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The prevalence and risk of allergic rhinitis in psoriasis patients: a systematic review and meta-analysis

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Psoriasis, a chronic inflammatory systemic disease, may increase the risk of allergic diseases. This meta-analysis assesses the prevalence and risk of developing allergic rhinitis in psoriasis. We systematically searched MEDLINE, Scopus, and EMBASE for population-based studies documenting AR in psoriasis compared to those without from inception to December 2023. Meta-analysis was conducted using the random-effects model. Eight studies, comprising 5 cross-sectional studies, 1 case-control study, 1 retrospective cohort study, and 1 prospective cohort study, were included. The increased prevalence of AR was 22.29% (95% CI: 0.135 to 0.281; $P < 0.001$; $I^2 = 99.05\%$) in the psoriasis population. The AR risk in psoriasis was insignificant (adjusted OR 1.19%; 95% CI: 0.69 to 2.06; $I^2 = 99\%$; $P < 0.00001$). Subgroup analysis in moderate to severe psoriasis cases revealed a trend of higher risk of AR (OR 1.41%; 95% CI: 0.94 to 2.10; $I^2 = 92\%$; $P = 0.0003$) with very low certainty of evidence. High heterogeneity was observed in most analyses. Our meta-analysis demonstrated a higher prevalence of AR in psoriasis patients. Evaluating and treating allergic diseases can enhance holistic treatment.

Keywords Psoriasis, Allergic rhinitis, Hay fever, Meta-analysis, allergy

Abbreviations

AR	Allergic rhinitis
BMI	Body mass index
CC	Case-control study
CI	Confidence interval
CS	Cross-sectional study
HR	Hazard ratio
NR	Not reported
OR	Odds ratio
PC	Prospective cohort study
RC	Retrospective cohort study
RR	Relative risk
SD	Standard deviation
UK	United Kingdom
USA	United States of America

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Psoriasis is a globally recognized inflammatory immune-mediated systemic disease affecting both sexes. Its prevalence varies across regions and age groups, with a noticeable upward trend recently[1,2]. The 2019 Global Burden of Disease (GBD) project reported 4,622,594 cases worldwide, with no notable gender-based prevalence differences across age groups[2]. The primary regions studied were high-income countries such as Western Europe, Oceania, South Latin, and North America, in contrast to other areas. However, a specific cross-sectional study in Spain revealed a significant predominance of male psoriasis patients compared to females. Despite a low mortality rate, psoriasis leads to impaired quality of life and significant psychosocial burdens. Clinically, psoriasis is categorized into non-pustular and pustular types, with psoriasis vulgaris being the most prevalent non-pustular form characterized by well-defined erythematous plaques with scales.

The pathogenesis of psoriasis is complex and involves interactions between keratinocytes, immune cells, and other skin-resident cells. The IL-23/IL-17 axis controls proinflammatory cytokines within psoriatic plaques. Activation of plasmacytoid dendritic (pDC) cells triggers myeloid dendritic cell maturation, leading to the activation of TNF-α, IL-12, and IL-23, which further activate Th1 and Th17 cells to secrete TNF-α, IL-17, IL-21, and IL-22.

Psoriasis is often linked with several comorbid conditions, including cardiovascular disease, obesity, diabetes mellitus (DM), stroke, allergic rhinitis (AR), and asthma[3–5]. While allergic rhinitis and asthma are typically driven by Th2 cells, emerging evidence suggests a role for Th-17 cells in Th2-driven diseases[6]. IL-22, primarily produced by Th-22 cells, has been found in allergic rhinitis patients, indicating a potential connection between psoriasis and allergic rhinitis through this mechanism[7]. Notably, a study involving a large cohort in the United States revealed a significant association between psoriasis and allergic rhinitis[8].

A comprehensive understanding of the risk of allergic rhinitis in psoriasis patients is lacking. Therefore, our systematic review and meta-analysis aim to estimate the risk of allergic rhinitis among individuals with psoriasis.

