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Review article

Prevalence of attention deficit hyperactivity disorder in adults: Umbrella review of evidence generated across the globe

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ABSTRACT

Background: Attention deficit hyperactivity disorder (ADHD) is a class of neurodevelopmental disorders which is commonly diagnosed in school-age children, but it can occur in any age group. To provide a robust synthesis of published evidence on the prevalence of ADHD in adults, we conducted an umbrella review of systematic reviews and meta-analyses.

Methods: The review was guided by preferred reporting items for systematic review and meta-analysis (PRISMA). We searched PsychINFO, Web of Science, PubMed, and Scopus to retrieve pertinent studies. The review protocol was registered with PROSPERO (CRD42023389704). A Measurement Tool to Assess Systematic Reviews (AMSTAR) was used to assess the quality of the included studies. A random-effects model was used to perform a meta-analysis.

Results: Five systematic reviews and meta-analyses (57 unique primary studies) with data on 21,142,129 adult participants were eligible for inclusion in this umbrella review. Inverse variance weighted random effect meta-analysis of these studies indicated that the pooled prevalence of ADHD in adults was 3.10% (95%CI 2.60–3.60%). ADHD-I (the inattentive type of ADHD) remained the commonest type of ADHD, followed by ADHD-HI (the hyperactive type) and ADHD-C (the combined type).

Conclusion: The results indicate that ADHD is relatively high in adults, with ADHD-I remaining the most common subtype. Attention should be given to preventing, reducing, identifying, and managing ADHD in adults.

1. Introduction

Attention deficit hyperactivity disorder (ADHD) is a complex neurodevelopmental disorder associated with age-inappropriate-inappropriate hyperactivity, impulsivity, and inattention (APA, 2013; Berger, 2011; Cortese et al., 2012). ADHD is one of the widely discussed neuropsychiatric problems that can impact individuals across the life-span and critically affects the lives of the affected individuals, family, caregivers, and the community (APA, 2013; Ayano et al., 2020; Berger, 2011; Cortese et al., 2012). The disorder is mainly detected in school-age children; however, it can happen in any age group (Ayano et al., 2020; Montano, 2004). Emerging epidemiological evidence indicates that ADHD affects a considerable number of the adult population (Song et al., 2021; Willcutt, 2012). There are several factors that contribute to the likelihood of ADHD persisting into adulthood (Kessler et al., 2005). These factors included: Severe ADHD during childhood; not receiving treatment for ADHD in childhood; comorbidity with other childhood and adolescent disorders; adverse experiences during childhood;

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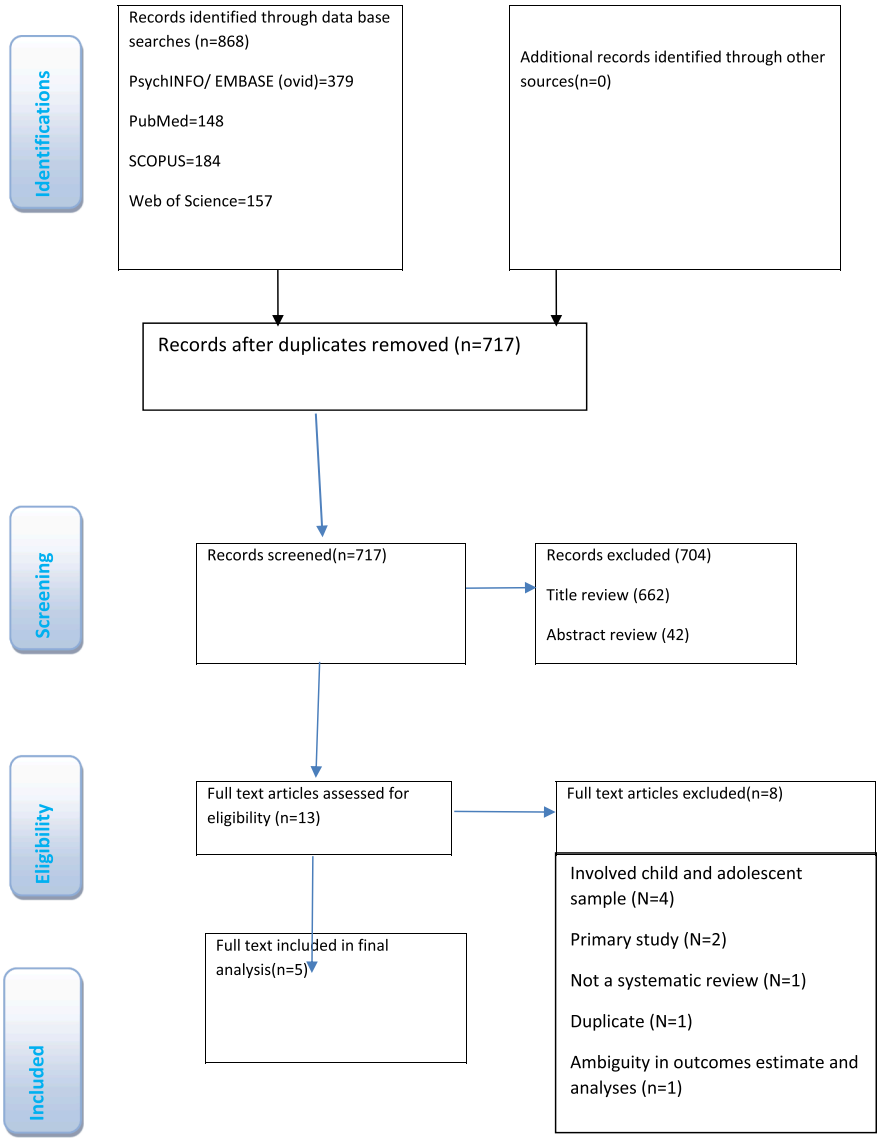

