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REVIEW

Prevalence of sleep disorders in atopic dermatitis: a systematic review and meta-analysis

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Abstract

The aim of this meta-analysis was to determine the prevalence of sleep disorders among patients with atopic dermatitis (AD) and to explore the association between AD and sleep disorders. This meta-analysis was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines and was prospectively registered in the International Prospective Systematic Review Registry (PROSPERO) database (registration number: CRD42024498045). Only English-written cross-sectional studies reporting the prevalence of sleep disorders in patients with AD were included in this analysis. We searched four databases: EMBASE, Web of Science, PubMed and the Cochrane Library as of 9 February 2025. Studies were screened using EndNote X9.1. Data were analyzed using STATA V15.0 software. Initially, a total of 861 studies were searched from databases. Ultimately, 32 studies including 85,921 participants were included in this meta-analysis. The prevalence of sleep disorders among individuals with AD was estimated using a random-effects model. The degree of heterogeneity was assessed by I^2 statistic. If significant heterogeneity was detected, the source of heterogeneity was determined by meta-regression, and sensitivity analyses were then conducted by sequentially excluding each study to assess the robustness of the findings. This analysis revealed that the combined prevalence of sleep disorders among patients with AD was 43.4% (95% confidence interval: 39.7%-47.1%). Subgroup analyses were conducted according to region, data source, year of publication, severity of AD, sleep disorder assessment scales, classification of sleep problems, nocturnal awakenings, and number of days of sleep disorders experienced per week.

Keywords Atopic dermatitis · Meta-analysis · Sleep disturbances · Prevalence · Pruritus

Introduction

Atopic Dermatitis (AD) is a prevalent inflammatory skin condition characterized by recurrent eczematous lesions and intense pruritus. AD is characterized by a significant genetic predisposition. The typical pathophysiological mechanisms involve dysfunction of the skin barrier and dysbiosis of the microbiota, as well as immune dysregulation and neuroimmune interactions. AD affects individuals across all age groups and ethnicities, exerting substantial psychosocial impacts on patients and their relatives. Furthermore, AD can lead to complications, including food allergies, asthma, allergic rhinitis, psychological health issues, and sleep disturbances [1, 2].

Sleep disturbances are common among the general population [3, 4]. Sleep disturbances encompass insomnia, sleep deprivation due to no sleep opportunities, and daytime somnolence, which are particularly prevalent among younger individuals [5, 6]. The prevalence of sleep disturbances varies across different countries. Research indicates that approximately one-third of the global population is afflicted by sleep disturbances [7]. Sleep disturbances can increase the risk of developing depression, inflammatory diseases, and infectious illnesses [8]. The exact mechanisms linking AD and sleep disturbances are not yet fully understood.

Ningxin Zhang and Huiyan Chi have contributed equally to this work and should be considered as co-first authors.

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However, recent studies have unveiled several potential mechanisms. For instance, pruritus caused by inflammatory mediators or allergens serves as the primary contributor to sleep disturbances in patients with AD. As the frequency of scratching increases, a behavioral cognitive cycle of insomnia combined with scratching is formed, which further exacerbates sleep disturbances. Additionally, tissue damage and the release of inflammatory mediators induced by scratching are also associated with sleep disturbances. Moreover, the disruption of the skin barrier function may lead to sleep disturbances by altering circadian rhythms and increasing sensitivity to environmental triggers. Emerging evidence also suggests that psychological problems such as stress and anxiety are prevalent in AD patients and have been proven to have a negative impact on their sleep quality [9–14]**.** However, numerous studies have reported that the prevalence of sleep disturbances in children with AD ranges from 47 to 80%, while in adults with AD, it varies from 33 to 90% [15–18].

Thus, there is no consensus on the global prevalence of sleep disturbances in patients with AD. The purpose of this meta-analysis is to ascertain the prevalence of sleep disturbances among individuals with AD and to explore the relationship between AD and sleep disturbances.

Methods

This systematic review and meta-analysis was reported according to the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) guidelines [19]. The study protocol has been registered with the International Prospective Register of Systematic Reviews (PROSPERO) database (registration number: CRD42024498045). Prior to the registration of our protocol, a thorough search of both PROSPERO and AD sleep disturbance was conducted to verify the existence of similar systematic reviews to avoid duplications.

Search strategy

Up until February 2025, we searched four databases (EMBASE, Web of Science, PubMed, and the Cochrane Library), so as to mitigate the risk of selection bias. Additional relevant studies were also searched by contacting corresponding authors.

The search strategy was designed by combining the following terms:

1. Terms related to AD ("atopic dermatitis", "Dermatitis, Atopic", "Atopic Dermatiti*", "Atopic Neurodermatiti*", "Disseminated Neurodermatiti*", "Atopic Eczema", "Infantile Eczema", "coca sulzberger disease", "coca sulzberger syndrome", "eczema endogenous", and "neurodermatitis constitutionalis");
2. Terms associated with relevant sleep disturbance ("Dyssomnia*", "Sleep Disorder*", "Nocturnal Eating Drinking Syndrome*", and "inadequate sleep");
3. Related Terms ("Prevalence*");
4. Only cross-sectional study designs ("prevalence studies", "cross-sectional studies", and "survey").

The search strategy can be briefly summarized as "atopic dermatitis" AND "dyssomnias" AND "Prevalence." Detailed search strategies for each database are provided in File S1.

Eligibility criteria

The inclusion and exclusion criteria were established according to the PICOS principle as follows:

Population: Studies involving participants diagnosed with AD.
Exposure: Studies assessing or reporting sleep disturbances in AD patients.
Outcomes: Studies providing quantitative data on the prevalence of sleep disturbances and the sample size.
Study design: Cross-sectional studies published in English.
No restrictions are placed on the characteristics of the participants. Abstracts, case reports, editorials, infographics, letters, narrative reviews, commentaries, opinions, position statements, and systematic reviews were excluded. File S2 detailing the exclusion of duplicates as well as the 97 studies that were screened for title and abstract but were not ultimately included and the reasons for exclusion (e.g., RCTs, incomplete data, non-English articles, etc.).

