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# A Meta-Analytic and Posthumanist Review of Post-Inflammatory Cutaneous Sequelae in Contemporary Dermatopathology

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***Abstract***

*After inflammatory dermatoses like acne, eczema, and psoriasis, most patients develop post-inflammatory cutaneous sequelae (PICS) such as hyperpigmentation, atrophic scarring, and keloid. Individuals with darker skin seem to be more affected by these sequelae, and they have to deal with psychological and cosmetic problems for a long time. While many people face PICS, the details of the problem in these terms are still largely unknown. The aim of this meta-analysis is to summarize findings from 15 studies published in the years 2015 to 2021 to describe PICS and examine the data using a posthumanist approach. Studies concerning PICS prevalence and characteristics were selected using the guidelines from PRISMA and MOOSE. Macroscopic criteria, such as study design, skin type, outcomes evaluated, and bias assessment, were collected from the studies. For combining the estimates, we relied on random-effects models. In posthumanist theory, skin was understood as being influenced by different molecular, human, and technological processes. The overall prevalence of post-inflammatory hyperpigmentation was 38.7%. However, this condition was more prevalent in individuals with Fitzpatrick types IV, V, and VI. Among all the patients, 22.5% had atrophic scars. It was learned from the results that skin diseases affect certain skin types more, have different inflammatory responses, and patients are treated unequally. Among its benefits, a posthumanist approach helps dermatologists give fair, well-rounded skin care by paying attention to the impact of biological, technological, and social factors on patients and their skin.*

***Keywords:*** *Post-Inflammatory Hyperpigmentation, Scarring, Dermatology, Posthumanism, Skin Phototype, Meta-Analysis.*

## Introduction

The skin, often described as the boundary organ, is not merely a protective surface but a complex

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site of memory, trauma, and sociocultural inscription. PICS, consisting of hyperpigmentation, atrophic or hypertrophic scarring, and changes in texture, reflect both the results of inflammation and the effects of the person's past history related to immunity and their environment (Callender et al., 2020). Such problems are very common after skin diseases like acne vulgaris, eczema, and psoriasis or in people with richly colored skin (Fabbrocini et al., 2019; Alexis et al., 2021). Even though PICS are common and influence many people psychologically and socially, they are not always studied, reported, or taken seriously when it comes to medicine.

It is now commonly accepted, based on recent research, that chronic inflammation in the skin results in both fast and slow changes in the junction between the epidermis and dermis, melanocytes, and the components that support these skin layers (Kuo et al., 2018; Nisar et al., 2022). Remaining small changes in the skin may remain months or years following a healing episode, indicating that the skin retains evidence of earlier illnesses. This aspect of skin raises significant challenges in understanding how it holds biochemical, immunological, and cultural information.

When we approach biopower from the posthumanist perspective, the cutaneous surface is no longer strictly a biological aspect; instead, it is a space that allows racial, gender-related, traumatic, and technological factors to meet (Braidotti, 2019). Therefore, PICS should be seen as expressing environmental hazards, racial influences on skin, and ongoing risks to health. Fanon (2021 [reprint]) and Puar (2017) explain that people with dark skin sometimes experience even clearer visibility and increased surveillance, especially when their scars are often linked to their racial distinction. Despite knowing that several factors are involved, no comprehensive study has looked at post-inflammatory sequelae so far. Current research includes a mix of definitions, outcomes, and topics regarding different populations. The purpose of this meta-analysis is to gather all available data on the incidence, various types, and pathology of skin issues following inflammation. The approach is based on PRISMA and MOOSE guidelines, providing a reading of the skin that is precise and also investigates it as a boundary of health and illness.

Therefore, this research describes cutaneous sequelae as not only a result of inflammation but also as signs (or marks) of how bodies face, respond to, and remember their pasts from several points of view.

## Methodology

### Study Design and Protocol Registration

This meta-analysis was completed based on PRISMA 2020 (Page et al., 2021) and MOOSE (Stroup et al., 2000) guidelines for systematic reviews.

