





# Prevalence of autism spectrum disorder among children in Southeast Asia from 2002 to 2022: An updated systematic review and meta-analysis

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## Abstract

**Background and Aims:** Autism spectrum disorder (ASD) is a neurodevelopmental condition that impacts the brain, characterized by challenges in social communication and interaction, often accompanied by repetitive behaviors or focused interests. This study sheds light on the prevalence of ASD within the Southeast Asian region.

**Methods:** The study protocol was registered in PROSPERO (Registration No: CRD42023413915). Appropriate search terms and Boolean operators were employed to explore electronic databases for relevant articles. Data thus extracted were prepared in Excel and analyzed in Comprehensive Meta-Analysis Software. The effect measure utilized in the study was represented by the proportion, and the choice between a fixed or random-effect model depended on the observed heterogeneity. Visual feedback was provided through the use of forest plots and funnel plots.

**Results:** A total of 14 studies were included in the qualitative and quantitative synthesis after screening the imported studies. The prevalence of ASD was six per 1000 population (proportion: 0.006; CI: 0.002–0.017;  $I^2$ : 99.263%). Among the ASD cases, 64.4% (proportion: 0.644; CI: 0.590–0.693;  $I^2$ : 9.937%) were males and 35.6% (proportion: 0.356; CI: 0.307–0.410;  $I^2$ : 9.937%) were females.

**Conclusion:** The prevalence of ASD in Southeast Asia was estimated to be six cases per 1000 individuals, with a higher prevalence among males. This study contributes to our understanding of ASD prevalence in the region, although it is essential to note certain limitations in estimating prevalence.

## KEYWORDS

autism, autism spectrum disorder, children, Southeast Asia

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## 1 | BACKGROUND

Autism spectrum disorder (ASD) is a neurodevelopmental condition impacting the brain, recognized by challenges in social communication and interaction, alongside repetitive patterns of behavior or interests.<sup>1</sup> It refers to a class of persistent developmental disorders that arise from a combination of genetic and environmental factors and are primarily inherited. Typically, ASDs occur in infancy.<sup>2</sup>

Understanding the frequency of ASDs and their effects on the broader community is crucial. The incidence of autism has been steadily increasing since the first epidemiological investigation.<sup>3</sup> In 2009, the Centers for Disease Control and Prevention (CDC) of the United States reported that the occurrence of autism is estimated to be one in 110 children.<sup>4</sup> More recently, the CDC has disclosed an updated figure of one in 88 children for autism prevalence, attributing this increase to improved case identification, heightened awareness, and increased availability of services.<sup>5</sup> The prevalence of ASDs varies significantly across nations. Autism was found to be present in the USA at a prevalence of 34 cases per 10,000 people whereas the UK exhibited a more elevated prevalence of 99 cases per 10,000 people.<sup>6,7</sup>

A recent analysis of 23 studies has revealed that the projected occurrence of ASDs in various Asian countries and territories such as China, Japan, Iran, Indonesia, Israel, and Taiwan, exhibited a range of prevalence rates spanning from 1.1 to 21.8 per 10,000 individuals.<sup>8</sup> In the early stages of study, autism's prevalence was noted to be four to five times higher in males compared to females, although this distinction became less pronounced in those with an intellectual disability.<sup>9</sup> However, comprehensive population-based studies indicate that males are impacted at a rate two to three times higher, irrespective of intellectual disability, and there is a possibility that females with autism might have been insufficiently identified.<sup>10-13</sup> The occurrence of autism in developing nations requires careful consideration of contextual factors to effectively allocate and utilize healthcare resources. Incorporating a diverse array of Southeast Asian countries contributes to providing a comprehensive regional outlook on the prevalence of ASD. Despite variations in cultural behaviors, healthcare systems, and socioeconomic contexts, collectively studying these countries allows for the identification of common trends and variations in ASD prevalence. Consequently, this study sheds light on the prevalence of ASD specifically within the Southeast Asian region.

## 2 | METHODS

### 2.1 | Study protocol and registration

We used the Meta-analysis Of Observational Studies in Epidemiology (MOOSE) guidelines for our study.<sup>14</sup> The study protocol was officially entered into PROSPERO, an international prospective database specifically designed for reviews (Registration No:

### Keypoints

- The prevalence of autism spectrum disorder (ASD) varies globally, with higher rates reported in some Western countries.
- This study provides an updated systematic review and meta-analysis of ASD prevalence in Southeast Asia from 2002 to 2022.
- The research reveals a prevalence rate of 0.6% in Southeast Asian children, mirroring the global trend of increasing ASD prevalence.
- Healthcare professionals should be aware of the rising prevalence of ASD in Southeast Asia and its potential impact on healthcare resources.

CRD42023413915). Ethical clearance was not taken as it is not applicable in case of Systematic Review and Meta-analysis.