Data abstraction and quality appraisal

The prevalence was defined as the number of patients with sleep disturbances among patients with AD divided by the total number of patients with AD. Two researchers (Ningxin Zhang and Ping Song) extracted data from each study using a standardized data extraction form. Any discrepancies were resolved through discussion. The collected data included author, publication time, country, total study sample size, sample size of sleep disturbances, prevalence rates, AD severity levels, follow-up durations, study types, sources of data, scales of sleep disorder assessment, classifications of sleep issues, frequency of nocturnal awakenings, and the number of days with sleep disturbances per week. Discrepancies in data or disagreements between two reviewers were addressed through discussion. In cases where a consensus

was unattainable, a third reviewer was consulted to make the final decision.

The quality of the included studies was independently assessed by two researchers (Huiyan Chi and Qiubai Jin) using the Joanna Briggs Institute (JBI) Critical Appraisal Quality Checklist [20]. The JBI instrument is a recognized and effective quality tool used to evaluate the overall quality of studies on prevalence from various aspects such as sampling methods, study subjects, data collection, and analysis methods. It is designed to assess the credibility, relevance, and results of studies on prevalence. The checklist consists of nine items, each scored from 1 to 4. A score of 1 denotes "yes," 2 indicates "no," 3 represents "unclear," and 4 stands for "not mentioned." The total score ranges from 9 to 36. A lower score indicates a higher quality of a study.

Data analysis

STATA V15.0 software was used for data analysis. The prevalence of sleep disturbances in AD patients was estimated using the random-effects DerSimonian-Laird method. All results were presented with a 95% confidence interval (CI). Heterogeneity tests (I^2 statistic) were conducted to measure the degree of heterogeneity in the reported prevalence rates of sleep disturbances that could be attributed to differences between the studies, rather than by chance alone. To determine the potential sources of heterogeneity among different studies, meta-regression was performed to evaluate the impact of several covariates on the overall heterogeneity, such as region, source of data, publication year, and classifications of sleep issues. Further subgroup analyses were performed. To assess the robustness of our results, a sensitivity analysis was conducted by separately excluding each study. Traditional methods such as funnel plots and asymmetry tests have been shown to be unsuitable for assessing publication bias in studies on prevalence [21], and thus, we did not assess publication bias in this study. A p-value of <0.05 was considered statistically significant in all analyses.

Results

Study screening and selection

A total of 861 studies were initially identified from databases. Of these, 289 duplicate studies were excluded, leaving 562 records. Following the review of titles and abstracts, 306 studies were eliminated as they did not meet the inclusion criteria. Upon full-text review, a further 72 irrelevant studies, 10 randomized controlled trials, six studies with insufficient data, and nine non-English language studies were excluded. Ultimately, 32 studies [22–53] were included in our analysis, encompassing a total of 85,921 participants. Figure 1 illustrates the study selection process.

The present meta-analysis included 32 studies with 85,921 individuals. These studies were conducted in 20 countries, including South Korea (k = 4), Iraq (k = 1), Italy (k = 4), Iran (k = 1), Japan (k = 2), Malaysia (k = 1), Australia (k = 1), the United States (k = 9), Kuwait (k = 1), France (k = 3), Germany (k = 3), Spain (k = 2), the United Kingdom (k = 4), the Netherlands (k = 1), Denmark (k = 1), Greece (k = 1), Indonesia (k = 1), Turkey (k = 1), Egypt (k = 1) and Brazil (k = 1). The sample sizes across these studies ranged from 30 to 42,641 individuals. All 32 studies adopted a cross-sectional design. In addition, all studies employed subjective sleep assessment scales to quantify the quality of sleep in participants. Further information regarding these studies is encapsulated in Table 1. The quality assessment showed that one study scored 9, six studies scored 10, five studies scored 11, six studies scored 12, eleven studies scored 13, one study scored 14, and two studies scored 15. The quality evaluation results of the included studies are provided in Table 2.

Prevalence of sleep disturbance in AD

Based on all eligible studies, this meta-analysis assessed the prevalence of sleep disturbances in patients with AD. The findings revealed that the prevalence of sleep disturbances among AD patients was 43.4% (95% CI 39.7–47.1%, $I^2 = 100.00\%$). The forest plot is shown in Fig. 2. The sensitivity analysis is illustrated in Fig. 3.

Subgroup analysis

There were 32 sets of data for subgroup analysis by regions (11 sets of data in Asia, 9 in Europe, 1 in Oceania, 9 in North America, 1 in Africa and 1 in South America). Among patients with AD in the Asian region, the prevalence of sleep disturbances was found to be 43.5% (95% CI 32.0–55.1%). In Europe, the prevalence of sleep disturbances among AD patients was slightly higher at 47.6% (95% CI 36.3–58.9%). The prevalence of sleep disturbances in AD patients in Oceania was similar, at a rate of 46.8% (95% CI 35.3–58.5%). In the North American region, the prevalence rate was slightly lower at 43.1% (95% CI 34.3–52.0%). The prevalence in Africa was the highest at 51.8% (95% CI 42.1–61.4%). Lastly, in South America, the prevalence was the lowest, at 23.0% (95% CI 15.2–32.5%). The results of subgroup analysis are provided in Table 3. The forest plot is shown in Fig. S1.

