking and 1 was monolingual and did not speak Dutch at home. Overall, 58.1% (25/43) of the self-referred cohort were multilingual compared to 41.9% (18/43) who were monolingual. Furthermore, 83.7% (36/43) of the cohort spoke Dutch at home whereas 16.3% (7/43) did not. Schools and pupil guidance centres (PGCs) accounted for 47.6 % of the referrals. Speech and physical therapists represented 10.4%. Psychologists and special education generalists accounted for 1.8% of the referrals. Surprisingly only 1.2% was referred by their general practitioner.

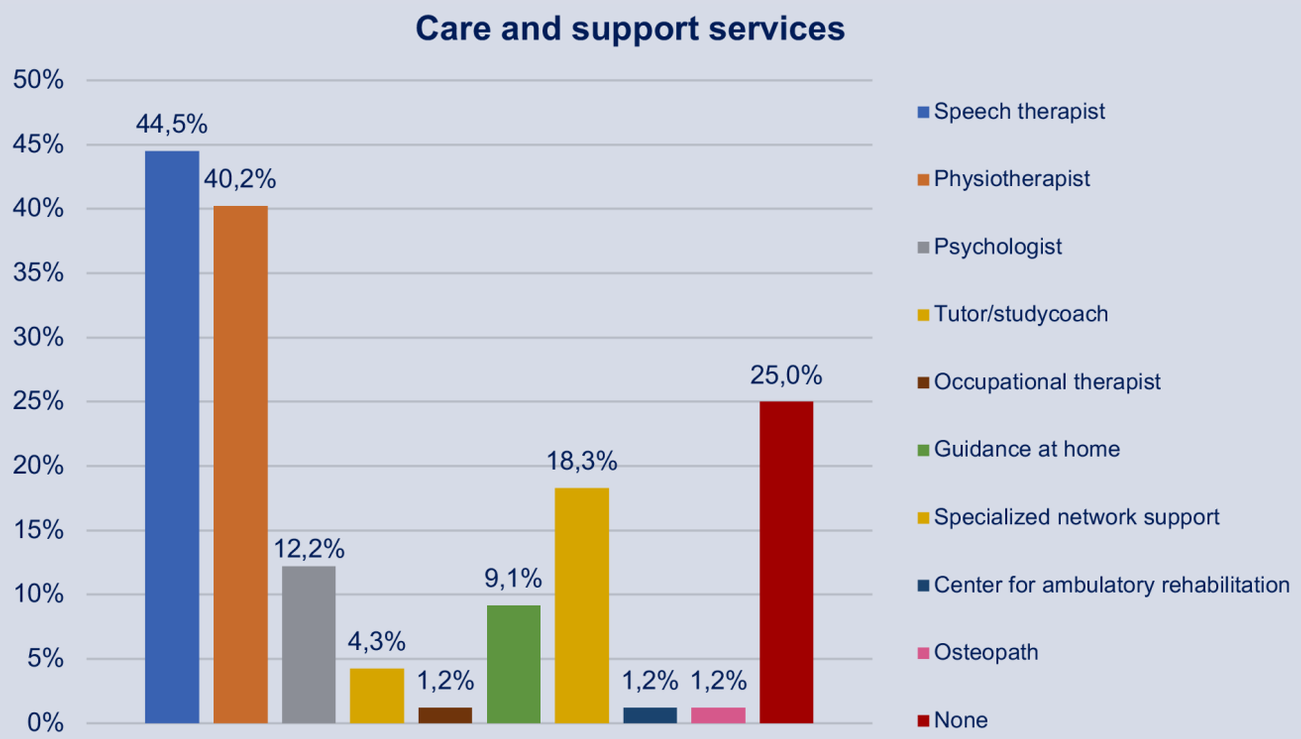
The primary reason for referral for a diagnostic evaluation was related to attention, concentration and hyperactivity difficulties consistent with ADHD's core diagnostic features. According to anamnestic data nearly half of the referrals (48%) presented with comorbid problems. Interestingly, 18% of referrals were made for reasons not related to attention, concentration or hyperactivity difficulties highlighting that children suspected of ADHD may present with a broad spectrum of developmental and functional issues. Other most prominent referral reasons included learning difficulties (26.2%), speech and language problems (19.5%) and motor difficulties (18.9%) (Figure 2).