Results

Search results

A total of 27,584 articles, with 15,910 from EMBASE, 11,267 from Scopus, and 407 from MEDLINE, were retrieved to assess eligibility. The 9286 duplicated articles were removed, and 18,298 were screened for title and abstract. Of these, 56 full-text articles were critically evaluated. Finally, we included eight eligible articles. The search process is depicted in the PRISMA diagram (Fig. 1).

Details of patient characteristics

A total of 2,451,435 participants with eight included studies[3,9–15], five of which were cross-sectional studies[3,10–12,14], one was a case-control study[13], one was a retrospective cohort study[15], and one was a prospective cohort study[9]. Of these, 20,202 patients with psoriasis and 238,765 patients without psoriasis were assessed for the prevalence and risk of allergic rhinitis. Table 1 shows the details of the included studies' patient characteristics and quality assessment. All studies demonstrated the risk of allergic rhinitis in patients of all age groups, especially psoriasis patients[3,9–15]. Of these, the risk of patients with allergic rhinitis in moderate-to-severe psoriasis patients was depicted in some studies[9,11]. The description of criteria diagnosis in patients with psoriasis and allergic rhinitis patients is represented in Supplementary Table S1.

Study quality, risk of bias, and certainty of evidence

According to the Newcastle-Ottawa quality assessment scale, the median of the total score is 7 (7–8) for cross-sectional studies[3,10–12,14] and 8 (7–9) for case-control[13] and cohort studies[9,15]. In addition, the risk of bias assessment is displayed in Supplementary Table S2. The studies were reported as low risk for seven studies[3,9–13,15] and moderate risk for one study[14]. The summarization and proportions in each detail of this assessment are depicted in Figs. 2 and 3. We also evaluated the certainty of evidence using the Grading of Recommendations, Assessment, Development, and Evaluations (GRADE) tool, as shown in Table 2. A very low risk was identified in the allergic rhinitis outcome.

Outcomes associated with the prevalence of allergic rhinitis

As illustrated in Fig. 4, seven studies examined the prevalence of allergic rhinitis in patients with psoriasis. The analysis revealed that the allergic rhinitis prevalence was higher among individuals with psoriasis, with a pooled prevalence rate of 20.8% (95% confidence interval (CI): 13.5 to 28.1; $P < 0.001$; $I^2 = 99.05\%$).

Outcome associated with the risk of allergic rhinitis in psoriasis patients

In the analysis of seven studies comparing the risk of allergic rhinitis between patients with psoriasis and those without, psoriasis patients did not exhibit an increased risk of allergic rhinitis. The crude odds ratio (OR) was 0.88% (95% CI: 0.41 to 1.88; $I^2 = 100\%$; $P < 0.00001$) (Supplementary Fig. S1), and the adjusted OR was 1.19% (95% CI: 0.69 to 2.06; $I^2 = 99\%$; $P < 0.00001$) (Supplementary Fig. S2). Further analysis focusing on moderate to severe psoriasis, based on data from five studies, suggested a trend towards a higher risk of developing allergic rhinitis in psoriasis patients compared to those without psoriasis, with an unadjusted OR of 1.41% (95% CI 0.94 to 2.10; $I^2 = 92\%$; $P = 0.0003$) (Supplementary Fig. S3).

Meta-regression

Since the I^2 was high in all meta-analyses, meta-regression using sex, study quality, study region, study design, and size of studies as covariates was conducted. The study region was a significant predictor for pooled OR ($p < 0.001$) (Supplementary Table S3), while the percentage of the females in the included studies ($p = 0.636$) (Supplementary Fig. S4 and Supplementary Table S4), study quality by Newcastle-Ottawa scores ($p = 0.825$) (Supplementary Fig. S5 and Supplementary Table S5), study design ($p = 0.207$), and study size ($p = 0.076$) were

