Original Article

Prevalence and Risk Factors of Attention Deficit-Hyperactivity Disorder in the Saudi Population: A Systematic Review and Meta-analysis

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Abstract

Objectives: To determine the prevalence and risk factors of attention deficit hyperactivity disorder (ADHD) in Saudi Arabia.

Methods: Observational studies (case–control, cohort, and cross-sectional) that reported the prevalence and risk factors of ADHD among Saudis and were published in English were included. In March 2022, a computerized search was conducted on Medline (via PubMed), Web of Science, and Scopus using keywords associated with ADHD and Saudi Arabia. Two-stage screening and data extraction were performed. The National Institutes of Health Quality Assessment Tool for Observational Cohort and Cross-sectional studies was used for the quality assessment. A random-effects model was used to estimate the prevalence. The Comprehensive Meta-analysis program was used for the analysis.

Results: Fourteen studies ($N = 455{,}334$ patients) were included. The pooled prevalence of ADHD in the Saudi population was 12.4% (95% CI: 5.4%–26%). For ADHD-Inattentive and ADHD-Hyperactive presentations, the prevalence was 2.9% (95% CI: 0.3%–23.3%) and 2.5% (95% CI: 0.2%–20.5%), respectively. Regarding the combined AD and HD, the prevalence was 2.5% (95% CI: 0.2%–20.5%). Children of women with psychological disorders during pregnancy ($P = 0.043$), insufficient vitamin B during pregnancy ($P = 0.006$), allergic reactions ($P = 0.032$), and disabling symptoms of muscle pain during pregnancy ($P = 0.045$) were associated with an increased risk of ADHD.

Conclusions: The prevalence of ADHD in the Saudi population is comparable with that in other countries from the Middle East and North Africa region. Careful monitoring of pregnant women, attention to nutritional sufficiency, psychological and emotional support, and avoidance of stressful events may lead to reducing the incidence of ADHD in the offspring.

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Keywords: Attention deficit-hyperactivity disorder; meta-analysis, prevalence; risk factor; Saudi Arabia

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INTRODUCTION

Attention Deficit-Hyperactivity Disorder (ADHD) is described as a persistent pattern of inattention or hyperactivity–impulsivity that interferes with functioning/development.[1] Low occupational performance, high family and community economic burden, low social skills, and low academic achievement are only some of the negative outcomes linked to this condition in both children and adolescents.[2] It is estimated that 30%–60% of children with ADHD will continue to have symptoms throughout adulthood.[3] Individuals with ADHD have a higher rate of acquiring sexually transmitted diseases, a higher risk of motor accidents, a higher rate of psychiatric disorders (such as substance abuse, personality disorder, and depression), and a greater incidence of unemployment, as compared with those without a history of ADHD.[4]

The prevalence of ADHD varies according to the cultural and geographical differences, measurement scale used (e.g., DSM-5, DSM-4, and ICD), sample type (class cluster, school, or clinical samples), and differences in reports from different assessors (self, physicians, parents, and teachers).[5] DSM-5 criteria for ADHD include presenting with a number of symptoms, including difficulty paying attention, being easily distracted, difficulty organizing tasks or activities, fidgeting, talking excessively, and acting without thinking.[6] ICD-11 criteria explicitly require impairment in more than one area of life activity such as learning, communication, family relationships, and social interaction; impairment in age-appropriate tasks such as reading, writing or arithmetic; developmentally inappropriate hyperactivity or impulsivity; and a significantly lower level of functioning before the age of 7 years than peers.[7]

Previously, systematic reviews and meta-analyses have found the worldwide prevalence of ADHD in children and adolescents was 5.3% and 5.9%.[8,9] However, more recently, a meta-analysis of 175 papers found that 7.2% of children and adolescents worldwide had ADHD.[10] In Europe, the estimated prevalence of ADHD ranges from 3.2% to 7.5%.[11] In America, in 2019, about 8.8% of children aged 3-17 years had been diagnosed with ADHD.[12] Southeast Asian countries such as China and Taiwan have reported an increased prevalence in recent years, ranging from 6.3%–18%.[13,14] Australia and New Zealand report an incidence rate of 5%–9%, while South American countries report a lower incidence rate of 2.1%–5%. In Africa, the prevalence varies from 0.6%–10%.[15,16] However, from the Arab countries, there is a lack of high-quality data from prevalence studies on ADHD.

