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Clinical and functional characteristics of children and young adults with cerebral palsy and co-occurring attention-deficit/hyperactivity disorder

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ABSTRACT

Background: Emerging research shows that children and young adults (CYAs) with cerebral palsy (CP) are at higher risk for attention-deficit/hyperactivity disorder (ADHD). However, little is known about the clinical and functional characteristics of CYAs with these co-occurring disorders.
Aim: To estimate associations between a diagnosis of ADHD among CYAs with CP and clinical and functional characteristics.
Methods: This retrospective, cross-sectional study used data from the electronic health records of CYAs (aged 4–26 years) with CP (n = 1145). We used bivariate and multivariable analyses to estimate associations between an ADHD diagnosis, CP type, Gross Motor Function Classification System (GMFCS) level, speech or language disorder, and intellectual disability.
Results: 18.1 % of CYAs with CP had a diagnosis of ADHD. CYAs with spastic-bilateral CP had lower odds of ADHD (adjusted odds ratio [AOR] = 0.58; 95 % confidence interval [CI], 0.35–0.96). Odds of having ADHD were significantly lower for those with GMFCS levels III-V (AOR = 0.10; 95 % CI, 0.06–0.15).
Conclusions: Our study found that a diagnosis of ADHD among CYAs with CP was associated with greater clinical and functional impairments compared to counterparts without ADHD. Findings highlight the need to screen for both conditions because of the high comorbidity rates in this population.

What this paper adds

Both cerebral palsy (CP) and attention-deficit/hyperactivity disorder (ADHD) can severely impact the physical, mental, and social

Abbreviations: ADHD, Attention-deficit/hyperactivity disorder; ASD, Autism spectrum disorder; CP, Cerebral palsy; CYA, Children and young adults.

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well-being of children and young adults (CYAs), and the burden of impairments and functional limitations is higher for CYAs with co-occurring CP and ADHD than for CYAs with CP without ADHD. However, information on clinical and functional characteristics of this vulnerable population is limited by a paucity of studies, as well as small sample sizes.

Given the increased risk of ADHD among CYAs with CP, there is a need to better understand the features associated with this comorbidity in order to more effectively target services and resources.

Our study expands the literature by showing that CYAs with CP who have co-occurring ADHD are more likely than those without ADHD to present with specific clinical and function limitations in terms of CP type and GMFCS level.

The findings highlight the need to screen for both conditions, particularly in primary care settings, because of the high rates of comorbidity in this population. They also underscore the importance of using a multidisciplinary and integrated approach to diagnose and treat CYAs with CP and co-occurring ADHD. This should include collaborative care models that emphasize early screening, diagnosis, and treatment, which can improve long-term outcomes and quality of life for both CYAs and their families.

1. Introduction

Cerebral palsy (CP) is the most common movement disorder in children, with prevalence estimated at 1.5 to more than 4 per 1000 live births globally (Centers for Disease Control and Prevention, 2023; Oskoui et al., 2013), and 2 to 4 per 1000 in the United States (Boulet et al., 2009; Casseus & Cheng, 2021; Christensen et al., 2014; Maenner et al., 2016; Van Naarden Braun et al., 2015). CP is defined as a group of neurodevelopmental disorders that affects body movement, posture, coordination, and balance. Individuals with CP also experience impairments in sensation, perception, cognition, communication, and behavior, as well as secondary musculoskeletal problems (Rosenbaum et al., 2007).

