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Social problems in children with neurodevelopmental symptoms: exploring gender or sex differences and potential underlying mechanisms

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Submitted in partial fulfilment of the requirements for the degree of

Doctorate in Clinical Psychology

School of Health and Wellbeing

College of Medical, Veterinary and Life Sciences

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University of Glasgow

School of Health
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Table of Contents

List of tables

Chapter 1

Chapter 2

List of Figures

Chapter 1

Chapter 2

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Chapter 1

Does exposure to social problems vary across gender or sex in children and adolescents with ADHD? A systematic review

Prepared in accordance with university guidelines and the author requirements for Research in Neurodiversity[1]; https://www.sciencedirect.com/journal/research-in-neurodiversity/publish/guide-for-authors

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[1] University of Glasgow guidelines preceded author requirements for the purpose of thesis submission

Abstract

Children and adolescents with ADHD are at risk of experiencing social problems, which increases their risk of negative mental health outcomes. Previous research suggests that increased ADHD symptom severity could increase vulnerability to social problems. Differences observed in ADHD symptomatology across gender and sex could then be reflected in differences in social problems. 1) In children and adolescents with ADHD, does exposure to social problems vary across gender or sex? 2) Does this association vary by: type of social problem or ADHD symptom severity? A systematic review was conducted. Six core databases were searched, with parameters set from 1994-February 2025. Quality appraisal of the studies was conducted using QualSyst. Narrative synthesis was used with reporting guidance from synthesis without meta-analysis. Nineteen papers were included, with a total sample of 10,826 5-18-year-olds with ADHD (69.1% boys). Studies were grouped to examine gender and sex differences separately. Most studies were of high-quality. Overall, there were no consistent variations in social problems across gender or sex. This was not found to vary across type of social problem or ADHD subtype; however, some findings suggest that boys may experience or perpetrate more overt peer victimisation, and girls with ADHD-IN may experience more peer functioning difficulties. Overall, no consistent gender or sex differences for overall social problems in children with ADHD were found, although there were specific differences observed by type of problem and ADHD subtype. Suggestions for future research include investigating possible confounding factors, such as age and medication use.

Keywords: ADHD, children, adolescents, gender differences, sex differences, social problems

Social problems in children and adolescents, such as social isolation, peer rejection, peer victimisation and poor friendship quality, are associated with negative social and emotional outcomes including poor wellbeing, anxiety, and depression (Alsarrani et al., 2022; Almeida et al., 2021; Moore et al., 2017; Mullan et al., 2023; Oncioiu et al., 2023). An increased frequency of such social problems is associated with an increased risk of mental health problems (Denham et al., 2016). Based on recent meta-analyses in typically developing children, boys are more likely to experience social isolation and overt traditional peer victimisation and perpetrate overt traditional or online bullying than girls (Maes et al., 2019; Cosma et al., 2022). However, there are no significant gender or sex differences in social adjustment or friendship quality in the general population (Casper et al., 2020).

We know that there are certain groups of children and adolescents who may be especially vulnerable to experiencing social problems. Children with neurodevelopmental conditions, such as Attention-Deficit Hyperactivity Disorder (ADHD), have a greater risk of experiencing social problems compared to their typically developing peers (Ros & Graziano., 2018). ADHD is a neurodevelopmental condition defined by marked differences in attention, hyperactivity and impulsivity that impacts on daily functioning (ICD-11, World Health Organization, 2022), with a global prevalence of 8% in children and adolescents (Ayano et al., 2023). The increased risk of social problems in children and adolescents with ADHD in turn increases the risk of poor outcomes including internalising symptoms, academic problems and behavioural problems (Marsus et al., 2022).

There have been several attempts to identify and understand possible underlying mechanisms for increased risk of social problems in children with ADHD. Ros and

Graziano proposed a conceptual framework to outline how ADHD symptoms can impact different domains of social functioning (i.e., peer functioning, social skills, social information processing) and how this may be moderated by method factors, such as informant effects (Ros & Graziano, 2018). The peer functioning domain encapsulates peer rejection/likeability, popularity and friendships; social skills domain consists of social skills performance and prosocial behaviour; and social information processing domain comprises of hostile attribution bias and positive illusory bias. In their meta-analysis, they found that children with ADHD were most severely impaired in peer functioning domains, followed by social skills and social information processing. For peer functioning, this study found largest effects from teacher reports and in younger samples; and did not observe significant gender differences as reported in their moderation analysis (Ros & Graziano, 2018). Despite being a key paper in the literature examining some domains of social problems in children and adolescents with ADHD, this study did not directly assess gender and sex differences as a function of ADHD symptom severity or ADHD symptom subtype, nor did it include peer victimisation or bully perpetration as outcomes.

A recent meta-analysis suggests that boys are twice as likely to be diagnosed with ADHD than girls (10% and 5%, respectively; Ayano et al., 2023). Boys are also found to score higher on symptom severity scales overall compared to girls (Arnett et al., 2015). Other research shows that impulsivity and hyperactivity are more prominent in boys, whereas inattentiveness is more apparent in girls (Quinn & Madhoo, 2014). These variations in symptom subtypes and severity may have varying implications. For example, research suggests that more severe ADHD symptoms may lead to poor emotional regulation skills, which manifests in impaired social functioning (Bunford et al., 2015). This was supported in longitudinal research, where increased symptom severity was indirectly associated with less support from a ‘best friend,’ increased association with ‘deviant’ peers, and greater peer aggression, through emotional dysregulation in adolescence (McQuade et al., 2021).

Given the evidence that boys with ADHD are more likely to present with greater symptom severity in comparison to girls, it would be reasonable to hypothesise that gender or sex differences in social problems in children and adolescents with ADHD will be different from those in the general population. Yet research on this is limited and riddled with inconsistent or unclear use of terminology.

The current evidence base presents a bias in focus, as it tends to focus on boys with ADHD and disregards the more complex impact that social problems can have on girls (Kok et al., 2016). For example, a study examining the pathway from ADHD symptoms to depression found that this was significantly mediated by peer dislike and peer victimisation in girls, but not boys (Roy et al., 2015). Furthermore, when we consider gender or sex differences and symptom severity, preliminary research suggests that peers are more likely to tolerate higher levels of ADHD symptoms in boys than in girls (Ek et al., 2008). Together, these findings suggest that there may be important gender and/or sex variations in social problems in children and adolescents with ADHD. Of note, when differences are reported or examined, there is a lack of clarity around terminology, where the term ‘gender’ or ‘sex’ is rarely defined, often used interchangeably and mostly used as a binary variable. This reflects broader issues with reporting on gender and sex differences in the literature, further entangles the overlapping effects of gender and sex, and risks excluding gender-diverse populations (Heidari et al., 2016; Cameron & Stinson, 2019).

There are currently no systematic reviews or meta-analyses that explore differences in levels of exposure to social problems across gender or sex in children and adolescents with ADHD including peer victimisation and bully perpetration, with gender or sex differences as a primary focus. This is a significant gap in the literature, especially when one considers type of social problem or ADHD symptom severity as possible contributing factors. This study addresses these gaps in the literature by conducting a systematic review on gender or sex differences in exposure to social problems in children and adolescents with ADHD.

Review Questions

1) In children and adolescents with ADHD, does exposure to social problems vary across gender or sex?
2) Does the association between gender or sex and social problems in children and adolescents with ADHD vary by:
    a. Type of social problem
    b. ADHD symptom severity

Methods

The current systematic review was initially registered on PROSPERO on 24/11/2024, and the most recent version (5.0) was submitted on 11/09/2025 (CRD42024593768). The guidelines described in the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA 2020) Statement (Page et al., 2021) were closely followed. Details on the PRISMA checklist can be found in Appendix A.

Eligibility criteria

Studies were included if they met the following criteria: (1) Participants have ADHD diagnosis or are deemed "at risk" or meeting clinical cutoff for ADHD based on ADHD symptoms using a valid and reliable measure. Studies examining co-morbidities may be included if ADHD (any subtype) is primary diagnosis or concern; (2) There is at least one quantitative measure of social problem. Self-report, caregiver-report and/or school staff-report measures are included; (3) Participants are school-aged (5-18); (4) Study reports on differences in social problems across gender or sex, including data on transgender or non-binary children and adolescents; (5) The paper is published from 1994 – final search date (due to DSM-IV changes to diagnostic criteria); (6) The study uses quantitative research methods including cross-sectional and prospective designs, including mixed-method studies with quantitative data regarding social problems; (7) The paper is published in English; (8) Published peer reviewed papers.

Exclusion criteria

Studies are excluded if: (1) Grey literature, book chapters, letters or conference abstracts; (2) single-case study design; (3) not available in English; (4) ADHD or ADHD symptoms are secondary diagnoses/concerns.

Information sources and search strategy

A search strategy was developed through consultation with a specialist librarian at the University of Glasgow. Six major databases were searched: Web of Science Core Collection, PsycINFO, MEDLINE, EMBASE, ASSIA and ERIC. Parameters were set from 1994 – the date of the literature search. Fully operationalised and truncated search terms were used, which can be found in Appendix B. A further search was conducted by examining reference lists of identified studies, hand-searching relevant journals such as "Journal of Attention Disorders" and using internet search engines such as Google Scholar. Initial searches were run on 28th February 2025.

Study selection and data extraction

After initial database searches, studies were exported to Endnote (Version 21) for de-duplication and screening. Studies were screened using the eligibility criteria upon examining titles and abstracts. A random sample of 273 (20%) articles were independently screened by a second rater (SA; trainee clinical psychologist) based on the title and abstract. The initial agreement rate was 96% before discussion and agreement.

Full text articles were retrieved and screened by the first author using eligibility criteria. Twelve lead authors were contacted for access to full text articles, with no response. The second rater independently screened a randomly chosen sample (n=28, 20%) of full texts. The agreement at this stage was 86% prior to discussion and final agreement.

A data extraction form was developed and piloted, in accordance with PRISMA guidelines (Page et al., 2021). The following domains were extracted: author, year of study, country, design, sample type (e.g. clinical or community), participant descriptive data, ADHD information (e.g. diagnosis, subtype, symptom severity, medication status), comorbidities, social problem outcome measures, test statistics. Six lead authors were contacted for more information on data reported, with no response. The first author completed data extraction, and the second reviewer extracted data for a random sample of 6 studies (33.33%) to ensure accuracy, with no issues noted.

Risk of bias and quality assessment

The Standard Quality Assessment Criteria for Evaluating Primary Research Papers (QualSyst; Kmet et al., 2004) was used by the first author to assess the quality of each study and risk of bias following data extraction to reduce bias by minimising knowledge of study quality (Boland et al., 2017). The tool comprises 14 criteria for quantitative studies using a three-point scale (‘yes’, ‘partial’, ‘no’) to describe whether each criterion is met. Criteria domains include study design, sample methods, measurement validity, control of confounding variables, transparency of analysis and results interpretation. Items are scored and a summary quality score is obtained, yielding values between 0 and 1. The closer the summary score is to 1, the higher the paper quality.

SA independently rated the quality of a random sample of 6 studies (33.3%) using the same tool. The agreement rating for quality assessment included minimal differences across domains and all papers were rated as the same overall quality category (100% agreement on final quality score).

Methods of synthesis

Given the heterogeneity across outcome measures, analysis and reported data, a quantitative meta-analysis was not possible. Due to this, Synthesis Without Meta-analysis (SWiM) guidelines (Campbell et al., 2020) were utilised to ensure research transparency and methodological rigor in integrating findings using narrative synthesis (Appendix C). Narrative synthesis is a methodological approach to analysing findings from multiple studies using text rather than statistical methods, allowing for comparisons of studies, exploration of relationships within data and assessment of strength of evidence (Lisy & Porritt, 2016).

Studies were grouped by 'gender' or 'sex' to examine overall effects, due to the heterogeneity of how this data was measured and reported, reflecting Sex and Gender Equity in Research guidelines (SAGER, Heidari et al., 2016). Studies were further grouped according to social problem type, informant, and ADHD subtype to allow for sub-group analysis. Social problem types comprised of peer functioning difficulties, peer victimisation, and bullying perpetration. Results were determined to be significant based on the alpha level of 0.05.

Effect sizes were categorised as large (OR >4.0, Cohen's *d* = .8, Pearson's *r* >.5), medium (OR = 2.5-4, Cohen's *d* =.5, Pearson's *r* = .3-.5) and small (OR = 1.5-2.5, Cohen's *d* =.2, Pearson's *r* = .1-.3; Cohen, 1988). Where not reported, effect sizes (odds' ratio (OR) and Cohen's *d*) were calculated where possible using an online calculator (https://www.psychometrica.de/effect_size.html); OR when frequency of exposure is reported across groups, and Cohen's d when means and standard deviations are reported.

Narrative synthesis was used to describe the directions and magnitudes of effects across groups.

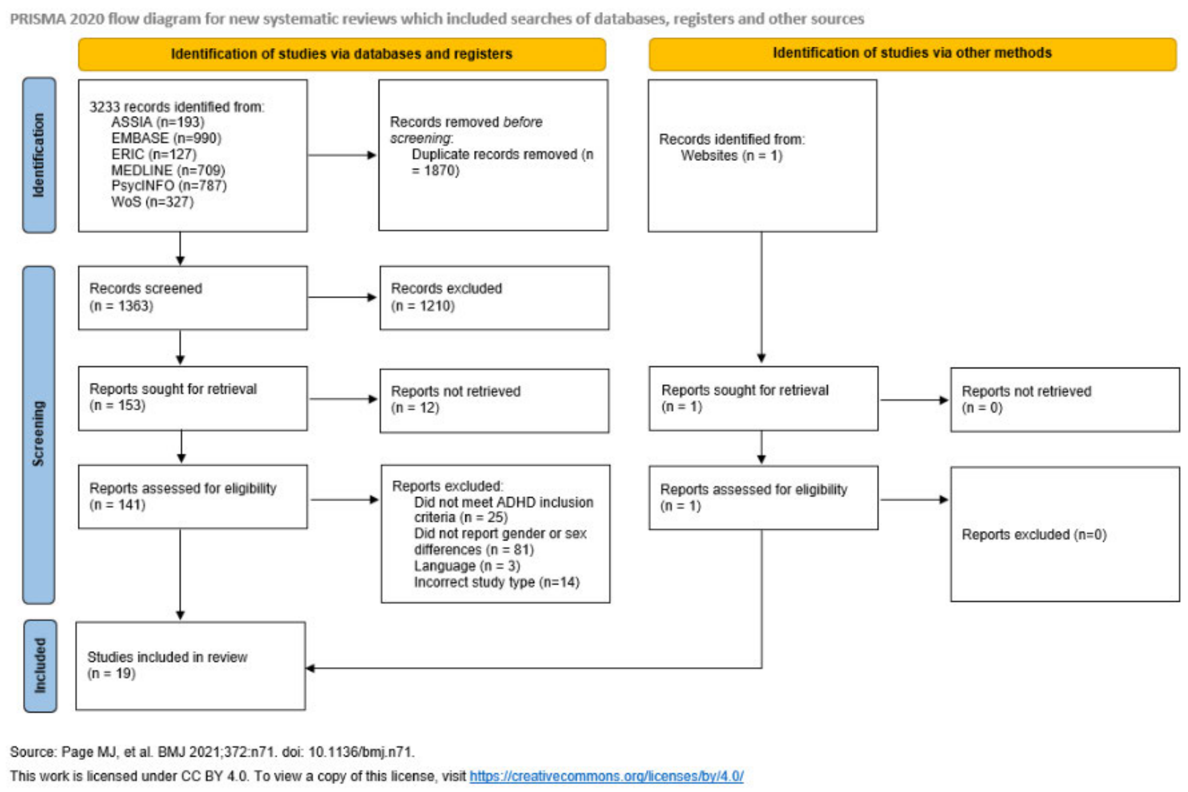
Results

Study selection

Following an initial database search, 3233 potentially related articles were identified and transferred to EndNote, then 1870 duplicates were removed. Out of 1363 papers, 1210 were eliminated when titles and abstracts were screened for inclusion and exclusion criteria. Following this, 153 papers were sought for retrieval, and 12 could not be retrieved. One hundred and twenty-three papers were removed when full texts were examined for inclusion and exclusion criteria. Exclusion reasons included: ‘did not meet ADHD inclusion criteria’ (*n*=25), ‘gender or sex differences not reported’ (*n*=81), language (*n*=3) and ‘incorrect type of study’ (*n*=14). After handsearching, an additional paper was found. This process yielded a final sample of 19 studies. A flowchart demonstrating the study selection process is shown in Figure 1.

Figure 1

A PRISMA flow-chart of included studies (Page et al., 2021)


PRISMA 2020 flow diagram for new systematic reviews which included searches of databases, registers and other sources

Source: Page MJ, et al. BMJ 2021;372:n71. doi: 10.1136/bmj.n71.

Study characteristics and results

The selected studies are summarised in Table 1. Publication years ranged from 1997-2024. Studies were from the USA (*n*=7), Australia (*n*=3), Canada (*n*=2), Iceland (*n*=2), Spain (*n*=1), Croatia (*n*=1), Turkey (*n*=1), Singapore (*n*=1) and Qatar (*n*=1). In total, there were 10,826 children and adolescents (girls *n*= 3345, 30.9%, boys *n*= 7481, 69.1%; age range 5-18 years). Ten studies recruited participants from community samples and nine from clinical samples. Eleven studies assessed ‘gender differences’ (total *n*= 3876, girls *n* = 1128, boys *n* = 2748), and eight reported on ‘sex differences’ (total *n* = 6950, girls *n* = 2207, boys *n* =4743). None of the studies reported definitions of ‘gender’ or ‘sex’. None of the included studies reported data from gender-diverse children or young people. Eight studies (1, 4, 5, 10, 13, 14, 15, 17) reported on racial or ethnic demographics, with the majority reporting on data from white participants (approximately 72.1%). Eight studies (1, 4, 10, 11, 13, 14, 15, 18) reported data on family income, demonstrating a range from families experiencing ‘financial strain’ to ‘high earnings.’ Twelve studies (1, 4, 5, 7, 9, 10, 11, 14, 15, 16, 17, 18) reported data on co-morbid conditions, which included: conduct disorder (CD), oppositional defiance disorder (ODD), anxiety, depression, obsessive compulsive disorder (OCD), borderline personality disorder (BPD), autism, speech and language disorders, specific learning disabilities, intellectual disability, tic disorders/Tourette’s syndrome, elimination disorders and genetic conditions.

