



# BMJ Open Prevalence of attention-deficit hyperactivity disorder in children, adolescents and adults in the Middle East and North Africa region: a systematic review and meta-analysis

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**To cite:** Al-Wardat M, Etoom M, Almhdawi KA, *et al.* Prevalence of attention-deficit hyperactivity disorder in children, adolescents and adults in the Middle East and North Africa region: a systematic review and meta-analysis. *BMJ Open* 2024;**14**:e078849. doi:10.1136/bmjopen-2023-078849

► Prepublication history and additional supplemental material for this paper are available online. To view these files, please visit the journal online (<http://dx.doi.org/10.1136/bmjopen-2023-078849>).

Received 14 August 2023  
Accepted 04 January 2024



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## ABSTRACT

**Objectives** To systematically estimate the overall prevalence of attention-deficit hyperactivity disorder (ADHD) in children, adolescents and adults across the Middle East and North Africa (MENA) region.

**Design** Systematic review and meta-analysis conducted according to the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) statement.

**Data sources** Medline and Scopus databases were comprehensively and systematically searched between 1990 and February 2023.

**Eligibility criteria for selecting studies** We included all cross-sectional or cohort studies that diagnosed ADHD using validated diagnostic tools (eg, Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition criteria, ADHD rating scales and ADHD diagnostic interview) or non-validated tools (eg, brain imaging techniques, computerised cognitive tests and quantitative electroencephalography).

**Data extraction and synthesis** Two reviewers performed the data extraction independently using standardised data collection sheet. Newcastle-Ottawa Scale was used to assess the quality of the included studies. Individualised and pooled event rate and upper and lower limit at 95% CI were calculated according to the ADHD cases and the total sample size using a random-effect model. The subgroup prevalence analyses according to ADHD subtypes, gender, MENA country and age were also performed.

**Results** A total of 63 articles met the inclusion criteria involving 849 902 participants. The overall prevalence of ADHD was 10.3% (95% CI 0.081 to 0.129). The prevalence rate ranged from 1.3% (Yemen) to 22.2% (Iran). Subgroup analyses showed that the prevalence in adults was 13.5 and 10.1 in children and adolescents. Males exhibited significantly higher prevalence compared with females as these were 11.1% and 7%, respectively. Attention-deficit subtype was significantly the most prevalent (46.7%) compared with hyperactivity/impulsivity (33.7%) and combined types (20.6%).

**Conclusion** The overall prevalence of ADHD was high in the MENA region. It is crucial to allocate more attention and resources towards the prevention and treatment of ADHD in children, adolescents and adults within the region.

## STRENGTHS AND LIMITATIONS OF THIS STUDY

- ⇒ This review includes a large number of studies conducted within different countries in the MENA region, enhancing the representation of MENA populations, cultures and contexts which might enhance the generalisation of the results.
- ⇒ These study methods obviously highlight the need for future research improvements, including comprehensive gender-specific assessments, focused studies on ADHD in adults and categorisation of age variations for adolescents.
- ⇒ This study acknowledges and emphasises the high heterogeneity among the included studies. This demonstrates a commitment to transparently interpret findings while encouraging more consistency in methodology and diagnostic criteria in future research.
- ⇒ The study's inability to identify gender differences in ADHD subtypes could have limited the understanding of how presentation may vary between genders.
- ⇒ Pooled prevalence data for adolescents without accounting for potential age-related variations might have oversimplified the analysis of ADHD prevalence across different age groups.

## INTRODUCTION

Attention-deficit hyperactivity disorder (ADHD) is a neurodevelopmental disorder in childhood and adolescence. ADHD is characterised by three primary traits: inattention, hyperactivity and impulsivity. Indeed, ADHD is widely recognised as one of the leading reasons for children being referred to mental health clinics and rehabilitation services.<sup>1 2</sup> Children diagnosed with ADHD often face challenges in maintaining focus, demonstrating self-control, managing impulsive behaviours and/or displaying an excess of physical activity.<sup>2 3</sup> The presence of hyperactivity, which is a prominent symptom of

ADHD, might contribute to psychological and social difficulties for a child within their home, school and community, leading to a sense of incompatibility.<sup>1–3</sup> According to the Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-5), the core feature of ADHD is a collection of behaviours that could disrupt social functioning.<sup>1–3</sup> Instances of these behaviours include increased motor activity in inappropriate situations, excessive fidgeting, engaging in fingerplay and excessive talkativeness.<sup>3</sup> These social challenges might significantly impact daily life functional abilities including personal and educational aspects of individual life.<sup>1 4–8</sup>

