Article

The Long-Term Impact of ADHD on Children and Adolescents' Health-Related Quality of Life: Results From a Longitudinal Population-Based Australian Study

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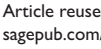

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Abstract

Background: ADHD is the most common neurodevelopmental disorder. While much is known about the functional and academic impacts of ADHD, impacts on long-term health-related quality of life (HRQoL) are less well-documented. **Aims:** To explore, in children aged 4 to 17 years, associations between clinical ADHD symptoms and (1) children's HRQoL; (2) whether internalizing or externalizing problems attenuate this association; and (3) factors contributing to this association. **Methods:** Data were drawn from the Longitudinal Study of Australian Children at child ages 4 to 17 years ($N = 4{,}194$). Clinical ADHD symptoms (e.g., score >8) were measured using the hyperactivity scale from the Strengths and Difficulties Questionnaire (SDQ). Internalizing or externalizing problems were classified as children with scores ≥ 5 on the Emotional Problems and scores ≥ 4 on the Conduct Problems scale on the SDQ, respectively. Children's HRQoL was measured using the Pediatric Quality of Life Inventory (PedsQL). Linear mixed models were used, adjusting for child and family factors. **Results:** Compared to those with no ADHD symptoms, children with ADHD symptoms had significantly lower HRQoL across all domains from 4 to 17 years (mean difference = 7.65, 95% CI [6.09, 9.19]). Internalizing and externalizing problems slightly attenuated the association between ADHD symptoms and children's HRQoL (mean difference = 4.91, 95% CI [3.40, 6.43]). Being a female or having autism or other medical conditions, or taking ADHD/ADD medication or caregiver having mental health problems was associated with poorer HRQoL while having two or more siblings was associated with better HRQoL. **Conclusion:** ADHD clinical symptoms are associated with poorer children's HRQoL from 4 to 17 years. Given that co-occurring medical conditions and poor caregiver mental health are associated with poorer child HRQoL, ADHD treatment needs to identify and address co-occurring conditions and parental mental health. *(J. of Att. Dis. XXXX; XX(X) XX-XX)*

Keywords
HRQoL, ADHD, children, adolescent

Introduction

ADHD is the most common childhood neurodevelopmental condition, affecting approximately 2% to 7.6% of children (Polanczyk et al., 2014; Salari et al., 2023). It is characterized by high levels of hyperactivity, inattention, and impulsivity and is often diagnosed during the primary school years, most commonly around the age of 7 years in the United States (US; American Psychiatric Association, 2000; Visser et al., 2014) or 7.5 years in Europe and Australia (Knott et al., 2024; Rocco et al., 2021). ADHD can affect a child's academic, cognitive, social, and emotional performance at school as well as impact their home and social life (American Psychiatric Association, 2000). Children with ADHD report a more negative classroom experience, reduced task-related motivation, and lower academic functioning compared to their peers (Morsink et al., 2021). They are more likely to have impaired social skills, anxiety, and peer relationship problems (Becker et al., 2015; Pollack et al., 2016) and poorer quality of life (Wanni Arachchige Dona et al., 2023).

Health, according to the World Health Organization (WHO), is "a state of complete physical, mental and social well-being" (World Health Organization, 2023). In line

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with this definition, an important tool to assess the overall health and well-being of children is the health-related quality of life (HRQoL). HRQoL is primarily a self-reported, multidimensional, and subjective appraisal of the impact of health conditions and their treatments on a person's physical, psychological, and social functioning (Dey et al., 2012). Yet children may find it challenging to provide accurate and valid self-rated questionnaire responses due to their underdeveloped linguistic and communicative capabilities, which may be compounded by concentration challenges in ADHD sufferers (Danckaerts et al., 2010). Parent-proxy HRQoL reporting is often used when a child's self-reported measurement may be unreliable, particularly in younger children (Lee et al., 2016). HRQoL has become increasingly common as a measurement of therapeutic effectiveness in clinical trials (Drummond et al., 2015) including ADHD treatment (Bellato et al., 2024) and patient care (Sung et al., 2010) due to its utility in guiding patient treatment and designing population health interventions. Improving understanding of how health conditions such as ADHD impact a child's HRQoL can provide insights for patient-focused service planning and support to optimize outcomes for individuals (Romero et al., 2013; Sharpe et al., 2016).

