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ORIGINAL CONTRIBUTION

Clinical factors associated with decision to recommend methylphenidate treatment for children with ADHD in France

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Abstract European guidelines advise on best practices for the diagnosis and non-pharmacological and pharmacological treatment of attention-deficit hyperactivity disorder (ADHD). This study aimed to (1) assess whether clinician's decisions to initiate methylphenidate treatment in children diagnosed with ADHD are in accordance with European guidelines and (2) identify clinical factors associated with the decision to recommend methylphenidate prescription. 5 to 13-year-old patients with an ADHD diagnosis were consecutively evaluated in an outpatient child and adolescent psychiatry clinic in France. Patients underwent a multidisciplinary evaluation including a diagnostic interview, symptom severity assessments with parent questionnaires, and IQ testing. We compared children with ($n = 105$) and without ($n = 55$) recommended methylphenidate treatment using Student's t test or Wilcoxon Mann–Whitney test and Chi-square or Fisher's test. Multivariate logistic regression was implemented to determine the respective influence of each variable on treatment recommendation. Recommendation to initiate methylphenidate treatment was associated with (1) ADHD combined presentation, (2) co-occurring Oppositional Defiant Disorder/Conduct Disorder (ODD/CD), Developmental Coordination Disorder (DCD) and Learning Disorder (LD), (3) clinical severity and impairment indicated on parent questionnaires, and (4) reduced perceptual reasoning. Using a multivariate regression model, ADHD combined presentation [combined versus predominantly hyperactive/impulsive and unspecified OR 4.52 (1.23–16.55), $p = 0.023$], age [OR 1.46 (1.14–1.88), $p = 0.003$], ODD/CD [OR 5.53 (2.19–14.01), $p < 0.001$], DCD [OR 4.22 (1.70–10.48), $p = 0.002$], PRI [OR 0.97 (0.94–0.99), $p = 0.01$] were significantly associated with recommendation of methylphenidate treatment. Our results indicate that clinicians' treatment decision-making complies with European guidelines and is furthermore associated with the type and severity of ADHD symptoms but also with co-occurring disorders.

Keywords Attention-deficit hyperactivity disorder (ADHD) · Stimulant medication · Methylphenidate · Neuropsychological assessments · Evidence-based treatment guidelines

Introduction

Attention-deficit/hyperactivity disorder (ADHD) is a chronic neurodevelopmental disorder with core symptoms of inattention, hyperactivity and impulsivity and resulting impairments in global functioning. ADHD is known to be associated with school failure, unemployment, substance abuse disorder, and increased mortality [1, 2]. When compared to youth without ADHD, children with ADHD are six times more likely than non-affected youth to have a high level of emotional, conduct, and peer problems and nine times more likely to manifest difficulties with friendships, home life, classroom learning and recreational activities [3, 4]. In France, the only commercialized pharmacological treatment available for ADHD is methylphenidate. The short-term

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efficacy and positive risk/benefit ratio of methylphenidate are well demonstrated in school-aged children [5, 6].

In France, methylphenidate prescription has rapidly increased over the last 10 years [7] as in other European countries [8]. However, the use of pharmacological treatment for ADHD in France remains one of the lowest of Europe [7, 9, 10]. Between 2009 and 2011, the defined daily dose (DDD) of methylphenidate was highest in Iceland (13.5 DDD per 1000 inhabitants per day), Canada (11.7 DDD) and United States (9.12 DDD). In France, the DDD is 0.28, compared to 0.15 in the United Kingdom, 2.18 in Belgium and 7.67 in the Netherlands [11], illustrating significant differences in treatment practices.

Diagnosis of ADHD remains dependent on clinical judgment given that no biomarker, neuropsychological or computerised test has demonstrated sufficient reliability as a stand-alone tool. However, clinicians do use these tests to inform their clinical judgment [12]. The guidelines consistently recommend the use of standardized interviews and questionnaires in the diagnosis of ADHD [1, 5, 13], a qualitative study investigating Belgian and British clinicians' decision-making regarding management of ADHD showed that only a minority of providers reported a standardized process based on explicit objective criteria [14]. Reliance on clinical intuition to reach clinical decisions has also been reported in a broader evaluation of psychiatrists' approaches to clinical practice leading to biases and errors in disease management [15].