### 2.2 | Search strategy

A systematic search was conducted using electronic databases such as PubMed, Scopus, Embase, PubMed Central, and Google Scholar. The search was conducted in April 2023 and included studies published from January 2002 to December 2022. The search strategy was developed using the appropriate search terms and Boolean operators as ("autism" or "autistic disorder" or "autism spectrum conditions") AND ("epidemiology" or "prevalence" or "rate") AND ("Southeast Asia" or "Nepal" or "India" or "Bhutan" or "Sri Lanka" or "Maldives" or "Bangladesh" or "Pakistan" or "Afghanistan"). Information regarding the search methodology and the results from each database can be found in the Supporting Information: File 1.

### 2.3 | Study selection

Inclusion criteria for this meta-analysis were: (1) studies reporting the prevalence of Autism in any country in Southeast Asia, (2) published in English language, (3) using validated diagnostic tools for Autism such as DSM-IV, DSM-5, or ICD-10, (4) reporting sample size and cases of Autism in the study, (5) conducted in community or clinical settings. Studies that did not meet these criteria or were duplicate publications were excluded.

### 2.4 | Data extraction and quality assessment

We screened the studies using Covidence.<sup>15</sup> Two independent reviewers screened the titles and abstracts based on the inclusion criteria. Any conflicts that arose during the extraction process were resolved through consensus reached with a third reviewer.

## 2.5 | Statistical analysis

An Excel-based data collection tool was devised and employed for extracting data from the 14 included studies. The extracted data underwent peer review for refinement. The tool included categories such as author/s, study year, design, center, address, sample size, population, total ASD cases, gender, and age. Statistical analysis was conducted using Comprehensive Meta-Analysis Software (CMA) version 3.9. Prevalence estimates from each study were transformed using the Freeman–Tukey double arcsine method to stabilize variance, allowing calculation of the pooled prevalence estimate with 95% confidence intervals. Heterogeneity was assessed using the  $I^2$  statistic, and a random or fixed effects model was used to account as potential sources of heterogeneity.

Forest plot and funnel plot was used to give visual feedback. Subgroup analyses were executed to investigate the origins of heterogeneity, while sensitivity analyses were carried out to evaluate the robustness of the results.

## 2.6 | Risk of bias assessment

Risk of bias assessment of the individual study was performed using the Joanna Briggs Institute critical appraisal tool.<sup>16</sup> Assessment of bias is shown in Table 1. Publication bias was evaluated using funnel plots and the application of Egger's regression test.

## 2.7 | Subgroup analysis

Subgroup analysis was done for prevalence among the 14 studies conducted in India, Bangladesh, Nepal, and Pakistan.<sup>17–30</sup>

## 2.8 | Reporting

The reporting of this meta-analysis adhered to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRIS-MA) guidelines. A flowchart depicting the study selection process was included to elucidate the search and selection procedures.

# 3 | RESULTS

## 3.1 | Search results and study characteristics

Initially, 6919 studies were gathered through the literature search, comprising 6914 from electronic database registers and five from manual searches. After removing duplicate studies, 58 eligible studies were identified through title and abstract review (Figure 1). During the screening stage, 44 articles were subsequently excluded after a thorough examination of the full text based on the predefined inclusion and exclusion criteria. Among these exclusions, four studies

were in the wrong setting, indicating a geographical or contextual misalignment with predefined criteria. Additionally, 36 studies were excluded due to reporting wrong outcomes, suggesting a disparity between the measured outcomes in these studies and the relevant outcomes required for the meta-analysis. Two studies were identified as duplicates, meaning they were published more than once, leading to redundancy. Lastly, two studies were excluded for having an inappropriate study design, indicating a mismatch between the research design used and the requirements outlined in the meta-analysis protocol. Finally, a total of 14 articles were included in the qualitative and quantitative synthesis. Among the 14 studies, six were conducted in India, three in Bangladesh, one in Nepal, and four in Pakistan. We didn't find any studies conducted in Bhutan, Afghanistan, and Sri Lanka. Studies published from 2002 to 2022 in southeast countries were included in the study.

## 3.2 | Qualitative synthesis

Table 2 provides a summary of the details of the included studies.

## 3.3 | Quantitative synthesis

### 3.3.1 | Prevalence of ASD

Given the  $I^2$  test results indicating substantial heterogeneity (98.938%) among the selected studies, the random-effects model was employed to amalgamate reported results and estimate the prevalence of ASD. The observed heterogeneity may be due to factors such as the study's origin, year of study, sample size, and sampling error.

Pooling data from 14 studies utilizing a random-effect model, which reported the total sample population and the total number of ASD cases, revealed a prevalence of 0.6% (proportion: 0.006; CI: 0.002–0.017;  $I^2$ : 98.938%) (Figure 2). Sensitivity analysis, performed by excluding individual studies, indicated no significant differences in the results.

