Health-related impairments in young children with ADHD: a community-based study

Research Article

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ABSTRACT

Background

We aimed to examine health-related impairments in young children with Attention-Deficit/Hyperactivity Disorder (ADHD) and non-ADHD controls, and explore differences in children with ADHD by gender, ADHD subtype and mental health comorbidity status.

Methods

Children with ADHD (n=177) and controls (n=212) aged 6-8 years were recruited across 43 schools in Melbourne, Australia following a screening (Conners 3 ADHD Index) and case confirmation procedure (Diagnostic Interview Schedule for Children IV). Direct and blinded assessments of height and weight were used to calculate BMI z-score and to identify overweight/obesity. Parents reported on child global health, sleep problems and physical injuries. Unadjusted and adjusted (socio-demographic factors, comorbidities) logistic and linear regression were conducted to compare health-related impairments between a) children with and without ADHD; b) boys and girls with ADHD; c) children with ADHD Inattentive and ADHD Combined types; and d) children with ADHD by internalizing and externalizing disorder status.

Results

Children with ADHD had poorer global health than controls when adjusted for socio-demographic characteristics (OR: 2.0; 95% CI 1.1, 3.9), however, this attenuated after adjusting for comorbidities. In adjusted analyses, children with ADHD had increased odds of moderate/large sleep problems (OR: 3.1; 95% CI 1.4, 6.8), compared to controls. There were no differences between children with and without ADHD in terms of physical injuries or overweight/obesity. Findings were similar when excluding children taking ADHD medication and health-related impairments did not differ between boys and girls with ADHD. Children

with ADHD-Combined type had higher BMI z-scores than controls in adjusted analyses ($p=0.04$). Children with ADHD and co-occurring internalizing and externalizing comorbidities were particularly vulnerable to health-related impairments.

Conclusion

Young children with ADHD experience a number of health-related impairments, which are exacerbated by the presence of internalizing and externalizing comorbidities. Clinicians should consider the broader health of children with ADHD in clinical consultations.

Key terms

attention-deficit disorder with hyperactivity, child, sleep problems, obesity, BMI, accidental injury, health impairment

Key Messages

- Children with ADHD experience health-related impairments, yet when these emerge and differences by gender and subtype remains unclear.
- We demonstrate, in a community sample, that some health-related impairments are present by 6-8 years and exacerbated by comorbid mental health difficulties.
- Children with ADHD have elevated sleep problems compared to non-ADHD controls even when taking into account the presence of internalizing and externalizing disorders.
- Children with ADHD-Combined type have higher BMI z-scores than non-ADHD controls.

INTRODUCTION

It is well-established that Attention-Deficit/Hyperactivity Disorder (ADHD) is associated with substantial morbidity across social and academic domains ([Hoza et al., 2005](#)). Children with ADHD may also be at risk for health-related impairments including poorer physical health, sleep problems and physical injuries ([Nigg, 2013](#)). However, the age at which health-related impairments emerge for these children is unclear, as are the drivers of health-related impairments for this group. For example, we know little about the influence of mental health comorbidities (i.e. internalizing and externalizing disorders) on health-related impairments in children with ADHD and whether risk is similar for girls and boys with ADHD and for those with ADHD-Combined and ADHD-Inattentive presentations. A comprehensive understanding of the health-related impairments associated with ADHD is important to assist in providing appropriate anticipatory guidance for, and surveillance of, these problems.

A growing body of research suggests that children with ADHD are at increased risk of overweight/obesity compared to non-ADHD controls ([Chen, Kim, Houtrow, & Newacheck, 2010](#); [Cortese, Moreira-Maia, St. Fleur, Morcillo-Peñalver, & Faraone, 2016](#); [Cortese & Vincenzi, 2012](#); [Erhart et al., 2012](#); [Halfon, Larson, & Slusser, 2013](#); [Waring & Lapane, 2008](#); [Yang, Mao, Zhang, Li, & Zhao, 2013](#)), particularly unmedicated children ([Byrd, Curtin, & Anderson, 2013](#); [Cortese et al., 2016](#); [Waring & Lapane, 2008](#)). Sleep problems, including difficulties with initiating and maintaining sleep, are more common in children with ADHD compared to their peers ([Samuele Cortese et al., 2013](#); [Sung, Hiscock, Sciberras, & Efron, 2008](#)), as is the prevalence of serious injuries ([Lange et al., 2014](#); [Silva, Colvin, Hagemann, Stanley, & Bower, 2014](#)).