European guidelines, including recommendations for general practitioners in France, support the use of pharmacological management of symptoms for children with pervasive/severe symptoms and when improvement is insufficient with behavioral treatment [6, 13, 16–18] contrary to American guidelines that recommend stimulant medication as a first-line treatment for ADHD [5]. For European clinicians, the decision whether or not to recommend medication may be even more subjective than the diagnosis of ADHD itself, given the lack of evidence-based criteria to establish defined symptom or impairment levels that warrant medication. As recently emphasized by Hoekstra and Buitelaar, it is unknown to what extent prescription practices in Europe align with current guidelines [19].

Few studies provide quantitative data about treatment initiation in ADHD [20–22]. In Central Europe and East Asia, Hong et al. found a higher level of severity at the onset of medication in ADHD medication-treated patients compared to ADHD medication-untreated patients, using Clinical Global Impressions-ADHD-Severity (CGI-ADHD-S) and Child Symptom Inventory-4 Parent Checklist (CSI-4) [22]. However, this study was based on the severity of symptoms and failed to take into account co-morbidities or neuropsychological profile as factors associated with initiation of pharmacological treatment. In an observational study in ten European countries, Falissard et al. showed that symptom severity and impairment were associated with initiation of pharmacotherapy at the baseline visit [21]. Patient characteristics associated with initiation of pharmacologic treatment for ADHD have been assessed in a study of US Medicaid claims. Initiation of pharmacologic treatment was associated with older age, male gender, rural dwelling and white ethnicity but clinical variables were not assessed [20]. While there is limited evidence from quantitative studies that describes initiation of medication treatment for ADHD as a result of a decision-making process between clinicians and families, to our knowledge no previous study has specifically assessed clinical factors that inform clinician treatment decisions.

An assessment of multiple parameters is needed to better understand determinants of clinicians' decision to recommend pharmacological treatment for ADHD. Improved understanding of the clinical decision-making process may help bridge the gap between theory (e.g., guidelines) and practice and help to further operationalize European pharmacological treatment guidelines for children with ADHD.

The objectives of the study were to (1) assess whether clinician's decisions to initiate methylphenidate treatment in children diagnosed with ADHD were in accordance with European guidelines according to severity of symptoms and impairment, (2) identify clinical factors associated with the decision to recommend methylphenidate prescription.

Methods

Study design and population

This observational, single site study included consecutive children with ADHD who underwent a multidisciplinary diagnostic assessment in the outpatient clinic of child and adolescent psychiatry at the University of Montpellier-affiliated hospital (Montpellier, France) between September 2011 and December 2014. This study was approved by the local Institutional Review Board (Comité de Protection des Personnes Sud Méditerrannée IV). All medical charts of children with a positive ADHD diagnosis at the end of the multidisciplinary assessment were retrospectively analyzed.

The multidisciplinary assessment has been developed by our team since 2011 and consists of a day-long evaluation including a semi-structured diagnostic interview, questionnaires, child observation in group activities and neuropsychological testing in a specific day-care setting for children aged 5–13. After receiving results of the assessment, the clinician in charge of the child discussed the comprehensive diagnostic evaluation with patients and parents and then proposed pharmacologic treatment or non-pharmacological treatment as a first-line option. Recommendation of pharmacologic treatment relied upon the clinician's judgment

and ultimately the decision to initiate pharmacotherapy was left to the families. All clinicians ($n = 19$) were child and adolescent psychiatrists ($n = 8$), with experience diagnosing ADHD between 6 and 16 years of practice, or psychiatric residents ($n = 11$) supervised by attending physicians for clinical decision-making.

