Clinical characteristics and outcomes of patients with COVID-19 and psoriasis

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Abstract
To summarize the clinical characteristics and explore the role of treatment types in outcomes among psoriasis patients with coronavirus disease 2019 (COVID-19). The principal summary measures were pooled prevalence and risk ratio (RR) with 95% confidential interval (CI). R statistic software was used for all the analysis. A total of 19 studies including 4073 psoriasis patients with COVID-19 were eligible for the meta-analysis. The overall hospitalization rate is about 20.2% (95% CI: 12.7%–28.7%), and changed to be 18.0% (95% CI: 9.9%–27.6%) or 14.1% (95% CI: 5.9%–24.6%) after systemic or biologic treatment. Moreover, the overall fatality rate is 1.5% (95% CI: 0.4%–3.0%), and turned to be 0.7% (95% CI: 0%–2.0%) or 0.5% (95% CI: 0%–2.2%) after systemic or biologic therapy. Notably, a lower hospitalization RR was found in patients receiving biologic therapy than those receiving other treatments (RR = 0.62, 95% CI: 0.42–0.94). The results were consistent after sensitivity analysis and trim-and-fill analysis. Systemic, especially biologic therapy could lessen the clinical severity in psoriasis patients with COVID-19. Our finding will help to guide current recommendations and provide a reference for clinical decision-making.

KEYWORDS
clinical characteristics, COVID-19, outcomes, psoriasis, systemic or biologic therapy

1 | INTRODUCTION

Psoriasis is a chronic, immune-mediated inflammatory skin disease that affects over 125 million people in the world.1 The coronavirus disease 2019 (COVID-19) pandemic raises concerns for psoriasis patients, especially those with moderate to severe psoriasis, because those patients usually had multi-comorbidities including hypertension, cardiovascular disease, diabetes and obesity, which is tightly associated with the clinical severity of COVID-19.2,3 Increasing studies have tried to explore the clinical characteristics and outcomes among patients with COVID-19 and psoriasis.4-20 However, small sample size and inconsistent results highlight the significance of a comprehensive analysis.

Systemic and biologic therapy represents an important breakthrough in the treatment of psoriasis patients.21 While extensive debate has been proposed for the use of these treatments in patients with COVID-19 and psoriasis.22-25 On one hand, the use of these treatments could control the psoriasis severity.13,26 On the other hand, the achieved immunosuppression could increase the risk of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infection, interfere with antiviral immunity, and worsen clinical outcomes.20,27,28 Several studies have concluded that psoriasis...
patients had a similar or perhaps even lower incidence of COVID-19 after receiving systemic or biologic treatment. However, how systemic and biologic therapy affected the outcomes of psoriasis patients with COVID-19 was still unknown.

Thus, we performed this meta-analysis to summarize the clinical characteristics and outcomes, and explored the role of treatment types in clinical outcomes among patients with COVID-19 and psoriasis. Our finding will help to guide current recommendations and provide a reference for clinical decision-making.

2 METHODS

This systematic review and meta-analysis followed the Preferred Reporting Items for Systematic Reviews and Meta-analyses guidelines and was registered on PROSPERO with the registration number CRD42022335563.

2.1 Literature search

Databases including Pubmed, Embase and Cochrane Library were searched from inception to 25th March 2022 using the following terms: "Psoriasis" AND "COVID-19." There are no limitations on publication languages and study types. The detailed search strategies were available in Table S1.

2.2 Inclusion and extraction criteria

Two of us (Y.M, and G.D.) independently screened all titles and abstracts after the initial deduplication. The inclusion criteria were as follows: (1) involving psoriasis patients with confirmed SARS-CoV-2 infection or COVID-19; (2) describing at least one of their characteristics and outcomes (hospitalization and mortality rates). Studies with less than 10 patients, conference papers or abstracts, preprint reports, article without full text, and studies with data inaccessible from the corresponding author were excluded. For studies with overlapping datasets, we selected those with the largest and most up-to-data studies. Discrepancies were solved by consensus.

2.3 Data extraction and quality assessment

Two investigators (Y.M and F.Z.) independently extracted the following information, including first author, publication year, patient number, age, sex, geographic region of residence, comorbidity (hypertension, cardiovascular disease, and diabetes), common COVID-19 symptoms (fever, dyspnea, and cough), psoriasis phenotype, psoriasis treatment type, and clinical outcomes (rate of hospitalization and mortality). The quality of the included cohort studies was assessed by two researchers (G.D. and F.Z.) independently using the Newcastle-Ottawa Scale. The nine-stars scale is comprised of three broad characteristics: selection, comparison and exposure/outcome. A score of 7 or more was reflective of high quality, a score of 5 or 6 indicated moderate quality, and a score of 4 or less indicated low quality.

