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REVIEW

Prevalence of Attention-Deficit Hyperactivity Disorder (ADHD) in Iranian Elementary School Children: A Systematic Review and Meta-Analysis

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Abstract
The aim of this systematic review and meta-analysis is to estimate the overall prevalence of Attention-Deficit/Hyperactivity Disorder (ADHD) among Iranian elementary school children, with a particular focus on potential variations by gender and diagnostic tools. A systematic review of nine studies meeting eligibility criteria was conducted, including data from 9,138 children aged 6 to 12 years. The results indicate a pooled ADHDt prevalence of 11.2% (95% CI: 9.4–13.2%), with a significantly higher prevalence observed in boys (10.1%) compared to girls (7%). The choice of diagnostic instrument was also a source of variability in results, with the Conners' Questionnaire indicating a prevalence of 10.9% and the CSI-4 Questionnaire yielding a prevalence of 12.1%. The study highlights notable heterogeneity across the studies ($I^2 = 87.6\%$), influenced by differences in sample size, location and diagnostic methodology. These findings highlight the necessity for the standardization of diagnostic practices in order to enhance the accuracy and consistency of estimates regarding the prevalence of ADHD in Iran. Additional research should concentrate on the elucidation of the social and cultural determinants. This will enable a deeper comprehension of these elements and the interwoven relationship between culture, society, and child mental health.

Keywords Attention deficit/hyperactivity disorder · Elementary school children · Prevalence · Meta-analysis

Introduction

Attention-deficit/hyperactivity disorder (ADHD) is the most common neuropsychiatric condition, affecting individuals from preschool age to adulthood. The condition is clinically identified by a pattern of deficits in attention and/or impulsivity-hyperactivity. These deficits are important as they significantly impact on children's home and school functioning [21, 39]. For example, studies have shown that children with ADHD are more likely to have absenteeism, exhibit increased dropout rates from school, and have a significantly poorer quality of life compared to their non-ADHD peers [14, 21, 49]. ADHD typically emerges during the preschool or early school years, and if untreated the symptoms may persist into adulthood leading to health, occupational and social functioning problems [21]; Sadock, 2014). With these ample of risks, economically, ADHD is associated with a number of burdens, including increased medical and educational costs, unemployment, and reduced productivity [11, 42, 46]. Thus early detection and intervention would have positive individual, social and economic outcomes.

A meta-analysis documented pooled global prevalence of ADHD in children and adolescents up to 8% with data from 3,277,590 participants [6]. This estimate revealed that boys are twice as likely to have the disorder as to girls [6].

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Similarly, Salari et al. [41] pooled global prevalence and found that 7.6% of children aged 3 to 12 years and 5.6% of adolescents aged 12 to 18 years have ADHD. However, evidence suggest an association of ADHD/HD prevalence rates with geographic origin of the studies [35, 48]. For example, in United States, the Center for Disease Control and Prevention (CDC) reported the prevalence of 11.3% for children and adolescents aged 5–17 years diagnosed with ADHD during 2020–2022 [36]. When compared with North America, the prevalence of ADHD in the Middle East was found to be higher. Estimated prevalence of ADHD among children in the Kingdom of Saudi Arabia was 13% [3]. This figure was influenced by various factors, including diagnostic criteria (e.g., DSM-IV), geographic region, and screening methods. These disparities may be due to cultural perceptions, access to diagnostic services, and variations in the use of full versus partial diagnostic criteria [35, 48].

In Iran, the focus of the present study, few studies have examined the prevalence of ADHD. Mohammadi et al. [30] estimated the prevalence of ADHD at 4% in a population-based study in Iran, with a sample of 30,532 children and adolescents aged at 6 to 18 years. Conversely, Al-Wardat et al. [2] estimated as high as 22.2%. Therefore, in Iran, the estimates reported vary substantially across studies, ranging from 3.17% in the study of Namdari et al. [33], 17.3% in the study of Safavi et al. [40] and 22.2% in Al-Wardat et al. [2]. Nevertheless, a meta-analysis of the prevalence of ADHD pooled from 27 eligible studies published between the years 2001–2016 demonstrated an overall prevalence of 12.0% among children and adolescents aged 6 to 14 years in Iran [53].

While biological factors are widely acknowledged as underpinning ADHD [20, 51], psychosocial factors also play a crucial role [43], that can be counted as the source of variability in ADHD prevalence rates. Parental factors such as maternal smoking during pregnancy as well as socioeconomic status (SES) are significant determinant of the etiology, prevalence and severity of ADHD symptoms [27, 37]. In Iran the rate of tobacco use among women is estimated 4.0%, compared to global estimate of 7.9% [50], conversely an estimate of 6.3% smoking water-pipe tobacco among reproductive age Iranian women is reported [8]. In Iran, studies have demonstrated a robust correlation between SES in prevalence, diagnostic and treatment of ADHD symptoms [19, 44]. Also, evidence suggests raising poverty in Iran, after 2010, primarily due to international sanctions [4]. Diagnostic criteria also influence reported ADHD prevalence rates. The National Institute for Health and Care Excellence (NICE) employs strict diagnostic criteria, estimating ADHD prevalence in children at approximately 5% globally [38]. Using the International Classification of Diseases, 10th Revision (ICD-10), identify hyperkinetic disorder, among 1 to 2% of children [15, 26]. In contrast, the prevalence of ADHD according to the full Statistical Manual of Mental Disorders, Fifth Edition (DSM-5) criteria is 3.55%, indicating slight variations in prevalence depending on the diagnostic criteria used [29].

Addressing the prevalence of ADHD is essential to inform public health strategies, resource allocation, and the development of effective intervention programs [52]. Also, the large variability reported in ADHD prevalence rates in Iran, a meta-analysis with good quality published papers is warranted to synthesize existing data and provide a more accurate estimate of ADHD prevalence among Iranian children. The current study builds on previous study such as Yadegari et al. [53] by inclusion of more recent high-quality studies without gray data (study), focusing on pre-and elementary school children and providing a detailed analysis stratified by gender and diagnostic tool. Given the fact that, the symptoms of ADHD must have been present before the individual turned 12 years old [34], we analyzed data for under 12 years old children.