Assessments

Assessments included the K-SADS lifetime version, a semi-structured diagnostic interview for current and past episodes of psychopathology in children and adolescents according to the DSM-IV criteria (Kaufman, 1997), French version [23]: DSM-IV combined presentation of ADHD (6 hyperactivity/impulsivity symptoms and 6 inattention symptoms with impairment present in two or more settings for at least 6 months), predominantly inattentive presentation (6 inattentive symptoms), predominantly hyperactive/impulsive presentation (6 hyperactive/impulsive symptoms), unspecified (not meet the full criteria for ADHD). The Attention-Deficit Hyperactivity Disorder Rating Scale (ADHD-RS)-parent rating was used to assess ADHD symptom severity [24]. The ADHD-RS is derived directly from DSM-IV criteria. It is an 18-item questionnaire consisting of two subscales: inattention and hyperactivity/impulsivity. The Strengths and Difficulties Questionnaire French version (SDQ-Fra) [25] is a 25 items auto-questionnaire completed by parents for the assessment of different emotions or behaviors of the child. The SDQ reports a total difficulties score (sum of four subscale scores: emotional symptoms, conduct problems, hyperactivity/inattention, peer relationship problems) and a prosocial behavior. Cut-off scores for the SDQ-parent completed version are (according to the UK norms): total problems "abnormal" ≥ 17; emotional symptoms "abnormal" ≥ 5; conduct problems "abnormal" ≥ 4; hyperactivity "abnormal" ≥ 7; peer problems "abnormal" ≥ 4; prosocial behavior "abnormal" ≤ 4. The SDQ impact score allows to differentiate between low impairment (impact score 0), medium impairment (impact score 1) and high impairment (impact score above 2). The SDQ was included in a holistic assessment of all outpatients after the beginning of the study in June 2012. Thus, only 84 SDQ were completed by parents. Cognitive functioning was assessed with the Weschler Intelligence Scale for Children, fourth version (WISC-IV, 2005) or the Wechsler Preschool and Primary Scale of Intelligence (WPPSI-III). The WISC-IV gives four factor scores: the Verbal Comprehension Index (VCI), the Perceptual Reasoning Index (PRI), the Working Memory Index (WMI), the Processing Speed Index (PSI) and a Full Scale Intellectual Quotient (IQ) score combining the four sub-scores. The Test of Everyday Attention for Children (TEA-Ch) assesses the attentional abilities of the child, divided in nine subtests: sustained attention (Score!, Score DT, Walk Don't Walk, Code Transmission), selective attention (Sky Search, Sky Search DT, Map Mission) and attentional control (Creature Counting Time, Opposite Worlds) (Manly) [26]. The subscores are given in percentile rank that corresponds to the number of persons achieving either that scaled score or less in the standardization sample. The performance level expected is > 50% for each subtest. In this study, we defined severity based on the presence of two subtests < 30%. A questionnaire assessing sociodemographic characteristics was also administered. Non-pharmacological treatments (psychosocial intervention, educational accommodations, children groups, parent training), medication history, and presence of learning disorders were obtained from medical record abstraction.

Several indicators were used to assess severity of ADHD: ADHD-RS total score, number of significant ADHD items in the K-SADS, the presence of co-morbidities, the number of co-morbidities, the total score of SDQ and the impact score.

Statistical analysis

We described our sample with frequencies for qualitative variables and mean, standard deviations or median and interquartile range ($IQR_{25–75}$) for quantitative variables.

The clinical and neuropsychological characteristics were compared between two groups: methylphenidate treatment recommendation by the psychiatrist (MPH +) vs. non-pharmacological treatment (MPH −) using Student's t test or Wilcoxon Mann–Whitney test depending on the distribution for quantitative variables and Chi-square test for categorical variables. When the validity conditions of the Chi-square test were not respected, the Fisher's exact test was used. To determine the respective influence of each co-variate on treatment recommendation, multivariate logistic regression was implemented on complete case. A confirmatory analysis was conducted after multiple imputation (MI) for the PRI missing for 11 patients.

The models were built with a backward procedure with 0.20 as the inclusion threshold and 0.10 as the outlet threshold. The adjusted odds-ratio and their 95% confidence interval were calculated. The significance level was set to 5% for all tests.

The statistical analysis was carried out using SAS version 9 (SAS Institute, Cary, NC).