In a meta-analysis, it was found that among school-aged children in Arab nations, including Egypt, Saudi Arabia, Palestine, Oman, Qatar, and the United Arab Emirates (UAE), the prevalence of ADHD varied between 5.1% and 14.9%.[17] Another systematic review of 26 articles demonstrated that the prevalence of ADHD in Arab countries, including Lebanon, Jordan, Saudi Arabia, Egypt, Bahrain, Sudan, Palestine, Qatar, Tunisia, Kuwait, Iraq, Oman, UAE, and Yemen, over the past 25 years ranged from 1.3% to 34.5%.[18] However, these reviews included only three studies from Saudi Arabia. In 2019, a national survey in Saudi Arabia showed that the overall prevalence of ADHD was 8%.[19]

The development of therapeutic and educational services for children with ADHD is limited by the lack of data on the disorder's prevalence among school-aged populations.[20] In addition, identifying the prevalence rate of ADHD contributes to the design of public policy and mental health programs for children and adolescents who have been diagnosed with the disorder. The detection of ADHD prevalence rates has been an urgent requirement and a crucial research priority worldwide, but notably in developing countries, due to the implications on national economies.[21] Therefore, this systematic review and meta-analysis was conducted with the aim of determining the prevalence of ADHD and its associated risk factors in Saudi Arabia.

METHODS

The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) checklist and Cochrane Handbook for Systematic Reviews of Interventions were used for reporting this study.[22,23] The study protocol was registered with PROSPERO (reference no.: CRD42023390040).

Eligibility criteria

Observational studies (case–control, cohort, and cross-sectional) that reported the prevalence and risk factors of ADHD among Saudis were included. Case reports, conference abstracts, and studies published in any language except English were excluded.

Information sources and search strategy

Searches were carried out in March 2022, in the following databases: Medline (via PubMed), Scopus, and Web of Science. The keywords used for the study were as follows: Attention deficit disorders with hyperactivity/ADHD/attention deficit-hyperactivity disorder/hyperkinetic syndrome(s)/hyperkinetic/attention deficit-hyperactivity

disorders/deficit-hyperactivity disorder/ADDH/attention deficit disorder/attention deficit disorders/minimal brain dysfunction and Saudi Arabia/Kingdom of Saudi Arabia/Saudi Arab. No publication date filters were applied. In addition, the reference lists of all the relevant articles and the published systematic reviews on the same topic were searched. All citations were imported to the EndNote X9 software, following which the duplications were removed.

Selection process

A screening sheet was created using the Microsoft Excel software, and it recorded the study ID, year of publication, title, abstract, keywords, DOI, and URL. For the selection process, three authors independently first screened the title and abstract of all studies retrieved in the searches, and then, the full text of studies that were deemed to meet the initial inclusion criteria. All disagreements between the authors were resolved by the supervisor of the study (A.A).

Data items and collection process

A pre-prepared Excel sheet was used for data extraction, and it elicited data regarding demographics (age and gender), study characteristics (study duration, sample size, and the primary findings), and outcomes (prevalence of ADHD and risk factors of ADHD, including patient-related, maternal, and sociodemographic risk factors). Four authors independently extracted the data.

Risk of bias and quality assessment

Two authors independently assessed the risk of bias and quality of the included articles using the National Institutes of Health (NIH) Quality Assessment Tool for Observational Cohort and Cross-sectional studies.[24] All disagreements were resolved by the supervisor of the study (A.A). The tool comprises 14 questions, and studies with scores <7 were classified as poor, 7–9 as fair, and >9 as good.

Data synthesis

The pooled prevalence of ADHD was calculated using the random-effects model with a 95% confidence interval (CI). Heterogeneity between studies was calculated using the I^2 statistic, wherein a value of 25% was considered as low heterogeneity, 50% as moderate, and 75% as high. If the heterogeneity was moderate and above (i.e., I^2 >50%), the random-effect model was used, while in the other cases, the fixed-effect model was used. Comprehensive Meta-analysis (version 3.3.070; Biostat Inc., Englewood, NJ) was used for all statistical analyses. To resolve heterogeneity, a sequential sensitivity analysis was performed, wherein one study was removed in each scenario. Furthermore, a subgroup analysis based on gender, assessors, quality of the study, and assessment tool was performed to minimize the risk of inconsistency. To assess the difference between males and females in terms of ADHD prevalence, we calculated the odds ratio (OR) using the Mantel-Haenszel model. Publication bias was assessed based on the criteria of Egger's test, and a funnel plot was generated for the forest plots that included ≥10 studies.