Therefore, the aim of the present study was to conduct a meta-analysis of high-quality studies (a) to ascertain the overall prevalence of ADHD among children under 12 years old, (b) to estimate the prevalence of ADHD separately for boys and girls and (c) to estimate the prevalence of ADHD based on the diagnostic tools.

Method

This article aimed to estimate the overall prevalence of ADHD among elementary school children, and by gender and diagnostic tool through systematically reviewing and meta-analyzing the relevant cross-sectional studies.

Data Sources and Search Strategy

A systematic search for relevant articles published in peer reviewed journals, both in English and Persian languages was conducted using international databases such as PubMed, Google Scholar, Medlib, and Science Direct as well as national databases including Magiran, Iran Medex and SID. We did not set a time limit for reviewing the articles. And we reviewed all the articles published until the end of 2023. The following PubMed/MeSh search syntax was used to search the articles: “attention deficit hyperactivity disorder” or “ADHD” or “Hyperkinetic Disorder” or “Attention Deficit symptom” and “prevalence” or “incidence” or “frequency” or “rate” and “Iran”. We did the same search with the corresponding words in Persian.

Eligibility Criteria

Inclusion criteria for papers were: (1) all cross-sectional studies with random or non-random sampling; (2) sampling that used diagnostic criteria including DSM-V, DSM-IV, and standardized questionnaires or screening tools to assess; (3) reporting the prevalence of ADHD among children for at least one gender in the general population of elementary school students (under 12 years old) in Iran.

Exclusion criteria were: (1) studies for which the full version was not available; (2) studies published in conferences, symposia and grey papers; (3) studies that received a score lower than 8 in the quality assessment; (4) studies conducted on specific groups and (5) studies that assessed the validity and reliability of the screening tools/questionnaires.

Quality Assessment and Data Extraction

For quality assessment of the methodology of the papers the JBI Critical Appraisal Checklist for Studies Reporting Prevalence Data checklist was used. The checklist poses 9 questions regarding sampling, procedure, tools and analyses allowing a minimum score of zero and a maximum score of 9 for each paper.

The inclusion and quality assessment were independently conducted by two authors. Disagreements were resolved independently by the third author. Finally, we reached 9 eligible articles for analysis. The search of relevant papers using the keywords, reached to 60 articles about the prevalence of ADHD in Iran (Fig. 1). Considering the exclusion and inclusion criterion for screening, 9 eligible published studies were selected for final analysis (Table 1). The total sample size was 9076 elementary school students aged 6 to 12 years. Data extracted included year of study, type of study (country vs. province vs. city; and population-based vs. school-based vs. etc.), type of sampling (random vs. non-random); source of report (parent vs. teacher vs. child), response rate; sample size; gender proportion, age range, ADHD diagnostic criteria, ADHD diagnostic tool; and prevalence reported for all sample and by gender. Data extracted are presented in Table 1. Due to the high heterogeneity of the reported prevalence, meta-analysis was performed using the random effects method.

Analysis & Results

The Comprehensive Meta-analysis software was used to analyze the data. Graphical methods and random effects models were used to obtain the prevalence estimates. Heterogeneity among studies was assessed using the I^2 statistic. To assess the source of potential heterogeneity, subgroup analysis was used. The analysis was performed based on gender and distribution in the general population of children. A funnel plot and Egger's test were used to report publication bias. Since studies with small sample sizes or non-significant findings are less likely to be published and may be excluded from meta-analysis, publication bias may exist. Therefore, trim-and-fill analysis was used to adjust for missing studies. P values < 0.05 were considered statistically significant Table 2.

Table 3. The I^2 statistic test was 87.6 indicating the heterogeneity of the selected articles [25]. Study heterogeneity may be due to differences in sample size, sampling error, year of articles, and location of study. To assess the risk of publication bias, a funnel plot and Egger's test were computed. This graph (Figs. 2, 3, 4 and 7) shows that there is a significant publication bias ($P = 0.01$). This means that there may be unpublished studies with negative results. Thus, a random effects model was used to combine the studies and estimate the overall prevalence [12, 16].

The first aim was to estimate the overall prevalence of ADHD. For this, an analysis was computed with 9 papers including a total sample size of 9076 participants under the age of 12. The results are presented in Fig. 5, indicating an overall prevalence of 11.2% (95% CI: 13.2–9.4%) for ADHD. The forest plot shows the overall prevalence in the studies examined, with the midpoint of each line segment indicating the prevalence in each study and a diamond shape indicating the population prevalence for the entire study (Fig. 5). The next step was to estimate the prevalence of ADHD separately for boys and girls. Of the 9 articles reviewed, only one focused on boys [47], and two articles did not report data by gender and only reported the percentage prevalence of both sexes together [9, 24]. At the end six articles with a total sample size of 7484 participants remained to do the analysis by gender. Figures 6 and 7 shows the result of analysis. It can be seen that the prevalence of ADHD in boys and girls were 10.1% (95% CI: 14.3-7%) (Fig. 6) and 7% (95% CI: 10.7–5.2%) (Fig. 7) respectively. The next step was to estimate the prevalence of ADHD based on the diagnostic tools. Of the 9 articles selected, one used the Rutter questionnaire [55]. four articles reported data based on the Conner's questionnaire and 4 articles reported data based on the CSI-4 questionnaire. To compute the meta-analysis, we removed one article that was measured by the Rutter tools and reviewed 8 other articles. According to the data, the prevalence of ADHD according to the Conner's questionnaire was 10.9% (95% CI: 14.8-8%) (Fig. 8) and the prevalence of ADHD in the CSI-4 questionnaire was 12.1% (95% CI: 15.3–9.5%) (Fig. 9,10,11).

