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A decade of subcutaneous mycoses in Indonesia: A systematic review

Mutiara Luthfi Ardiyanti [1], Evy Ervianti [2,*] and Priyo Budi Purwono [3]

[1] *Medical Programme, Faculty of Medicine, Universitas Airlangga, Surabaya, Indonesia.*
[2] *Department of Dermatology and Venereology, Dr. Soetomo General Academic Hospital/Faculty of Medicine, Universitas Airlangga, Surabaya, Indonesia.*
[3] *Department of Clinical Microbiology, Dr. Soetomo General Academic Hospital/Faculty of Medicine, Universitas Airlangga, Surabaya, Indonesia.*

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Abstract

Background: Subcutaneous mycoses are chronic fungal infections that commonly affect populations in tropical regions. Indonesia, with its humid climate and large agricultural workforce, is endemic for several subcutaneous mycoses; however, national data remain fragmented and largely derived from isolated case-based reports. A consolidated synthesis is needed to better understand their clinical patterns, diagnostic challenges, and treatment outcomes.

Methods: A systematic search was performed using PubMed, Google Scholar, GARUDA, and institutional repositories for studies published from 2013 to 2025. Eligible studies included retrospective case series and case reports with clinically or histopathologically confirmed subcutaneous mycoses in Indonesia. Extracted data included demographic characteristics, clinical presentations, diagnostic methods, etiological agents, and treatment outcomes. Study selection followed PRISMA guidelines.

Results: Seventeen publications from several Indonesian provinces were identified. Chromoblastomycosis was the most frequently reported infection, followed by eumycetoma, phaeohyphomycosis, and basidiobolomycosis. Clinical presentations were typically chronic. Chromoblastomycosis often manifested as verrucous or nodular lesions, while eumycetoma showed swelling, sinus tracts, and grains. Histopathology was the main diagnostic modality and consistently demonstrated muriform bodies or fungal grains. Culture was less frequently performed and yielded growth in few cases, with *Fonsecaea pedrosoi* being the predominant identified species. Itraconazole was the most commonly used antifungal and produced favorable responses, though improvement varied with lesion duration.

Conclusion: Subcutaneous mycoses in Indonesia remain underdiagnosed and often identified at late stages. Enhanced early detection, improved diagnostic access, and broader availability of antifungal therapy are essential to reduce morbidity.

Keywords: Subcutaneous Mycoses; Chromoblastomycosis; Mycetoma; Indonesia

1. Introduction

Subcutaneous mycoses are chronic, progressive fungal infections of the skin and subcutaneous tissues caused primarily by melanized ("dematiaceous") fungi and traumatic inoculation of environmental organisms [1,2]. These infections, including diseases such as chromoblastomycosis, eumycetoma and phaeohyphomycosis, occur predominantly in tropical and subtropical regions where humid climate, soil exposure and agricultural work converge [2–4]. The Chromoblastomycosis in particular is recognized as a neglected tropical disease (NTD), affecting impoverished rural

* Corresponding author: Evy Ervianti

populations and causing significant morbidity due to late presentation, scarring, functional impairment, and potential malignant transformation [5].

Indonesia, with its extensive rural and agricultural communities exposed to soil and vegetation trauma, provides ideal ecological conditions for implantation mycoses [6]. However, national epidemiologic data are fragmented and largely limited to small case series and isolated reports. This paucity of comprehensive data contrasts with the global literature where the burden of chromoblastomycosis and related subcutaneous mycoses remains under-estimated [1,3,5]. Moreover, diagnostic and therapeutic capabilities in many Indonesian settings remain constrained, contributing to delayed diagnosis and suboptimal outcomes [7].

Given these gaps, a systematic synthesis of available Indonesian studies is essential to clarify the spectrum of clinical presentations, highlight diagnostic and therapeutic challenges, and inform policy and clinical practice. The objective of this review is to collate all published data from Indonesia between 2013 and 2025 on subcutaneous mycoses, describe their epidemiology, clinical and microbiological features, diagnostic approach, treatment patterns and outcomes, and identify priorities for improving care and reducing disease burden in endemic settings.