CP is classified by its motor type and distribution of limb involvement, depending on the areas of the brain affected (Noritz et al., 2022; Wimalasundera & Stevenson, 2016). The four main types of CP are spastic, dyskinetic (dystonia, chorea and athetosis), ataxic, and mixed pattern. The most common type of CP is spastic CP, which affects approximately 80 % of children and young adults (CYAs) with CP (Christensen et al., 2014; Durkin et al., 2015; Påhlman et al., 2021; Yeargin-Allsopp et al., 2008). Spastic CP can be unilateral (involving only one side of the body) or bilateral (involving both sides of the body). People with spastic CP have increased muscle tone resulting in muscles that are stiff (Noritz et al., 2022; Wimalasundera & Stevenson, 2016). Dyskinetic CP accounts for 3 %– 15 % of CYAs with CP and includes athetoid, choreoathetoid, and dystonic CP (Påhlman et al., 2021; Påhlman et al., 2020; Yeargin-Allsopp et al., 2008). It is characterized by recurring, uncontrollable, and involuntary movements including uncoordinated writhing and jerky movements (Wimalasundera & Stevenson, 2016). Between 2 % and 7 % of CP cases are classified as ataxic (Påhlman et al., 2021; Yeargin-Allsopp et al., 2008), which presents as problems with balance and coordination, abnormal force, rhythm and control or accuracy of movement (Centers for Disease Control and Prevention, 2023; Noritz et al., 2022; Wimalasundera & Stevenson, 2016). Approximately 8 %– 14 % of CYAs with CP have mixed or unspecified CP (Christensen et al., 2014; Durkin et al., 2015; Yeargin-Allsopp et al., 2008).

CP is often characterized by significant functional limitations and clinical impairments including intellectual disability (49 %); epilepsy (38.1 %); behavior problems (20 %); problems with vision (11 %), hearing (4 %), or speech (23 %); and gastrointestinal problems (35 %) (Berry et al., 2018; Casseus & Cheng, 2021; Novak et al., 2012). The functional impairments of CP also encompass a broad range of other disorders, and there is emerging evidence that CYAs with CP have a higher risk for other neurodevelopmental disorders, such as autism spectrum disorders (ASD) and attention-deficit/hyperactivity disorder (ADHD), than children in the general population (Noritz et al., 2022).

ADHD is the most common neurodevelopmental disorder among children (Perou et al., 2013) with a global prevalence of 5 % (Sayal et al., 2018). ADHD symptoms include pervasive inattentiveness, impulsivity, and/or hyperactivity that lead to impaired functioning (American Psychiatric Association, 2013). The three main types of ADHD are 1) predominantly inattentive; 2) predominantly hyperactive/impulsive; and 3) combined (American Psychiatric Association, 2013). Diagnosis of ADHD has increased in the past two decades from 6.1 % in 1997 to 10.2 % in 2016 (Danielson et al., 2018; Xu et al., 2018).

Studies have found that ADHD is more prevalent among CYAs with CP than in the general population of CYAs, with overall estimates ranging from 19 % to 35 % (Craig et al., 2019). In three population-based studies Påhlman et al., (2021, 2022, 2020) reported rates ranging from 30 % to 50 % among Swedish children, and Casseus and Cheng (2021) found that the prevalence of ADHD was 15.5 % among children with CP compared with 8.7 % among the general U.S. population.

Both CP and ADHD can severely impact the physical, mental, and social well-being of CYAs, and the burden of impairments and functional limitations is higher for CYAs with co-occurring CP and ADHD than for CYAs with CP without ADHD. For example, intellectual disability and speech or language disorders are more prevalent in children with co-occurring CP and ADHD (Påhlman et al., 2021; Påhlman et al., 2020). However, information on clinical and functional characteristics of this vulnerable population is limited by a paucity of studies, as well as small sample sizes (Craig et al., 2019). Given the increased risk of ADHD among CYAs with CP, there is a need to better understand the features associated with this comorbidity in order to more effectively target services and resources. To address this important gap in the literature, this study examined co-occurring CP and ADHD in a sample of clinically referred CYAs. The objective was to estimate associations between a diagnosis of ADHD among CYAs with CP and clinical and functional characteristics.