ADHD can be classified into three primary subtypes: attention deficit, hyperactive-impulsive and combined types.<sup>5</sup> The attention-deficit subtype is characterised by difficulties sustaining attention, being easily distracted and struggling with organisation and task completion.<sup>5</sup> Adolescents and adults with this subtype may appear forgetful, have trouble following instructions and exhibit a tendency to daydream or become lost in their thoughts.<sup>4 5 9</sup> The hyperactive-impulsive subtype, on the other hand, is usually marked by high levels of activity, restlessness and difficulty remaining still or quiet.<sup>5 10</sup> Adolescents and adults with this subtype often exhibit impulsive behaviours such as speaking out of turn, interrupting others and engaging in improper or impulsive decision-making.<sup>10</sup> Finally, the combined type, the most common ADHD subtype, usually involves a combination of both attention-deficit and hyperactive-impulsive symptoms.<sup>10</sup> Individuals with the combined type might experience difficulties with attention, hyperactivity and impulsivity across various settings, leading to functional challenges in academic, social and/or personal domains.<sup>5 10</sup>

Previous studies have assessed the prevalence of ADHD across various countries, specific regions and globally. These studies have incorporated child, adolescent and adult populations. It is important to mention that ADHD global prevalence ranged between 5.9% and 12.4%. More recently, a global estimation of ADHD and its related subtypes revealed an overall prevalence of 7.6% in children and adolescents.<sup>11</sup> Specifically, the prevalence of the attention subtype was 33.2%, the hyperactive-impulsive subtype was 30.3% and combined ADHD was observed at 31.4%.<sup>11</sup> Additionally, a previous systematic review reported that the global prevalence of persistent adult ADHD from childhood was 2.58%, and the prevalence of symptomatic adult ADHD was 6.76%.<sup>12</sup> Furthermore, a recent umbrella review found that the global prevalence of ADHD in adults was estimated at 3.10%.<sup>13</sup> In a recent systematic review, Aljadani *et al* reported that the prevalence of ADHD among Saudis was 12.4%.<sup>14</sup> Additionally, three previous studies estimated the prevalence of ADHD in Arab Gulf countries, Arab countries and Africa between 5.9% and 10.5%.<sup>9 14 15</sup> Despite these accumulated evidence and variations in ADHD estimated prevalence, it is well known that its prevalence might be influenced by various factors such as gender, culture, environment, socioeconomic status and demographics.<sup>16 17</sup> Extensive

prior research has consistently documented marked gender differences in the prevalence of ADHD and its various subtypes.<sup>12 18–21</sup> Notably, males exhibited a particularly higher probability of receiving clinical diagnoses of ADHD compared with females, with male-to-female prevalence ratios varying within the range of 2:1 to 10:1 across studies.<sup>22–24</sup>

The prevalence of ADHD differs significantly between childhood/adolescence and adulthood, as evidenced by global estimates and insights from previous systematic reviews and meta-analyses.<sup>12 21 25</sup> Diverse cultural and methodological factors could have contributed to the wide range of prevalence rates identified in the literature targeted childhood and adolescence populations.<sup>26</sup> Prevalence variation between genders further highlights the complexity of understanding ADHD.<sup>20 22</sup> Assessment, diagnostic tools and data sources, including self-reported information and medical records, have also introduced more prevalence variability.<sup>27</sup> In adulthood, global estimates of ADHD are generally lower than younger population, ranging from 2.5% to 2.58%, with ongoing debates on the manifestation of symptoms and potential underdiagnosis in females.<sup>12</sup> The transition to adulthood brings its own set of challenges, including diverse assessment methodologies and persisting gender differences, highlighting the need for more appropriate analyses adopting standardised diagnostic criteria for a better comprehensive understanding of ADHD prevalence across lifespan.<sup>12 28 29</sup>

To the best of our knowledge, there is no study that estimated the overall prevalence of ADHD in the Middle East and North Africa (MENA) region. The MENA region is characterised by its consistent and unique cultural, social and environmental factors, which suggests a different prevalence of ADHD and its characteristics compared with other world regions. Most of the MENA countries are at medium to high population growth and fertility.<sup>30</sup> MENA population is primarily young, with over half of the population under the age of 25 years.<sup>30</sup> Understanding the estimated prevalence of ADHD and its characteristics in the MENA region could be crucial for identifying the scope of this disorder and informing appropriate interventions and healthcare planning. Therefore, the primary purpose of the present systematic review and meta-analysis was to estimate the overall prevalence of ADHD in children, adolescents and adults, as well as to examine gender differences in ADHD prevalence and explore the distribution of different ADHD subtypes within the MENA population.