Fig. 1. PRISMA flowchart of review search.

antisocial behavior; and drug use (Barkley et al., 2004; Kessler et al., 2005). The disorder affect the social, cognitive, physical, and mental health and well-being of the individual (Ayano et al., 2023; Ayano et al., 2021, 2022; Ayano et al., 2019; Pang et al., 2021).

So far, dozens of primary studies and a number of systematic reviews and meta-analyses studies have been conducted on the prevalence estimates of ADHD in adults (Cenat et al., 2021; Dobrosavljevic et al., 2020). However, mixed findings have been reported across these systematic reviews and meta-analyses (Cenat et al., 2021; Dobrosavljevic et al., 2020; Willcutt, 2012). For instance, Simon et al. (2009) found that the prevalence of ADHD in adult was 2.5% (Simon et al., 2009). In another meta-analytic review by Dobrosavljevic et al. (2020) including 20,999,871 adults the prevalence estimate of ADHD was 2.18% (Dobrosavljevic et al., 2020). Moreover, a 2012 meta-analytic systematic review by Willcutt involving 14,081 adults found that the prevalence of ADHD was 5% (Willcutt, 2012). Low socioeconomic environment may contribute to differences in ADHD prevalence. Willcutt et al.'s meta-analysis included studies from the US, Iran, Colombia, and Australia, reporting 5.0% prevalence in adults, 1.5 to 2.3 times higher than European studies (Ramos-Quiroga et al., 2013; Willcutt, 2012). Epidemiologic evidence indicates individuals from low SES environments were 1.5–2.3 times more likely to meet ADHD criteria than those from high SES families (Russell et al., 2016; Waschbusch et al., 2007; Zwirs et al., 2007). Age also influences prevalence; Ramos-Quiroga et al.'s meta-analysis with older adults found 2.18%, lower than studies with younger adults (Ramos-Quiroga et al., 2013).

Another potential reason for the disparities in prevalence rates is the methodological differences across studies, including variations in study design, diagnostic criteria, assessment tools, and sample characteristics. Additionally, the years the studies were conducted (ranging from 2009 to 2021), the sample size and scope of the meta-analysis (e.g., focusing on a single country, continent, or international perspective) could have also contributed to the observed variations.

To address these limitations and offer a comprehensive synthesis of published evidence regarding the prevalence of ADHD in adults, we conducted an umbrella review of systematic reviews and meta-analyses. Our aim was to provide policymakers, researchers, and clinicians with robust and reliable data on international prevalence estimates of ADHD in adults. Adopting an umbrella review methodology allowed us to evaluate the quality and methodological rigor of the included studies, while conducting a rigorous synthesis of the evidence encompassing a wide range of results.

This approach allows for a comprehensive assessment of the evidence as well as a more nuanced understanding of the international

Table 1
The characteristics of studies included in the umbrella review.