RESULTS

Study selection

The initial searches retrieved 387 relevant articles. After removing duplicates, the title/abstract of 276 studies were screened, and of these, 256 did not meet the inclusion criteria. Therefore, the full text of 20 studies were screened and a further 6 were excluded. Finally, 14 articles with 455,334 patients were included in the qualitative and quantitative synthesis.[25-38] Figure 1 shows the PRISMA flow diagram of the included studies.

Characteristics of the included studies and patients

All included studies were cross-sectional, except one study by Khan 2021,[31] which was a qualitative exploratory study. The age of the included patients ranged from 1 to 17 years. All studies included both genders, except in Al Hamed *et al.*,[38] who only included males, and Jenahi *et al.*,[28] who only included females. Table 1 summarizes the characteristics of the included studies and patients.

Quality of the included studies

According to the NIH Quality Assessment Tool for Observational Cohort and Cross-sectional Studies, about 57% of the studies were classified as Fair and 43% as Good; there were no Poor studies.

Prevalence of attention deficit-hyperactivity disorder and its subtypes

The pooled effect estimates of 14 studies showed that the prevalence of ADHD in the Saudi population was 12.4% (95% CI: 5.4%–26%) [Figure 2]. The pooled data were heterogeneous and were not resolved with a sensitivity analysis ($I^{2:}$ 99.12%, $P < 0.001$). No publication bias was detected based on the funnel plot and Egger's test ($P = 0.363$) [Figure 3]. The prevalence of ADHD subtypes was reported in seven studies. For ADHD-Inattentive and ADHD-Hyperactive presentations, the prevalence was 2.9% (95% CI: 0.3%–23.3%), and 2.5% (95% CI: 0.2%–20.5%), respectively. Regarding the combined ADHD-Inattentive and ADHD-Hyperactive presentations, the prevalence was 2.5% (95% CI: 0.2%–20.5%) [Figure 4a-c].

