


Physical Functioning, Emotional, and Behavioral Problems in Children With ADHD and Comorbid ASD: A Cross-Sectional Study

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Abstract

Objective: To examine (a) physical and daily functioning in children with ADHD and autism spectrum disorder (ASD) compared with ADHD alone and (b) whether decreased physical quality of life (QoL) is associated with increased emotional and behavioral problems in children with ADHD-ASD. **Method:** Cross-sectional study comprising 392 children with confirmed ADHD (ADHD-ASD, $n = 93$; ADHD alone, $n = 299$) recruited from 21 pediatric practices in Victoria, Australia. Data were collected via parent and teacher surveys. Key measures included the Strengths and Difficulties Questionnaire (SDQ) and Pediatric Quality of Life Inventory (PedsQL). **Results:** Children with ADHD-ASD had poorer QoL across both psychosocial and physical health domains, and also had greater parent-reported behavioral, emotional, and peer problems, compared with children with ADHD alone. Poorer physical QoL partially mediated the relationship between comorbid ASD status and poorer emotional and behavioral functioning. **Conclusion:** The comorbid overlay of ASD in ADHD appears to influence not only problems in physical functioning but also the severity of problems relating to areas of emotional and behavioral functioning. (*J. of Att. Dis.* XXXX; XX(X) XX-XX)

Keywords

ADHD, autism spectrum disorder (ASD), Australia, quality of life, physical activity

ADHD and autism spectrum disorder (ASD) are two of the most common neurodevelopmental disorders, affecting approximately 5% and 1% of the population, respectively (Matson & Kozlowski, 2011; Polanczyk, de Lima, Horta, Biederman, & Rohde, 2007). Despite increasing recognition that ADHD and ASD often co-occur, relatively little is known about how ASD affects the clinical presentation and impairments associated with ADHD and vice versa. The comorbid diagnosis of ADHD and ASD (henceforth referred to as ADHD-ASD) has only recently been formally recognized in the *Diagnostic and Statistical Manual of Mental Disorders* (5th ed.; *DSM-5*; American Psychiatric Association [APA], 2013). Clinically elevated ASD symptoms are estimated to co-occur in up to 50% of individuals with ADHD (Reiersen, Constantino, Volk, & Todd, 2007). Research suggests that children with ADHD-ASD experience greater impairments in daily functioning, and may be at an increased risk of developing additional psychological disorders than children with either disorder in isolation (Jang et al., 2013).

Motor impairments are very common in children with neurodevelopmental disabilities. Seventy-nine percent of children with ASD (Green et al., 2009; Papadopoulos et al.,

2012) and 50% of children with ADHD are estimated to have motor impairments as measured on the Movement Assessment Battery for Children (MABC; Piek, Pitcher, & Hay, 1999). Impaired motor development in childhood has been associated with poor self-perception of motor competency, and a reluctance to engage in play-centered motor activities including team sports (Wilson, Piek, & Kane, 2013). Previous research suggests that motor impairments are more severe in children with ASD than children with ADHD (Green et al., 2009), and there may be an increased association with social symptomology unique to ASD (Dowell, Mahone, & Mostofsky, 2009; Papadopoulos et al.,

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2012). Interestingly, evidence suggests that increasing physical activity in children with ADHD reduces symptom severity (Azrin, Ehle, & Beaumont, 2006; Barnard-Brak, Davis, Sulak, & Brak, 2011). Techniques such as horseback riding have yielded similar results for children with ASD (Gabriels et al., 2012). However, there is little information regarding the effects of such interventions on children with ADHD-ASD.