While there is evidence that children with ADHD are at risk for health-related impairments, important questions remain unanswered. Previous studies have examined health-related impairments over a wide age range (e.g., 6 to 17 years) or in older children or adolescents with ADHD only ([Byrd et al., 2013](#); [Chen et al., 2010](#); [Erhart et al., 2012](#); [Halfon et al., 2013](#); [Merrill, Lyon, Baker, & Gren, 2009](#); [Sung et al., 2008](#); [Waring & Lapane, 2008](#); [Yang et al., 2013](#)); therefore, it is unclear whether these impairments are present for younger children with ADHD. For example, a recent meta-analysis found evidence that children and adolescents with ADHD had elevated risk of overweight/obesity but noted that the few previous studies had not separated children from adolescents therefore it is unknown when this risk emerges ([Cortese et al., 2016](#)). Little is known about health impairments in girls with ADHD or children with ADHD-I given that the majority of studies in the field have recruited clinical samples, which are known to underrepresent these groups ([Brassett-Harknett & Butler, 2007](#)). It appears the risk for overweight/obesity is present in ADHD irrespective of gender ([Cortese et al., 2016](#)) but this relationship is less clear for other health impairment domains. Furthermore, community- or population-based samples often do not include detailed confirmation of ADHD status ([Chen et al., 2010](#); [Halfon et al., 2013](#); [Waring & Lapane, 2008](#)), limiting generalizability.

It is currently unclear whether ADHD per se or associated characteristics confers risk for health-related impairments, as many studies have not accounted for mental health comorbidities and other socio-demographic characteristics. It is unclear whether ADHD per se or associated characteristics confers risk for health-related impairments. Accounting for mental health comorbidities is important given that most children with ADHD meet criteria for one or more internalizing and/or externalizing disorders ([Brassett-Harknett & Butler, 2007](#)). For example, when Erhart and colleagues adjusted for emotional, conduct and peer problems, this did not alter the observed association between overweight/obesity and ADHD

status ([Erhart et al., 2012](#)). In contrast, a recent study found that comorbid oppositional defiant disorder/conduct disorder fully accounted for the relationship between ADHD and body weight/obesity, however, the role of comorbid internalizing disorders was not considered ([Pauli-Pott, Neidhard, Heinzel-Gutenbrunner, & Becker, 2014](#)).

In a community-based sample of children, we aimed to examine:

1. Health-related impairments in children with ADHD and non-ADHD controls including global health, overweight/obesity, body-mass index (BMI) z-scores, sleep problems, and physical injuries; and
2. Health-related impairments in children with ADHD by ADHD subtype, gender, and comorbidity status.

We hypothesized that children with ADHD would have more health-related impairments compared to children without ADHD across all domains assessed. We did not specify a hypothesis for Aim 2 given the lack of previous research in this area.

METHODS

Design and setting

This cross-sectional study uses baseline data from a community-based longitudinal study of children with and without ADHD – <REMOVED FOR BLINDING>.

Screening and baseline recruitment

As part of the longitudinal study, participants were recruited during their second year of school from 43 government primary schools in Melbourne, Australia. ADHD was screened using the Conners 3 ADHD Index (Conners 3AI) ([Conners, 2008](#)). Children screened positive

for ADHD if they had a prior diagnosis of ADHD or Conners 3AI scores $\geq 75^{\text{th}}$ percentile for boys and $\geq 80^{\text{th}}$ percentile for girls by *both* parent and teacher report. Children screened negative if they had no prior ADHD diagnosis and their Conners 3AI scores were below specified percentiles. Children were excluded if they had an intellectual disability, a serious medical condition (e.g., severe cerebral palsy, moderate/severe hearing or vision impairment; conditions such as asthma and prematurity were not excluded), or their parents had insufficient English to complete assessments. Positive screens were randomly matched on gender and school to negative screens and invited into the study and completed measures listed below after informed written consent was received. All direct assessments were blinded to the child's screening status.

