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An item-level systematic review of the presentation of ADHD in females

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ABSTRACT

Previous studies examining sex differences in attention deficit hyperactivity disorder (ADHD) have primarily examined total or subscale scores. This systematic review aimed to examine which symptoms contribute to the female presentation of ADHD at an item-level. Six research literature databases were searched for studies comparing ADHD symptoms and their impact at an item-level in females with ADHD compared with: 1) males with ADHD and 2) females without ADHD. Thirteen studies were included. In childhood, females were more likely to display the symptoms 'fails to sustain attention in tasks' and 'often easily distracted', whereas males were more likely to display the symptoms 'often fidgets', 'difficulty remaining seated when required', 'runs/climbs in situations when inappropriate', 'always on the go', 'often noisy in playing', 'difficulty waiting turn', 'often blurts out answers' and 'often interrupts others'. In adulthood, females were more likely to endorse the symptoms 'easily distracted', 'difficulty organising tasks', 'blurts out answers' and 'talks excessively', as well as to report mind wandering and adverse home impacts. Females with ADHD differ in their symptom profile to males with ADHD, highlighting the need for future research to identify and characterise symptoms typical of female ADHD.

1. Introduction

Attention deficit/hyperactivity disorder (ADHD) is a common neurodevelopmental condition, characterised by inattention and hyperactivity-impulsivity, that has an estimated global prevalence of 5.3 % (Polanczyk et al., 2014), ranging up to 8 % in children and adolescents (Ayano et al., 2023). It is a highly impairing condition associated with a range of adverse outcomes (French et al., 2024), including peer rejection, criminality, poor educational and employment outcomes (Dalsgaard et al., 2013; Gershon and Gershon, 2002; Nijmeijer et al., 2008; Young et al., 2020), mental health and physical health conditions and premature mortality (Cortese et al., 2016; Galera et al., 2023; Schiavone et al., 2022; Young et al., 2020). Timely identification and treatment of ADHD is important as treatment can reduce symptoms and potentially improve outcomes (Daley et al., 2019; Dalsgaard et al., 2013; Shaw et al., 2012).

Sex differences in the prevalence of ADHD are well reported in the literature (Martin, 2024; Young et al., 2020), with childhood ADHD diagnosed 7–8 times more frequently in males than females, despite a population sex ratio of 3–4:1 (Faraone et al., 2015; Willcutt, 2012). This sex difference was previously assumed to be due to a genuine prominent male excess in ADHD risk (Arnett et al., 2015). However, recent research suggests that this may not be the only explanation and that at least part of the difference is due to under-recognition of ADHD in females (Martin, 2024; Young et al., 2020). In addition, females often receive an ADHD diagnosis later than males (Grevet et al., 2006; Wimberley et al.,

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2020), with the mean age at first diagnosis being around 10.9 years in males and 12.6 years in females (Martin et al., 2024).

ADHD is reportedly under-recognised and under-diagnosed, particularly in females (Quinn and Madhoo, 2014; Young et al., 2021) for several possible reasons (Martin, 2024; Young et al., 2020). ADHD symptom profiles may differ by sex, with females reportedly displaying more inattentive symptoms and fewer hyperactive and impulsive symptoms than males (Gershon and Gershon, 2002; Quinn and Madhoo, 2014). Further, the field trials for establishing the Diagnostic and Statistical Manual of Mental disorders (DSM) version IV criteria (American Psychiatric Association, 2000) for ADHD were developed and validated using a majority male sample (79 % males) (Lahey et al., 1994). As such, the diagnostic criteria may be biased towards the male manifestation of ADHD, with males more likely than females to meet the diagnostic criteria (Willcutt, 2012). Additionally, co-occurring anxiety and emotional difficulties are more common in females and tend to be less overt or disruptive than associated conduct difficulties that are more common in males (Quinn and Madhoo, 2014). This may also contribute to females being more likely to be overlooked for an ADHD diagnosis (Quinn and Wigal, 2004; Quinn and Nadeau, 2002) and instead receive a primary diagnosis of depression or anxiety (Martin et al., 2024; Powell et al., 2021), delaying diagnosis of ADHD.

Several literature reviews have examined sex differences in ADHD symptom profiles based on total scores, hyperactive-impulsive and inattention sub-scales and impact scores. These reviews (Gershon and Gershon, 2002; Quinn and Madhoo, 2014) and meta-analyses (Loyer Carbonneau et al., 2021), using both clinical and community populations, have suggested that females with ADHD may display a different symptom profile than males with ADHD. Gershon and Gershon (2002) reported that females with ADHD were rated by parents and teachers as having fewer symptoms of hyperactivity, impulsivity, inattention, and behavioural problems, but more emotional problems than males with ADHD. Quinn and Madhoo (2014), in a selective review of the literature, suggested that females with ADHD predominately display inattentive symptoms, whereas males with ADHD display predominately hyperactive and impulsive symptoms. Additionally, females with ADHD demonstrate more difficulty with peer relationships than males with ADHD, and more difficulty with social behaviours, peer functioning and interpersonal relationships, including having fewer friends and less stable relationships, than females without ADHD (Quinn and Madhoo, 2014). Further, Loyer Carbonneau et al. (2021) conducted a meta-analysis of 54 studies and concluded that in children and adolescents, males with ADHD expressed significantly more hyperactivity symptoms than females with ADHD. There were no differences in the expression of inattentive or impulsive symptoms. Further, when results were analysed separately by rater, teacher-reports identified that hyperactive-impulsive symptoms were higher in males, whereas parent-reported symptoms were similar in males and females with ADHD (Loyer Carbonneau et al., 2021).

Overall, existing research findings imply that females with ADHD may have different symptom profiles to males with ADHD, including being less likely to manifest symptoms that are overt and impactful on others. However, these reviews and meta-analyses only included comparisons of total or subscale scores. Understanding sex differences in ADHD symptoms at an item-level may better help us to understand in more detail the female manifestation of ADHD, which is needed to improve recognition, identification and refinement of the phenotype of ADHD in females.

The overarching aim of this systematic review was to examine if there are specific symptoms that characterise the manifestation of ADHD in females compared to: 1) males with ADHD and 2) females without ADHD. The specific aims were to determine whether there are: (1) sex differences in individual ADHD symptom items as defined by DSM-5 or impact related to ADHD, (2) sex differences in symptoms of co-occurring mental health or neurodevelopmental conditions, and (3) specific co-occurring mental health or neurodevelopmental symptoms in females with ADHD compared to females without ADHD.

2. Methods

The protocol for this systematic review has been registered in the International Prospective Register of Systematic Reviews (PROSPERO) database (www.crd.york.ac.uk/PROSPERO, CRD42023395625). It was developed according to the Preferred Reporting Items for Systematic Review and Meta-Analyses Protocol (PRISMA-P) guidelines (Moher et al., 2009). The full PRISMA-P checklist is included in the Supplementary Materials (Table S1).