Author year	Database searched	Number of primary studies	Case	Sample size	Prevalence rates
SimonV et.al., 2009	MEDLINE, PsycLit, and EMBASE	7	143	5717	2.5
Song et al., 2021	PubMed, Medline, Embase, and PsycINFO	20	2768	107 282	2.58
Dobrosavljevic et.al., 2021	Pubmed/MEDLINE, PsycINFO, Web of Science and EMBASE,	20	41,420	20,999,871	2.18
Willcutt et.al., 2012	Pubmed, PsycINFO, Educational Resources Information Center (ERIC), and Social Sciences Citation Index databases	11	705	14,081	5.0
Ramos-Quiroga et.al., 2012	NA	6	502	15,519	3.2

prevalence of ADHD in adults. By considering the methodological aspects and synthesizing diverse findings, this umbrella review enhances the reliability and generalizability of the prevalence estimates, guiding informed decision-making in policy, research, and clinical practice (Slim and Marquillier, 2022).

2. Methods

2.1. Research design and methods

We performed an umbrella review of systematic review and meta-analyses studies that determined the prevalence of ADHD in adults. The review was guided by preferred reporting items for systematic review and meta-analysis (PRISMA) (Moher et al., 2009).The review protocol was registered with the International Prospective Register of Systematic Reviews (PROSPERO) (CRD42023389704).

2.2. Data source and searches

We searched PsychINFO, Web of Science, PubMed, and Scopus to retrieve pertinent studies. According to predefined inclusion and exclusion criteria, two invetsigators (GA and YG) independently undertook a reviewed full-text papers. We performrmed a search by using the following terms and keywords: (i) attentina deficit hyeractivity disorders, ADHD; (ii) epidemiology, prevalence, rates; (iii) adults; and (iv) quantitative synthesis, meta-analy, Systematic review, systematic literature review. The supplementary material contains the details of the search strategy (**supplementary material 1**). The references of the included systematic review and meta-analyses were manually searched to identify studies that may be missed in our electronic search.

2.3. Eligibility criteria

Systematic review and meta-analyses satisfying the following criteria were included in this umbrella review: (1) reported data to quantify prevalence (i.e., if they reported the prevalence of ADHD); (2) performed in adults; and (3) published in the English language. We excluded studies conducted in children and adolescents, commentaries, and narrative reviews.

2.4. Data abstraction

We extracted the following data from each included study: the first author's name, database searched, year of publication, number of ADHD cases, total sample size, number of primary studies, and the prevalence of ADHD for the three subtypes of ADHD.

2.5. Study quality

A Measurement Tool to Assess Systematic Reviews (AMSTAR) was used to assess the quality of the included studies (AMSTAR) tool (Shea et al., 2007). Two investigators (GA and YG) independently evaluated the methodologic quality of the included systematic review and meta-analyses studies. Three standard scoring categories were used to report the quality of the studies — such as high quality (scored 8–11), moderate quality (scored 4 – 7, and low quality (Scored 0–3), and (Chesney et al., 2014).

2.6. Data synthesis and analysis

All meta-analyses were performed in Stata Version 16.1. Invariance variance weighted random-effect meta-analysis was employed to pool prevalence rates from the included studies due to the heterogeneity of the reported estimates. The heterogeneity across the studies was measured by using Cochrane's Q and I^2 test (Borenstein et al., 2010). Subgroup analysis were conducted by the by the subtype of ADHD —the hyperactive (ADHD-HI), the inattentive type of ADHD (ADHD-I) and the combined types (ADHD-C)]. A p value of <0.05 was considered as statistically significant.

3. Results

3.1. Study selection

As shown in the PRISMA flow diagram, our initial electronic search identified a total of 868 studies (Fig. 1). We detected no additional papers through a manual search of other sources. After removing 151 duplicate citations, we screened title and abstract of 717 papers. Further, we evaluated a full text of 13 papers and excluded 8 of them. Finally, five systematic review and meta-analyses studies that satisfied the full eligibility criteria were included in the current umbrella review (Dobrosavljevic et al., 2020; Ramos-Quiroga et al., 2013; Simon et al., 2009; Song et al., 2021; Willcutt, 2012) (Table 1).

3.2. Characteristics of included studies

Table 1 summarises the key characteristics of the included studies. We included Six systematic review and meta-analytic studies involving 57 primary articles and 253,528 adults with ADHD. These systematic reviews were published between 2009 (Simon et al., 2009) and 2021 (Song et al., 2021). The number of searched electronic databases in the included articles ranged from six to twenty, with a median of nine; whereas the median number of participants in the included studies was 14,800 (ranged 1327–20,999,871) and the median number of ADHD case was 603 (ranged from 143 to 255,241).