Several studies have assessed HRQoL in children with ADHD (Lee et al., 2016; Wanni Arachchige Dona et al., 2023). A recent systematic review and meta-analysis found that ADHD has a significant negative effect on children's HRQoL (Wanni Arachchige Dona et al., 2023). Yet the impact of ADHD is not uniform across all HRQoL domains. The psychosocial HRQoL domain appears to be the most affected by ADHD, with effect magnitude variability seen between self-reported and parent proxy results (Wanni Arachchige Dona et al., 2023). HRQoL physical domain scores may also be lower in children with ADHD yet this association is questionable as several studies have found no difference in HRQoL physical domain scores between children with and without ADHD (Lee et al., 2016). In line with this, one study found that improving ADHD symptoms results in higher children's HRQoL only in the psychosocial domain, not the physical domain (Matza et al., 2004). The review also highlighted a limited number of longitudinal studies to explore the long-term impact of ADHD on HRQoL. Several studies used longitudinal data to explore this association but they mainly include a short period, for example, 1 year (Bussing et al., 2010; Kazda et al., 2022; Mulraney et al., 2019). No existing study has examined the long-term impact of ADHD symptoms over an extended period, such as the 13 years covered in our study. Longitudinal research is essential for understanding how children's HRQoL evolves, whether disparities persist, widen, or diminish with age. Unlike cross-sectional studies, which assume stability, a longitudinal approach provides critical insights into these dynamic patterns. Such evidence is crucial for informing policy and intervention strategies. If HRQoL disparities widen over time, it may indicate the need for sustained or adaptive interventions at different developmental stages.

Children may present with high levels of clinical ADHD symptoms without a formal diagnosis, especially at younger ages (e.g., under 8 years; Sainsbury et al., 2023), yet limited research has examined the association between ADHD clinical symptoms and children's HRQoL (Coghill & Hodgkins, 2016). In Australia, the average diagnostic delay for children with ADHD is about 3.5 years (Knott et al., 2024). This diagnosis delay of ADHD may occur despite symptomatology, in part due to inequities that exist in both the healthcare and education systems (Zhao et al., 2023). There are effective treatments for ADHD. A recent review and meta-analysis found that pharmacology treatment was efficacious in improving children's HRQoL and ADHD symptoms (Bellato et al., 2024). Therefore, understanding the impact of ADHD clinical symptoms on children's HRQoL is important to advocate for early diagnosis and treatment of ADHD to minimize the long-term adverse effects of ADHD on children, their families, and societies.

Many child, family, and social factors could influence children's HRQoL and/or ADHD symptoms, yet research exploring this topic is scarce. The home environment and family adversity have been shown to affect ADHD symptoms in children and impact their HRQoL (Mulligan et al., 2013). A European study found that living with a parent who is suffering from either a physical or mental health condition and not living with both parents are all associated with poorer HRQoL (Riley et al., 2006). Children with ADHD commonly present with mental health comorbidities, with 50% to 70% of children with ADHD also having an externalizing problem (e.g., oppositional defiant disorder) and up to 64% with an internalizing problem (e.g., anxiety and depression; Gillberg et al., 2004; Jarrett & Ollendick, 2008; Sciberras et al., 2014). Research shows that children with ADHD and co-occurring internalizing and/or externalizing problems were associated with poorer peer functioning, reduced daily functioning and HRQoL (Armstrong et al., 2015; Pan & Yeh, 2017; Sciberras et al., 2014). Understanding the interrelationships between ADHD clinical symptoms and co-occurring internalizing/externalizing problems and their impact on children's HRQoL is important for treatment planning to maximize the effectiveness of treatment strategies.

Existing evidence is largely cross-sectional, limited by small samples and lacking the exploration of the factors influencing the relationship between ADHD and children's HRQoL.

The current study will address some of the gaps in the literature by using the large population-based Longitudinal Study of Australian Children to explore (1) the 13-year association between ADHD clinical symptoms and children's HRQoL/HRQoL domains at 4 to 17 years of age, (2)

whether internalizing or externalizing behavior attenuates this association; and (3) the other factors influencing children's HRQoL. We hypothesize that ADHD clinical symptoms were negatively associated with children's HRQoL from 4 to 17 years and that internalizing or externalizing problems attenuate this association.

Methods

Study Design and Participants

LSAC is a nationwide cohort study of children and their families. The initial recruitment and study design have been reported previously (Sanson et al., 2002). In brief, the initial wave of LSAC commenced in 2004 and followed two separate cohorts of children, a birth (B) and a kindergarten (K) cohort, each containing around 5,000 children (Soloff et al., 2005). At the time of the analysis, the study contained nine waves, with data collected biennially.

Children were selected from the Australian Medicare database using a two-stage cluster sampling design (Soloff et al., 2005). First, postcodes (excluding the most remote) were sampled after stratifying by state of residence and urban versus rural status. Within the selected postcodes, children in the Kindergarten (K) cohort were chosen if they were born between March 1999 and February 2000 and enrolled in the Australian Medicare database. Of the contactable families, 4,983 four- to five-year-old children participated in Wave 1 data collection in 2004. This paper involves K cohort children and their caregiver's reports of HRQoL from the age of 4 to 17 years (waves 1–7) where the HRQoL or SDQ measures were available (N=4,194).