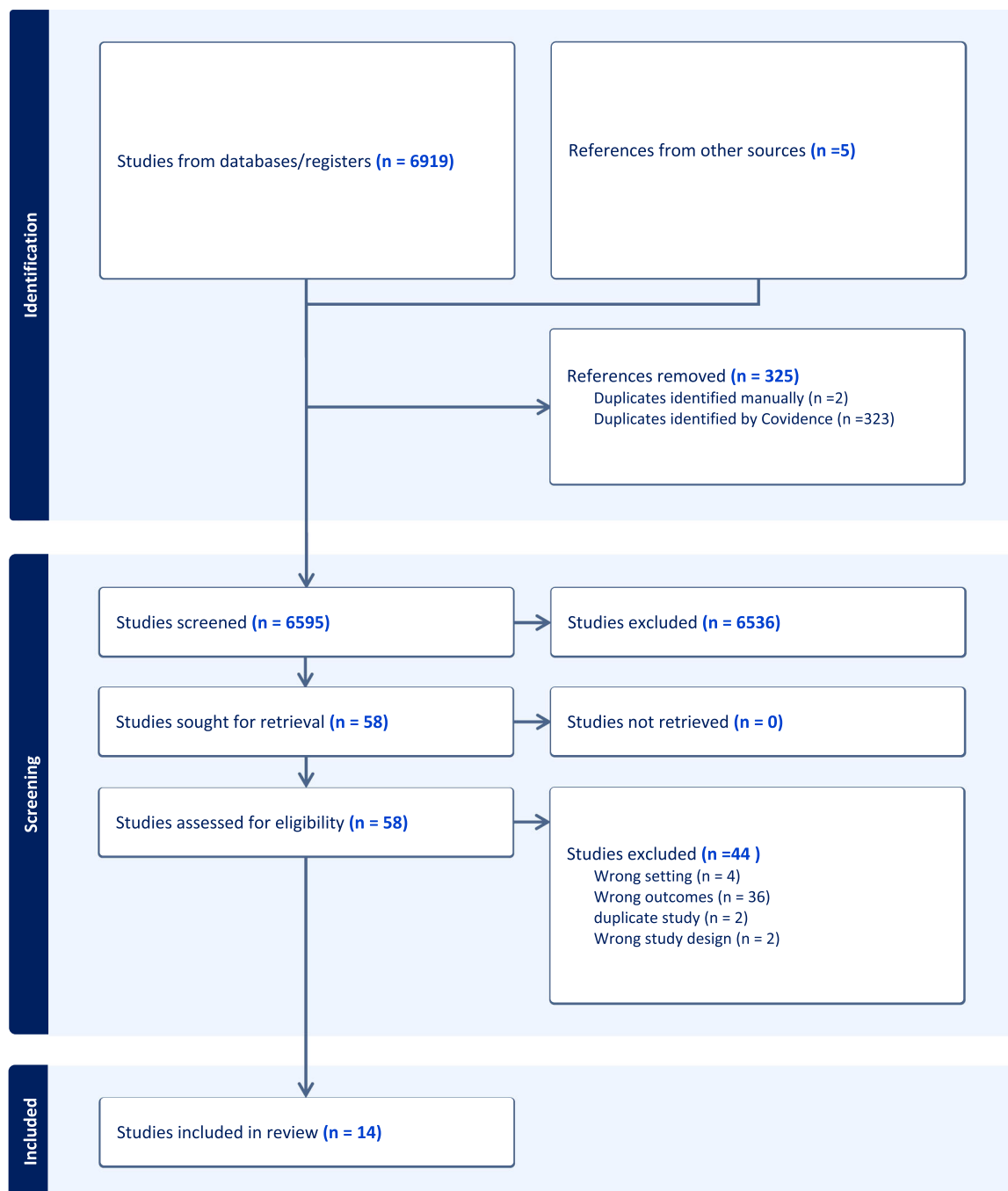
### 3.3.2 | Heterogeneity and publication bias

Egger's regression test and the Funnel plot (Figure 3) both indicated that publication bias did not significantly impact the overall prevalence of ASD ( $p \leq 0.05$ ).

### 3.3.3 | Sex distribution

Among the studies included, 12 provided data on the distribution of sex. Pooling this data using a fixed-effect model revealed that among individuals with ASD, 64.4% were males (proportion: 0.644; CI: 0.590–0.693;  $I^2$ : 9.937%), while 35.6% were females (proportion: 0.356; CI: 0.307–0.410;  $I^2$ : 9.937%). Forest plot is given in Figures 4 and 5.





**FIGURE 1** PRISMA flow diagram. PRISMA, preferred reporting items for systematic reviews and meta-analyses.

### 3.3.4 | Meta-regression test

To explore potential factors influencing the heterogeneity of ASD prevalence in southwest Asia, meta-regression was conducted for variables such as sample size and the study year. Figure 5 indicates a statistically significant decrease in ASD prevalence in southwest Asia with an increase in sample size ( $p < 0.05$ ) (Figure 6). Moreover, the prevalence showed an initial increase for a specific study year, followed by a subsequent decrease with

an increase in the study year, and this trend was statistically significant ( $p < 0.05$ ) (Figure 7).

### 3.3.5 | Subgroup analysis

Out of the 14 studies, six were conducted in India, three in Bangladesh, one in Nepal, and four in Pakistan. The prevalence of ASD in these countries was 0.3% (CI: 0.000–0.030), 0.2% (CI:

TABLE 2 Summary details of the included studies.