2.4 Statistical analysis

Meta-analysis was performed using R statistic software (3.6.3). The principal summary measures were pooled prevalence and risk ratio (RR) with 95% confidential interval (CI). $\chi^2$ test and $I^2$ statistic were performed to evaluate the statical heterogeneity of the results in the included studies. We considered heterogeneity to be significant when the p value by $\chi^2$ test was <0.1 or the $I^2$ statistic was ≥50%. Random-effects model was adopted if there was evidence of heterogeneity; otherwise, fixed-effects model was used. The pooled prevalence was assessed using the Freeman-Tukey double arcsine method. DerSimonian and Laird method was used for the estimator of between-study variance. The funnel plots and Egger’s test were used to assess for publication bias. If publication bias existed ($p<0.1$), trim-and-fill analysis was performed to adjust publication bias and further evaluate the stability of the pooled results. A p value less than 0.05 was considered statistically significant.

3 RESULTS

3.1 Literature search and main characteristics of identified studies

The literature search identified 1743 records through database mining (Figure 1). After the removal of duplicate articles, 1326 records were screened. We further obtained 50 studies for eligibility. Of these, 31 were excluded for the following reasons: patients with suspected but not confirmed SARS-CoV-2 infection ($n=10$), review ($n=2$), and inaccessible outcomes ($n=19$). Finally, a total of 19 studies were included in the meta-analysis.

The main characteristics and clinical outcomes of the studies were shown in Table S2. In general, 4073 patients with COVID-19 and psoriasis were included, of which about 48.9% were men and 51.1% were women; most of the patients were over 45 years of age since the diagnosis of COVID-19 (Table S2). Fever and anemia were the most common presenting symptoms at time of hospital admission by using 5 studies where symptoms were recorded (Table S3). The most common comorbidities were hypertension and obesity (Table S4). Plaque psoriasis is the most common type in 6 reported studies (Table S5). The treatment types including systemic or biologic therapy were displayed in Table S6. All the studies reported at least 1 clinical outcomes (hospitalization and fatality rates) of patients with COVID-19 and psoriasis.

The quality of the cohort studies was assessed based on the NOS tool, which showed that 16 studies had high quality with score over
7, whereas one study were of moderate quality. The two case series studies were considered low quality (Table S7).

3.2 | Overall hospitalization and fatality rates

The meta-analysis of 16 studies with reported hospitalization rate as outcome indicated that the overall case hospitalization rate among patients with COVID-19 and psoriasis was 20.2% (95% CI: 12.7%-28.7%) (Figure 2A). The funnel plot and Egger’s test ($p = 0.05$) suggested the existence of publication bias in these studies (Figure S1A). After 5 studies were filled, the funnel plot showed the relative symmetry (Figure S1B), and Egger’s test showed no evidence of significant publication bias ($p = 0.74$). The overall hospitalization rate turned to be 10.9% (95% CI: 5.8%-18.1%). Besides, the sensitivity analysis performed by using the “leave-one-out” did not markedly change our results (Figure S1C). Neither of sensitivity analysis performed by excluding 2 case series studies demonstrated an obvious change in overall hospitalization rate in these patients with COVID-19 and psoriasis (23.6%, 95% CI: 15.2%-33.1%) (Figure S1D).

The meta-analysis of 15 studies with reported fatality rate as outcome indicated that the overall case fatality among patients with COVID-19 and psoriasis was 1.5% (95% CI: 0.4%-3.0%) (Figure 2B). The funnel plot and Egger’s test ($p = 0.09$) suggested the evidence of publication bias in these studies (Figure S2A). After 3 studies were added, the funnel plot showed the relative symmetry (Figure S2B), and Egger’s test showed no existence of significant publication bias ($p = 0.67$). The overall fatality rate turned as 0.7% (95% CI: 0%-2.0%). Moreover, the sensitivity analysis performed by using the “leave-one-out” did not markedly change our results except omitting Lima et al.’s study (Figure S2C). Neither of sensitivity analysis performed by excluding 2 case series studies demonstrated an obvious change in overall fatality rate in these patients with COVID-19 and psoriasis (1.8%, 95% CI: 0.6%-3.6%) (Figure S2D).
The meta-analysis of 11 studies with reported hospitalization rate as outcome indicated that the overall case hospitalization rate among patients with COVID-19 and psoriasis after systemic therapy was 18.0% (95% CI: 9.9%–27.6%) (Figure 3A). The funnel plot and Egger's test ($p = 0.32$) did not detect the existence of publication bias (Figure S3A). The sensitivity analysis performed by using the “leave-one-out” did not significantly change our results (Figure S3B). Moreover, there is no statistical difference in the hospitalization rate between patients receiving systemic treatment or other treatments ($RR = 0.89$, 95% CI: 0.61–1.31) (Figure S3C).