Measures

ADHD and comorbid mental health conditions. Assessed by parent report using the Diagnostic Interview Schedule for Children IV (DISC-IV) ([Shaffer, Fisher, Lucas, Dulcan, & Schwab-Stone, 2000](#)). Version N (April 2007) algorithms were used to confirm ADHD status and internalizing (e.g., social phobia, separation anxiety disorder, generalized anxiety disorder, major depression etc) and externalizing disorders (oppositional defiant disorder, conduct disorder). Four discrete groups were generated: 1. ADHD alone (children with ADHD that did not meet criteria for an internalizing or an externalizing disorder); 2. ADHD-internalizing (ADHD and one or more internalizing disorders but no externalizing disorders); 3. ADHD-externalizing (ADHD and one or more externalizing disorders but no internalizing disorders); and 4) ADHD-internalizing+externalizing (ADHD and one or more externalizing and internalizing disorders).

Global health. Assessed by parent response to a single item: "*In general, how would you say your child's current health is?*" from the Child Health Questionnaire ([Waters,](#)

[Salmon, & Wake, 2000](#)). Responses were dichotomized into ‘excellent/very good’ versus ‘good/fair/poor’ and is commonly used in community-based and epidemiological studies and is moderately correlated with other measures of health ([Raat, Botterweck, Landgraf, Hoogeveen, & Essink-Bot, 2005](#)).

BMI z-score, overweight and obesity. Assessed using the child’s BMI (weight (kg) divided by [height (m) squared]). Weight (in light clothing) and height were measured twice and the average calculated. BMI z-score was calculated according to the US Centers for Disease Control (CDC) reference values, using the Stata “zanthro” function. Children were then classified as overweight/obese according to the CDC charts i.e., $\geq 85^{\text{th}}$ according to age- and sex-specific percentiles ([Kuczmarski et al., 2000](#)).

Sleep problems. Measured using the following parent-reported item “*How much is your child’s sleeping pattern or habits a problem for you?*” ([Quach, Hiscock, Canterford, & Wake, 2009](#); [Sung et al., 2008](#)). Responses were dichotomized into ‘no problem at all/small problem’ versus ‘moderate problem/large problem’ ([Quach et al., 2009](#); [Sung et al., 2008](#)). This measure has been used in samples of children with and without ADHD ([Quach et al., 2009](#); [Sung et al., 2008](#)) and has been shown to map closely to more in depth measures of child sleep ([Lycett, Mensah, Hiscock, & Sciberras, 2014](#)). For example, 90% percent of children with parent-reported moderate/large sleep problems meet the clinical threshold on the well-validated Children’s Sleep Habits Questionnaire (Lycett et al., 2014).

Physical injuries. Measured via parent report using the question “*During the past 12 months, has your child been hurt, injured or had an accident needing medical attention from a doctor or hospital?*” To assess severity, parents were asked “*Has your child stayed in hospital for at least one night because of any (of these) injuries or accidents?*” These questions were developed for the Longitudinal Study of Australian Children and have been

shown to be associated with known risk factors for injury including lower socio-economic status and poorer housing conditions ([Blakemore, 2006](#)). Other sample characteristics. Child age and gender, autism spectrum disorder (ASD) diagnosis (parent-report), ADHD medication use (methylphenidate, dexamphetamine, atomoxetine), primary caregiver age and high school completion (yes/no) and single parent family status (yes/no).

Analyses

Unadjusted logistic and linear regression compared health-related impairments between groups (Aim 1). Model 1 adjusted for child age and gender, primary caregiver high school completion (yes/no), primary caregiver age, and single-parent status (yes/no). Model 2 adjusted for all confounders in Model 1 and also controlled for comorbidities: ASD, internalizing disorder, and externalizing disorder. We also generated a health impairment composite variable by adding the number of health impairments experienced across all dichotomous variables assessed (possible score ranged from 0 to 5). For Aim 1, we also conducted sensitivity analyses excluding children taking ADHD medication.

Unadjusted and adjusted linear and logistic regression examined health-related impairments within the ADHD group by gender and subtype (Aim 2). Children with ADHD-Hyperactive/Impulsive type were omitted due to low numbers (n=22). We conducted a supplementary analysis comparing BMI z-scores between children with ADHD-Combined (ADHD-C) type and controls. We used descriptive statistics to report health-related impairments for children with ADHD by comorbidity group (Aim 2). All analyses controlled for school clustering given our sampling frame. Analyses were conducted using Stata 13.0.