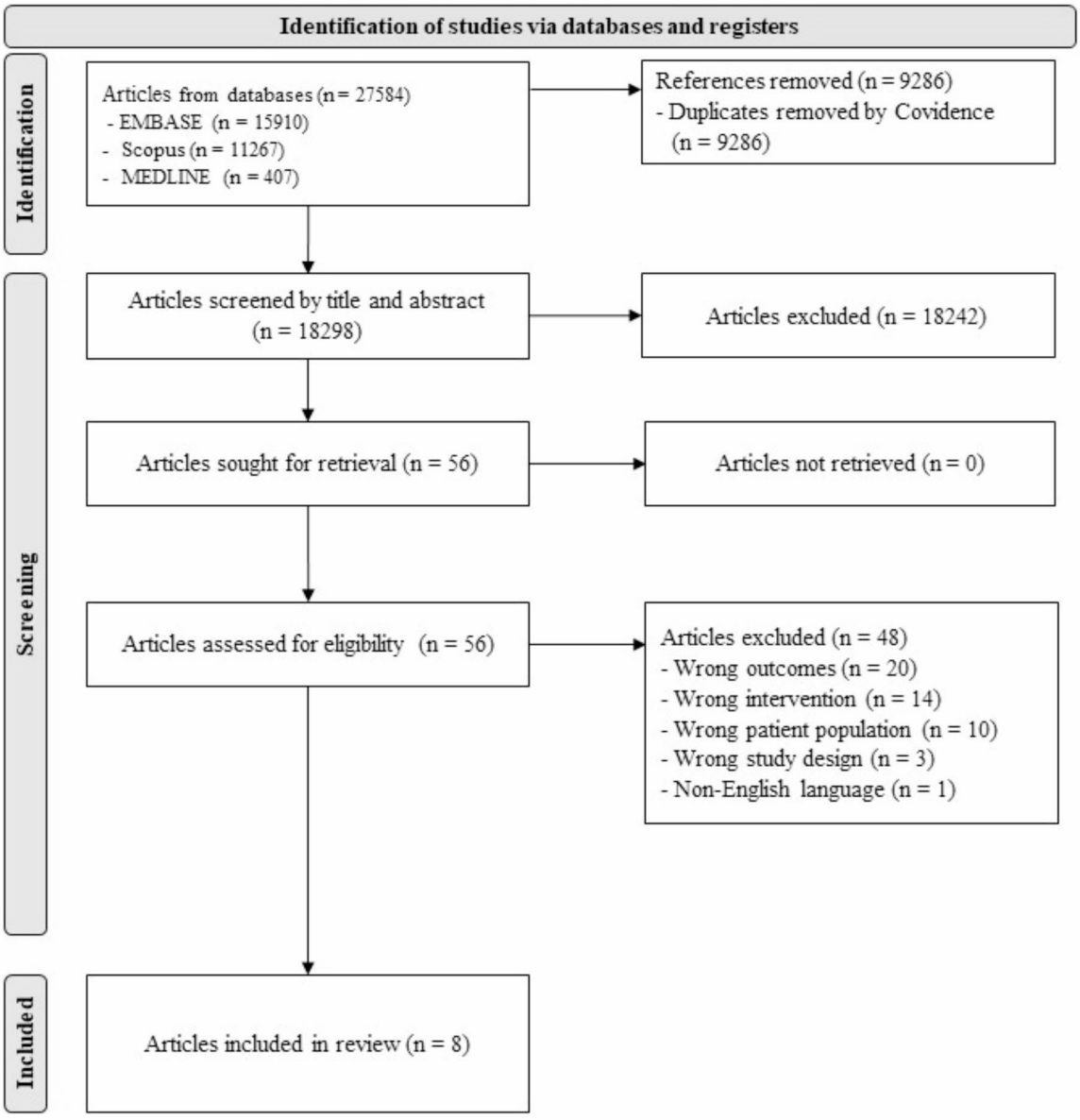

Fig. 1. The PRISMA diagram for the systematic review in this study.

not (Supplementary Fig. S6 and Supplementary Table S6, S7. The high heterogeneity in this meta-analysis arose from the variation in the regions where the included studies were conducted. There was insufficient evidence supporting that sex, study quality, study design, and study size were the sources of heterogeneity in this study.