In the subgroup analysis by source of the data, there were 32 sets of data. Among patients with AD from hospitals, the prevalence of sleep disturbances was notably higher, at 52.7% (95% CI 33.5–71.8%). In contrast, for people with AD

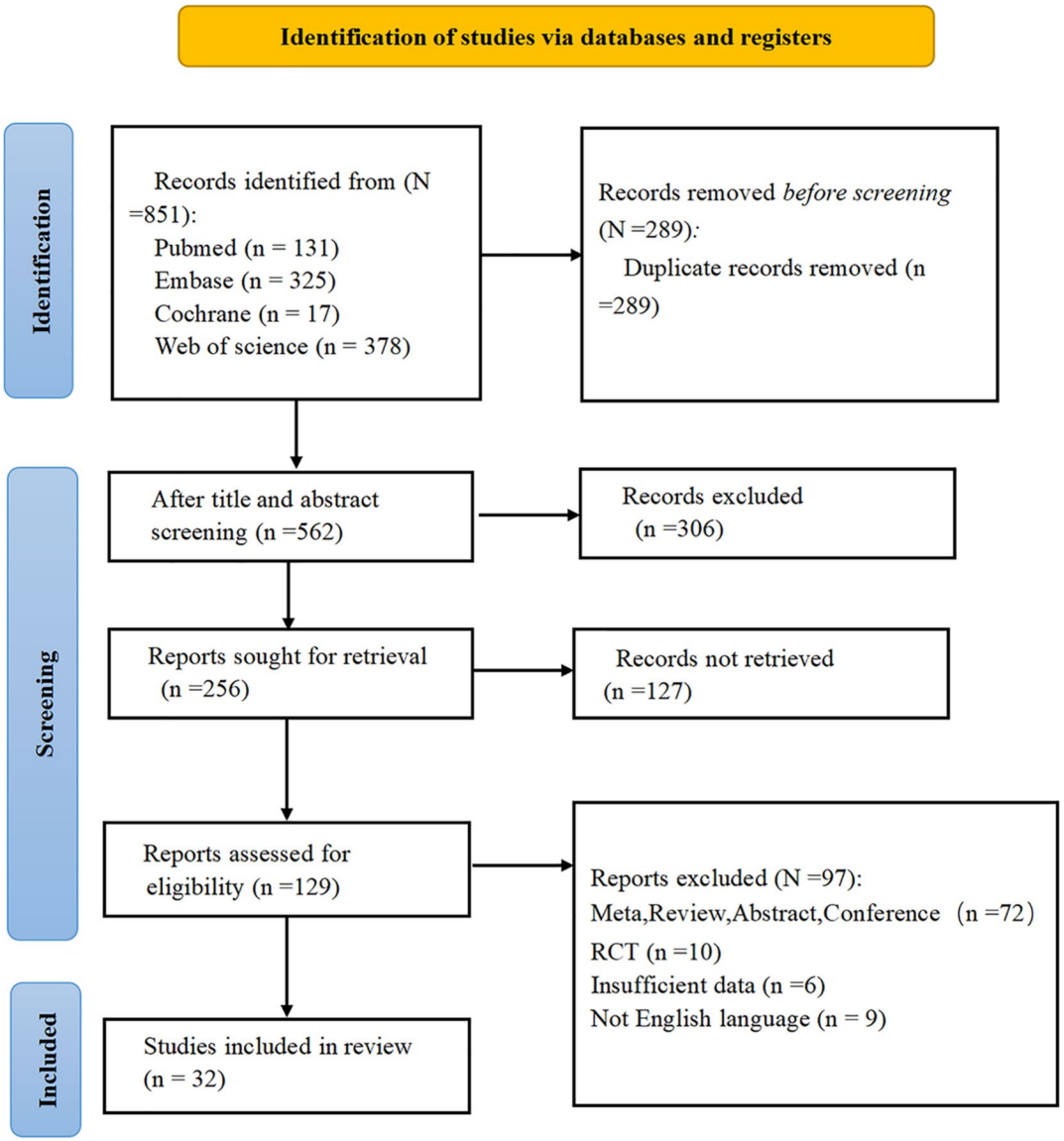

Fig. 1 Prisma literature screening process

whose data were not from hospitals, the prevalence of sleep disturbances was lower, at 36.4% (95% CI 28.6–44.1%). The forest plot for the subgroup analysis by the source of the data is illustrated in Fig. S2.

For subgroup analysis by years of publication, there were 32 sets of data. The prevalence of sleep disorders among patients with AD from 2000 to 2015 was reported to be 35.9% (95% CI 16.4–55.4%). For patients with AD from 2016 to 2025, the reported prevalence was 46.3% (95% CI 39.6–52.9%). The forest plot for subgroup analysis by the years of publication is illustrated in Fig. S3.

In the subgroup analysis by the severity of AD, there were 10 sets of data. The prevalence of sleep disorders among patients with mild AD was 7.5% (95% CI 6.2–8.9%). For those with moderate AD, the prevalence of sleep disorders was 21.7% (95% CI 19.6–23.9%). In patients with severe AD, the prevalence of sleep disorders was 10.3% (95% CI 8.7–11.8%). Among patients with mild to moderate AD, the prevalence of sleep disorders was 17.9% (95% CI 9.6–29.2%). In patients with moderate to severe AD, the prevalence of sleep disorders was higher, at 14.0% (95% CI 7.9–2.4%). For patients with severe to very severe AD, the prevalence of sleep disorders was higher, at 34.3% (95% CI 23.2–46.9%). The forest plot for subgroup analysis by the severity of AD is shown in Fig. S4.