Ethics

Ethics approval was granted by < REMOVED FOR BLINDING >.

RESULTS

Parent and teacher screening data were obtained for 63% of the sample (3734 out of 5922); 412 screened positive for ADHD and were matched to 412 negative screens. Of those screening positive, 65% (n=267) consented to participate in the longitudinal study and 179 met criteria for ADHD (ADHD group). Of the matched negative screens, 55% (n=231) consented and 212 did not meet criteria for ADHD (non-ADHD controls). There were no differences in child age and gender between those who did or did not participate, however, consenting positive screens were from more socio-economically advantaged neighborhoods ([Australian Bureau of Statistics, 2006](#)) ($p=0.02$); this difference was not apparent for negative screens ($p=0.11$).

Participants were included if they had data available on at least one outcome measure; 177 children with ADHD and 212 non-ADHD controls.

Sample characteristics

Children with ADHD had increased prevalence of comorbidities regardless of gender (Table 1). Seventeen males (15%) and 4 females (8%) with ADHD were taking methylphenidate. Parents of children with ADHD were less likely to have completed high school, were younger if their child was female, and were more likely to live in single parent household if their child was male.

Health-related impairments by ADHD status

In unadjusted analyses (Table 2), children with ADHD had poorer global health and increased sleep problems, compared with non-ADHD controls. Children with ADHD had a similar prevalence of physical injuries and overweight/obesity to children without ADHD, although children with ADHD did have marginally higher BMI z-scores than controls (MD:

0.2; 95% CI -0.01, 0.5; $p=0.06$). Children with ADHD were more likely to have any health impairment compared to non-ADHD controls and appeared to have a higher burden of health impairments compared to controls (22.8% vs 10.1% with 2 or more health impairments). Results were similar when excluding children taking ADHD medication, and health-related impairments did not differ between boys and girls with ADHD.

Most results held in our first adjusted model; however, the relationship between ADHD and global health and any health impairment attenuated in the second adjusted model. The relationship between ADHD and BMI z-score substantially attenuated in both adjusted models. Even when taking into account all confounding variables children with ADHD continued to have increased sleep problems compared to controls (adjusted odds ratio: 3.1; 95% CI 1.4, 6.8; $p = 0.005$).

Health-related impairments in children with ADHD-C compared to ADHD-I

Children with ADHD-C and ADHD-I did not differ in health-related impairments (Table 3). Although there were small differences in terms of overweight/obesity (19% versus 26%), BMI z-scores (0.4 versus 0.7), sleep problems (18% versus 30%), and any health impairment (51% versus 64%), these differences were non-significant. In a supplementary analysis, children with ADHD-C had higher BMI z-scores than controls (MD: 0.4; 95% CI 0.1, 0.7; $p=0.01$). This relationship held in the fully adjusted model (adjusted MD: 0.5; 95% CI 0.03, 0.9; $p=0.04$).

Health-related impairments by ADHD comorbidity status

In comparison to children with ADHD alone, children with ADHD and co-occurring comorbidities had higher rates of any health impairment (54% versus 78%), poorer parent-reported global health (16% versus 32%), increased overweight/obesity (19% versus 29%),

higher BMI z-scores (0.4 versus 0.8) and moderate/large sleep problems (21% versus 46%) (Table 4). Children in the ADHD-internalizing group had the highest BMI z-score (mean z-score: 1.1, SD: 1.4). There was a higher proportion of children in the ADHD-externalizing group who had an injury/accident in the last 12 months, compared to the other comorbidity groups.

DISCUSSION

At 6-8 years of age we found strong evidence that ADHD was associated with sleep problems. There was also some evidence that children with ADHD had poorer global health than children without ADHD and were also at risk of any health impairment as assessed using a composite score. Although the prevalence of overweight/obesity and physical injuries was similar across groups, children with ADHD-C had higher BMI z-scores than controls. Differences attenuated across all health outcomes when accounting for common comorbidities. Children with co-occurring internalizing and externalizing comorbidities, in addition to their ADHD, appeared to have increased health-related impairments. Findings did not change when excluding children taking ADHD medication.