Discussion

This systematic review and meta-analysis encompassed eight studies, comprising five cross-sectional studies, one case-control study, one retrospective cohort study, and one prospective cohort study. These studies investigated the prevalence of allergic rhinitis (AR) in individuals with psoriasis compared to those without the condition. The pooled data revealed a higher prevalence of allergic rhinitis among psoriasis patients than the non-psoriasis population. However, the analysis did not indicate a significantly increased risk of allergic rhinitis in psoriasis patients. Nevertheless, a trend emerged indicating a higher risk of developing allergic rhinitis when conducting subgroup analysis focusing on moderate to severe psoriasis cases.

Psoriasis recognized as a chronic systemic inflammatory disease, is associated with various comorbid conditions, including cardiovascular disease, diabetes mellitus, obesity, stroke, allergic rhinitis, and asthma[5]. Its pathophysiology involves activating Th1 and Th17 cells, with the IL-23/IL-17 axis playing a pivotal role in regulating proinflammatory cytokines. Although robust Th2 inflammatory responses characterize atopic diseases such as allergic rhinitis and asthma, there is evidence of overlapping immunopathogenesis between

Authors, Year	Study design	Country	Duration of study	Number of participants (psoriasis/AR)	Mean age, years (SD)	Mean BMI, kg/m^2 (SD)	Type of psoriasis (*n*)	Adjusted outcomes (OR/RR/HR; 95% CI)	Confounders	Newcastle-Ottawa scale
Joel, 2023	CS	USA	2018 to 2022	235,551	54.7 (16.6)	29.83 (7.70)	NR (5,165)	OR 2.57 (2.42–2.73)	age, sex, race, BMI, annual household income, smoking status	Selection: 3, Comparability:1, Outcome: 3
Kirsten, 2021	CS	Germany	2006 to 2014	90,265	43.2 (10.7)	NR	NR (1,788)	OR 0.86 (0.77–0.97)	age, sex	Selection: 3, Comparability:2, Outcome: 3
Egeberg, 2020	PC	Denmark	May to July 2018	10,128	53.77 (16.07)	NR	Plaque psoriasis (3,348)	NR	NR	Selection: 3, Comparability:1, Outcome: 3
Galili, 2020	CS	Israel	1999 to 2014	887,765	17.45 (4.2)	21.53 (3.80)	NR (3,112)	OR 1.31 (1.16–1.49)	age, sex, country of origin, socioeconomic status, number of siblings, BMI	Selection: 3, Comparability: 1, Outcome: 3
Hosseini, 2019	CC	Iran	2016	102	37.52 (15)	NR	Plaque (36) Guttate (3) Inverse (6) Pustular (3) Erythrodermic (4)	NR	NR	Selection: 4, Comparability: 2, Outcome: 3
Hajdarbegovic, 2013	CS	Netherlands	March 2009 to February 2011	448	51.77 (14.43)	NR	NR (133)	OR 0.80 (0.38–1.67)	age, sex, methotrexate use, current smoking	Selection: 4, Comparability:1, Outcome: 3
Landgren, 2006	RC	Sweden	1952 to 1977	1,226,193	NR	NR	NR (6,131)	RR 0.93 (0.86–1.01)	living in northern Sweden, rural living, living in a farming household, overcrowding, being the first-born boy	Selection: 3, Comparability: 2, Outcome: 3
Beer, 1992	CS	UK	April 1988 to July 1990	983	36.3 (23.1)	NR	Any types of psoriasis except pustular and palmoplantar (473)	NR	NR	Selection: 3, Comparability:1, Outcome: 3

Table 1. The characteristics and quality assessment of included studies.

psoriasis and atopic diseases, with Th17 cells implicated in allergic diseases[6]. These cells produce a range of cytokines including IL-17, IL-6, TNF-α, and IL-22[16].