2. Methods

2.1. Study design

This was a retrospective, cross-sectional study of the electronic health records (EHRs) of patients with CP who received care from a large pediatric hospital in the U.S. that provides services for CYAs with developmental disabilities and other special health care needs. The sample included patients who used inpatient and outpatient services between January 1, 2016 and July 1, 2021. International Classification of Diseases - 10th Revision (ICD-10) codes were used to identify CP, ADHD, and co-occurring medical conditions associated with CP. Review of ICD-10 codes and problem lists was performed on patients' records. All data were deidentified and included the patient's age, sex, race and ethnicity, insurance status, preferred language, and zip code. Ascertainment of medical conditions, clinical, and functional characteristics was based on documentation by qualified clinicians including physiatrists (physical medicine and rehabilitation physicians), neurologists, pediatricians, neuropsychologists, advanced practice registered nurses, physical therapists, occupational therapists, and speech and language pathologists. The study was approved by the Western Institutional Review Board.

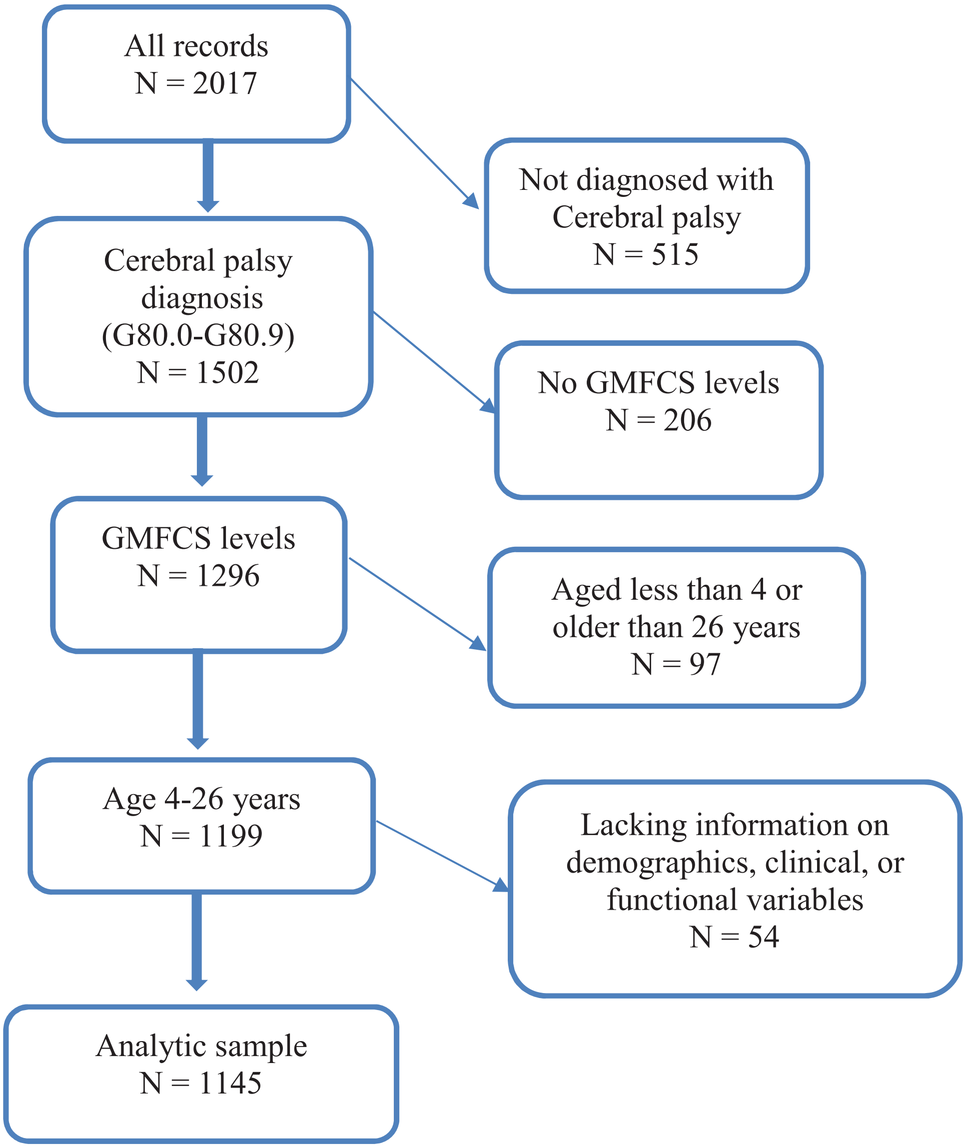

Fig. 1. Derivation of analytic sample. Note: GMFCS, Gross Motor Function Classification System.

2.2. Study population

All CYAs were identified based on billing diagnoses associated with at least one hospital encounter during the study period. 2017 records were reviewed of which 1502 patients had a CP diagnosis. Although ADHD has been reported in 2.4 % of children 2–5 years old (Danielson et al., 2018), the American Academy of Pediatrics' clinical practice guideline addresses the evaluation, diagnosis, and treatment of ADHD in children from age 4 years to young adulthood (Wolraich et al., 2019). Hence, our study population was comprised of CYAs between the ages of 4 and 26 years with CP. After excluding records with missing information on outcomes or other analysis variables, the analytic sample included 1145 patients (938 without ADHD and 207 with ADHD) (Fig. 1). Comparisons of patients in our sample to patients excluded from our sample indicated that those in our sample were more likely to be older and report Other non-Hispanic or White non-Hispanic race/ethnicity (results not shown).

2.3. Variables