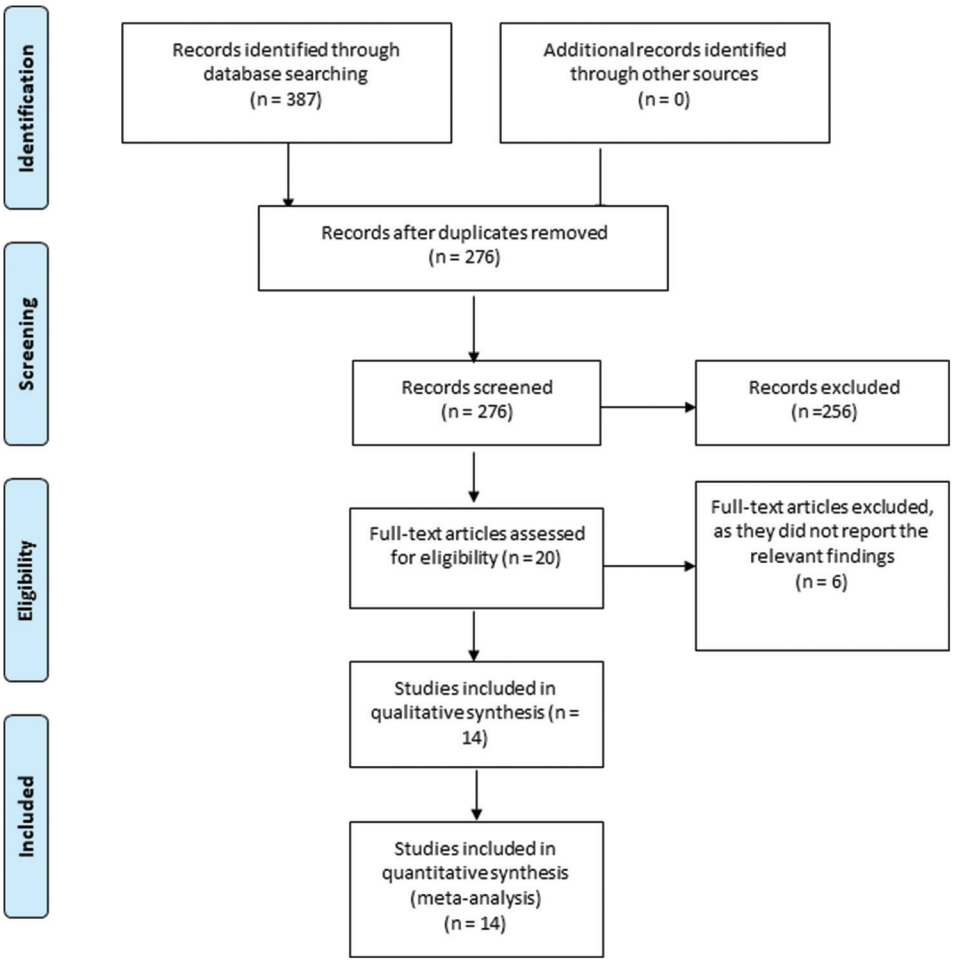
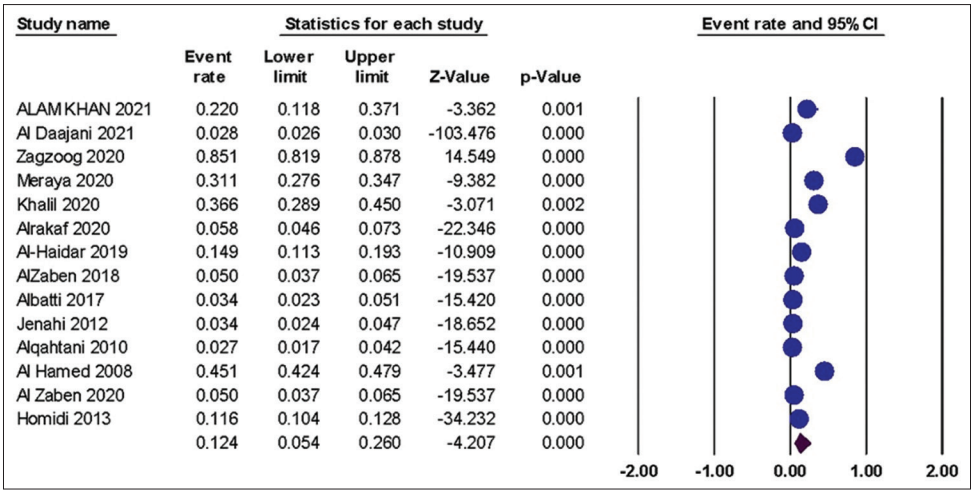


Figure 1: PRISMA flow diagram. PRISMA: Preferred Reporting Items for Systematic Reviews and Meta-Analyses



Study name	Event rate	Lower limit	Upper limit	Z-Value	p-Value
ALAM KHAN 2021	0.220	0.118	0.371	-3.362	0.001
Al Daajani 2021	0.028	0.026	0.030	-103.476	0.000
Zagzoog 2020	0.851	0.819	0.878	14.549	0.000
Meraya 2020	0.311	0.276	0.347	-9.382	0.000
Khalil 2020	0.366	0.289	0.450	-3.071	0.002
Alrakaf 2020	0.058	0.046	0.073	-22.346	0.000
Al-Haidar 2019	0.149	0.113	0.193	-10.909	0.000
AlZaben 2018	0.050	0.037	0.065	-19.537	0.000
Albatti 2017	0.034	0.023	0.051	-15.420	0.000
Jenahi 2012	0.034	0.024	0.047	-18.652	0.000
Alqahtani 2010	0.027	0.017	0.042	-15.440	0.000
Al Hamed 2008	0.451	0.424	0.479	-3.477	0.001
Al Zaben 2020	0.050	0.037	0.065	-19.537	0.000
Homidi 2013	0.116	0.104	0.128	-34.232	0.000
	0.124	0.054	0.260	-4.207	0.000

Figure 2: The overall prevalence of ADHD among Saudi population. ADHD: Attention-deficit/hyperactivity disorder

Subgroup analysis

There was no significant difference between both genders in terms of the prevalence of ADHD (OR = 1.34, 95% CI: 0.84–2.14, $P = 0.215$) [Figure 5]. Based on the study tool, the prevalence of ADHD was higher in the studies that used ADDES (13.5%; 95% CI: 3.2%–43.0%), followed by DSM-IV (11.2%; 95% CI: 0.6%–71.3%), self-developed questionnaire (9.3%; 95% CI: 3.6%–22.4%), ASRS (8.9%; 95% CI: 1.3%–42.7%), and Vanderbilt ADHD Rating Scale (4%; 95% CI: 2.6%–6.3%). Regarding the reporter,