2. Material and methods

2.1. Study Design

This study is a systematic review synthesizing published case reports and case series of subcutaneous mycoses in Indonesia over the last decade. The review followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines to ensure methodological transparency and reproducibility.

2.2. Search Strategy

A literature search was performed in PubMed, Google Scholar, GARUDA (Garba Rujukan Digital), and institutional repositories. The search covered publications from January 2015 to November 2025. The following keywords were used in various combinations: *"subcutaneous mycoses," "chromoblastomycosis," "mycetoma," "phaeohyphomycosis," "sporotrichosis," "deep fungal infection,"* and *"Indonesia."* Reference lists of included articles were reviewed to identify additional publications.

2.3. Eligibility Criteria

Studies were eligible for inclusion if they were conducted in Indonesia, involved human subjects with any form of subcutaneous mycosis, and provided clinical, diagnostic, or therapeutic information. Only original articles published within the last decade (approximately 2015 to 2025) were included, encompassing case reports, case series, and retrospective observational studies. Publications were excluded if they consisted of reviews, editorials, conference abstracts without patient-level data, non-human studies, or articles published before this time period.

2.4. Study Selection

Titles and abstracts were screened for relevance, followed by full-text assessment based on the eligibility criteria. Seventeen studies met the inclusion criteria and were included in the final analysis. The selection process followed PRISMA guidelines.

2.5. Data Extraction

Data extracted from each study included: study location, study design, number of patients, type of subcutaneous mycosis, clinical characteristics, diagnostic methods, treatments used, and reported outcomes. Extraction was performed manually and cross-checked for accuracy.

2.6. Data Synthesis

Data extracted from each study were synthesized using a descriptive, narrative approach. Given the heterogeneity in study design, sample size, diagnostic work-up, and reporting detail, quantitative pooling was not feasible. Extracted variables were organized into predefined domains, including geographic origin, clinical manifestations, diagnostic modalities, fungal species, and therapeutic interventions. Patterns within each domain were compared across studies to identify areas of convergence and variation. Findings were integrated narratively to outline the overall clinical and

diagnostic landscape of subcutaneous mycoses in Indonesia. No meta-analysis or formal statistical aggregation was undertaken due to the case-based nature of the included evidence.

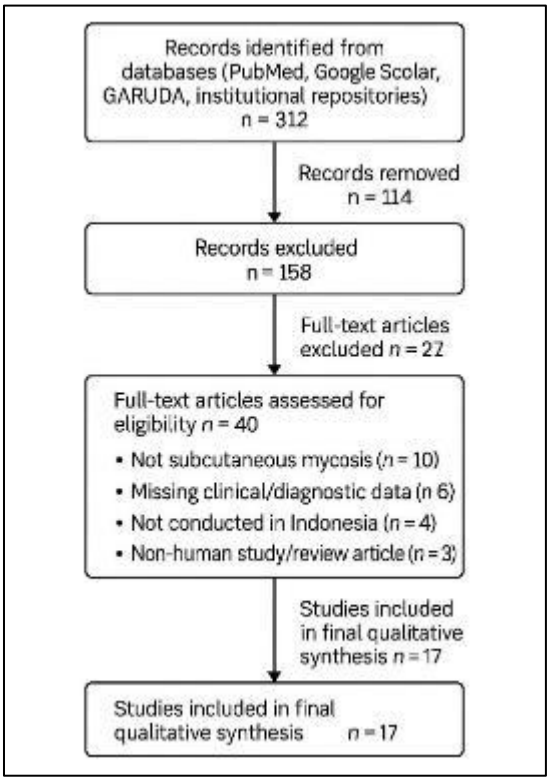

Figure 1 PRISMA Flow Chart

3. Results and discussion

Seventeen eligible studies from various Indonesian regions were included, representing a range of study designs and settings and providing an overview of the current evidence on subcutaneous mycoses in the country.