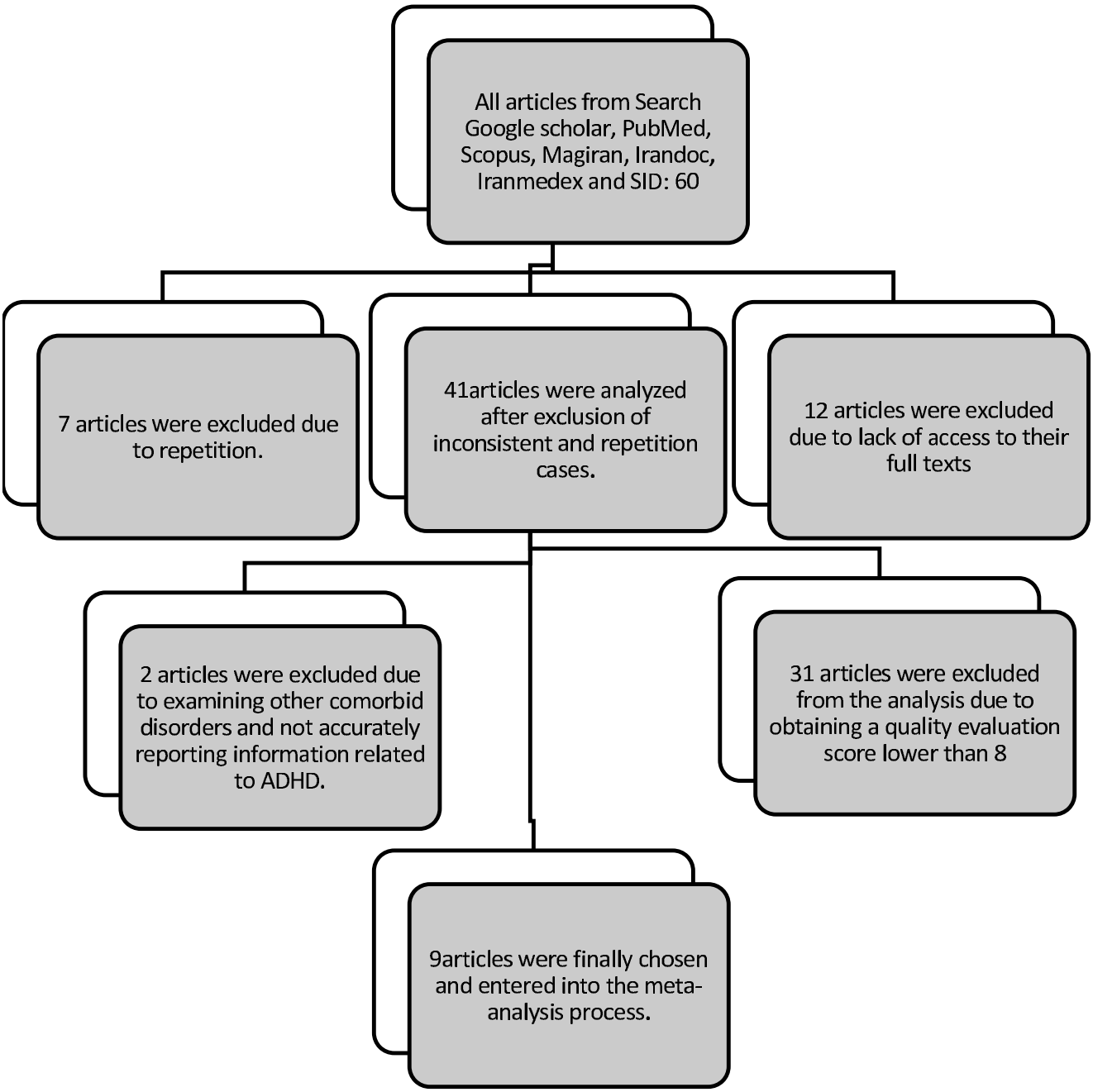


Fig. 1 Study flowchart

Table 1 An overview of the data extracted from selected articles for Meta-Analysis

ID	Publication	Quality score	Language	First author	Year of publication	Year of study	Place of study
1	[1]	9	English	Abolhassanzadeh	2016	2011–2012	City (Ardabil)
2	[9]	8	Persian	Bakhshi	2012	2007–2008	City (Rasht)
3	[40]	8	English	Safavi	2016	2013	City (Shahrekord)
4	[55]	8	Persian	Zia Aldini	2006	1999–2000	City (Sirjan)
5	[22]	9	English	Ghanizadeh	2008	2000	City (Shiraz)
6	[31]	9	Persian	Moradi	2008	2006–2007	City (Neyshabor)
7	[32]	9	Persian	Najafi	2009	2005	City (Shiraz)
8	[24]	8	Persian	Haghjoo	2017	2016	City (Sarepole zahab)
9	[47]	8	English	Talaei	2010		City (Mashhad)

Table 2 An Overview of the Data Extracted from Selected Articles for Meta-Analysis

ID	Type of sampling (study base)	Response rate, %	Total, n	Male, n%	Female, n%	Age (range*)
1	Random (elementary school population-based)	93	2628	1236 (47.0)	1392 (53.0)	9.5 ± 1.56
2	Random (elementary school population-based)	90.5	181	91	90	9
3	Random (elementary school population-based)	90	631	308 (48.8%)	323 (51.2%)	9±1.4 (6-12)
4	Random (elementary school population-based)	85	656	322 (49/91 %)	334 (50/9 %)	9/05±1/43 (7-11)
5	Random (elementary school population-based)	80	1600	800 (50 %)	800 (50 %)	9.1 (7-11)
6	Random (elementary school population-based)	79.6	722	402 (55.7)	320 (44.3)	9.04±1.4 (6-10)
7	Random (elementary school population-based)	93	1205	639 (53 %)	566 (47 %)	8.5
8	Random (elementary school population-based)	100	740	370	370	10
9	Random (elementary school population-based)	99	713	713	0	7 to 9

Table 3 An Overview of the Data Extracted from Selected Articles for Meta-Analysis

ID	Instrument	Count disorder outcome/s		
		Male	Female	Both (%)
1	Conner's' Teacher Rating Scale (CTRS)	142)	115	9
2	Conner's' Teacher Parent Rating Scale (CTRS)			7.7
3	CSI-4-Parent Rating Questionnaire	63	46	17.3
4	Rutter	28	26	8.15
5	CSI-4-Parent Rating Questionnaire	108	52	10.1
6	Conner's' Parent Rating Questionnaire	10.9	14.3	12.5
7	CSI-4-Parent Rating Questionnaire	94	47	10.8
8	CSI-4-Parent Rating Questionnaire			11.22
9	DSM-IV-Conner's-Parent Rating Questionnaire	15.27	0	15.27