Table 1

A summary of included studies

ID	Author, Year, Country	Population	Gender or sex	Age Mean (*SD*), range	ADHD (*n*)			Medication (*n*)
					Total	Girls	Boys	
1	Babinski et al., 2019, USA	Community	Sex	10-15	60	17	43	16
2	Becker et al., 2017, USA	Clinical	Sex	12.56 (0.98) 11-15	131	35	96	-
3	Carlson et al., 1997, USA	Community	Gender	7.55 (1.86)	57	11	46	-
4	Cuba Bustinza et al., 2023, USA	Community	Sex	6-17	5932	1893	4039	3878
5	Efron et al., 2021, Australia	Community	Sex	8.9 (0.5)	173	51	122	22
6	Elkins et al., 2011, USA	Community	Sex	11.9	253	109	144	-
7	Fennolar Cortes et al., 2017, Spain	Clinical	Sex	9.59 (2.38) 6-16	131	39	92	94
8	Graetz et al., 2005, Australia	Community	Gender	6-13	324	99	225	-
9	Gudjonsdottir et al., 2024, Iceland	Clinical	Gender	10.07 (2.98) 5-18	1550	572	978	-
10	Hoza et al., 2005, USA	Clinical	Sex	7-9.9	165	35	130	-
11	Kafali et al., 2021, Turkey	Community	Sex	13.9 (1.8) 10-18	105	28	77	85
12	Kamal., 2021, Qatar	Community	Gender	15(1.6)	150	57	93	-
13	Lau et al., 2021, Singapore	Clinical	Gender	6-18	773	96	677	-
14	McKay et al., 2023, Australia	Clinical	Gender	14.5 (1.5) 13-18	30	9	21	25
15	Mikami & Lorenzi, 2011, USA	Community	Gender	6-10	63	21	42	42
16	Ragnarsdottir et al., 2018, Iceland	Clinical	Gender	8.5 (girls), 7.8 (boys) 5.1-10.9	592	182	410	0
17	Ralić et al., 2018, Croatia	Community	Gender	12 (-) 7-15	72	13	59	4

18	Smit et al., 2020, Canada	Clinical	Gender	8.58 (1.55) 6-11	213	66	147	124
19	Wiener and Mak., 2009, Canada	Clinical	Gender	9-14	52	12	40	36

Note: This table demonstrates information from all included studies in this review. Missing data is denoted by ‘-’.

ADHD diagnosis

Participants from 13 studies had pre-existing diagnoses of ADHD (4, 5, 7, 9, 10, 11, 13, 14, 15, 16, 17, 18, 19). To confirm diagnosis, or to determine whether participants met the clinical threshold for ADHD in the remaining studies, the following tools and measures were used: Kiddie Schedule for Affective Disorders and Schizophrenia (K-SADS; 1, 15, 16, 18), Parent’s version of the Children’s Interview for Psychiatric Syndromes (P-ChIPS; 2), Diagnostic Interview Schedule for Children, Version IV (DISC-IV; 8), DSM-IV rating scale (3, 6, 7), Child Behaviour Checklist (CBCL; 3), Conners-3 (5, 7, 19), Swanson, Nolan and Pelham-IV (SNAP-IV; 10, 12) and medical records (10, 13).

One study reported information regarding ADHD severity (4; mild *n*=2593, moderate *n*=2691, severe *n*=651), however this could not be distinguished across sex. Thirteen studies (1, 2, 5, 6, 8, 9, 11, 12, 14, 15, 16, 17, 18) reported data on ADHD sub-types, for ADHD-IN (*n*=1227), ADHD-HI (*n*=285), and ADHD-C (*n*=2161). Subtype was recorded as unknown for some participants in these studies (*n*=20). Five studies (6, 8, 12, 14, 18) reported subtypes across gender or sex: ADHD-IN (girls *n*=153, boys *n*=234), ADHD-HI (girls *n*=76, boys *n*=131) and ADHD-C (girls *n*=91, boys *n*=249). A full breakdown of this can be found in Appendix D. Nine studies (4, 5, 7, 11, 14, 15, 17, 18, 19) reported on medication status, revealing that at least 39.79% (*n*=4308) of the total sample were on medication for ADHD.

Social problems

Eleven studies reported data on social problems across gender and eight across sex, with a total of 21 and 14 comparisons, respectively. The assessment approaches were used in these comparisons: Child-Behaviour Checklist (CBCL, *n*=4), Dishion Social Acceptance Scale (DSAS*, n*=3), Strengths and Difficulties Questionnaire (SDQ*, n*=6), Conners-3 (*n*=2), peer nomination (*n*=2), School-bullying questionnaire (*n*=4), Bully/victim questionnaire (BVQ, *n*=4), Social Skills Rating System (SSRS parent and teacher rating forms *(n*=2), Revised Peer Experiences Questionnaire (RPEQ, *n*=4), and questions derived by author (*n*=4). Tools such as the CBCL, DSAS, SDQ and Conners-3 assessed social problems more generally and were grouped as peer functioning difficulties (including domains such as peer dislike, difficulty making friends, peer isolation) whereas the BVQ, RPEQ and school-bullying questionnaire were more specific to peer victimisation or bully perpetration. To capture this, and reflect previous research, the following three social problem types were therefore identified: peer victimisation, bully perpetration, and peer functioning difficulties. There were 12 comparisons on peer victimisation, six on bully perpetration and 17 on peer functioning difficulties.

Quality Assessment/Risk of Bias

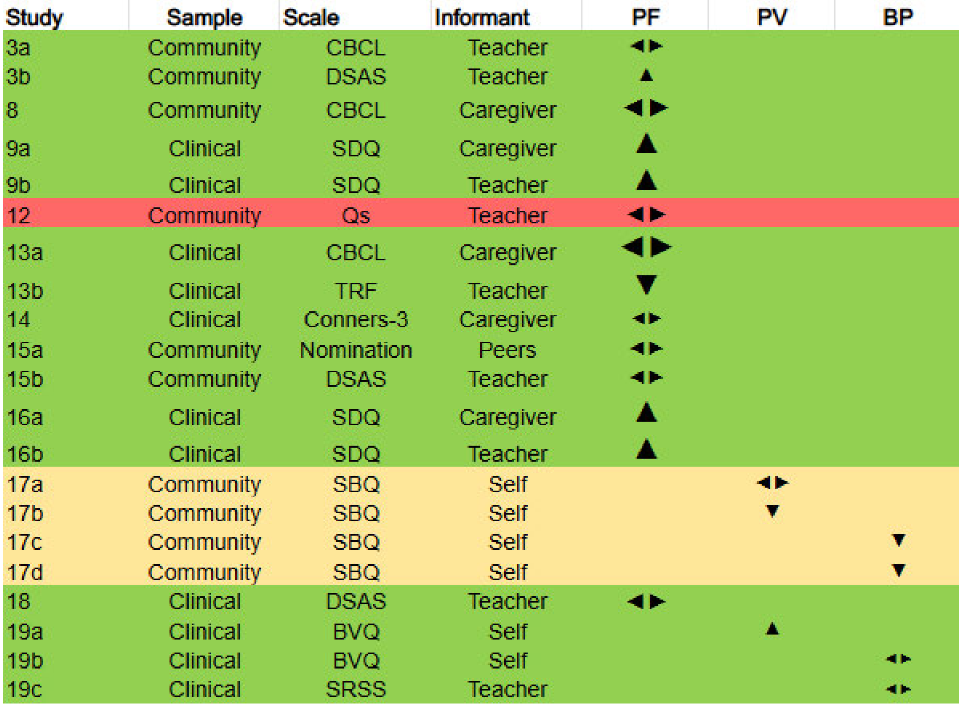
Two studies achieved a perfect quality score as they addressed the applicable elements of quality described by the rating scale. Fourteen received a high-quality score (>= 90%), 2 received a good quality score (80-89%) and one received a poor-quality score (63%). Common aspects that contributed to lower quality ratings included unclear/lack of power, and poorly defined study design and sample. The study with a poor-quality (12) rating also had poorly defined analysis plan and unclear results. See Appendix E for full details on quality appraisal scoring.

Synthesis of results

Synthesised results are summarised in Tables 2a and 2b, which depict direction of effects plots for gender and sex respectively. Full details on synthesised results can be found in the Appendix F.

Table 2a

Direction of effects plot for studies examining gender differences



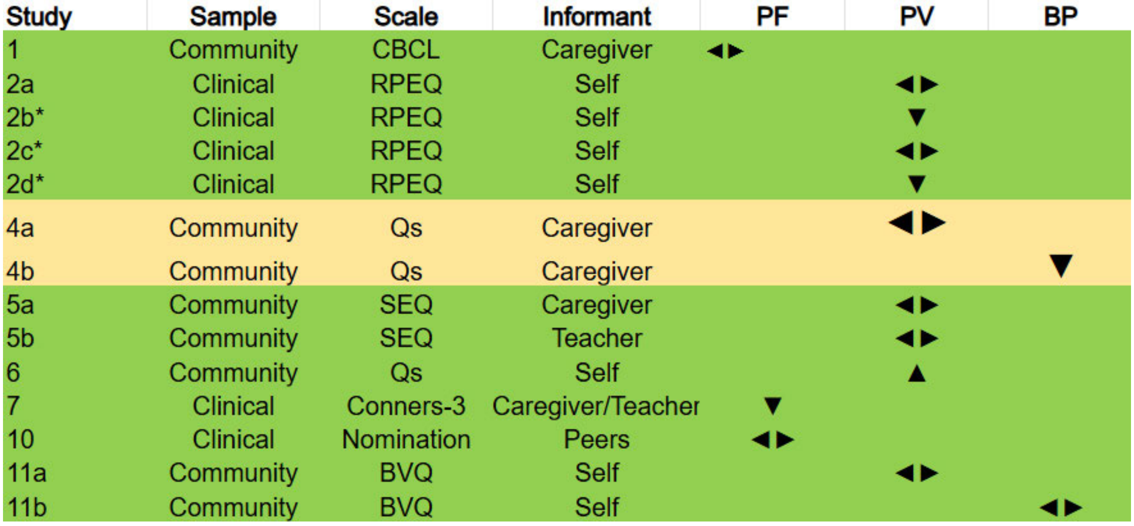
Study	Sample	Scale	Informant	PF	PV	BP
3a	Community	CBCL	Teacher	◀▶		
3b	Community	DSAS	Teacher	▲		
8	Community	CBCL	Caregiver	◀▶		
9a	Clinical	SDQ	Caregiver	▲		
9b	Clinical	SDQ	Teacher	▲		
12	Community	Qs	Teacher	◀▶		
13a	Clinical	CBCL	Caregiver	◀▶		
13b	Clinical	TRF	Teacher	▼		
14	Clinical	Conners-3	Caregiver	◀▶		
15a	Community	Nomination	Peers	◀▶		
15b	Community	DSAS	Teacher	◀▶		
16a	Clinical	SDQ	Caregiver	▲		
16b	Clinical	SDQ	Teacher	▲		
17a	Community	SBQ	Self		◀▶	
17b	Community	SBQ	Self		▼	
17c	Community	SBQ	Self			▼
17d	Community	SBQ	Self			▼
18	Clinical	DSAS	Teacher	◀▶		
19a	Clinical	BVQ	Self		▲	
19b	Clinical	BVQ	Self			◀▶
19c	Clinical	SRSS	Teacher			◀▶

Note: direction of effects plot from Boon & Thomson (2020). PF denotes 'peer functioning difficulties', PV is 'peer victimisation' and BP is 'bully perpetration'. 'Qs' denotes questions developed by authors.
LEGEND
Effect direction: upward arrow ▲= positive effect (significantly more social problems in girls), downward arrow ▼= negative effect (significantly more social problems in boys), sideways arrow ◀▶= no significant differences
Sample size: Final sample size (individuals) in intervention group. Large arrow ▲>300; medium arrow ▲ 50-300; small arrow ▲ <50

Study quality: denoted by row colour: green = low risk of bias; amber = some concerns; red = high risk of bias

Table 2b

Direction of effects plot for studies examining sex differences



Study	Sample	Scale	Informant	PF	PV	BP
1	Community	CBCL	Caregiver	◀▶		
2a	Clinical	RPEQ	Self		◀▶	
2b*	Clinical	RPEQ	Self		▼	
2c*	Clinical	RPEQ	Self		◀▶	
2d*	Clinical	RPEQ	Self		▼	
4a	Community	Qs	Caregiver		◀▶	
4b	Community	Qs	Caregiver			▼
5a	Community	SEQ	Caregiver		◀▶	
5b	Community	SEQ	Teacher		◀▶	
6	Community	Qs	Self		▲	
7	Clinical	Conners-3	Caregiver/Teacher	▼		
10	Clinical	Nomination	Peers	◀▶		
11a	Community	BVQ	Self		◀▶	
11b	Community	BVQ	Self			◀▶

Note: direction of effects plot from Boon & Thomson (2020). PF denotes ‘peer functioning difficulties’, PV is ‘peer victimisation’ and BP is ‘bully perpetration’. Studies denoted with an ‘*’ measure PV type; including physical, relational and reputational, respectively. ‘Qs’ denotes questions developed by authors.

LEGEND

Effect direction: upward arrow ▲= positive effect (significantly more social problems in girls), downward arrow ▼= negative effect (significantly more social problems in boys), sideways arrow ◀▶= no significant differences

Sample size: Final sample size (individuals) in intervention group. Large arrow ▲>300; medium arrow ▲ 50-300; small arrow ▲ <50

Study quality: denoted by row colour: green = low risk of bias; amber = some concerns; red = high risk of bias

Overall Effects[2]

Gender. Eleven studies reported on 21 social problem comparisons across gender in girls and boys with ADHD (3a, 3b, 8, 9a, 9b, 12, 13a, 13b, 14, 15a, 15b, 16a, 16b, 17a, 17b, 17c, 17d, 18, 19a, 19b, 19c). Eleven comparisons (3a, 8, 12, 13a, 14, 15a, 15b, 17a, 18, 19b, 19c) showed no differences in social problems between girls

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[2] Effect sizes could not be calculated for the following comparisons: 1, 5a, 5b, 7, 8, 10, 17a-d.

and boys, with very small to medium effect sizes (OR=0.32, *d*: (–.36) - .746). Four of these were caregiver reports, four teacher reports, two self-reports and one peer report. Six comparisons (3b, 9a, 9b,16a, 16b, 19a) showed that girls had more social problems than boys, with small effect sizes (*d:* (–.45)- (-.18). Three were teacher reports, two caregiver reports and one self-report. Four comparisons (13b, 17b, 17c, 17d) showed that boys had more social problems than girls, with one effect size reported (13a, *r*= -.06). Three were self-reports and one teacher report.

Sex. Eight studies reported on14 comparisons examining sex differences in social problems between girls and boys with ADHD (1, 2a, 2b, 2c, 2d, 4a, 4b, 5a, 5b, 6, 7, 10, 11a, 11b). Nine comparisons (1, 2a, 2c, 4a, 5a, 5b, 10, 11a, 11b) showed no differences in social problems between girls and boys, with very small-small effect sizes (OR 0.6196-2.1181; *d:* .15-.167). Four of these comparisons were based on self-report, three on caregiver report, one peer-report and one teacher report. Four comparisons (2b, 2d, 4b, 7) showed that boys experienced more social problems than girls, with very small-small effect sizes (OR 0.69, *d:*.06-.47). Two of these comparisons were based on self-reports and two on caregiver reports. One comparison (6) based on self-report data showed that girls experienced more social problems than boys, with a small effect size (OR = 1.42).

Social problem type effects

Peer victimisation

Gender. Three comparisons (17a, 17b, 19a) describe rates of peer victimisation from self-report data across gender, reporting mixed results. One comparison (19a) found that girls experienced more overall peer victimisation than boys, with a small effect size (*d*= -.45). Study 17 compared verbal and physical peer victimisation, with no difference in verbal victimisation (17a), whereas boys experienced more physical victimisation than girls (17b). It was not possible to calculate effect sizes for either comparison.

Sex. Nine comparisons (2a, 2b, 2c, 2d, 4a, 5a, 5b, 6, 11a) described rates of peer victimisation across sex, reporting mixed results. Five comparisons compared overall peer victimisation rates (2a, 4a, 5a, 5b, 11a) from self-report (*n*=2), caregiver report (*n*=2) and teacher-report (*n*=1) data, with no differences found, with very small-small effect sizes (OR = 1.15-2.12, *d*= .15). One comparison (6) found that girls experienced more overall peer victimisation than boys, based on self-report data, with a small effect size (OR=1.42). Study 2 examined different types of peer victimisation from self-report measures, including physical (2b), relational (2c) and reputational (2d). No effect of sex was observed in relational peer victimisation, with a very small effect size (*d*=.167). On the other hand, boys experienced more reputational and physical peer victimisation than girls, with very small and small effect sizes respectively (*d:* .05, .47).

Bully Perpetration

Gender. Four comparisons (17c, 17d, 19b, 19c) examined bully perpetration, showing mixed results. Two comparisons (19b, 19c) examined overall bully perpetration rates from self and caregiver report respectively, and found no significant effect of gender, with medium effect sizes (*d:* .57-.75). Two comparisons looked at verbal (17c) and physical (17d) bully perpetration from self-report measures and found that boys partake in more bully perpetration for both; however, it was not possible to calculate effect sizes.

Sex. Two comparisons (4b, 11b) examined bully perpetration across sex, showing mixed results. One (4b) found that boys partake in more bully perpetration than girls based on self-report, with a very small effect size (OR = 0.69) and the other (11b) observed no effect of sex based on caregiver report with a very small effect size (OR = 0.62).

Peer functioning difficulties

Gender. Fourteen comparisons (3a, 3b, 8, 9a, 9b, 12, 13a, 13b, 15a, 15b, 16a, 16b, 18) examined peer functioning difficulties across gender. Eight comparisons (3a, 8, 12, 13a, 14, 15a, 15b, 18) from caregiver (*n*=3), teacher (*n*=4) and peer reports (*n*=1) found no effect of gender on peer functioning, with very small-small effect sizes (OR = 0.3207, *d:* (-.36)-.35). It was not possible to calculate effect sizes for one comparison (8). Five comparisons (3b, 9a, 9b, 16a, 16b) from teacher (*n*=3) and caregiver reports (*n*=2) found that girls experience more peer functioning difficulties than boys, with very small-small effect sizes (*d:(*-.34) - .14).

Sex. Three comparisons (1, 7, 10) examined peer functioning across sex, from combined parent/teacher and peer-reports, respectively. Two found no effect of sex on peer functioning, (1, 10) and the other found that boys experience more peer functioning difficulties than girls (7). It was not possible to calculate effect sizes for any comparison.

ADHD Subtype

Gender. Two studies (8, 12) looked at ADHD sub-type and social problems across gender, with 6 comparisons (8i, 8ii, 8iii, 12i, 12ii, 12iii) reported. Study 8 used caregiver reports, whereas study 12 used reports from teachers. Four comparisons (8ii, 8iii, 12ii, 12iii) found no effect of gender on social problems for ADHD-hyperactive/impulsive or ADHD-combined, with very small-small effect sizes (OR =

0.14-0.24; *d:*.26-.31). One comparison (12i) observed no effect of gender on social problems (peer functioning difficulties) in ADHD-inattentive subtype with a very small effect size (OR=0.52). One comparison (8i) found a small effect with girls experiencing more social problems (peer functioning difficulties) than boys with ADHD-inattentive subtype with a small effect size (*d*=-.38).

Sex. One study (6) examined ADHD sub-type and social problems across sex based on self-report measures, with three comparisons (6i, 6ii, 6iii). Two comparisons (6ii, 6iii) found no effect of sex on ADHD hyperactive-impulsive or ADHD-combined subtype, respectively, with very small-small effect sizes (OR=0.68-1.22). One comparison (6i) found that girls with ADHD-inattentive subtype experienced more social problems (peer victimisation) that boys, with a medium effect size (OR=2.45).

Discussion

Nineteen papers were included in the current review, with a total sample of 10,826 5-18-year-olds with ADHD (69.1% boys). Studies were grouped to examine gender and sex differences separately, with most included studies rated as high-quality. Overall, there was no clear indication for consistent differences in the experience of overall social problems in children with ADHD across either gender or sex. Nonetheless, when specific outcome domains were examined and ADHD subtype considered, across gender and sex, boys appeared to experience or perpetrate more overt peer victimisation than girls, and across gender, girls with ADHD-IN may experience more social problems than boys. These results highlight the need to consider type of social problem and ADHD presentation when examining sex or gender differences.