Results

Among the 276 out-patients assessed for ADHD, 219 (79%) children aged 5–13 years received a confirmed diagnosis of ADHD after the multidisciplinary assessment (Fig. 1). In this ADHD sample, the child psychiatrist recommended

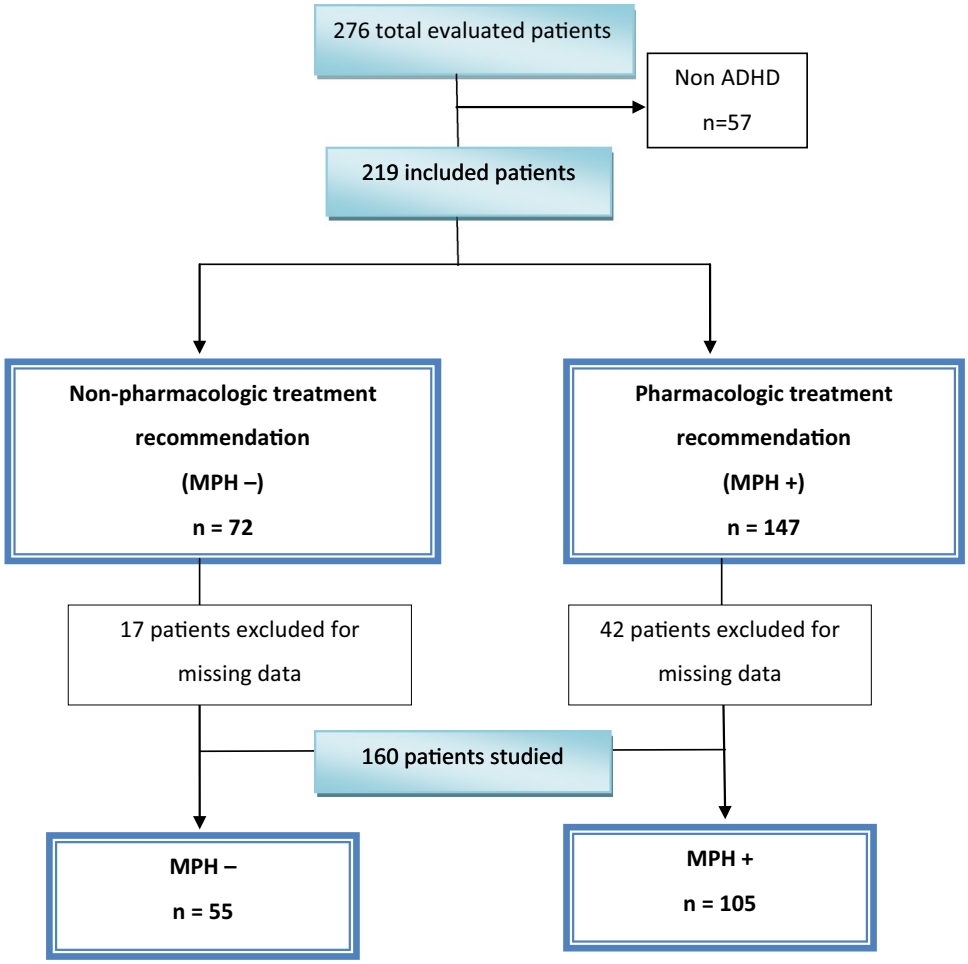

Fig. 1 Flow-chart of the study

pharmacologic treatment in 67% of children ($n = 147/219$). The main symptom assessments were missing for 59 children (K-SADS or ADHDRS missing or not completed). Finally, data from 160 patients were analyzed. Patient characteristics are reported in Table 1.

Clinical severity

In our sample, the mean SDQ-parent total difficulties score, hyperactivity–inattention score and the SDQ impact score was abnormal for 59.5, 56 and 92.4% of patients, respectively. The K-SADS semi-structured interview showed a number of inattention items ≥ 6 for 71.9% of patients, and a number of hyperactive–impulsive items ≥ 6 for 46.9% of patients in the total sample.

Cognitive tests

In the WISC-IV, the mean IQ score and each index were under 100, corresponding to below-average range (Table 1). The lowest composite scores were WMI (89.9, SD 16.5) and PSI (88.8, SD 17.7). In the TEA-Ch, performed for 49 patients, the sustained attention performance was the poorest, especially in the "Walk Don't Walk" subtest [median 9.5%, IQR $_{25–75}$ (5–25.5)] and in the "Code Transmission" subtest [median 22%, IQR $_{25–75}$ (6–36)]. In our sample, 87.8% of children with ADHD had two or more TEA-Ch scores below 30%.

