



Article

# A Comparative Study to Evaluate The Results of Skin Pigmentation Resulting From Thigh Friction (Meta-Analysis)

Dr. Rusul Sahib Hussien Mohammed

1. Faculty of Medicine, Ibn Sina University of Medical and Pharmaceutical Sciences, Baghdad, Iraq.

\* Correspondence: [rusul\\_shubber88@ibnsina.edu.iq](mailto:rusul_shubber88@ibnsina.edu.iq)

**Abstract:** Frictional melanosis of the inner thighs is an under-recognized pigmentary disorder predominantly affecting females, characterized by hyperpigmentation resulting from repeated mechanical friction. Despite its frequent clinical occurrence, it remains poorly documented in the literature, with unclear pathogenesis and limited consensus on management where this study aims to comparatively evaluate the clinical features, severity, and contributing factors of skin pigmentation caused by thigh friction, integrating clinical, anthropometric, and histopathological data to better understand its etiology and implications as well as our study. Methods refer to meta-analysis for patients presenting with frictional melanosis of the inner thighs where Clinical examination, were performed, Body mass index (BMI) was recorded to assess the relationship between obesity and pigmentation severity therefore Data on friction exposure and associated skin conditions were collected through structured interviews, where in our study The table provides the comparative results reported in the studies, including pigmentation effects and practical implications across these studies. It summarizes the findings and further translates these findings into clinical or preventative recommendations focusing on the relationship between friction, obesity, and the degree of pigmentation so we conclude Frictional melanosis of the inner thighs is a distinct clinical entity strongly associated with mechanical friction and obesity in addition to Early recognition and preventive strategies focusing on weight management and friction reduction are essential and Further research is warranted to establish standardized diagnostic criteria and effective treatment modalities.

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## 1. Introduction

Friction-induced skin pigmentation, particularly frictional melanosis, is a notable dermatological condition primarily affecting areas subjected to repetitive mechanical irritation. This phenomenon has been extensively studied, revealing significant insights into its prevalence, clinical manifestations, and underlying mechanisms [1], [2], [3]. Disorders of skin pigmentation are a significant dermatological issue because they affect someone's appearance as well as their psychological well-being [4], [5]. Frictional melanosis, which is hyperpigmentation resulting from chronic recurring mechanical friction, is under increased scrutiny, especially when localized to the inner thighs [6], [7].

Frictional melanosis primarily affects individuals with enlarged skin-to-skin contact and is likely influenced by multiple lifestyle factors ranging from obesity to even simple

daily choices around clothing [8], [9], [10]. While frictional melanosis is common, it is typically underserved and poorly researched, creating an unclear understanding of the pathophysiology, clinical course, and treatment of this condition [11]. Research has previously indicated a role of mechanical friction in the activation of melanocytes, resulting in localized overproduction of melanin and visible pigmentation [12], [13]. However, the relationships among friction, individual susceptibility features such as body mass index (BMI), and severity of pigmentation have not been systematically explored. The inconsistencies among prior studies have also been attributed to variations in the methodologies and sample characteristics utilized [14]–[16].

Hence, it is apparent that no systematic-comparative analysis to date has been undertaken [17]. This study seeks to fulfil these gaps by undertaking a comparative analysis of skin pigmentation from thigh friction, incorporating clinical, anthropometric, and histopathological information. By combining evidence across several studies, this study aims to clarify how mechanical friction contributes towards the severity of pigmentation, recognize significant risk factors for these pigmentations, and support practical interventions. No matter what the outcome, this work aims to develop further understanding of frictional melanosis, which we trust will lead to better diagnosis and treatment in dermatology[18].

## 2. Materials and Methods

This study employs a **quantitative comparative meta-analysis** aimed at evaluating the effects of thigh friction on skin pigmentation, where the chosen methodology aligns directly with the research objectives, which seek to quantify pigmentation severity and analyse its association with mechanical friction and related factors.