ADHD can predispose children to being more talkative, noisy, off-task, intrusive, disruptive, and active, which may frustrate or annoy their peers (Erhardt and Hinshaw, 1994; Sciberras et al., 2012). Boys are more likely to score higher on symptom severity scales than girls (Arnett et al., 2015), and boys and girls typically present with varying subtypes of ADHD (Quinn & Madhoo., 2014). Therefore, it would have been reasonable to expect some gender or sex differences in social problems. Nonetheless, no clear patterns for differences emerged when overall social problems were examined together. There might be several reasons for this finding. Firstly, it is possible that because ADHD symptoms are better tolerated in boys than in girls by peers (Ek et al., 2008), that may buffer the negative impact on social problems minimising differences between boys and girls. Secondly, girls are consistently under-identified and under-diagnosed in clinical research and practice (Kok et al., 2016), with issues highlighted with diagnostic criteria (Mowlem et al., 2019; Nussbaum, 2012).

This has meant that girls are more likely to be diagnosed only when symptoms are more severe, or when their presentation is similar to that of boys (Carucci et al., 2022). Therefore, some of the gender or sex differences may have been masked due to sampling and diagnostic issues that may include girls with more severe presentations.

Another option is that differences across gender or sex should be explored separately across social problem types and ADHD subtypes to more accurately capture experiences and exposures. When the specific type of social problem was examined, studies that investigated *physical* peer victimisation found that boys were more likely to be physically victimised by others compared to girls. Similarly, for overall bully perpetration, there were mixed results regarding the effect of gender and sex. Yet studies that investigated *physical* bully perpetration found that boys were more likely to physically bully others compared to girls. These findings reflect the patterns observed in typically developing children, where boys have been found to engage in more externalising behaviours (including aggression) than girls, and are more likely to experience overt peer victimisation or bully perpetration than girls (Mayes et al., 2020; Cosma et al., 2022).

In children with ADHD, research has found that boys are more physically aggressive in comparison to girls (Rucklidge, 2010), which could explain the higher prevalence of overt peer victimisation and bully perpetration. This effect may be linked to research suggesting a higher severity of Oppositional Defiance Disorder (ODD) symptoms in boys with ADHD (Mphahlele et al., 2023), which is of note as ODD symptoms have been found to mediate the association between physical aggression and physical victimisation (McQuade et al., 2018). For bully perpetration, research has found that bullying others has been associated with higher levels of impulsivity (Bong et al., 2021), and that impulsivity is more prominent in boys with ADHD (Quinn & Madhoo., 2014), which may further explain this effect.

When peer functioning was examined, the narrative synthesis did not find effects of gender on peer functioning and revealed mixed results for sex. These findings are consistent with a previous meta-analysis that did not observe any significant moderating effects of gender on peer functioning outcomes (Ros & Graziano, 2018).

When the ADHD subtype was considered, no differences in gender or sex were observed on social problems in children and adolescents with ADHD-HI or ADHD-C. On the other hand, there were some gender and sex differences with children and adolescents with ADHD-IN, whereby girls with ADHD-IN experienced more social problems than boys. Girls are more likely to be diagnosed with ADHD-IN than boys, are less likely to be hyperactive, and are more likely to experience increased internalising behaviours than boys with ADHD (Mowlem et al 2019, Rucklidge, 2010). Increased internalising problems have been associated with social problems in children and adolescents with ADHD (Marsus et al., 2022), which may shed light on this difference.

Overall, these results highlight the importance of understanding social problems experienced by children and adolescents with ADHD and how those experiences may vary across gender and sex depending on the type of problem and ADHD subtype. These findings could support the early identification of ADHD symptoms in children and adolescents, for example by screening for ADHD in children and adolescents experiencing social problems while being aware of possible gender/sex differences.

Limitations of included studies

Despite most included studies having high-quality scores, it is important to consider methodological limitations of these papers. Most studies did not define gender or sex nor describe how this was measured, which led to studies being grouped by ‘gender’ or ‘sex,’ despite the likelihood that the studies were measuring the same variable. This highlights an important issue in the wider literature, therefore future studies should refer to guidelines, such as sex and gender equity in research (SAGER) guidelines, which suggests that authors use ‘gender’ and ‘sex’ carefully, to avoid confusion and to improve the ability to conduct meta-analyses (Heidari et al., 2016).

In addition, all studies measured gender or sex as a binary variable, therefore not distinguishing data from transgender and gender diverse children and adolescents. This is important to consider, as transgender and gender diverse children and adolescents are at greater risk of bullying, physical assault, discrimination, and social exclusion (Strauss et al., 2020). Furthermore, research suggests that there is an increased prevalence of transgender or gender diverse identities in children and adolescents with ADHD, compared to their typically developing peers (Goetz & Adams., 2024). Therefore, data from this population of children and adolescents with ADHD, are not currently captured, consistent with under-representation in the wider literature (Goetz & Adams., 2024). Future research should aim to be inclusive of this where possible (Cameron & Stinson, 2019).

Further, inconsistent reporting of necessary data was common across many of the included studies, due to gender or sex comparisons being secondary or exploratory analyses in the reviewed studies. Few studies reported effect sizes, and only two conducted power analyses, therefore increasing the likelihood of type II errors.

Strengths, limitations, and future directions

According to researchers in the field, there is a lack of studies in ADHD literature that prioritise research in gender and sex differences, and as discussed, those that do are often inconsistent with the terminology used (Babinski, 2024; Kok et al., 2016). With calls for future research to consider possible underlying mechanisms for these differences and attempt to 'disentangle' the effects of gender and sex (Babinski, 2024), this paper attempted to bridge this gap by systematically reviewing the available data and linking results to possible theories.

The current study shows similar gender/sex ratios to recent reports, suggesting good gender/sex representation in comparison to the wider literature. The overall gender/sex ratio of the sample was approximately 3:7 girls to boys. The APA reported that the gender ratio of ADHD in children is approximately 1:3 girls to boys, however more recently, research suggests that this could be closer to 1:2 (Ayando et al., 2023).

Various steps were taken to reduce bias and increase quality. This systematic review adhered to PRISMA and SWiM guidelines, increasing the transparency of the narrative synthesis (Campbell et al., 2020). The search strategy, data extraction form and quality appraisal tool were piloted (Page et al., 2021). A second reviewer examined 20% of the studies for title and abstract and full-test screening, and 33.33% for data extraction and quality appraisal, leading to good agreement. Most included papers had a high-quality score, with two receiving a good score and one with a poor-quality score.

Despite the overall strengths, this review is not without limitations and methodological constraints. Eligibility criteria may have limited the current study, where grey literature and studies not available in English language were excluded. Therefore, the review could be subject to publication bias, and data may have been lost in study selection (Paez, 2017; Hartling et al., 2017). Next, studies were excluded if full text or relevant data could not be accessed; however, attempts were made to contact authors to obtain this.

Attempts were made to increase the reliability of the results using SWiM guidelines, particularly the calculation of effect sizes for included studies and the results were tabulated using an effect direction plot that considers sample size. Nonetheless, it was not possible to run a quantitative synthesis, which could be pursued in future research when consistent terminology and statistical reporting across outcomes are available.

Furthermore, there are other potential confounders or factors that may moderate the association between gender or sex and social problems that should be explored in future research. For example, evidence from a meta-analysis suggests significant effects of age on peer functioning, showing that younger children experience higher rates of difficulty than older children (Ros and Graziano, 2018). Additionally, some included studies suggested significant interactions with age and gender, with some only finding gender or sex differences in younger (Gudjonsdottir et al., 2024) or older children (Lau et al., 2021). Future research should therefore include age as a possible confounding variable and examine effects and interactions where possible. In addition, although this review included multiple informants, which is a strength of the paper, it was not possible to analyse agreement or consistency across reports. This is important to note, as previous literature suggests variability in agreement from informants (Huang, 2017).

This review did not explore the possible impact of comorbid conditions, despite it being widely established that individuals with ADHD are highly likely to have at least one psychiatric co-morbidity (Reale et al., 2017). An included paper suggests that children with dual diagnoses of ADHD and autism were significantly more likely to experience social problems than children with ADHD alone (Gudjonsdottir et al., 2024), and other research suggests that children with ADHD and a comorbid diagnosis are more likely to experience peer victimisation than children with ADHD alone (Bejerot & Humble, 2013). Yet, as data for comorbidities across gender or sex were not available, this could not be explored further. Similarly, the possible impact of medication was not explored, due to data across gender or sex being unavailable or inconsistently reported across most studies. This is important to note, especially as ADHD medication can reduce symptom severity, which could in turn reduce social problems (Cortese et al., 2018; Bunford et al., 2015). When one considers that girls are less likely to be prescribed medication, and that peers are more likely to tolerate higher symptoms in boys compared to girls, it would be reasonable to expect that some of the gender or sex differences may have been masked. Thus, possible impact of comorbid conditions and medication should be addressed in future empirical studies and reviews.

It is further notable that some participants are under-represented in this review. Eight papers reported sufficient data to calculate overall participant race or ethnicity, revealing a majority of white participants. This under-reporting is reflected in the wider literature, where a recent meta-analysis revealed that over 25% of randomised clinical trials for ADHD medication did not report data on race/ethnicity (Riccioni et al., 2024). There was also inadequate reporting of socio-economic status, with only eight papers having data on this domain. These issues may reflect under-representation and selection bias in the research and likely are influenced by geographical region of the included studies. Given this, future empirical studies examining social problems in children and adolescents with ADHD should be inclusive of race, ethnicity and socio-economic status.

Conclusion

Overall, this review found limited and inconsistent evidence for significant differences in overall social problems across gender or sex in children with ADHD. Yet there is some evidence that boys experience more physical victimisation and physical bully perpetration than girls and that girls with ADHD-IN may experience more social problems than boys with ADHD-IN. Future research should focus on intersecting factors that could impact on outcomes, including age and medication.

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Chapter 2

The role of social skills and perception in the association between neurodevelopmental symptom severity and social problems in children and adolescents

Prepared in accordance with university guidelines and the author requirements for Research in Neurodiversity[3]; https://www.sciencedirect.com/journal/research-in-neurodiversity/publish/guide-for-authors

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[3] University of Glasgow guidelines preceded author requirements for the purpose of thesis submission

Plain language summary

The role of social skills and perception in the association between neurodevelopmental symptom severity and social problems in children and adolescents

Neurodevelopmental symptoms include difficulties with attention, hyperactivity, behaviour and social communication. Children with neurodevelopmental conditions are at greater risk of experiencing social problems than their peers. This has been linked to increased mental health difficulties and further social problems throughout life. Research investigating why this occurs suggests that social perception (e.g., difficulties in recognising others' emotions) and social skills are potential factors. However, this has not been examined over time.

This study aimed to investigate:

1. What effects do neurodevelopmental symptoms have on social problems in children over time?
2. Do social perception and social skills have a role in these effects?

This study used information gathered from the Province of Ontario Neurodevelopmental (POND) Network database. Participants are children aged 5-18 attending an ADHD clinic in the Hospital for Sick Children, Toronto. All patients were given the opportunity to take part in research on an opt-in basis. Information on the participant demographics, social problems, neurodevelopmental symptoms, social perception, and social skills were gathered through assessments and questionnaires from the children and their caregivers across two time points (T1 and T2). This information was shared with the trainee and research supervisor in January 2026 for the purpose of this study.

Information from 491 participants (average age 10.59 years, 62.63% male) was gathered from T1. Information for 68 participants was gathered at T2. Data analysis found that neurodevelopmental symptoms were associated with poorer social skills and social problems at T1. Only difficulties with behaviour and poorer social skills were found to predict social problems at T2. Poor emotion recognition was associated with higher difficulties with attention/hyperactivity and social communication difficulties. Only social skills were found to link the effect between neurodevelopmental symptoms and social problems at T1 and T2.

More severe neurodevelopmental symptoms were linked with greater social problems in children and adolescents. Poor social skills, but not emotion recognition, partly explains this relationship. Results from this study could be used to support children with neurodevelopmental symptoms and social problems, with overall aims of reducing mental health difficulties in this population. The results from this paper could also inspire future research.

Abstract

Children with neurodevelopmental conditions, such as ADHD and autism, are more likely to experience social problems than their peers. This study aimed to examine the cross-sectional and longitudinal effects of neurodevelopmental symptom severity on social problems, and the mediating effects of social skills and social perception (such as affect recognition) on this association, in a clinical sample of children and adolescents. Data from a clinic-attending sample of 5 –18-year-olds from the Province of Ontario Neurodevelopmental (POND) Network database were used. Data on neurodevelopmental symptoms (ADHD, social communication and repetitive behaviours), social skills and affect recognition were collected. Social problems were measured across two timepoints. Data from 491 participants (mean age 10.59 years (SD = 3.08); 62.53% male) at baseline (T1) were used. Of those, 68 participants had available data at follow-up (T2). Analysis using both cross-sectional and longitudinal outcome data included correlations, multiple regression and regression-based mediation models using PROCESS with boot-strapped methods. Positive associations were observed between neurodevelopmental symptoms and social skills with social problems at T1. Only repetitive behaviour symptoms and social skills were associated with and uniquely predicted social problems at T2. Poor affect recognition was associated with higher ADHD symptoms and social communication difficulties but not with repetitive behaviour or social problems. Only social skills significantly mediated the effect between all three neurodevelopmental symptom domains and social problems at T1 and T2. Neurodevelopmental symptom severity is associated with the extent of social problems children and adolescents experience. Poor social skills, but not affect recognition, in part explains the association between neurodevelopmental symptom severity and social problems. Findings could be used to inform interventions to support children and adolescents with neurodevelopmental symptoms and conditions who experience peer difficulties.

Keywords: ADHD, autism, neurodevelopmental symptoms, children, adolescents, social problems

Social problems, such as peer victimisation and poor peer relationships, can negatively impact the mental health of children and adolescents. Peer victimisation in childhood has been linked to increased anxiety, depression, sleep difficulties, self-harm, and suicidality (Hong et al., 2019; Christina et al., 2021; Hansson et al., 2020; Katsaras et al., 2018; Husky et al., 2020). Peer relationship difficulties in childhood and adolescence have also been associated with increased depressive symptoms, loneliness, and self-harm (Schwartz-Mette et al., 2020). Longitudinal literature shows that social problems in childhood can have detrimental and long-lasting effects on mental health throughout adolescence and into adulthood, increasing risk for affective psychopathology (Forbes et al., 2019; Armitage et al., 2021; Östberg et al., 2017; Geoffroy et al., 2018). Some children and adolescents are particularly at-risk for experiencing social problems, for example, those with neurodevelopmental symptoms and/or conditions (Libster et al., 2022; Fogleman et al., 2018). In this study we were interested in examining the cross-sectional and longitudinal effects of neurodevelopmental symptom severity on social problems to identify possible underlying vulnerability mechanisms that can inform future interventions.

Children and adolescents with neurodevelopmental symptoms and conditions, such as Attention-Deficit Hyperactivity Disorder (ADHD) or Autism Spectrum Disorder (ASD, hereby referred to as ‘autism’), are at a greater risk of experiencing social problems compared to their typically developing peers (Fogleman et al., 2018; Grygiel et al., 2018; Libster et al., 2022). ADHD is characterised by symptoms of inattention, hyperactivity, and/or impulsivity (ICD-11; World Health Organization, 2022). Autism can be defined by difficulties in making and maintaining social interaction and communication, as well as rigid and repetitive patterns of behaviours, thoughts, and interests (ICD-11; World Health Organization, 2022).

Research in children and adolescents with ADHD demonstrates a high prevalence of peer victimisation and fewer friends (Fogleman et al., 2018; McQuade et al., 2018; Becker et al., 2017; Grygiel et al., 2018), which have been linked to negative affect (Fogleman et al., 2016), a pessimistic view of the social world (Grygiel et a., 2018) and poor educational outcomes (Zendarski et al., 2021). Social problems in children with ADHD are also associated with later mental health difficulties in adolescence and adulthood (Mrug et al., 2012; Ferrigno, 2022). Similarly, children with autism are more likely to experience social problems such as peer victimisation and difficulties making friends than their peers without autism (Libster et al., 2022). Evidence suggests that social problems in turn could increase loneliness, anxiety and depressive symptoms (Ung et al., 2016) and educational problems (Adams et al., 2016) for those children.

Research has further found that the severity of neurodevelopmental symptoms in childhood is associated with social problems in adolescence. For example, children with more caregiver-reported neurodevelopmental symptoms aged 9-12 were more likely to experience peer victimisation in adolescence at age 15 (Törn et al., 2015). The directionality of this effect has only been recently investigated. Two longitudinal studies demonstrated that neurodevelopmental symptoms in childhood predict later peer victimisation (Rizeq et al., 2022) and social isolation (Thompson et al., 2023), with no evidence of bidirectional effects. These effects are yet to be tested in clinical samples to see whether severity of symptoms is associated with the extent of social problems children with neurodevelopmental conditions experience. Given the evidence describing the immediate and long-term impact of social problems in children with neurodevelopmental conditions, it would be therefore beneficial to identify shared factors that could underly this population's vulnerability to experiencing social problems, such as difficulties in social skills and social perception observed across neurodevelopmental conditions (Törn et al., 2015).

In this study, we were interested in the mediating role that social skills and perception have in explaining the increased risk of social problems in children and adolescents with neurodevelopmental conditions. Social perception can be defined as 'the ability to perceive, interpret and respond appropriately to the social world' and encapsulates processes such as affect recognition and theory of mind (Duerden et al., 2025). Social skills and perception are associated with core diagnostic criteria of neurodevelopmental conditions such as ADHD and autism, and understanding potential underlying effects of these domains could inform screening and support for children and young people.

Research shows that difficulties with core social skills such as interacting socially, initiating and maintaining friendships, expressing and recognising emotions and engaging in social activities (Harrison & Oakland, 2015) are linked to neurodevelopmental symptom severity (Tal-Saban et al., 2024). Further, children and adolescents with neurodevelopmental conditions show difficulties with social perception, such as affect recognition. Affect recognition describes the ability to recognise and accurately identify emotional cues displayed by others (Staff et al., 2022). For example, affect recognition was found to be a predictor of social and emotional difficulties in children and adolescents with ADHD (Staff et al., 2022; McKay et al., 2023). Findings are similar with children and adolescents with autism. Specifically, evidence showing that poor affect recognition is associated with increased peer victimization in adolescents with autism (Liu et al., 2019).

Although the literature demonstrates a possible underlying role of social skills and perception in social problems in children and adolescents with neurodevelopmental conditions, the evidence base is still growing. There is also a lack of empirical research directly examining these effects as a function of symptom severity in clinical samples.

Aims and Research Questions

This study aimed to investigate the longitudinal effects of ADHD and autism symptom severity on social problems and the mediating effect of social skills and perception on this association in a clinic attending sample of children and adolescents. The literature highlights an important need to support children and adolescents with neurodevelopmental conditions with social problems, especially due to the negative long-term effects social problems can have on mental health and wellbeing. Examining these effects could identify vulnerability mechanisms in this population and inform future prevention and intervention efforts.

The following research questions were developed from the aims of the study:

1) To what extent is neurodevelopmental symptom severity associated with social problems cross-sectionally and longitudinally in a sample of clinic-attending children and adolescents?

2) Do domains of social skills and perception mediate the association between neurodevelopmental symptom severity and social problems?