## METHODS

### Search strategies

This study was performed according to the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) statement.<sup>31</sup> A comprehensive electronic search was conducted to identify articles in two databases (PubMed and Scopus). We used the World Bank's definition to encompass the MENA region, which comprises

20 countries with an estimated population of approximately 355 million. The MENA region includes Algeria, Bahrain, Djibouti, Egypt, Iran, Iraq, Israel, Jordan, Kuwait, Lebanon, Libya, Morocco, Oman, Qatar, Saudi Arabia, Syria, Tunisia, United Arab Emirates, Palestinian territories and Yemen.<sup>32</sup> The following keywords were used to search the literature: attention-deficit hyperactivity disorder, ADHD, prevalence, epidemiology, Middle East, North Africa, MENA and each of the names of the MENA countries (Algeria, Bahrain, Egypt, Iran, Iraq, Israel, Jordan, Kuwait, Lebanon, Libya, Morocco, Oman, Qatar, Saudi Arabia, Syria, Tunisia, United Arab Emirates and Yemen). A full list of search terms and strategies is presented in online supplemental table S1. The manual search was conducted also by two authors (MA-W and ME) to collect any potential paper that was not imported through the search term in all the databases.

### Eligibility criteria

We included studies that met the following criteria: (1) cross-sectional or cohort studies published between 1990 and February 2023, (2) diagnosed ADHD using validated diagnostic tools (eg, DSM-5 criteria, ADHD rating scales and ADHD diagnostic interview) or non-validated tools (eg, brain imaging techniques, computerised cognitive tests and quantitative electroencephalography; we included studies that did not report the diagnostic criteria), (3) provided the prevalence of overall ADHD or its subtypes, (4) comprised independent samples with a relatively large sample sizes ( $n > 100$ ) and (5) published in peer-reviewed journals in English. The exclusion criteria were as follows: (1) studies with duplicate or overlapping data, (2) studies without full text and (3) reviews, case reports, editorials, letters to editors and conference abstracts. In cases where multiple studies used the same population, the study with the highest number of participants was selected.

### Data extraction and quality assessment

Two authors performed the data extraction independently, using standardised data collection sheet to obtain the following information: (1) characteristics of the study (the name of the last author, publication year, year of data collection, country and type of the study), (2) diagnostic tools (reported screening for ADHD in adulthood/adolescence, self-reported screening for ADHD or clinical interview), (3) diagnostic criteria used for diagnosis (DSM-III, DSM-IV and DSM-5), (4) characteristics of the participants (sample size, age range and gender) and (5) overall prevalence of ADHD according to both genders and the prevalence of ADHD subtypes.

### Quality assessment

Two authors (MA-W and ME) independently rated the quality of each study using the Newcastle-Ottawa Scale (NOS), a commonly used tool for evaluating observational studies with a score range of 0–9.<sup>33</sup> The NOS scale assessed the sample selection (maximum of four points

for cohort studies and three points for cross-sectional studies), comparability of sample groups (maximum of two points) and outcome (maximum of three points for cohort studies and one point for cross-sectional studies).<sup>33</sup> A higher score indicates a better research quality. In cases of disagreements or uncertainty, a third researcher (KAA) was consulted for discussion and resolution. If both authors had any disagreements, the third author calculated the average of the quality assessment.

### Statistical analyses

Meta-analysis was performed using comprehensive meta-analysis software V.4. Individualised and pooled event rate and upper and lower limit at 95% CI were calculated by taking the ratio of the ADHD cases to the total sample size. The random-effect model was adopted due to the variation of sampling methods and sample sizes in the included studies. The analysis of ADHD subtypes was also performed. Subgroup analyses were performed for the prevalence according to gender (male versus female), MENA country and age (children versus adults). Heterogeneity in effect size was examined by calculating the  $I^2$  index.<sup>34</sup>