Table 1: Summary of the included studies and patients

Study	Study design	Total sample	Prevalence of ADHD (%)	Study tool	Reporter	Age (years)	Gender male, *n* (%)	Autism, *n* (%)	Mental retardation, *n* (%)	Learning problems, *n* (%)
Khan[31]	Qualitative exploratory study	41	21.95	ASRS	Self-report	Adults	NR	NR	NR	NR
Al-Daajani *et al*.[32]	Cross-sectional	444,259	0.1976	Vanderbilt ADHD rating scale	Parents and teachers	8.06±1.7	207,109 (46.6)	NR	NR	NR
Zagzoog *et al*.[25]	Cross-sectional	550	85.24	DSM-V	Teachers	From 6 to 13	77 (14)	NR	NR	NR
Meraya *et al*.[26]	Cross-sectional	647	31.5	ICD	Physicians	Between 1 and 17	462 (71.5)	176 (27.6)	153 (24)	
Khalil *et al*.[35]	Cross-sectional	134	36.6	DSM-IV	Parents	<18	NR	85 (63.43)	NR	NR
Alrakaf *et al*.[36]	Cross-sectional	1177	5.78	Self-developed	Self-report	From 18 to 24 and above 24	601 (51.1)	NR	NR	NR
Al-Haidar *et al*.[33]	Cross-sectional	309	14.9	Self-developed	Interview	From 5 to 14	151 (48.9)	5 (1.16)	14 (4.53)	22 (7.12)
Al-Zaben *et al*.[34]	Cross-sectional	929	5	Vanderbilt ADHD rating scale	Teachers	From 6 to 12	25 (4.7)	NR	NR	25 (2.69)
Albatti *et al*.[27]	Cross-sectional	646	3.4	ASRS	Parents and teachers	NR	322 (49.85)	NR	NR	NR
Jenahi *et al*.[28]	Cross-sectional	948	3.5	ADDES	Parents and teachers	9.2±1.9	948 (100)	NR	NR	NR
Alqahtani *et al*.[37]	Cross-sectional	708	2.7	DSM-IV	Parents and teachers	NR	318 (44.9)	NR	NR	NR
Al Hamed *et al*.[38]	Cross-sectional	1287	45.11	ADDES	Parents and teachers	From 6 to 13	1287 (100)	NR	NR	NR
Al Zaben *et al*.[30]	Cross-sectional	929	4.95	Vanderbilt ADHD rating scale	Teachers	8.8±1.8	25	NR	NR	NR
Homidi *et al*.[29]	Cross-sectional	2770	11.6	ADDES	Teachers	From 6 to 12	1414 (51)	NR	NR	NR

NR – Not reported; ADDES – Attention Deficit Disorders Evaluation Scale; ADHD – attention deficit-hyperactivity disorder; ASRS – Adult ADHD Self-Report Scale; ICD – International Classification of Diseases; DSM – Diagnostic and Statistical Manual of Mental Disorders

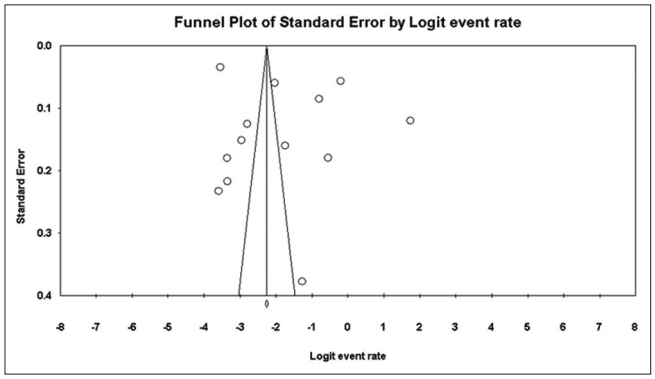


Figure 3: The funnel plot of the overall prevalence of ADHD. ADHD: attention deficit-hyperactivity disorder

the highest prevalence of ADHD was found in the studies that relied on physician diagnosis (22.1%; 95% CI: 10.1%–41.7%), followed by teachers (17.5%; 95% CI: 2.8%–61.1%), self-report (11.2%; 95% CI: 2.8%–35.9%), and both parents and teachers (8.1%; 95% CI: 1.6%–32.5%). According to the quality of the included studies, fair studies reported an overall prevalence of 5.5% (95% CI: 3.1%–7.9%), while good studies reported a prevalence of 36% (95% CI: 7.9%–64.2%), as shown in Table 2.