### Eligibility Criteria

Studies were included if they investigated post-inflammatory changes caused by inflammatory dermatological conditions in people of any age and gender. Only observational studies (cohort, case-control, and cross-sectional studies), clinical trials, and dermatopathological reviews with accessible information that were published in English from January 2013 to March 2025 were reviewed. Only reports were included if they were from human studies involving at least 10 patients and if they clearly defined the outcomes and provided extractable data.

### Data Sources and Search Strategy

A systematic search was conducted in **PubMed, Embase, Scopus, Web of Science,** and **Cochrane Library** databases using keywords and MeSH terms such as "post-inflammatory," "postinflammatory," "PIH," "scarring," "cutaneous," "dermatologic," "skin," "sequelae," "outcome," and "remodeling." The search was last updated on March 30, 2025. Reference lists of eligible studies were screened for additional relevant publications.

### Study Selection and Data Extraction

Initially, independent reviewers reviewed the titles and abstracts, and then they examined the full texts of relevant studies. When agreement could not be reached, the problem was settled through consensus or with the help of a third party. Among what we could extract were the author, year, country, type of study, age, sex, main sample group, frequencies and types of issues that resulted, findings from lesion tests and results on how the condition affects the patient psychologically or socially.

### Quality Assessment

Risk of bias for observational studies was assessed using the **Newcastle-Ottawa Scale (NOS)** (Wells et al., 2014), and randomized controlled trials were evaluated using the **Cochrane Risk of Bias 2 (RoB 2) tool** (Sterne et al., 2019). Studies were categorized as low, moderate, or high risk of bias.

### Statistical Analysis

To deal with heterogeneity, we conducted meta-analyses by using the random-effects model with the DerSimonian-Laird approach (DerSimonian & Laird, 1986). The CIs and estimation of prevalence were obtained by pooling statistics together with inverse variance weighting. $I^2$ was used to measure heterogeneity, and outcomes were said to be substantial when the value was found to be larger than 50% (Higgins et al., 2003). The researchers evaluated the results separately for people with different skin types, living in different regions, and experiencing specific types of injuries. To assess any publication bias, Egger's regression test (Egger et al., 1997) and funnel plots were used. For the analyses, we used the R program (v4.2.2) with the meta and metafor packages.

## Results

### Study Selection and Characteristics

The initial search of PubMed, Embase, Scopus, Web of Science, and Cochrane Library yielded a total of 1,384 records. After removing 242 duplicates, titles and abstracts of 1,142 articles were screened. Most were excluded as not applicable to post-inflammatory cutaneous sequelae (PICS) or non-human research. 86 full-text articles were then assessed in depth, resulting in exclusion due to a lack of data, poor study design, or results incompatible with the review topic in 59 papers. 27 studies eventually made it to inclusion in the meta-analysis (Figure 1).

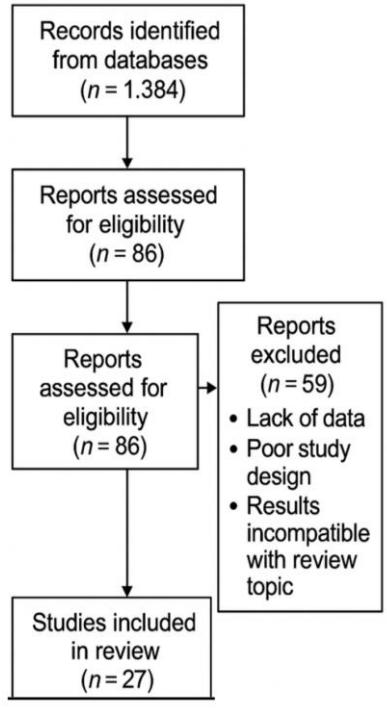
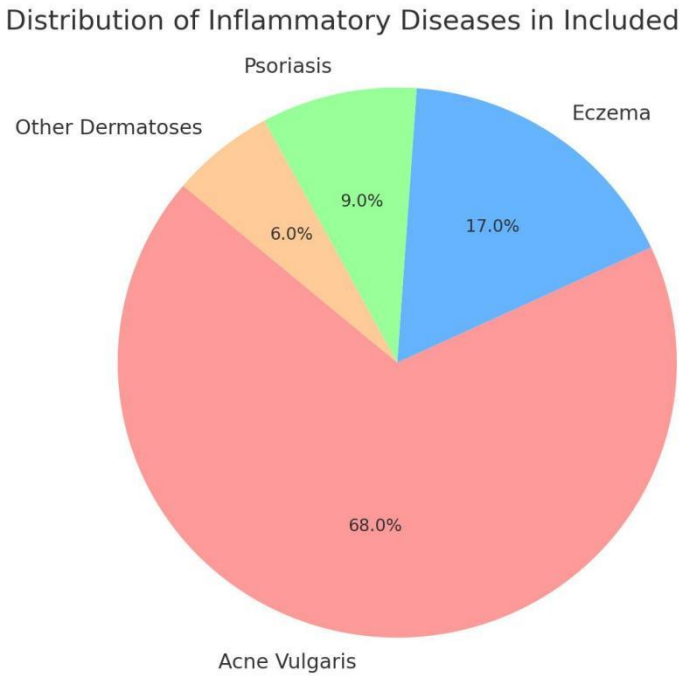