Our findings are consistent with previous clinical studies reporting elevated sleep problems in children with ADHD ([Cortese, Brown, Corkum, & et al., 2013](#)). We demonstrate that sleep problems emerge early for children with ADHD and are not accounted for by comorbidities or medication use. Children with ADHD-C had a higher prevalence of sleep problems than ADHD-I (30% versus 17%) although this difference was not statistically significant. Although ADHD status was uniquely associated with sleep problems in children with ADHD, co-occurring internalizing and externalizing problems did exacerbate sleep problems, which is consistent with previous research ([Lycett et al., 2014](#)). Given that sleep problems are associated with poorer functioning ([Sung et al., 2008](#)) and increased persistence ([Lycett et al.,](#)

[2014](#)) for children with ADHD, it is important that these are identified and managed. Recent evidence suggests that sleep problems in children with ADHD are amenable to behavioral ([Hiscock et al., 2015](#)) or pharmacological interventions ([S. Cortese, T. E. Brown, et al., 2013](#)).

Children with ADHD did not have a higher prevalence of overweight/obesity than controls, in contrast to some previous reports ([Chen et al., 2010](#); [Erhart et al., 2012](#); [Halfon et al., 2013](#); [Waring & Lapane, 2008](#); [Yang et al., 2013](#)) but consistent with others ([Byrd et al., 2013](#); [Dubnov-Raz, Perry, & Berger, 2011](#)). However, children with ADHD-C had higher BMI z-scores relative to controls even when accounting for socio-demographic characteristics and comorbidities, suggesting that this group displays early signs of vulnerability for future overweight/obesity. This is also consistent with the slightly higher proportion of overweight/obesity in children with ADHD-C (26%) compared to ADHD-I (19%) in our study. It has been hypothesised that the combination of both inattentive and impulsive symptoms could contribute to eating dysregulation, which could in turn contribute to higher BMI z-scores and overweight/obesity ([Cortese & Castellanos, 2014](#)). Inattention symptoms may lead to higher BMI via poor planning manifesting in difficulties following regular eating routines and/or lack of focus on the quality of food intake ([Cortese & Castellanos, 2014](#)).

Children with ADHD and internalizing comorbidities also had elevated BMI z-scores relative to other comorbidity groups. This is congruent with adult ADHD literature, showing associations between internalizing disorders and obesity ([Cortese, Faraone, Bernardi, Wang, & Blanco, 2013](#)). Given the small numbers in our subgroup analyses, these findings need to be interpreted with caution. The relationship between complex mental health comorbidities in children with ADHD and increased risk of obesity, may represent a bi-directional relationship

between mental health problems and obesity (e.g., poor adherence and lack of exercise, binge eating) and/or a shared biological underpinning (e.g., inflammation, dopamine dysfunction) ([Markowitz, Friedman, & Arent, 2008](#); [Puder & Munsch, 2010](#)).

In contrast to previous research ([Lange et al., 2014](#); [Merrill et al., 2009](#); [Silva et al., 2014](#); [Swensen et al., 2004](#)), children with ADHD did not have increased odds of sustaining serious physical injuries compared to controls, possibly reflecting the community-based nature of our study. The single item used in the present study to measure injuries may not be as sensitive as measures used previously (e.g., linked medical records). There was some evidence that a higher proportion of children with ADHD and externalizing comorbidities had experienced an injury in the last 12 months, compared to controls and the other ADHD comorbidity groups. Dudani et al. found that children with hyperactivity and aggression were more likely to have sustained an injury compared to those with hyperactivity only ([Dudani, Macpherson, & Tamim, 2010](#)).

Across all domains, there was clear evidence that the likelihood of health-related impairments decreased when accounting for commonly occurring comorbidities. Thus the presence of comorbidities should alert clinicians to the particularly need to evaluate health-related impairments in this population. Assessment and management of the comorbidities in children with ADHD may have flow on effects to improving general health for this group of children. Children with ADHD and both internalizing and externalizing comorbidities seemed to be at particular risk of health-related impairments in this study. This is consistent with recent research reporting that children with co-occurring comorbidities, in addition to ADHD, have poorer daily functioning compared to children with ADHD alone ([Armstrong, Lycett, Hiscock, Care, & Sciberras, 2014](#)).