Discussion

The results of meta-analyzing the prevalence of ADHD reported in nine papers from 2008 to 2017 indicated a pooled prevalence rate of 11.2% among elementary school children in Iran. This estimated prevalence rate is beyond the estimated global 8% [6]. However, it is close to the estimate 12% reported by [53]. The higher prevalence of ADHD among Iranian children is consistent with higher ADHD prevalence rate (12.7%) among Turkish elementary school children [18]. Similar findings were reported in international studies such as those conducted by [35]. These studies highlighted variations in the overall prevalence of ADHD, as well as variations by gender and diagnostic tools. These findings underscore the need for greater standardization of ADHD assessments. A noteworthy finding is the gender disparity observed with regard to ADHD diagnoses. In comparison to girls, who represented about 7% of

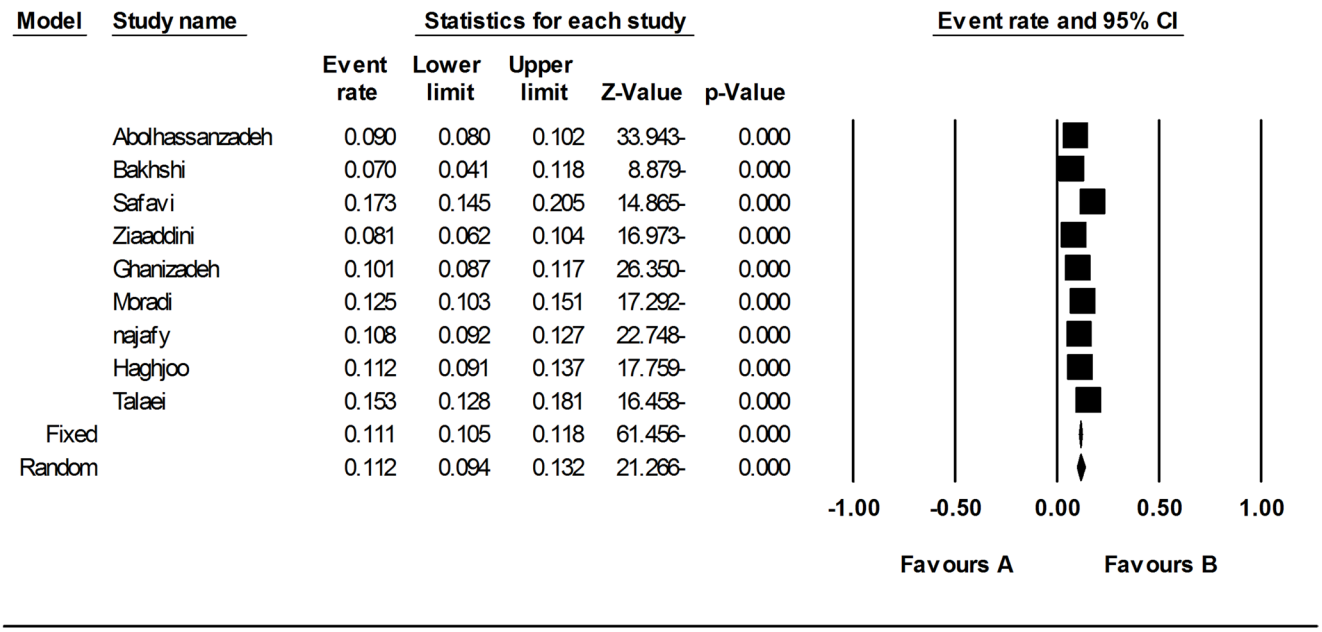
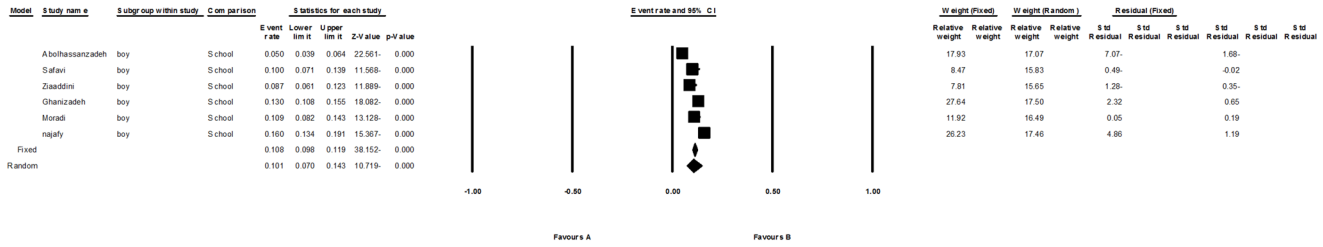
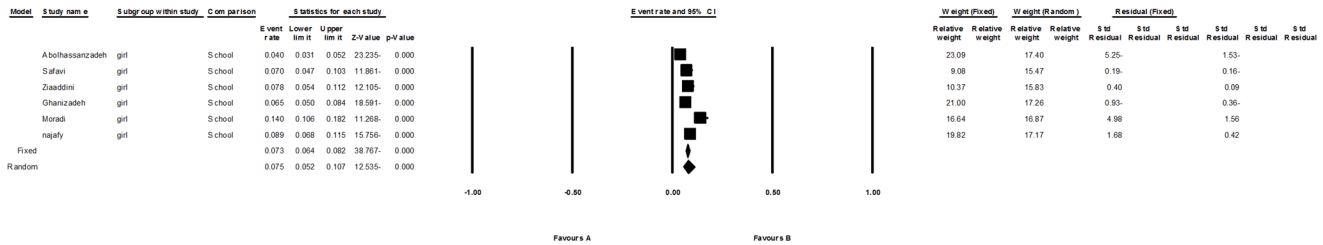