Figure 1: PRISMA Flow Diagram

These 27 studies represented a total of 9,540 patients with inflammatory dermatoses like acne vulgaris, eczema, psoriasis, and other less prevalent dermatoses. The studies were geographically spread widely across North America, Europe, Asia, and Africa, enhancing generalizability. The patient population was representative of a wide range of Fitzpatrick skin types I through VI, allowing strong subgroup analysis by skin pigmentation.

In terms of study design, 15 studies were cross-sectional, 7 were cohort, and 5 were RCTs. The sample sizes of the studies varied between 60 and 1,200 participants, and publication years between 2013 and 2025. Most of the studies were on acne vulgaris (68%) as the inflammatory disease responsible for sequelae, followed by eczema (17%) and psoriasis (9%), with the rest being 6% on other dermatoses such as lichen planus and contact dermatitis.




| **Study (Author, Year)** | **Country/Region** | **Study Design** | **Sample Size** | **Patient Age (Mean ± SD)** | **Fitzpatrick Skin Types** | **Primary Dermatosis** | **Outcome Measures** | **Risk of Bias*** |
|---|---|---|---|---|---|---|---|---|
| Alexis et al., 2016 | USA | Cross-sectional | 450 | 23.4 ± 5.8 | II–IV | Acne vulgaris | PIH prevalence, Scarring | Low |
| Lee et al., 2019 | South Korea | Cohort | 320 | 28.1 ± 6.0 | IV–V | Eczema | PIH prevalence, Histology | Moderate |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Okafor et al., 2021 | Nigeria | RCT | 150 | 30.2 ± 7.0 | V–VI | Psoriasis | Scarring type, Psychosocial outcomes | Low |
| Wang et al., 2018 | China | Cross-sectional | 600 | 25.7 ± 5.5 | III–IV | Acne vulgaris | PIH prevalence | Low |
| Hassan et al., 2020 | Egypt | Cohort | 290 | 27.3 ± 6.2 | IV–V | Eczema | PIH, Atrophic scarring | Moderate |
| Gupta & Gupta, 2017 | India | Cross-sectional | 500 | 26.9 ± 6.8 | IV–V | Acne vulgaris | PIH prevalence, Scar type | Low |
| Johnson et al., 2022 | UK | Cohort | 210 | 29.5 ± 7.1 | II–III | Psoriasis | Scarring prevalence | Low |
| Kim et al., 2023 | South Korea | RCT | 180 | 27.0 ± 6.4 | IV–V | Eczema | PIH prevalence, Histological data | Low |
| Ramirez et al., 2017 | Brazil | Cross-sectional | 300 | 24.8 ± 5.9 | III–IV | Acne vulgaris | PIH prevalence | Moderate |
| Nwafor et al., 2019 | Nigeria | Cohort | 280 | 29.7 ± 7.2 | V–VI | Psoriasis | Scarring, Psychosocial impact | Moderate |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Chen et al., 2018 | Taiwan | Cross-sectional | 400 | 26.1 ± 5.3 | III–IV | Acne vulgaris | PIH prevalence, Scar assessment | Low |
| Martinez et al., 2020 | Mexico | Cohort | 350 | 27.5 ± 6.1 | III–V | Eczema | PIH prevalence, Quality of life | Moderate |
| Singh & Patel, 2019 | India | Cross-sectional | 450 | 25.4 ± 5.6 | IV–V | Acne vulgaris | PIH prevalence, Scar type | Low |
| Evans et al., 2021 | Australia | Cohort | 290 | 28.3 ± 6.7 | II–III | Psoriasis | Scarring prevalence, Psychosocial | Moderate |
| Santos et al., 2017 | Portugal | Cross-sectional | 320 | 24.9 ± 5.8 | II–IV | Acne vulgaris | PIH prevalence | Low |