Risk factors associated with attention deficit-hyperactivity disorder (qualitative synthesis)

Regarding risk factors of ADHD, Khalil *et al*. conducted a univariate analysis to detect the risk factors of ADHD among the Saudi population. Their findings showed that mothers with psychological disorders during pregnancy ($P = 0.043$), lack or insufficient vitamin B during pregnancy ($P = 0.006$), mothers with allergic reactions ($P = 0.032$), mothers who were exposed to gasoline and paint ($P = 0.049$), and mothers with disabling symptoms of muscle pain during pregnancy ($P = 0.045$) were associated with increased risk of ADHD in their children.[35] Al-Haidar *et al*. showed a significant association between low socioeconomic status and the prevalence of ADHD. On the other hand, there was no significant association between ADHD and growth deficit, thyroid dysfunction, and obesity.[33] A univariate analysis conducted by Albatti *et al*. demonstrated a significant association between the prevalence of ADHD and the level of education of the mother ($P = 0.033$) and gender ($P = 0.013$).[27] Similarly, Jenahi *et al*. showed that the prevalence of ADHD was higher in families with low educational status, higher numbers of siblings, later-born siblings, and government school students.[28] Based on

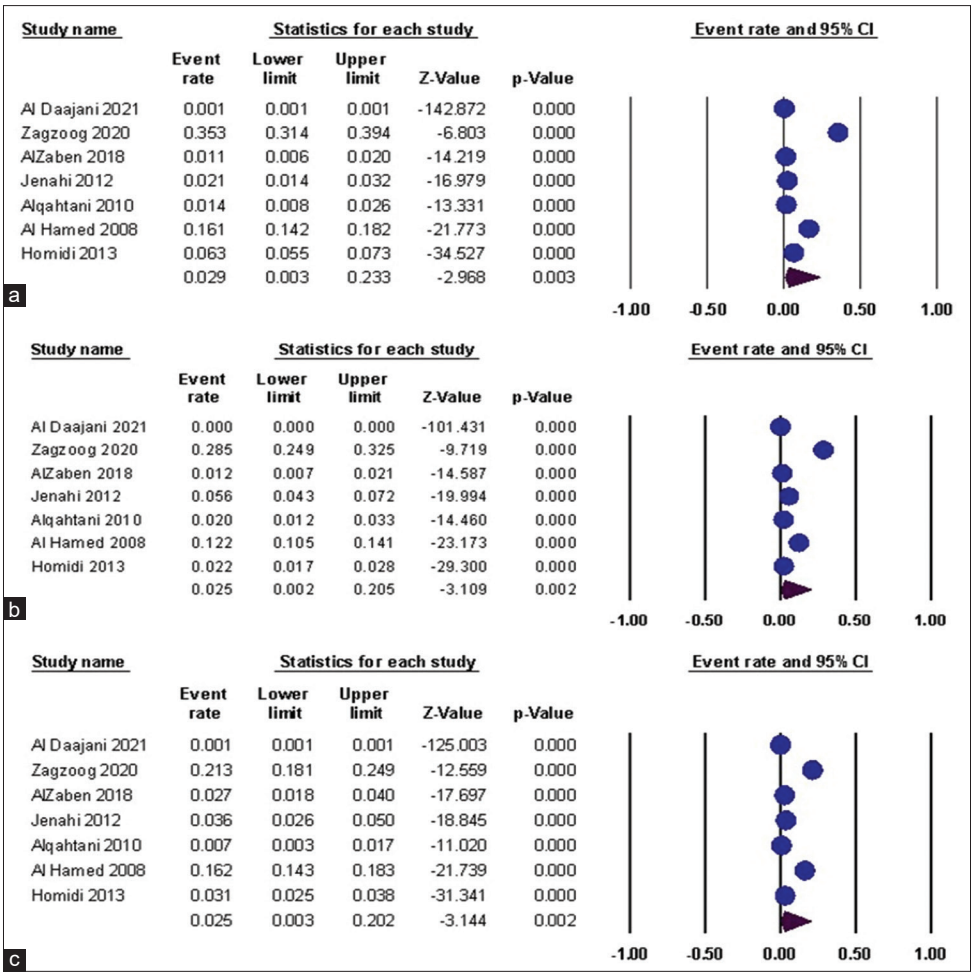


Figure 4: The prevalence of ADHD subtypes: (a) AD, (b) HD, (c) Both AD and HD. ADHD: attention deficit-hyperactivity disorder