Measures

Health-Related Quality of Life. HRQoL was measured from waves 1 to 7 using the parent proxy-reported 23-item Pediatric Quality of Life (PedsQL) generic core scale 4.0 which comprises four domains including social (e.g., feeling afraid or scared; sad or blue; angry; trouble sleeping; and worrying about what will happen), emotional, physical, and school functioning (Varni et al., 2003). Different parent proxy-reported formats were used depending on the age of the child including 5 to 7 years (young child), 8 to 12 years (child), and 13 to 18 years (adolescent). A 5-point response scale (0=never a problem; 1=almost; 2=sometimes; 3=often; and 4=always) is used for ages 8 to 18 years. An HRQoL summary score ranging between 0 and 100 was generated by combining all items with a higher score indicating a better HRQoL (Varni et al., 2003). A parent proxy-reported HRQoL difference of 4.5 points in the summary score (or 6.9, 7.8, 9.0, and 9.7 in the physical, emotional, social, and school functioning respectively) was considered the minimum for clinical significance between the two comparison groups (Varni et al., 2003). Across all age groups, the parent proxy-reported HRQoL score has high internal reliability (alpha coefficient $>$.9 for the summary score and $\geq$.8 for all four domain scores; Varni et al., 2003).

ADHD Clinical Symptoms. ADHD clinical symptoms were measured from 4 to 17 years (waves 1–7) using the five hyperactivity-inattention subscale questions from the parent-reported 25-item Strengths and Difficulties Questionnaire (SDQ; Goodman, 2001). Five questions make up the hyperactivity-inattention domain, which uses a 3-point Likert scale (0="not true," 1="somewhat true," and 2="certainly true"). We defined ADHD clinical symptoms using the standard cut-off of $\geq$90th percentile (score $\geq$8, possible scores range from 0 to 10) as per previous literature (Sciberras et al., 2017). The SDQ hyperactivity-inattention subscale has high internal consistency reliability (alpha coefficient of .74; Palmieri & Smith, 2007). Children scoring at or above the 90th percentile on the hyperactivity-inattention subscale are about 18 times more likely to meet the Diagnostic and Statistical Manual for Mental Disorders (DSM-IV; American Psychiatric Association, 1994) criteria for ADHD compared to their peers (Hawes & Dadds, 2004).

Internalizing and Externalizing Problems. Internalizing and externalizing problems were assessed using the 5-item Emotional Problems and Conduct Problems scales, respectively from the SDQ (Goodman, 2001), collected from waves 1 to 7. Scores for each scale ranged from 0 to 10, with higher scores representing more problems. Children with scores greater than 90th percentile (e.g., scores of 5 or more on the Emotional Problems and scores of 4 or more on the Conduct Problems scale) were classified as internalizing or externalizing problems.

Child and Family Characteristics. Study child and family characteristics (e.g., child's age, gender, number of siblings, and primary caregiver having a partner) were collected across different time points (Supplemental Table S1). The presence of parental psychological distress (in the primary caregiver) was assessed using the six-item Kessler 6 depression scale and was measured at ages 4 to 17 years (waves 1–7; Kessler et al., 2003). Family socioeconomic position (SEP) was measured using parent information about educational attainment, combined annual family income and parents' occupational status for each family (Gibbings et al., 2009). These characteristics, chosen from the literature (Mulligan et al., 2013; Riley et al., 2006), were used as explanatory variables in the analyses.

Ethics

Ethical approval for LSAC was granted by the Royal Children's Hospital Melbourne and the Australian Institute

for Family Studies (Soloff et al., 2005). All participating caregivers provided written and informed consent.

Statistical Analyses

Baseline characteristics of the whole sample and the analytic sample with complete HRQoL and SDQ data at each time point were described. Cross-sectional associations between children's HRQoL at each time point (waves 1–7) and children's ADHD symptoms (waves 1–7) were explored using multivariable linear regression. Despite the relative skewness of HRQoL data, estimation was robust given that the normality assumption is not required in a large sample (Lumley et al., 2002). We conducted the analysis using general linear models (GLM) to test the robustness of our model choice. Results of the GLM model were similar to the multivariable linear model, confirming the robustness of our estimation. The analyses were adjusted for child and family characteristics identified from the literature (Supplemental Table S1).

Predictors were chosen using the best variable sets from the *vselect* command. We used the Akaike Information Criteria (AIC; i.e., the smallest AIC represents the best model) to select the final regression models. In the primary analysis, we did not include internalizing and externalizing problems. We included both of these factors in the secondary analysis to assess whether the association between ADHD clinical symptoms and children's HRQoL is affected by internalizing/externalizing problems.

Longitudinal association between children's overall HRQoL and HRQoL domains (from 4 to 17 years) and ADHD clinical symptoms (measured at each wave from 1 to 7) were explored using the mixed effects model with individual child indicator and family postcode indicator as random effects. The mixed effects model accounts for the possible correlation of repeated measures within each child over time and utilizes all available data (Howard, 2008). The mixed effects model estimated the mean children's HRQoL/HRQoL domains associated with having ADHD clinical symptoms over the period of 4 to 17 years, with a 95% confidence interval. Sample weights were applied in all analyses to account for cluster sampling design and sample attrition (Sipthorp & Misson, 2007). Analyses were conducted using STATA 18 (StataCorp LLC, 2024).