Fig. 2 Forest plot of the prevalence of ADHD among Iranian children



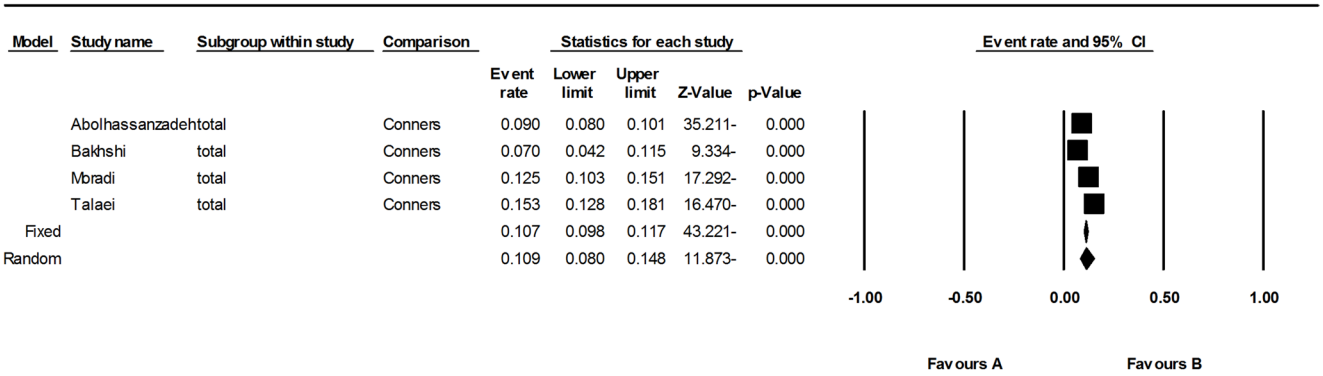
Meta Analysis

Fig. 3 Forest plot of the prevalence of ADHD among Iranian boy's children



Meta Analysis

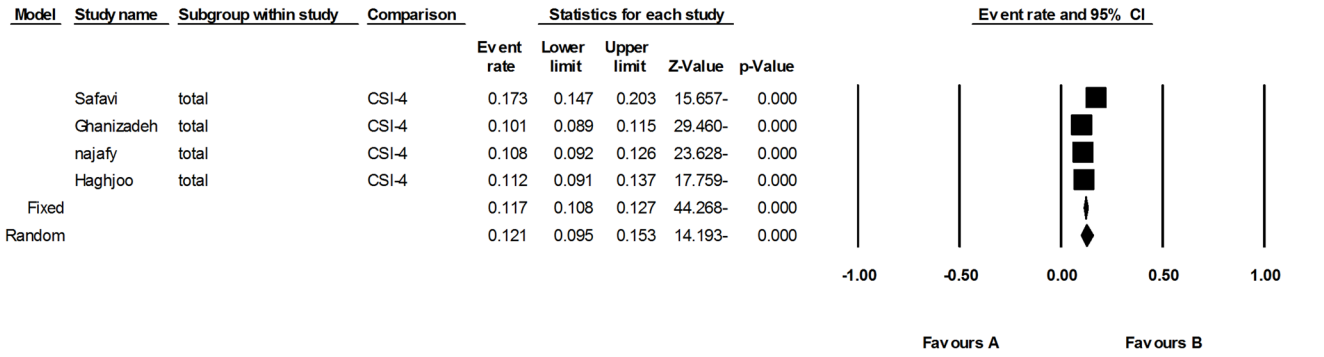
Fig. 4 Forest plot of the prevalence of ADHD among Iranian girl's children



Meta Analysis

Fig. 5 Forest diagram of prevalence of ADHD among Iranian children based on Conners Questionnaire

identified cases, boys account for about 10.1%. This finding is consistent with numerous studies, including Ayano et al. [7, 10], which consistently report a higher prevalence of ADHD in boys. This sex discrepancy may be attributed to a combination of biological and sociocultural factors. Given the fact that, it is more common for boys to display externalizing behaviors, such as hyperactivity and impulsivity, which increases the likelihood of a referral for diagnosis and conversely for girls, that they frequently demonstrate internalizing symptoms, such as inattention, which may be undervalued in clinical assessments [11, 28]. Beyond biological factor, Societal constraints and norms may cause individuals who identify as female to conceal or control their symptoms more often, resulting in lower reported scores. Conversely, men often struggle with certain tasks and maintaining attention, which can impact their performance in school and at work [45]. In addition, the study by Soheilipour et al. [44], did not directly assess SES. However, maternal education level, offspring birth weight (BW), and delivery date could be indicating family SES. Children



Meta Analysis

Fig. 6 Forest diagram of prevalence of ADHD among Iranian children based on CSI-4 Questionnaire