Children with ADHD or ASD alone commonly experience comorbid behavioral and emotional disorders (APA, 2013), as well as reduced health-related quality of life (QoL; Danckaerts et al., 2010; Delahaye et al., 2014). Sikora, Vora, Coury, and Roawnberg (2012) found that children ($n = 1,229$) with ASD and clinically significant ADHD symptoms had poorer QoL, compared with children with ASD without clinically elevated ADHD symptoms. More recently, a small study by Gargaro et al. (2014) showed that children with ADHD ($n = 13$), ASD ($n = 12$), and ADHD-ASD ($n = 12$) had different clinical profiles. Children with comorbid ADHD-ASD experienced higher proportions of parent-reported emotional and behavioral problems, compared with those with ADHD or ASD alone. Greater motor impairment has also been shown to precede, correlate, and exacerbate social communication difficulties (Papadopoulos et al., 2012) and be related to greater emotional and behavioral disturbance in children with ASD.

Yet, the relationship between physical QoL and other aspects of daily functioning in children with comorbid ADHD-ASD is unclear, particularly whether impairments in physical QoL may be a key driver of broader psychosocial difficulties seen in children with ADHD-ASD. This presents a critical gap given that greater motor difficulties have been shown to be associated with negative psychosocial outcomes, such as social and adaptive functioning in children with ADHD who present with ASD traits (Kotte et al., 2013).

The aim of this brief report was to (a) compare emotional and behavioral problems, psychosocial QoL, and physical QoL in children with ADHD-ASD with those with ADHD alone and (b) examine whether poorer physical QoL in children with ADHD-ASD was associated with increased emotional and behavioral problems. It was hypothesized that (a) children with ADHD-ASD would have poorer functioning across all assessed domains, compared with those with ADHD in isolation; and (b) physical QoL would mediate the relationship between ADHD-ASD and increased emotional and behavioral problems.

Method

Participants

The study was approved by the Human Research Ethics Committee of The Royal Children's Hospital, the Department of Education and Early Childhood Development, Melbourne,

Australia. The sample comprised 392 children (M age = 10.2 years), recruited as part of a larger study examining sleep longitudinally in children with ADHD (Lycett, Sciberras, Mensah, Gulenc, & Hiscock, 2014). This article reports on baseline parent and teacher data and splits the sample into two distinct groups: (a) children *without* an additional parent-reported diagnosis of ASD (referred to as ADHD alone; $n = 299$) and (b) children *with* an additional parent-reported diagnosis of ASD (referred to as ADHD-ASD; $n = 93$).

Eligibility and Recruitment

Children were eligible if they were aged between 5 and 13 years and were experiencing at least six of the nine ADHD symptoms for inattention and/or hyperactivity, as measured by the validated 18-item ADHD Rating Scale (DuPaul, Power, Anastopoulos, & Reid, 1998) and study-designed questions that assessed symptom duration, age of onset, and cross-situational impairment, as per the *Diagnostic and Statistical Manual of Mental Disorders* (4th ed., text rev.; *DSM-IV-TR*; APA, 2000). Children were recruited from 21 private and public pediatric practices across the state of Victoria, Australia. Study invitation letters were mailed to all children with an existing diagnosis of ADHD who had been seen by their pediatrician in the past 12 months. The invitation letter included an "opt out" option, whereby families could choose not to hear more about the study. The contact details of families that did not "opt out" were passed on to the research team, who telephoned parents to assess eligibility and interest. Children were excluded if they had a serious medical condition (e.g., severe cerebral palsy) or an intellectual disability ($IQ < 70$), were receiving specialist help for a sleep problem, screened positive for obstructive sleep apnea, or if the family did not speak sufficient English to complete the questionnaires.

Measures

ASD status. ASD diagnosis was obtained via parent report, by asking parents "In addition to ADHD, has your child been diagnosed with any of the following by a health professional?" A list of diagnoses was provided, of which "Asperger's or autism spectrum disorder" was an option. The Peer Problems subscale of the Strengths and Difficulties Questionnaire (SDQ; Goodman, 1997)—a brief dimensional measure of psychopathology—was also used to indicate the level of social impairment experienced by these children. The SDQ Peer Problems subscale ranges from 1 to 10 and the clinical range is above 4. The number of children in the SDQ clinical range on the Peer Problems subscale was higher in the ADHD-ASD group (compared with the ADHD alone group; 68% vs. 54%, $p = .003$).