Results

ADHD clinical symptoms prevalence from 4 to 17 years (waves 1–7) is presented in Figure 1. Baseline characteristics of the analytic sample (i.e., with data on both the PedsQL and SDQ) at wave 1 are comparable between children with and without ADHD clinical symptoms, however, there were more boys with ADHD clinical symptoms than girls. In addition, a higher proportion of children with ADHD clinical symptoms were from lower SEP or caregivers with a possible mental health illness than those without ADHD clinical symptoms (Table 1). A similar pattern was found at 16 to 17 years (wave 7) however, there was a higher proportion of children with clinical ADHD symptoms who took ADHD medication compared to 4 to 5 years (wave 1).

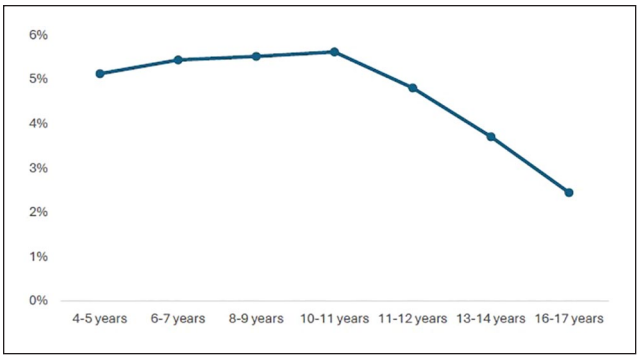

Figure 1. ADHD clinical symptoms prevalence from waves 1 to 7 (4–17 years).

Age-Related Associations Between ADHD Clinical Symptoms and Children's HRQoL, From 4 to 17 Years: Multivariable Model Results

At all time points, children with ADHD symptoms experienced poorer HRQoL than their peers without the condition (Figure 2). From 4 to 17 years, considering child and family factors, multivariable linear regression results showed that compared to children without symptoms of ADHD, children with clinical ADHD symptoms had poorer HRQoL (Table 2). At all time points, the mean differences in children's HRQoL between those with and without ADHD symptoms were larger than the meaningful clinical difference of 4.5 points for the PedsQL.

Longitudinal Association Between ADHD Clinical Symptoms and Children's HRQoL From 4 to 17 years: Mixed Effect Model Results

Mixed effects model showed that children with clinical ADHD symptoms experienced significantly poorer HRQoL than children without ADHD symptoms for overall HRQoL (mean difference = 7.65, 95% CI [6.09, 9.19]) and for all HRQoL domains including physical (mean difference = 5.77, 95% CI [3.83, 7.72]), social (mean difference = 9.23, 95% CI [7.29, 11.17]), emotional (mean difference = 9.73, 95% CI [7.50, 11.97]), and school (mean difference = 3.06, 95% CI [0.78, 5.35]) domains (Table 3). The mean differences in overall HRQoL, social and emotional domains were larger than the meaningful clinical differences for the PedsQL or its social and emotional domains.

Table 1. Baseline Characteristics of the LSAC Sample for Both Analyses.

Factors	Whole sample (*N* = 4,966)	Wave 1 analytic sample (*N* = 4,194)		Wave 7 analytic sample (*N* = 2,985)	
		No ADHD symptoms (*N* = 3,960)	ADHD symptoms[b] (*N* = 234)	No ADHD symptoms (*N* = 2,912)	ADHD symptoms[b] (*N* = 233)
Child sex, male	2,540 (51.1%)	2,321 (49.7%)	219 (73.1%)	1,409 (50.5%)	65 (83.5%)
Indigenous	194 (3.9%)	178 (3.8%)	16 (5.4%)	63 (2.2%)	1 (1.3%)
No. of siblings					
0	570 (11.5%)	535 (11.5%)	35 (11.6%)	221 (8.1%)	7 (9.6%)
1	2,364 (47.6%)	2,220 (47.6%)	144 (48.1%)	1,257 (45.9%)	30 (39.5%)
2	1,329 (26.8%)	1,255 (26.9%)	74 (24.6%)	827 (30.2%)	29 (37.4%)
3 and more	703 (14.2%)	657 (14.1%)	47 (15.6%)	434 (15.9%)	10 (13.5%)
Living with both parents	4,061 (99.4%)	3,848 (99.4%)	212 (99.2%)	2,010 (99.3%)	40 (93.3%)
Having autism at any time point	329 (11.3%)	273 (9.9%)	57 (34.1%)	143 (5.4%)	20 (26.1%)
Internalizing problems	399 (8.0%)	337 (7.2%)	62 (20.6%)	414 (14.8%)	45 (58.1%)
Externalizing problems	1,432 (28.8%)	1,219 (26.1%)	213 (71.1%)	145 (5.2%)	42 (53.9%)
Other medical conditions	557 (11.2%)	462 (9.9%)	95 (31.7%)	159 (6.0%)	26 (33.3%)
Had ADD or ADHD medicine	13 (0.3%)	4 (0.1%)	8 (2.8%)	48 (1.7%)	21 (27.4%)
Parental mental health[a]	159 (3.9%)	128 (3.3%)	31 (12.7%)	70 (2.6%)	5 (7.5%)
Socioeconomic position, mean (*SD*)	−0.106 (0.983)	−0.077 (0.982)	−0.554 (0.891)	0.035 (0.974)	−0.342 (0.875)

Note. Analyses are weighted and account for LSAC survey design. LSAC = Longitudinal Study of Australian Children; HRQoL = Health-related Quality of life; *SD* = standard deviation.