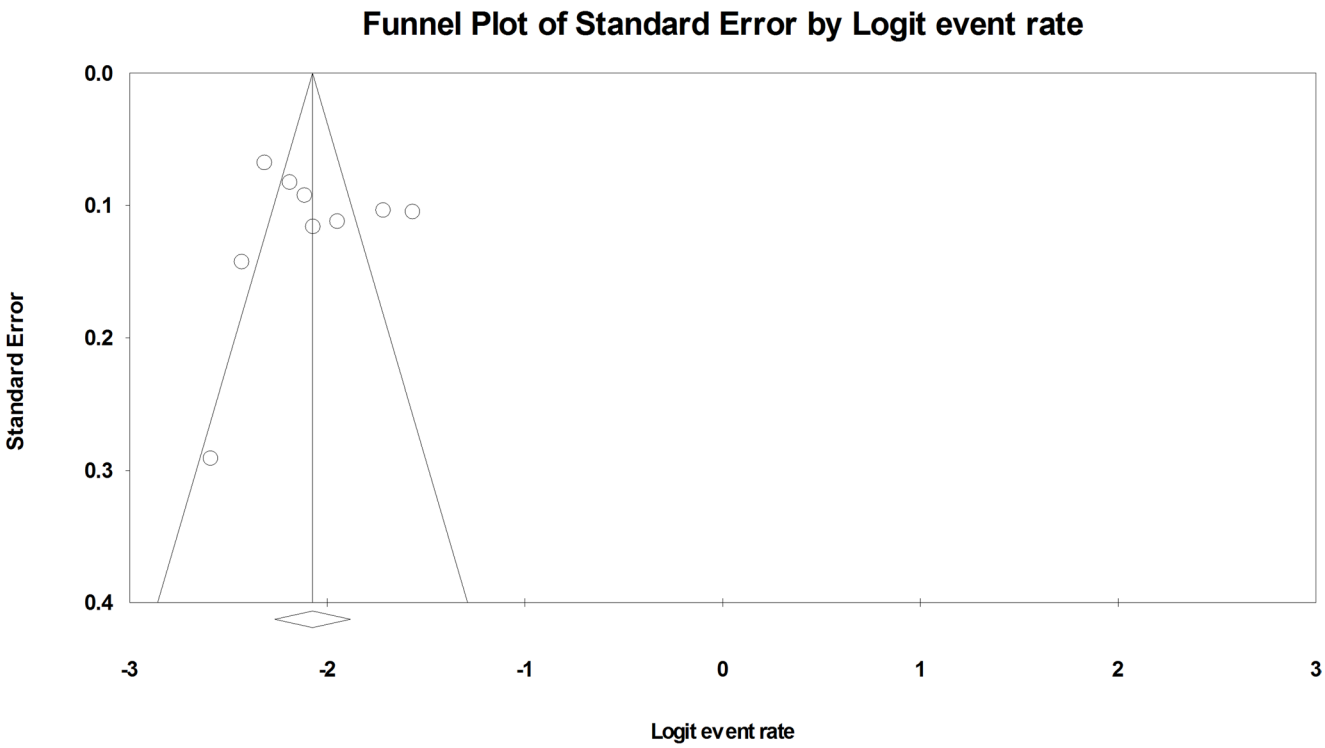


Fig. 7 Begg's funnel plot for publication bias in the risk difference (RD) analysis total

born preterm with a high birth weight were considered to be at a higher risk for ADHD also reported that higher birth weights (>3500 g) were related to a higher risk of ADHD compared with children with normal birth weights (2500–3500 g).

Nevertheless, this gender disparity underscores the necessity for more comprehensive diagnostic protocols that take into account the disparate manifestations of ADHD in boys and girls. The ways in which ADHD manifests in girls and women, as well as the factors that lead to delayed diagnoses, are influenced by social expectations and a lack of knowledge and education about how symptoms present themselves in women and girls [13]. A diagnosis of ADHD is never received by many girls, and those who do receive it do so significantly later in life than their male counterparts [5]. In addition, socially adaptive behaviors such as compliance, increased resilience, and masking to avoid social repercussions are more likely to be developed by girls. These behaviors allow girls to appear to socialize successfully, but they come at a great mental and emotional cost to girls because they suppress their true selves and personalities [54].

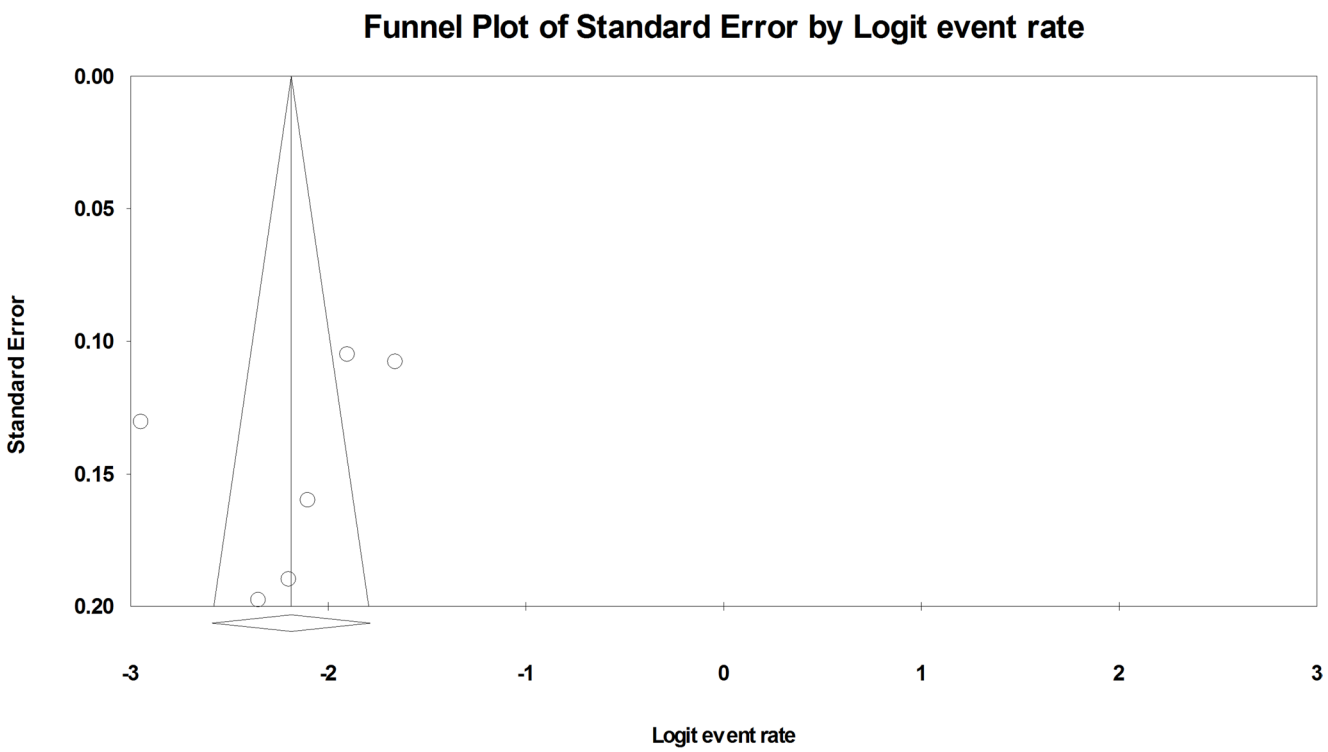


Fig. 8 Begg's funnel plot for publication bias in the risk difference (RD) analysis boys