CP was ascertained using the ICD-10 codes G80.0-G80.9. CP types, which were classified according to documentation of relevant physical findings and diagnostic summaries, were categorized as spastic – unilateral, spastic – bilateral, other non-spastic (dyskinetic, ataxic, mixed, and hypotonic), and unspecified CP. The category of "unspecified CP" was based on ICD-10 code G80.9 and is sometimes used when the presence of multiple forms of hypertonia is identified during patient examination and to document mixed CP type, along with G80.8. Dyskinetic ($n = 13$, 1.1 %), ataxic ($n = 14$, 1.2 %), mixed ($n = 71$, 6.2 %), and other ($n = 48$, 4.2 %) CP types were combined into "other non-spastic" due to small samples with ADHD. Gross motor function was classified according to the Gross Motor Function Classification System (GMFCS), which is a 5-level system for classifying children and youth with CP based on gross motor functional abilities and limitations (Palisano et al., 2008). The higher the GMFCS level, the more severe the limitations in terms of sitting, walking, and using mobility devices. Due to small sample sizes in the ADHD group, GMFCS levels III, IV, and V were combined into one category ($n = 33$, 2.9 %).

Patients were categorized as having ADHD if the ICD-10 codes for attention-deficit hyperactivity disorder – predominantly inattentive type (F90.0); attention-deficit hyperactivity disorder – predominantly hyperactive type (F90.1); attention-deficit hyperactivity disorder – combined type (F90.2); attention-deficit hyperactivity disorder – other type (F90.8); or attention-deficit hyperactivity disorder – unspecified type (F90.9) were included in the medical record. Clinical documentation (e.g., problem lists, clinical notes) of ADHD was also used for ascertainment. Speech or language disorders were abstracted from ICD-10 codes (F80.0-F80.9) or diagnostic summaries and descriptions by physicians and clinicians such as speech and language pathologists, neurologists, psychologists, neuropsychologists, and developmental specialists. In the absence of ICD-10 codes indicating intellectual disability (F70-F79), clinical summaries (noting, for example, "cognitive impairment," "mental retardation," "global developmental delay," or "intellectual

Table 1
Demographic characteristics by attention-deficit/hyperactivity disorder (ADHD) diagnosis among children with cerebral palsy (CP), n = 1145.