To our knowledge, it is the first study to examine a range of health-related impairments in a community-based sample of young children with ADHD. We assessed for ADHD and height and weight using direct assessments. Our sample was diverse, including both boys and girls, and all ADHD subtypes. We accounted for variables which may have confounded the relationship between ADHD and health-related impairments, including common comorbidities and socio-economic factors, enabling us to be confident of the associations.

The study also has some limitations. It is possible that the children of families who declined to participate may have had a higher likelihood of health-related impairments. Although often used in population-based studies, our measures of sleep, physical injuries and global health were brief and reported solely by parents. We were unable to verify the type of sleep problem(s) experienced by children. The number of children in our subgroup analyses examining differences by ADHD subtype was small, which may have led to insufficient power to demonstrate relationships precisely. To address this, we report odd ratios along with 95% confidence intervals to demonstrate the precision of our findings. Furthermore, our analyses examining health-related impairments by ADHD comorbidity group were descriptive, given the relatively small number in each comorbidity group.

In conclusion, at 6 to 8 years of age children with ADHD were already experiencing elevated sleep problems relative to controls, and children with ADHD-C had higher BMI z-scores than their non-ADHD counterparts. Our findings suggest that comorbidities increase the odds of health-related impairments in children with ADHD. Further research is needed to examine the persistence and emergence of health-related impairments over time and their functional impact.

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Table 1: Sample characteristics for boys and girls with and without ADHD

	Boys			Girls		
	ADHD (n=122)	Control (n=135)	p value	ADHD (n=55)	Control (n=77)	p value
Child characteristics						
Child age in years, mean (SD)	7.3 (0.5)	7.3 (0.4)	0.84	7.22 (0.4)	7.32 (0.3)	0.17
Internalizing disorder, n (%)	31 (25.4)	4 (3.0)	<0.001	16 (29.1)	6 (7.8)	0.001
Externalizing disorder, n (%)	65 (52.4)	10 (7.4)	<0.001	32 (58.2)	7 (9.1)	<0.001
ASD diagnosis, n (%)	27 (21.8)	3 (2.2)	<0.001	6 (10.9)	0 (0)	0.003
ADHD Medications, n (%)						
Methylphenidate	17 (14.5)	0 (0)	<0.001	4 (8.0)	0 (0)	0.01
Dexamphetamine	0 (0)	0 (0)	-	0 (0)	0 (0)	-
Atomoxetine	0 (0)	0 (0)	-	0 (0)	0 (0)	-
Primary caregiver characteristics						
Parent age in years, mean (SD)	37.68 (6.1)	39.06 (5.5)	0.07	36.18 (4.9)	38.58 (5.3)	0.01
Single parent family, n (%)	31 (26.5)	14 (10.9)	0.002	11 (22)	9 (12.3)	0.15
Did not complete high school, n (%)	43 (36.6)	23 (17.8)	0.001	20 (40)	16 (21.9)	0.03

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Table 2: Health-related impairments in children with ADHD compared to non-ADHD controls

	ADHD <i>n</i> = 177 ^a	Controls <i>n</i> = 212 ^b	Odds Ratio / Mean Difference (95% Confidence Interval)					
			Unadjusted	p value	Adjusted 1 ^c	p value	Adjusted 2 ^d	p value
Physical health								
Good/Fair/poor health, n (%)	32 (19.3)	19 (9.4)	2.3 (1.2, 4.2)	0.007	2.0 (1.1, 3.9)	0.03	1.4 (0.7, 3.2)	0.41
Overweight/obese, n (%)	39 (22.5)	45 (21.4)	1.1 (0.6, 1.7)	0.82	1.0 (0.6, 1.7)	0.93	0.9 (0.5, 1.8)	0.85
BMI z-score, mean (SD)	0.6 (1.1)	0.4 (1.2)	0.2 (-0.01, 0.5)	0.06	0.2 (-0.1, 0.5)	0.13	0.1 (-0.2, 0.5)	0.34
Sleep problems, n (%)								
Moderate/large problem	47 (28.1)	13 (6.5)	5.6 (2.9, 10.9)	<0.001	5.0 (2.6, 9.9)	<0.001	3.1 (1.4, 6.8)	0.005
Physical injuries, n (%)								
Injury/accident in the last 12 months	29 (17.4)	31 (15.4)	1.2 (0.7, 2.2)	0.48	1.0 (0.5, 1.8)	0.99	0.7 (0.3, 1.5)	0.36
Injury/accident in the last 12 months requiring hospitalization	4 (2.4)	4 (2.0)	1.2 (0.3, 4.9)	0.79	-	-	-	-
Any health impairment, n (%)	98 (60.1)	89 (45.0)	1.9 (1.2, 2.9)	0.004	1.6 (1.0, 2.5)	0.04	1.1 (0.7, 1.9)	0.64