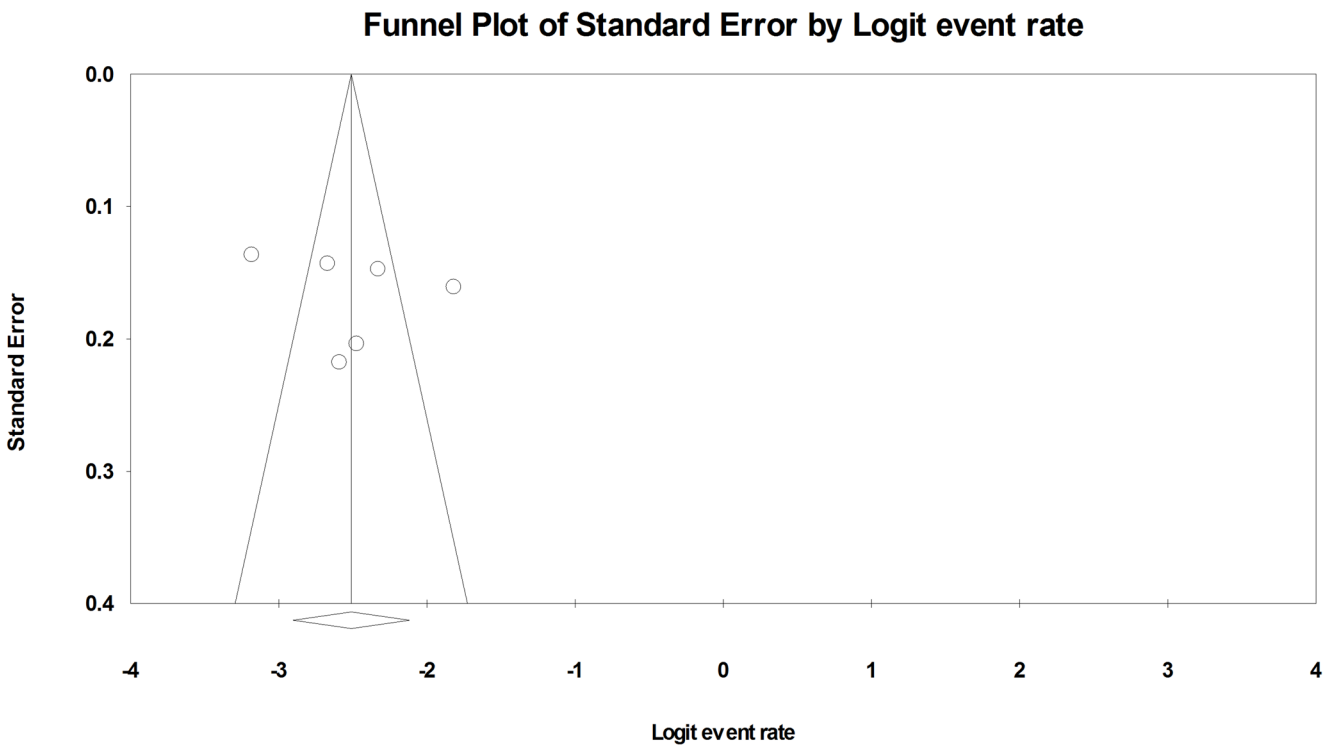


Fig. 9 Begg's funnel plot for publication bias in the risk difference (RD) analysis girls

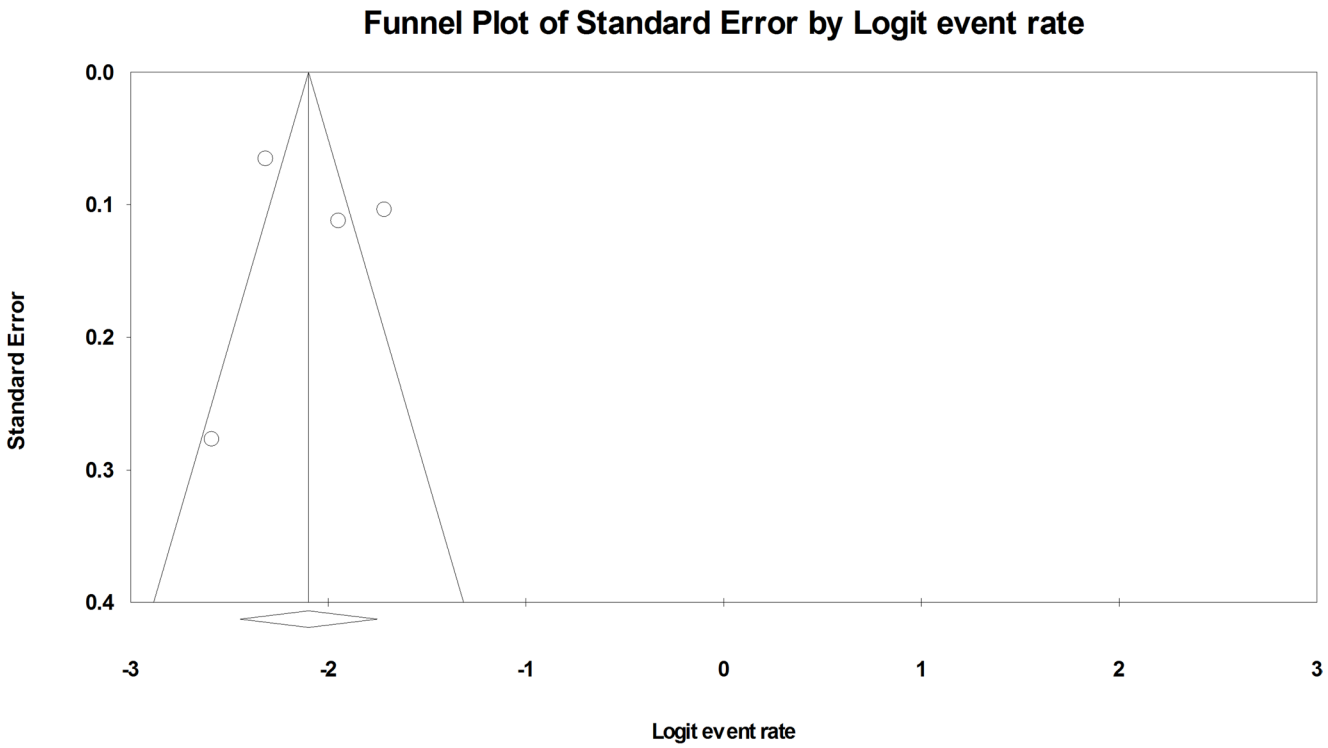


Fig. 10 Begg's funnel plot for publication bias in the risk difference (RD) analysis based on Conners Questionnaire