Pharmacological treatment

Children who received treatment were prescribed methylphenidate immediate release and/or long acting formulations; the dose range in equivalent methylphenidate was 10 to 60 mg/day. For 79 patients, the mean time between the diagnosis and treatment initiation was 7 months (SD 7.6). This time was influenced by the consultation period which was very different between child and adolescent psychiatrists and psychiatric residents.

Factors associated with pharmacologic treatment recommendation. The univariate comparison between MPH + and MPH − groups were reported in Table 1. In MPH + children, the combined presentation of ADHD was more frequent than in the MPH − group (57.1 versus

Table 1 Patient characteristics and comparison between MPH groups

	n	Total sample ($n = 160$)	Treatment recommendation MPH + ($n = 105$)	Non-treatment recommendation MPH − ($n = 55$)	*p* value
Age (years), median ($IQR_{25–75}$)*; (range)	160	9 (8–10); (5–13)	9 (8–10); (5–13)	9 (7–10); (5–13)	0.15
Gender, *n* (%)	160				0.73
Male		119 (74.4)	79 (75.2)	40 (72.7)	
Female		41 (25.6)	26 (24.8)	15 (27.3)	
ADHD presentation*, K-SADS, *n* (%)	160				**< 0.001**
Combined		75 (46.9)	60 (57.1)	15 (27.3)	
Predominantly inattentive		68 (42.5)	38 (36.2)	30 (54.6)	
Other		17 (10.6)	7 (6.7)	10 (18.2)	
Predominantly hyperactive/impulsive		12 (7.5)	7 (6.7)	5 (9.1)	
Unspecified		5 (3.1)	0 (0)	5 (9.1)	
K-SADS, median ($IQR_{25–75}$)	160				
Number of inattentive items		7 (5–8)	7 (6–9)	5 (4–7)	**< 0.001**
Number of hyperactive/impulsive items		5 (3–7)	6 (4–8)	4 (2–6)	**< 0.001**
Comorbidities, *n* (%)	160				
Oppositional defiant disorder/conduct disorder*		92 (57.5)	70 (66.7)	22 (40.0)	**0.001**
Learning disorders*		107 (67)	76 (72.4)	31 (56.4)	**0.04**
Developmental coordination disorder*		73 (45.6)	56 (53.3)	17 (30.9)	**0.007**
Anxiety disorder		100 (62.5)	67 (63.8)	33 (60.0)	0.64
Mood disorder		26 (16.3)	15 (14.3)	11 (20.0)	0.35
Tourette's syndrome*		23 (14.4)	18 (17.1)	5 (9.1)	0.17
Number of co-morbidities, mean (SD)*		2.6 (1.1)	2.8 (1.1)	2.3 (1.0)	**0.03**
Baseline ADHD-RS, mean (SD)					
Total	160	31.3 (10)	34.0 (9.5)	26.2 (8.9)	**< 0.001**
Inattentive score	136	17.5 (5.3)	19.1 (4.9)	15 (5)	**< 0.001**
Hyperactive/impulsive score	136	14 (7)	15.7 (6.9)	11.3 (6.6)	**< 0.001**
SDQ-parent, median ($IQR_{25–75}$)					
Total difficulties	84	18 (14–23)	21 (15–25)	16 (11–20)	**0.004**
Hyperactive–inattentive	84	7 (6–8)	8 (6–9)	6 (6–8)	0.11
Conduct problems	84	4 (2–6)	4 (2–6)	3 (1–4)	**0.002**
Impact score	79	4 (3–6)	5 (4–7)	4 (2–5)	**0.025**