### Patient and public involvement

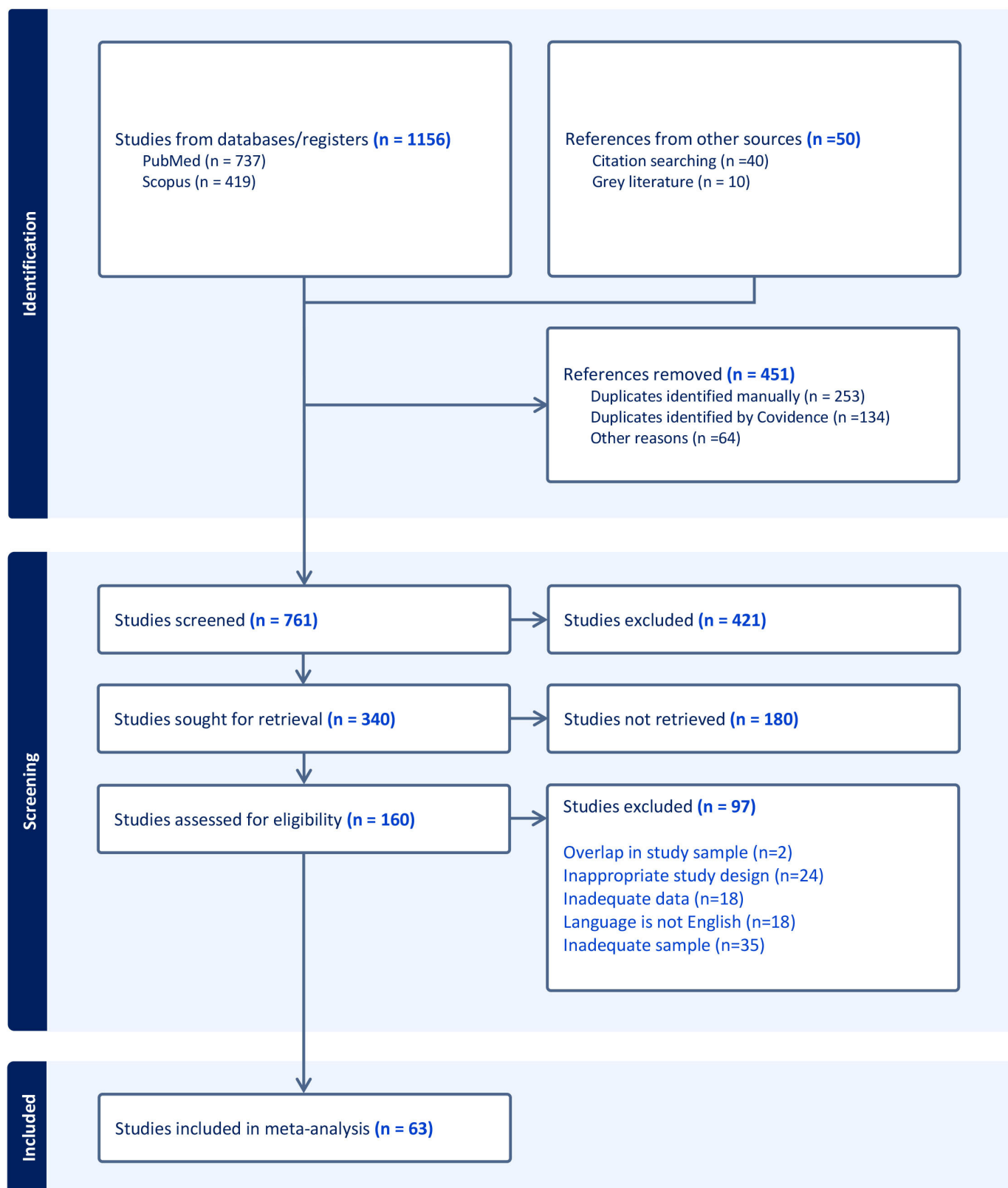
Due to its design, patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

## RESULTS

### Study selection

The database search resulted in a total of 1206 articles. After eliminating duplicate entries, 761 titles and abstracts were reviewed. Out of these, 166 studies were considered relevant and assessed in full text. A total of 97 studies were excluded for different reasons: two studies had overlapped samples; 35 studies recruited samples that were composed entirely of individuals with ADHD; 24 articles had no appropriate study design including case studies, letters to editors and conference abstracts; 18 studies had no adequate data (did not report overall and/or subtype prevalence of ADHD); 18 articles were not in English language (figure 1). Finally, 63 articles involving 849 902 participants were included in the meta-analysis (as shown in PRISMA, figure 1).<sup>35–97</sup> The studies and participant characteristics are reported in online supplemental table S2.

This meta-analysis pooled 63 original articles, including a total of 849 902 participants (88.89% children and adolescents (age range 3–18 years) and 11.11% adults (age range 17–70 years)).<sup>35–97</sup> Two studies were published before 2000 period, whereas 20.63% of studies (13 studies) were published between 2000 and 2010, and 76.20% of studies (48 studies) were published after 2010. The analysis included data from 15 countries: Iran (19 studies, 30.15%), Egypt (8 studies, 12.69%), Jordan (2 studies, 3.17%), Saudi Arabia (10 studies, 15.87%),



**Figure 1** Screening process for systematic review in accordance with Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA).