Methods

Design, Data Access and Ethics

This study adopts a longitudinal observational design using quantitative data from the Province of Ontario Neurodevelopmental (POND) Network, which is a research network across five Ontario universities and hospitals (Queen's University, McMaster University and the Offord Centre, the Lawson Health Research Institute, Holland Bloorview Kids Rehabilitation Hospital and the Hospital for Sick Children). The dataset accessed and used in this study was gathered from the Hospital for Sick Children only, due to data availability at the time of analysis. This study and its aims are covered within the existing ethical approval as part of a wider research project, granted by the Research Ethics Board at the Hospital for Sick Children, Toronto (REB number: 1000000346). Access to the final dataset used for current study was granted in January 2026. Data is stored securely on the University of Glasgow's OneDrive system and managed in accordance with university policy. Full details on the research proposal and project approval can be found in appendices H and I, respectively.

Participants and Procedure

Participants are school-aged children (5-18 years old) who were recruited through a specialist ADHD outpatient psychiatry clinic at the Hospital for Sick Children, Toronto, Canada. Those children attended the clinic for primary assessment and/or treatment of ADHD and other possible psychiatric comorbidities. Assessment and treatment at the Hospital for Sick Children is publicly available. Interpreters were available if required. All patients and families at POND clinics were provided information about the opportunity to take part in research. Informed consent was obtained from patients and families who were interested in taking part. Families were reimbursed for taking part in the research: $10 plus a toy or educational community service hours for questionnaire completion, and $15 or a parking voucher for a full research day. Demographic baseline (T1) data was collected from in-person clinical assessments. Follow-up (T2) social problem data was then gathered online.

In this study, data was available for 491 participants at T1 (mean age 10.59 years (SD = 3.08); 62.53% male) and 68 participants at T2 (mean age 9.6 years, SD= 2.51; 70.59% male). T1 assessments were conducted between June 2012 and September 2025. Follow up social problem data collection ranged between one year and four months to ten years and four months. The average time elapsed between T1 and T2 was four years and three months. Most participants had a primary diagnosis of ADHD (53.56%). Caregiver reported demographics at T1 are summarised in Table 1.

Table 1

A table showing a summary of demographic data for the sample at T1.

Variable		n (%)
Total sample size		491
Mean age (SD)		10.59 (3.08)
Sex	Female	181 (36.86%)
	Male	307 (62.53%)
	Missing or not reported	3 (0.61%)
Gender	Female	89 (18.13%)
	Male	136 (27.70%)
	Gender diverse	3 (0.61%)
	Missing or not reported	263(53.56%)
Ethnicity	White	31 (6.30%)
	Black	2 (0.41%)
	East Asian	2 (0.41%)
	Mixed	26 (5.30%)
	Missing or not reported	430 (87.58%)
Household Income	<$10,000	2 (0.41%)
	$10,000-$24,999	10 (2.04%)
	$25,000 to $49,999	13 (2.65%)
	$50,000 to $74,999	17 (3.46%)
	$75,000 to $99,999	27 (5.50%)
	$100,000 to $149,999	54 (11.00%)

	\$150,000 to \$199,999	44 (8.96%)
	>\$200,000	50 (10.18%)
	Missing or not reported	274 (55.80%)
Primary Diagnosis	No diagnosis	3 (0.61%)
	ADHD	263 (53.56%)
	ADHD traits	56 (11.41%)
	OCD	38 (7.74%)
	Tics (Chronic Vocal or Motor Tics)	9 (1.83%)
	Tourette's Syndrome	14 (2.85%)
	Autism	15 (3.06%)
	MID	1 (0.20%)
	Anxiety	7 (1.43%)
	Missing or not reported	85 (17.31%)

Note: OCD (Obsessive Compulsive Disorder), MID (Mild Intellectual Disability).

Measures

Social problems

The social problems subscale of the 'Child Behavior Checklist' was used (CBCL-SP/6-18; Achenbach & Rescorla, 2001). The CBCL is a 113-item caregiver questionnaire using a 3-point Likert scale to measure child behaviour (0 = absent, 1 = occurs sometimes, 2 = occurs often). The CBCL has high criterion validity, internal consistency, and test-retest reliability (Achenbach & Rescorla, 2001). The CBCL-SP contains 11 items. Higher total scores in this subscale indicate more social problems. *T*-scores, based on normative data of the CBCL-SP, indicate clinical levels of symptoms (non-clinical <= 59, borderline clinical 60-64, clinical >= 65). Social problems subscale *t*-scores were obtained for participants at T1 and T2.

ADHD symptoms

The 'Strengths and Weakness of Attention-Deficit/Hyperactivity Disorder Symptom and Normal Behavior Scale' was used (SWAN; Swanson et al., 2012). Caregiver-reported versions are used to report on ADHD symptoms using 18 items with a 7-point Likert-type scale, ranging from –3 "far above average" and +3 "far below average”. Caregivers are asked to report on how their child is compared to same aged peers. Items 1-9 are associated with inattentive symptoms and items 10-18 are associated to hyperactive-impulsive symptoms, with a total ADHD symptom score across all items. Total scores of >= 7 indicate clinical levels of symptoms. Higher reversed total scores are associated with higher ADHD symptoms. A systematic review found the SWAN to have good reliability and validity when compared to other measures of ADHD (Brites et al., 2015).

Autism symptoms

The ‘Social Communication Questionnaire’ (SCQ, Rutter et al., 2003) and the revised ‘Repetitive Behavior Scale’ (RBS-R, Bodfish, 1999) were used to assess the main domains of autism symptomatology through caregiver reports. The SCQ measures lifetime and current social communication with 40 “yes or no” questions (0=no, 1=yes). Total scores of >= 15 suggest clinical levels of autism. A meta-analysis found that the SCQ is a reliable and valid screener for autism in children aged over 4 years old (Chesnut et al., 2017). The RBS-R gathers data on restricted and repetitive behaviours (RRBs) on a 44-item measure with a 4-point Likert scale, (0=behaviour does not occur, 1=behaviour occurs and is a mild problem, 2=behaviour occurs and is a moderate problem, 3=behaviour occurs and is a severe problem). The RBS-R has high internal consistency and good inter-rater reliability (Strum et al., 2022). Higher total scores on each scale indicates higher behavioural difficulties and social communication difficulties, respectively.

Neurodevelopmental symptoms

‘Neurodevelopmental symptoms’ will be used to collectively describe the three domains tested in this study – ADHD symptoms, social communication difficulties and RRBs.

Social skills

Social skills were assessed using the caregiver-reported social domain of the Adaptive Behaviour Assessment (ABAS-2, Harrison & Oakland, 2008). The ABAS-2 assesses ten skill areas within three adaptive domains, conceptual, social, and practical, showing strong reliability, validity, and sensitivity (Harrison & Oakland, 2008). The social domain (ABAS-S) consists of two skill areas, social and leisure. This scale assesses children’s skills in in social interactions and communication and in their use of leisure time. Caregivers rate statements on a 3-point scale (1 = “Never” and 3 = “Always”) to indicate the frequency of their child’s behaviours. They can give a score of 0 if the child is not able and can check a box to indicate if they have guessed their answer or not. Lower scores in this domain indicate a lower level of adaptive social ability. Social domain composite scores based on normative data are calculated, allowing for comparison against same-age peers. Composite scores have a mean of 100 and a standard deviation of 15, ranging from ‘extremely low’ (<69) to ‘high’ (>130).

Social perception

Social perception was assessed using the affect recognition subtest of the NEPSY-II (‘developmental neuropsychological assessment;’ (Korkman et al., 2007). The NEPSY-II is a battery of tests conducted by clinicians, used to measure neuropsychological development in children aged 3-16. The NEPSY-II shows good inter-rater reliability, test-retest reliability, and validity (Brooks et al., 2009). The NEPSY-II assesses six functional domains, including attention and executive functioning, language, memory and learning, sensorimotor, visuospatial processing, and social perception. The social perception domain consists of affect recognition and theory of mind (ToM) subtests[4]. The affect recognition subtest is designed to determine a child's ability to accurately identify emotions using four different tasks using photographs depicting a range of emotions. Scaled scores based normative data were used for the affect recognition scale, with higher scores indicating better abilities. Scaled scores range from 1-19, with a mean of 10 and standard deviation of 3.

Analysis Plan

All analyses were run cross-sectionally with available T1 data and longitudinally with available follow up data on the outcome, social problems.

RStudio (R version 4.5.2) was used to clean the data and conduct the analysis. First, descriptive statistics for all variables were generated and histograms and scatterplots were used to visualize univariate distributions and associations, respectively. Bivariate correlations among all variables including outcome at T1 and T2 were also calculated. Independent *t*-tests were conducted to determine any differences on T1 measures between groups of participants who have follow up data from those who do not. To address the first research question correlations and multiple regression were used. Multiple regression models were used to estimate unique effects of symptoms of ADHD and autism on social problems at T1 and T2. To address the second research question, separate mediation models were run using PROCESS with boot-strapped methods (Hayes, 2017) to test the mediating, or 'indirect', effect of social skills and perception on the association between symptoms of ADHD and autism and

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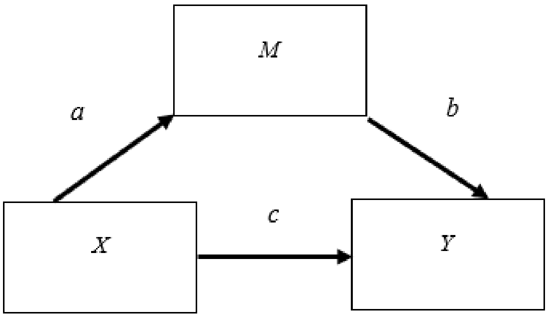
[4] We had originally planned to also include ToM, but due to data availability this scale was not consistently scored and thus we were unable to use it in our analysis

social problems at T1 and at T2, as outlined in Figure 1. Six separate models were estimated for the three neurodevelopmental domains (ADHD symptoms, social communication and RRBs) and two mediators (performance-based affect recognition and caregiver-rated social skills). Those models were run with T1 and T2 social problems.

Figure 1

An example of the mediation models used in this study



Note: X = independent variable, Y = outcome variable, M = mediator, a = X-M path, b = M-Y path, c = X-Y path or 'direct effect'

Sample Size/Power

A paper by Fritz & McKinnon (Fritz & Mackinnon, 2007) provides estimates of the required sample size to produce a power of 0.8 for various tests of mediation and possible effect sizes. Previous literature with similar analysis protocols suggests that medium to high effect sizes for the *a* and *b* paths in a mediation model could be observed (Rizeq et al., 2022). Based on the estimates for bias-corrected bootstrapping for medium and high a and b paths, this study required a sample size between 71-115 for 0.8 power. As the sample size with follow up data (*n* = 68) is just below the lower recommended sample size, the models were run cross-sectionally and longitudinally.

Results

Descriptive statistics and bivariate correlations

Descriptive statistics for all variables can be found in Table 2. Mean social problems *t*-scores at T1 are in the ‘borderline clinical’ range, whereas T2 social problems *t*-scores are in the ‘normal’ range (Achenbach & Rescorla, 2001). Mean ADHD severity scores are elevated, whereas mean social communication difficulties and mean RRBs scores are low. Mean affect recognition scaled scores show that the sample are at the expected level compared to same-age peers, whereas mean social skills composite scores are within the ‘extremely low’ range.

To account for incomplete datasets at T2, Welch two-sample *t*-tests were conducted to examine any differences on variables at T1 between the group that completed T2 and group that did not (only has T1 data). Significant group differences were observed for mean social communication difficulties (t (118.5) = 2.18, p <.05) and mean RRBs (t (133.09) = 2.12, p<.05), where scores were significantly higher in the group with only T1 data than the group that had follow up data as well. This means that those with more severe autism symptoms at T1 did not have T2 data. All other *t*-tests revealed no significant differences between groups. Full details of conducted *t*-tests can be found in Appendix J.

Table 2

A table showing n, mean scores and standard deviations for each variable.

Variable	*n*	mean	*SD*
Social problems *t*-scores T1	474	60.01	8.82
Social problems *t*-scores T2	68	57.18	6.57
ADHD symptoms	410	21.18	17.42
Social communication symptoms	412	6.58	5.39

RRBs	401	15.15	14.61
Affect recognition scaled score	233	10.15	2.71
Social skills composite score	279	53.62	9.02

Note: all variables (excluding social problems) were recorded at T1 only.

Bivariate correlations among variables are presented in Table 3. Social problems *t*-scores at T1 and T2 were significantly and positively correlated. Social problems *t*-score at T1 was significantly and positively correlated with neurodevelopmental symptoms domains, with a weak association with ADHD symptom severity, and moderate associations with social communication symptoms and RRBs total scores. Only RRBs were positively and significantly correlated with social problems *t*-scores at T2, with a moderate association. ADHD symptom severity had a small significant and positive association with social communication symptoms, whereas ADHD and RRBs symptoms were not correlated. Social communication and RRBs symptoms had a strong positive correlation.

Affect recognition scaled scores were negatively and significantly correlated with ADHD and social communication symptoms. On the other hand, affect recognition scaled scores were not associated RRBs symptoms, social skills or social problems *t*-scores at T1 and T2.

Social skills composite scores were significantly and negatively correlated with all neurodevelopmental symptoms and social problems at T1 and T2, with weak to moderate associations.

Table 3

Correlation matrix for test variables.

Variable	1	2	3	4	5	6	7
1) Social problems *t*-score T1	1.00						

2) Social problems *t*-score T2	.49**	1.00					
3) ADHD symptoms	.27***	.21	1.00				
4) Social communication symptoms	.38***	.18	.18***	1.00			
5) RRBs	.44***	.34**	.06	.53***	1.00		
6) Affect recognition scaled score	-.05	-.02	-.12***	-.18***	-.10	1.00	
7) Social skills composite score	-.34***	-.42***	-.23***	-.35***	-.28***	.11	1.00

Note: p-values are represented in the table as follows: *<.05, ** <.01, ***<.001

Multiple regression

Model 1

A multiple regression analysis was conducted, regressing T1 social problems *t*-scores on symptoms of ADHD, social communication and RRBs. The overall model fit was statistically significant, explaining 28% of the variance in the outcome [adjusted R^2 = 28.02, F (3, 371) = 49.54, p<.001). All three neurodevelopmental symptom domains were significant unique correlates of T1 social problems *t*-scores, as shown in Table 4.

Table 4

A table showing multiple regression values for T1 data.

Variable	*B*	β	*SE*	*p*
ADHD symptoms	.11	.22	.02	<.001
Social communication symptoms	.31	.19	.08	<.001
RRBs	.19	.33	.03	<.001

Model 2

A multiple regression analysis was conducted regressing T2 social problems *t*-scores on symptoms of ADHD, social communication and RRBs. First, a paired *t*-test examining differences in social problems between T1 and T2 was conducted to determine whether to control for T1 scores in the model. The test was not significant $t(64) = 1.21$, $p = .23$, therefore T1 social problems scores were not controlled for in the following multiple regression model.

The overall model fit was statistically significant, explaining approximately 10% of the variance [adjusted $R^2 = 10.38$, $F(3, 61) = 3.47$, $p<.05$). Only RRBs significantly uniquely predicted T2 social problems *t*-scores, as shown in Table 5.

Table 5

A table showing multiple regression values for T2.

Variable	*B*	β	*SE*	*p*
ADHD symptom severity	.08	.17	.06	.19
Social communication difficulties	-.01	-.01	.22	.95
RRBs	.18	.31	.08	<.05

Mediation Analysis

Regression-based mediation analysis using PROCESS with boot-strapped methods (Model 4; Hayes 2017) was used to test the mediating effect of social perception and social skills on the association between neurodevelopmental symptoms and social problems.

Due to missing data/incomplete datasets, some participants were excluded from mediation analysis. Total samples for each mediator at each time point are outlined in Table 6.

Six models were run with social problems as the outcome at T1 and six models were run with social problems as the outcome at T2. Twelve models were conducted in total, as demonstrated in Figures 1 and 2.

Table 6

A table showing n for each mediator at T1 and T2

Variable	T1	T2
Affect recognition	*n*=205	*n*=44
Social skills	*n*=282	*n*=59

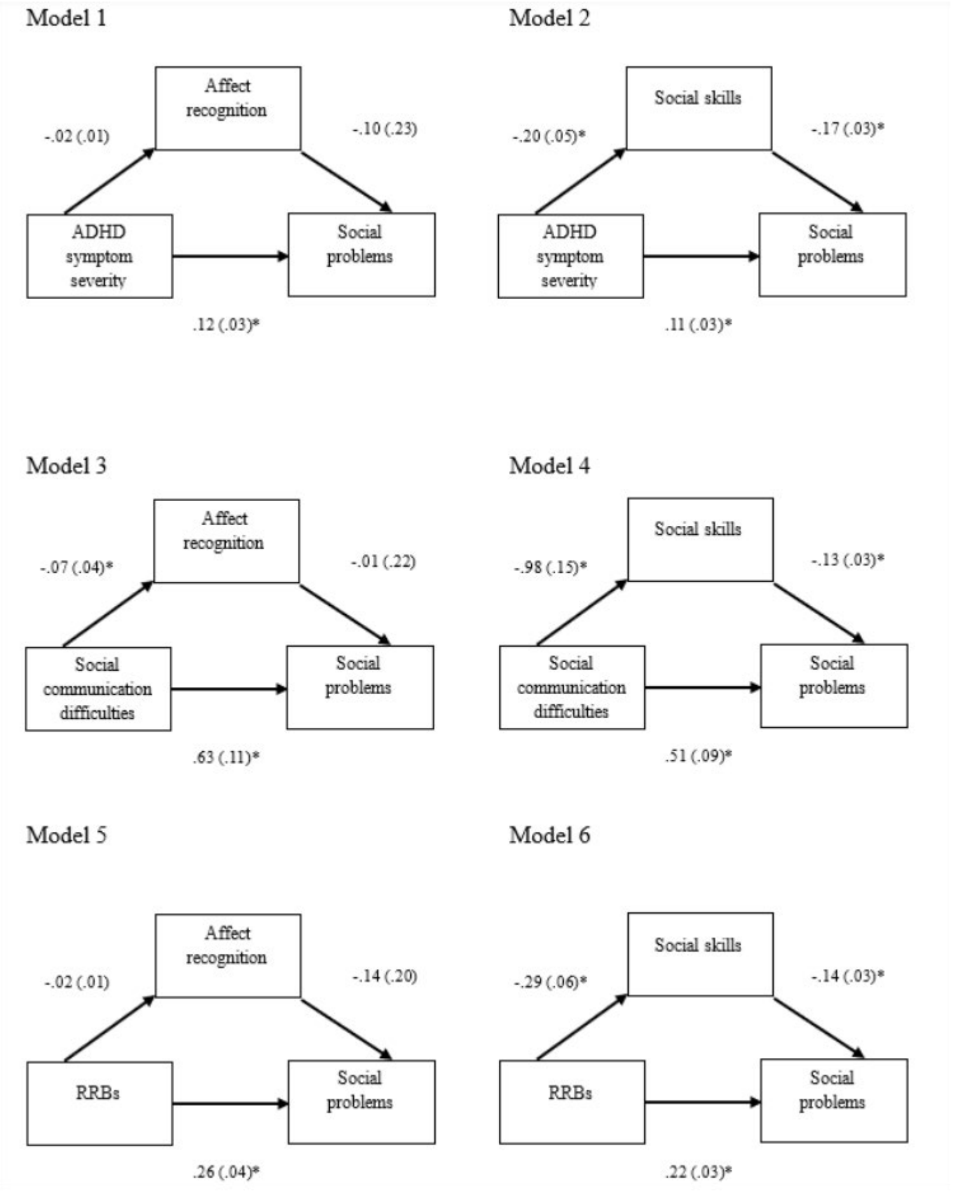
Note: affect recognition = *M* in models 1, 3, 5, 7, 9, 11. Social skills = *M* in remaining models. See Figures 2 and 3 for further details on each model.