Demographic characteristic	n (%)	CP without ADHD (n = 938) n (%)	CP with ADHD (n = 207) n (%)	Comparison between groups p-value
Sex				0.5859
Male	671 (58.6)	546 (58.2)	125 (60.4)	
Female	474 (41.4)	392 (41.8)	82 (39.6)	
Age group (yrs.)				0.0017
4-8	330 (28.8)	266 (28.4)	64 (30.9)	
9-12	270 (23.6)	213 (22.7)	57 (27.5)	
13-17	312 (27.3)	248 (26.4)	64 (30.9)	
18-26	233 (20.4)	211 (22.5)	22 (10.6)	
Race/ethnicity				0.6780
White, non-Hispanic	395 (34.5)	317 (33.8)	78 (37.7)	
Black, non-Hispanic	199 (17.4)	168 (17.9)	31 (15.0)	
Hispanic	263 (23.0)	220 (23.5)	43 (20.8)	
Other non-Hispanic	246 (21.5)	199 (21.2)	47 (22.7)	
Unknown	42 (3.7)	34 (3.6)	8 (3.9)	
Median household income				0.3019
≤ $49,999	198 (17.3)	160 (17.1)	38 (18.4)	
$50,000-$74,999	295 (25.8)	243 (25.9)	52 (25.1)	
$75,000-$99,999	306 (26.7)	242 (25.8)	64 (30.9)	
$100,000 +	346 (30.2)	293 (31.2)	53 (25.6)	
Health insurance status				0.6136
Private	507 (44.3)	421 (44.9)	86 (41.6)	
Public	624 (54.5)	505 (53.8)	119 (57.5)	
Other[a]	14 (1.2)	12 (1.3)	2 (1.0)	
Preferred language				0.0008
English	932 (81.4)	747 (79.6)	185 (89.4)	
Language other than English	213 (18.6)	191 (20.4)	22 (10.6)	

Percentages may not total 100 % in each category due to rounding.
[a] Uninsured or self-pay.

disability") were used for ascertainment (Moeschler & Shevell, 2014).

Demographic variables examined were sex (Male, Female), age groups in years (4–8, 9–12, 13–17, 18–26), race/ethnicity (White non-Hispanic, Black non-Hispanic, Hispanic, Other non-Hispanic, Unknown), median household income (≤ $49,999, $50,000-$74,999, $75,000-$99,999, $100,000 +), health insurance status (Private, Public, Other), and patient's preferred language (English, Language other than English). Uninsured or self-pay patients were classified as "Other" in terms of health insurance status. Sex, race/ethnicity, and preferred language were based on self-report. Patient zip codes were used to determine median household income based on the US Census Bureau 2020 American Community Survey 5-year estimates.

2.4. Data analysis

We first calculated the prevalence of ADHD in the sample and described the sociodemographic (sex, age, race/ethnicity, median household income, health insurance status, and preferred language), clinical (CP type), and functional (GMFCS level, intellectual disability, and speech or language disorder) characteristics of the study population. Second, we used bivariate analyses, Pearson chi-square, and Fisher's exact tests to compare distributions of sociodemographic, clinical, and functional characteristics of patients with CP alone and patients dually diagnosed with CP and ADHD. Third, we examined the distribution of CP type by ADHD type. Lastly, we conducted multivariable logistic regression models to estimate associations between an ADHD diagnosis and the following predictor variables: CP type, GMFCS level, speech or language disorder, and intellectual disability. We excluded unspecified CP from multivariable analysis of CP type in order to examine comparisons among specified CP types. Logistic models were adjusted for the patient's sex, age, race/ethnicity, median household income, health insurance status, and preferred language. All analyses were conducted with SAS version 9.4 (SAS Institute, Cary, NC).