2.1. Eligibility criteria

Studies were eligible for inclusion if they were a primary study or grey literature (i.e., Dissertations and Theses) written in English. There were no country or sample size restrictions. Only studies published from 1987 onwards were eligible for inclusion, as that was the publication date of the DSM-III-R where the contemporary conceptualisation of ADHD was introduced (American Psychiatric Association, 1987). Eligible studies included participants with a diagnosis of ADHD or hyperkinetic disorder, including either a clinical or DSM/International Classification of Diseases (ICD) research diagnosis, or scoring above a screening threshold for ADHD on a validated questionnaire, as well as a comparison sample of participants without ADHD. Participants from clinical and community samples were included. There were no restrictions on participant age, ethnicity or any other demographic information. To be eligible for inclusion, studies had to include statistical analyses comparing: 1) males and females with ADHD on item-level ADHD symptoms or co-occurring difficulties or 2) comparing females with ADHD to a group of females without ADHD, on item-level co-occurring mental health or neurodevelopmental difficulties. For studies to be included, these outcomes needed to be reported using statistical comparisons of group differences on item-level results, including percentages and effect sizes. Studies were also included if they contained the data needed (e.g. means) to calculate comparisons.

Studies were excluded if they only showed results for total ADHD scores and not item-level statistical results. Qualitative studies, case reports, reviews, systematic reviews, meta-analyses, non-human animal model studies, letters and editorials were not eligible for inclusion.

2.2. Comparison variables

The primary variables examined in this systematic review were core DSM-5 ADHD symptoms and impact of ADHD symptoms on functioning. Both types of variables were examined at an item-level. Impact included domains such as, but not limited to, education, peer relationships, and conduct problems. Co-occurring mental health or neurodevelopmental difficulties and impact were additional outcomes that were considered, including but not limited to emotional difficulties (e.g. anxiety, depression, irritability, and emotional dysregulation), peer and social relationship problems, learning problems, autistic traits, and behavioural difficulties. For details on the comparison variables (i.e. how they were measured/assessed) please see Table 1.

2.3. Information sources

Six electronic research databases were searched on 10/02/2023; Medline, EMBASE, APA PsychInfo (via Ovid), ProQuest (Dissertations & Theses Global), ERIC and British Education Index (via EBSCO) (see Table S2 for databases searched and the coverage of dates).

2.4. Search strategy

The search strategy was developed based on a scoping search of the existing literature and consultation with a university librarian. The

Table 1
Characteristics of the studies included in the systematic review.

Study characteristics					Participant characteristics						Variables analysed at an item-level	
Year	Author(s)	Country	Study population	Study design / comparison	Sample size			Age range	Age group	Definition of ADHD	ADHD symptoms	Non-ADHD items (e.g. impact)
					F with ADHD	M with ADHD	F without ADHD					
2004	Biederman et al.*	United States	Clinical sample	M and F with ADHD	82 (69 with item-level results)* *	137 (106 with item-level results)* *	n/a	37.6 ± 10.5 (mean - ADHD) & 38.7 ± 4.2 (mean - controls)	Adult	DSM-III-R (Structured Clinical Interview)	14 DSM-III-R items (K-SADS-E)	
2005	Graetz et al.	Australia	Population sample	M and F with ADHD	99	225	n/a	6–13 years	Child/ adolescent	DSM-IV (DISC-IV)		6 impairment items (DISC-IV)
2010	Monuteaux et al. *	United States	Clinical sample	M and F with ADHD	140	140	n/a	6–17 years	Child/ adolescent	K-SADS-E (for those < 18 years) and DSM-III-R (SCID) (for those > 18 years)	14 DSM-III-R symptoms (K-SADS-E and SCID)	
2012	Fedele et al.	United States	Population sample	M and F with ADHD	92	72	n/a	Young adults (college students)	Adolescent/ adult	Previously endorsed an ADHD diagnosis or DSM-IV-TR (BCSS-SR)		10 impairment items (BCSS-SR)
2016	Cortese et al.	United States	Population sample	M and F with ADHD	162	178	n/a	18–24 years	Adolescent	DSM-IV (AUDADIS-IV)	18 DSM-IV symptoms (AUDADIS-IV)	
2019	Ghanizadeh et al.	Iran	Clinical sample	M and F with ADHD	280	904	n/a	5.5–19 years	Child/ adolescent	DSM-IV diagnostic criteria (psychiatrist)	18 DSM-IV symptoms (Persian version)	
2019	Mowlem et al.	United Kingdom	Population sample	M and F with and without ADHD	32	121	49	7–12 years	Child	DSM−5 (PACS)		5 school impairment items (PACS)
2019	Vildalen et al.	Norway	Clinical sample	M and F with and without ADHD	340	342	522	17–71 years	Adolescent/ adult	ICD−10 research criteria (with allowance for the DSM-IV-TR subtypes)	18 DSM-IV-TR symptoms (ASRS)	
2020	Moukhtarian et al.	United Kingdom	Clinical sample and population sample	F with and without ADHD	28	n/a	29	18–65 years	Adolescent/ adult	DSM-IV criteria (DIVA)		5 mind wandering items (MEWS)
2021	Kamal et al.	Qatar	Population sample	M and F with and without ADHD	57	93	1001	15 ± 1.5 years (mean age)	Adolescent	DSM−5 (SNAP-IV rating scale)		6 behavioural adaptation questions (academic and social difficulties) devised by lead author
2022	Liu et al.	China	Clinical sample	M and F with ADHD	678	3355	n/a	6–16 years	Child/ adolescent	DSM-IV (CDIS)	18 DSM-IV symptoms (ADHD RS-IV)	
2022	Meyer et al.	Sweden	Clinical and population samples	M and F with and without ADHD	105	59	73	15–18 years (ADHD) 14–19 years (controls)	Adolescent	DSM−5 (ADHD module in the MINI-KID)		3 functional impairment items (CSDS)
2023	McKay et al.	Australia	Population sample	M and F with and without ADHD	29	43	18	13–17 years	Adolescent	DSM−5 (DAWBA)		2 friendship items (DAWBA)

Note. *Item-level results provided by authors (not available in published text) * *Item-level results only available for a subset of the data
M= male, F = female, n/a = not applicable, DISC-IV = Diagnostic Interview Schedule for Children, AUDADIS-IV = Alcohol Use Disorder and Associated Disabilities Interview Schedule, SNAP-IV = Swanson, Nolan and Pelham Questionnaire, K-SADS-E = Kiddie Schedule for Affective Disorders and Schizophrenia, SCID = Structured Clinical Interview for DSM-III-R, BCSS-SR = Barkley's Current Symptom Scale – Self-report, PACS = Parental Account of Childhood Symptoms, DAWBA = Developmental and Well-being Assessment, MINI-KID = Mini-International Neuropsychiatric Interview, CDIS = Clinical Diagnostic Interview Scale, MEWS = Mind Excessively Wandering Scale, CSDS = Child Sheehan Disability Scale.

search strategy consisted of three elements: (1) terms related to ADHD, (2) terms related to sex, and (3) terms related to symptoms. Terms within each element were combined with the Boolean operator OR and then all three terms were combined with the operator AND. The search used subject headings (controlled vocabulary) and free text terms. Due to the large number of potential co-occurring difficulties with ADHD, no additional terms were used to search for co-occurring difficulties other than the terms already used relating to symptoms (i.e. 'symptom'). Results were filtered to only include studies published from 1987 onwards. As a scoping search indicated that a high number of results would be retrieved from database searches, terms related to ADHD were only searched in the title and terms related to sex and symptoms were searched in the title/abstract. The full search strategy for each database is in Table S3.