Study year	Study	Country	Age range	Sample size	Male with ASD (n)	Total cases	Diagnostic tools	Outcome measures instruments	Prevalence (%)
2018	Akhter et al. <sup>17</sup>	Bangladesh	18–36 months	5286	3	4	DSM-IV & ADOS	MCHAT & SDQ	0.1
2022	Akhter et al. <sup>18</sup>	Bangladesh	16–30 months	38,440	47	67	DSM-IV and red flag tools	M-CHAT	0.2
2021	Ali et al. <sup>19</sup>	Bangladesh	8–11 years	8225	37	61	ADOS-2 & ADI-R	SCQ	0.7
2015	Raina et al. <sup>20</sup>	India	1–10	11,000	0	10		ISAA	0.1
2021	Arun et al. <sup>21</sup>	India	1.5–10 years	8451	10	19	ADI-R and CARS-2	-	0.2
2016	Poovathinal et al. <sup>22</sup>	India	1–30 years	43,000	29	43	DSM-IV-TR	SCQ	0.1
2014	Michelle et al. <sup>23</sup>	Nepal	9–13 years	4098	8	14		AQ-10	0.3
2017	Rudra et al. <sup>24</sup>	India	3–8 years	11,849	6	6	ADOS	SCDC & SCQ	0.1
2014	Nair et al. <sup>25</sup>	India	0–6 years	2477	-	17	DDST-II & REELS	TDSC	0.7
2012	Sharda et al. <sup>26</sup>	India	School children	500	50	74	DSM-IV	RQC	14.8
2009	Tareen et al. <sup>27</sup>	Pakistan	0–18 years	169	5	9	ICD-10	ICD-10	5.3
2007	Syed et al. <sup>28</sup>	Pakistan	0–15 years	290	-	7	DSM-IV TR	DSQ	2.4
2007	Sarwat et al. <sup>29</sup>	Pakistan	0–14 years	200	5	9	DSM-IV TR	-	4.5
2011	Imran et al. <sup>30</sup>	Pakistan	-	1000	21	32	DSM-IV TR	-	3.2

Abbreviations: ADOS, autism diagnostic observation schedule; ADI-R, autism diagnostic interview-revised; AQ-10, autism spectrum quotient 10-items; ASD, autism spectrum disorder; CARS-2, childhood autism rating scale-2; DDST-II, Denver developmental screening test-II; DSM-IV-TR, diagnostic and statistical manual of mental disorders, fourth edition, text revision; DSQ, the developmental screening questionnaire; ISAA, Indian scale for assessment of autism; M-CHAT, modified checklist for autism in toddlers; REELS, receptive expressive emergent language scale; RQC, reporting questionnaire for children; SCDC, social communication disorder checklist; SCQ, social communication questionnaire; SDQ, strengths and difficulties questionnaire; TDSC, Trivandrum developmental screening chart.