The meta-analysis of 10 studies with reported fatality rate as outcome indicated that the overall case fatality rate among patients with COVID-19 and psoriasis after systemic therapy was 0.7% (95% CI: 0%–2.0%) (Figure 3B). No evidence of publication bias was observed after Egger's test ($p = 0.57$) and funnel plot (Figure S4A). The sensitivity
analysis performed by using the “leave-one-out” did not significantly change our results (Figure S4B). No statistical difference was found in fatality rate between patients receiving systemic treatment or other treatments (RR = 0.40, 95% CI: 0.13–1.23) (Figure S3C).

3.4 Hospitalization and fatality rates after biologic therapy

The meta-analysis of 9 studies with reported fatality rate as outcome indicated that the overall case fatality rate among patients with COVID-19 and psoriasis after systemic therapy was 0.5% (95% CI: 0%–2.2%) (Figure 4B). No evidence of publication bias was observed after Egger’s test (p = 0.82) and funnel plot (Figure S6A). The sensitivity analysis performed by using the “leave-one-out” did not significantly change our results (Figure S6B). No statistical difference was found in fatality rate between patients receiving systemic treatment or other treatments (RR = 0.94, 95% CI: 0.29–3.05) (Figure S6C).

4 DISCUSSION

Psoriasis is a chronic inflammatory disease associated with comorbidities known to increase the risk of severe COVID-19.34 Therefore, concerns arise for the clinical characteristics and outcomes among patients with COVID-19 and psoriasis.

In the study, through combing data from 19 studies, we first summarized the clinical characteristics and illness outcomes in
patients with COVID-19 and psoriasis. Further, we found that the overall hospitalization rate is about 20.2%, and changed to be 18.0 or 14.1 after systemic or biologic treatment. In line with this finding, the overall fatality rate is 1.5%, and then turned to be 0.7 or 0.5 after systemic or biologic therapy. Notably, a lower hospitalization RR was found in patients receiving biologic therapy than those receiving other treatments. These results suggested that systemic, especially biologic therapy could lessen the clinical severity in patients with COVID-19 and psoriasis. Considering that hyperinflammation and cytokine storm play pivotal roles in driving the progression of COVID-19,\textsuperscript{35–37} there is biologic plausibility for a protective effect of systemic or biologic treatments on the illness severity.

Whether to treat COVID-19 patients with biologics has been a big debate. Previous studies showed that the use of biologics including tumor necrosis factor (TNF) inhibitor and interleukin-17 inhibitors was related to an increased risk of serious infection.\textsuperscript{38,39} However, several studies reported that TNF inhibitors could reduce the risk of COVID-19-associated hospitalization among patients with rheumatic disease and decrease the risk of hospitalization or fatality among IBD patients.\textsuperscript{40,41} Moreover, discontinuation of systematic and biologic therapy could result in psoriasis relapse and therapy resistance.\textsuperscript{42,43} It seems that our knowledge needs to progress in real time to meet the unprecedented challenges treating patients with COVID-19 and psoriasis. Here, we performed the first meta-analysis to date the risk of hospitalization and fatality in patients with COVID-19 and psoriasis after receiving systemic or biologic treatments. Our finding will help to guide current recommendations and provide a reference for clinical decision-making.

Admittedly, our study has several limitations. First, a number of demographic and clinical characteristics were lacking in included studies and could affect the prognosis evaluation. Second, notable heterogeneity or publication bias was seen in some comparisons, although sensitivity analysis, subgroup analysis and trim-and-fill analysis were used for meta-analysis. Third, comorbidities of psoriasis including hypertension, cardiovascular diseases and diabetes could impact our conclusions, and perspective clinical trials need to adjust for these confounders. Finally, it needs to be further clarified whether the conclusion is consistent among other countries, because the included studies were mainly from North America and Europe.

**FIGURE 4** The pooled hospitalization rate (A) and fatality rate (B) among patients with COVID-19 and psoriasis after biologic therapy. COVID-19, coronavirus disease 2019.
5 | CONCLUSION

In aggregate, our meta-analysis described the clinical characteristics and outcomes of patients with psoriasis and COVID-19. Besides, systemic therapy for psoriasis, especially biologics, might be associated with reduced risk of disease severity among these patients. Our study provides evidence that for psoriasis patients with COVID-19, systemic or biologic therapy should not be routinely withheld due to a fear of COVID-19 associated hospitalization and death.

AUTHOR CONTRIBUTIONS

Concept and design: Guangtong Deng, Xiang Chen, and Furong Zeng.
Acquisition and interpretation of data: Yu Meng and Furong Zeng.
Drafting of the manuscript: Furong Zeng and Yu Meng. Critical revision of the manuscript: Guangtong Deng, Xiang Chen, Huiyun Sun, and Yayun Li. Final approval: All authors.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

DATE AVAILABILITY STATEMENT

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

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