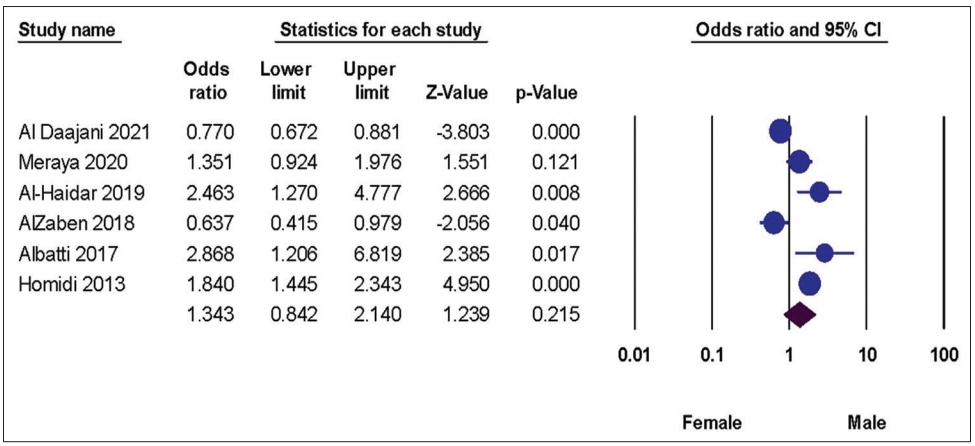


Figure 5: The random effects estimated OR in terms of the risk of ADHD between males and females. ADHD: attention deficit-hyperactivity disorder, OR: Odds ratio

the multivariate analysis, Meraya reported that ADHD was associated with significantly increased stimulant use (OR = 4.37, 95% CI: 2.83–6.74, $P < 0.001$); however, there was no significant association with antidepressants use (OR = 1.45, 95% CI: 0.59–3.59, $P = 0.42$) or polypharmacy (OR = 0.92; 95% CI: 0.57–2.99, $P = 0.73$).[26]

DISCUSSION

This meta-analysis showed that the prevalence of ADHD among the Saudi population was 12.4%, which is comparable with the findings of previous systematic reviews and meta-analyses. In a systematic review to

Table 2: Subgroup analysis regarding the prevalence of attention deficit-hyperactivity disorder

Subgroups	Number of studies	Prevalence (%)	Heterogeneity; *P*
Study tool			
ASRS	2	8.9 (1.3–42.7)	95.60; <0.001
Vanderbilt ADHD rating scale	3	4 (2.6–6.3)	92.69; <0.001
DSM-IV	2	11.2 (0.6–71.3)	99.06; <0.001
Self-developed	2	9.3 (3.6–22.4)	96.25; <0.001
ADDES	3	13.5 (3.2–43.0)	99.69; <0.001
Reporter			
Parents and teachers	6	8.1 (1.6–32.5)	99.81; <0.001
Teachers	4	17.5 (2.8–61.1)	99.69; <0.001
Physicians	2	22.1 (10.1–41.7)	96.34; <0.001
Self-report	2	11.2 (2.8–35.9)	93.19; <0.001
Quality assessment			
Fair	8	5.5 (3.1–7.9)	96.99; <0.001
Good	6	36.0 (7.9–64.2)	99.82; <0.001

ADDES – Attention Deficit Disorders Evaluation Scale; DSM – Diagnostic and Statistical Manual of Mental Disorders; ADHD – Attention deficit-hyperactivity disorder; ASRS – Adult ADHD Self-Report Scale

determine the prevalence of ADHD among Arab countries, Alhraiwil *et al.* found the prevalence of ADHD to range between 1.3% and 16%.[39] Similarly, another systematic review demonstrated that the rate of ADHD symptoms using rating scales in the school setting among Arab students ranged from 5.1% to 14.9%.[17] In terms of ADHD subtypes, we found that the prevalence of ADHD-Inattentive and ADHD-Hyperactive presentations were comparable. On the other hand, Alhraiwil *et al.* found that the prevalence of HD was between 1.4% and 7.8%, and the prevalence of AD was between 2.1% and 2.7%.[39] In this analysis, several studies reported greater prevalence estimates than others, which could be explained by many factors. The different study tools were associated with variable prevalence rates. ADDES and DSM-IV tools were associated with higher prevalence compared with Vanderbilt ADHD Rating Scale and self-developed questionnaires.