Table 1 (continued)

	n	Total sample ($n = 160$)	Treatment recommendation MPH + ($n = 105$)	Non-treatment recommendation MPH − ($n = 55$)	*p* value
WISC-IV, mean (SD)					
IQ	146	94.2(16.8)	93 (17.3)	96.2 (15.7)	0.34
VCI	150	99.9(17.7)	100.2 (18.6)	99.3 (16.3)	0.77
PRI*	149	96.3(16.4)	94.1 (15.8)	100.4 (16.9)	**0.02**
WMI	124	89.9(16.5)	88.7 (16.8)	92.4 (15.7)	0.23
PSI	149	88.8(17.7)	87.4 (18.1)	91.3 (17)	0.19

Significant *p* value are indicated in bold ($p < 0.05$)

*Candidate variables tested for the multivariate analysis

27.3%, $p < 0.001$). They also had a greater number of co-occurring disorders [mean (SD), 2.8 (1.1) versus 2.3 (1.0), $p = 0.03$], with significantly more frequent Oppositional Defiant Disorder/Conduct Disorder (ODD/CD) (66.7 versus 40.0%, $p = 0.001$), developmental coordination disorder (DCD) and learning disorders (72.4 versus 56.4%, $p = 0.04$). MPH + patients demonstrated greater clinical severity and a higher level of impairment as documented by SDQ-parent. The cognitive profile assessed with WISC-IV showed a significantly lower Perceptual Reasoning Index scores (PRI) in the MPH + group [mean (SD), 94.1 (15.8) versus 100.4 (16.9), $p = 0.025$]. In the TEA-Ch ($n = 49$) sustained attention was poorer in the MPH + group. The "Score!" subtest was significantly lower in MPH + patients [mean (SD), 24.6% (24.2%) versus 62.7% (32.6%), $p < 0.001$], as the scores of the "Code transmission" subtest [mean (SD), 23.1% (24.0%) versus 37.3% (28.5%), $p = 0.056$]. Pharmacologic treatment was recommended in five of six patients with co-occurring autism spectrum disorder.

Multivariate analysis

We included variables according to significance level or clinical coherence: age, ADHD presentation (combined, inattentive predominantly and others), comorbid Oppositional Defiant Disorder/Conduct Disorder (ODD/CD), developmental coordination disorder (DCD) and learning disorder (LD), number of comorbidities, Tourette's syndrome and PRI. SDQ was not introduced in the model because it was only completed by a subset of the population.

Recommendation to initiate methylphenidate by the child psychiatrist was significantly associated with age, ADHD combined presentation (*vs* predominantly hyperactive/impulsive and Unspecified), ODD/CD, developmental coordination disorder and PRI (Table 2). These results were confirmed by the models with imputed data.

Discussion

The clinical severity and type of ADHD symptoms were associated with the clinician's decision to recommend pharmacologic treatment. Combined presentation of ADHD predicted pharmacologic treatment recommendation by the clinician. These results are concordant with the findings of Hong et al. and Falissard et al. using other assessments of symptom severity [21, 22]. They are also

Table 2 Clinical characteristics associated with pharmacological treatment recommendation

	Univariate analysis		Complete case multivariate analysis ($n = 149$)		Multivariate analysis after IM ($n = 160$)	
	OR (95% CI)	p	OR_{cc} (95% CI)	p_{cc}	OR_{IM} (95% CI)	p_{IM}
Presentation						
Combined	5.71 (1.87–17.50)	0.002	4.52 (1.23–16.55)	0.023	4.96 (1.37–17.9)	0.015
Predominantly inattentive	1.80 (0.62–5.32)	0.281	1.38 (0.38–5.07)	0.63	1.36 (0.38–4.93)	0.63
Others[a]	1		1		1	
Age, 1 unit	1.14 (0.95–1.37)	0.164	1.46 (1.14–1.88)	0.003	1.38 (1.09–1.76)	0.009
Oppositional defiant disorder/conduct disorder						
Yes	3.0 (1.53–5.89)	0.001	5.53 (2.19–14.01)	< 0.001	4.84 (1.97–11.87)	0.0007
No	1		1		1	
Learning disorders						
Yes	2.03 (1.02–4.02)	0.042	–		–	
No	1					
Developmental coordination disorder						
Yes	2.56 (1.28–5.09)	0.008	4.22 (1.70–10.48)	0.002	3.76 (1.57–9.01)	0.003
No	1		1		1	
Tourette's syndrome						
Yes	2.07 (0.72–5.91)	0.175	–		–	
No	1					
Number of co-morbidities, 1 unit	1.52 (1.10–2.10)	0.012	–		–	
PRI, 1 unit	0.98 (0.96–1.00)	0.028	0.97 (0.94–0.99)	0.01	0.97 (0.94–0.99)	0.01