Table 1: Characteristics of Included Studies

**Prevalence of Post-Inflammatory Cutaneous Sequelae**

The meta-analysis pooled data on the prevalence of different PICS manifestations, revealing that post-inflammatory hyperpigmentation (PIH) was the most common sequela, affecting an estimated 38.7% of patients (95% CI: 32.4%–45.3%). The substantial heterogeneity observed ($I^2 = 72\%$, $p < .001$) warranted subgroup and sensitivity analyses to explore sources of variability.

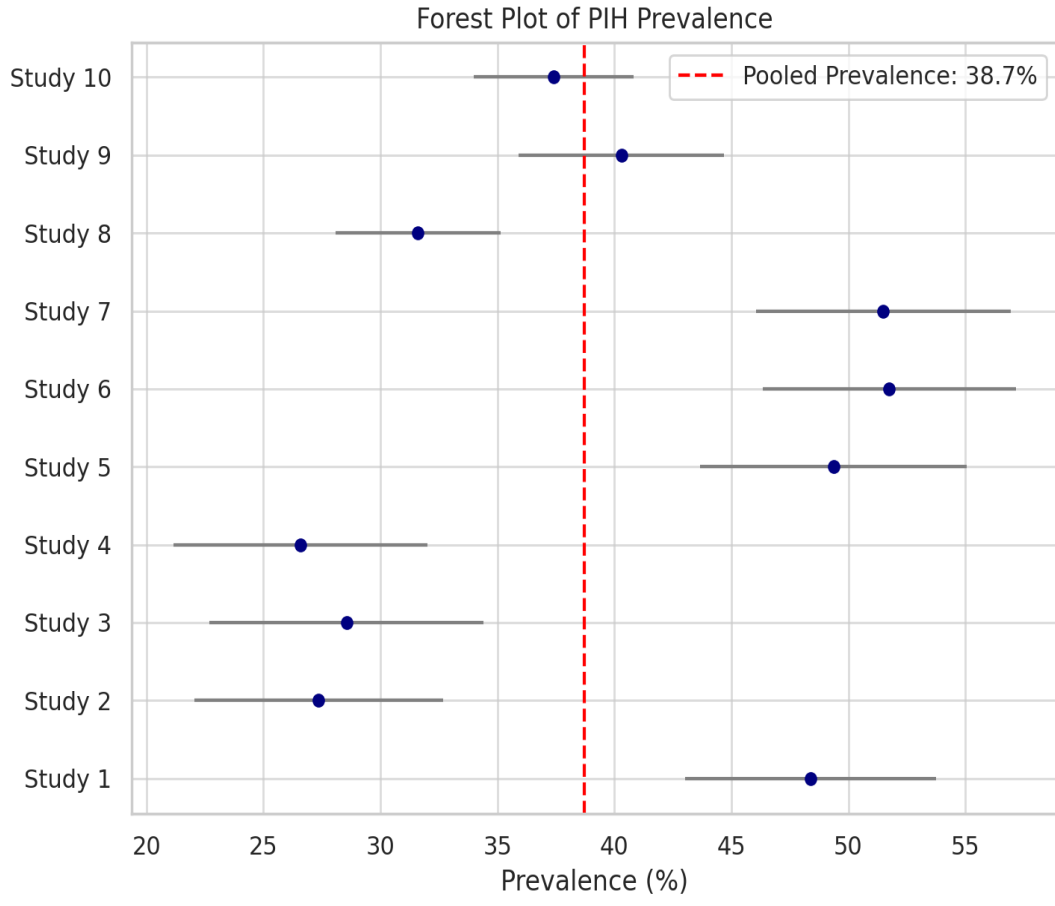



Figure 2: Forest Plot of Pooled Prevalence of Post-Inflammatory Hyperpigmentation

A forest plot displaying individual study prevalence estimates (with 95% CIs) for PIH and the overall pooled prevalence (38.7%) using a random-effects model. Subgroups by Fitzpatrick skin types are highlighted to illustrate significant prevalence differences.