### Prevalence of Autism Spectrum Disorder

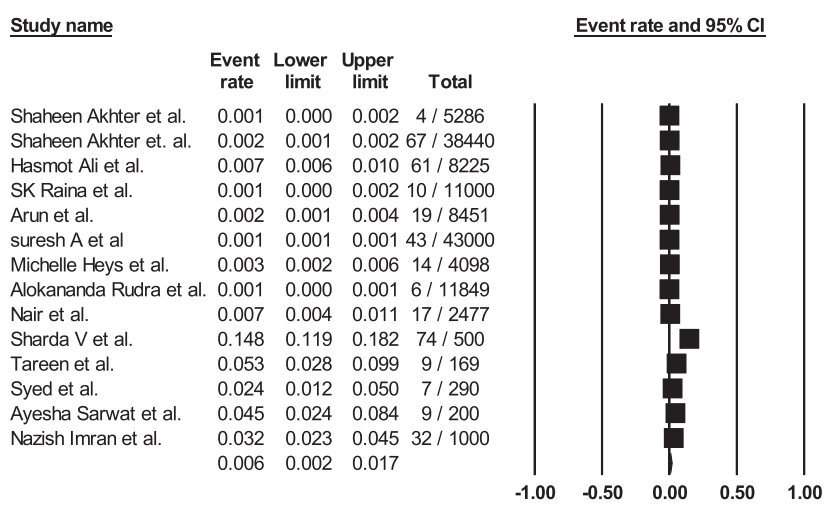
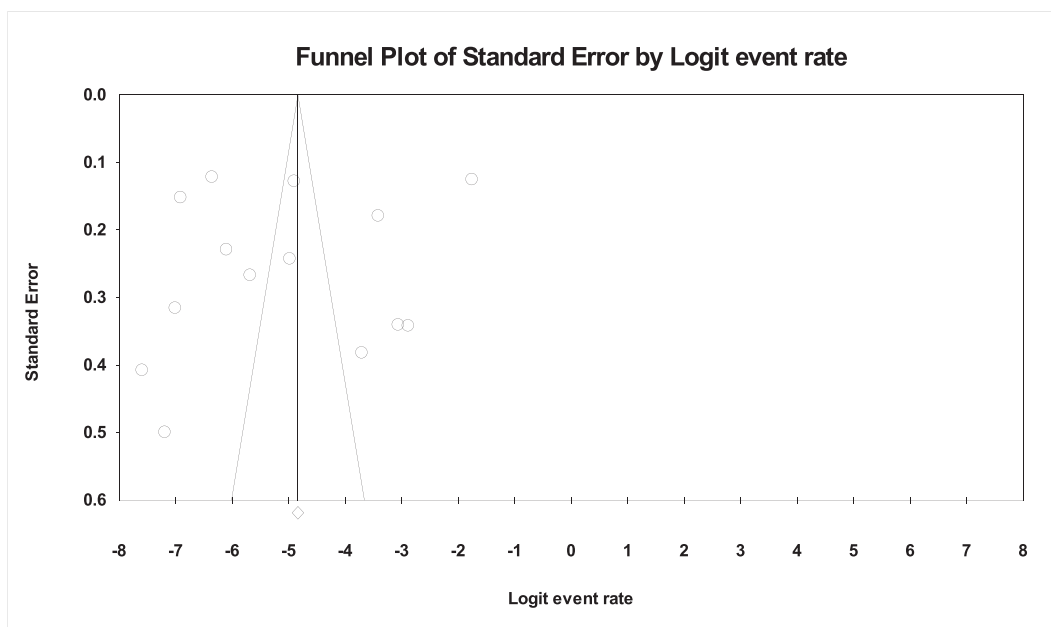
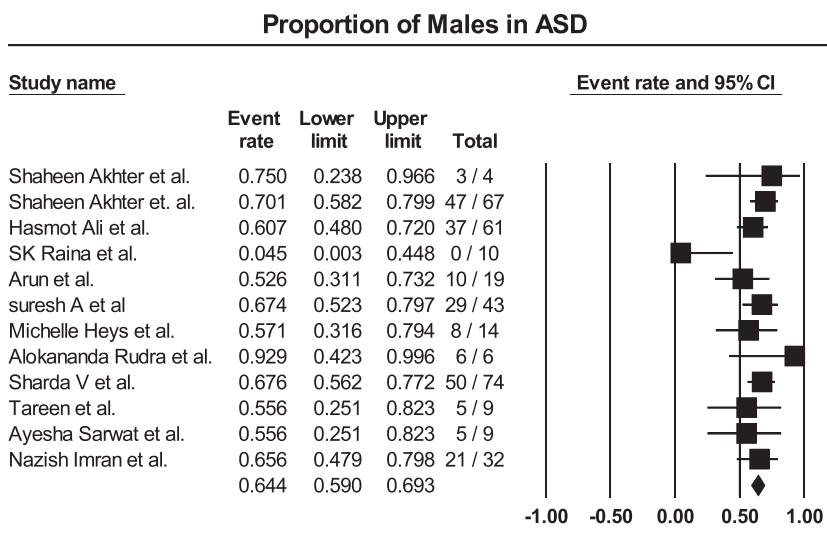


FIGURE 2 Forest plot showing the prevalence of autism spectrum disorder.



**FIGURE 3** Funnel plot results related to the prevalence of ASD in Southeast Asia. ASD, autism spectrum disorder.

**FIGURE 4** Proportions of males in ASD. ASD, autism spectrum disorder.



0.001–0.008), 0.3% (CI: 0.002–0.006), and 3.5% (CI: 0.27–0.046), respectively (Table 3).

## 4 | DISCUSSION

In this study, we performed a systemic review and meta-analysis to provide a general and up-to-date estimate of the prevalence of ASD among children in Southeast Asia. Among the 58 eligible studies, a total of 14 articles were included in the qualitative and quantitative synthesis.

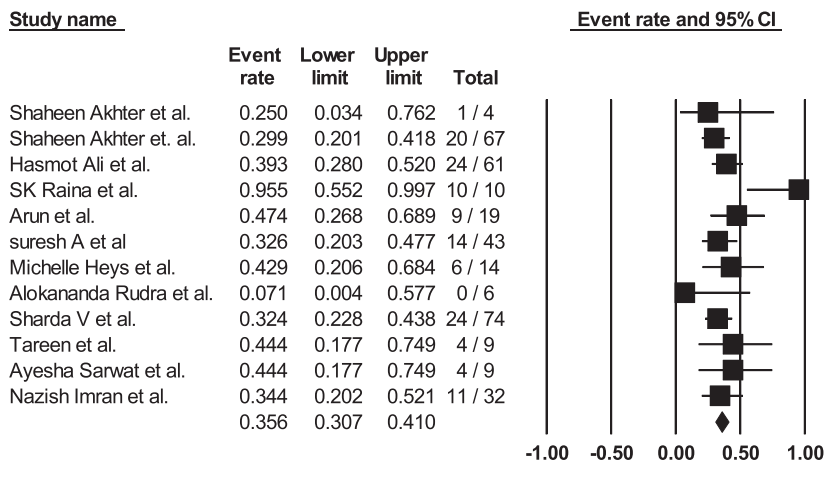
Globally, the prevalence of autism stands at 0.6%. In recent times, there has been a rapid upsurge in the occurrence of ASD. This rise can be attributed to factors such as changes in diagnostic criteria,