Studies on the prevalence of ADHD in Saudi Arabia have been conducted in schools where access to participants is easier. However, this may not be representative of the true prevalence of ADHD in this country, as it may fail to include a subset of children who exhibit the symptoms but are not enrolled in regular or "special needs" educational settings. If this subgroup of patients is excluded, the actual prevalence of ADHD in Saudi Arabia may be underestimated. Therefore, we recommend conducting a nationwide study to evaluate the burden of ADHD in the entire population.

We did not find a significant difference between both genders in terms of the prevalence of ADHD (males to females 1.34:1), which is similar to the previous systematic review that showed the prevalence rate of ADHD among males to females was 1.61:1.[39] Previous study findings indicate that males are more often diagnosed with ADHD than females, with a reported male-to-female ratio of about 4:1 in population samples.[40] Findings from studies on gender differences in ADHD prevalence and symptoms are variable, depending on the sample of study.[41,42] Considering that women are disproportionately and adversely impacted by referral bias, Gaub and Carlson argued that ascertainment in clinic settings may conceal gender differences.[41] Another review suggested that research on ADHD should pay greater attention to females and ADHD subtypes when examining gender differences.[43] Across ADHD subtypes, Graetz *et al.* observed no variation in the male-to-female prevalence ratio in a population-based sample from Australia, but they did find disparities in co-occurring issues and symptom-specific impairment depending on gender.[44] However, Biederman *et al.* did not find significant differences between males and females in terms of impairment, mental comorbidity, or ADHD subtypes in their small study of non-referred participants with ADHD (siblings of ADHD probands).[45]

Regarding the risk factors, we could not conduct a meta-analysis based on the available data, which could be explained by the fact that almost all included studies were cross-sectional studies. Although there may be a genetic link to ADHD, this was not investigated in the studies that were evaluated.

High rates of ADHD were found in children of Saudi mothers who suffered from mental illness during pregnancy. Similar studies found that maternal somatic or psychiatric disorders during pregnancy not only provide the biological backgrounds for psychiatric disorders in children but also may disturb the nurturing role of parents, leading to unfavorable conditions for the family as a whole.[46,47] Furthermore, it has been observed that exposure to severe stress during pregnancy may increase the incidence of ADHD in children.[48] Mothers' exposure to psychosocial stresses during pregnancy has been demonstrated to be an independent risk factor for the development of ADHD in children.[49] ADHD has been linked to a lack of, or inadequate, vitamin B during pregnancy. Prenatal nutrition has been associated with both fetal brain development and adult psychopathology. The increasing incidence of ADHD and allergic reactions were shown to be substantially associated. Similarly, earlier research highlighted allergy conditions as potential contributors to ADHD.[50,51] A study indicated that, particularly among girls, maternal prenatal active atopy might be an independent predictor of ADHD symptoms.[52]

Strengths and limitations

To the best of our knowledge, this is the first meta-analysis that investigates the prevalence of ADHD among the Saudi population. However, we acknowledge that our study has some limitations, including 1) the high heterogeneity that could not be solved with sensitivity analysis and subgroup analysis, 2) inclusion of studies that were conducted in schools, which may not be representative of the true prevalence of ADHD in the country, and 3) that a meta-analysis based on age and risk factors could not be conducted because of the lack of data and with almost all the included studies being cross-sectional, respectively.

CONCLUSIONS

The current evidence suggests that the prevalence of ADHD in the Saudi population is comparable with the other countries in the Middle East and North Africa region and global estimates. There are many risk factors related to the parents, especially mothers during pregnancy; therefore, careful monitoring, attention to nutritional sufficiency, psychological and emotional support, and avoidance of stressful events for these mothers may lead to reducing the incidence of ADHD in their offspring. A nationwide campaign is required to increase the awareness of parents, teachers, and the public about the symptoms of ADHD and provide educational materials to enhance the physician–parent communication.

Peer review

This article was peer-reviewed by two independent and anonymous reviewers.

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Conflicts of interest

There are no conflicts of interest.

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