[a]Indication of primary caregiver's mental illness: measured by the Kessler Psychological Distress Scale (K6).

[b]ADHD clinical symptoms: measured by the Strengths and Difficulties Questionnaire hyperactivity scale score where a score >8 is suggestive of ADHD.

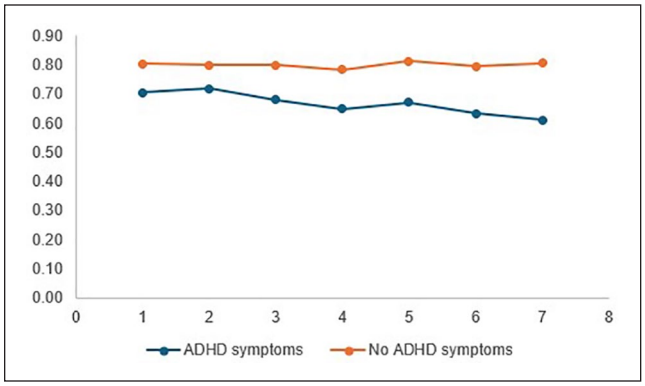

Figure 2. Health-related quality of life of children with and without ADHD symptoms from waves 1 to 7 (4–17 years).

Factors Contributing to the Association Between ADHD Clinical Symptoms and Children's HRQoL/HRQoL Domains

Child and family factors that influenced children's HRQoL are presented in Table 3. Having two or more siblings was associated with better HRQoL while parental mental health, having autism or other medical conditions or taking ADHD medication was associated with reduced children's HRQoL (Table 3). When additionally considering internalizing and externalizing problems in the analysis, the association between ADHD clinical symptoms and children's HRQoL were still significant and clinically meaningful albeit slightly reduced (mean difference = 4.91, 95% CI [3.40, 6.43]; Supplemental Table S2). Both internalizing (mean difference = 10.92, 95% CI [9.71, 12.13]) and externalizing problems (mean difference = 5.54, 95% CI [4.56, 6.51]) were associated with significantly poorer children's HRQoL with the mean difference in HRQoL well above the minimal clinically meaningful difference (Supplemental Table S2).

Discussion

This study is the first to explore the long-term association between ADHD clinical symptoms and children's HRQoL from 4 to 17 years and the factors that influence this association. We found that from 4 to 17 years of age, children with ADHD clinical symptoms have significantly poorer overall HRQoL across all domains than children without significant ADHD symptoms. Being from a family with two or more siblings was associated with better children's HRQoL while having other medical conditions or autism, taking ADHD medication, and having a caregiver with mental illness were associated with poorer overall HRQoL.

Our findings about the poorer overall HRQoL in children with high ADHD symptoms compared to children

Table 2. HRQoL in Children With and Without ADHD Symptoms From 4 to 17 Years (Multivariable Regression Models).

	Whole analytic sample		ADHD symptoms		No ADHD symptoms		Unadjusted analyses		Adjusted analysis[a]	
Time point	*N*	Mean (*SD*)	*N*	Mean (*SD*)	*N*	Mean (*SD*)	Mean difference	95% *CI*	Mean difference	95% *CI*
4–5 years (wave 1)	4,194	79.70 (11.41)	234	70.45 (12.15)	3,960	80.28 (11.10)	**−9.83**	**[−11.60, −8.07]**	**−6.31**	**[−8.49, −4.12]**
6–7 years (wave 2)	3,433	79.47 (12.70)	197	71.71 (13.73)	3,236	79.96 (12.46)	**−8.09**	**[−10.26, −5.92]**	**−5.40**	**[−8.20, −2.59]**
8–9 years (wave 3)	3,794	79.12 (13.15)	217	68.08 (14.86)	3,577	79.83 (12.70)	**−11.68**	**[−14.05, −9.31]**	**−9.24**	**[−12.82, −5.65]**
10–11 years (wave 4)	4,116	77.42 (15.48)	239	64.91 (16.01)	3,877	78.23 (15.08)	**−13.33**	**[−15.84, −10.83]**	**−11.65**	**[−15.40, −7.89]**
12–13 years (wave 5)	3,851	80.41 (14.33)	193	67.07 (15.70)	3,658	81.17 (13.85)	**−13.77**	**[−16.33, −11.21]**	**−11.15**	**[−14.88, −7.42]**
14–15 years (wave 6)	3,368	78.72 (15.95)	125	63.30 (16.70)	3,243	79.36 (15.58)	**−16.58**	**[−20.13, −13.03]**	**−8.14**	**[−12.66, −3.62]**
16–17 years (wave 7)	2,985	79.95 (14.76)	73	61.10 (17.74)	2,912	80.47 (14.30)	**−19.02**	**[−23.75, −14.28]**	**−13.23**	**[−18.92, −7.54]**

Note. Analyses are weighted and account for LSAC survey design. Significant statistics at a 5% significance level are in bold. *SD* = standard deviation.