[a]Others = predominantly hyperactive/impulsive + unspecified; if we pooled, predominantly inattentive and others, *OR*cc = 3.59 (1.46–8.80) in complete case analysis

consistent with the algorithm of the Dundee ADHD clinical pathway and evidence-based protocol for assessment, titration and monitoring of treatment outcomes [27]. In this pathway, the severity of ADHD symptoms (e.g., children meeting ICD-10 criteria for hyperkinetic disorder[1]) is a criterion for considering medication as first-line treatment for patients aged 6 years and over. The decision to recommend first-line medication treatment for severe ADHD is also consistent with findings that in individuals with hyperkinetic disorder the superiority of medication to behavioral treatment was greater than for children meeting DSM-IV ADHD criteria [28].

In a comparison of the predictive validity of ADHD and HKD in 804 patients, Schachar et al. found that number of symptoms, teacher and parent-rated impairment as well as inhibitory control deficit were greatest in hyperkinetic disorder, followed by ADHD-Combined, ADHD-Hyperactive/Impulsive and ADHD-Inattention. Symptom severity also predicted greater exposure to risk factors and consequences following a quantitative trend. However, hyperkinetic disorder and ADHD subtypes were similar (and distinct of normal controls) across a range of other variables such as comorbidity other than CD, exposure to psychosocial risk, neurodevelopmental risk, family history of ADHD, interparental discord, working memory, academic and intelligence test scores. Similar predictive validity across clinical hyperkinetic disorder and ADHD groups, even after exclusion of cases with comorbidity, suggest that the treatment needs of all ADHD groups are clinically relevant [29]. Taken together, our findings demonstrating that ADHD severity was associated with medication recommendation by the clinician are in line with European guidelines and practices.

In our study, the presence of ODD/CD was significantly associated with pharmacologic treatment recommendation by the treating clinician. Parental report of overall difficulties and externalized symptoms followed the same pattern: among 84 parents who completed SDQ, the total score, the conduct problems score and the impact score were significantly higher in the MPH + group. Our results highlight that externalized disorders and dimensions are associated with the clinician's treatment decision. Several studies have demonstrated that children with co-occurring externalizing disorders have a worse overall outcome compared with children having ADHD alone [30, 31]. As described in the MTA study, ADHD and ODD/CD subjects usually

[1] ICD-10 criteria for HKD hyperkinetic disorder require five inattentive, three hyperactive and one impulsive symptoms in several major life situations.

responded to medication (only or combined with behavioral treatment) [31]. A systematic review and meta-analysis showed an efficacy with stimulant medication to treat oppositional behavior and conduct problems when associated with ADHD; furthermore, psychostimulants generally show more benefits in reducing aggressive and oppositional symptoms in children with ADHD than other medications [32, 33]. Because ADHD with ODD/CD is associated with poor prognosis and is amenable to methylphenidate treatment, the treatment recommendation seems particularly warranted in this population.

ADHD and Development Coordination Disorder (DCD) are frequently co-occurring and impact the daily life of children with ADHD. However, motor problems often go unnoticed by clinicians who treat ADHD [34]. It has been demonstrated that the use of stimulant medication improves motor skills in children with ADHD over the long term. Nonetheless, children with DCD and ADHD maintain motor deficits even following initiation of stimulant medication [35–37]. We found that presence of DCD in children with ADHD predicted methylphenidate treatment recommendation by the clinician. Low PRI scores, probably in line with the same dimension of motor/visuo-spatial difficulties were also found to be significant predictors of treatment in our sample. Of note, the IQ of our sample showed low average skills for age, with the lowest scores in WMI and PSI (89.9 and 88.8, respectively). These results are consistent with data usually found in children with ADHD showing that IQ is impacted by difficulties in sustained attention, working memory and attentional control and that motor/visuo-spatial difficulties are prevalent in this population [38, 39].