Data on academic functioning revealed that 15.2% (n = 25) of our population had repeated a school year and 3.7% (n = 6) were enrolled in special education. 25% (n = 41) of the children had not yet received any therapeutic support at the time of the assessment. Of the 123 children who were already receiving care and support 12 (9.8%) independently requested an assessment. Speech therapy (44.5%) and physical therapy (40.2%) were the most common interventions followed by specialized network support at school (18.3%) (Figure 3). In most of the cases previously existing involvement of multiple healthcare professionals was reported.

2. Co-occurrence of neurodevelopmental disorders

Our cohort reflects the well-documented high comorbidity in children with ADHD and other neurodevelopmental disorders. The neurodevelopmental disorders are a group of conditions with onset in the developmental period. In general, a delay is considered a temporary lag in development often influenced by external factors with the potential for catch-up given appropriate support and intervention. In contrast, a disorder is characterized by persistent impairments whereby abilities are substantially and quantifiably below those expected for the individual's chronological age and cannot be explained by another medical or neurological condition. For a more detailed description and diagnostic criteria reference is made to the DSM-5-TR (2). Most of the children (n = 136) received more than one diagnosis with 62.2% exhibiting at least one delay in the domain of language, learning

FIGURE 3: Involved care and support services before diagnostic assessment for ADHD.



or motor development. The most frequently observed comorbid conditions were developmental coordination disorder (19.5%), learning disorders (13.4%) and communication disorders (12.2%) (Figure 4). Although parents report normal early development in 69 cases (42.1%), clinical evaluation revealed that 81.7% of these 69 children have a developmental delay or disorder in the

FIGURE 4: Proportion of co-occurring neurodevelopmental disorders.