[a]Analyses were adjusted for ADHD symptoms (waves 1–7), SEP (waves 1–7), child gender (wave 1), Indigenous status (wave 1), autism (self-reported of ever had a diagnosis of autism), other medical conditions (waves 1–7), number of siblings (waves 1–7), living with both parents (waves 1–7), parental mental health (waves 1–7), had ADD/ADHD medication (waves 1–7).

Table 3. Longitudinal Association Between ADHD Symptoms and Children's Overall HRQoL/HRQoL Domains From 4 to 17 Years (Mixed-effect Models).

	Overall HRQoL		Physical domain		Social domain		Emotional domain		School domain	
Factors	Coefficient	95%*CI*	Coefficient	95%*CI*	Coefficient	95%*CI*	Coefficient	95%*CI*	Coefficient	95%*CI*
ADHD symptoms	**−7.65**	**[−9.19, −6.09]**	**−5.77**	**[−7.72, −3.83]**	**−9.23**	**[−11.17, −7.29]**	**−9.73**	**[−11.97, −7.50]**	**−3.06**	**[−5.35, −0.78]**
Female	**−0.91**	**[−1.56, −0.27]**	**−0.83**	**[−1.61, −0.04]**	**−1.25**	**[−2.04, −0.45]**	−0.69	[−1.52, 0.14]	−0.10	[−0.92, 0.72]
Indigenous	−2.24	[−5.19, 0.70]	−2.98	[−6.48, 0.52]	0.78	[−2.47, 4.03]	**−4.60**	**[−8.64, −0.55]**	0.17	[−3.43, 3.76]
Having autism	**−5.11**	**[−6.99, −3.23]**	**−3.19**	**[−5.43, −0.96]**	**−3.19**	**[−5.36, −1.01]**	**−10.27**	**[−12.70, −7.84]**	−1.57	[−3.61, 0.48]
Having other medical conditions	**−4.57**	**[−5.76, −3.38]**	**−4.72**	**[−6.18, −3.25]**	**−2.59**	**[−4.03, −1.15]**	**−6.11**	**[−7.74, −4.48]**	**−6.92**	**[−8.62, −5.22]**
Had ADD/ADHD medication	**−6.47**	**[−9.59, −3.35]**	−1.27	[−4.79, 2.25]	**−11.36**	**[−15.07, −7.64]**	**−9.58**	**[−13.74, −5.42]**	−0.68	[−3.75, 2.39]
Number of siblings										
1	0.48	[−0.88, 1.85]	0.84	[−0.66, 2.35]	0.28	[−1.35, 1.91]	0.21	[−1.59, 2.02]	0.95	[−0.72, 2.62]
2	**1.51**	**[0.08, 2.93]**	**2.13**	[0.57, 3.70]	1.01	[−0.72, 2.74]	1.46	[−0.41, 3.33]	1.00	[−0.75, 2.75]
3 and more	**2.14**	**[0.61, 3.66]**	**2.58**	[0.81, 4.35]	**2.15**	**[0.27, 4.02]**	1.44	[−0.58, 3.46]	0.92	[−1.11, 2.96]
Living with both parents	6.77	[−0.45, 14.00]	8.80	[−0.16, 17.77]	1.64	[−5.85, 9.14]	**7.61**	**[0.77, 14.45]**	−2.60	[−7.41, 2.22]
Socioeconomic position	0.38	[−0.03, 0.79]	**0.56**	**[0.06, 1.06]**	−0.22	[−0.67, 0.24]	**0.71**	**[0.22, 1.20]**	**2.02**	**[1.50, 2.53]**
Caregiver's mental health	**−5.20**	**[−8.01, −2.39]**	**−3.75**	**[−6.87, −0.62]**	**−7.27**	**[−10.21, −4.34]**	**−6.48**	**[−10.10, −2.86]**	−3.53	[−7.27, 0.22]
Wave										
2	−0.68	[−1.67, 0.32]	−0.76	[−1.90, 0.37]	**2.21**	**[1.15, 3.28]**	**−3.42**	**[−4.74, −2.09]**	**−3.89**	**[−5.16, −2.62]**
3	**3.26**	**[1.92, 4.60]**	**4.64**	**[3.00, 6.28]**	**3.58**	**[2.03, 5.13]**	0.68	[−1.20, 2.56]	1.86	[−0.01, 3.73]
4	**2.51**	**[1.08, 3.94]**	0.83	[−0.95, 2.62]	**4.93**	**[3.38, 6.49]**	**2.54**	**[0.61, 4.48]**	**2.01**	**[0.12, 3.91]**
5	**1.01**	**[0.10, 1.92]**	0.32	[−0.74, 1.39]	**4.08**	**[2.96, 5.20]**	−0.95	[−2.13, 0.23]	**−5.15**	**[−6.44, −3.86]**
_cons	**74.40**	**[67.12, 81.67]**	**74.51**	**[65.60, 83.42]**	**71.52**	**[63.88, 79.17]**	**77.99**	**[71.06, 84.92]**	**92.98**	**[88.00, 97.95]**