Previous research demonstrated that IL-17 A-deficient mice significantly reduced allergic symptoms, serum IgE levels, and eosinophil infiltration in the nasal mucosa[17]. Additionally, Ciprandi G et al. observed a correlation between increased IL-17 levels and allergic symptoms in patients allergic to birch pollen[16]. These findings suggest a substantial involvement of IL-17 in allergic rhinitis and its associated symptoms. Studies on IL-17 levels in patients with psoriasis have revealed that IL-17 is a primary driver of skin pathology and correlated with the psoriasis area and severity index[18].

Our analysis indicated that while the overall risk of developing allergic rhinitis in psoriasis patients may not be significant, there appears to be a rising trend for the risk in cases of moderate to severe psoriasis. This might be explained by previous research suggesting a correlation between IL-17 levels and disease activity. Higher IL-17 secretion may lead to more robust downstream effects, including IL-20 family cytokines, associated with a higher risk of developing allergic diseases in moderate-to-severe psoriasis. However, only two studies were included in our subgroup analysis. Further large studies in moderate-to-severe psoriasis are needed to explore the prevalence and risk of developing allergic diseases.

This study's strength lies in its adherence to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guideline and Meta-analyses Of Observational Studies in Epidemiology (MOOSE) checklist to ensure the quality and validity of the results. In addition, the included studies were of moderate to high quality with a low risk of biases. However, the study has several limitations, including heterogeneity among included studies and the possibility of missing relevant studies (as evidenced by the funnel plot in the Supplementary Fig. S7) despite an extensive search, which may influence causal inference. The heterogeneity among studies was due to the study regions, which can be implicated in the fact that studies from Europe, the Middle East, and the United States differed. Because of high heterogeneity, the interpretation should be performed with caution. We also found that several included studies reported the number of participants in each arm in a way that needed further calculations or subjective interpretations[3,9–13]. To assist future meta-analysis on this topic, studies in this field should follow standard reporting guidelines and include a Consolidated Standards of Reporting Trials (CONSORT) diagram to report the participants.