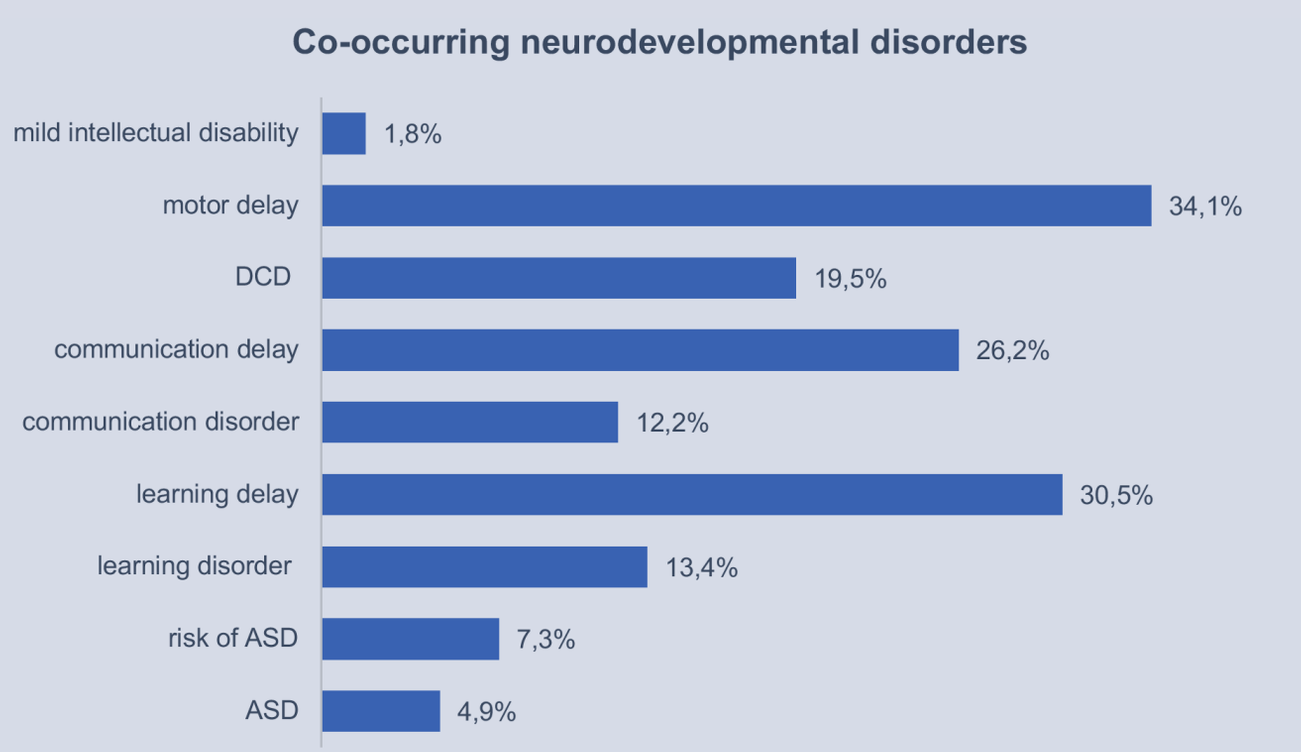


TABLE 2: Diagnosis within the referred group and distribution by home language.

Referral for communication problems (N=33)					
Diagnosis of disorder N=8		**Diagnosis of delay N=20**		**No diagnosis N=5**	
4 Dutch	4 non Dutch	8 Dutch	12 non Dutch	2 Dutch	3 non Dutch
3 multi	5 mono	13 multi	7 mono	1 multi	4 mono
Referral for learning problems (N=43)					
Diagnosis of disorder N=16		**Diagnosis of delay N=19**		**No diagnosis N=8**	
10 Dutch	6 non Dutch	13 Dutch	6 non Dutch	6 Dutch	2 non Dutch
8 multi	8 mono	10 multi	9 mono	6 multi	2 mono
Dutch = children that do speak Dutch at home (N=110) Non Dutch = children that don't speak Dutch at home (N=54) Multi = children that are raised in multilingual household (N = 79) of whom 56 also spoke Dutch Mono = children that are raised in monolingual household (N = 85) of whom 54 spoke Dutch					

domain of language, learning or motor development illustrating a significant discrepancy between parental perception and objective assessment. In 9 cases information on early development was not provided.

- a) Intellectual disability
  Cognitive functioning was assessed using the total intelligence quotient (TIQ). The TIQ was measured based on various intelligence tests depending on the child's age and functioning. TIQ scores were generally, in 63.4 % (n = 104), in the average to low-average range (80–100) and equal findings were observed across genders. To maintain uniformity this study reports only the total IQ (TIQ), even though 9.1% exhibited a disharmonic cognitive profile which is known to impact the interpretation. Within our study population 1.8% had a diagnosis of mild intellectual disability (IQ 50-69).
- b) Communication disorder
  Within the total study population of 164 children, 79 were raised in a multilingual context at home including 23 who grew up in households where Dutch was not spoken. In 54 of the 164 children, Dutch was not spoken at home implying that they were raised in a language different from the language of instruction. Our results indicate that children who did not speak Dutch at home were referred three times more frequently for speech and language difficulties. In contrast, the distinction between monolingual and multilingual background did not appear to affect the likelihood of referral (Table 2).
  A notably higher prevalence of language delay was observed among children who were not raised in Dutch at home, meaning in a language different from the language of instruction. Comparable proportions of language disorders were found between children raised in Dutch-speaking and non–Dutch-speaking households. However, children raised in multilingual environments showed a higher prevalence of both language disorders and language delays (Table 3). Despite being diagnosed with a communication disorder or delay, 55.6% of the children had no such concerns noted by their environment at the time of referral (Table 2 and 3).
- c) Specific learning disorder
  According to our findings, growing up in a non-Dutch-speaking family did not influence referral rates for learning difficulties. Children raised in multilingual environments, however, were referred more frequently due to learning problems (Table 2). The prevalence of diagnosed learning disorders was comparable between children who were exposed to Dutch at home and those who were not. In contrast, learning delays were 2.5 times more frequently diagnosed among children who spoke Dutch at home. Learning disorders were slightly more prevalent in the group raised in a multilingual environment compared to the monolingual group, whereas the prevalence of learning delays was similar across both groups (Table 3). In 51.4% of children diagnosed with a learning disorder or delay, no such concerns were reported by their environment at the time of referral (Table 2 and 3).
- d) Motor disorders
  Neurological examinations revealed motor abnormalities in 39.6% of cases with fine motor deficits being the most frequent finding (n = 47). Impairments in gross motor function were observed in 7.9% (n = 13) of the children while disturbances in gait and balance were noted in 6.7% (n = 11). Coordination difficulties were present in 4.9% of cases. Motor difficulties also appear to occur with a notably high prevalence. Of the 31 children referred with concerns regarding motor development, 58.1% were diagnosed with developmental coordination disorder (DCD) and 35.5% exhibiting delayed motor development.
- e) Autism spectrum disorder
  Within our cohort 4.9% were diagnosed with ASD. Of those referred for suspected ADHD and ASD (n=10), 30% did not receive a diagnosis while 40% were considered 'at risk' at the moment of assessment due to either the need for further assessment because of their young age, the limited cooperation or possible alternative explanations such as hearing impairments or genetic conditions.
- f) Other
  Referrals due to a general developmental delay including language acquisition, academic learning and motor skill development, were seen in 12 individuals of which 66.7% (n = 8) were diagnosed with a developmental delay and 16.7% (n = 2) were determined to exhibit a general developmental disorder. Meaning 2 were left without a diagnosis of developmental delay or disorder.