2.5. Screening process

EndNote 20 was used to manage the search results (The EndNote Team, 2013) which automatically deduplicated the initial results. This was followed by manual deduplication. Any results with animal terms in the title or abstract (e.g. rat, mice) were removed. The remaining citations were then imported into Rayyan (Ouzzani et al., 2016). The study selection process was undertaken in two-stages. In stage one, titles and abstracts were screened according to the eligibility criteria. In stage two, full text articles were obtained and screened for eligibility. All screening, data extraction and quality appraisal was independently completed by two reviewers (TW, LH) with any conflicts being resolved through discussion with a third reviewer (JM). The reference lists for reviews, systematic reviews, and meta-analyses identified during the first stage of the screening process, were reviewed for any relevant studies. During stage two of the screening process, lead authors of papers were contacted to enquire about item-level results if these were mentioned but not included in published materials.

2.6. Data extraction process

Data were extracted from eligible studies by two reviewers (TW, LH) who both extracted 100 % of the data, with the extractions then checked by both reviewers. Data extraction was managed using Microsoft Excel. Data extracted included study characteristics (i.e., authors, title, year, country, study type and design, sample size, numbers of males and females), participant characteristics (age range and ADHD definition [i.e. how an ADHD diagnosis was described in each paper]), and item-level statistical results. ADHD items were grouped according to the DSM-5 criteria (American Psychiatric Association, 2013), where possible, or considered as 'other ADHD' items if they were from previous DSM criteria (i.e. DSM-III-R).

2.7. Quality assessment

The Joanna Briggs Institute (JBI) Critical Appraisal checklist for Analytical Cross-Sectional studies was used to judge the risk of bias (i.e. quality) of each study. The JBI checklist is used to assess the methodological quality of a study and determine the extent to which a study has addressed the possibility of bias in its design, conduct and analysis. The JBI checklist was adapted to suit the needs of the systematic review, with the eight questions being reduced to six (see **Supplementary Text: Quality Assessment**). Studies were judged as 'high risk' if one of the questions was answered 'no' or if three or more questions were answered 'unclear', as 'some concern' if two questions were answered 'unclear,' and as 'low risk' if all questions were answered as 'yes' or if one question, judged and discussed by the research team (TW, LH and JM) to be especially important, was answered as 'unclear'.

2.8. Data synthesis

Studies were grouped by comparison type (female ADHD vs male ADHD or female ADHD vs female comparison). Where possible, studies were grouped by age of participants: children (<13 years), adolescents/young adults (13–24 years) or adults (25 + years). Where sufficient data were available, and study designs were suitably similar (e.g. within the same age range and items relating to the same behaviour/difficulty), fixed effects meta-analyses were conducted per item to examine group comparisons on the outcomes listed above.

For the meta-analyses, available data (e.g. the percentage/number of participants endorsing item-level results) from all studies were transformed into odds ratios (OR) with 95 % confidence intervals (CI). The ORs and CIs were then adjusted in Stata 17 (StataCorp, 2021), with the meta-analyses being conducted with the "metan" command using the inverse variance model. Weighting of the meta-analyses was done based on study sample size. To examine heterogeneity statistics of any meta-analyses, I^2 was used.

Where meta-analysis was not feasible, the data was synthesised narratively, based on broad themes/domains (e.g. social impact).

3. Results

3.1. Search selection

The PRISMA flow chart (Fig. 1) describes the search and selection process. A total of 5344 records were identified through the database search, with one record identified through searching references lists. After the abstract screening, 4952 studies were removed as they did not meet the eligibility criteria. After full-text screening, 13 studies were eligible for inclusion within the review (Biederman et al., 2004; Cortese et al., 2016; Fedele et al., 2012; Ghanizadeh et al., 2019; Graetz et al., 2005; Kamal et al., 2021; Liu et al., 2022; McKay et al., 2023; Meyer et al., 2022; Monuteaux et al., 2010; Moukhtarian et al., 2020; Mowlem et al., 2019a; Vildalen et al., 2019). Six of the eligible studies found were included in meta-analyses. Three studies were included in the child/-adolescent meta-analyses (Ghanizadeh et al., 2019; Liu et al., 2022; Monuteaux et al., 2010) and included 1098 females and 4399 males. The other three studies were included in the adult meta-analyses (Biederman et al., 2004; Cortese et al., 2016; Vildalen et al., 2019) and included 571 females and 626 males. The remaining seven studies could not be meta-analysed and were instead narratively synthesised. These seven studies included 442 females with ADHD, 613 males with ADHD and 2619 females without ADHD. A list of articles excluded during full-text screening (n = 374), including reasons for exclusion, is provided in Table S4.

3.2. Study characteristics

The characteristics of the 13 included studies are described in Table 1. Studies were published between 2004 and 2023. The studies were from a variety of countries, including four from the United States, two from the United Kingdom, two from Australia and one each from Iran, Qatar, Norway, Sweden, and China. Five studies included clinical samples, six included general population samples and two studies a mixture of both. Six studies examined ADHD symptoms at an item-level and seven studies explored impact at an item-level. No studies looked at both symptoms and impact.

Of the included studies, six compared ADHD symptoms in males and females with ADHD, two compared impact in males and females with ADHD and five compared impact in females with and without ADHD. No studies examined co-occurring mental health or neurodevelopmental difficulties at an item-level. Of the 13 eligible studies, one focused on children (<13 years), four focused on adolescents/young adults (13–24 years) and one focused on adults (25 + years). The remaining seven studies reflected samples that crossed these age group boundaries, with