Among the five studies, only one study separately conducted analyses for the various categories of ADHD — inattentive type (ADHD-I), hyperactive type (ADHD-H), and the combined type (ADHD-C) (Simon et al., 2009).

3.3. Quality assessment

The methodological quality of the included systematic review and meta-analytic studies was appraised by using the AMSTAR tool. Three studies were medium quality (60%), and the remaining two studies were high quality (40%) **(Supplementary material 2).** Surprisingly, only

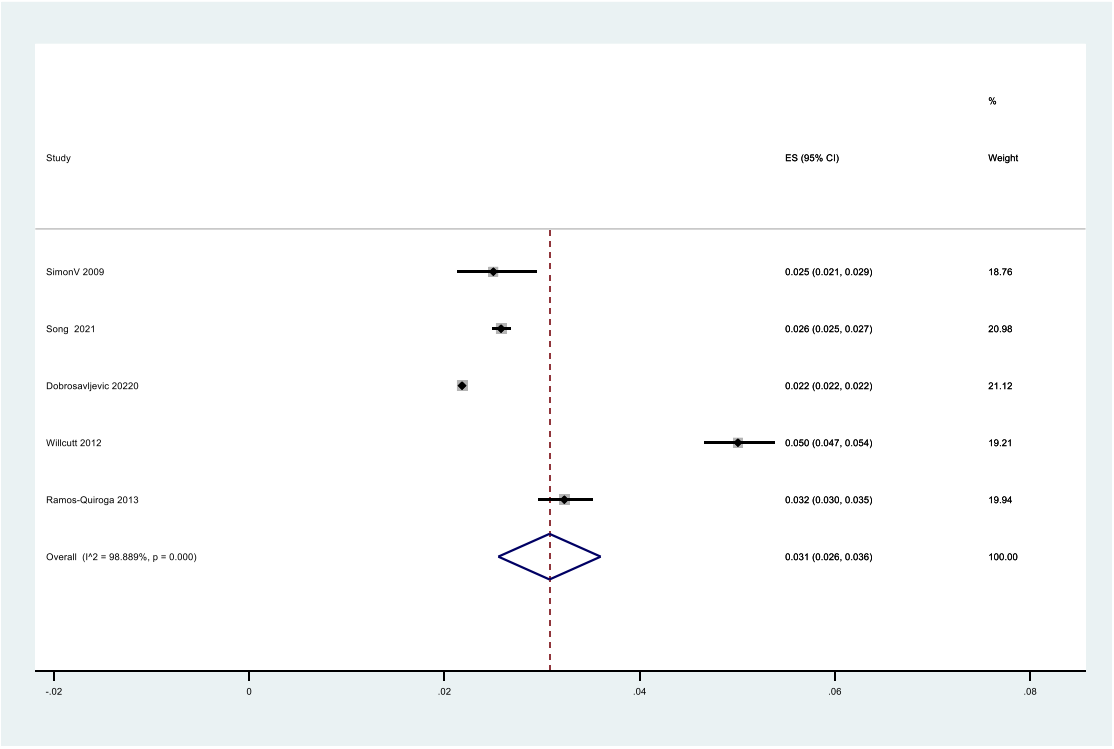

Fig. 2. The pooled prevalence estimates of ADHD in adults.

two systematic reviews reported the excluded studies and two reported the prespecified study protocol.

3.4. Duplicate assessment

In the current umbrella review, we conducted a comprehensive assessment of the literature to identify and evaluate duplicate studies' presence and impact on the overall results. Through this evaluation, we identified seven primary studies from four meta-analytic reviews that were found to be duplicates, and consequently, these duplicates were excluded from the final analyses (**Supplementary material 3**). This rigorous process ensures the validity and reliability of our findings and helps to avoid any potential bias introduced by duplicate data. **3.5. Prevalence of ADHD**

We performed the meta-analysis based on 57 unique primary studies to avoid the effects of bias associated with duplicates. According to the included meta-analytic reviews, the prevalence estimates of ADHD in adults ranged from 2.18% to 5%. Based on a random effect meta-analysis, the pooled prevalence of ADHD in adults was 3.10% (95%CI 2.60–3.60%), with significant heterogeneity across the studies ($Q = 359.897$; $p < 0.001$; $I^2 = 98.89\%$) (Fig. 2). This pooled prevalence of ADHD in adults was yielded based on data from five systematic review and meta-analyses studies with a total of 253,528 ADHD cases and 21,142,129 participants.