Oman (2 studies, 3.17%), Iraq (4 studies, 6.34%), Israel (3 studies, 4.76%), Qatar (3 studies, 4.76%), Lebanon (2 studies, 3.17%), United Arab Emirates (4 studies, 6.34%), Tunisia (2 studies, 3.17%), Sudan (1 study, 1.58%),

Palestine (1 study, 1.58%), Yemen (1 study, 1.58%) and Algeria (1 study, 1.58%). Table supplementary S2 lists the details of studies included from each country and other relevant characteristics. Most studies used clinical



diagnosis tools (58.5%,  $n=33$ ), while 21.1% ( $n=30$ ) used self-reported screenings of childhood ADHD, and 20.4% ( $n=29$ ) used self-reported screenings of adolescent/adult ADHD. 43 studies adopted validated diagnostic criteria, with the following breakdown: DSM-5 (3 studies), DSM-III (1 study), DSM-III-R (3 studies), DSM-IV (33 studies), DSM-IV and International Classification of Diseases 10th Revision (ICD-10) (2 studies), DSM-IV-TR (1 study) and DSM-V (1 study). However, 20 studies did not report the diagnostic criteria used. Overall, the quality of the included studies was high according to NOS<sup>98</sup> (online supplemental table S3). It is important to mention that all included studies scored 5 or higher on the NOS, except for one study,<sup>97</sup> which scored 4 according to the NOS. Despite the lower score, we decided to include this study in our review and analysis due to its significance as the sole available study from Algeria.

### Pooled prevalence

#### Overall prevalence of ADHD

The overall prevalence of ADHD in children, adolescents and adults (63 studies and a sample of 850 250 individuals) was calculated at 10.3% (95% CI 8.1 to 12.9), with high heterogeneity ( $I^2=99.85$ ) (online supplemental table S4).

#### Proportion of ADHD subtypes among those with ADHD

19 studies suggested that the overall prevalence of ADHD subtypes (including attention deficit, hyperactivity/impulsivity and combined types) among children, adolescents and adults with ADHD, from a sample of 461 596 individuals, was 34.7% (95% CI 34.2 to 35.1) (online supplemental table S5). Notably, these findings demonstrated considerable heterogeneity across the studies ( $I^2=97.97$ ). Of all individuals with ADHD, the estimated proportions of the ADHD subtypes were 46.7% (95% CI 45.8 to 47.5) for attention deficit, 33.7% (95% CI 33.7 to 32.9) for hyperactivity/impulsivity and 20.6% (95% CI 19.9 to 21.3) for the combined types. The heterogeneity across the included studies was high ( $I^2=94.80$ ) (online supplemental table S5).

#### Overall prevalence of ADHD by MENA country

19 studies have shown that the overall prevalence of ADHD in Iran was 22.2% (95% CI 21.9 to 22.5). The pooled estimated prevalence in Tunisia was 14.3% (95% CI 12.2 to 16.7). The pooled estimated prevalence was equal in Egypt (12%; 95% CI 11.1 to 12.9), Iraq (12.9%; 95% CI 11.6 to 14.3), Israel (12.6%; 95% CI 12.5 to 12.8), Jordan (12.1%; 95% CI 11.1 to 13.2) and Palestine (12%; 95% CI 9.7 to 14.6). The estimated prevalence of ADHD in Lebanon was 6.7% (95% CI 5.4 to 8.2), and in Oman, it was 8.8% (95% CI 7.6 to 10.2). The prevalence of ADHD was also similar in Qatar (9.2%; 95% CI 8.6 to 9.8) and the United Arab Emirates (9.2%; 95% CI 8.4 to 10.1). Additionally, the pooled prevalence in Algeria was 3% (95% CI 1.0 to 8.9), Saudi Arabia was 3.2% (95% CI 3.1 to 3.2), Yemen was 1.3% (95% CI 0.8 to 2.1), and in Sudan, it was

9.4% (95% CI 7.7 to 11.4). The heterogeneity across all studies was high and ranged between  $I^2=0$  and  $I^2=99.755$ .

#### Overall prevalence of ADHD by age and gender

The pooled prevalence of ADHD in adults (included four studies) was 13.5% (95% CI 8 to 20), with high heterogeneity across studies ( $I^2=94.98$ ). The pooled prevalence of ADHD in children and adolescents (included 59 studies) was 10.1% (95% CI 7 to 12), with high heterogeneity across studies ( $I^2=99.86$ ) (online supplemental table S5).

Related to gender, 31 studies showed that the overall prevalence of ADHD in females was 7% (95% CI 3.9 to 14.4), while in males, it was 11.1% (95% CI 6.9 to 17.4), with high heterogeneity across studies ( $I^2=99.77$ ) (online supplemental table S5).