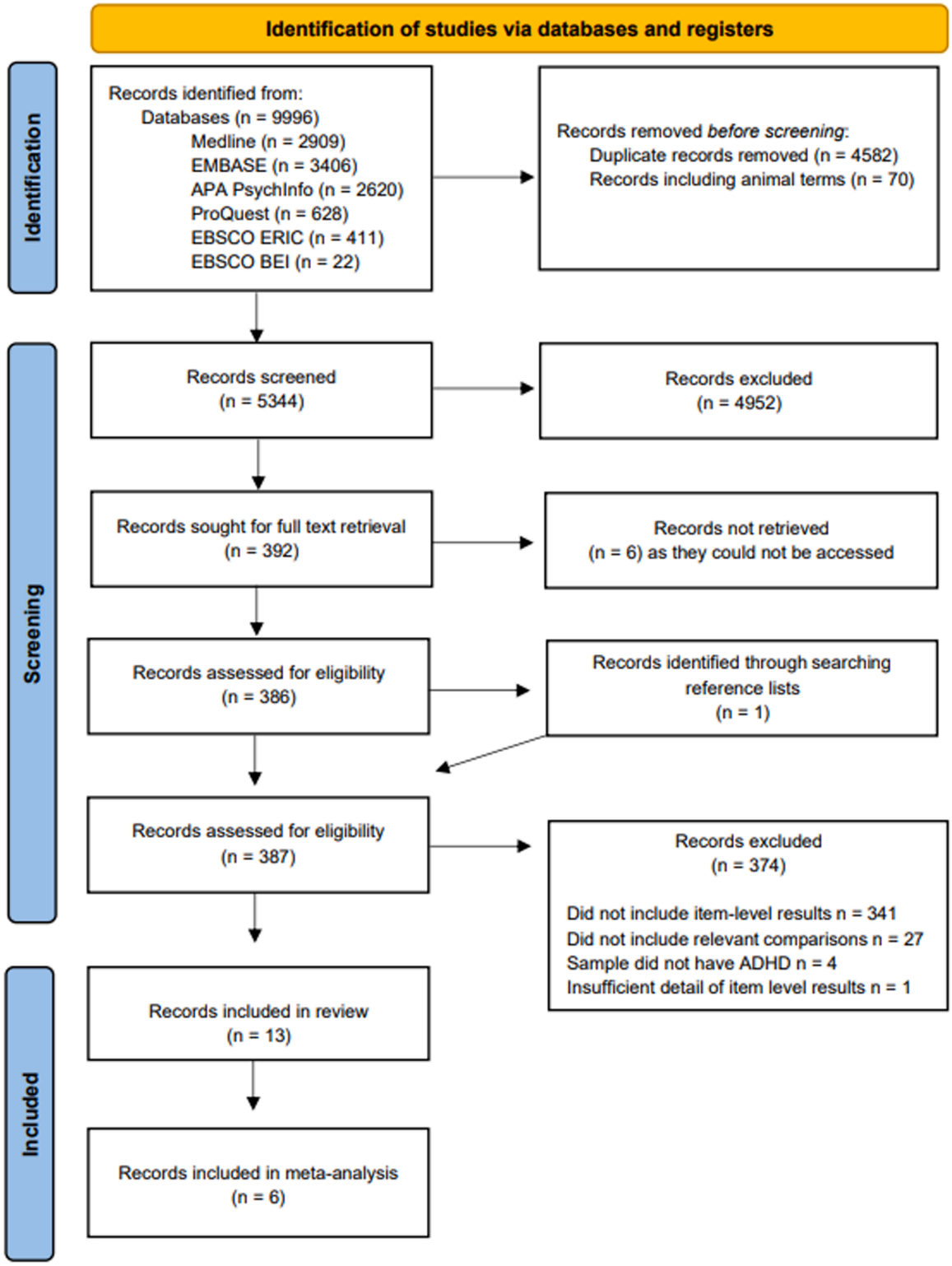

Fig. 1. PRISMA flow chart.

four studies including children/adolescents and three including adolescents/adults.

Within the studies, ADHD was confirmed using a variety of methods. 10 studies used research diagnostic interview measures (Biederman et al., 2004; Cortese et al., 2016; Ghanizadeh et al., 2019; Graetz et al., 2005; Liu et al., 2022; McKay et al., 2023; Meyer et al., 2022; Monuteaux et al., 2010; Moukhtarian et al., 2020; Mowlem et al., 2019a), two used research diagnostic questionnaires, one completed by expert committees (Kamal et al., 2021) and one used self-report data (Fedele et al., 2012), and another used a questionnaire using teacher-report (Vildalen et al., 2019). Studies also used a range of diagnostic criteria to define ADHD with two using the DSM-III-R, five using the DSM-IV, four using the DSM-5, one using the DSM-IV-TR and another using the ICD-10.

The seven studies examining impact at an item-level all used different measures and examined a variety of impact domains, including home life, friends and school, and another study focused on mind

wandering as a symptom of ADHD. Six studies used validated measures of impact (see Table 1**)**, with one study using a questionnaire devised by the lead author and consultant educational psychologist, which was validated by experienced paediatricians and psychologists and another study using the Mind Excessively Wandering Scale (MEWS) (Mowlem et al., 2019b).

Two studies used self-report (Fedele et al., 2012; Moukhtarian et al., 2020), three studies used parent-report (Graetz et al., 2005; McKay et al., 2023; Mowlem et al., 2019a), one study used teacher-report (Kamal et al., 2021) and one study used both self- and parent-report (Meyer et al., 2022). As all measures of impact were different, a meta-analysis was not possible, so results were narratively synthesised.

3.3. Risk of bias in studies

The overall risk of bias for all studies was medium to high; a summary of the risk of bias within each study is presented in Figure S1. One study was judged as 'low risk', five studies judged to have 'some concerns', and seven studies judged to be 'high risk'. The overall risk of bias for question three ('Was ADHD measured in a valid, objective and reliable way?') was low, with only one study (Fedele et al., 2012) being judged as 'high risk' for this question as they included participants with a self-reported ADHD diagnosis. However, nine of the 13 studies either did not identify any confounding factors or did so but did not deal with them appropriately (e.g. did not account for age in comparisons), or it was unclear how they did so (e.g. effect of medication status), and therefore four studies were judged as unclear, and five studies were judged as high risk for that question.

3.4. Meta-analysis results

The child/adolescent meta-analyses comparing females and males with ADHD were conducted on all 18 DSM-IV symptoms (see Fig. 2 note for item list) across three studies. Six DSM-IV items (items 3, 7, 9, 12 and 13) were only available in two studies (Ghanizadeh et al., 2019; Liu et al., 2022) – those items were not measured in Monuteaux et al. (2010) as they used the DSM-III-R. All child/adolescent studies used parent-report.

The results suggest that in children with ADHD, parents reported that females were more likely than males to display the symptoms "fails to sustain attention in tasks" (OR= 1.39, 95 % CI=1.12, 1.71) and "often easily distracted" (OR=1.54, 95 % CI=1.19, 1.96). In contrast, parents were more likely to report males as displaying the symptoms "often fails to follow through on instructions from others", "often fidgets", "difficulty remaining seated when required", "runs/climbs in situations when inappropriate", "always on the go", "often noisy in playing", "difficulty waiting turn", "often blurts out answers" and "often interrupts others". There was no sex difference for the other eight items. The strongest effects were OR= 1.54, 95 % CI= 1.19–1.98 for the item "often easily distracted" and OR= 0.86, 95 % CI = 0.75–0.99 for the item "often blurts out answers".

Heterogeneity, as indicated by I^2, ranged from 0 % (item 2, 3, 7, 8, 9, 10, 13 and 14) to 84.1 % (item 4) (Fig. 2).

The overall parent endorsement rates for the ADHD symptoms that had statistically significant sex differences were medium-high. The average endorsement rates in females for the ADHD symptoms with significant sex differences ranged from 28.91 % to 76.30 %. The item that was, on average, the highest endorsed was "fails to sustain attention in tasks". See Table S5 for all item endorsement rates.

The adult meta-analyses were conducted on three studies, across 16 DSM-IV items (see Fig. 3 note). Two items (items 2 and 12) could not be meta-analysed as they were only measured in one study (Cortese et al., 2016). Additionally, five items were only meta-analysed in two studies as four items (3, 7, 8 and 9) were not measured by Biederman et al. (2004) and one item (13) was not measured by Vildalen et al. (2019). All adult studies used self-report.

Adult females were more likely than males to endorse "often easily distracted" (OR= 1.49, 95 % CI=1.02, 2.16)., "often has difficulty organising tasks" (OR=1.40, 95 % CI=1.06, 1.85), "often blurts out answers" (OR=1.32, 95 % CI=1.02,.170), and "often talks excessively" (OR= 1.65, 95 % CI=1.30, 2.09). The item with the biggest sex difference in those with ADHD was "often easily distracted" and "often talks excessively", with females more likely than males to endorse these items. There was no sex difference for the other 12 items.