Table 1 Characteristics of Included Studies

Study (Author, Year)	Region	Study Design	Sample Size	Disease Type(s)
Mulianto et al., 2025	Central Java	Retrospective	12	Chromoblastomycosis, eumycetoma, sporotrichosis
Pramita et al., 2024	Bali	Retrospective	21	Chromoblastomycosis, actinomyetoma, sporotrichosis, lobomycosis
Siregar et al., 2025	East Nusa Tenggara	Case series	8	Chromoblastomycosis
Khairani et al., 2021	South Sumatra	Case report	1	Chromoblastomycosis
Ariani et al., 2023	West Sumatra	Case report	5	Chromoblastomycosis
Horo et al., 2022	Bali	Case report	1	Chromoblastomycosis
Handayani et al., 2023	Aceh	Case report	1	Chromoblastomycosis
Dharmawan et al., 2021	Central Java	Case report	1	Chromoblastomycosis
Indranarum et al., 2023	East Java	Case report	1	Chromoblastomycosis

Earlia et al., 2024	Aceh	Case report	1	Chromoblastomycosis
Septiafni et al., 2022	South Sumatra	Case report	1	Chromoblastomycosis
Hidayah et al., 2025	West Java	Case report	1	Chromoblastomycosis
Hutabarat et al., 2022	South Sulawesi	Case report	1	Eumycetoma
Fran et al., 2021	Riau	Case report	1	Eumycetoma
Ahmad et al., 2019	East Java	Case report	1	Phaeohyphomycosis
Pramitha et al., 2021	East Java	Case report	1	Basidiobolomycosis
Christi et al., 2023	East Java	Case report	1	Basidiobolomycosis

The extracted variables from all studies demonstrate considerable variation in clinical severity, diagnostic completeness, and treatment access, reflecting disparities in healthcare resources among regions. These differences form the basis of the thematic synthesis below.

Table 2 Clinical, Diagnostic, and Treatment Findings

Study (Author, Year)	**Clinical Features**	**Histopathology Findings**	**Identified Organism(s)**	**Treatment and Outcomes**
Mulianto et al., 2025	Erythematous nodules, ulceration; black dots; seropurulent discharge	Muriform bodies; grains; granuloma	-	Itraconazole; improved
Pramita et al., 2024	Erythematous nodules; verrucous plaques	-	-	-
Siregar et al., 2025	Verrucous, nodules, plaque; ulcers	-	-	Ketoconazole; partial improvement; 1 case progressed to SCC*
Khairani et al., 2021	Erythematous plaques and cauliflower-like tumor	Muriform bodies; granuloma	-	Itraconazole; partial clinical improvement
Ariani et al., 2023	Verrucous or cauliflower-like plaques	Muriform bodies; granuloma	*Fonsecaea pedrosoi*	Itraconazole; improved
Horo et al., 2022	Erythematous nodule with fluctuance	Muriform bodies; granuloma	*Cladophialophora carrionii*	Itraconazole; improved
Handayani et al., 2023	Verrucous plaque with black dots	Muriform bodies; granuloma	-	Itraconazole; improved
Dharmawan et al., 2021	Verrucous, nodules	Muriform bodies; granuloma	*Fonsecaea pedrosoi*	Itraconazole with surgery and cryotherapy; improved
Indranarum et al., 2023	Erythematous plaques, verrucous	Muriform bodies; granuloma	-	Itraconazole with adjuvant thermotherapy and CO_2 laser; improved
Earlia et al., 2024	Verrucous plaques, papules, nodules, some erosion and crusts	Muriform bodies; granuloma	-	Itraconazole; improved