T1 Models

Six models were conducted at T1. Figure 2 shows these models and the direct paths tested. All six models had significant total and direct effects from predictor to outcome as shown in Figure 2. Only models with social skills as a mediator were found to have significant indirect effects on T1 social problems scores, with small effects overall. Indirect paths are shown in Table 7.

Figure 2

T1 mediation models



Note: values are denoted as coefficient (standard error). A '*' marks values with significant confidence intervals. All effects in models are boot-strapped.

Table 7

A table showing indirect effects for mediation models at T1.

Indirect path	Standardised indirect bootstrapped effect	*SE*	*CI*
Model 1	.00	.01	(-.01), .02
Model 2	.07	.02	.03, .11*
Model 3	.00	.01	(-.02), .02

Model 4	.08	.03	.03, .14*
Model 5	.00	.01	(-.01), .02
Model 6	.07	.02	.03, .11*

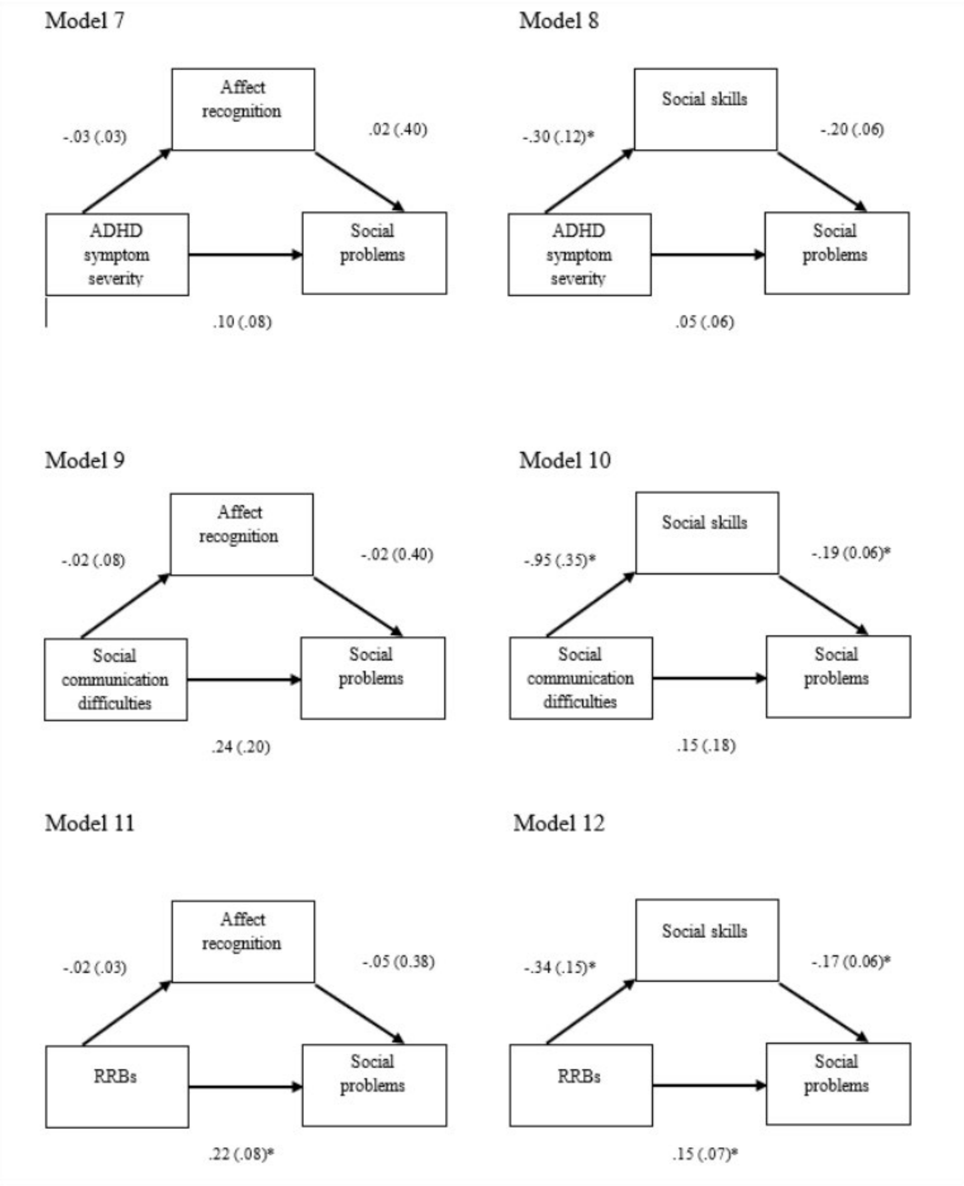
Note: CI that indicate a significant mediation are marked with ‘*’

T2 Models

Six models were conducted with social problems at T2. Figure 3 shows these models and the direct paths tested. Unlike the cross-sectional models, only two models had significant total and direct effects (models 11 and 12). Only models with social skills as a mediator were found to have significant indirect effects on T2 social problems scores. All indirect effects are reported in Table 8.

Figure 3

T2 mediation models



Note: values are denoted as coefficient (standard error). A '*' marks values with significant confidence intervals. All effects in models are boot-strapped.

Table 8

A table showing indirect effects for mediation models at T2.

Indirect path	Standardised indirect bootstrapped effect	*SE*	*CI*
Model 7	-.00	.04	(-.09), .07

Model 8	.12	.06	.02, .26*
Model 9	.00	.02	(-.04), .04
Model 10	.13	.06	.02, .27*
Model 11	-.01	.03	-.07, .05
Model 12	.10	.05	.02, .22*

Note: CI that indicate a significant mediation are marked with ‘*’

Discussion

This study examined both cross-sectional and longitudinal effects of neurodevelopmental symptoms on social problems, and how domains of social skills and social perception mediate this association in a clinical sample of children and adolescents. ADHD and autism symptoms were uniquely associated with higher social problems cross-sectionally, but only RRBs predicted social problems longitudinally. Affect recognition was not associated with social problems, whereas adaptive social skills provided partial mediation between neurodevelopmental symptoms and social problems at T1 and T2.

Findings from this study add to the literature investigating effects of neurodevelopmental symptoms on social problems in children. Results support previous findings that children with ADHD and/or autism and those with neurodevelopmental symptoms are at greater risk of experiencing social problems (Libster et al., 2022; Fogleman et al., 2018, Marsus et al., 2022). These social problems have important repercussions as they have been linked to poorer mental health and educational outcomes in this population (Ung et al., 2016; Adams et al., 2016; Fogleman et al., 2016; Zendarski et al., 2021; Marsus et al., 2022). Examining this in a sample of clinic-attending children allowed us to investigate symptom severity, with results suggesting that symptoms of ADHD and autism are positively associated with social problems. Therefore, these results can be used to promote earlier identification of social problems in children and adolescents with more severe symptoms and highlight the importance of early intervention to support positive social functioning in this population.

Although all symptom domains presented with unique cross-sectional associations with social problems, only RRBs uniquely predicted social problems at T2. This is interesting, particularly as previous research has suggested that in a sample of 6–10-year-old children with and without ADHD, baseline ADHD symptoms predicted social problems at two-year follow-up based on separate parent and teacher reports (Humphreys et al., 2016). However, the current sample was based on clinic-attending children and adolescents only, which could explain weaker effects due to restricted symptom variation as opposed to studies with both clinical and non-clinical samples. In addition, the bivariate associations between ADHD symptoms and social problems at T1 and T2 are in the expected direction, although small in effect size overall. It is possible that with a small sample at follow up, the study is not well powered to detect smaller effects.

Nonetheless, the unique effect of autism symptoms on social problems in this sample, supports previous findings that observed longitudinal effects of childhood autism symptoms, but not ADHD symptoms, on later peer victimisation (Rizeq et al., 2022). Rizeq and colleagues argue that ADHD and autism symptoms may have distinctive roles in this effect, with impact of ADHD symptoms on peer victimisation being more apparent in early school years, compared to autism symptoms which were found to have more impact in middle childhood. They suggest this may be due to children with ADHD being more likely to be prescribed medication in middle childhood and adolescence (Danielson et al., 2018), which could limit longitudinal effects of ADHD symptoms on social problems in the current study. The longitudinal effect of RRBs on social problems may be explained further when one considers the effect of comorbid RRBs and anxiety on social functioning at school in young people with autism (Russell et al., 2019). Longitudinal effects of RRBs on social problems, and the possible additive or interactive effect of internalising difficulties, should therefore be explored further.

When investigating possible underlying factors, including deficits in social skills and perception that create risk for social problems in this population, as expected this study found that neurodevelopmental symptoms were associated with poorer affect recognition and deficits in adaptive social skills. Although previous research found that deficits in affect recognition were associated with increased peer victimisation in children with autism (Liu et al., 2019) and were a predictor of social difficulties in children and adolescents with ADHD (Staff et al., 2022; McKay et al., 2023), affect recognition in this study was not associated with social problems at T1 or T2. When examining these contrasting effects, it is of note that two of the previous studies (Liu et al., 2019; Staff et al., 2022) used modified versions of facial recognition tasks derived from other studies, which are distinct from the affect recognition scale of the NEPSY-AR used in this study. In addition to this, results from the current study show that the sample's mean score was within the average range for affect recognition. The absence of clear deficits in affect recognition in our clinical sample could explain the lack of association with social problems for the current sample. It is possible that the affect recognition scale was not sensitive to social perception difficulties.

Affect recognition, as measured by NEPSY-II, has been critiqued for construct validity and inability to test 'pure' affect recognition without influence of external factors in general populations of children (Singh et al., 2025). Additionally, researchers have argued that the NEPSY-II may be better at capturing impairments in children with specific neurological disorders rather than neurodevelopmental disorders (Singh et al., 2025). These limitations may impact on our ability to detect impairments in social perception and its associations with relevant outcomes. Alternatively, it is possible that other domains of social perception have stronger impact on social outcomes and problems, such as theory of mind (ToM). ToM describes one's ability to conceptualise others' mental states, such as their thoughts and beliefs (Kafali et al., 2021). Poor ToM has been associated with increased peer victimisation and bully perpetration in children with ADHD (Kafali et al., 2021) and increased social problems in children with autism (Mazza et al., 2017). Therefore, future work may investigate multiple aspects of social perception to determine the domains most relevant in social problems.

On the other hand, deficits in adaptive social skills significantly mediated the association between neurodevelopmental symptoms and social problems at both T1 and T2. These findings advance previous research that links poorer social skills with higher ADHD symptoms (Tal-Saban et al., 2024; Feldman et al., 2016) and autistic traits (Mylett et al., 2024). Further, cross-sectional evidence shows that social skills impairments mediate the association between ADHD and depression (Feldman et al., 2016) and between autism and anxiety and depression (Mylett et al., 2024). This study builds on this literature and shows the mediating effect of social skills on the association between neurodevelopmental symptom severity and social problems, both cross-sectionally and longitudinally. This work further highlights how impairments in social skills increases the risk of negative outcomes in children and adolescents with neurodevelopmental conditions.

There are several important considerations and caveats when interpreting these findings. The social skills domain of the ABAS-2 allows for a natural assessment of a child's social skills based on caregiver report across multiple environments; it is a broad construct consisting of various elements which means it is not possible to determine what specific aspect of social skills could be driving the mediating effect without further investigation. Given this, it could be that one or more specific domains of social skills are driving this effect. Next, it is important to consider recent research that suggests that social domains of the CBCL and ABAS measure an equivalent construct of ‘social behaviour’ and argues that these measures can be used interchangeably (Simmons et al., 2024). However, these results are based on the social domain of the most recent version of the ABAS (ABAS-3) in a sample of autistic adolescents only and therefore may not be generalisable to the ABAS-2 or other neurodevelopmental profiles. Furthermore, the current study suggests that the CBCL and ABAS-2 are moderately correlated, meaning that although the measures are related, the strength of the association does not indicate that they are measuring the same construct. On this, the same could be said for the significant moderate negative correlation between the SCQ and the social skills domain of ABAS-2, as the SCQ is used to screen for social communication difficulties indicative of autism, whereas the social skills domain of the ABAS-2 is a tool to assess general adaptive social functioning.

Finally, it is important to consider that caregivers may be over-rating their child’s difficulties in the current sample, particularly given the stark difference in ability ranges observed between caregiver-reported adaptive social skills (‘extremely low-range') and performance-based affect recognition (‘average range’). Previous findings suggest weak to moderate agreement across informants in research assessing child mental health and social functioning (De Los Reyes et al., 2015; Gresham et al., 2010), which again could account for some of the variation in findings across measures.

Strengths and limitations

This study adds to the literature examining social problems in children and adolescents with neurodevelopmental conditions and attempts to address a gap in the literature by investigating possible underlying mechanisms of this effect through mediation analysis. This study accessed data from clinic-attending children and adolescents with ADHD concerns and/or diagnoses as their primary presenting difficulty. Although this is a strength of the study in terms of access to clinical samples and representation of children and adolescents with severe neurodevelopmental symptoms, this may also restrict variation in symptom levels and thus limit the effects or associations with outcomes. It would be expected to find larger differences or effects when comparing clinical to non-clinical samples for instance.

Further, the study utilised a longitudinal research design allowing for the associations to be analysed over time. This study also used information gathered from multiple informants, including a standardised performance-based test assessed by clinicians, and caregiver-report questionnaires with normative data that allows for age and sex corrected scores.

Despite the strengths of the study, it is important to note its limitations. Firstly, it is important to highlight that due to limited access to POND sites/clinics, T2 data did not reach the minimum sample size needed to achieve acceptable power for the mediation analysis. Nonetheless, bootstrapping methods are preferred with smaller samples. Furthermore, indirect effects from models run with T1 data only were consistent with those with T2 data, increasing our confidence in the findings. Future research should endeavour to explore this further in a statistically powered sample to draw more reliable conclusions.

Next, there may be selection-bias in the sample, which calls into question the generalisability of results. Although assessment and treatment at the Hospital for Sick Children is publicly available, the barriers in accessing this service (such as travel costs, caregivers being able to take time off work to attend appointments) is not accounted for. This may be reflected in the sample demographics, where most of the caregivers were highly educated and had high household incomes. Furthermore, the pitfalls of convenience sampling should be taken into account, especially when one considers that the sample was recruited from a population of families seeking support for their child. This is particularly important to keep in mind, when we consider the difference between caregiver-reported social skills and clinically assessed affect recognition.

It is important to further highlight that the study aimed to assess effects of ADHD and autism on social problems, however most of the sample had primary diagnoses of ADHD due to issues with access to wider data from other clinics. Therefore, results may not be representative of broader neurodevelopmental profiles, for example autism only or comorbid ADHD and autism. Comorbid diagnoses were not considered in the current study, even though we know children with ADHD are likely to have at least one psychiatric co-morbidity (Reale et a., 2017); with a high prevalence of dual diagnoses of ADHD and autism (Bougeard et al., 2021). When compared with children with ADHD-only, children with ADHD and comorbid autism are significantly more likely to experience social problems (Gudjonsdottier et al., 2024). Therefore, differences in outcomes across groups of children with comorbid diagnoses should be investigated further.

Finally, this study does not control for medication use, which may be a possible confounding variable, especially as there is emerging research that suggests that stimulant medication can improve social skills and functioning in children with ADHD (Levi-Shachar et al., 2020).

Clinical implications and future directions

Results from this study could be used to inform interventions for children and adolescents with neurodevelopmental conditions who experience peer difficulties, particularly those with symptoms of autism, with an overall aim to prevent and support mental health and wellbeing of this group. This could include social skills training, behavioural interventions, peer support groups and caregiver resources for mental health teams and schools. Recent meta-analyses suggest that there is some evidence that social skills training and behavioural interventions can support children with autism and ADHD (Alahmari et al., 2025; Darling et al., 2021). Furthermore, there is some emerging evidence to suggest that education and training for teachers can improve teachers' knowledge of ADHD and autism (Ward et al., 2022; Petersson-Bloom et al., 2023) and may support the move towards inclusive education and early identification of neurodevelopmental conditions.

This study could also inform future research, such as similar studies with other mediators relevant to social perception over time. This would include analysing ToM as well as other processes involved in social perception and social cognition, like executive function. Previous research has observed executive function to mediate effects of social problems in children with ADHD (Bullard et al., 2024) and predict social competence in children with autism (Fong & Iarocci, 2020), therefore it would be interesting to examine this longitudinally.

In addition, other neurodevelopmental profiles could be included in future research, as this study, and the wider literature, tends to focus on ADHD and autism. Examining other neurodevelopmental profiles is important, as we know that there are high instances of comorbidities in neurodiverse populations (Reale et al., 2017). Outcome measures that capture symptoms associated with Foetal Alcohol Spectrum Disorder (FASD), Speech and Language Disorders, Intellectual Disabilities, Developmental Coordination Disorder (DCD), Tic Disorders and Tourette’s Syndrome could be prioritised in future work.

Future research could also examine longitudinal effects into later adolescence and adulthood, which could further add to the literature attempting to understand mechanisms involved in social functioning and outcomes across the lifetime.

Conclusion

This study attempted to understand the role of symptom severity and underlying social mechanisms in the high rates of social problems experienced by children and adolescents with neurodevelopmental conditions. Results support the wider literature that suggest positive associations between symptoms of ADHD and autism and social problems, with support for longitudinal associations between autism symptoms and social problems. Importantly, social skills deficits mediated the association between neurodevelopmental symptom severity and social problems at T1 and T2. In neurodivergent populations, certain symptom profiles may be indicative of more severe social problems, such as in the case of autism symptoms which can help early identification and intervention planning. Further, adaptive social skills may be a promising target for intervention and further examination to better understand which aspects of social skills lead to social problems later in life.