According to current European guidelines, pharmacological treatment is recommended in the case of severe ADHD [1, 5, 6, 13, 21]. In our study, the MPH + group had greater clinical severity characterized by combined presentation of ADHD and greater total scores in parent-rated questionnaires and a particular comorbidity profile with presence of ODD/CD and DCD. Our results suggest that French clinicians seem to comply with European guidelines in their treatment recommendations for children with ADHD. However, American guidelines [5, 40] advocate a different approach to medication as psychostimulants are recommended as a first-line choice in children ages 6 and above with ADHD. Canadian guidelines also recommend multimodal treatment including medication as a first-line treatment [1]. The question remains whether these differences are data-driven or if they merely reflect differences in medical culture. There is evidence from the MTA study that children with severe/comorbid ADHD respond more poorly to medication compared with those having uncomplicated ADHD [41, 42]. In another study, optimal treatment success was associated with core ADHD symptoms, lower impairment in non-core ADHD symptoms/behaviors and have fewer pre-existing co-morbidities [43]. These data suggest that medication could also be a valid first-line option in the case of less severe ADHD. Adherence to European guidelines as regards medication thus raises the question of the risk of neglecting optimal treatment in children with less severe, uncomplicated ADHD that are theoretically those likely to experience the best improvements and for some the complete remission of symptoms.

Our study has several limitations that must be acknowledged. The studied population was limited to a single site and was not representative of ADHD treatment for the general French population given that the studied population was drawn from a single university-affiliated outpatient clinic setting with specialized facilities for ADHD. It is important not to generalize the findings of our study to be representative of clinical treatment in France and/or Europe regarding the children's clinical characteristics. However, our sample also showed a clinical profile with similar rates of co-occurring disorders compared to the French sub-sample of the ADORE European clinical cohort of over 1500 children with ADHD. In the French sub-sample of the ADORE study ($n = 241$), the frequency of learning disorders was 63% and CD and/or ODD were found in 54% [3]. Our results demonstrated rates of 67 and 58%, respectively. Ratings on the parent-rated SDQ were similar in both studies [3]. Subtle differences in diagnostic rates of co-occurring disorders may be due to varying diagnostic procedures: the ADORE study relied on clinician diagnoses whereas our sample was systematically assessed for ODD and CD using a diagnostic interview.

Our sample of child and adolescent psychiatrists is not representative of all prescribing child psychiatrists in France as they conducted specialized consultations in a university setting. Furthermore, our study mainly focused on the relationship between the children's clinical characteristics and the decision to recommend methylphenidate treatment. However, clinician and parent-related variables, such as influence of external pressure, years of experience and clinician type or attitudes towards guidelines are important to consider in medication-related decisions [44, 45]. Therefore, it would be interesting to assess the child and family's point of view and to further identify factors that influence parents to treat their child with medication.

As a further limitation, no clinician-rated global severity assessment was used during the multidisciplinary assessment.

Our study contributes to specifying the clinical and neuropsychological characteristics of ADHD children with methylphenidate treatment indication based on objective data. Primary predictors of pharmacologic treatment recommendation by the treating clinician were symptom-related variables above impact scores and cognitive characteristics. Our data suggest that the clinicians' decision to

recommend methylphenidate treatment was in accordance with European guidelines. Considering that ADHD severity and ADHD with co-occurring disorders is associated with worse treatment response, further research is needed to optimize pharmacological treatment response in patients based on their unique characteristics. The fact that less severe ADHD is associated with improved response to pharmacological treatment, first-line medication treatment approaches could markedly improve the outcome of these patients. This finding directly challenges European guidelines that recommend pharmacological treatment only in cases with severe or resistant symptoms. Further research is necessary to examine individual and cultural determinants of medical decision-making in ADHD.

Compliance with ethical standards

Conflict of interest The author(s) EC, FP, LS, MCP, EN, VM, ES declare no potential conflicts of interest with respect to the research, authorship, and/or publication of this article. Pr Purper-Ouakil reports personal fees from Shire, Otsuka, Jensen and Boiron and research funding from Mensia outside the submitted work.

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