Note. Number of observations = 9,715. Analyses are weighted and account for LSAC survey design. Significant statistics at a 5% significance level are in bold.
Mean difference (coefficient): difference in mean HRQoL scores between children with and without ADHD symptoms, estimated as a random effect once random intercept.
and random slope have been modelled to represent within child variability in repeated measures. Analyses were adjusted for ADHD symptoms (waves 1–7), SEP (waves 1–7), child gender (wave 1), Indigenous status (wave 1), autism (self-reported of ever had a diagnosis of autism), other medical conditions (waves 1–7), number of siblings (waves 1–7), living with both parents (waves 1–7), parental mental health (waves 1–7), had ADD/ADHD medication (waves 1–7). *SE* = standard errors; SEP = socioeconomic position; HRQoL = Health-related quality of life.

without ADHD symptoms are consistent with the current meta-analyses and systematic reviews (Lee et al., 2016; Wanni Arachchige Dona et al., 2023). We extended the current knowledge about the association between ADHD symptoms and children's HRQoL by presenting the longitudinal findings from 4 to 17 years. No research has explored the long-term impact of ADHD symptoms on children's HRQoL across a 13-year period.

Association Between ADHD Clinical Symptoms and Children's HRQoL

Consistent with previous studies (Danckaerts et al., 2010; Wanni Arachchige Dona et al., 2023), we found a reduction in HRQoL in social, emotional, and school domains (i.e., social and emotional HRQoL) in children and adolescents with ADHD clinical symptoms compared to typically developing children, with the magnitude of the reduction being twice the minimum clinically important difference of HRQoL measured by the PedsQL. Both social and communication skills may be reduced in children and adolescents with ADHD (Klimkeit et al., 2006). This can impact their relationships and activities within the home, at school (McQuade & Hoza, 2008) and more broadly in the community (Moyá et al., 2014). Additionally, children with ADHD face social difficulties including peer rejection, inappropriate behavior (Ros & Graziano, 2018) as well as learning difficulties, putting them at greater risk for low academic achievement (Daley & Birchwood, 2010).

We found a reduction in the physical domain of HRQoL in children with ADHD clinical symptoms, yet the magnitude of the HRQoL reduction is lower than that of the psychosocial domains. There are mixed findings about the impact of ADHD on the physical domain (Lee et al., 2016; Wanni Arachchige Dona et al., 2023). Despite likely being hyperactive, children with ADHD are less likely to be physically active and participate in organized recreational activities (Engel-Yeger & Ziv-On, 2011). This lower participation rate may be associated with cognitive and emotional difficulties experienced by children with ADHD, or challenges related to social interactions not related to physical capabilities. Additionally, when engaged in physical activities, children with ADHD are more likely to become injured (Tai et al., 2013). On the other hand, a recent Spanish study found a positive correlation between increased levels of physical activity practices and children's HRQoL among those aged 8 to 14 years (Gallego-Méndez et al., 2020).

Child and Family Factors Influencing Children's HRQOL

Findings about the negative association between parental mental health and children's HRQoL align with current research in this area (Galloway et al., 2019). Stressed mothers exhibited less responsiveness and empathy, and are more likely to show criticism, hostility, and negativity (Whaley et al., 1999). Children of stressed parents have a greater risk of receiving reduced emotional and practical care (Kavanaugh et al., 2006). This may be particularly problematic in families of children with ADHD, who often face psychological and learning difficulties and require increased emotional, social, and learning support from parents. Research has also shown that strain on family functioning may lead to an increase in risk-taking behaviors by the child and worsen their resilience, resulting in reduced coping strategies and lower family involvement (Riley et al., 2006). Parental mental health may also influence how they rate their children's HRQoL. Research showed that parents with mental illness are more likely to rate their children's HRQoL lower than the children's rating and that parental mental health was the main predictor for this disagreement (Radicke et al., 2021).

The finding of poorer HRQoL in children with co-occurring medical conditions such as autism is consistent with the existing literature (Ikeda et al., 2014; Van Heijst & Geurts, 2015). Our study revealed that the additional reduction in children's HRQoL in children with autism or other medical conditions is itself considered clinically meaningful. It is, therefore, important to recognize and treat the co-occurring conditions in tandem with ADHD symptoms to improve children's overall health and well-being.

We found that accounting for internalizing and externalizing behaviors did not attenuate the association between ADHD clinical symptoms and children's HRQoL across all HRQoL domains. This finding suggests that both ADHD symptoms and internalizing/externalizing problems contribute to reducing children's HRQoL.