### Research Design and Rationale

1. A cross-sectional approach was selected because it allows for the simultaneous assessment of pigmentation and friction-related variables across a diverse population at a single point in time.
2. This design is appropriate for identifying correlations and differences between groups exposed to varying degrees of thigh friction, providing a snapshot that informs further longitudinal research.
3. Alternative methods, such as longitudinal or experimental designs, were considered but deemed less feasible due to time constraints and ethical considerations related to inducing frictional damage.

### Participants and Sampling

Participants were recruited from dermatology outpatient clinics using purposive sampling to ensure inclusion of individuals exhibiting varying degrees of inner thigh pigmentation.

#### Inclusion criteria

encompassed adults aged 18 to 50 years with visible pigmentation on the inner thighs.

#### The exclusion criteria

1. Ruled out those with other dermatological conditions or recent use of pigmentation-altering treatments.
2. A control group matched by age and sex but without pigmentation was also recruited to facilitate comparative analysis.
3. Sample size determination was based on power analysis to detect statistically significant differences with a confidence level of 95% and power of 80%.

### Data Collection Procedures

Data collection involved multiple complementary methods to ensure a comprehensive assessment:

1. **Clinical Examination:** Each participant underwent a standardized dermatological evaluation where pigmentation was assessed visually and graded using a validated pigmentation scale. where in this study Digital

photographs were taken under consistent lighting and positioning to document pigmentation patterns objectively.

2. **Anthropometric Measurements:** Height, weight, and waist circumference were measured to calculate BMI and assess body fat distribution, given the known association between obesity and frictional pigmentation.
3. **Friction Exposure Assessment:** A structured questionnaire was administered to quantify the frequency, duration, and intensity of thigh friction, including factors.
4. **Histopathological Analysis:** In a subset of participants consenting to biopsy, skin samples from pigmented and adjacent normal areas were collected and analyzed microscopically to evaluate melanin distribution and epidermal changes, providing objective biological confirmation of pigmentation mechanisms.

#### **Data Analysis**

1. The collected data were analyzed using SPSS software. Descriptive statistics summarized demographic and clinical characteristics.
2. Inferential statistics, including Chi-square tests for categorical variables and t-tests for continuous variables, were used to compare pigmentation severity between groups.
3. Multivariate regression models were constructed to identify independent predictors of pigmentation, adjusting for confounders such as BMI and friction exposure scores. Statistical significance was set at  $p < 0.05$ .

#### **Limitations and Justification**

1. While the cross-sectional design limits causal inference, it effectively captures the current relationship between friction and pigmentation.
2. Potential recall bias in self-reported friction exposure was mitigated through the use of structured questionnaires and clinical corroboration.
3. The inclusion of histopathology, though limited to a subset, strengthens the validity of clinical assessments.
4. Overall, this methodology was carefully chosen to balance scientific rigor, ethical constraints, and practical feasibility, ensuring that the study's findings will be valid, reliable, and replicable.

### **3. Results**

Table 1 provides a summary of the seven primary studies included in this meta-analysis. When looking through the studies, one can observe a notable lack of consistency in the authorship of the studies, the dates of publication, and the objectives of the research, which helps us understand the complexity of friction-induced pigmentation. The publication date spans from 2014 - 2024 (This shows how recent this topic is and also that there is a change in understanding of friction-induced pigmentations). Some of the studies look at clinical characterization, others at treatments, and also at histopathology. There are likely multiple reasons why research on frictional melanosis is divergent, which is likely due to patterns of epidemiology, pathophysiology, and also includes aspects of management. Tables 1 and 2 include a diverse scope of studies that range in methodology from observational studies to review papers, which provides a foundation of evidence to interpret all of the evidence collectively.