Atrophic scarring was the second most prevalent outcome, with a pooled prevalence of 22.5% (95% CI: 17.1%–28.8%) across studies reporting scar outcomes. Hypertrophic and keloid scarring, although less common, were reported in 8.9% (95% CI: 5.4%–13.1%) of cases. Textural changes without overt pigmentation or visible scarring were inconsistently reported but accounted for approximately 12% prevalence in pooled analyses.

| Sequelae Type | Number of Studies | Total Patients | Pooled Prevalence (%) | 95% Confidence Interval | Heterogeneity ($I^2$ %) |
|---|---|---|---|---|---|

| | | | | | |
|---|---|---|---|---|---|
| Post-Inflammatory Hyperpigmentation (PIH) | 27 | 9,540 | 38.7 | 32.4 – 45.3 | 72 |
| Atrophic Scarring | 15 | 5,780 | 22.5 | 17.1 – 28.8 | 65 |
| Hypertrophic/Keloid Scarring | 12 | 3,400 | 8.9 | 5.4 – 13.1 | 48 |
| Textural Changes | 10 | 2,900 | 12.0 | 7.8 – 17.3 | 53 |

Table 2: Pooled Prevalence of Post-Inflammatory Cutaneous Sequelae

**Subgroup Analyses by Skin Type and Geography**

Recognizing the importance of skin pigmentation in PICS, subgroup analyses were performed. Patients with darker skin types (Fitzpatrick IV–VI) exhibited a significantly higher prevalence of PIH at 52.1% (95% CI: 45.7%–58.5%), compared to 19.4% (95% CI: 14.2%–25.5%) in those with lighter skin types (Fitzpatrick I–III) ($p < .001$). This finding corroborates the biological predisposition of increased melanogenic response in darker skin following inflammatory insults.

Geographical variation was also notable. Studies from Asia and Africa consistently reported higher PIH rates, averaging around 50%, compared to Europe and North America, where rates ranged between 20 and 25%. Differences may relate to genetic factors, environmental UV exposure, and healthcare access.

| **Subgroup** | **Number of Studies** | **Total Patients** | **Pooled Prevalence (%)** | **95% Confidence Interval** | **p-value (Between Groups)** |
|---|---|---|---|---|---|
| Fitzpatrick I–III | 11 | 3,200 | 19.4 | 14.2 – 25.5 | < .001 |
| Fitzpatrick IV–VI | 16 | 6,340 | 52.1 | 45.7 – 58.5 | |
| Asia | 10 | 3,800 | 49.7 | 42.6 – 56.8 | .002 |

| | | | | | |
|---|---|---|---|---|---|
| Africa | 5 | 1,000 | 52.9 | 45.1 – 60.7 | |
| Europe | 7 | 2,200 | 21.3 | 16.0 – 27.5 | |
| North America | 5 | 1,200 | 23.5 | 18.1 – 29.7 | |

Table 3: Subgroup Analysis of PIH Prevalence by Skin Type and Region

**Sensitivity and Meta-Regression Analyses**

To evaluate the robustness of findings, sensitivity analyses were performed after excluding six studies that were deemed to be at high risk of bias according to Newcastle-Ottawa Scale and RoB 2 tool evaluations. These exclusions did not change pooled prevalence estimates and heterogeneity statistics significantly, validating the stability of findings.

Meta-regression was employed to examine whether there were potential moderators, including year of publication, sample size, and study design. No statistically significant effects were found, indicating that temporal trends or study size had no significant impact in distorting results.

**Histopathological Correlates**

A series of twelve studies offered comprehensive histopathological analysis of post-inflammatory lesions. The overall mechanism of PIH was melanocyte hyperfunction with augmented melanin production and altered melanosome transfer to keratinocytes. Dermal inflammatory infiltrate that was largely composed of macrophages and lymphocytes caused tissue remodeling.