Septiafni et al., 2022	Papule-plaque verrucose	Muriform bodies; granuloma	-	Itraconazole; improved
Hidayah et al., 2025	Verrucous plaque	Muriform bodies; granuloma	*Fonsecaea* spp.	Itraconazole with heat therapy; improved
Hutabarat et al., 2022	Nodules surrounded by ulcers and pustules with crust	Granuloma; grains	*Madurella mycetomatis*	Itraconazole; complete resolution
Fran et al., 2021	Hypertrophic scars, atrophic scars, nodules, and erythematous papules	Suppurative granuloma; grains	-	Fluconazole; died due to diabetes-related complications
Ahmad et al., 2019	Firm-to-soft, cystic swellings	Granuloma	*Exophiala dermatitidis*	Itraconazole; improved
Pramitha et al., 2021	Nodules and swelling	Splendore-Hoeppli	*Basidibolus ranarum*	Itraconazole; complete resolution
Christi et al., 2023	Nodules and swelling	Splendore-Hoeppli	*Basidibolus ranarum*	Itraconazole; complete resolution

*SCC = Squamous Cell Carcinoma

3.1. Epidemiological and Study Characteristics

Seventeen studies from various Indonesian regions met the inclusion criteria, representing diverse designs and healthcare settings and collectively providing the clearest picture to date of subcutaneous mycoses reported nationally [8-24]. Most publications originated from Java, Bali, and Sumatra, a pattern that likely reflects the distribution of dermatology referral centers and pathology laboratories rather than true regional differences in disease occurrence. Similar geographic biases have been noted globally, where reporting density often mirrors diagnostic capacity more than actual epidemiology [1,5,23,24].

Nearly all included publications were case reports, with only a few small retrospective series. This predominance tends to highlight severe, atypical, or diagnostically challenging presentations, a bias also observed in international chromoblastomycosis and mycetoma literature [25,26]. Within the Indonesian dataset, chromoblastomycosis was the most frequently documented condition, followed by eumycetoma, phaeohyphomycosis, and basidiobolomycosis. This distribution aligns with global observations that implantation mycoses are strongly shaped by environmental exposure, delayed presentation, and uneven diagnostic access rather than true pathogen prevalence [5,27].

3.2. Clinical Presentation Across Diseases

Chronicity was a defining feature across the included reports. Many chromoblastomycosis lesions had progressed for years—sometimes exceeding a decade—before a diagnosis was established, echoing delays described in Latin America, South Asia, and Madagascar [25,27]. Clinically, chromoblastomycosis presented with verrucous plaques, nodules, or cauliflower-like growths, often accompanied by black dots or crusting, consistent with established global descriptions [5,25]. Misdiagnosis at early stages was common, with several cases initially treated as tuberculosis verrucosa cutis, eczema, or cutaneous neoplasms.

Eumycetoma cases displayed the classical triad of swelling, sinus tracts, and grains, paralleling presentations in Sudan, Mexico, and India [26]. Phaeohyphomycosis manifested as cystic swellings, whereas basidiobolomycosis showed indurated or edematous soft-tissue swelling, comparable to reports from tropical Africa and the Middle East (30). One fatal case occurred due to complications of uncontrolled diabetes mellitus rather than the fungal infection itself, underscoring the impact of comorbidities on disease trajectory.

3.3. Diagnostic Pattern and Histopathology

Histopathology was consistently the primary diagnostic tool, reinforcing its essential role in regions where culture facilities remain limited. Muriform bodies in chromoblastomycosis were reliably detected and remain pathognomonic, aligning with contemporary international consensus [25,29]. Eumycetoma cases showed grains embedded within granulomatous inflammation, consistent with hallmark diagnostic features described worldwide [26]. Culture results

varied and were frequently hindered by contamination, limited laboratory infrastructure, or prolonged incubation times—challenges also documented in African and South Asian neglected tropical disease programs [1,25,27]. These findings highlight an urgent need to strengthen mycology laboratory capacity and training at regional levels.

3.4. Fungal Species and Microbiological Confirmation

Where culture was successful, *Fonsecaea pedrosoi* predominated as the etiologic agent of chromoblastomycosis, mirroring species patterns reported in Brazil, Madagascar, and Sri Lanka [25,27,30]. Eumycetoma cases involving *Exophiala jeanselmei* were consistent with its recognized role as a black-grain mycetoma agent worldwide [26]. Species variability across provinces likely reflects differences in diagnostic capability rather than true ecological diversity, a mismatch similarly reported in Southeast Asia and East Africa [23,25].