Heterogeneity, as indicated by I^2, ranged from 0 % (item 3, 5, 9, 18) to 92.6 % (item 13); see Fig. 3.

The overall endorsement rates for the ADHD symptoms that had statistically significant sex differences were high. The average endorsement rates for the ADHD symptoms with significant sex differences ranged from 52.66 % to 86.24 %. The item that was, on average, the highest endorsed was "often easily distracted". See Table S6 for all item endorsement rates.

3.5. Narrative synthesis

Mind wandering. Moukhtarian et al. (2020) found that spontaneous self-reported mind wandering was greater in intensity in adult females with compared to without ADHD, across all five items measured (see **Supplementary Text: Mind wandering item measurement**).

Home impact. Overall, females with ADHD were found to be more impaired on items measuring their home life than both males with ADHD and females without ADHD. In adults with ADHD, females endorsed significantly higher impact than males (Fedele et al., 2012). Females with ADHD had higher self-reported home impact than males with ADHD, and higher self- and parent-reported impact than females without ADHD (Meyer et al., 2022). Further, sex by ADHD-subtype interactions generally found that males were more impaired than females in the combined and hyperactive-impulsive subtype and were equally or less impaired than females with the inattentive subtype (Graetz et al., 2005). In contrast, Graetz et al. (2005) found no significant sex differences on ratings of annoyance to parents and interference with family activities.

Social impact. Females with ADHD were more impaired on items measuring social impact than females without ADHD, including being more impaired with friendships (Meyer et al., 2022) and finding it harder than average to make and maintain friends (McKay et al., 2023). Further, females with ADHD were more impaired than females without ADHD on making and maintaining friends and experiencing friend-related distress (Kamal et al., 2021). There were mixed findings when examining sex differences. Some studies reported that females were more impaired than males in their social life (Fedele et al., 2012) and with friendships (Meyer et al., 2022), including finding it harder than average to make and maintain friends (McKay et al., 2023). However, some studies reported no significant sex differences in social difficulties or impact of ADHD symptoms on peer activities (Graetz et al., 2005; Kamal et al., 2021).

School impact in children. Females with ADHD were more impaired on items measuring school impact than females without ADHD (Kamal et al., 2021; Meyer et al., 2022; Mowlem et al., 2019a). Females with ADHD were found to receive more special education provisions and complaints about hyperactive behaviour (Mowlem et al., 2019a) and more likely to be perceived as a burden to the teacher or class, impaired in class learning and experienced more difficulty with emotions, concentration, and behaviour at school than females without ADHD (Kamal et al., 2021). Further, compared to females without ADHD, females with the hyperactive-impulsive and combined subtype were more impaired in classroom learning and emotions and behaviour, while only those with the combined subtype were more impaired in burden to the teacher or classroom (Kamal et al., 2021). There were mixed findings when examining sex differences. Fedele et al. (2012) and Meyer et al. (2022) reported that females were more impaired at educational activities and at school than males. In contrast, Graetz et al. (2005) reported that males

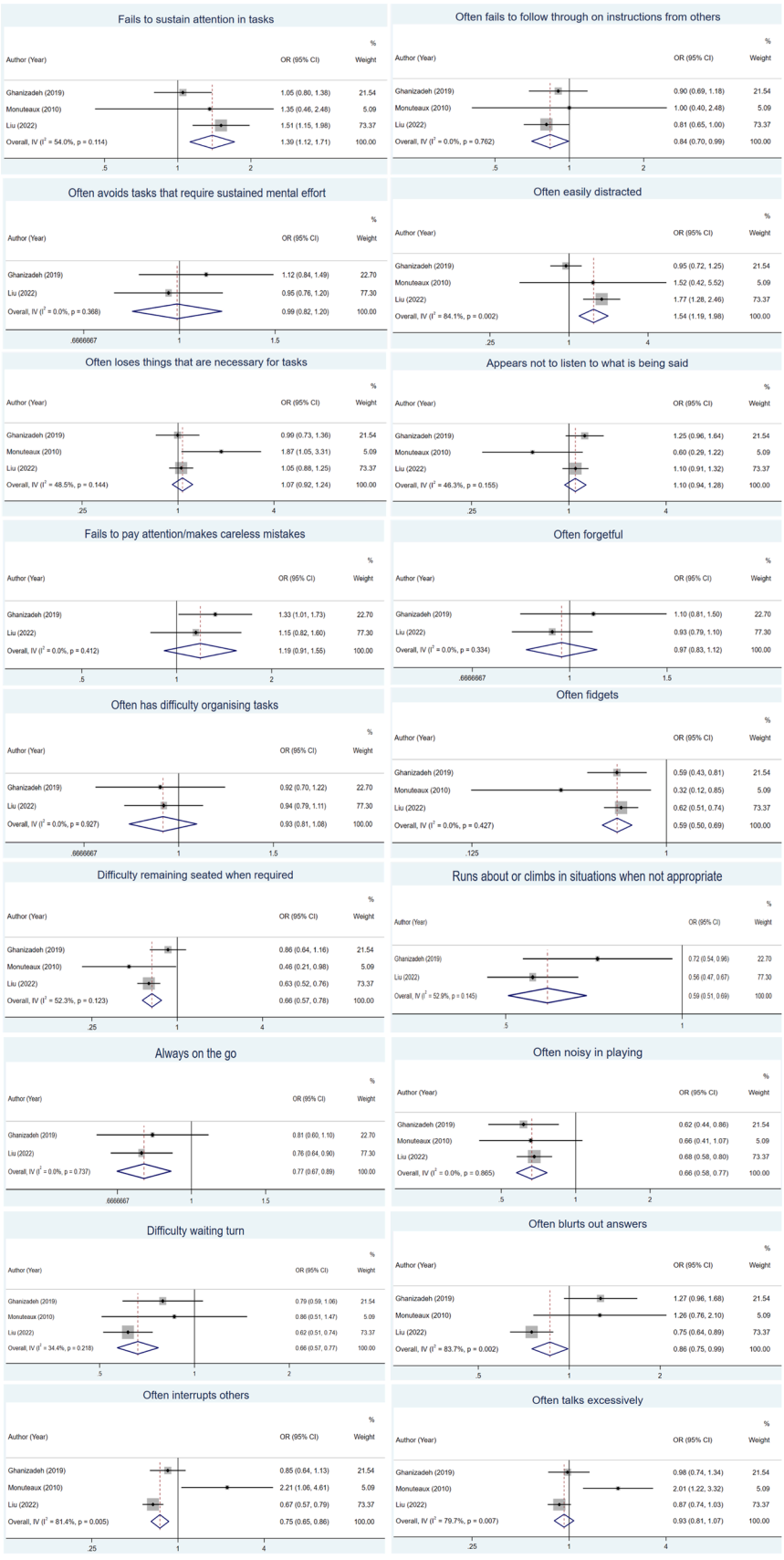

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Fig. 2. Meta-analysis forest plots for child/adolescent studies comparing males and females for individual ADHD items. Note. Weighted by study's sample size (Ghanizadeh et al., 2019 $n = 1184$; Monuteaux et al., 2010 $n = 280$; Liu et al., 2022 $n = 4033$). An odds ratio of < 1 suggests that males were more likely to display an item whereas an odds ratio of > 1 suggests that females were more likely to display an item. Item 1 = "Fails to sustain attention in tasks, Item 2 = "Often fails to follow through on instructions from others", Item 3 = "Often avoid tasks that require sustained mental effort", Item 4 = "Often easily distracted", Item 5 = "Often loses things that are necessary for tasks", Item 6 = "Appears not to listen to what is being said", Item 7 = "Fails to pay attention/makes careless mistakes", Item 8 = "Often forgetful", Item 9 = "Often has difficulty organising tasks", Item 10 = "Often fidgets", Item 11 = "Difficulty remaining seated when required", Item 12 = "Runs about or climbs in situations when not appropriate", Item 13 = "Always on the go", Item 14 = "Often noisy in playing", Item 15 = "Difficulty waiting turn", Item 16 = "Often blurts out answers", Item 17 = "Often interrupts others" and Item 18 = "Often talks excessively".