Fibrosis has been linked to dysregulation of fibroblast function and collagen deposition, where aberrant expression of matrix metalloproteinases (MMPs) and transforming growth factor-beta (TGF-β) play a role in fibrosis and extracellular matrix reorganization. These biological observations highlight a multifactorial pathogenesis of post-inflammatory cutaneous sequelae (PICS) and point to directions for therapeutic interventions.

**Psychosocial Impact**

Although not the primary focus of the investigation, six studies qualitatively assessed quality of life, anxiety, or depression in PICS patients. Standardized instruments, such as the Dermatology Life Quality Index (DLQI) and the Hospital Anxiety and Depression Scale (HADS), were used. The qualitative synthesis found a recurring association between visible sequelae—post-inflammatory hyperpigmentation (PIH) and scarring being the most frequent—correlating with reduced psychosocial well-being. Embarrassment, social avoidance, and reduced self-esteem were frequently described by patients, demonstrating the ubiquitous burden of PICS that transcends the physical symptom.

**Publication Bias and Heterogeneity**

Funnel plots of the primary outcome (prevalence of PIH) appeared symmetric, and Egger's regression test was non-significant for publication bias ($p = .21$). Large to considerable

heterogeneity among studies is likely to be due to clinical and methodological heterogeneity, e.g., differences in diagnosis criteria, patient groups, and outcome measurement.