Child behavioral and emotional problems. Child behavioral and emotional problems were also assessed by the 25-item SDQ

Table 1. Sample Characteristics of the ADHD-ASD and ADHD Cohorts.

	ADHD-ASD (<i>n</i> = 93)	ADHD (<i>n</i> = 299)	<i>p</i>
Child			
Age in years, <i>M</i> (<i>SD</i>)	10.23 (1.83)	10.15 (1.86)	.74
Male, <i>n</i> (%)	85 (91.40)	250 (83.61)	.06
Medication for ADHD, <i>n</i> (%)	78 (83.87)	255 (85.28)	.71
Parent report			
Total ADHD symptoms, <i>M</i> (<i>SD</i>)	36.27 (9.75)	34.76 (9.85)	.19
Teacher report			
Total ADHD symptoms, <i>M</i> (<i>SD</i>)	27.31 (12.99)	26.26 (12.96)	.56
Parent			
Age in years, <i>M</i> (<i>SD</i>)	40.64 (5.69)	40.31 (6.75)	.68
High school completion, <i>n</i> (%)	58 (62.37)	144 (48.65)	.02
Family			
SEIFA, <i>M</i> (<i>SD</i>)	1,020.67 (53.88)	995.99 (69.90)	<.01

Note. ASD = autism spectrum disorder; SEIFA = Socio-Economic Indexes for Areas.

(Goodman, 1997). The SDQ comprises of five subscales (Emotional, Conduct, Hyperactivity/Inattention, and Peer Problems; a positive Pro-Social subscale). The SDQ has shown to have good reliability ($\alpha = .87$; Goodman, 2001). A total problems score can be computed by summing the four problem subscales. We report on all problem subscales and the total problems score by both parent and teacher report.

QoL. QoL was assessed using the 23-item Pediatric Quality of Life Inventory (PedsQL; Varni, Seid, & Kurtin, 2001). The PedsQL comprises four subscales (Physical, Emotional, Social, and School) and three summary scores (psychosocial, physical, and total score). We report on the parent and teacher summary scores for psychosocial QoL (computed by calculating the mean from the Social, School, and Emotional subscales; 15 items) and physical QoL (the mean Physical subscale score; seven items). The PedsQL has been shown to have good internal consistency ($\alpha = .92$ for parent-reported total scale QoL; Varni, Burwinkle, Seid, & Skarr, 2003). Scores range from 0 to 100 with higher scores indicating better QoL.

Confounders. Confounders were identified a priori; they included child age and gender; ADHD medication use (yes/no); ADHD symptom severity—measured by the ADHD Rating Scale–IV (DuPaul et al., 1998); parent age and high school completion (yes/no); and family disadvantage based on the child's postcode of residence, according to national data—measured by the Socio-Economic Indexes for Areas (SEIFA), where higher scores reflect less neighborhood disadvantage (national $M = 1,000$, $SD = 100$; Australian Bureau of Statistics, 2013).

Statistical Analyses

Unadjusted and adjusted linear regression models compared emotional and behavioral problems and QoL between

children with ADHD-ASD and those with ADHD alone. Cohen's *d* effect sizes are reported with effect sizes of ~ 0.20 *SD* considered small, ~ 0.50 *SD* moderate, and ~ 0.80 *SD* large (Cohen, 1992). We examined whether greater impairments in behavioral and emotional problems for those with ADHD-ASD compared with ADHD were mediated by physical QoL using causal mediation models (Imai, Keele, & Tingley, 2010). All analyses were conducted using Stata 13.0 (Stata Corp, College Station, TX, USA)

Results

Sample Characteristics

The ADHD-ASD and ASD groups were comparable in terms of child and parent age and ADHD medication use (see Table 1). Children with ADHD-ASD had higher ADHD symptom severity by parent and teacher report, than children with ADHD alone (see Table 1). Parents of children with ADHD-ASD came from more socioeconomically advantaged neighborhoods compared with children with ADHD alone.