The subgroup pooled analysis based on gender separately within children and adolescents based on 29 studies showed that the prevalence of ADHD in females was 7.6% (95% CI 3.9 to 14.2), while in males, it was 17.3% (95% CI 8.6 to 31.9). In addition, the subgroup pooled analysis based on gender separately for adults based on four studies showed that the prevalence of ADHD in females was 8.6% (95% CI 2.5 to 25.6), while in males, it was 12.3% (95% CI 5.9 to 23.9) (online supplemental table S5).

### DISCUSSION

The main aim of these systematic reviews and meta-analyses was to estimate the prevalence of ADHD in children, adolescents and adults in the MENA region. Overall, 10.3% of children, adolescents and adults were found to have ADHD in the MENA region. Particularly, the overall prevalence of ADHD in children and adolescents was 10.1% and in adults was 13.5%. We noticed a significant variation in the prevalence of ADHD among different countries, with rates ranging from 1.3% in Yemen to 22.2% in Iran. The variability in ADHD prevalence across different MENA countries may be attributed to several factors. These might include methodological discrepancies, variations in the age of the children studied, perinatal complications, differences in assessment tools for measuring ADHD, gender distribution among participants, cultural influences, socioeconomic status of families and the presence of other concurrent mental and neurological disorders.<sup>99 100</sup> It is not surprising to observe such variations given the complex interplay of these potential contributing factors.

The overall prevalence of ADHD in the current meta-analysis (10.3%) aligns closely with previous studies conducted in Arab and African populations,<sup>9 14 15 100</sup> which reported a range of ADHD prevalence between 1.3% and 16%. However, these previous studies did not pool the data from Iran or Israel and did not include a large sample size like in this current study. In this review, there were 22 studies conducted in Iran and Israel. It is important to note that Israel and Iran exhibit notable differences in terms of culture and various related factors compared with Arabic MENA countries. Based on the latest findings

from a study conducted in 2023 to estimate the global prevalence of ADHD, the prevalence of ADHD among children aged 3–12 years was 7.6%, while among adolescents aged 12–18 years, it was found to be 5.6%.<sup>11</sup> These figures indicate a slightly lower worldwide prevalence compared with our own findings in the MENA region. In this current study, the estimated prevalence of ADHD in adults stands out as notably higher than the globally pooled estimates for this respective age group. Indeed, the global estimates for adults with ADHD typically range from 2.5% to 2.58%.<sup>12 19 101</sup> Even when considering less conservative estimates, such as symptomatic adult with ADHD at 6.76%,<sup>12</sup> the prevalence rates identified in the current review were significantly elevated compared with the world estimates.

Indeed, there are several potential reasons for these discrepancies in the estimated prevalence in the MENA region. We observed that two of the included studies from Iran reported a relatively higher prevalence of ADHD.<sup>35 41</sup> Notably, both studies were community based; however, there were distinctions in their sampling methods. In the case of Salmanian *et al*, the study sample comprised 1000 participants randomly selected from all provinces of Iran.<sup>35</sup> This method of selective enrolment, which aimed for a geographically diverse representation, might explain the relatively higher prevalence of 32.9% observed in this study. Conversely, Ghanizadeh *et al* estimated the prevalence of ADHD to be around 32.34%.<sup>41</sup> It is essential to note that this study's sample was recruited from the child and adolescent psychiatric clinic in the Fars region of Iran. The authors reported that the clinic received referrals from various geographical regions, including urban, suburban and rural communities surrounding the medical centre in Fars, as well as some neighbouring provinces. Importantly, this clinic's sample was unselected, implying that the children were referred for a general psychiatric evaluation rather than for an evaluation of any specific disorder. Therefore, both studies may have contributed to the overall increase in the prevalence of ADHD in the MENA region, as indicated by our pooled analyses.

Furthermore, the majority of the population is young in the MENA region which could have increased the odds of having more ADHD cases.<sup>30</sup> The variability in ADHD diagnostic criteria included in our study emphasises the importance of relying on standardised diagnostic criteria, such as the DSM or the ICD.<sup>1 23</sup> Moreover, diagnosing ADHD is characteristically challenging, as specialists may tend to either overdiagnose or underdiagnose the condition.<sup>27 29</sup> However, different regions and healthcare settings might apply these criteria with varying levels of accuracy and consistency. For example, we noted that studies with higher prevalence rates tend to cover a broader age range, such as 5–18 years, compared with those with a more limited age scope. Specifically, seven studies within the dataset investigated ADHD prevalence across a wider age spectrum, ranging from 5 to 18 years. Interestingly, the reported prevalence for these studies was extremely high, ranging between 32% and

40%.<sup>35 45 57 58 60 62 71 82</sup> Furthermore, we observed that studies using different versions of the DSM show varying prevalence rates. The included studies using DSM-IV, DSM-IV-TR, DSM-III, and DSM-5 exhibit different prevalence rates. Different diagnostic criteria may have been applied to different age groups, potentially contributing to the variations reported in ADHD prevalence in our study. Thus, we speculated that the choice of DSM version may impact ADHD diagnostic criteria and, subsequently, its prevalence rates.