TABLE 3: Diagnosis according to language environment.

Communication disorder	Communication delay	Learning disorder	Learning delay
Group of children raised in Dutch-speaking household (N=110)			
13 (11.8%)	19 (17.2%)	14 (12.7%)	36 (32.7%)
Group of children raised in a non-Dutch-speaking household (N=54)			
7 (12.9%)	24 (44.4%)	8 (14.8%)	14 (12.7%)
Group of children raised in a multilingual household (N=79)			
12 (15.2%)	25 (31.6%)	12 (15.2%)	23 (29.1%)
Group of children raised in a monolingual household (N=85)			
8 (9.4%)	18 (21.2%)	10 (11.8%)	27 (31.8%)

3. Behavioural problems

Amongst the 14 individuals who were referred for behavioural problems, only 2 were diagnosed with a behavioural disorder. No specific behavioural disorders were identified because of the

young age of the children. Further diagnostic clarification will be pursued throughout the ongoing treatment and support process. However, given the very small sample size these observations should be interpreted with caution.

4. Medical conditions

Perinatal data indicated that 21.3% (n = 35) of children were born prematurely (<37 weeks of gestation). It should, however, be noted that in 6.7% of the cohort gestational age data were missing. Moreover, 11.0% was classified as small for gestational age (SGA, birth weight below the 10th percentile) and 10.4% as large for gestational age (LGA, above the 90th percentile) demonstrating a relatively balanced distribution across growth percentiles. Notably one-third (33.3%) of children who met the criteria for SGA were also born preterm. 14.6% (n = 25) of the children experienced neonatal complications, within this group 13.5% was born preterm. Three cases involved term births with admission for phototherapy, respiratory support, IV antibiotics and/or tube feeding. Medical history analysis revealed a wide spectrum of comorbid conditions within the cohort. Otolaryngologic issues were reported in 12.2% of the children consisting primarily of surgical interventions. Neurological conditions were present in 13.4% with cerebral haemorrhage and headaches being the most frequently documented. Cardiovascular disorders were identified in 2.4% of the sample while 12.8% presented with respiratory conditions, predominantly related to bronchial hyperreactivity. Urological or nephrological concerns were documented in 7.9% of the children, approximately half of whom were diagnosed with nocturnal enuresis. Atopic disorders were observed in 14.6% of the cohort mainly characterized by allergic manifestations. An additional 6.1% presented with other medical conditions (Table 4). Genetic abnormalities were identified in 12 children representing 7.3% of the cohort. Within our study population three distinct syndromic conditions (Turner syndrome, Jacob's syndrome and the 22q11.2 duplication syndrome) were identified along with a pathogenic variant in the SOX gene. All of these have previously been reported in association with ADHD. The remaining cases involved variants of uncertain significance.