3.5. Treatment Response and Determinants of Outcome

Itraconazole—administered continuously or in pulse regimens—was the most consistently effective antifungal across chromoblastomycosis, sporotrichosis, and phaeohyphomycosis, aligning with current recommendations and recent global reviews [5,25,30]. In areas with limited access to itraconazole, ketoconazole was used as an alternative but was associated with slower or incomplete responses, echoing findings from African chromoblastomycosis programs [1,27].

Disease chronicity substantially affected therapeutic response. Long-standing chromoblastomycosis tended to show only partial improvement despite appropriate antifungal treatment, consistent with patterns described internationally [25]. One Indonesian case demonstrated malignant transformation into squamous cell carcinoma, a recognized complication of long-standing chromoblastomycosis documented in recent literature [30].

3.6. Integrated Interpretation

Interpretation of the findings should take into account the characteristics of the available literature. The 17 included studies were conducted in different provinces and clinical settings, which naturally leads to variations in how cases were identified and documented. The concentration of reports in Java, Bali, and Sumatra may reflect the distribution of published clinical observations rather than a definitive pattern of disease occurrence, a situation also noted in reports from other tropical regions [1,5,23,24]. The predominance of case reports influences the type of information presented, as case reports often describe more notable or complex presentations. This may help explain why many of the documented chromoblastomycosis and eumycetoma cases involved long-standing or extensive lesions, similar to descriptions in international literature [25–27]. These patterns highlight the diversity of clinical expression rather than suggesting differences in disease severity between regions.

Diagnostic approaches varied across studies, with histopathology appearing most consistently due to its wide applicability. Culture results were less frequently reported, which aligns with experiences in many countries where laboratory procedures differ across institutions [5,25,27]. Because of this variation, the fungal species observed in published cases may reflect the methods used in individual studies, as also described in reports from Southeast Asia and Africa [23,25]. Molecular identification, although increasingly used elsewhere [25,26], was not mentioned in the included studies. Treatment outcomes similarly reflected differences in therapeutic choices reported across studies. Itraconazole was the most frequently used antifungal and showed beneficial responses in several conditions, consistent with international recommendations [5,25,30]. In some reports, alternative agents such as ketoconazole were used, demonstrating the range of therapeutic approaches described in the literature [1,27]. Long-standing lesions were associated with more gradual improvement, a trend also noted in reports from other endemic regions [25].

Overall, the findings from the 17 studies provide a valuable overview of subcutaneous mycoses as documented in different Indonesian settings. While the available publications vary in design and diagnostic detail, they collectively help outline the clinical spectrum, diagnostic features, and therapeutic patterns observed to date. Continued documentation from a wider range of settings may further enrich understanding and align national observations with global trends in implantation mycoses [1,5,23,24,27].

4. Conclusion

Subcutaneous mycoses in Indonesia continue to represent a neglected and underrecognized burden of disease, shaped more by systemic healthcare limitations than by fungal virulence itself. The seventeen included studies consistently demonstrate that delayed diagnosis, reliance on limited laboratory resources, and unequal access to effective antifungal therapy contribute to the chronic, deforming, and difficult-to-treat presentations observed across endemic regions. Histopathology remains the most dependable diagnostic modality, particularly in resource-limited settings, whereas

fungal culture often adds limited value due to operational constraints. Itraconazole shows the greatest therapeutic benefit, yet disparities in drug availability continue to influence treatment outcomes. Strengthening early detection at primary-care levels, expanding histopathology access in rural areas, and improving the distribution of effective antifungals are essential steps toward reducing the morbidity associated with these infections. Coordinated national strategies are needed to ensure that subcutaneous mycoses receive appropriate clinical and public health attention within Indonesia's broader neglected tropical disease framework.

Compliance with ethical standards

Disclosure of conflict of interest

The authors declare that there are no conflicts of interest regarding the publication of this article.

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