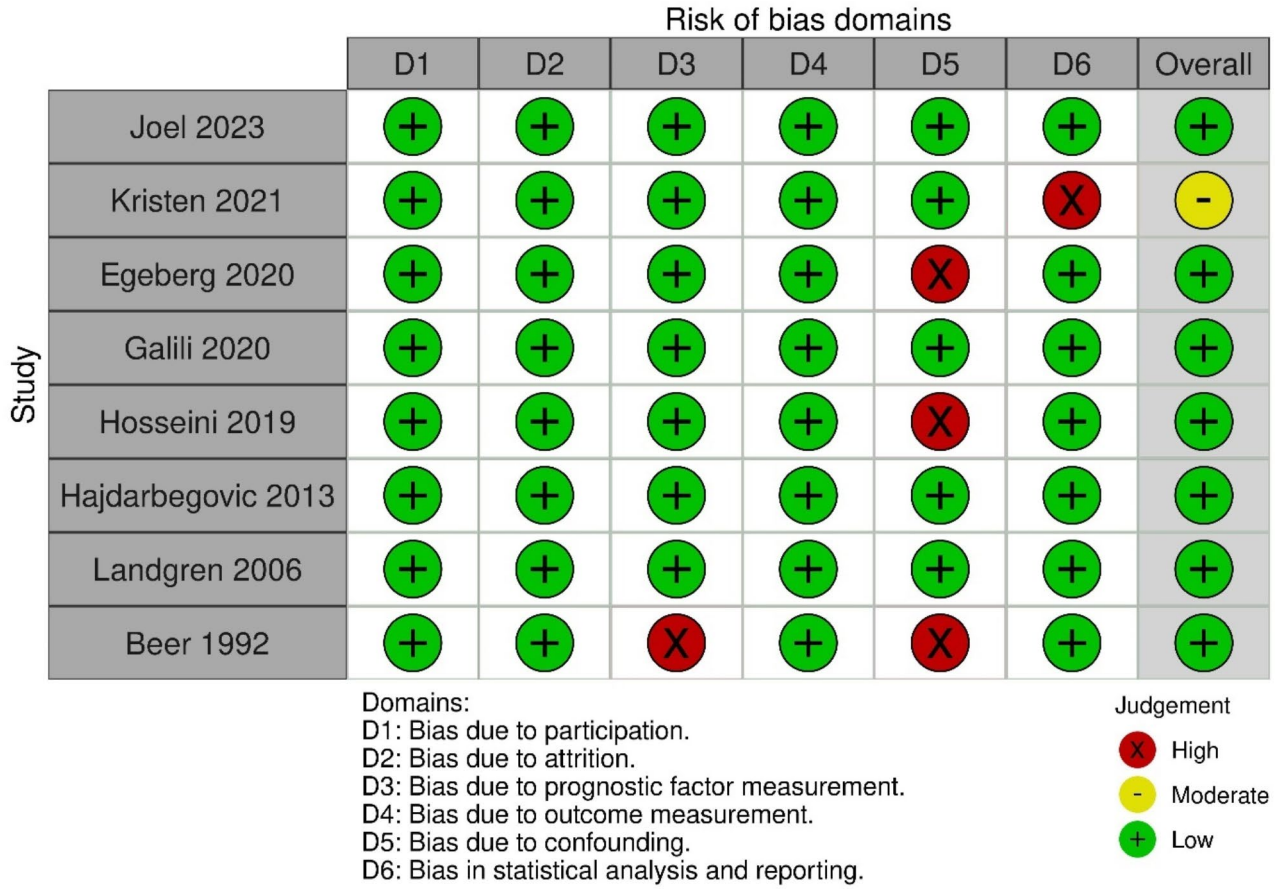

Fig. 2. The summarization of biases in each included study as evaluated using the Quality In Prognosis Studies (QUIPS) tool.

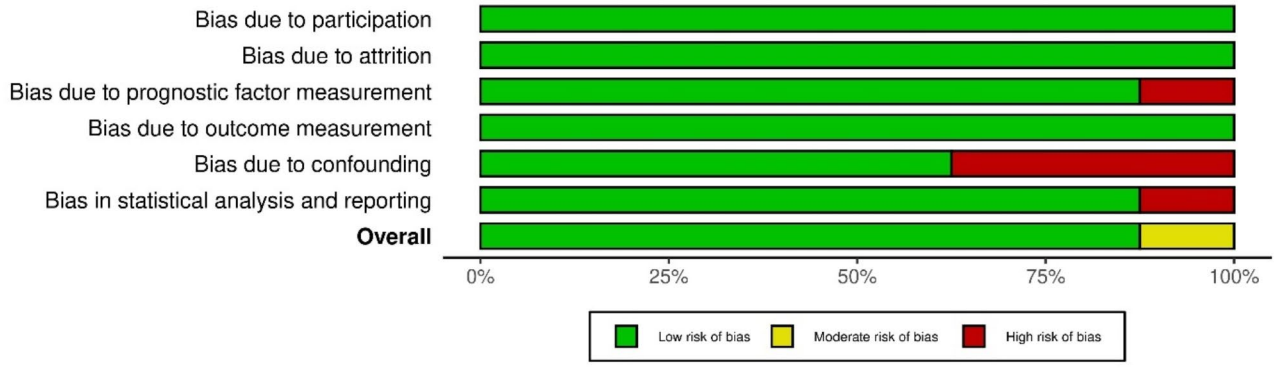

Fig. 3. The proportion of biases from included studies as evaluated using the Quality In Prognosis Studies (QUIPS) tool.