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Appendices

Appendix A

PRISMA checklists

Section and Topic	Item #	Checklist item	Location where item is reported
TITLE			
Title	1	Identify the report as a systematic review.	Page 8
ABSTRACT			
Abstract	2	See the PRISMA 2020 for Abstracts checklist.	Page 97
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of existing knowledge.	Pages 10-12
Objectives	4	Provide an explicit statement of the objective(s) or question(s) the review addresses.	Page 13
METHODS			
Eligibility criteria	5	Specify the inclusion and exclusion criteria for the review and how studies were grouped for the syntheses.	Page 14
Information sources	6	Specify all databases, registers, websites, organisations, reference lists and other sources searched or consulted to identify studies. Specify the date when each source was last searched or consulted.	Page 15
Search strategy	7	Present the full search strategies for all databases, registers and websites, including any filters and limits used.	Appendix B
Selection process	8	Specify the methods used to decide whether a study met the inclusion criteria of the review, including how many reviewers screened each record and each report retrieved, whether they worked independently, and if applicable, details of automation tools used in the process.	Pages 15-16
Data collection process	9	Specify the methods used to collect data from reports, including how many reviewers collected data from each report, whether they worked independently, any processes for obtaining or confirming data from study investigators, and if applicable, details of automation tools used in the process.	Pages 15-16
Data items	10a	List and define all outcomes for which data were sought. Specify whether all results that were compatible with each outcome domain in each study were sought (e.g. for all measures, time points, analyses), and if not, the methods used to decide which results to collect.	Pages 15-16
	10b	List and define all other variables for which data were sought (e.g. participant and intervention characteristics, funding sources). Describe any assumptions made about any missing or unclear information.	Pages 15-16

Study risk of bias assessment	11	Specify the methods used to assess risk of bias in the included studies, including details of the tool(s) used, how many reviewers assessed each study and whether they worked independently, and if applicable, details of automation tools used in the process.	Page 16
Effect measures	12	Specify for each outcome the effect measure(s) (e.g. risk ratio, mean difference) used in the synthesis or presentation of results.	Page 17
Synthesis methods	13a	Describe the processes used to decide which studies were eligible for each synthesis (e.g. tabulating the study intervention characteristics and comparing against the planned groups for each synthesis (item #5)).	Pages 16-17
	13b	Describe any methods required to prepare the data for presentation or synthesis, such as handling of missing summary statistics, or data conversions.	Page 17
	13c	Describe any methods used to tabulate or visually display results of individual studies and syntheses.	Pages 18, 20, 23-25
	13d	Describe any methods used to synthesize results and provide a rationale for the choice(s). If meta-analysis was performed, describe the model(s), method(s) to identify the presence and extent of statistical heterogeneity, and software package(s) used.	Pages 16-17
	13e	Describe any methods used to explore possible causes of heterogeneity among study results (e.g. subgroup analysis, meta-regression).	n/a
	13f	Describe any sensitivity analyses conducted to assess robustness of the synthesized results.	n/a
Reporting bias assessment	14	Describe any methods used to assess risk of bias due to missing results in a synthesis (arising from reporting biases).	n/a
Certainty assessment	15	Describe any methods used to assess certainty (or confidence) in the body of evidence for an outcome.	n/a
RESULTS			
Study selection	16a	Describe the results of the search and selection process, from the number of records identified in the search to the number of studies included in the review, ideally using a flow diagram.	Page 18
	16b	Cite studies that might appear to meet the inclusion criteria, but which were excluded, and explain why they were excluded.	Page 18
Study characteristics	17	Cite each included study and present its characteristics.	Page 20
Risk of bias in studies	18	Present assessments of risk of bias for each included study.	Pages 22-25
Results of individual studies	19	For all outcomes, present, for each study: (a) summary statistics for each group (where appropriate) and (b) an effect estimate and its precision (e.g. confidence/credible interval), ideally using structured tables or plots.	Pages 19-28
Results of syntheses	20a	For each synthesis, briefly summarise the characteristics and risk of bias among contributing studies.	Pages 22-25
	20b	Present results of all statistical syntheses conducted. If meta-analysis was done, present for each the summary estimate and its precision (e.g. confidence/credible interval) and measures of statistical heterogeneity. If comparing groups, describe the direction of the effect.	Pages 22-28

	20c	Present results of all investigations of possible causes of heterogeneity among study results.	n/a
	20d	Present results of all sensitivity analyses conducted to assess the robustness of the synthesized results.	n/a
Reporting biases	21	Present assessments of risk of bias due to missing results (arising from reporting biases) for each synthesis assessed.	n/a
Certainty of evidence	22	Present assessments of certainty (or confidence) in the body of evidence for each outcome assessed.	n/a
DISCUSSION			
Discussion	23a	Provide a general interpretation of the results in the context of other evidence.	Page 29
	23b	Discuss any limitations of the evidence included in the review.	Pages 31-32
	23c	Discuss any limitations of the review processes used.	Pages 32-35
	23d	Discuss implications of the results for practice, policy, and future research.	Pages 32-35
OTHER INFORMATION			
Registration and protocol	24a	Provide registration information for the review, including register name and registration number, or state that the review was not registered.	Page 14
	24b	Indicate where the review protocol can be accessed, or state that a protocol was not prepared.	Page 14
	24c	Describe and explain any amendments to information provided at registration or in the protocol.	Page 14
Support	25	Describe sources of financial or non-financial support for the review, and the role of the funders or sponsors in the review.	n/a
Competing interests	26	Declare any competing interests of review authors.	n/a
Availability of data, code and other materials	27	Report which of the following are publicly available and where they can be found: template data collection forms; data extracted from included studies; data used for all analyses; analytic code; any other materials used in the review.	n/a

From: Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ 2021;372:n71. doi: 10.1136/bmj.n71. This work is licensed under CC BY 4.0. To view a copy of this license, visit https://creativecommons.org/licenses/by/4.0/

Section and Topic	Item #	Checklist item	Reported (Yes/No)
TITLE			
Title	1	Identify the report as a systematic review.	Yes
BACKGROUND			
Objectives	2	Provide an explicit statement of the main objective(s) or question(s) the review addresses.	Yes
METHODS			
Eligibility criteria	3	Specify the inclusion and exclusion criteria for the review.	Yes
Information sources	4	Specify the information sources (e.g. databases, registers) used to identify studies and the date when each was last searched.	Yes
Risk of bias	5	Specify the methods used to assess risk of bias in the included studies.	Yes
Synthesis of results	6	Specify the methods used to present and synthesise results.	Yes
RESULTS			
Included studies	7	Give the total number of included studies and participants and summarise relevant characteristics of studies.	Yes
Synthesis of results	8	Present results for main outcomes, preferably indicating the number of included studies and participants for each. If meta-analysis was done, report the summary estimate and confidence/credible interval. If comparing groups, indicate the direction of the effect (i.e. which group is favoured).	Yes
DISCUSSION			
Limitations of evidence	9	Provide a brief summary of the limitations of the evidence included in the review (e.g. study risk of bias, inconsistency and imprecision).	Yes
Interpretation	10	Provide a general interpretation of the results and important implications.	Yes
OTHER			
Funding	11	Specify the primary source of funding for the review.	n/a
Registration	12	Provide the register name and registration number.	n/a

From: Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ 2021;372:n71. doi: 10.1136/bmj.n71.

Appendix B

***Fully truncated search terms for each host site and database*.**

Clarivate: Web of Science Core Collection

Limiter: timespan 1994-01-01 – 2025-02-28

"attention deficit hyperactivity disorder" OR ADHD OR ADD OR AD/HD OR "attention-deficit/hyperactivity disorder" OR impulsiv* OR inattent* OR hyperkine* OR disrupt* OR overactiv* OR (defian* near/3 disorder*) or (defian* near/3 behav*) (Topic)

and social prob* OR social diff* OR peer victimi* OR bully* OR bullie* OR peer diffi* OR peer reject* OR peer relation* OR peer iso* OR “cyber-bull*” or “online-bull*” or bully* near/3 social media OR social funct* OR internali* OR externali* OR peer dislike* OR peer problem* (Topic)

and child* OR adolescen* "young pe*" OR youth* OR teen* OR school-child* (Topic)

and gender differen* OR sex differen* OR boy* OR male* OR girl* OR female* OR sex factor* OR transgender OR non-binary OR gender divers* (Topic)

EBSCOhost: PsycINFO

Limiters – publication year: 1994 – current

Search	Search Terms

S1	attention deficit hyperactivity disorder OR adhd OR "add" OR impulsiv* OR inattent* OR hyperkine* OR overactiv* OR disruptiv* OR defian* OR hyperactiv*
S2	bullying OR "peer victim*" OR "peer diffi*" OR "peer reject*" OR "peer relation*" OR "peer isolat*" OR "social prob*".ti,ab,kw. OR "social diff*".ti,ab,kw. OR victim* OR harass* OR intimidat* OR (aggress* OR violen* OR hostil*) OR (antisocial* OR fight* OR fought) OR (cyber-bull* OR online-bull*)
S3	child OR adolescent OR teen* OR youth OR juvenile OR "young pe*" OR "school child*"
S4	"sex difference*" OR "gender diff*" OR boy OR girl OR ("transgender and gender non-binary")
S5	S1 AND S2 AND S3 AND S4

OVID: EMBASE and MEDLINE

1. "attention deficit hyperactivity disorder".ti,ab,kw.
2. adhd.ti,ab,kw.
3. "add".ti,ab,kw.
4. impulsiv*.ti,ab,kw.
5. inattent*.ti,ab,kw.
6. hyperkine*.ti,ab,kw.
7. disrupt*.ti,ab,kw.

8. defian*.ti,ab,kw.

9. overactiv*.ti,ab,kw.

10. 1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9

11. "peer victimi*".ti,ab,kw.

12. "peer diff*".ti,ab,kw.

13. "peer reject*".ti,ab,kw.

14. "peer relation*".ti,ab,kw.

15. "peer iso*".ti,ab,kw.

16. "social prob*".ti,ab,kw.

17. "social diff*".ti,ab,kw.

18. bully*.ti,ab,kw.

19. bullie*.ti,ab,kw.

20. victim*.ti,ab,kw.

21. "cyber-bull*".ti,ab,kw.

22. "online-bull*".ti,ab,kw.

23. 11 or 12 or 13 or 14 or 15 or 16 or 17 or 18 or 19 or 20 or 21 or 22

24. child*.ti,ab,kw.

25. adolescen*.ti,ab,kw.

26. "young pe*".ti,ab,kw.

27. youth*.ti,ab,kw.

28. teen*.ti,ab,kw.

29. "school child".ti,ab,kw.

30. 24 or 25 or 26 or 27 or 28 or 29

31. "gender diff*".ti,ab,kw.

32. "sex diff*".ti,ab,kw.

33. "sex factor*".ti,ab,kw.

34. boy*.ti,ab,kw.

35. male*.ti,ab,kw.

36. girl*.ti,ab,kw.

37. female*.ti,ab,kw.

38. transgender*.ti,ab,kw.

39. "non-binary".ti,ab,kw.

40. 31 or 32 or 33 or 34 or 35 or 36 or 37 or 38 or 39

41. limit 10 to yr='1994 -Current"

42. 10 and 23 and 30 and 40 and 41

ProQuest: ASSIA and ERIC

((exp attention deficit hyperactivity disorder/ OR adhd.ti,ab,kw. OR "add" .ti,ab,kw. OR impulsiv*.ti,ab,kw. OR inattent*.ti,ab,kw. OR hyperkine*.ti,ab,kw. OR overactiv*.ti,ab,kw. OR disruptiv*.ti,ab,kw. OR defian*.ti,ab,kw. OR hyperactiv*.ti,ab,kw.)

AND (exp bullying/ OR "peer victimi*" .ti,ab,kw. OR "peer diffi*" .ti,ab,kw. OR "peer reject*" .ti,ab,kw. OR "peer relation*" .ti,ab,kw. OR "peer isola*" .ti,ab,kw. OR "social prob*".ti,ab,kw. OR "social diff*".ti,ab,kw. OR victim*.ti,ab,kw. OR harass*.ti,ab,kw. OR intimidat*.ti,ab,kw. OR aggress*.ti,ab,kw. OR conflict*.ti,ab,kw. OR antisocial*.ti,ab,kw. OR violen*.ti,ab,kw. OR hostil*.ti,ab,kw. OR fight*.ti,ab,kw. OR fought.ti,ab,kw. OR cyber-bull*.ti,ab,kw. OR online-bull*.ti,ab,kw.) OR Social funct* .ti,ab,kw. OR Internali* .ti,ab,kw.OR Externali*.ti,ab,kw. OR Peer dislike* .ti,ab,kw. OR Peer problem* .ti,ab,kw. OR social prob* .ti,ab,kw. OR peer prob* .ti,ab,kw. OR social diff* .ti,ab,kw.

AND (exp child/ OR exp adolescent/ OR exp juvenile/ OR youth.ti,ab,kw. OR "young pe*" .ti,ab,kw. OR teen*.ti,ab,kw. OR "school child*" .ti,ab,kw.)

AND (exp sex difference/ OR "gender diff*" .ti,ab,kw. OR exp boy/ OR exp girl/ OR exp "transgender and gender nonbinary" /))

AND stype.exact("Scholarly Journals")

AND la.exact("English")

AND pd(>19940101)

Appendix C

Synthesis without meta-analysis checklist

The citation for the Synthesis Without Meta-analysis explanation and elaboration article is: Campbell M, McKenzie JE, Sowden A, Katikireddi SV, Brennan SE, Ellis S, Hartmann-Boyce J, Ryan R, Shepperd S, Thomas J, Welch V, Thomson H. Synthesis without meta-analysis (SWiM) in systematic reviews: reporting guideline BMJ 2020;368:l6890 http://dx.doi.org/10.1136/bmj.l6890

SWiM is intended to complement and be used as an extension to PRISMA			
SWiM reporting item	**Item description**	**Page in manuscript where item is reported**	**Other***
Methods			
1 Grouping studies for synthesis	1a) Provide a description of, and rationale for, the groups used in the synthesis (e.g., groupings of populations, interventions, outcomes, study design)	17	
	1b) Detail and provide rationale for any changes made subsequent to the protocol in the groups used in the synthesis	17	
2 Describe the standardised metric and transformation methods used	Describe the standardised metric for each outcome. Explain why the metric(s) was chosen, and describe any methods used to transform the intervention effects, as reported in the study, to the standardised metric, citing any methodological guidance consulted	17-18	
3 Describe the synthesis methods	Describe and justify the methods used to synthesise the effects for each outcome when it was not possible to undertake a meta-analysis of effect estimates	17-18	
4 Criteria used to prioritise results for	Where applicable, provide the criteria used, with supporting justification, to select the particular studies, or a particular study, for the main synthesis or to draw conclusions from the synthesis (e.g., based on study design, risk of bias assessments, directness in relation to the review question)	19-20	

summary and synthesis			
SWiM reporting item	**Item description**	**Page in manuscript where item is reported**	**Other***
5 Investigation of heterogeneity in reported effects	State the method(s) used to examine heterogeneity in reported effects when it was not possible to undertake a meta-analysis of effect estimates and its extensions to investigate heterogeneity	17-18	
6 Certainty of evidence	Describe the methods used to assess certainty of the synthesis findings	n/a	
7 Data presentation methods	Describe the graphical and tabular methods used to present the effects (e.g., tables, forest plots, harvest plots). Specify key study characteristics (e.g., study design, risk of bias) used to order the studies, in the text and any tables or graphs, clearly referencing the studies included	21, 24, 25	
Results			
8 Reporting results	For each comparison and outcome, provide a description of the synthesised findings, and the certainty of the findings. Describe the result in language that is consistent with the question the synthesis addresses, and indicate which studies contribute to the synthesis	24-29	
Discussion			
9 Limitations of the synthesis	Report the limitations of the synthesis methods used and/or the groupings used in the synthesis, and how these affect the conclusions that can be drawn in relation to the original review question	34	

PRISMA=Preferred Reporting Items for Systematic Reviews and Meta-Analyses.

*If the information is not provided in the systematic review, give details of where this information is available (e.g., protocol, other published papers (provide citation details), or website (provide the URL)).

Appendix D

Study characteristics table – with ADHD subtype data per study

A summary of included studies

ID	Author, Year	Country	Population	Gender or sex	Age Mean (*SD*), range	ADHD (*n*)			ADHD subtype									Medication (*n*)
									ADHD-IN			ADHD-HI			ADHD-C			
						Total	Girls	Boys	Total	Girls	Boys	Total	Girls	Boys	Total	Girls	Boys	
1	Babinski et al., 2019	USA	Community	Sex	10-15	60	17	43	36	-	-	1	-	-	10	-	-	16
2	Becker et al., 2017	USA	Clinical	Sex	12.56 (0.98) 11-15	131	35	96	69	-	-	0	-	-	62	-	-	-
3	Carlson et al., 1997	USA	Community	Gender	7.55 (1.86)	57	11	46	-	-	-	-	-	-	-	-	-	-
4	Cuba Bustinza et al., 2023	USA	Community	Sex	6-17	5932	1893	4039	-	-	-	-	-	-	-	-	-	3878
5	Efron et al., 2021	Australia	Community	Sex	8.9 (0.5)	173	51	122	64	-	-	22	-	-	93	-	-	22
6	Elkins et al., 2011	USA	Community	Sex	11.9	253	109	144	120	58	62	59	25	34	74	26	48	-
7	Fennolar Cortes et al., 2017	Spain	Clinical	Sex	9.59 (2.38) 6-16	131	39	92	-	-	-	-	-	-	-	-	-	94
8	Graetz et al., 2005	Australia	Community	Gender	6-13	324	99	225	160	52	108	62	21	41	102	26	76	-
9	Gudjonsdottir et al., 2024	Iceland	Clinical	Gender	10.07 (2.98) 5-18	1550	572	978	448	-	-	24	-	-	1078	-	-	-
10	Hoza et al., 2005	USA	Clinical	Sex	7-9.9	165	35	130	-	-	-	-	-	-	-	-	-	-
11	Kafali et al., 2021	Turkey	Community	Sex	13.9 (1.8) 10-18	105	28	77	40	-	-	5	-	-	60	-	-	85
12	Kamal., 2021	Qatar	Community	Gender	15(1.6)	150	57	93	38	20	18	70	26	44	42	11	31	-
13	Lau et al., 2021	Singapore	Clinical	Gender	6-18	773	96	677	-	-	-	-	-	-	-	-	-	-

14	McKay et al., 2023	Australia	Clinical	Gender	14.5 (1.5) 13-18	30	9	21	10	7	3	5	0	5	7	2	5	25
15	Mikami & Lorenzi, 2011	USA	Community	Gender	6-10	63	21	42	16	-	-	0	-	-	47	-	-	42
16	Ragnarsdottir et al., 2018	Iceland	Clinical	Gender	8.5 (girls), 7.8 (boys) 5.1-10.9	592	182	410	149	-	-	26	-	-	417	-	-	0
17	Ralić et al., 2018	Croatia	Community	Gender	12 (-) 7-15	72	13	59	18	-	-	0	-	-	54	-	-	4
18	Smit et al., 2020	Canada	Clinical	Gender	8.58 (1.55) 6-11	213	66	147	59	20	39	11	4	7	56	15	41	124
19	Wiener and Mak., 2009	Canada	Clinical	Gender	9-14	52	12	40	-	-	-	-	-	-	-	-	-	36

Note: This table demonstrates information from all included studies in this review. Missing data is denoted by '-'. Due to missing data, some subtype fields do not equal the total sample size. ADHD = Attention Deficit Hyperactivity Disorder. ADHD-IN = ADHD predominately inattentive subtype. ADHD-HI = ADHD predominately hyperactive-impulsive subtype. ADHD-C = ADHD combined subtype.