While previous studies reported on the positive effects of pharmaceutical treatment of ADHD on functional outcomes and HRQoL (Coghill, 2010; Coghill et al., 2017), with smaller effect sizes for children's HRQoL (Bellato et al., 2024), in our population, having ADHD medication was associated with lower children's HRQoL. We found that those taking ADHD medication in our sample experienced more severe ADHD symptoms (analysis not shown), which may have significantly impacted children's functioning, such as social and emotional domains (Kazda et al., 2022). Furthermore, the small sample size of children taking ADHD medication, especially in the early childhood phase (4–8 years) in our study, may affect the reliability of this finding. Caution must be taken when interpreting this result.

Strengths and Limitations

The strengths of this study include a large representative population sample, the exploration of the longitudinal association between ADHD symptoms and children's HRQoL and the inclusion of sample weights to account for

sample attrition and clustering design. Limitations include the use of SDQ as a clinical measure for ADHD symptoms. While the SDQ is a valuable screening tool, it should not be used alone as an assessment tool for ADHD. However, it is the only available possible measure for ADHD clinical symptoms in LSAC. Research has found that SDQ is a valid outcome measure in randomized controlled trials and clinical setting (Hall et al., 2019) and that children with parent-reported ADHD were very similar to those with ADHD clinical symptoms on the SDQ (Sciberras et al., 2011, 2017).

Furthermore, the use of parent-proxy reports on both children's HRQoL and ADHD clinical symptoms may result in shared measure variance. Empirical research shows that among children with ADHD, parents rated their children's HRQoL and HRQoL domains lower than the children themselves (Wanni Arachchige Dona et al., 2023). In the absence of the self-rated HRQoL in LSAC at ages 4 to 14 years, the parent-proxy report was the only available alternative. The parent-reported SDQ hyperactivity-inattention subscale has high internal consistency and reliability (Palmieri & Smith, 2007). While incorporating multiple informants would enhance robustness, parent reports remain highly informative, particularly in capturing behaviours across different settings, including the home environment, where ADHD symptoms are often most evident (Jungersen & Lonigan, 2021). Previous research has also reported moderate to good agreement between parent and teacher reports of SDQ (Bied et al., 2017; Cheng et al., 2018).

Implications for Policy, Practice, and Future Research

Our study findings have important implications for both policy and future research. First, the findings about the poorer HRQoL across all HRQoL domains in children with ADHD clinical symptoms compared to children with no symptoms underscores the need for ADHD intervention/treatment to comprehensively address the behavioral, psychological, and educational needs of the child to improve overall health and well-being, not just manage the underlying symptoms (Wilens & Spencer, 2010). A recent meta-analysis supports the efficacy of pharmacological treatments in reducing core ADHD symptoms and improving HRQoL although the effects on HRQoL remain modest (Bellato et al., 2024). It also highlights the need to explore the effects of combining pharmacological and non-pharmacological interventions for more holistic improvement in children's well-being.

Furthermore, physical activity interventions have been shown to have a significant improvement in ADHD symptomology (Xie et al., 2021), thus encouraging children with ADHD to participate in appropriate physical activities may improve ADHD core symptoms. Further research is warranted to explore integrated treatment strategies to optimize children's overall well-being.

Given the negative association between caregiver's mental health and children's HRQoL, supporting caregivers is essential to improve family functioning, children's social-emotional aspects, and overall well-being. Research shows that family cohesion and parental support not only improve children's HRQoL but also reduce emotional problems in adolescents with ADHD (Schei et al., 2016). Interventions targeting both caregivers' mental health and family dynamics can, thus play a pivotal role in fostering better long-term outcomes for children (Otto et al., 2017).

Although we attempted to include many child and family factors in the analysis, we may have not included all factors that could influence children's HRQoL due to the unavailability of data in LSAC. For example, reduced psychosocial HRQoL may also be affected by external environmental factors such as lack of support and other significant contextual factors relating to school and family-based characteristics (Shabat et al., 2021). Future research should explore other environmental and contextual factors to fully understand the determinants of children's HRQoL.

Conclusion

Children from 4 to 17 years of age with ADHD clinical symptoms have significantly poorer overall HRQoL across all HRQoL domains than children without ADHD symptoms. Children from families with two or more siblings had better children's HRQoL. Conversely, those with other medical conditions or autism, ADHD medication use, or a caregiver with mental illness were likely to experience poorer overall HRQoL. ADHD treatment needs to address psychosocial and learning needs in addition to ADHD core symptoms.

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Data Availability Statement

The Australian Institute for Family Studies approved the data used in this paper. The authors do not have permission to share the data. Data requests should be made following the LSAC public available form and appropriate approval would be needed.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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Ethical Considerations

Ethical approval for LSAC was obtained from The Royal Children's Hospital (Melbourne) and the Australian Institute for Family Studies.

Consent to Participate

All attending caregivers provided written consent for themselves and the study child.

Consent for Publication

Not applicable.

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Supplemental Material

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