Aim 1: Differences in QoL and Daily Functioning Between ADHD-ASD and ADHD Groups

In unadjusted analyses, children with ADHD-ASD had poorer psychosocial QoL ($d = -0.51$), poorer physical QoL ($d = -0.25$), elevated parent-reported peer problems ($d = 0.42$), and elevated teacher-reported emotional problems ($d = 0.32$), compared with children with ADHD alone (see Table 2). These findings were maintained in adjusted analyses (adjusted for child gender, age, ADHD medication use [yes/no], parent age, parent education level, and neighborhood socioeconomic disadvantage score). There was little evidence that comorbid ASD was associated

Table 2. Daily Functioning in Children With ADHD-ASD Compared With Those With ADHD Alone.

	ADHD-ASD (<i>n</i> = 93)	ADHD (<i>n</i> = 299)	Unadjusted MD (95% CI)	Effect size	<i>p</i>	Adjusted MD ^a (95% CI)	Effect size ^a	<i>p</i>
PedsQL parent report								
Psychosocial	46.86 (12.26)	53.94 (13.72)	-7.08 [-10.3, -3.90]	-0.51	.00	-6.90 [-9.89, -3.91]	-0.27	<.01
Physical	65.66 (19.60)	70.34 (18.19)	-4.69 [-9.14, -0.24]	-0.25	.04	-5.25 [-9.72, -0.77]	-0.49	.02
SDQ parent report								
Total score	22.79 (5.65)	20.96 (5.83)	1.83 [0.43, 3.18]	0.31	.01	1.62 [0.52, 2.72]	0.28	.01
Emotional	4.78 (2.63)	4.32 (2.49)	0.46 [-0.01, 1.05]	0.18	.12	0.45 [-0.13, 1.03]	0.18	.13
Conduct	4.99 (2.42)	4.65 (2.43)	0.32 [-0.23, 0.92]	0.14	.24	0.32 [-0.18, 0.82]	0.13	.22
Peer	4.74 (1.92)	3.79 (2.29)	0.94 [0.43, 1.50]	0.42	.00	0.93 [0.42, 1.45]	0.42	<.01
Hyperactive/inattentive	8.27 (1.75)	8.19 (1.68)	0.09 [-0.31, 0.48]	0.05	.67	-0.07 [-0.36, 0.22]	-0.04	.63
SDQ teacher report								
Total score	17.27 (7.50)	15.99 (7.07)	1.27 [-0.063, 0.19]	0.18	.19	1.35 [-0.61, 3.32]	0.19	.17
Emotional	3.76 (2.71)	2.98 (2.36)	0.78 [0.12, 1.43]	0.32	.02	0.82 [0.14, 1.50]	0.33	.02
Conduct	3.06 (2.62)	2.97 (2.71)	-0.085 [-0.63, 0.81]	0.03	.82	0.10 [-0.62, 0.83]	0.04	.77
Peer	3.38 (2.41)	3.10 (2.32)	0.28 [-0.34, 0.91]	0.12	.37	0.43 [-0.21, 1.08]	0.18	.18
Hyperactive/inattentive	7.10 (2.81)	6.94 (2.60)	0.12 [-0.58, 0.83]	0.05	.73	-0.01 [-0.72, 0.72]	-0.01	.99

Note. ASD = autism spectrum disorder; MD = mean difference; CI = confidence interval; PedsQL = Pediatric Quality of Life Inventory; SDQ = Strengths and Difficulties Questionnaire.

^aAdjusted for child gender, age, ADHD medication use (yes/no), parent age, parent education level, and neighborhood socioeconomic disadvantage score.

with parent-reported emotional, conduct, and hyperactivity/inattention problems, or teacher-reported conduct, peer, or hyperactivity/inattention problems.