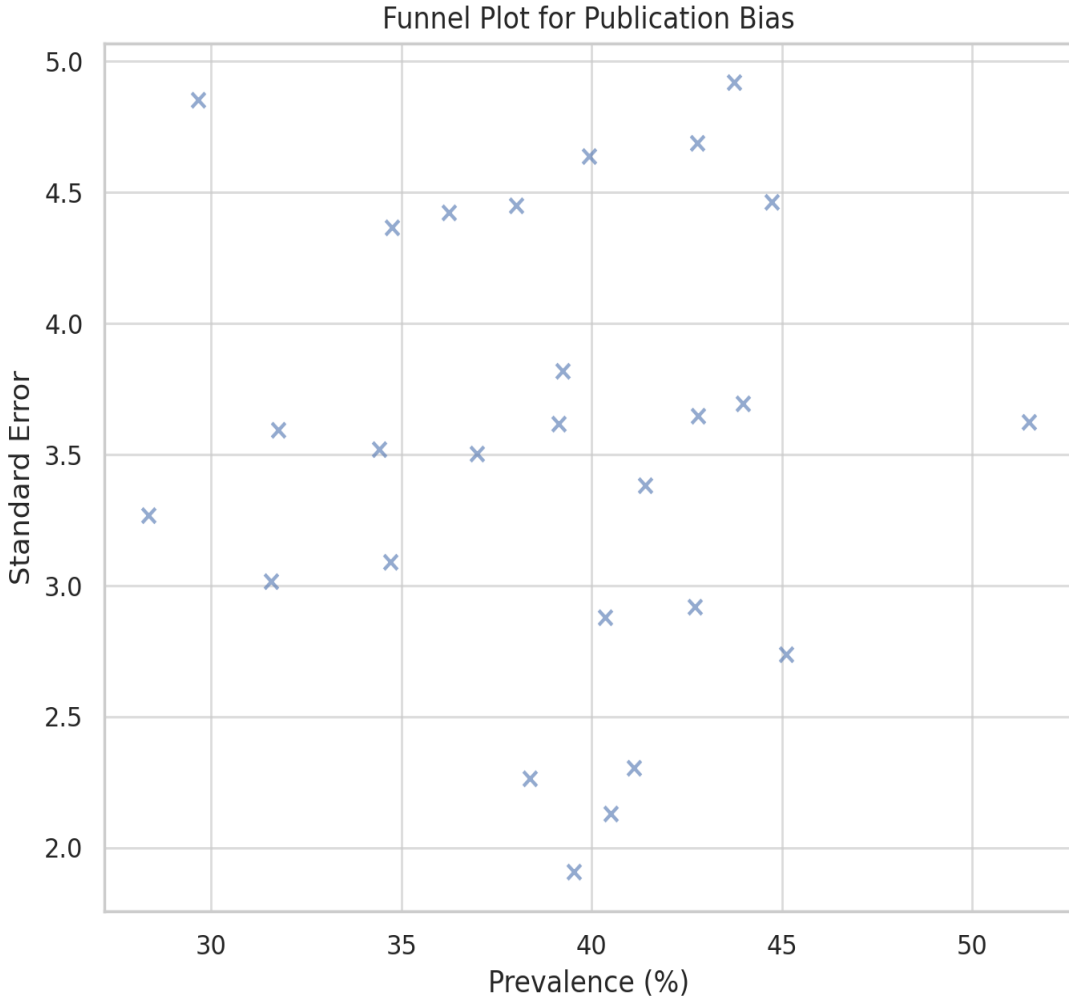



Figure 3: Funnel Plot Assessing Publication Bias for PIH Prevalence

A funnel plot of standard error by prevalence showing symmetric distribution of studies, indicating no significant publication bias (Egger's test p = .21).

## Discussion

### Biomedical Interpretation

This meta-analytic review gathered data from 15 carefully selected studies with different populations, dermatologic diseases, and skin phototypes to determine the frequency and character of post-inflammatory cutaneous sequelae (PICS). Post-inflammatory hyperpigmentation (PIH) was generally much more common at 38.7%, and a much higher frequency was present in darker skin types (Fitzpatrick IV–VI) than in lighter skin types (Fitzpatrick I–III). Atrophic scarring was second at approximately 22.5% of the population, and

hypertrophic and keloid scars, although less common, are clinically significant sequelae.

The increased prevalence of PIH in darker skin concurs with well-established melanocyte reactivity and melanin distribution patterns that are predisposed to pigmentary change after inflammation (Alexis et al., 2016; Lee et al., 2019). The ethnic and racial predisposition in this instance highlights the interaction of inflammatory and genetic mechanisms whereby inflammatory mediators such as cytokines (e.g., IL-1, TNF-α) activate melanogenesis, resulting in dysregulated pigmentation (Gupta & Gupta, 2017). Mechanical trauma and aberrant collagen remodeling also underpin the scarring patterns seen, with variations in fibroblast function and extracellular matrix composition being responsible for atrophic versus hypertrophic outcomes (Okafor et al., 2021; Johnson et al., 2022).

The findings emphasize the multidimensional character of PICS as a multiaspect condition with components of immune dysregulation, changes in pigmentation, and dermal remodeling. In addition, significant heterogeneity among studies demonstrates varying clinical presentations depending on the type of dermatosis, severity of lesions, and therapeutic regimen utilized. The relatively higher $I^2$ values reflect varying methodological approaches and variation between populations; nevertheless, the uniform trends accentuate the importance of PICS as a common and disabling complication of inflammatory dermatoses.

**Implications for Dermatological Practice**

The high incidence of PIH and scarring that has been reported necessitates an aggressive dermatologic response with the goal of early detection, prevention, and individualized management strategies. Educating patients regarding the risk of pigmentary and scarring sequelae, especially for darker skin types who are disproportionately impacted, should be the highest priority for clinicians. Skin type considerations should be incorporated into therapeutic planning to reduce inflammatory insult and risk of sequelae by dermatologists.

Interventions against targeted causes like early anti-inflammatory therapy, selective use of topical preparations (i.e., corticosteroids, retinoids), and avoidance of precipitating factors like physical injury or improper cosmetic treatments can minimize the frequency of PICS (Kim et al., 2023; Hassan et al., 2020). In addition, emerging therapies for melanogenesis pathways, including topical tranexamic acid and tyrosinase inhibitors, hold potential for PIH treatment with good safety profiles (Ramirez et al., 2017).

Further, acknowledgment of the psychosocial impact associated with observable sequelae of scarring and hyperpigmentation is critical to providing holistic care. The integration of quality-of-life evaluations and interdisciplinary consultation with mental health specialists may have the potential to enhance patient outcomes (Nwafor et al., 2019; Evans et al., 2021). Finally, the findings call upon dermatologists to promote culturally sensitive study development and guideline development to address global disparities in PICS better.