In the subgroup analysis by assessment scales for sleep disorders, six sets of data were used. The prevalence of sleep disorders in AD patients assessed by the PSQI (Pittsburgh Sleep Quality Index) scale was 41.9% (95% CI 33.7–50.1%). When the PROMIS (Patient-Reported

Table 1 Relevant information on the included studies

Author	Year	Country	AD	Sleep Disorder	Prevalence	AD severity	Follow-up time	Study type
Hye-Jin Ahn	2019	Korea	42,641	938	2.20%	NA	156 months	Cross-sectional study
Ahang Mohammed Hamid	2020	Iraqi	100	73	73.00%	Mild, Moderate, Severe	12 months	Cross-sectional study
N. L. Bragazzi	2021	Italy	30	21	70.00%	Mild, Moderate, Severe	13 months	Cross-sectional study
Najmolsadat Atef	2019	Iran	95	31	32.63%	NA	12 months	Cross-sectional study
Kazuhiko ARIMA	2018	Japan	634	82	12.93%	Mild, Moderate, Severe	12 months	Cross-sectional study
Asmaa' Hazirah Abdullah	2023	Malaysia	64	60	93.75%	NA	12 months	Cross-sectional study
Danny Camfferman	2010	Australia	77	36	46.75%	NA	6 months	Cross-sectional study
Sarah L. Chamlin	2005	USA	270	183	67.78%	Mild, Moderate, Severe	NA	Cross-sectional study
Ali H. Ziyab, PhD	2022	Kuwait	724	249	34.39%	NA	12 months	Cross-sectional study
Vonita Chawla	2016	USA	123	38	30.89%	NA	36 months	Cross-sectional study
Won Jun Choi	2012	Korea	594	103	17.34%	Mild, Moderate, Severe	7 months	Cross-sectional study
Laurent Eckert	2017	USA	349	116	33.24%	NA	12 months	Cross-sectional study
Laurent Eckert	2019	France, Germany, Italy, Spain, Britain	1860	423	22.74%	NA	12 months	Cross-sectional study
Alexander EGEBERG	2021	France, Italy, Germany, Britain	631	311	49.29%	NA	12 months	Cross-sectional study
R.M.EMERSON	2000	Britain	290	60	20.69%	Mild, Moderate, Severe	12 months	Cross-sectional study
Junfen Zhang	2022	Holland	1288	580	45.03%	Mild, Severe	96 months	Cross-sectional study
Anna B. Fishbein	2021	USA	180	134	74.44%	Mild, Moderate, Severe	2 months	Cross-sectional study
T. Gerner	2021	Denmark	1234	577	46.76%	Mild, Moderate, Severe	60 months	Cross-sectional study
Jonathan Ian Silverberg	2021	USA	602	255	42.36%	Mild, Moderate, Severe	NA	Cross-sectional study
Giampiero Girolomoni	2020	France, Germany, Italy, Spain, Britain	1014	625	61.64%	Mild/Moderate, Severe/ Extremely severe	12 months	Cross-sectional study
Stamatis Gregoriou	2022	Greece	67	46	68.66%	NA	12 months	Cross-sectional study
Stephanie M. Rangel	2022	USA	248	184	74.19%	NA		Cross-sectional study
Hanifin	2007	USA	6931	67	0.97%	NA	12 months	Cross-sectional study
Irwanto	2019	Indonesia	35	30	85.71%	NA	2 months	Cross-sectional study
Bohye Kim	2020	Korea	2393	1177	49.19%	NA	17 months	Cross-sectional study
Harutaka Yamaguchi	2015	Japan	59	32	54.24%	NA	1 month	Cross-sectional study

Table 1 (continued)

Author	Year	Country	AD	Sleep Disorder	Prevalence	AD severity	Follow-up time	Study type
Shawn G. Kwatra	2021	USA	1017	576	56.64%	Moderate, Severe	12 months	Cross-sectional study
Emine Gulsah Torun	2020	Turkey	80	40	50.00%	NA	13 months	Cross-sectional study
Mark A. Strom	2016	USA	12,975	1371	10.57%	NA	48 months	Cross-sectional study
Fadia Sorour	2017	Egypt	110	57	51.82%	NA	NA	Cross-sectional study
Marília Magalhaes Moraes	2024	Brazil	100	23	23.00%	Mild, Moderate, Severe	21 months	Cross-sectional study
Jae Hyeok Lim	2024	Korea	9106	1869	20.52%	NA	36 months	Cross-sectional study

Notes: Basic information of included studies encompasses author, year, country, sample size, number of sleep disorders, prevalence of sleep disorders, AD severity, follow-up time, and study type

Table 2 Quality evaluation results of the included studies

Author	I	II	III	IV	V	VI	VII	VIII	IX	Total
Hye-Jin Ahn	1	1	1	1	1	3	3	1	1	13
Ahang Mohammed Hamid	1	1	2	1	1	3	1	1	1	12
N. L. Bragazzi	1	1	2	1	1	1	1	1	1	10
Najmolsadat Atef	1	1	2	1	2	1	3	1	1	13
Kazuhiko ARIMA	1	1	1	1	1	3	3	1	1	13
Asmaa' Hazirah Abdullah	1	1	2	1	1	1	1	1	1	10
Danny Camfferman	1	1	2	1	1	1	1	1	1	10
Sarah L. Chamlin	1	1	1	1	1	1	1	1	1	9
Ali H. Ziyab, PhD	1	1	1	1	1	3	3	1	1	13
Vonita Chawla	1	1	2	1	2	3	3	1	1	15
Won Jun Choi	1	1	1	1	1	3	3	1	1	13
Laurent Eckert	1	1	1	3	1	3	1	1	1	13
Laurent Eckert	1	1	1	3	1	3	1	1	1	13
Alexander EGEBERG	1	1	1	1	1	3	1	1	1	11
R.M.EMERSON	1	1	1	1	2	1	2	1	1	11
Junfen Zhang	1	1	1	3	1	1	2	1	1	12
Anna B. Fishbein	1	1	1	1	1	1	2	1	1	10
T. Gerner	1	1	1	1	1	3	3	1	1	13
Jonathan Ian Silverberg	1	1	1	3	2	1	3	1	1	14
Giampiero Girolomoni	1	1	1	1	1	1	3	1	1	11
Stamatis Gregoriou	1	1	2	1	1	1	1	1	1	10
Stephanie M. Rangel	1	1	1	1	3	1	1	1	1	11
Hanifin	1	1	1	1	2	1	2	1	1	11
Irwanto	1	1	2	1	3	1	1	1	1	12
Bohye Kim	1	1	1	3	2	1	1	1	1	12
Harutaka Yamaguchi	1	1	2	1	2	3	1	1	1	13
Shawn G. Kwatra	1	1	1	3	3	3	1	1	1	15
Emine Gulsah Torun	1	1	2	1	1	1	1	1	1	10
Mark A. Strom	1	1	1	3	1	3	1	1	1	13
Fadia Sorour	1	1	2	1	3	1	1	1	1	12
Marília Magalhaes Moraes	1	1	2	1	1	1	3	1	1	12
Jae Hyeok Lim	1	1	1	1	1	3	3	1	1	13