The inattentive type of ADHD was the commonest type of ADHD (ADHD-I) [3% (95%CI 2.0–4%); $n = 4633$] followed by the hyperactive type (ADHD-HI) [2.95% (95%CI 1.8–4%); $n = 4633$] and the combined type (ADHD-C) [(2.44% (95%CI 1.5–3.5%); $n = 4300$].

4. Discussion

We conducted, to our knowledge, the first umbrella review quantifying the prevalence of ADHD in adults. Our work includes five systematic reviews and meta-analyses involving 57 primary studies and 21,142,129 participants. The review summarized the overall general prevalence of ADHD in adults, as well as the prevalence estimates for each subtype of ADHD. The findings of this meta-analytic umbrella review will provide solid evidence about the prevalence estimates of ADHD in adults including more than twenty-one million adult sample across the globe. Understanding the prevalence estimates of ADHD in adults helps to plan effective prevention and early intervention strategies for this population group.

The current umbrella review has the following key findings: First, the prevalence estimate of ADHD in adults is relatively high (3.1%). This prevalence is comparable or only slightly lower with the reported prevalence estimates of mental disorders that received significant attention by the government across the globe such as schizophrenia (4%) (Saha et al., 2005), and major depressive disorders (5%) (Steel et al., 2014). However, the prevalence rates of ADHD is higher than other well-known mental disorders in adult populations including bipolar disorders (1%) and some anxiety disorders including PTSD, OCD, GAD and panic disorders (Clemente et al., 2015). Unlike the aforementioned disorders, ADHD in adults received less attention. For Example, a 20,120 study suggested that only 90% adults with ADHD receive the intended treatment (Huang et al., 2020). On the contrary, the current prevalence was lower than the prevalence estimates of psychiatric disorders among homeless people (Ayano et al., 2017; Ayano et al., 2019; Gutwinski et al., 2021).

Second, in this umbrella review, similarly with children and adolescents(Ayano et al., 2020), ADHD-I remained the commonest type of ADHD, followed by ADHD-Hand ADHD-C [(2.44] (Ayano et al., 2023). There are several explanations for the highest prevalence of ADHD-I compared with other subtypes. One of the potential explanations could be due to the consistent nature of this subtype of ADHD (Weyandt et al., 2003). Research has shown that inattentive symptoms of ADHD remain comparatively stable over time (Weyandt et al., 2003) while the hyperactive–impulsive symptoms of ADHD are developmentally sensitive and tend to decrease over time (Weyandt et al., 2003).

There strengths of the current umbrella review included: (1) it is the first umbrella review to quantitative prevalence estimates of ADHD in adults (2) we adhered to the PRISMA guideline, and the methodological quality of the included systematic review and meta-analyses was

evaluated by using robust tool designed to measure the quality of meta-analyses; (3) The strength of the findings lies in conducting analyses based on 57 unique primary studies and employing rigorous methodology to evaluate the risk of bias. By avoiding duplicate studies and carefully assessing the potential effects of studies with extreme values, the results provide a robust and reliable estimation of ADHD prevalence in different populations. This approach ensures the accuracy and validity of the findings, making them valuable for informing clinical practice, research, and public health interventions related to ADHD; (4) analysed data for each subtype of ADHD.

The main limitations of the current umbrella review are related to the included systematic reviews. First, to estimate the prevalence of ADHD in adults, we relied on data reported by the included articles, suggesting other gray and published literature could be missed. Second, the methodological quality of four studies was low as they did not report the details their methodology for the systematic review and/or did not preregister the review protocol.

5. Conclusion

This umbrella review provides the most robust evidence of the prevalence of ADHD in adults. The findings indicates that the prevalence of ADHD is relatively high in adults, with ADHD-I remaining the most common subtype followed by ADHD-H and ADHD-C. Attention should be given prevent, reduce, early identify, and manage ADHD adults. Furthermore, future studies estimating the prevalence rates in certain ethnic groups or countries, including Black Americans, Indigenous people, and individuals from various socioeconomic backgrounds are required.

Contributions

GA, LT, RA, and YG developed the methodology, abstracted the data and evaluate the quality of the studies. GA conceived the study, involved in identification of the studies, conducted the analyses and drafted the manuscript. MN, KY, MA, TA and SD reviewed the draft of the manuscript and analyses. All author dead and approved the final manuscript.

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Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.psychres.2023.115449.

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