Appendix E

Quality appraisal scores

ID	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Total	Summary Score	Quality	Notes
1	2	2	2	2	n/a	n/a	n/a	2	1	2	2	2	2	2	21	0.96	high	may be underpowered - no power calculation
2	2	2	2	2	n/a	n/a	n/a	2	1	2	2	2	2	2	21	0.96	high	no power calculation
3	2	2	2	2	n/a	n/a	n/a	2	1	2	1	2	2	2	20	0.91	high	no power calculation, doesn't report variances for all results
4	2	1	2	1	n/a	n/a	n/a	1	1	2	2	2	2	2	18	0.82	good	vague study design, doesn't really describe characteristics, no power calculation but large sample,
5	2	2	2	2	n/a	n/a	n/a	2	1	2	2	2	2	2	21	0.96	high	no power calculation, analysed confounding variables
6	2	2	2	2	n/a	n/a	n/a	2	1	2	2	2	2	2	21	0.96	high	no power calculation
7	2	2	2	2	n/a	n/a	n/a	2	1	2	2	2	2	2	21	0.96	high	no power calculation
8	2	2	2	2	n/a	n/a	n/a	2	1	2	2	2	2	2	21	0.96	high	no power calculation
9	2	2	2	2	n/a	n/a	n/a	2	1	2	2	2	2	2	21	0.96	high	no power calculation but large sample
10	2	2	2	2	n/a	n/a	n/a	2	1	1	2	2	2	2	20	0.91	high	no power calculation, doesn't describe analyses of all outcomes
11	2	2	2	2	n/a	n/a	n/a	2	1	2	2	2	2	2	21	0.96	high	no power calculation
12	1	2	2	1	n/a	n/a	n/a	2	1	1	1	1	1	1	14	0.64	medium	question is vague, subjects not described fully, no power calculation, analysis plan is vague for some outcomes, does not control for all confounders, results

																		are not reported in sufficient detail
13	2	2	2	1	n/a	n/a	n/a	2	1	2	2	2	2	2	20	0.91	high	does not describe ADHD subtype or why 2005-2007 was selected, no power calculation reported
14	2	2	2	2	n/a	n/a	n/a	2	2	2	2	2	2	2	22	1	perfect	
15	2	2	2	2	n/a	n/a	n/a	2	1	2	2	2	2	2	21	0.96	high	no power calculation
16	2	2	2	2	n/a	n/a	n/a	2	1	2	2	1	2	2	20	0.91	high	no power calculation
17	2	1	2	1	n/a	n/a	n/a	2	1	2	2	2	2	2	19	0.86	good	study design not defined, participants not described in sufficient detail (e.g. race, SES), no power calculation
18	2	2	2	2	n/a	n/a	n/a	2	2	2	2	2	2	2	22	1	perfect	
19	2	2	2	2	n/a	n/a	n/a	2	1	2	2	2	2	2	21	0.96	high	no power calculation

Note: 2 = yes, 1 = partially met, 0 = no, n/a = non-applicable.

Details on items and scoring guidelines can be found on:

https://www.ihe.ca/files/standard_quality_assessment_criteria_for_evaluating_primary_research_papers_from_a_variety_of_fields.pdf

Appendix F

Synthesised results tables

Table i

Main findings of studies examining gender differences

	ID	Age Mean (*SD*), range	SP measure	SP type	Informant	Main findings							Study Quality
						Girls SP *n* (%)	Boys SP *n* (%)	Girls SP mean (*SD*)	Boys SP mean (*SD*)	Test	Outcome	Effect size	
3	3a	7.55 (1.86), 6-17	CBCL	Peer functioning difficulties	Teacher	-	-	4.4 (3.83)	4.84 (2.9)	ANOVA	No difference	D 0.139 (CI –0.249-0.526)	High
	3b		DSAS	Peer functioning difficulties	Teacher	-	-	2.18 (0.98)	1.91 (0.94)	ANOVA	Positive	D -0.284 (-0.673-0.105)	
8		6-13	CBCL	Peer functioning difficulties	Caregiver	-	-	-	-	ANOVA	No difference	-	High
	8i ADHD-IN	6-13	CBCL	Peer functioning difficulties	Caregiver	-	-	4.2(3.3)	3.1(2.7)	*t*-test	Positive	d -0.378 (-0.712- -0.045)	
	8ii ADHD-HI	6-13	CBCL	Peer functioning difficulties	Caregiver	-	-	2.1(2.4)	3.1(3.6)	*t*-test	No difference	D 0.308 (-0.221 -0.836)	
	8iii ADHD-C	6-13	CBCL	Peer functioning difficulties	Caregiver	-	-	4(3.1)	4.8(3.1)	*t*-test	No difference	d 0.258 (-0.189-0.705)	
9	9a	10.07 (2.98), 5-18	SDQ	Peer functioning difficulties	Caregiver	-	-	60.14 (13.74)	56.39(13.78)	*t*-test	Positive	D -0.272 (-0.376 - -0.169)	High
	9b	10.07 (2.98), 5-18	SDQ	Peer functioning difficulties	Teacher	-	-	57.6 (14.36)	55.08 (11.7)0	*t*-test	Positive	D -0.198 (-0.301- -0.094)	
12		15 (1.6)	Questions	Peer functioning difficulties	Teacher	15 (43%)	49 (57%)	-	-	*t*-test	No difference	OR 0.3207 (v 0.1336)	Medium
	12i ADHD-IN	15 (1.6)	Questions	Peer functioning difficulties	Teacher	9 (53%)	11 (61%)	-	-	*t*-test	No difference	OR 0.5207 (v 0.4358)	

	12ii ADHD-HI	15 (1.6)	Questions	Peer functioning difficulties	Teacher	4 (28.6%)	19 (51%)	-	-	*t*-test	No difference	OR 0.2392 (v 0.3881)	
	12iii ADHD-C	15 (1.6)	Questions	Peer functioning difficulties	Teacher	2 (50%)	19 (61%)	-	-	*t*-test	No difference	OR 0.1404 (v 0.7471)	
13	13a	6-18	CBCL	Peer functioning difficulties	Caregiver	-	-	-	-	Mann-Whitney U	No difference	R = -0.06	High
	13b	6-18	TRF	Peer functioning difficulties	Teacher	-	-	-	-	Mann-Whitney U	Negative	R = -0.09	
14		14.5 (1.5), 13-18	Conners-3	Peer functioning difficulties	Caregiver	-	-	4.44 (4.75)	5.24 (4.74)	*t*-test	No difference	D 0.169 (-0.613 - 0.951)	Perfect
15	15a	6-10	Peer nomination	Peer functioning difficulties	Peers	-	-	0.05(0.17)	0.12(0.21)	Multiple linear regression	No difference	D 0.354 (-0.174 - 0.881)	High
	15b		DSAS	Peer functioning difficulties	Teacher	-	-	2.19 (1.39)	1.79 (1.05)	Multiple linear regression	No difference	D -0.341 (-0.868 - 0.186)	
16	16a	7.8/8.5 5-10.9	SDQ	Peer functioning difficulties	Caregiver	-	-	59.6(14.3)	57.1(13.3)	*t*-test	Positive	D -0.184 (-0.359- -0.009)	High
	16b	7.8/8.5 5-10.9	SDQ	Peer functioning difficulties	Teacher	-	-	60 (15.2)	56.9 (10.8)	*t*-test	Positive	D -0.252 (-0.427- -0.076)	
17	17a	12 7-15	SBQ	Peer victimisation (verbal)	Self	-	-	-	-	Multivariate regression analysis	No difference	-	Good
	17b	12 7-15	SBQ	Peer victimisation (physical)	Self	-	-	-	-	Multivariate regression analysis	Negative	-	
	17c	12 7-15	SBQ	Bullying perpetration (verbal)	Self	-	-	-	-	Multivariate regression analysis	Negative	-	
	17d	12 7-15	SBQ	Bullying perpetration (physical)	Self	-	-	-	-	Multivariate regression analysis	Negative	-	
18		8.58 (1.55), 6-11	DSAS	Peer functioning difficulties	Teacher	-	-	24 (23)	17 (18)	Regression	No difference	D -0.357 (-0.647- -0.068)	Perfect

19	19a	9-14	BVQ	Peer victimisation	Self	-	-	15.5 (5.65)	13.1 (5.28)	ANOVA	Positive	D -0.447 (-1.098-0.203)	High
	19b	9-14	BVQ	Bully perpetration	Self	-	-	8.25 (2.01)	10.32 (3.98)	ANOVA	No difference	D 0.569 (-0.086-1.223)	
	19c	9-14	SRSS	Bully perpetration	Caregiver and teacher combined	-	-	0.33 (0.492)	1.03 (1.03)	ANNOVA	No difference	D 0.746 (0.085-1.407)	

Note: This table demonstrates main findings from studies in 'gender' group. Missing data is denoted by '-'. 'Positive' effect notes that girls score higher than boys for social problems. 'Negative' effect means that boys score higher than girls.

Table ii

Main findings of studies examining sex differences

ID		Age Mean (SD), range	SP measure	SP type	Informant	Main findings							Study Quality
						Girls with SP *n* (%)	Boys with SP *n* (%)	Girls with SP mean (*SD*)	Boys with SP mean (*SD*)	Test	Outcome	Effect size	
1		10-15	CBCL	Peer functioning difficulties	Caregiver	-	-	-	-	Logistic regression	No difference	-	High
2	2a	12.56 (0.98), 11-15	RPEQ	Peer victimisation	Self	21 (60%)	54 (56%)	1.8 (0.64)	1.92 (0.85)	*t*-test	No difference	D 0.15 (-0.237-0.537)	High
	2b	12.56 (0.98),11-15	RPEQ	Physical PV	Self	3 (9%)	15 (16%)	1.44 (0.69)	1.84 (0.91)	*t*-test	Negative	D 0.466 (0.075-0.858)	
	2c	12.56 (0.98),11-15	RPEQ	Relational PV	Self	18 (51%)	49 (51%)	1.85 (0.98)	2.01(0.95)	*t*-test	No difference	D 0.167 (-0.221-0.555)	
	2d	12.56 (0.98),11-15	RPEQ	Reputational PV	Self	7 (20%)	15 (20%)	1.81 (0.95)	1.86(0.98)	*t*-test	Negative	D 0.051 (-0.336-0.438)	
4	4a	6-17	Questions	Peer victimisation	Caregiver	931 (49.2%*)	1850 (45.8%*)	-	-	Logistic regression	No difference	OR 1.1451 (v0.0031)	Good
	4b	6-17	Questions	Bullying perpetration	Caregiver	244 (12.9%*)	715 (17.7%*)	-	-	Logistic regression	Negative	OR 0.6879 (v0.0064)	
5	5a	8.9 (0.5)	SEQ	Peer victimisation	Caregiver	-	-	-	-	Linear regression	No difference	-	High
	5b	8.9 (0.5)	SEQ	Peer victimisation	Teacher	-	-	-	-	Linear regression	No difference	-	
6		11.9 11	Questions	Peer victimisation	Self	51 (47%)	55 (38%)	-	-	ANOVA	Positive	OR 1.4229 (v0.0663)	High

	6i – ADHD-IN	11.9 11	Questions	Peer victimisation	Self	29 (50%)	18 (29%)	-	-	ANOVA	Positive	OR 2.4444 (v0.1472)	
	6ii – ADHD-HI	11.9 11	Questions	Peer victimisation	Self	13 (52%)	16 (47.1%)	-	-	ANOVA	No difference	OR 1.2188 (v0.2783)	
	6iii – ADHD-C	11.9 11	Questions	Peer victimisation	Self	9 (34.6%)	21 (43.8%)	-	-	ANOVA	No difference	OR 0.6807 (v 0.2546)	
7		9.59 (2.38), 6-16	Conners 3	Peer functioning difficulties	Caregiver /teacher	-	-	-	-	Linear regression	Negative	-	High
10		7-9.9	Peer nomination	Peer functioning difficulties	Peers	-	-	-	-	*t*-test	No difference	-	High
11	11a	13.9 (1.8), 10-18	BVQ	Peer victimisation	Self	10 (35.7%)	16 (20.7%)	-	-	Binary regression analysis	No difference	OR 2.1181 (v0.2344)	High
	11b	13.9 (1.8), 10-18	BVQ	Bully perpetration	Self	5 (18%)	20 (26%)	-	-		No difference	OR 0.6196 (v0.311)	

Note: This table demonstrates main findings from studies in ‘sex’ group. Missing data is denoted by ‘-’. ‘Positive’ effect notes that girls score higher than boys for social problems. ‘Negative’ effect means that boys score higher than girls.

Appendix G

Glossary of Terminology

Neurodevelopmental, Emotional, and Behavioural Disorders

ADHD – Attention Deficit Hyperactivity Disorder: A neurodevelopmental condition marked by inattention, hyperactivity, and/or impulsivity.

ADHD-C (Combined Presentation): A subtype of ADHD involving both inattentive and hyperactive-impulsive symptoms.

ADHD-HI (Predominantly Hyperactive-Impulsive Presentation): A subtype of ADHD characterised mainly by hyperactivity and impulsive behaviour.

ADHD-IN (Predominantly Inattentive Presentation): A subtype of ADHD where difficulties with attention, focus, and organization are most prominent.

Anxiety: A mental health condition involving excessive worry or fear that interferes with daily life.

Autism: A neurodevelopmental condition affecting social communication, behaviour, and sensory processing.

BPD – Borderline Personality Disorder: A disorder involving instability in emotions, relationships, and self-image.

Conduct Disorder: A behavioural disorder characterised by persistent aggression, rule-breaking, and violation of others' rights.

Depression: A mood disorder involving persistent sadness and loss of interest or pleasure.

Elimination Disorders: Conditions involving inappropriate elimination of urine or faeces.

Genetic Conditions: Disorders caused by abnormalities in genes or chromosomes.

Intellectual Disability: A condition with significant limitations in intellectual functioning and adaptive behaviour.

OCD – Obsessive Compulsive Disorder: A disorder involving intrusive thoughts and repetitive behaviours.

ODD – Oppositional Defiant Disorder: A pattern of defiant, argumentative, and hostile behaviour toward authority figures.

Speech and Language Disorders: Conditions affecting communication, including speech production and understanding.

Specific Learning Disabilities: Disorders affecting the ability to learn skills such as reading, writing, or math.

Tic Disorders: Conditions involving sudden, repetitive movements or vocalizations.

Tourette's Syndrome: A disorder characterised by multiple motor and vocal tics over time.

Assessment Tools, Questionnaires and Research Methods

BVQ – Bully/Victim Questionnaire: A self-report tool assessing bullying behaviour and victimisation.

CBCL – Child Behavior Checklist: A parent-report questionnaire measuring emotional and behavioural problems.

Conners-3: An assessment tool used to evaluate ADHD and related behaviours.

DISC-IV – Diagnostic Interview Schedule for Children (Version IV): A structured interview assessing psychiatric disorders in children.

DSAS – Dishion Social Acceptance Scale: A measure of peer acceptance and social status.

K-SADS – Kiddie Schedule for Affective Disorders and Schizophrenia: A semi-structured diagnostic interview for mood and other disorders in children.

P-CHiPS 2 – Parent's Version of the Children's Interview for Psychiatric Syndromes: A parent-completed structured diagnostic interview.

Peer Nomination: A method where individuals identify peers who fit certain behavioural or social characteristics.

RPEQ – Revised Peer Experiences Questionnaire: A self-report measure of bullying and peer victimisation.

SBQ – School-Bullying Questionnaire: An instrument assessing bullying in school settings.

SDQ – Strengths and Difficulties Questionnaire: A brief screening tool for emotional and behavioural difficulties.

SNAP-IV – Swanson, Nolan, and Pelham-IV: A rating scale assessing ADHD symptoms.

SSRS – Social Skills Rating System: A tool measuring social skills, behaviour, and academic competence.

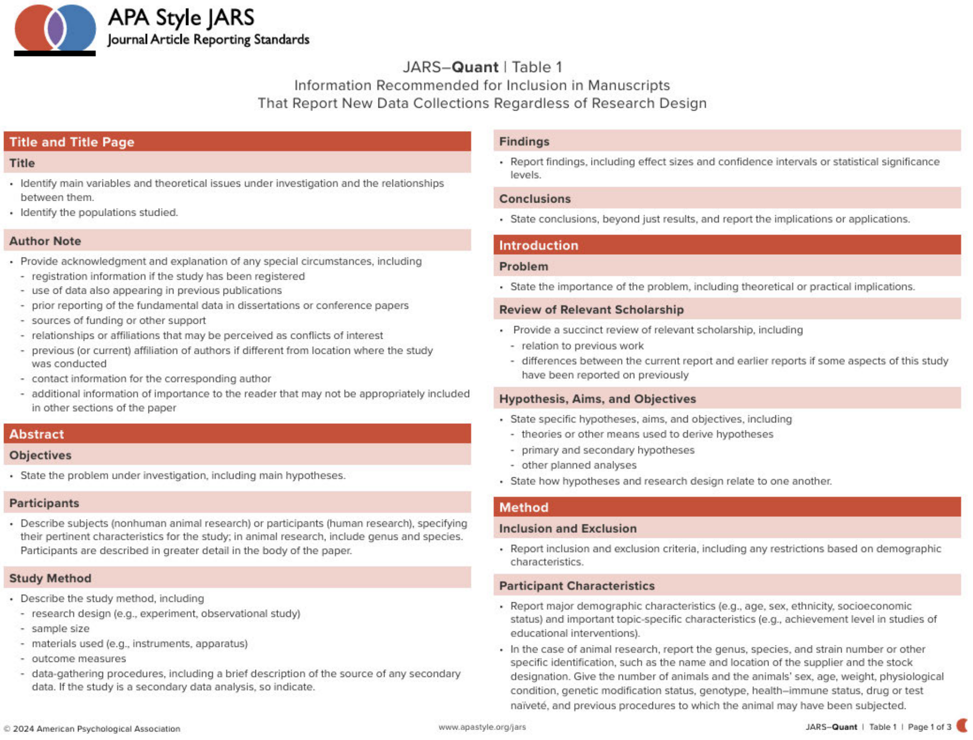
Diagnostic Manuals

DSM-5 – Diagnostic and Statistical Manual of Mental Disorders (Fifth Edition): The current standard manual used to diagnose mental disorders.

DSM-IV – Diagnostic and Statistical Manual of Mental Disorders (Fourth Edition): An earlier edition of the diagnostic manual.

Appendix H

Main research project reporting checklist: APA Journal Article Reporting Standards (Tables 1 and 4)



APA Style JARS
Journal Article Reporting Standards

JARS–**Quant** | Table 1
Information Recommended for Inclusion in Manuscripts
That Report New Data Collections Regardless of Research Design

Title and Title Page

Title

- Identify main variables and theoretical issues under investigation and the relationships between them.
- Identify the populations studied.

Author Note

- Provide acknowledgment and explanation of any special circumstances, including
  - registration information if the study has been registered
  - use of data also appearing in previous publications
  - prior reporting of the fundamental data in dissertations or conference papers
  - sources of funding or other support
  - relationships or affiliations that may be perceived as conflicts of interest
  - previous (or current) affiliation of authors if different from location where the study was conducted
  - contact information for the corresponding author
  - additional information of importance to the reader that may not be appropriately included in other sections of the paper

Abstract

Objectives

- State the problem under investigation, including main hypotheses.

Participants

- Describe subjects (nonhuman animal research) or participants (human research), specifying their pertinent characteristics for the study; in animal research, include genus and species. Participants are described in greater detail in the body of the paper.

Study Method

- Describe the study method, including
  - research design (e.g., experiment, observational study)
  - sample size
  - materials used (e.g., instruments, apparatus)
  - outcome measures
  - data-gathering procedures, including a brief description of the source of any secondary data. If the study is a secondary data analysis, so indicate.

Findings

- Report findings, including effect sizes and confidence intervals or statistical significance levels.

Conclusions

- State conclusions, beyond just results, and report the implications or applications.

Introduction

Problem

- State the importance of the problem, including theoretical or practical implications.

Review of Relevant Scholarship

- Provide a succinct review of relevant scholarship, including
  - relation to previous work
  - differences between the current report and earlier reports if some aspects of this study have been reported on previously

Hypothesis, Aims, and Objectives

- State specific hypotheses, aims, and objectives, including
  - theories or other means used to derive hypotheses
  - primary and secondary hypotheses
  - other planned analyses
- State how hypotheses and research design relate to one another.