the inclusion of outpatients in ASD registries, heightened awareness about ASD, and improved screening procedures.<sup>31</sup> Our research revealed that the prevalence of ASD in Southeast Asia mirrored this global rate of 0.6%. A prior meta-analysis led by Qiu et al. reported an ASD prevalence of 0.36% in Asia, with East Asia (0.51%) having a higher prevalence compared to West Asia (0.35%) and South Asia (0.31%).<sup>32</sup> While this aligns with the worldwide ASD prevalence, it remains notably lower than figures in western countries.

Gender significantly influences the prevalence of ASD, with a noted male-to-female ratio of 3:1 among children with ASD. Our study's outcomes echoed this pattern, indicating a higher occurrence of ASD in males (64.4%) compared to females (35.6%), consistent with previous research. This gender disparity could be linked to girls exhibiting less atypical behavior, making ASD diagnosis less

Proportion of Females in ASD

FIGURE 5 Proportions of females in ASD. ASD, autism spectrum disorder.



Regression of Logit event rate on sample

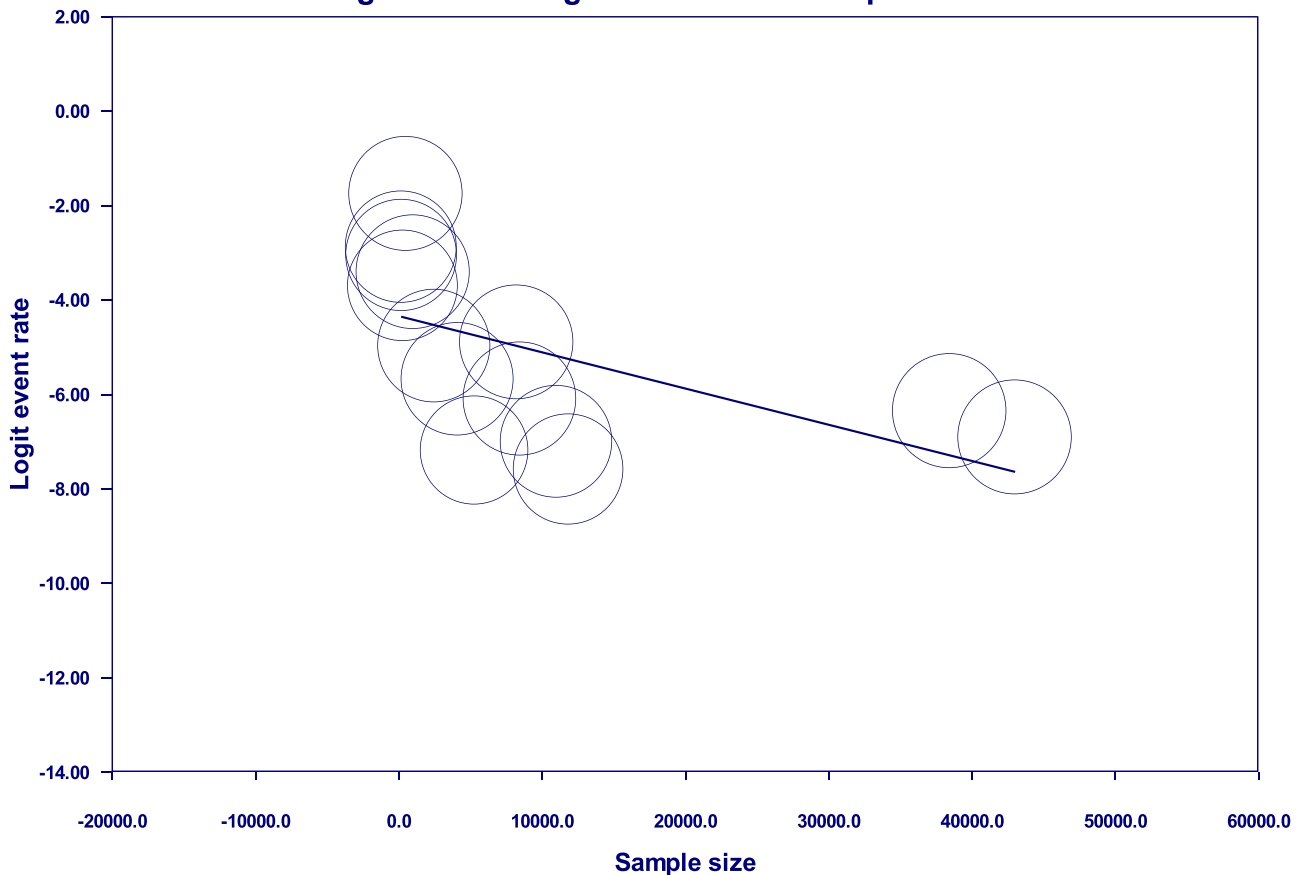