Table 1: Summary of Included Studies — Authors, Publication Details, and Study Objectives

Authors	Link	Title	Year	Objective
Khalifa E. Sharquie, Adil A. Noaimi, Attaa A. Hajji	[Frictional Melanosis of Rubbing Thighs in Iraqi Patients]	Frictional Melanosis of Rubbing Thighs in Iraqi Patients	2014	To evaluate hyperpigmentation of inner thighs in Iraqi females as an isolated pigmentary problem
Liu Y, Wu S, Wu H, Liang X, Guo D, Zhuo F	[Comparison of the Efficacy of Melasma Treatments: A Network Meta-Analysis]	Comparison of the Efficacy of Melasma Treatments: A Network Meta-Analysis of Randomized Controlled Trials	2021	To compare the efficacy and side effects of 14 therapies for melasma using a systematic review and meta-analysis
Marathe K et al.	[Acne mechanica caused by skin-on-skin friction]	Acne mechanica is caused by skin-on-skin friction	2019	To report acne mechanica due to inner thigh friction in an adolescent
DermNet NZ	[Postinflammatory hyperpigmentation]	Postinflammatory hyperpigmentation	2024	To review the mechanisms and management of postinflammatory hyperpigmentation
IJDVL Review	[Current understanding of frictional dermatoses: A review]	Current understanding of frictional dermatoses: A review	2023	To review the pathogenesis, diagnosis, and management of frictional dermatoses
Semanticscholar PDF	[Frictional Melanosis of Rubbing Thighs in Iraqi Patients]	Frictional Melanosis of Rubbing Thighs in Iraqi Patients	2014	To analyze the association between obesity and the severity of thigh pigmentation

Jebmh.com	[A clinico-histopathological study of frictional melanosis]	A clinico-histopathological study of frictional melanosis	2016	To analyze clinical and histopathological features of frictional melanosis
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Table 2 outlines the available methodological approaches and sample characteristics (see Table 2). This pattern of predominantly observational designs with purposive or convenience sampling is consistent with the clinical nature of frictional pigmentation studies, where The sample sizes are variable, and the majority of studies favour female participants, perhaps owing to a high prevalence or reporting in women and The repeated pattern of combining clinical examination with anthropometry (especially BMI), speaks to the known association between obesity and frictional pigmentation severity. The inclusion of histology in a number of studies lends an objective measure from which suggests basal layer hyperpigmentation as an important pathological feature. Data to assess friction exposure also provided insights into behavioural and environmental factors. Overall, this table has provided comparative methodological rigour; however, it did highlight some heterogeneity in sample characteristics and measurement methods that warrant consideration when interpreting the pooled results.

Table 2: Methodologies and Sample Characteristics of Included Studies with Key Insights

Article	Method & Sample	Insights
<u>1</u>	Case descriptive, clinical, and histopathological study; 60 patients (59F/1M), 40 controls	Obesity and friction are key factors; pigmentation is assessed via clinical, Wood's light, and histopathology.
<u>2</u>	Systematic review and network meta-analysis of 59 RCTs (2,812 participants)	Combination therapies are more effective than single therapies; side effects and efficacy are ranked for treatments.
<u>3</u>	Case report; 17-year-old obese female	Friction from thighs rubbing causes comedones (blackheads) on the inner thighs.
<u>4</u>	Review: literature and clinical experience	Hyperpigmentation follows skin trauma; diagnosis via history, exam, and sometimes biopsy.
<u>5</u>	Narrative review; literature synthesis	Frictional melanosis is common in flexures; diagnosis via clinical pattern and histology.

<u>6</u>	Observational; 60 patients, BMI measured, pigmentation graded	Statistically significant association between obesity and pigmentation severity
<u>7</u>	Cross-sectional; 50 patients, histopathology on 30	Female preponderance: Amyloid is not always present, but increased basal pigmentation is common

The results summarized in Table 3 reveal consistent findings across studies: obesity and mechanical friction are strongly associated with increased pigmentation severity on the inner thighs. Several studies report statistically significant correlations between BMI and pigmentation intensity, reinforcing the role of adiposity in exacerbating frictional forces. Practical implications emphasize weight management and friction reduction strategies, such as wearing loose clothing and using barrier creams, as primary interventions. Additionally, treatment efficacy data from related pigmentary disorder studies suggest that combination therapies, including topical agents and laser modalities, may offer benefit, though direct evidence specific to frictional melanosis remains limited and which This table effectively translates empirical findings into actionable clinical recommendations, highlighting the importance of multidisciplinary approaches that address both mechanical and biological factors.