Method

Inclusion and Exclusion

- Report inclusion and exclusion criteria, including any restrictions based on demographic characteristics.

Participant Characteristics

- Report major demographic characteristics (e.g., age, sex, ethnicity, socioeconomic status) and important topic-specific characteristics (e.g., achievement level in studies of educational interventions).
- In the case of animal research, report the genus, species, and strain number or other specific identification, such as the name and location of the supplier and the stock designation. Give the number of animals and the animals' sex, age, weight, physiological condition, genetic modification status, genotype, health–immune status, drug or test naïveté, and previous procedures to which the animal may have been subjected.

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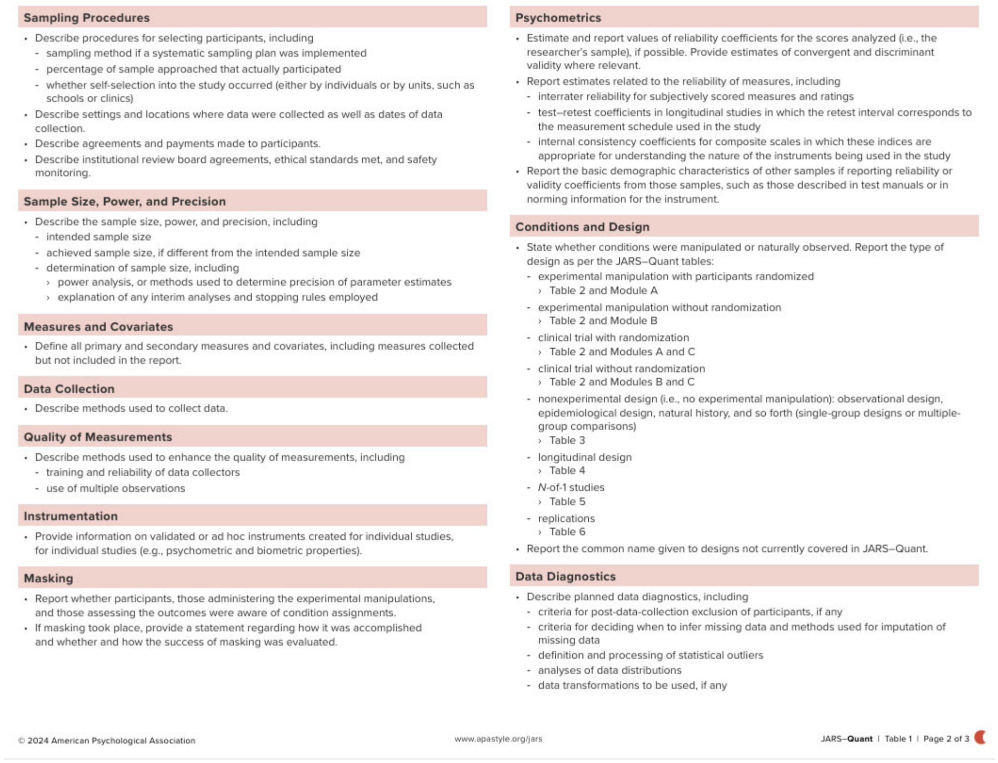
JARS–**Quant** | Table 1 | Page 1 of 3



Sampling Procedures

- Describe procedures for selecting participants, including
  - sampling method if a systematic sampling plan was implemented
  - percentage of sample approached that actually participated
  - whether self-selection into the study occurred (either by individuals or by units, such as schools or clinics)
- Describe settings and locations where data were collected as well as dates of data collection.
- Describe agreements and payments made to participants.
- Describe institutional review board agreements, ethical standards met, and safety monitoring.

Sample Size, Power, and Precision

- Describe the sample size, power, and precision, including
  - intended sample size
  - achieved sample size, if different from the intended sample size
  - determination of sample size, including
    - › power analysis, or methods used to determine precision of parameter estimates
    - › explanation of any interim analyses and stopping rules employed

Measures and Covariates

- Define all primary and secondary measures and covariates, including measures collected but not included in the report.

Data Collection

- Describe methods used to collect data.

Quality of Measurements

- Describe methods used to enhance the quality of measurements, including
  - training and reliability of data collectors
  - use of multiple observations

Instrumentation

- Provide information on validated or ad hoc instruments created for individual studies, for individual studies (e.g., psychometric and biometric properties).

Masking

- Report whether participants, those administering the experimental manipulations, and those assessing the outcomes were aware of condition assignments.
- If masking took place, provide a statement regarding how it was accomplished and whether and how the success of masking was evaluated.

Psychometrics

- Estimate and report values of reliability coefficients for the scores analyzed (i.e., the researcher's sample), if possible. Provide estimates of convergent and discriminant validity where relevant.
- Report estimates related to the reliability of measures, including
  - interrater reliability for subjectively scored measures and ratings
  - test–retest coefficients in longitudinal studies in which the retest interval corresponds to the measurement schedule used in the study
  - internal consistency coefficients for composite scales in which these indices are appropriate for understanding the nature of the instruments being used in the study
- Report the basic demographic characteristics of other samples if reporting reliability or validity coefficients from those samples, such as those described in test manuals or in norming information for the instrument.

Conditions and Design

- State whether conditions were manipulated or naturally observed. Report the type of design as per the JARS–Quant tables:
  - experimental manipulation with participants randomized
    - › Table 2 and Module A
  - experimental manipulation without randomization
    - › Table 2 and Module B
  - clinical trial with randomization
    - › Table 2 and Modules A and C
  - clinical trial without randomization
    - › Table 2 and Modules B and C
  - nonexperimental design (i.e., no experimental manipulation): observational design, epidemiological design, natural history, and so forth (single-group designs or multiple-group comparisons)
    - › Table 3
  - longitudinal design
    - › Table 4
  - *N*-of-1 studies
    - › Table 5
  - replications
    - › Table 6
- Report the common name given to designs not currently covered in JARS–Quant.

Data Diagnostics

- Describe planned data diagnostics, including
  - criteria for post-data-collection exclusion of participants, if any
  - criteria for deciding when to infer missing data and methods used for imputation of missing data
  - definition and processing of statistical outliers
  - analyses of data distributions
  - data transformations to be used, if any

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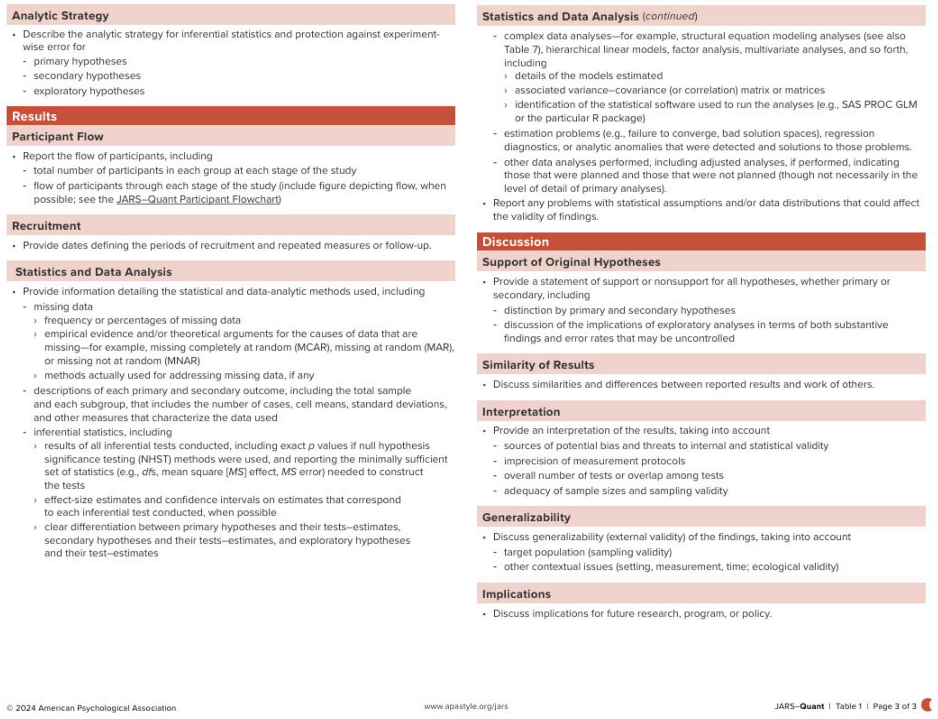
JARS–**Quant** | Table 1 | Page 2 of 3



Analytic Strategy

- Describe the analytic strategy for inferential statistics and protection against experiment-wise error for
  - primary hypotheses
  - secondary hypotheses
  - exploratory hypotheses

Results

Participant Flow

- Report the flow of participants, including
  - total number of participants in each group at each stage of the study
  - flow of participants through each stage of the study (include figure depicting flow, when possible; see the JARS–Quant Participant Flowchart)

Recruitment

- Provide dates defining the periods of recruitment and repeated measures or follow-up.

Statistics and Data Analysis

- Provide information detailing the statistical and data-analytic methods used, including
  - missing data
    - frequency or percentages of missing data
    - empirical evidence and/or theoretical arguments for the causes of data that are missing—for example, missing completely at random (MCAR), missing at random (MAR), or missing not at random (MNAR)
    - methods actually used for addressing missing data, if any
  - descriptions of each primary and secondary outcome, including the total sample and each subgroup, that includes the number of cases, cell means, standard deviations, and other measures that characterize the data used
  - inferential statistics, including
    - results of all inferential tests conducted, including exact *p* values if null hypothesis significance testing (NHST) methods were used, and reporting the minimally sufficient set of statistics (e.g., *df*s, mean square [*MS*] effect, *MS* error) needed to construct the tests
    - effect-size estimates and confidence intervals on estimates that correspond to each inferential test conducted, when possible
    - clear differentiation between primary hypotheses and their tests–estimates, secondary hypotheses and their tests–estimates, and exploratory hypotheses and their test–estimates

Statistics and Data Analysis *(continued)*

  - complex data analyses—for example, structural equation modeling analyses (see also Table 7), hierarchical linear models, factor analysis, multivariate analyses, and so forth, including
    - details of the models estimated
    - associated variance–covariance (or correlation) matrix or matrices
    - identification of the statistical software used to run the analyses (e.g., SAS PROC GLM or the particular R package)
  - estimation problems (e.g., failure to converge, bad solution spaces), regression diagnostics, or analytic anomalies that were detected and solutions to those problems.
  - other data analyses performed, including adjusted analyses, if performed, indicating those that were planned and those that were not planned (though not necessarily in the level of detail of primary analyses).
- Report any problems with statistical assumptions and/or data distributions that could affect the validity of findings.

Discussion

Support of Original Hypotheses

- Provide a statement of support or nonsupport for all hypotheses, whether primary or secondary, including
  - distinction by primary and secondary hypotheses
  - discussion of the implications of exploratory analyses in terms of both substantive findings and error rates that may be uncontrolled

Similarity of Results

- Discuss similarities and differences between reported results and work of others.

Interpretation

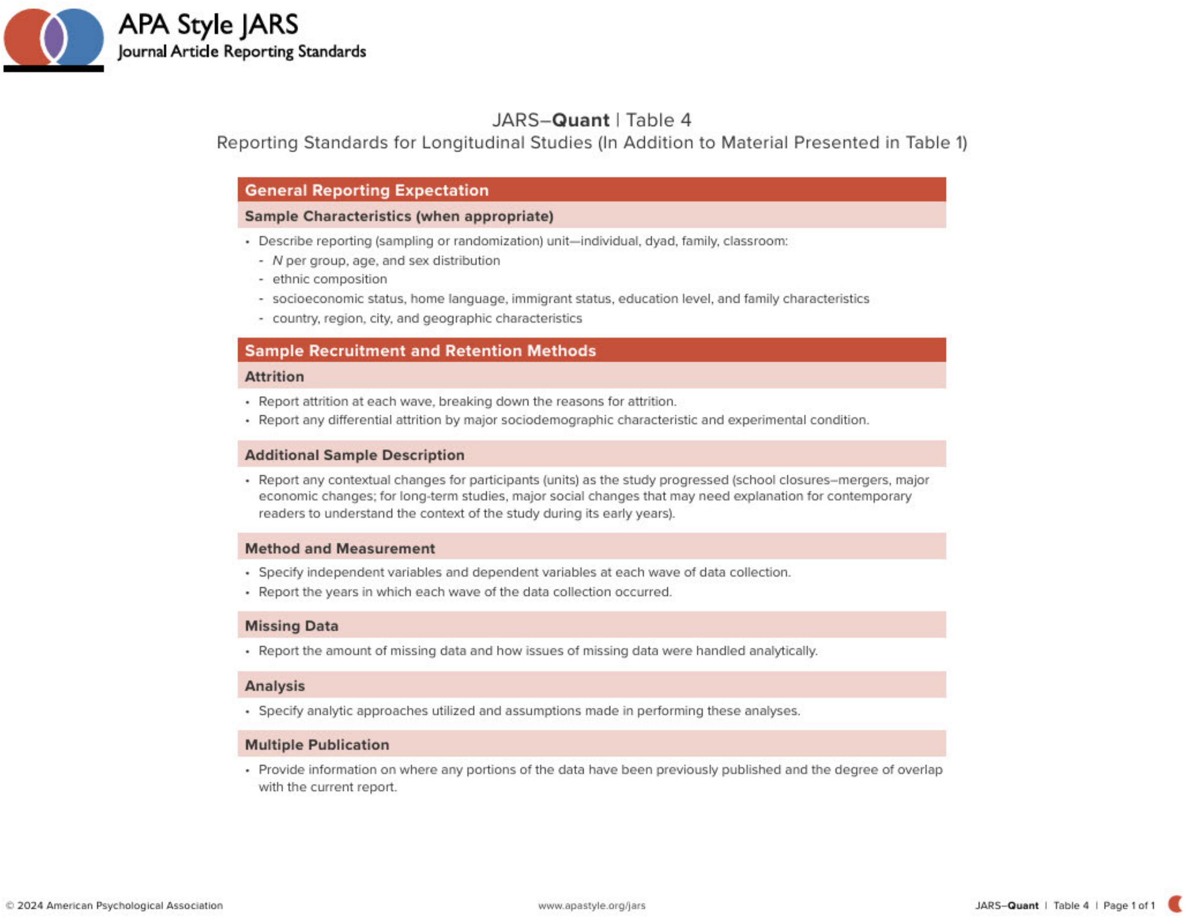
- Provide an interpretation of the results, taking into account
  - sources of potential bias and threats to internal and statistical validity
  - imprecision of measurement protocols
  - overall number of tests or overlap among tests
  - adequacy of sample sizes and sampling validity

Generalizability

- Discuss generalizability (external validity) of the findings, taking into account
  - target population (sampling validity)
  - other contextual issues (setting, measurement, time; ecological validity)

Implications

- Discuss implications for future research, program, or policy.



APA Style JARS
Journal Article Reporting Standards

JARS–**Quant** | Table 4

Reporting Standards for Longitudinal Studies (In Addition to Material Presented in Table 1)

General Reporting Expectation

Sample Characteristics (when appropriate)

- Describe reporting (sampling or randomization) unit—individual, dyad, family, classroom:
  - *N* per group, age, and sex distribution
  - ethnic composition
  - socioeconomic status, home language, immigrant status, education level, and family characteristics
  - country, region, city, and geographic characteristics

Sample Recruitment and Retention Methods

Attrition

- Report attrition at each wave, breaking down the reasons for attrition.
- Report any differential attrition by major sociodemographic characteristic and experimental condition.

Additional Sample Description

- Report any contextual changes for participants (units) as the study progressed (school closures–mergers, major economic changes; for long-term studies, major social changes that may need explanation for contemporary readers to understand the context of the study during its early years).

Method and Measurement

- Specify independent variables and dependent variables at each wave of data collection.
- Report the years in which each wave of the data collection occurred.

Missing Data

- Report the amount of missing data and how issues of missing data were handled analytically.

Analysis

- Specify analytic approaches utilized and assumptions made in performing these analyses.

Multiple Publication

- Provide information on where any portions of the data have been previously published and the degree of overlap with the current report.

Appendix I

Main research project proposal

A copy of this proposal and an updated data analysis plan can be found on the OpenScience Framework:

https://osf.io/3hcbt/overview?view_only=0ead43f6e5a74285a8c4e2c207d81552

Appendix J

Letter from the University of Glasgow granting project approval:

University of Glasgow
School of Health & Wellbeing

HM/PR

9th December 2024

Mhairi Gilmour
[redacted]@student.gla.ac.uk

Dear Mhairi,

Major Research Project Proposal

The longitudinal association between neurodevelopmental symptoms and social problems: The role of social perception

The above project has been reviewed by your University Research Supervisor and by a member of staff not involved in your project and has now been deemed fit to proceed to ethics.

Congratulations and good luck with the study.

Yours sincerely

Prof Hamish McLeod
Professor of Clinical Psychology
DClinPsy Research Director

School of Health & Wellbeing
College of Medical, Veterinary and Life Sciences
University of Glasgow
Mental Health and Wellbeing, Clarice Pears Building
90 Byres Road, Glasgow G12 8TB
Email: dclinpsy@glasgow.ac.uk

The University of Glasgow, charity number SC004401

Appendix K

A table showing Welch two sample t-tests for variables

Variables	T1 mean	T2 mean	*t*	*df*	*p*
ADHD symptoms	20.80	22.99	-1.09	119.26	.28
Social communication difficulties	6.82	5.45	2.18	118.5	.03
RRBs	15.77	12.40	2.12	133.09	.04
Social skills	86.68	89.67	-1.44	99.96	.15
Affect recognition	10.17	10.10	0.15	77.68	.88

Note: decimal points are rounded to 2 decimal places

Appendix L

Data availability statement

As outlined in the data management plan (see details in Appendix G, main research project proposal), the author and research supervisor were granted access to a secondary dataset by the primary research team for the purpose of this study. The sharing of this data with others will be determined by the primary research team and their data sharing policy.

The data is stored and backed up using the University OneDrive account. Responsibility for preservation and archiving will be transferred to the primary research supervisor upon the author's completion of doctoral studies (approximately July 2026). It will be stored for 10 years as per university guidance and will then be deleted.

Appendix M

Author Reflexivity Statement

I used supervision sessions and my own time to reflect on the following topics while writing my thesis.

Firstly, it is important to note that I chose the systematic review and major research project topics largely due to my own interest in neurodiversity. I have previous experience in conducting research in autistic populations, from both my undergraduate and master's degrees. I have significant clinical experience in working with neurodiverse populations, in both therapeutic and caring roles. Additionally, the participant age group is in line with my specialist training alignment of child and adolescent mental health, which is an area I also have a lot of experience in. I recognise the potential bias that may come from researching an area I have prior knowledge and experience in, particularly in interpreting the results.

Next, I reflected on how data collection methods for the main research project were predetermined by the research team as part of a bigger project. I acknowledge how there was less flexibility to change the design or add measures and recognise how there may be potential bias associated with this.

Finally, it is important to highlight a personal reason why I am so passionate about neurodiversity research. Not only do I have neurodivergent friends and family members, but I am currently on a waitlist for an ADHD assessment myself. This offers me a helpful perspective in conducting research in this population and motivates me to advocate for gender-inclusive ADHD research and early intervention, as a cis-gender woman. However, it is important that I acknowledge the potential bias that may arise while conducting such research, particularly when interpreting and discussing results.