3. Results

Among the 1145 CYAs with CP in the sample, two hundred and seven (18.1 %) had a diagnosis of ADHD (Table 1). A majority of patients were male (58.6 %) and 28.8 % were between the ages of 4 and 8 years (mean age = 12.5, SD = 5.4, range 4–26). A third of the sample was White, non-Hispanic (34.5 %). More than half of the participants had public health insurance (54.5 %), and the vast majority reported English as their preferred language (81.4 %). The predominant type of CP documented was spastic – bilateral (52.0 %), followed by spastic – unilateral (18.8 %). Among the 189 participants diagnosed with unspecified CP, one hundred and thirty did not have co-occurring ADHD, while 59 had ADHD. (Results not shown). Approximately a quarter were classified in GMFCS levels II (27.3 %) and V (25.8 %), whereas 18.8 % were classified in GMFCS level I. Eighty-one percent had a documented speech or language disorder, and over two-thirds (68.3 %) had an intellectual disability. Bivariate analyses indicated that CYAs with ADHD were predominantly younger and more likely to report English as their preferred language (89.4 % vs 79.6 %).

Forty-three percent of the 207 patients with ADHD had ADHD - combined type, and a third (32.9 %) had ADHD – unspecified type. Only 7.7 % had ADHD – hyperactive type (Table 2). Results of unadjusted and adjusted logistic regression models of ADHD diagnosis are presented in Table 3. Multivariable models adjusted for sex, age group, race/ethnicity, median household income, health insurance status, and preferred language. CYAs with ADHD were less likely to have spastic bilateral CP than peers without ADHD (44.6 % vs. 65.4 %), and a diagnosis of spastic – bilateral CP was associated with 42 % lower odds of ADHD (AOR = 0.58; 95 % CI [0.35–0.96]). Patients who had severe functional limitations characterized by GMFCS levels III-V were less likely to have ADHD (15.9 % vs. 62.2 %) and had lower odds of an ADHD diagnosis (AOR = 0.10; 95 % CI [0.06–0.15]). Odds of speech or language disorder were 0.83 (95 % CI [0.57–1.23]), while odds of intellectual disability were 0.76 (95 % CI [0.55–1.06]) among those with ADHD.

4. Discussion

This study examined clinical and functional characteristics of individuals with CP aged 4 to 26 years who had co-occurring ADHD. We found that nearly one out of five CYAs with CP had a diagnosis of ADHD, with combined inattentive and hyperactive type being most common and hyperactive type the least common. Compared with CYAs with other non-spastic CP, those with spastic-bilateral CP had lower odds of an ADHD diagnosis. Odds of having an ADHD diagnosis were significantly lower for those with severe physical limitations characterized by GMFCS levels III-V compared to those with GMFSC level I. Speech or language disorders and intellectual disability were not significantly associated with ADHD diagnosis.

Table 2
Cerebral palsy (CP) type among participants with attention-deficit/hyperactivity disorder (ADHD) n = 207.

ADHD type				
CP type	**Combined inattentive and hyperactive (n = 89, 43.0 %) n (%)**	**Hyperactive (n = 16, 7.7 %) n (%)**	**Inattentive (n = 34, 16.4 %) n (%)**	**Unspecified (n = 68, 32.9 %) n (%)**
Spastic - unilateral	17 (8.2)	4 (1.9)	10 (4.8)	25 (12.1)
Spastic - bilateral	29 (14.0)	6 (2.9)	13 (6.3)	18 (8.7)
Other, non-spastic	12 (5.8)	2 (1.0)	6 (2.9)	6 (2.9)
Unspecified	31 (15.0)	4 (1.9)	5 (2.4)	19 (9.2)

Table 3
Functional characteristics of participants with cerebral palsy (CP) with and without attention-deficit/hyperactivity disorder (ADHD) n = 1145.