The cultural beliefs and attitudes towards mental health and ADHD could also have impacted the identification and reporting of ADHD cases in the MENA region. Additionally, cultural norms and expectations might influence the perception of ADHD symptoms, possibly leading to different prevalence rates.<sup>102</sup> The MENA region consists of multiple countries with diverse cultural, social and economic contexts.<sup>102 103</sup> Prevalence rates might vary significantly between different countries within the region due to regional-specific factors.<sup>102 103</sup>

The findings from this analysis provide significant insights into ADHD prevalence among children, adolescents and adults, shedding light on gender-based differences. In adults, the overall prevalence was estimated at 13.5% across four studies, notably higher than previous estimates of 2.5%–6.9%.<sup>101 104 105</sup> Gender-specific subgroup analysis within the adult population from these studies indicated rates of 8.6% in females and 12.3% in males. These findings reveal substantial variations from previously reported rates.<sup>12 18 19</sup> Moving to the younger demographic, among 59 studies, the combined ADHD prevalence for children and adolescents was estimated at 10.1%. Within this group, the analysis based on gender from 29 studies highlighted rates of 7.6% in females and notably higher rates of 17.3% in males. Particularly, the prevalence of ADHD in children and adolescents in the MENA region appeared to be significantly higher than in other parts of the world, as evidenced by a 2018 study estimating prevalence between 2% and 7%.<sup>23</sup> However, our findings align well with the previous study that reported global prevalence rates of 11.4% among children aged 6–12 years and 8% among 12–18-year-olds.<sup>23</sup> These rates are consistent with our observed prevalence rates, although variations could be attributed to the use of different diagnostic criteria from the DSM in the included studies. This study also emphasised significant gender-based differences in ADHD prevalence, especially higher in males than females, consistent with previous findings in Africa.<sup>9</sup> However, it is crucial to note the high heterogeneity across our studies, suggesting potential variations in sample characteristics and methodologies. This heterogeneity emphasises the complex nature of ADHD and highlights the necessity for further research in the MENA region to comprehend the factors contributing to gender-based prevalence differences.

The results of this study indicated that among children, adolescents and adults with ADHD, the prevalence of all ADHD subtypes (including attention deficit,

hyperactivity/impulsivity and combined types) was 34.7% of all individuals with ADHD in the MENA region. In accordance with prior meta-analytic studies, our meta-analysis confirms that the predominantly attention-deficit subtype prevalence (46.7% out of the total ADHD prevalence) remains the highest of all ADHD subtypes.<sup>9 99</sup> Certainly, the continual prevalence of the attention-deficit subtype within the spectrum of ADHD may have contributed significantly to the increased frequency of its occurrence.<sup>106</sup> This suggests that the sustained presence of this subtype plays a pivotal role in the overall higher prevalence of ADHD. However, previous studies indicate that the attention-deficit symptoms of ADHD display a relatively stable pattern over time,<sup>106 107</sup> whereas the other subtypes of ADHD, such as hyperactive-impulsive symptoms, are more susceptible to developmental changes and tend to decrease over time (although the sensation of restlessness may persist).<sup>99 106 107</sup> Within our study, the hyperactivity/impulsivity type of ADHD emerged as the second most prevalent subtype, with the combined type following closely behind. Indeed, these results are in line with the previous meta-analysis conducted in Africa.<sup>9</sup> The variation in findings could be attributed to methodological differences among the studies included in this meta-analysis, as well as the presence of diverse cultural and demographical factors influencing ADHD in children and adolescents.