Conclusion

Our meta-analysis provides supporting evidence that individuals with psoriasis have a higher prevalence of allergic rhinitis compared to individuals without psoriasis. The risk of developing allergic rhinitis in psoriasis was not significant. However, the increasing trend has been shown in moderate-to-severe psoriasis populations. Future studies in the field should adhere to the reporting guidelines to assist future meta-analysis.

Certainty assessment								
Outcome	No. of studies (Total *N*)	Risk of bias	Inconsistency	Indirectness	Imprecision	Publication bias	Certainty	Importance
Allergic rhinitis	8 (2,451,435)	not serious	serious	not serious	serious	none	⨁◯◯◯ Very low	critical

Table 2. GRADE (grading of recommended Assessment, Development, and evaluation) assessment of included studies in patients with psoriasis.

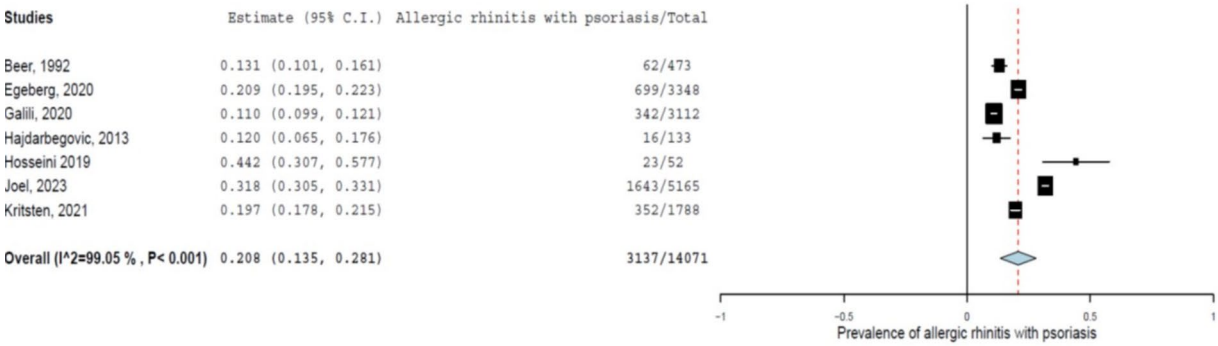

Fig. 4. A pooled prevalence of allergic rhinitis in patients with psoriasis.

Methods

This systematic review and meta-analysis complied with the MOOSE and PRISMA checklists (Supplementary Table S8). The prespecified protocol was registered in INPLASY before the study (INPLASY202440077)[19].

Search strategy

Six investigators (SU., TA., PK., WD., SS, and PS.) conducted the search strategy independently for published studies using three databases, including MEDLINE, EMBASE, and SCOPUS, from inception to December 2023. The search strategy was developed using terms associated with psoriasis and allergic rhinitis. The search strategy is described in detail in Supplementary Table S9. No language restriction was applied to the search strategy. The bibliography of eligible studies was further examined to avoid omitting relevant studies.

Eligibility criteria

Studies that complete the following criteria were included: (1) consisting of patients with psoriasis as exposure and individuals without psoriasis as a control and (2) reporting the allergic rhinitis development or prevalence. Exclusion criteria were (1) studies that are review articles, case reports, or case series, (2) studies that involved patients with other types of allergies, (3) studies with no abstract or available full-text, (4) duplicated published studies, and (5) studies that failed to report additional outcomes.

Duplicated articles were removed automatedly by Covidence (Covidence.org, Australia). The five researchers (SU., TA., PK., WD., SS., and PS.) independently screened the titles and abstracts of the studies using a screening form developed by the authors. The selected studies were retrieved to review the full-text articles. They were also responsible for independently extracting the information from the studies that fulfilled the eligibility criteria. All the conflicts during the procedures were resolved through discussion.