were more likely than females to have problems with their schoolwork and grades than females. Graetz et al. (2005) also reported that males were more likely than females to be considered annoying by teachers. Some studies reported no sex differences in school related-impact or academic difficulties (Kamal et al., 2021; Mowlem et al., 2019a). Additionally, males with ADHD were rated as more impaired than females in the combined and hyperactive-impulsive groups on problems with schoolwork and grades and annoyance to teachers, but equally impaired in the inattentive group (Graetz et al., 2005).

Other impacts. In adults, females with ADHD were significantly more impaired in their money management and daily life activities than males with ADHD (Fedele et al., 2012). There were no statistically significant sex differences found in community, dating or marital relationships, work, driving and leisure impact, although on all measures aside from community, females reported higher impact than males (Fedele et al., 2012). Graetz et al. (2005) found no significant sex differences across or within ADHD subtype on ratings of personal distress caused by symptoms in children.

4. Discussion

The aim of this systematic review was to examine if there were specific ADHD symptoms or types of impact that characterise the manifestation of ADHD in females compared to males with ADHD and females without ADHD. Despite using broad search terms to find relevant studies, only 13 eligible studies were found. Six studies of sex differences in ADHD symptoms could be meta-analysed, whereas the seven studies examining impact could only be synthesised narratively. Overall, our results suggest that there are some sex differences in ADHD symptom profile and that females with ADHD are generally more impaired across a range of domains compared to males with ADHD and females without ADHD.

The main meta-analysis results of sex differences in item-level ADHD symptoms demonstrate that in children with ADHD, parents report that females are more likely to display certain inattentive symptoms ("fails to sustain attention in tasks" and "often easily distracted") whereas males were more likely to display 8 of the 9 DSM-IV hyperactive-impulsive symptoms (all except "talks excessively"). In adults with ADHD, females were more likely than males to endorse a mix of inattentive ("often easily distracted" and "often has difficulty organising tasks") and hyperactive-impulsive ("often blurts out answers" and "often talks excessively") symptoms. Overall, the current results are consistent with previous research of diagnostic subtypes and total scores, which highlighted that females with ADHD are more likely to express inattentive symptoms (Quinn and Madhoo, 2014) and less likely to express hyperactive-impulsive symptoms (Loyer Carbonneau et al., 2021) (Gershon and Gershon, 2002; Quinn and Madhoo, 2014) than males with ADHD.

The results also demonstrate that there are fewer significant sex differences in endorsement of symptoms in adults relative to children. This may be due to developmental changes or how ADHD symptoms were measured, with parent-report used for children and self-report used for adults. Previous work has found that parents are more likely to rate DSM-IV symptoms of ADHD (excluding "talks excessively") as male-descriptive (Ohan and Johnston, 2005) and also overrate males' hyperactive-impulsive symptoms compared to objective interviews (Mowlem et al., 2019a). As such, differential misclassification may be operating, resulting in parents endorsing more robust sex differences in ADHD symptoms, especially on hyperactive-impulsive symptoms. Although, given the male-biased sex ratio of ADHD in childhood reducing to near 1:1 in adulthood (Williamson and Johnston, 2015), parents may be reporting real sex differences in symptoms, rather than this reflecting a bias in reporting. Additionally, another possibility may be that females are more willing to take part in research studies (Glass et al., 2015) and as such there may be a bias in who takes part in adult studies.

Further, when examining sex differences in adults, "talks excessively" was found to have a large effect size, with females being more likely to endorse the symptom than males. This finding is interesting as it is congruent with previous studies that have attempted to characterise 'female-sensitive' ADHD behaviours and have included items such as "talks excessively" and "likes to talk a lot" (Grskovic and Zentall, 2010; Ohan and Johnston, 2005) and indeed this was the only hyperactive-impulsive item not showing a male-bias in our meta-analysis of sex differences in children.

In sum, the results suggest that there are sex differences in the core diagnostic symptoms related to ADHD. This could contribute to the under-recognition of ADHD in females. The overall endorsement rates for individual ADHD symptoms with observed sex differences were high in adults and medium to high in children. This indicates that symptoms commonly differ between sexes across samples with ADHD. These findings have useful clinical implications as they highlight which ADHD symptoms clinicians may want to be more aware of when assessing females with suspected ADHD, such as certain inattentive symptoms in childhood (e.g. "fails to sustain attention in tasks") and hyperactive-impulsive symptoms in adulthood (e.g. "talks excessively"), which may aid more accurate and timely ADHD diagnoses, allowing for earlier treatment, which would promote improved quality of care.

Further, while there was evidence of sex differences in some ADHD symptoms, there were many symptoms where we did not see any sex differences, in both child- and adulthood, particularly for inattentive symptoms. This may indicate that the diagnostic criteria/symptom checklists used may be valid tools to capture inattentive symptoms overall. Although, given that the development of the diagnostic criteria may be biased towards the male presentation (Mowlem et al., 2019c), there are likely more female-sensitive ADHD-related difficulties omitted (e.g. previously suggested items such as 'doodles instead of completing classwork', 'impulsively changes conversation topics' & 'changes friends without thinking') (Ohan and Johnston, 2005); if included in the diagnostic criteria, such additional items could theoretically better capture female ADHD and help identify ADHD in females at an earlier age. Also, given the eligible studies in our review included females with recognised ADHD, females with different or atypically presenting ADHD symptoms are likely not to have been included. This could also include difficulties related to mind wandering.