Notes: I–IX represent nine items in the JBI

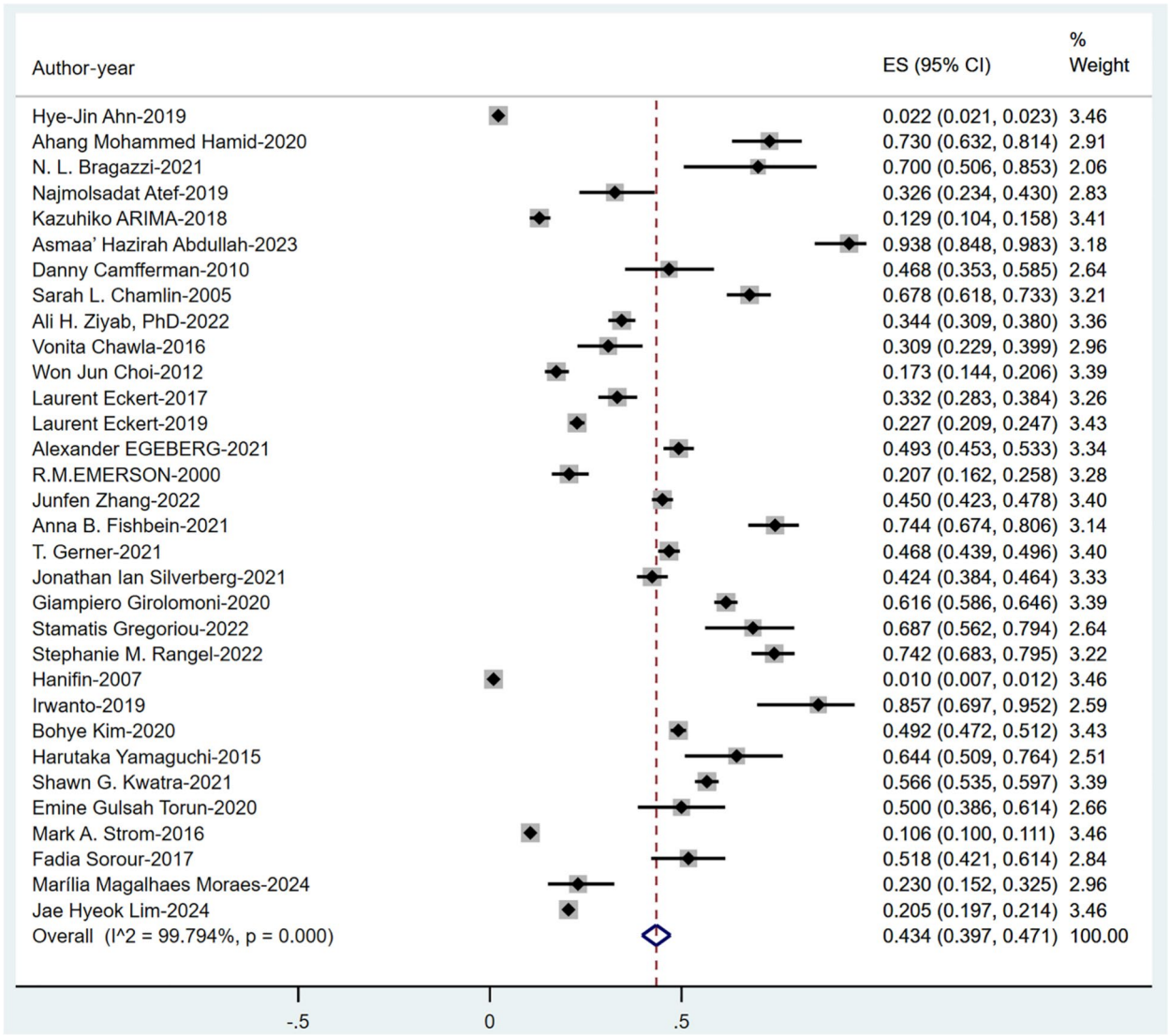

Fig. 2 Summary forest plot

Outcomes Measurement Information System) scale was used to evaluate sleep disorders in AD patients, the prevalence was 74.3% (95% CI 70.2–78.4%). Additionally, the prevalence of sleep disorders in AD patients assessed by the BISQ (Brief Insomnia Screening Questionnaire) scale was 66.9% (95% CI 58.9–74.8%). The forest plot for subgroup analysis by assessment scales is provided in Fig. S5.

For subgroup analysis by the classification of sleep disturbances, there were 17 sets of data, including 14 on insomnia and 3 on somnolence. The prevalence of insomnia among patients with AD was 51.7% (95% CI 36.8–66.5%). The prevalence of somnolence among AD patients was 15.9% (95% CI − 2.5 to 34.3%). The forest plot for subgroup analysis by the classification of sleep disturbances is provided in Fig. S6.