Characteristics	CP without ADHD (n = 938) n (%)	CP with ADHD (n = 207) n (%)	Unadjusted OR (95 % CI)	Adjusted OR (95 % CI)[a]
CP type[b]				
Spastic - unilateral	159 (19.7)	56 (37.8)	1.63 (0.96-2.74)	1.51 (0.88-2.58)
Spastic - bilateral	529 (65.4)	66 (44.6)	0.58 (0.35-0.95)	0.58 (0.35-0.96)
Other non-spastic	120 (14.9)	26 (17.6)	Reference	Reference
GMFCS				
I	134 (14.3)	82 (39.6)	Reference	Reference
II	221 (23.6)	92 (44.4)	0.68 (0.47-0.98)	0.71 (0.48-1.03)
III-V	583 (62.2)	33 (15.9)	0.09 (0.06-0.14)	0.10 (0.06-0.15)
Speech or language disorder				
Yes	763 (81.3)	164 (79.2)	0.86 (0.60-1.27)	0.83 (0.57-1.23)
No	175 (18.7)	43 (20.8)	Reference	Reference
Intellectual disability				
Yes	651 (69.4)	131 (63.3)	0.76 (0.56-1.04)	0.76 (0.55-1.06)
No	287 (30.6)	76 (36.7)	Reference	Reference

Percentages may not total 100 % in each category due to rounding.
CI = Confidence interval.
GMFCS = Gross Motor Function Classification System.
[a] Adjusted odds ratio - models adjusted for sex, age, race/ethnicity, median household income, health insurance status, and preferred language.
[b] Unspecified CP type (n = 189) was excluded from multivariable analysis of CP type in order to examine comparisons among specified CP types.

Results from our study align with recent findings of increased odds of ADHD among CYAs with CP (Casseus & Cheng, 2021; Craig et al., 2019; Påhlman et al., 2021, 2022; Påhlman et al., 2020). Researchers have also found a similar association between CP and ASD (Christensen et al., 2014; Delobel-Ayoub et al., 2017; Påhlman et al., 2021, 2022; Påhlman et al., 2020). The findings from previous studies along with the results of our study point to growing evidence of phenotypic, genetic, and pathophysiologic overlap between CP, ADHD, and ASD (Påhlman et al., 2022; Rao & Landa, 2013; Sokolova et al., 2017; Taurines et al., 2012; Zwaigenbaum, 2014).

Consistent with previous research, CYAs with spastic – bilateral CP had a lower likelihood of an ADHD diagnosis compared to their counterparts with other non-spastic CP (Påhlman et al., 2021). Two previous European studies suggest that ADHD is more prevalent among individuals with ataxic CP (Ahsgren et al., 2005; Påhlman et al., 2021). While a population-based study in Europe indicated low prevalence of ADHD among children with more severe motor impairment (Påhlman et al., 2021), another study using data from the same population found no association between ADHD and severity of motor impairment (Påhlman et al., 2020). Our findings indicate that CYAs with CP and co-occurring ADHD have lower odds of presenting with more severe motor impairments characterized by higher GMFCS levels III, IV, and V. Contradictory results may be due, in part, to methodological differences in the assessment of ADHD. Prevalence of ADHD among individuals with CP varies based on the data source (national registries, EHR, screening, and clinical assessments). Prevalences using medical records (as in this study) are generally lower than those from screening, and clinical assessments tend to be the most accurate in diagnosing ADHD (Bjorgaas et al., 2012; Påhlman et al., 2020). Hence, it is important to exercise caution in interpreting results because differences in data sources make it difficult to compare across studies.

Inconsistent results also highlight several areas of concern that warrant further investigation. First, motor impairments can mask other neurological impairments in this population, which can make it more difficult to identify symptoms of ADHD among individuals with CP because of neuromotor involvement. For example, what may appear as uncontrollable movements due to dyskinesia might actually be fidgeting or other hyperactive behavior. Second, there are persistent limitations to diagnosing neurodevelopmental and other conditions in populations with CP due to a lack of validated instruments (Craig et al., 2019; Påhlman et al., 2020; Zwaigenbaum, 2014).