Our findings on mind wandering (Moukhtarian et al., 2020) support previous work and literature reviews, suggesting that spontaneous mind wandering is associated with ADHD (Biederman et al., 2006; Lanier et al., 2021), with females with ADHD displaying more intense mind wandering than females without ADHD (Moukhtarian et al., 2020). Mind wandering can have a negative effect for individuals, including reducing overall wellbeing, even after accounting for the effects of ADHD symptoms (Mowlem et al., 2019b). These findings on mind wandering are interesting as they suggest it is associated with more

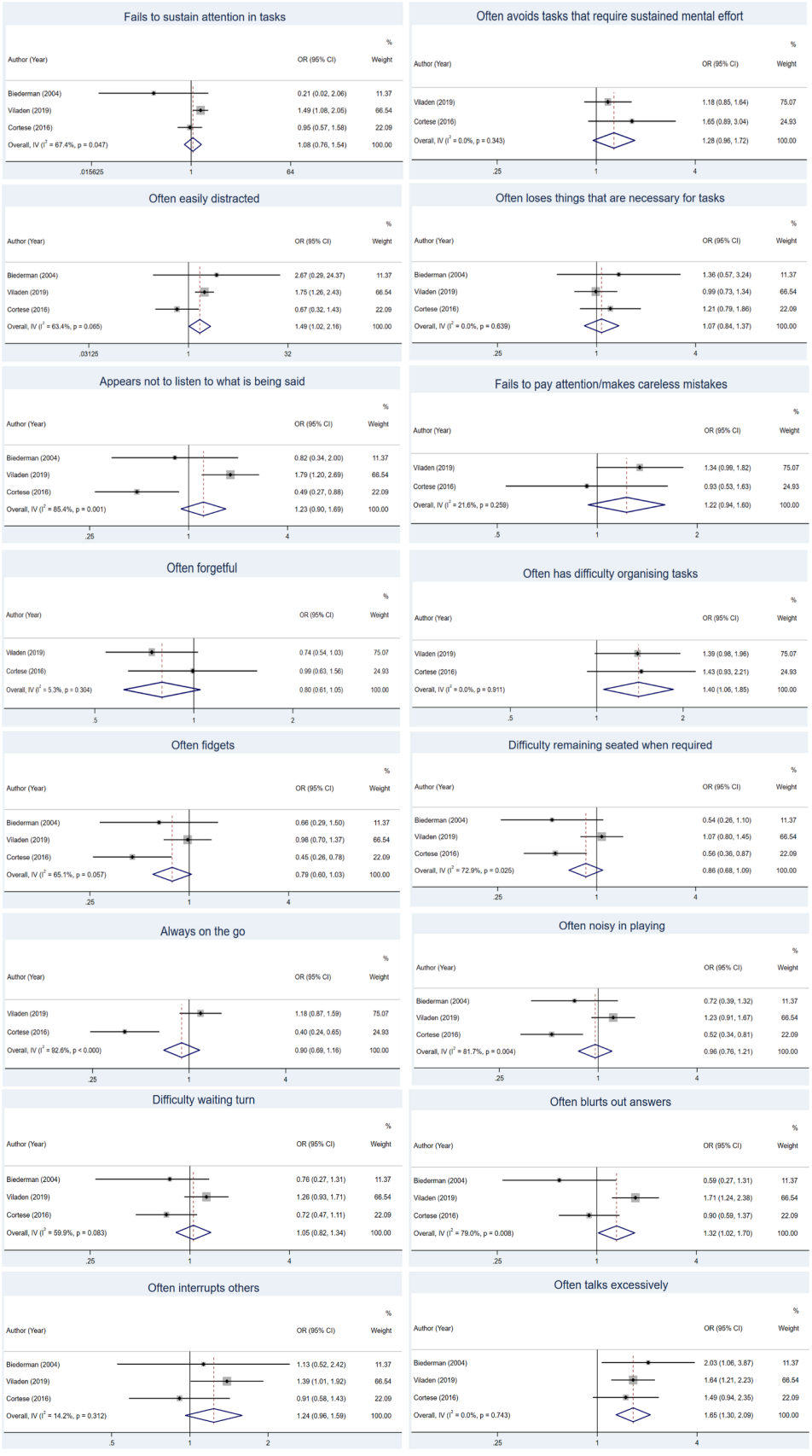

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Fig. 3. Meta-analysis forest plots for adult studies comparing males and females for individual ADHD items. Note. Weighted by study's sample size (Biederman et al., 2004 $n = 175$; Vildalen et al., 2019 $n = 1024$; Cortese et al., 2016 $n = 340$). An odds ratio of < 1 suggests that males were more likely to endorse an item whereas an odds ratio of > 1 suggests that females were more likely to endorse an item. Item 1 = "Fails to sustain attention in tasks, Item 3 = "Often avoid tasks that require sustained mental effort", Item 4 = "Often easily distracted", Item 5 = "Often loses things that are necessary for tasks", Item 6 = "Appears not to listen to what is being said", Item 7 = "Fails to pay attention/makes careless mistakes", Item 8 = "Often forgetful", Item 9 = "Often has difficulty organising tasks", Item 10 = "Often fidgets", Item 11 = "Difficulty remaining seated when required", Item 13 = "Always on the go", Item 14 = "Often noisy in playing/doing leisure activities quietly", Item 15 = "Difficulty waiting turn", Item 16 = "Often blurts out answers", Item 17 = "Often interrupts others" and Item 18 = "Often talks excessively".

functional impairment when present, requiring further research given the limited literature available.

Our review also examined sex differences in impact related to ADHD at an item-level. In general, females had more impact from ADHD at home than males (Fedele et al., 2012; Meyer et al., 2022). Although one study reported males were generally more impaired than females when comparing children with the same ADHD subtype (Graetz et al., 2005), this may be because the items used to measure home impact aligned closely with descriptions of hyperactivity-impulsivity ("ratings of annoyance" and "interference with family activities"), which are often more likely to be endorsed by parents as male-descriptive (Quinn and Madhoo, 2014). These findings suggest that females compared to males with ADHD are more likely to be impacted in their home life (Biederman et al., 2006).

Females with ADHD were more impaired on items measuring social impact than females without ADHD (Kamal et al., 2021; McKay et al., 2023; Meyer et al., 2022). This is consistent with previous work indicating that females with ADHD are impaired on peer functioning and have lower levels of friendships participation (Kok et al., 2016; Quinn and Madhoo, 2014). Some of the reviewed studies reported that females with ADHD are more socially impaired than males, including with making and maintaining friends (Fedele et al., 2012; McKay et al., 2023; Meyer et al., 2022). These results are in line with a recent systematic review on sex differences in social functioning (Faheem et al., 2022). However, two studies found no evidence of sex differences in social impairment (Graetz et al., 2005; Kamal et al., 2021), possibly partly due to reliance on teacher reports to accurately compare students' behaviours to descriptors on a checklist, after only knowing students for six months (Kamal et al., 2021). These findings are important as social skill impairment and limited social activities have been suggested to be associated with long-term mental health difficulties in those with ADHD (Mrug et al., 2012).

The results on school impairment suggested that females with ADHD were more impaired than females without ADHD, consistent with previous literature (Biederman et al., 2006). Sex differences in school impairment suggest that females are more impaired in school and educational activities (Fedele et al., 2012; Meyer et al., 2022), with inattentive females more impaired in classroom learning, emotions, concentration and behaviour (Kamal et al., 2021), while males are more impaired in schoolwork/grades and annoyance to teachers (Graetz et al., 2005). Previous work suggests that females with ADHD are more impaired at school than males with ADHD (Wolraich et al., 1996). The mixed results identifying males with ADHD as more impaired in their schoolwork/grades than females with ADHD may be because Graetz et al. (2005) assessed the extent to which an individual's ADHD influenced their schoolwork/grades, not if the individual was academically impaired. This highlights the importance of reporting item-level results to understand the nuances of this issue. Additionally, males with ADHD may be rated as being more of an annoyance to teachers than females with ADHD as they are rated by teachers as displaying more problem behaviour (e.g. aggression) (Derks et al., 2007). This also highlights that comorbidity is likely to vary by sex. The mixed findings on school impairment by Mowlem et al. (2019a) and Kamal et al. (2021) may have been due to a variety of reasons. These include reduced power to find group differences due to a large mismatch between the number of male and female (121 vs 32) participants (Mowlem et al., 2019a) and small sample sizes in the inattentive group (12 males and 11 females) (Kamal et al., 2021).