The subgroup analysis by nocturnal awakening issues was performed based on 6 sets of data. The prevalence of sleep–wake transition disorders among patients with AD was 13.0% (95% CI 6.4–22.6%). The prevalence of nocturnal awakenings in AD patients was 34.4% (95% CI 30.9–38.0%). The prevalence of awakenings at night three or more times in AD patients was 52.4% (95% CI 43.7–61.2%). The prevalence of AD patients who spent a total of one hour or more awake during the night was 25.2% (95% CI 17.3–33.2%). The forest plot for subgroup analysis by nocturnal awakening issues is provided in Fig. S7.

For subgroup analysis by on the number of days with sleep disturbances per week, 6 sets of data were used. The prevalence rate of sleep disturbances from 0 to 3 days per week in patients with AD was 66.9% (95% CI 37.3–96.4%).

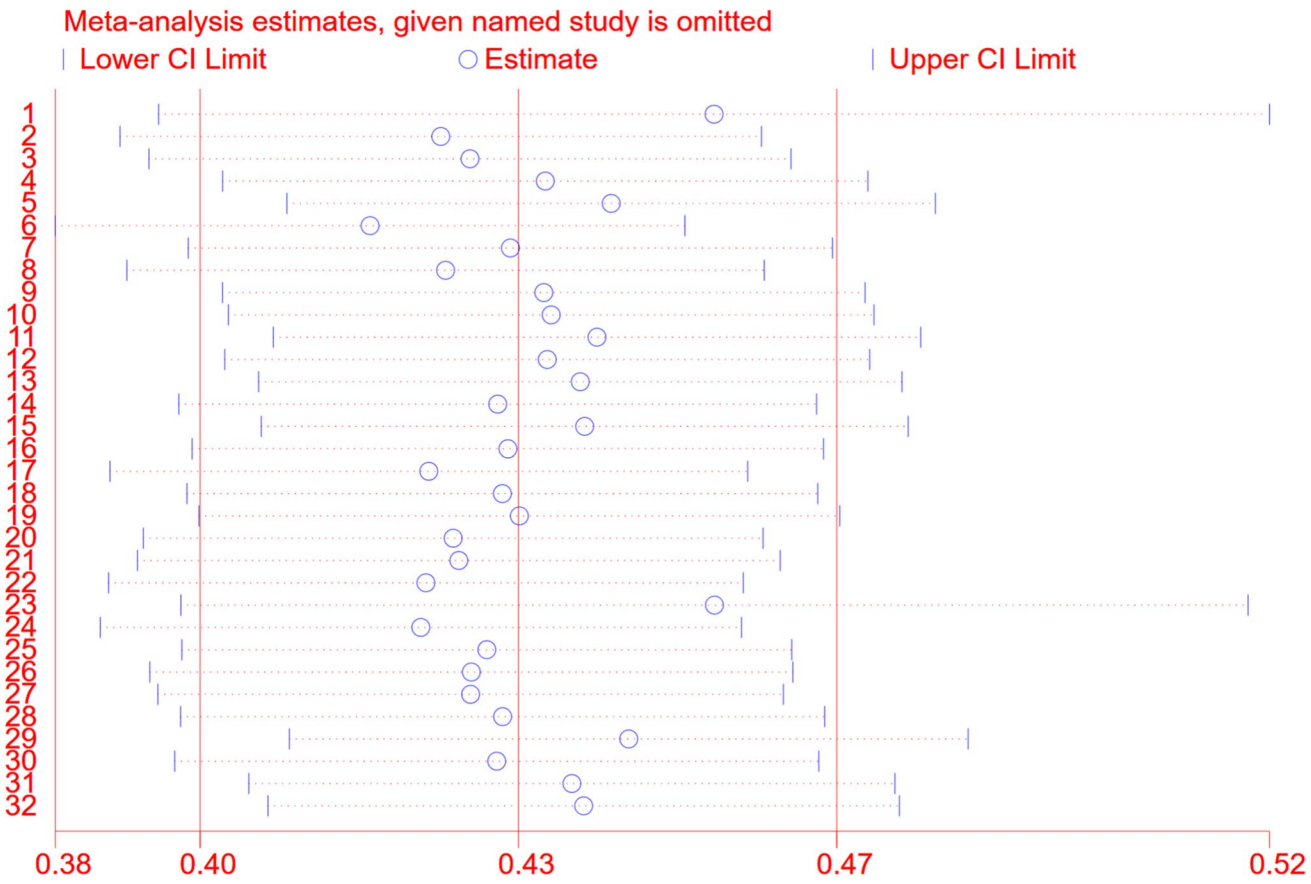

Fig. 3 Summary sensitivity analysis

The prevalence rate for sleep disturbances on 4 to 7 days per week in AD patients was 25.0% (95% CI 7.0–43.0%). The forest plot for subgroup analysis by the number of days with sleep disturbances per week is depicted in Fig. S8.

Subgroups with more than ten studies were region, source of data, publication year, and sleep disorder classification. Meta-regression was employed to assess the sources of heterogeneity across different studies. For region ($p = 0.866$), data source ($p = 0.067$), publication year ($p = 0.092$), and severity of AD ($p = 0.846$), no significant heterogeneity was found. However, the classification of sleep disturbance ($p = 0.009$) might be a source of heterogeneity.

To assess the robustness of the results, a sensitivity analysis was also conducted by sequentially excluding each study. The specific results of the sensitivity analysis are presented in Fig. 3.

Discussion

This is the first meta-analysis to investigate the prevalence of sleep disturbances in patients with AD. The meta-analysis, encompassing 32 datasets, reveals a high prevalence of sleep disturbances among patients with AD, at 43.4% (95% CI 39.7–47.1%). Further subgroup analysis unravels that the highest incidence of sleep disturbances was observed in patients from the African region, those from hospitals, studies published between 2016 to 2025, patients with severe- to very severe AD, patients assessed by PROMIS scales, individuals with a nighttime wake-up frequency of three times or more, and those with sleep disturbances for 0 to 3 days per week.