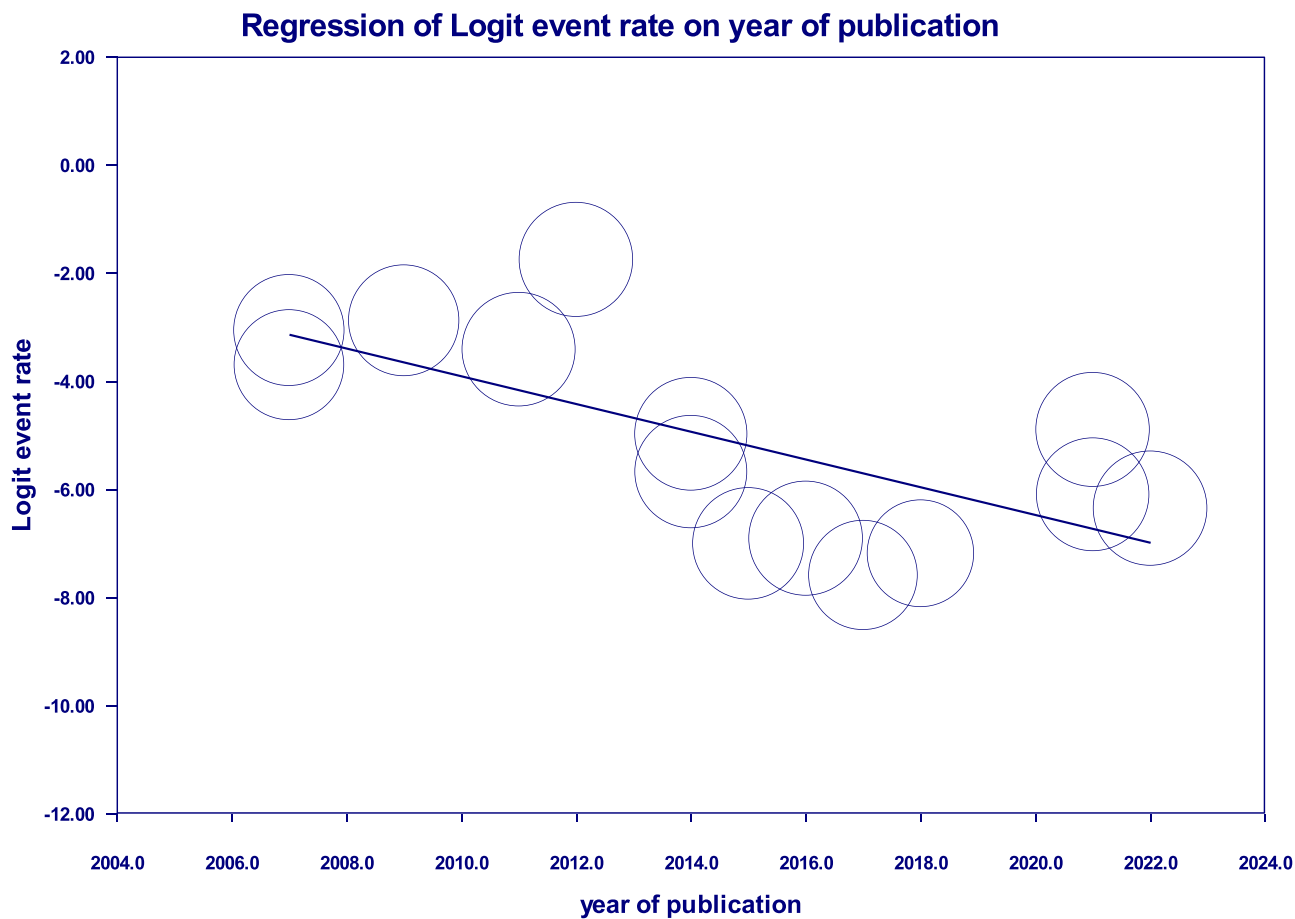


FIGURE 6 Meta-regression chart of the prevalence of ASD in Southeast Asia by sample size. ASD, autism spectrum disorder.

probable.<sup>32</sup> Girls with ASD tend to display stronger speech behaviors and fewer social and communication difficulties than boys. These enhanced social and communication abilities might enable them to navigate social situations better, concealing some primary symptoms of autism and potentially resulting in either delayed or incorrect diagnoses in girls.<sup>33-36</sup>

Statistically significant factors influencing the prevalence of ASD include the sample size and the year when the study was conducted. Our findings align with prior research, demonstrating that ASD prevalence diminishes as the sample size increases.<sup>32,37</sup> Furthermore, the prevalence of ASD in southwest Asia displayed fluctuations over the study years, characterized by an initial increase followed by a subsequent decrease.





**FIGURE 7** Meta-regression chart of the prevalence of ASD in Southeast Asia by year of publication. ASD, autism spectrum disorder.