Some studies within the review analysed impact items across and within individual ADHD subtypes (Graetz et al., 2005; Kamal et al., 2021). The findings highlight sex-specific risks associated with different ADHD subtypes on impact, which are often overlooked when studies only examine sex differences across ADHD regardless of subtypes, highlighting that ADHD subtype should be considered when examining ADHD sex comparisons.

Overall, the results on impact found that females with ADHD were more impaired than females without ADHD in terms of school, social and home impact. Females with ADHD compared to females without ADHD also reported more 'ADHD-related' difficulties such as mind wandering. Females with ADHD were also more impaired than males with ADHD in their home life, with mixed findings on school and social impact. Impact at school and in an individual's social and home life can have further negative knock-on effects, including increased loneliness due to difficulties with social relationships which may have adverse effects on mental health, including contributing to the development of co-occurring mood and anxiety disorders (Houghton et al., 2020; Jong et al., 2024). Difficulties at school such as receiving complaints about hyperactivity (Mowlem et al., 2019a) can increase the likelihood of suspension (Loe and Feldman, 2007), and along with impairment in classroom learning (Kamal et al., 2021), affect overall academic performance (Keilow et al., 2018), which can result in lower employability and quality of life (Shifrin et al., 2010). These findings suggest that timely identification and diagnosis of ADHD are vital, especially in females who often receive a delayed diagnosis, as it allows for treatment and support, such as facilitating social support and accommodations/interventions at school (Lovett et al., 2023), that can help mitigate or reduce the impact of symptoms.

5. Strengths and limitations

This systematic review is novel as it is the first to explore and synthesise findings from studies that report item-level sex differences in ADHD symptoms and impact, using rigorous review methods. The eligibility criteria included participants scoring above a screening threshold for ADHD, allowing results to include females who would be sub-threshold for conventional ADHD diagnostic criteria, increasing the chance of finding sex differences on ADHD symptoms or related impact. Findings highlight important differences in ADHD symptom profiles between males and females. The protocol for this review was pre-registered, and made publicly available via PROSPERO, reducing the risk of reporting bias. Additionally, we gathered unpublished data from eligible studies where possible. However, there were some limitations with the review. There were a limited number of studies found, with only six studies able to be meta-analysed. Additionally, the overall risk of bias of the systematic review is medium-high. All studies of ADHD rely on established ADHD criteria. If these are indeed male biased, then female ADHD behaviours not included in these criteria will have been missed. Females may also need greater symptom levels and impact for their ADHD to be recognised and included in a research study which could account for our sex difference findings. This review also only included studies published in English. Further, there was a lack of adjustment for psychiatric comorbidities and medication status which may have influenced the results and could explain why heterogeneity in the meta-analyses was large for some items. The search terms for the review may have been too broad to identify studies examining sex differences in co-occurring mental health or neurodevelopmental

conditions and may have benefited from a narrower scope. Additionally, there are limitations to consider with the studies included in the review. First, only a limited number of studies meeting inclusion criteria have been published, which limits the interpretation of the results. Second, the included studies used a variety of ADHD definitions and measures, as such, some ADHD symptoms could not be meta-analysed, or the analysis included a subset of studies. Similarly, the impairment measures used were all different, making it hard to draw robust conclusions. Finally, the risk of bias assessment suggested that not all the studies included in the review were of high quality, with only one study being deemed low risk overall. Further, many studies reported confounding variables, but not all dealt with them appropriately, increasing the risk of bias.

6. Clinical implications and future studies

As previously mentioned, these findings have useful clinical implications as they highlight the individual ADHD symptoms that clinicians may want to be aware of when assessing and diagnosing suspected female ADHD. Increasing awareness of how ADHD manifests in girls, including improving future assessment tools to more readily identify ADHD in girls, is essential as it will potentially facilitate earlier ADHD diagnoses. Further, given our findings indicate that females compared to males with ADHD are more likely to report family and interpersonal difficulties, when clinicians diagnose girls with ADHD, they should ask about these and consider what kinds of relevant support could be offered, such as family-based therapies or counselling tailored to the individual. The findings also have implications for future studies. Given the limited research on item-level sex differences in ADHD symptoms, we strongly recommend that future studies include this level of detail, even if it is not the primary analysis. This will provide more detailed results and allow researchers to unpick which specific symptoms are contributing to different presentations of ADHD. Future studies should also address the limitations of the present review, by adjusting and reporting on confounding factors such as mental health comorbidities, ADHD subtype and medication status.

Further, given that the ADHD diagnostic criteria field studies were based mainly on males (Lahey et al., 1994), future research should examine if other difficulties related to ADHD, not in the diagnostic criteria, characterise the manifestation of ADHD in females compared to males and those without ADHD. Other factors may include emotion dysregulation, which has been identified as a potential characteristic of female ADHD (Quinn and Madhoo, 2014), and symptoms previously suggested as 'female-sensitive' (e.g. emotional impulsivity such as changing friends impulsively) (Grskovic and Zentall, 2010; Ohan and Johnston, 2005). Revisions to diagnostic criteria for ADHD could include additional symptoms or refinements to existing criteria, but the evidence base for these needs to be robust. Finally, future studies should also examine, and report item-level sex differences in mental health or neurodevelopmental comorbidities in individuals with ADHD as no studies were found to be eligible for the present review.

7. Conclusion

This systematic review and meta-analysis provided insights into the sex differences in individual core symptoms and impact related to ADHD. In childhood, females were more likely to display specific inattentive symptoms, such as "fails to sustain attention in tasks" and "often easily distracted", than males, who were more likely to display most of the hyperactive-impulsive symptoms, such as "often fidgets" and "difficulty remaining seated when required". In adulthood, females with ADHD were more likely than males with ADHD to endorse the symptoms "often easily distracted", "often has difficulty organising tasks", "often blurts out answers" and "often talks excessively". Further, the results suggested that females with ADHD are more impaired than males with ADHD and females without ADHD on a range of items, including school impact, and their home and social life. Overall, the review highlights the need for future research to identify and characterise symptoms typical of female ADHD, as it may have important implications for clinical practice and aid future development of a more inclusive ADHD assessment tool to help earlier ADHD recognition and diagnosis in females.

CRediT authorship contribution statement

- Tamara Williams (first author): study design, protocol writing & revision, screening & data extraction, analysis/synthesis, manuscript writing & revision
- Louise Horstmann: protocol/manuscript editing, screening & data extraction
- Annabelle Lim: screening
- Laiba Kayani: screening
- Abby Russel, Kate Langley, Tamsin Ford, Ann John, Kapil Sayal, Anita Thapar: protocol/manuscript editing
- Joanna Martin (senior author): study design, protocol writing, resolving data screening discrepancies, manuscript writing & editing, supervision

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Disclosures

Tamsin Ford's research group received funds for research methods consultation with Place2Be, a third sector organisation providing mental health interventions and training within schools.

Kate Langley has been part of the scientific advisory board for Medice, on topics unrelated to this work.

All other authors report no conflicts of interest.

Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.neubiorev.2025.106064.

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