There are few previous meta-analyses of sleep disorders in AD. A meta-analysis evaluating the sleep quality of AD patients (Miaolan Guo) [54] included seven case–control or cohort studies involving 173 AD patients and 122 controls. Their analysis revealed that the sleep quality was poor in AD patients, particularly those with severe AD, men, and adults. This observation aligns with the findings presented in the current study. Another meta-analysis of the risk of psychiatric disorders in children and adolescents with AD (Qian-Wen Xie) [55] showed that children and adolescents with AD were at higher risk of psychiatric disorders, including sleep disorders, which is consistent with the findings of the current study. However, it only included children and adolescents with AD compared to

Table 3 Information of subgroups

Subgroup	No. of studies	No. of sleep disorder	Sample size	Subgroup analysis			Meta-regression	
				Estimated rate (95% CI)	I^2 (%)	*p*-value	I^2 (%)	*p*-value
Study region								
Asia	11	4650	56,445	0.435 (0.320, 0.551)	99.83%	< 0.01	100.00%	0.690
Europe	9	2683	6494	0.476 (0.363, 0.589)	98.82%	< 0.01	–	–
Oceania	1	36	77	0.468 (0.353, 0.585)	–	–	–	–
North America	9	2924	22,695	0.431 (0.343, 0.520)	99.82%	< 0.01	–	–
Africa	1	57	110	0.518 (0.421, 0.614)	–	–	–	–
South America	1	23	100	0.230 (0.152, 0.325)	–	–	–	–
Overall	32	10,373	85,921	0.434 (0.397, 0.471)	99.79%	< 0.01	–	–
Study data source								
Hospital	16	2485	45,677	0.527 (0.335, 0.718)	99.67%	< 0.01	99.79%	0.066
Non-hospital	16	7888	40,244	0.364 (0.286, 0.441)	99.85%	< 0.01	–	–
Overall	32	10,373	85,921	0.434 (0.397, 0.471)	99.79%	< 0.01	–	–
Study sleep disorder assessment scale								
PSQI	2	52	125	0.419 (0.337, 0.501)	–	–		
PROMIS	2	318	428	0.743 (0.702, 0.784)	–	–		
BISQ	2	70	115	0.669 (0.589, 0.748)	–	–		
Overall	6	440	668	0.645 (0.499, 0.790)	93.92%	< 0.01		
Study year								
2000–2015	6	487	8221	0.359 (0.164, 0.554)	99.44%	< 0.01	99.99%	0.354
2016–2025	26	9886	77,700	0.463 (0.396, 0.529)	99.82%	< 0.01	–	–
Overall	32	10,373	85,291	0.448 (0.410, 0.485)	99.79%	< 0.01	–	–
Subgroup	No. of studies	No. Of sleep disorder	Sample size	Subgroup analysis				
				Estimated rate (95% CI)	I^2 (%)	*p*-value		
Study AD severity								
Mild	3	106	1414	0.075 (0.062, 0.089)	–	–	99.99%	0.846
Moderate	2	311	1414	0.217 (0.196, 0.239)	–	–	–	–
Severe	2	177	1414	0.103 (0.087, 0.118)	–	–	–	–
Mild/Moderate	1	12	67	0.179 (0.096, 0.292)	–	–	–	–
Severe/Extremely severe	1	23	67	0.343 (0.232, 0.469)	–	–	–	–
Moderate/Severe	1	14	100	0.140 (0.079, 0.224)			–	–
Overall	10	710	6606	0.177 (0.127, 0.228)	95.70%	< 0.01	–	–
Study sleep problem								
Sleep debt	14	4968	20,164	0.517 (0.368, 0.665)	99.70%	< 0.01	99.66%	0.009
Drowsiness	3	56	1400	0.159 (-0.025, 0.343)	–	–	–	–
Overall	17	5024	21,564	0.454 (0.356, 0.553)	99.71%	< 0.01	–	–
Study nocturnal awakening								
Sleep–wake transition disorder	1	10	77	0.130 (0.064, 0.226)	–	–		
Nocturnal awakening	1	249	724	0.344 (0.309, 0.380)	–	–		
Number of wakings during the night ≥ 3	2	59	115	0.524 (0.437, 0.612)	–	–		
Nocturnal waking hours ≥ 1 h	2	29	115	0.252 (0.173, 0.332)				
Overall	6	347	1031	0.345 (0.225, 0.465)	91.60%	< 0.01		
Study number of days per week with sleep disorders								
0–3	3	11,884	13,478	0.669 (0.373, 0.964)	–	–	–	–
4–7	3	1534	13,478	0.250 (0.070, 0.430)	–	–	–	–
Overall	6	13,418	26,956	0.460 (0.024, 0.896)	99.99%	< 0.01	–	–

Notes: The number of included studies, number of patients with sleep disorders, sample size, and estimated I^2 and p value of subgroup analysis (95%cl), I^2 and p value of meta-regression in 8 subgroups: region, data source, year of publication, AD severity, sleep assessment scales, classification of sleep disorders, nocturnal awakening issues, the number of days with sleep disturbances per week

our study, and did not cover a wider range of people of different ages.