We did not find an association between diagnoses of ADHD and intellectual disability or speech or language disorder. This null finding contrasts with previous literature suggesting that children diagnosed with co-occurring CP and ADHD were more likely to have intellectual disability and speech impairments compared to children with CP alone (Påhlman et al., 2020). The sensory and motor limitations that are often characteristic of both CP and ADHD pose significant challenges in accurately diagnosing these co-occurring conditions. Furthermore, instruments used to measure ADHD, speech disorders, intellectual disability, and other disorders among children with CP may not accurately assess children with more severe motor and sensory impairments (Craig et al., 2019; Påhlman et al., 2020; Zwaigenbaum, 2014). Implications of this finding include the need to identify valid and reliable screening methods to evaluate motor, receptive, expressive, and other impairments among individuals with CP.

Accurate diagnosis and treatment of ADHD in CYAs with CP have important clinical and policy implications (Noritz et al., 2022). With the availability of a wide range of evidence-based pharmacological and non-pharmacological interventions (Wolraich et al., 2019), identifying and treating ADHD in CYAs with CP can greatly facilitate habilitation efforts unique to this population.

Our study expands the literature by showing that CYAs with CP who have co-occurring ADHD are more likely than those without ADHD to present with specific clinical and function limitations in terms of CP type and GMFCS level. Strengths of this study include the use of data from a larger and more diverse sample than previous studies on the topic (Påhlman et al., 2021; 2022; 2020). Diagnoses were derived from ICD-10 billing codes and record review. Additionally, data were derived from a sample of patients receiving care from a pediatric hospital with highly trained neurodevelopmental pediatricians, advanced practice nurses, psychiatrists, psychologists, therapists, and others specializing in diagnosis and treatment of ADHD and other neurodevelopmental disorders. Further, the pediatric hospital is the largest provider of services for children with CP in the state and is staffed by pediatric physiatrists who specialize in CP.

Several limitations should be considered in interpreting the findings from this study. We used data from a clinical sample which likely has more severe impairments than non-clinical samples, and the findings may not apply to samples or populations with less severe impairments. Hence, there is the potential for selection bias which limits the generalizability of the study. Due to small sample sizes, certain CP types and GMFCS levels were combined which limited analysis of those variables. Nearly one fifth of patients had unspecified CP, which may reflect insufficient diagnosis. It is possible that some providers used unspecified CP for convenience, or to describe mixed CP (e.g., combined spastic and dyskinetic CP). This was a cross-sectional study, so causality should not be inferred. This was a retrospective study using EHRs and, therefore, misclassification of variables and missing diagnoses are possible. Additionally, prevalence of the disorders may be underestimated. For example, patients with higher GMFCS levels and more severe physical and communication impairments may be more likely to be misdiagnosed or underdiagnosed for ADHD and other neurodevelopmental disorders (Påhlman et al., 2021; Påhlman et al., 2020; Zwaigenbaum, 2014).

4.1. Conclusion

Findings from this retrospective study suggest that a diagnosis of ADHD among CYAs with CP was associated with greater clinical and functional impairments compared to counterparts without an ADHD diagnosis. The findings highlight the need to screen for both conditions, particularly in primary care settings, because of the high rates of comorbidity in this population. They also underscore the importance of using a multidisciplinary and integrated approach (e.g., physicians, mental health professionals, physical and occupational therapists, etc.) to diagnose and treat CYAs with CP and co-occurring ADHD (Noritz et al., 2022). This should include collaborative care models that emphasize early screening, diagnosis, and treatment, which can improve long-term outcomes and quality of life for both CYAs and their families.

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CRediT authorship contribution statement

JenFu Cheng: Writing – review & editing, Writing – original draft, Resources. **Nancy E Reichman:** Writing – review & editing, Writing – original draft. **Myriam Casseus:** Writing – review & editing, Writing – original draft, Validation, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization.

Declaration of Competing Interest

There are no conflicts of interest to declare.

Data availability

The authors do not have permission to share data.

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