5. Psychosocial factors

Analysis of prenatal exposures demonstrates that 12.2% of the mothers of the included children reported medication use during pregnancy predominantly for managing pregnancy-related complications. Tobacco use during pregnancy was reported by 4.9% of mothers and 1.2% reported alcohol use. It is important to note that prenatal exposure data were incomplete in 20.7%. Socioeconomic status (SES) was assessed indirectly through parental education level. In only 3.7% of families neither of the parents had received their high school diploma. In 89% of families one or both parents had finished high school and in 37.8% of the couples at least one parent had completed higher education (7.3% missing data). This pattern may reflect underlying sociodemographic characteristics of the ADHD population or indicate a referral bias within our sample. Family composition data indicated that 31.1% of children grow up with divorced parents with 12.8% experiencing limited or no contact with one of the parents. Within our cohort one child had been adopted and two lived in foster care. Review of the occurrence of neurodevelopmental disorders within the families showed that 67 out of 164 participants (40.1%) had other family members with a neurodevelopmental disorder. Among those, ADHD and attention and/or concentration problems were the most frequently reported (n = 34) followed by learning difficulties (n = 23) and ASD (n = 16). Additional reported conditions included communication problems (n = 9), motor problems (n = 4), intellectual disabilities (n = 3) and other developmental problems not otherwise specified (n = 4). Of the familial cases, 27 were reported in first-degree relatives, 32 in second-degree, 13 in third-degree and 17 in fourth-degree relatives. In four cases the degree of relatedness was not clearly specified by the parents.

Discussion

Most children in our cohort were referred for core ADHD symptoms and nearly half presented with ADHD and other developmental comorbidities. These findings are consistent with studies highlighting ADHD as a complex, multidimensional disorder associated with academic underachievement and increased support needs, as suggested by the elevated rates of grade retention observed in our sample (11). Furthermore, our data suggest a potential gap in access to care indicated by the substantial proportion of children who had not received prior therapeutic support. Based on these observations, several hypotheses can be proposed and might be recommended for further investigation. The higher retention rates among children with ADHD may be explained by core deficits in attention, executive functioning and self-regulation which are often exacerbated by comorbid learning disorders and reduced school engagement. In addition, these outcomes may be reinforced by structural limitations within the educational system. For instance, in practice, schools in Belgium frequently require a formal diagnosis before initiating support which's necessity is not supported by the guidelines, even though school-based intervention is the most common. Moreover, long waiting times and high private costs, as reported in literature, may further restrict access to care and delay timely intervention. Such delays have been associated with increased societal costs and elevated risks, including school dropout, substance abuse and worsening of existing comorbidities, outcomes that could potentially be mitigated by early and adequate support (12, 13).

In the context of healthcare accessibility, our study revealed an unexpectedly low proportion of referrals originating from primary care physicians. A plausible explanation is that general practitioners may initially refer children to general paediatricians or paediatric neurologists, who are subsequently recorded as the referring clinicians. This observation may also serve as a rationale for further evaluation and optimization of interdisciplinary collaboration with primary care providers to ensure timely identification, referral and management of children with ADHD. An additional finding in our study concerns differences in self-referral patterns between Dutch-speaking and non-Dutch-speaking families with Dutch-speaking families appearing more likely to initiate referral. This may suggest more limited access to diagnostic services among non-Dutch-speaking families. However, this interpretation should be made with caution as no comparison with the general population is available to determine whether this distribution reflects a true representation. Moreover, access to care is a multifactorial construct that extends beyond language proficiency alone. Factors such as cultural background, knowledge and confidence in the local healthcare system and overall health literacy are also likely to play a significant role in shaping referral behaviours and service utilization. These findings should furthermore be interpreted within the specific institutional and sociolinguistic context of the present cohort. The centre for developmental disorders in which this study was conducted operates within the Flemish healthcare system. Within this context, children raised in monolingual French-speaking environments are generally directed toward the French-speaking care circuit. In contrast, for multilingual and non-Dutch-speaking families with diverse cultural backgrounds referral pathways are less clearly defined. In such cases the choice between Dutch- and French-speaking services is frequently influenced by the language of the child's school. This

structural complexity may further contribute to variability in access to care and to the observed differences in referral patterns.

The high frequency of developmental delay in our cohort aligns with literature describing frequent comorbid neurodevelopmental conditions in ADHD (7, 14, 15). However, a key discrepancy emerged between parental reports and clinical findings. Although not well quantified in the literature, this gap may reflect limitations in parental recall or knowledge which may in turn be influenced by language barriers and low levels of health literacy. This may lead to an underestimation of developmental difficulties and underscores the value of professional, objective evaluation.