The relationship between AD and sleep disorders may be attributed to three potential mechanisms [9], including itching as a direct result of allergens or inflammatory mediators, conditioned reflex due to prolonged scratching, and changes in the circadian rhythm of multiple substances. Firstly, AD patients often experience increased nocturnal scratching during disease flares, which can disrupt sleep. Secondly, prolonged nocturnal scratching may gradually become a conditioned reflex, leading to insomnia and cognitive behavioral problems. The itch-scratch cycle leads to impaired sleep and transforms acute insomnia into long-term chronic insomnia. Nocturnal scratching also leads to tissue damage, the release of inflammatory mediators, and pruritus [8, 10]. Released mediators and substances can exacerbate sleep disturbances, as they can induce hyperalgesia to sensory pain. Finally, this association may be related to changes in the circadian rhythms of cytokines and melatonin production [11]. In general, cytokines such as IL-1β, IL-2, IL-6, TNF-α, and IFN-γ show increased performance at night and facilitate sleep. Conversely, cytokines such as IL-4, IL-10 and IL-13 rise in the early morning and promote wakefulness. One study showed that a lower IFN-γ/ IL-4 ratio in AD patients was associated with reduced sleep efficiency [56]. In addition, another study showed that IL-6 levels were higher in AD patients in the morning [57]. This increase may lead to difficulties in waking up in the morning, daytime drowsiness, and thus disruption of nocturnal sleep. Changes in the expression levels of these cytokines in AD may disrupt normal circadian rhythms and constitute an important mechanism for the development of sleep disorders in AD patients [58–60].

According to subgroup analysis, the prevalence of sleep disturbance in AD varies slightly across geographic locations. The highest prevalence is observed in Africa, possibly due to the increased prevalence of AD in Africans in recent years [61]. Patients in Africa are at higher risk of developing loss of encoding filaggrin (FLG) than patients from other regions [62, 63]. FLG is the main structural protein of the epidermis and plays a key role in supporting the skin barrier. As a result, FLG loss can lead to damage to the skin barrier, and promote inflammation and T-cell infiltration, leading to AD, which in turn increases the risk of sleep disorders. Patients with hospital-derived AD show a notably higher prevalence of sleep disturbances compared to non-hospital-derived patients. This could be ascribed to the fact that AD patients seeking hospital care often present with more severe conditions, thereby increasing their likelihood of experiencing sleep disturbances. Furthermore, the prevalence of sleep disturbances among AD patients is the highest in studies published between 2016 and 2025. This might be attributable to the enhanced accuracy in diagnosing the related clinical manifestations of AD over the past few years, which in turn, has elevated the detection rate of both AD and sleep disturbances. Previous research has indicated that for well over a century, no consensus on AD has been reached, where the pathophysiological mechanism of AD remains equivocally defined. The nomenclature utilized in the clinical diagnosis of AD worldwide remains inconsistent. In fact, earlier articles have employed the term "atopic eczema" and even "eczema" to delineate AD [64]. Patients with severe to very severe AD exhibit the highest prevalence of sleep disturbances, which may be associated with certain AD severity scoring scales like the SCORAD [65] and POEM [66]. These scales include sleep disturbances as a parameter in assessing the severity of AD, thus correlating higher severity grades with an increased prevalence of sleep disorders. Among the various sleep disturbance assessment scales, AD patients evaluated with the PROMIS tool are found to have the highest prevalence of sleep disturbances, possibly because PROMIS primarily focuses on assessing various aspects of sleep quality, sleep depth, and the restoration associated with sleep. Additionally, it considers difficulties and concerns related to falling asleep or maintaining it. The scale also extends its scope to aspects of alertness during waking hours, somnolence, and feelings of fatigue. The PROMIS scale offers a more nuanced assessment of sleep disturbances compared to other scales like the PSQI or the BISQ. Consequently, the number of individuals identified with sleep disturbances tends to be higher in those assessed by PROMIS, which might explain the elevated prevalence of sleep disturbances reported in AD patients using this tool. In a narrow sense, sleep disturbances are often equated with insomnia. Thus, most articles simply classify sleep issues into insomnia, which may contribute to the observed higher prevalence rates of insomnia compared to somnolence. Additionally, physiologically, there exists a circadian variation in skin blood flow [10], which could potentially disrupt the circadian rhythms in AD patients [58–60]. This disruption might be another significant contributor to the increased prevalence of nocturnal insomnia in AD patients. According to our subgroup analysis based on the frequency of sleep disturbances per week, the prevalence rate of sleep disturbances from 0 to 3 days per week was the highest in AD patients. This result might be attributable to a higher proportion of patients with mild to moderate AD in the research cohort.

This systematic review has several limitations. Firstly, only four major databases were searched, and studies published in journals not included in the four databases may have provided more insights or different perspectives on this research topic. Hence, some existing evidence may be omitted. Omitting these studies may introduce selection bias, which could affect the overall findings or conclusions of our review. Secondly, during the data organization process, we found that most studies lacked data on the

prevalence of sleep disorders across different age groups. Therefore, it is impossible to conduct relevant analyses. In fact, the existing AD literature primarily focuses on the pediatric population, with a lack of research on adults. Further studies are needed to explore the impact of age as a confounding variable on the prevalence of AD sleep disorders. Finally, among the 32 articles, only three had data on the comorbidity of AD and the prevalence of sleep disorders, and their comorbidities were different. It is recommended that future research pay more attention to these variables.

Conclusions

In conclusion, patients with AD have significantly higher rates of sleep disturbances compared to the general population, and a greater number of AD patients in Africa suffer from sleep disorders. The prevalence of sleep disorders was significantly higher in the last decade compared with previous years. Furthermore, sleep disorders were positively correlated with the severity of AD. Sleep disturbances are more commonly observed in the following populations: those from African regions, subjects recruited from hospital settings, studies published between 2016 and 2025, individuals with severe to very severe AD, those assessed using the PROMIS scales, those who awaken at least three times during the night, and those with sleep disturbances for 0 to 3 days a week. The relationship between AD and sleep disturbances is not yet fully understood, and further research should be dedicated to exploring the link and the underlying mechanisms between the two conditions.

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Data availability The data that support the findings of this study are available from the corresponding author upon reasonable request.

Declarations

Competing interests The authors declare no competing interests.

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