Indeed, the results of this meta-analysis provide insights into the prevalence of ADHD across several countries in the MENA region. The findings reveal significant variability in ADHD estimated prevalence rates, highlighting the importance of considering regional differences. The highest prevalence was observed in Iran, with approximately 30.1% of the adolescents and adults affected by ADHD. Tunisia had the second highest prevalence at 14.3%, followed by Iraq, Israel, Jordan and Palestine, all with estimates ranging from 12% to 12.9%. Lebanon and Oman had relatively lower prevalence rates, with estimates of 6.7% and 8.8%, respectively. Qatar and the United Arab Emirates shared similar prevalence rates of 9.2%. Algeria and Saudi Arabia had lower prevalence rates, both around 3%, while Yemen had a prevalence rate of 1.3%. Sudan had a higher prevalence rate of 9.4%. It is important to note that there was considerable heterogeneity across all the studies, indicating potential variations in methodology, sample characteristics and other factors influencing the reported prevalence rates. Among the MENA countries included in this study, it is important to note that there was no study from Bahrain, Djibouti, Kuwait, Morocco, Libya or Syria estimating the prevalence of ADHD. These findings emphasise the need for further comprehensive research in the MENA region to explore the underlying factors contributing to the variability in ADHD prevalence across all MENA countries and to develop tailored interventions and support for individuals with ADHD.

## Limitations and recommendations

This study has several limitations to be considered in future research. First, the study lacks the ability to identify gender differences in ADHD subtype prevalence within the MENA region. Future research should conduct more comprehensive assessments considering gender variations. Second, the estimated prevalence of ADHD in adults relied on four studies only, highlighting the need for more focused research on ADHD in adults in the MENA region. Third, the pooled prevalence data for children and adolescents (aged 3–18 years) do not account for potential age variations within this range due to unclear categorisation in the included studies. Future studies should address this by providing a detailed analysis of ADHD prevalence across different age groups within the adolescent population in the MENA region. Fourth, the predominantly cross-sectional design of the included studies hinders the establishment of causality, emphasising the need for longitudinal studies to explore risk factors, protective factors and the trajectory of ADHD over time in the MENA region. Fifth, 20 studies in the analysis did not report specific diagnostic criteria for identifying ADHD, highlighting the importance of clearer reporting in future research. Finally, the high heterogeneity among the included studies emphasises the need for caution in generalising across the MENA region. Future research should strive for consistency in methodology and diagnostic criteria to improve comparability and reduce heterogeneity in ADHD prevalence studies. Additionally, a comprehensive large-scale study across multiple MENA countries is recommended. The limited inclusion of assessments from both parents and teachers constrains the depth of exploration into ADHD prevalence in children and adolescents. Inconsistencies in reporting practices, such as reliance on self-reports, further complicated ADHD prevalence interpretation in this study. Future research is encouraged to adopt comprehensive reporting, including both self-reports and informant reports. While this systematic review aimed to comprehensively identify evidence on ADHD prevalence in the MENA region, its limitation to English language studies suggests a need for future research to include studies published in languages commonly used in the region (Arabic, Hebrew, Persian and French). Despite these limitations, the included studies demonstrated high quality according to the NOS. At any rate, this study is valid and added significant contributions as the first and the most comprehensive attempt to characterise ADHD in the MENA region.

## Conclusion

Overall, the prevalence of ADHD (10.3%) was high in both children and adolescents (10.1%) and adults (13.5%), being significantly higher among males compared with females. The predominantly attention deficit (46.7% of total prevalence) was the most prevalent subtype of ADHD followed by hyperactivity/impulsivity type (33.7% of total prevalence) and combined type (20.6% of total



prevalence). The prevalence rates of ADHD varied across different countries in the MENA region, emphasising the need for further research and targeted interventions to address the high prevalence of ADHD in children and adolescents. Finally, it is crucial to allocate more attention and resources towards the prevention and treatment of ADHD in adolescents and adults within the MENA region. Future studies are recommended to conduct more comprehensive cross-sectional investigations that include data from multiple countries within the MENA region. These future studies should employ standardised assessments for diagnosing ADHD, ensuring consistent and accurate identification of individuals with ADHD. Furthermore, it is advisable to conduct interventional studies exploring the efficacy of various ADHD treatment approaches efficacy.

**Acknowledgements** The authors are grateful to the Deanship of Research and Graduate Studies, Jordan University of Science and Technology.

**Contributors** MA-W: conceptualisation, data curation, validation, formal analysis, funding acquisition, methodology, project administration, resources, writing original draft. ME: conceptualisation, data curation, validation, formal analysis, funding acquisition, methodology, project administration, resources, writing original draft. KAA: methodology, validation, writing—review and editing. ZH: methodology, validation, writing—review and editing. YK: writing—review and editing. The final manuscript has been approved by all authors. MA-W acts as the guarantor for this work.

**Funding** The authors have not declared a specific grant for this research from any funding agency in the public, commercial or not-for-profit sectors.

**Competing interests** None declared.

**Patient and public involvement** Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

**Patient consent for publication** Not applicable.

**Ethics approval** Not required.

**Provenance and peer review** Not commissioned; externally peer reviewed.

**Data availability statement** Data are available upon reasonable request. The data is available from the corresponding author upon reasonable request.

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