**TABLE 3** Subgroup analysis of ASD prevalence by country.

Country	Total cases	Sample size	Heterogeneity (I <sup>2</sup> )	Prevalence (%) (CI)
India	169	77,277	99.442%	0.3% (0.000–0.030)
Bangladesh	132	51,951	97.375	0.2% (0.001–0.008)
Nepal	14	4098	0	0.3% (0.002–0.006)
Pakistan	57	1659	14.092%	3.5% (0.027–0.046)

Abbreviation: ASD, autism spectrum disorder.

This pattern could be linked to the transition in ASD diagnosis criteria from DSM-IV to DSM-V in 2013. The American Psychiatric Association eliminated subcategories like Pervasive Developmental Disorder, Rett syndrome, Childhood Disintegrative Disorder, and Asperger's syndrome, unifying them under the diagnosis of ASD. This shift could have influenced prevalence trends. Despite observed heterogeneity among studies and subgroups, sensitivity analyses affirmed the stability and credibility of this meta-analysis. The overall quality of the studies in our meta-analysis was good and studies with low quality was not included.

There are some limitations of this meta-analysis. First, age distribution was not taken into account due to vague distribution in study group. Second, publication bias was identified among the

studies. Third, studies only conducted from India, Bangladesh, Nepal, and Pakistan was included in the study. No studies conducted in Bhutan, Afghanistan, and Sri Lanka was found. Thus, our study may lack generalizability across Southeast Asia.

None of the countries in the analysis have a universally free healthcare system with completely free access at the point of use. In most cases, healthcare services involve some form of cost, and access can vary based on factors like geographic location and economic status. The variability in healthcare systems across the included countries, combined with potential barriers related to resource limitations and awareness, could influence the detection and reporting of ASD cases. The presence of surveillance programs is crucial for enhancing the accuracy of prevalence studies.

Cultural factors impact how ASD is perceived and addressed. Stigma, influenced by cultural beliefs, affects diagnosis-seeking and intervention choices. Language and communication differences pose challenges. In essence, cultural considerations are pivotal in understanding and addressing ASD prevalence.

ASD prevalence in Southeast Asia is on the increasing trend but remains lower than that in Western countries. In resource limited countries, further study about autism, its nature, and its socio-economic burden is a must to contribute to formulation of strategies for the improvement of the growing autism community.

## 5 | CONCLUSION

The prevalence of ASD in Southeast Asia has been determined to be six cases per 1000 individuals, with a greater prevalence among males in comparison to females. The substantial increase in ASD prevalence in recent times has raised significant concerns. In the developing nations of Southeast Asia, precise and dependable prevalence estimates are essential to inform effective policymaking and enable informed analysis by healthcare professionals. Early diagnosis and intervention play a pivotal role in mitigating complications and associated disabilities in children with ASDs. Given the limited research conducted in Southeast Asian countries, there is a pressing need for further studies to gather reliable data, facilitating improved ASD management strategies.

### AUTHOR CONTRIBUTIONS

**Manju Shrestha:** Conceptualization; data curation; formal analysis; investigation; methodology; supervision; validation; visualization; writing—original draft; writing—review and editing. **Sunil Basukala:** Conceptualization; data curation; formal analysis; investigation; methodology; supervision; validation; visualization; writing—original draft; writing—review and editing. **Niranjan Thapa:** Conceptualization; data curation; formal analysis; investigation; methodology; validation; visualization; writing—original draft; writing—review and editing. **Oshan Shrestha:** Conceptualization; data curation; formal analysis; investigation; methodology; validation; visualization; writing—original draft; writing—review and editing. **Mahima Basnet:** Data curation; formal analysis; investigation; methodology; validation; visualization; writing—original draft; writing—review and editing. **Kala Shrestha:** Data curation; formal analysis; investigation; methodology; validation; visualization; writing—original draft; writing—review and editing. **Shiva K. Regmi:** Data curation; formal analysis; investigation; methodology; validation; visualization; writing—original draft; writing—review and editing. **Suchit T. Chhetri:** Data curation; formal analysis; investigation; methodology; validation; visualization; writing—original draft; writing—review and editing. **Bishal Kunwor:** Data curation; formal analysis; investigation; methodology; validation; visualization; writing—original draft; writing—review and editing.

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### CONFLICT OF INTEREST STATEMENT

The authors declare no conflict of interest.

### DATA AVAILABILITY STATEMENT

Curated data that was analyzed is available from the corresponding author upon reasonable request.

### ETHICS STATEMENT

We used the Meta-analysis Of Observational Studies in Epidemiology (MOOSE) guidelines for our study. The study protocol was registered in PROSPERO, an international prospective database for reviews. Registration No: CRD42023413915.

### TRANSPARENCY STATEMENT

The lead author Suchit T. Chhetri affirms that this manuscript is an honest, accurate, and transparent account of the study being reported; that no important aspects of the study have been omitted; and that any discrepancies from the study as planned (and, if relevant, registered) have been explained.

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## SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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