Consistent with prior research, cognitive functioning in our cohort was generally within the average to low average range supporting the view that ADHD is characterized by executive dysfunction and uneven cognitive performance rather than global intellectual disability (ID) (16). The low prevalence of mild intellectual disability in our sample was surprising as the literature suggests an overlap between ADHD and ID but also highlights the difficulties in assessing ADHD in individuals with ID (17). This discrepancy may reflect under-recognition as co-occurring difficulties are often attributed to the disability itself or referral bias as individuals with ID are more likely to be assessed in specialized settings.

The observed prevalence of learning and communication impairments is consistent with findings in the literature confirming that ADHD frequently co-occurs with learning and communication disorders (14, 18). Our findings extend the literature by highlighting language exposure and multilingualism as critical contextual factors. Children from non-Dutch-speaking households were more frequently referred for speech concerns but more often diagnosed with delays rather than disorders. These findings should be interpreted with caution as no inferential statical analyses were performed, however, they may suggest that limited exposure to the language of instruction can mimic or exacerbate communication difficulties raising the possibility of misclassification.
Although prior research supports the importance of considering language background in diagnostic evaluation, a factor particularly relevant in diverse urban settings such as Brussels, evidence focusing specifically on these subgroups remains limited (19). In contrast and warranting cautious interpretation, learning delays were more frequently observed among children who spoke Dutch at home. This finding suggests the possibility of underrepresentation of non-Dutch-speaking households as cultural differences and communication barriers may limit access to healthcare services as discussed above.

The prevalence of developmental coordination disorder (DCD) in our cohort was substantially lower than the 50% prevalence reported in the literature (20). This discrepancy may reflect underdiagnosis or differences in assessment practices as motor difficulties are often secondary concerns and may not be systematically evaluated. Nevertheless, the identification of such deficits remains important as existing evidence indicates that motor impairments can intensify academic difficulties, as fine motor skills support many cognitive and school-related tasks (20).

Despite the lower prevalence of autism spectrum disorder (ASD) in our cohort, the observed co-occurrence still supports literature identifying ADHD and ASD as frequently overlapping conditions (7, 14, 15). The difference likely reflects differences in diagnostic thresholds, referral patterns or population characteristics. The presence of a substantial at-risk group for ASD indicates the

TABLE 4: Detailed summary of the medical conditions observed among the study group

Neurological disorders (N = 22)	**13,4%**
migraine	3
tension headache	2
headache, not other specified	1
epilepsy	2
febrile convulsion	3
cerebral haemorrhage *	6
axial hypotonia	1
Erb's palsy	3
periventricular leukomalacia	1
Respiratory disorders (N = 20)	**12,2%**
bronchial hyperreactivity	9
asthma	9
bronchopulmonary dysplasia	4
Atopic diseases (N = 24)	**14,6%**
atopic eczema	9
allergic rhinitis	6
allergy not further defined	13
Uro/nephrological disorders (N = 13)	**7,9%**
hydronephrosis	1
vesicourethral reflux	2
nephrolithiasis	1
duplicated renal system	1
enuresis nocturnal	6
cryptorchidism	3
Cardiac disorders (N = 4)	**2,4%**
supraventricular extrasystoles	1
congenital heart disease	1
ASD II	1
VSD	1
Otolaryngological disorders (N = 20)	**12,2%**
adenectomy or adenotonsillectomy	14
eardrum tubes	9
thyroglossal cyst	1
tympanoplasty	1
obstructive sleep apnoea	2
vocal cord paresis	1
Genetic abnormalities (N = 12)	**7,3%**
Other (N = 10)	**6,1%**
dyssomnia	1
strabismus	3
herniotomy	2
oral aversion	2
Obesity	2

* Cerebral haemorrhage: pinpoint haemorrhage, subdural, cerebellar, subependymal, intraventricular haemorrhage

necessity of continued monitoring and follow-up and may reveal higher rates over time

A striking discrepancy was observed in the extremely low rate of behavioural disorder diagnosis which contrast sharply with literature reporting high comorbidity rates for conditions such as oppositional defiant disorder (20-60%) or anxiety disorders (1-44%) (11, 21). This difference may be explained by service organization rather than true prevalence as children with suspected behavioural disorders are more likely to be referred to specialized services. Additionally, such disorders may emerge later beyond the timeframe of assessment in developmental centres.