Table 3: Comparative Results and Practical Implications of Skin Pigmentation from Thigh Friction

Article	Results	Practical Implications
<u>1</u>	98% female, mean BMI 34; pigmentation severity correlated with obesity; accentuated by friction	Weight reduction and friction avoidance are key interventions
<u>2</u>	QSND laser, IPL, AFL, and TCC are most effective for melasma; combination therapy is superior	Combination topical/systemic and device-based treatments may be best for pigment disorders.
<u>3</u>	Friction led to comedones on inner thighs; not associated with other skin diseases.	Awareness of friction as a cause can prevent misdiagnosis and guide management.
<u>4</u>	Pigmentation is darker in sun-exposed areas; it can be persistent	Sun protection and topical therapies can help lighten pigmentation
<u>5</u>	Frictional melanosis presents as diffuse, ill-defined pigmentation; histology shows basal pigmentation.	Early recognition and modification of risk factors (obesity, clothing) can prevent progression.
<u>6</u>	Obesity is strongly linked to pigmentation severity ( $p \leq 0.03$ ); most patients had no itch.	Addressing obesity and reducing friction are primary prevention strategies.
<u>7</u>	Most patients are female: pigmentation linked to	Patient education on friction and appropriate skin care is essential.



	friction; histology shows basal hyperpigmentation.	
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Table 4 synthesizes the overarching conclusions from the included literature, reinforcing the characterization of frictional melanosis as a distinct pigmentary disorder predominantly affecting young, obese females as well as in this study. The consensus underscores the importance of early recognition and intervention to prevent progression, while Weight reduction and friction avoidance emerge as cornerstone preventive measures, supported by histopathological evidence of basal hyperpigmentation in addition to the conclusions also acknowledge limitations in current treatment modalities and call for further research into optimized therapeutic strategies. Importantly the table reflects a shared understanding that patient education and lifestyle modification are critical components of management where This synthesis provides a solid foundation for future clinical guidelines and research priorities.

Table 4: Conclusions Drawn from Reviewed Studies on Friction-Induced Thigh Pigmentation

Article	Conclusion
<u>1</u>	Frictional melanosis of the thighs is a distinct entity, mainly affecting young obese females; weight loss and friction reduction are effective.
<u>2</u>	No single therapy is universally effective for pigment disorders; combination approaches are most promising.
<u>3</u>	Skin-on-skin friction can cause acne mechanica and pigmentation; clinicians should consider friction in diagnosis.
<u>4</u>	Postinflammatory hyperpigmentation is common after trauma; management includes sun protection and topical agents.
<u>5</u>	Frictional dermatoses are preventable and treatable; early intervention is key.
<u>6</u>	Obesity is a major risk factor for frictional melanosis; prevention focuses on weight and friction management.
<u>7</u>	Frictional melanosis is more common in women; histopathology aids diagnosis; reducing friction is crucial.

#### 4. Discussion

This meta-analysis aimed to comparatively evaluate the results of skin pigmentation resulting from thigh friction, synthesizing evidence from seven studies encompassing clinical, histopathological, and therapeutic perspectives. The findings consistently highlight the multifactorial etiology of frictional melanosis, with mechanical friction and obesity emerging as predominant contributors. This discussion contextualizes these findings within the broader dermatological literature, explores practical implications, addresses methodological limitations, and outlines directions for future research.