Data extraction

Non-English articles were primarily screened using their English abstracts and Google Translate. Translation using interpreters was sought when necessary. A standardized data collection form was utilized to extract the following data from each included study. The following data were extracted: (1) study characteristic including last name of the first author, country where the study was conducted, publication year, study design, number of participants, recruitment methods, criteria for psoriasis, type of psoriasis, criteria for allergic rhinitis, mean Body Mass Index (BMI) of participants, mean age of participants, percentage of female participants, and variables adjusted in multivariate analysis, (2) primary outcome of interest including prevalence of allergic rhinitis in patients with psoriasis and risk of allergic rhinitis development in patients with psoriasis including adjusted and unadjusted OR, relative risk (RR), hazard risk ratio (HR), standardized incidence ratio (SIR) or incidence rate ratio (IRR) with their associated 95% CI, and (3) additional outcomes including number of patients with allergic rhinitis in moderate to severe psoriasis patients, number of allergic rhinitis patients in patients with non- moderate to severe psoriasis, number of patients with allergic rhinitis in non- moderate to severe psoriasis

patients, and number of non-allergic rhinitis patients in non-moderate to severe psoriasis patients were extracted if included studies reported of number of patients with moderate-to-severe psoriasis.

If data were unavailable in the original publications, we contacted the corresponding authors for more details. Two researchers independently assessed the quality of the included studies using the Newcastle-Ottawa quality assessment scale for case-control, cohort, and cross-sectional studies[20].

Risk of bias assessment

Two investigators (SU. and TA.) independently used the Quality In Prognosis Studies (QUIPS) tool by robvis (Risk-Of-Bias VISualization)[21] to assess the risk of bias in the included studies. Any disagreements were resolved through discussion.

Certainty of evidence assessment

Two investigators (SU. and TA.) independently used the GRADE tool to assess the certainty of evidence in the included studies. Any disagreements were resolved through discussion.

Statistical analysis

Review Manager 5.3 software from the Cochrane Collaboration was used for the meta-analyses of the association between allergic rhinitis and psoriasis, while OpenMetaAnalyst for Windows 8[22] was used for the meta-analysis of the prevalence. Instead of the fixed-effect model, a random-effect model was used since allergic rhinitis[23], and psoriasis[24] are heterogeneous diseases. We assessed clinical and methodological heterogeneity by examining participant characteristics, follow-up period, outcomes, and comparators. We then assessed statistical heterogeneity using the I^2 statistic for magnitude, direction, and strength of evidence for heterogeneity. Cochran's Q test and I^2 statistic were used to assess between-study heterogeneity. A value of I^2 of 0–25% represents insignificant heterogeneity, 26–50% low heterogeneity, 51–75% moderate heterogeneity, and > 75% high heterogeneity[25]. Meta-regression, one of the methods used to explore the source of heterogeneity[26], analyses by study design, quality of studies, country region, sex, and diagnosis criteria for psoriasis and allergic rhinitis were planned a priori. Meta-regression analyses by study type and size were analyzed post hoc.

Publication bias

The visual inspection of the funnel plot was used to assess for the presence of publication bias. The significant asymmetry indicated the possibility of publication bias or heterogeneity. Egger's test for the funnel plot asymmetry would be used if there were at least 10 included articles[27].

Data availability

The datasets generated during and/or analyzed during the current study are available from the corresponding author upon reasonable request.

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Author contributions

SU made conception, data acquisition, interpretation of data, drafting the manuscript; TA made conception, data acquisition, interpretation of data, drafting the manuscript; NL made conception, interpretation of data, data analysis, drafting the manuscript, critical revision of the manuscript; WO made conception, interpretation of data, data analysis, drafting the manuscript, critical revision of the manuscript; PK made conception, data acquisition, interpretation of data, data analysis, drafting the manuscript; WD made conception, data acquisition, interpretation of data; SS made conception, data acquisition, interpretation of data; PS made conception, data acquisition, interpretation of data; WP made conception, interpretation of data, critical revision of the manuscript; WL made conception, interpretation of data, drafting the manuscript, critical revision of the manuscript; All of the authors approved the final version of this manuscript.

Declarations

Competing interests

The authors declare no competing interests.

Additional information

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