Overall, the pattern of somatic comorbidities in our cohort is largely consistent with existing literature particularly regarding respiratory, atopic, urological and cardiovascular conditions (8, 22-25). However, some differences emerged. Although epilepsy was not specifically observed in our cohort, literature reports a significantly higher prevalence of ADHD (30.7%) among children with epilepsy compared to the general population (7.2%) (26). The presence of neurological symptoms in our sample may reflect a broader neurodevelopmental vulnerability, though the absence of epilepsy limits direct comparison. Additionally, otolaryngologic issues were relatively frequent, a finding not widely discussed in literature and potentially indicative of underexplored developmental or anatomical associations. Prematurity and SGA births were consistent with known risk factors though literature suggests that genetic and familial influences may outweigh isolated prenatal factor underscoring the need to explore postnatal and epigenetic mechanisms (27). Genetic findings in our cohort further support ADHD's polygenic nature. Notably, none of the identified variants matched those described in the reviewed literature underscoring the heterogeneity of genetic contributions and the limitations of current knowledge (6). This observation may also reflect underrepresentation as genetic testing is not routinely performed in children with ADHD.

Our findings diverge from literature in several psychosocial domains. Most notably, prenatal tobacco exposure was reported at low rates contrasting with strong evidence identifying maternal smoking as a major risk for ADHD (28). This discrepancy likely reflects underreporting and recall bias as well as incomplete documentation. In contrast, family disruptions rates were consistent with prior studies supporting the association between parental separation and ADHD risk and may be of particular relevance as early family interactions can shape the developmental trajectory or lead to secondary behavioural issues (2, 29). Socioeconomic findings however differed substantially. Only 3.7% of parents had not completed secondary education which is lower than expected based on literature linking low parental education to increased ADHD risk (29, 30).

This finding may be indicative of selection and access bias as families with lower socioeconomic status may face greater obstacles to reaching specialized services including limited awareness, cultural or language barriers and practical or financial constraints. Differences in how "low education" is defined across studies, as well as the requirement for Dutch language schooling at our centre, may also contribute to the observed discrepancy. It is also important to note that socioeconomic adversity may be underestimated in our study as detailed indicators of socioeconomic status such as income and wealth, occupational status and housing conditions were not available. Finally, the high rate of family history aligns with literature emphasizing the strong heritability of ADHD and ASD, supporting the role of genetic predisposition (5).

Interpretation of our results requires caution due to several limitations. As this was a retrospective review data quality depended on the accuracy and consistency of clinical documentation. Some variables, particularly prenatal exposures and early milestones, were incomplete or inconsistently reported. Parent-reported information may be affected by recall bias and language barriers. The tertiary setting likely introduced selection bias, over-representing complex cases and limiting generalizability particularly across socioeconomic and linguistic groups. Absence of a neurotypical control group and small sample size further restricts comparisons and statistical power. These limitations highlight the need for large-scale, prospective studies with standardized data, control groups and systematic follow-up to clarify ADHD's interactions with comorbidities and contextual factors enabling earlier and more targeted interventions.

Conclusion

This retrospective study of a tertiary care cohort confirms that ADHD in children and adolescents is a complex, multidimensional disorder often accompanied by comorbid neurodevelopmental difficulties. While many findings align with existing literature, discrepancies regarding prenatal exposures, parental education and context-dependent factors, such as language exposure, suggest underexplored influences. Additionally, limited referrals from primary care and many children lacking prior therapeutic support may reflect systemic barriers affecting clinical presentation and outcomes. The results underscore the importance of multidimensional, interdisciplinary, context-sensitive assessment and targeted strategies to improve access to care and support early intervention.

Statements

Funding details: this research received no specific grant from any funding agency.
Disclosure statement: the authors report no competing interests.
Use of artificial intelligence: artificial intelligence tools (e.g. ChatGPT and Copilot) were used for language editing and refinement during manuscript preparation.

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