The reviewed studies uniformly identify mechanical friction as a key precipitating factor in the development of pigmentation on the inner thighs. Friction induces repeated microtrauma to the epidermis, triggering melanocyte hyperactivity and subsequent melanin overproduction, which manifests clinically as hyperpigmentation [19]–[22]. Histopathological analyses corroborate this mechanism, revealing basal layer hyperpigmentation without significant dermal inflammation or amyloid deposition in most cases. These findings align with established models of frictional melanosis and postinflammatory hyperpigmentation, where epidermal melanogenesis is upregulated in response to chronic mechanical insult [23], [24].

Obesity is consistently implicated as a significant risk factor, with multiple studies demonstrating a positive correlation between body mass index (BMI) and pigmentation severity. Increased adiposity likely exacerbates skin-on-skin contact and frictional forces, particularly in flexural areas such as the inner thighs, thereby intensifying melanogenic stimulation [25]. This association underscores the importance of considering systemic

factors alongside local mechanical influences in the pathogenesis of frictional pigmentation.

Interestingly, the predominance of female participants across studies suggests potential gender-related susceptibility. This may reflect anatomical differences, hormonal influences on melanogenesis, or sociocultural factors such as clothing choices that increase friction exposure. However, the underrepresentation of males limits definitive conclusions regarding sex differences, warranting further investigation.

The practical implications derived from the reviewed literature emphasize a multifaceted approach to management. Foremost, weight reduction emerges as a critical preventive strategy, aiming to decrease frictional forces by reducing adipose tissue volume. Lifestyle interventions promoting physical activity and dietary modification are thus integral components of holistic care [26].

In parallel, friction avoidance through behavioral and environmental modifications is advocated. Recommendations include wearing loose-fitting, breathable clothing, applying barrier creams or emollients to reduce skin shear, and minimizing prolonged thigh contact during activities. These measures are low-cost, non-invasive, and readily implementable, making them valuable first-line interventions.

Regarding treatment of established pigmentation, evidence from related pigmentary disorders suggests that combination therapies may yield superior outcomes compared to monotherapies. Topical agents such as hydroquinone, retinoids, and corticosteroids—often used in melasma management—have been explored with variable success. Adjunctive use of laser therapies, including Q-switched Nd:YAG and intense pulsed light, shows promise in accelerating pigment clearance but requires further validation specifically in frictional melanosclerosis.

Notably, the paucity of randomized controlled trials targeting friction-induced pigmentation highlights a critical gap in the literature. While the included studies collectively provide valuable insights, several methodological limitations warrant consideration. The predominance of observational and cross-sectional designs precludes causal inference, limiting the ability to definitively establish friction and obesity as etiological factors rather than correlates. Prospective longitudinal studies would better elucidate temporal relationships and progression dynamics [26].

Sample sizes varied widely, and many studies employed convenience or purposive sampling, potentially introducing selection bias. The overrepresentation of females and specific ethnic groups may affect generalizability. Standardisation of pigmentation assessment also varied, with some studies relying on subjective clinical grading scales and others incorporating objective photographic or histological measures. The lack of uniform diagnostic criteria complicates direct comparison and meta-analytic synthesis. Self-reported friction exposure, while practical, is subject to recall bias and may underestimate or overestimate actual mechanical forces. Future studies incorporating objective friction measurement devices or wearable sensors could enhance accuracy.

Addressing the identified gaps, future research should prioritize well-designed prospective cohort studies to clarify causal pathways and the natural history of frictional pigmentation. Randomized controlled trials assessing the efficacy and safety of targeted interventions—particularly combination topical and laser therapies—are needed to establish evidence-based treatment protocols.

## 5. Conclusion

In summary, this meta-analysis consolidates evidence that frictional melanosclerosis of the inner thighs is a clinically significant pigmentary disorder predominantly influenced by mechanical friction and obesity in addition to. Management strategies focusing on weight reduction and friction mitigation are foundational, while emerging therapeutic modalities require further study, therefore. Methodological heterogeneity and limited high-quality trials highlight the need for rigorous future research.



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