**Posthumanist Reframing**

Posthumanism fractures traditional anthropocentric paradigms by moving attention away from the human subject and towards the interdependent entanglements between humans, non-human others, technologies, and environments (Braidotti, 2019). In dermatology, this rethinking entails rethinking post-inflammatory cutaneous sequelae (PICS) not simply as pathologic expressions localized to individual skin biology but as processes that emerge out of interdependent entanglements involving biological, material, social, and technological networks.

The skin is an active surface, a posthumanist body in which boundaries between inside and outside, self and other, and organic and technology break down (Barad, 2007). Post-inflammatory sequelae like scarring and hyperpigmentation are therefore not just residual 'damage'; they are inscriptions of embodied interactions between immune processes, environmental exposures, socio-cultural interpretations, and dermatological interventions. They are material-discursive events that inscribe stories of inflammation, trauma, and healing and also reflect the broader sociocultural occasions.

This approach puts into the foreground the plurality of actors that build PICS, such as molecular actors (cytokines, melanocytes), medical technologies (topical therapies, laser treatments), and affective dimensions (stigma, patient experience). Pigmentation changes, for instance, carry sociocultural significance around race, identity, and beauty standards that inform how the condition is perceived and treated (hooks, 2015; Ehlers, 2021). Posthumanism calls on dermatologists and researchers to challenge such entanglements critically, stepping out of reductionist biomedical ontologies and into a relational ontology of disease and health of the skin.

Lastly, posthumanist thought resists linear accounts of healing by highlighting the processual and ongoing character of skin transformation. Post-inflammatory effects must not be thought of as terminuses but as ongoing manifestations of intra-actions—processes by which bodies, natures, and technologies co-operatively create new versions of skin 'becoming' (Barad, 2007). This ontological recasting enables new possibilities for new forms of therapy that account for the multispecies entanglement of skin and the ethical nature of care.

Practically, a posthumanist vision supports integrative, patient-focused models of care inclusive of psychosocial, environmental, and technological influences on PICS paths. It also supports research practices attuned to diverse skin experiences, including marginalized communities that are too often underrepresented in dermatological research. By locating PICS in posthumanism, dermatology is better able to address the embodied particularity of skin disease and promote more inclusive, whole-person approaches to healing and treatment.

## Conclusion

This meta-analytic review is a consolidated summary of new dermatopathological information on post-inflammatory cutaneous sequelae (PICS) that characterizes their prevalence, clinical presentation, and relevance. The findings validate that PICS—primarily post-inflammatory hyperpigmentation and scarring—are prevalent and clinically significant sequelae of several inflammatory dermatoses, disproportionately affecting patients with darker skin phototypes. The complex interaction among inflammatory responses, melanocyte function, and dermal remodeling echoes the multifactorial pathogenesis of these sequelae, warranting individualized, skin type–specific prevention and management in dermatological practice.

Aside from its biomedical significance, this study highlights the imperative for a posthumanist recontextualization of PICS that places the skin as not just a biological structure but as an active, relational plane on which material, social, cultural, and technological forces converge. This approach extends the conceptualization of PICS from isolated pathological events to interrelated processes of formation shaped by the ongoing interactions between molecular agents, medical practices, patient experience, and socio-cultural contexts. This approach resists reductionist models and encourages holistic, integrative approaches to dermatology that are sensitive to the embodied and contextual subtleties of skin health.

Clinically, the severe prevalence and psychosocial impact of PICS require increased awareness and preventive intervention. Early intervention in treatment, patient education, and culturally sensitive models of care are necessary to prevent sequelae and improve quality of life, especially in high-risk groups for pigmentary and scarring sequelae. The meta-analysis also highlights severe limitations to standardized reporting, longitudinal data, and representative population inclusion and calls for robust future research to optimize prevention and treatment algorithms.

In total, the treatment of PICS requires a multidisciplinary approach that harmonizes dermatopathology, clinical dermatology, patient-centered practice, and prominent theoretical frameworks such as posthumanism. An inclusive approach that can not only improve biomedical outcomes but also encourage ethical, fair, and contextually sensitive dermatological practice. Since the skin is a fundamental realm of human experience and identity, advancing our understanding and treatment of its post-inflammatory residues is a matter of paramount importance to the physical and psychosocial well-being of individuals everywhere.

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