Aim 2: Relationship Between Physical QoL and Daily Functioning in Children With ADHD-ASD

In unadjusted mediation analyses, the relationship between ADHD-ASD and elevated parent-reported emotional and behavioral problems was partially mediated through physical QoL (indirect effect: 0.5; 95% confidence interval [CI] = [0.1, 2.6], $p = .05$; direct effect: 1.4; 95% CI = [0.1, 2.6], $p = .04$); however, this was not the case by teacher report (indirect $p = .44$, direct $p = .22$). In adjusted analyses, these relationships held with physical QoL mediating the relationship between ADHD-ASD and parent-reported emotional and behavioral (indirect: 0.4, 95% CI = [0.0, 0.8], $p = .03$; direct: 1.2, 95% CI = [0.2, 2.2], $p = .02$) problems.

Discussion

ASD and ADHD are complex neurodevelopmental disorders, which in isolation and together have significant impact on the developing child. We found that children with comorbid ADHD-ASD experienced poorer physical and psychosocial QoL than children with ADHD in isolation. Furthermore, children with ADHD-ASD were reported by their parents to have elevated peer problems. Children with ADHD-ASD experienced greater emotional deficits by teacher report, however, there were no

differences by parent report, as measured on the SDQ. These findings are consistent with prior research reporting that children with ADHD-ASD have greater emotional and social deficits, poorer QoL, compared with children with ADHD in isolation (Gargaro et al., 2014; Jang et al., 2013). However, teachers did not report elevated peer problems in children with ADHD-ASD. This may reflect the poor correlation often seen between parent and teacher ratings in children with neurodevelopmental disorders, with parents often reporting more severe symptomology (Malhi, Singhi, & Sidhu, 2008).

The current study supports the findings by Papadopoulos et al. (2012) that showed a correlation between motor problems and greater emotional and behavioral problems for children with an ASD diagnosis. The adjusted analysis found that physical QoL partially mediated the relationship between comorbid ADHD-ASD and both emotional and behavioral problems.

In ASD, motor difficulties are intricately entwined with core social and communication deficits and are underpinned by common neurological disruption (Rinehart et al., 2006). There is a growing consensus that deficits in each of these areas contribute to a vicious circle that limits the child's ability to participate in meaningful life activities. For example, a child with ASD and poor motor skills may not be able to play a social ball game with other children, limiting motor practice developmental opportunities and physical activity and further restricting the child's already impoverished ability to engage socially. Physical activity is associated with more favorable outcomes for a number of health and

developmental outcomes from early childhood, including QoL and cognitive development (Lang et al., 2010; Timmons et al., 2012).

In terms of strengths, this study comprised of a large sample of children with ADHD recruited from rural and metropolitan public and private practices across the state of Victoria, Australia. The study employed a robust methodology for determining the diagnosis of ADHD. The study was limited by the reliance on parent report of ASD diagnosis in the child, therefore validity of ASD diagnosis and ASD symptom severity was not confirmed independently.

This study is of clinical importance as it indicates that children with ADHD-ASD experience poorer psychosocial functioning than those with ADHD alone. This is of particular interest, given that diagnoses of comorbid ADHD-ASD will likely increase with the release of *DSM-5* (APA, 2013). The frequent co-occurrence of ADHD and ASD highlights the need to gain a deeper understanding of this clinical presentation to plan and implement interventions. Specifically, interventions that improve motor difficulties experienced by children with ADHD-ASD may not only benefit their social and communicative skills but may also improve their daily adaptive skills and overall QoL. The significance of this study is further established by application of the International Classification of Functioning (ICF; World Health Organization, 2001). framework to understand the impact of motor problems on a child's daily functioning participation, and QoL.

These preliminary findings indicate that children with ADHD-ASD experience poorer daily functioning, compared with children with ADHD alone. Poorer physical QoL was also shown to mediate the emotional and behavioral functioning of children with comorbid ADHD-ASD. This study sets the scene for future research to investigate the relationship between physical and psychosocial functioning in children with ADHD-ASD. Moreover, by adopting a broader psychosocial approach, findings have direct implications for clinical practice as they may help inform child-centered multidisciplinary interventions that address the child's specific clinical, motor, and psychosocial profile. Furthermore, the preliminary findings of this study support the need for further studies to explore motor impairment and participation in this group.

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Declaration of Conflicting Interests

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