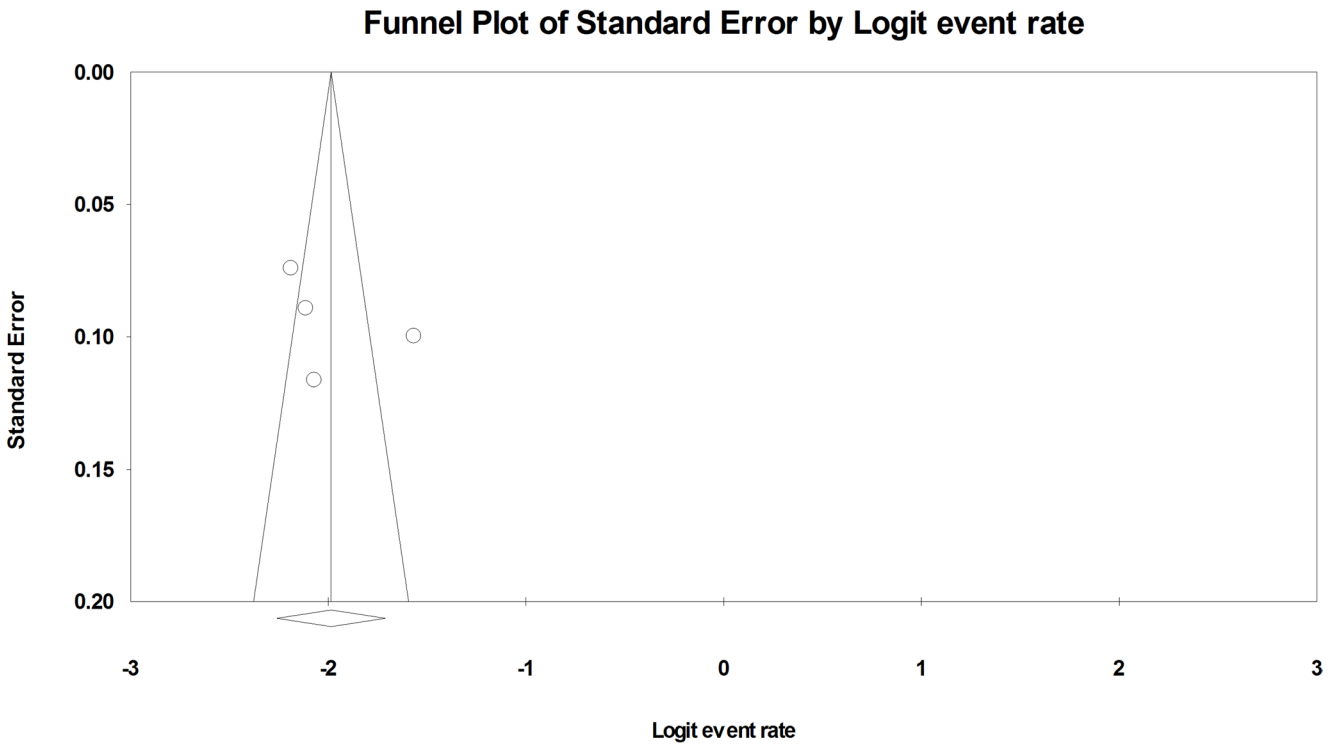


Fig. 11 Begg's funnel plot for publication bias in the risk difference (RD) analysis based on CSI-4 Questionnaire

Another significant factor contributing to the observed variation in prevalence rates is the diagnostic tool employed. In this study, the prevalence of ADHD exhibited notable variation contingent on the specific diagnostic tool employed, namely the Conners' and the CSI-4 questionnaire. The CSI-4 tool identified a higher rate of prevalence (12.1%) than the conners questionnaire (10.9%). These discrepancies are consistent with the findings of other international studies, which similarly indicate that more rigorous diagnostic criteria, such as those outlined in the ICD-10, tend to result in lower prevalence estimates compared to more inclusive criteria, such as those outlined in the DSM-5 [15]. Another analysis, conducted by Epstein and Loren [17], the aim was to determine the prevalence of ADHD using different diagnostic criteria. The prevalence of ADHD was higher when the DSM-5 criteria were used than when the DSM-IV criteria were used. The DSM-5 employs lower thresholds and a dimensional approach, which differ from the DSM-IV's symptom domain thresholds. Given these circumstances, it is reasonable that the number of patients diagnosed with ADHD based on the DSM-5 criteria has increased. Similarly, it is reasonable that there has been an increase in patients diagnosed with ADHD based on these criteria. The findings underscore the necessity of employing standardized, validated diagnostic instruments in ADHD research to guarantee consistency and comparability across studies. A following study indicating the rate of overlaps between the one-stage evaluation process and the consequent referral to diagnostic screening warrants an investigation. The study by Ghanizadeh and Jafari [23], provides direct empirical evidence on how Persian-speaking parents rate ADHD symptoms and aimed to identify the underlying cultural structures of these ratings. A key finding was that item loadings and the factor structure of parental symptom ratings differed from established models in Western cultures. These differences suggest that, although the core symptomatology of ADHD is globally recognized, parents' interpretation, emphasis, and threshold for reporting specific behaviors can be subtly but significantly shaped by prevailing cultural norms and expectations within Iranian society.

Conclusion

This meta-analysis estimated the overall prevalence to be 11.2%. The study's findings illustrate notable gender-based discrepancies in prevalence, with a higher prevalence observed among boys compared to girls. This pattern aligns with existing national and international literature. The discrepancy in prevalence rates based on the diagnostic tool used highlights the importance of selecting appropriate, standardized diagnostic instruments. These findings are consistent with those of global studies. There is an urgent need to implement standardized diagnostic practices for ADHD among Iranian children to reduce variability in prevalence estimates. Furthermore, the results of this study underscore the importance of future research investigating the long-term progression of ADHD and its social determinants. Additionally, these findings clarify the importance of determining the rate at which the one-stage evaluation process overlaps with subsequent referrals for diagnostic screening.

Limitation and Recommendations

This study has limitations that should be considered for future research. While studies with good quality methodology were selected for the meta-analysis, all the study populations were limited to a city. Therefore country/province wide studies are required to reach a more reliable prevalence rate among children in Iran.

Author Contributions The inclusion and quality assessment were independently conducted by two authors (S. A 1 & E.RP 2). Disagreements were resolved independently by the third author (Z.T 3)0.1 Sajad Ayoubi2 Elham Rabaniparsa3 Zahra Tabibi.

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Data Availability The data supporting the results of this study are available on request from the corresponding author.

Declarations

Conflict of interest The authors declared no conflict of interest.

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