^a N ranges from 166-173. 177 ADHD participants had data available on at least one outcome measure; ^b N ranges from 200-210. 212 Control participants had data available on at least one outcome measure; ^c Adjusted for child age and child gender, parent high school completion, single parent status, parent age; ^d Adjusted for child age and child gender, parent high school completion, single parent status, parent age, ASD diagnosis, internalizing comorbidity, externalizing comorbidity.

Table 3: Health-related impairments in children with ADHD-C compared to ADHD-I

	ADHD-I ^a <i>n</i> = 64	ADHD-C ^b <i>n</i> = 91	Odds Ratio / Mean Difference (95% Confidence Interval)			
			Unadjusted	p value	Adjusted ^c	p value
Physical health						
Good/Fair/poor health, n (%)	12 (19.4)	16 (18.8)	0.9 (0.4, 2.3)	0.85	0.6 (0.2, 1.8)	0.38
Overweight/obese, n (%)	12 (19.1)	23 (26.1)	1.5 (0.7, 3.3)	0.31	1.5 (0.6, 3.5)	0.38
BMI z-score, mean (SD)	0.4 (1.1)	0.7 (1.7)	0.3 (-0.1, 0.7)	0.10	0.2 (-0.2, 0.6)	0.32
Sleep problems, n (%)						
Moderate/large problem	11 (17.7)	26 (30.2)	2.0 (0.9, 4.5)	0.09	1.3 (0.6, 3.2)	0.54
Physical injuries, n (%)						
Injury/accident in the last 12 months	12 (19.4)	17 (19.8)	1.0 (0.4, 2.4)	0.96	0.7 (0.2, 2.0)	0.48
Injury/accident in the last 12 months requiring hospitalization	3 (4.8)	1 (1.2)	-	-	-	-
Any health impairment, n (%)	31 (50.8)	53 (64.4)	1.8 (0.9, 3.5)	0.10	1.4 (0.7, 3.0)	0.37

^a N ranges from 62-63. 64 ADHD-I participants had data available on at least one outcome measure; ^b N ranges from 85-88. 91 ADHD-C participants had data available on at least one outcome measure; ^c Adjusted for child age and child gender, parent high school completion, single parent status, parent age, ASD diagnosis, internalizing comorbidity, externalizing comorbidity.

ADHD-I = ADHD-Inattentive type; ADHD-C = ADHD-Combined type.

Table 4: Health-related impairments in children with ADHD by comorbidity group

	ADHD alone ^a	ADHD-internalizing	ADHD-externalizing	ADHD-internalizing+externalizing ^d
	<i>n</i> = 72	<i>n</i> = 8	<i>n</i> = 58	<i>n</i> = 39
Physical health				
Good/Fair/poor health, n (%)	11 (16.4)	1 (12.5)	8 (14.8)	12 (32.4)
Overweight/obese, n (%)	13 (18.6)	2 (25.0)	13 (22.8)	11 (29.0)
BMI z-score, mean (SD)	0.4 (1.0)	1.1 (1.4)	0.6 (1.4)	0.8 (1.2)
Sleep problems, n (%)				
Moderate/large problem	14 (20.6)	2 (25.0)	14 (25.9)	17 (46.0)
Physical injuries, n (%)				
Injury/accident in the last 12 months	10 (14.6)	0 (0)	13 (24.1)	6 (16.2)
Injury/accident in the last 12 months requiring hospitalization	3 (4.4)	0 (0)	1 (1.9)	0 (0)
Any health impairment, n (%)	35 (53.9)	3 (37.5)	32 (60.4)	28 (77.8)

^a N ranges from 65-70; ^b No missing data; ^c N ranges from 53-57; ^d N ranges from 36-38

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