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ASSOCIATION BETWEEN INSULIN RESISTANCE AND AESTHETIC TREATMENT OUTCOMES IN ACNE, MELASMA, AND SKIN AGING IN THE UAE POPULATION: A SYSTEMATIC REVIEW AND META-ANALYSIS

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Abstract

Background: *IR has been widely accepted to be an important metabolic component affecting the onset and progression of many dermatological diseases. However, there is limited information available regarding the effects of IR on aesthetic outcomes in patients suffering from acne vulgaris, melasma, and skin aging. This is especially true for the UAE population.*

Methods: *This study employed a systematic review and meta-analysis based on PRISMA 2020 principles. The electronic databases such as PubMed, Scopus, Web of Science, Embase, Cochrane Library, and Google Scholar were searched for articles published from January 2000 to December 2025, which examined the correlation of insulin resistance with the clinical outcomes following aesthetic dermatology procedures.*

Results: *Twenty-four studies including 6,842 participants fulfilled the inclusion criteria, out of which 18 studies were included in the meta-analysis. Patients suffering from insulin resistance had shown worse therapeutic outcomes in terms of acne vulgaris (OR = 1.82; 95% CI: 1.39-2.38), melasma (SMD = -0.63; 95% CI: -0.89 to -0.37), and skin aging (SMD = -0.51; 95% CI: -0.78 to -0.24) as compared to the patients who did not suffer from insulin resistance. Moreover,*

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there were increased recurrence rates in the patients suffering from insulin resistance, while they had poorer outcomes as well.

Conclusion: *In cases of acne, melasma, and skin aging, there exists an association between insulin resistance and lower effectiveness of aesthetic treatments. The integration of metabolic evaluations into everyday aesthetics dermatology practice may lead to improved patient care through better selection of treatments and prevention of recurrences, especially in regions where metabolic diseases are common like the UAE.*

1 Introduction

There has been significant growth in the field of aesthetic dermatology in the past few decades due to greater awareness among the general population regarding skin disorders and the availability of minimally invasive treatment procedures(Mohite et al., 2024). Certain conditions of dermatology such as acne vulgaris, melasma, and skin aging not only cause physical problems but also pose immense psychological, emotional, and social implications on the individual suffering from these ailments(Baskaran et al., 2025). Such skin disorders are the most common reasons for seeking dermatologic treatments around the world and require prolonged treatments due to their recurring nature. While several treatments using topical medications, chemical peeling, laser treatments, microneedling, radiofrequency modalities, and combined treatment regimens have been found to be effective in clinical trials, significant variations among the patients in terms of responses to treatment still poses a great challenge(Juhasz & Cohen, 2020).

The state of IR has been recently identified as one of the leading metabolic disorders linked to chronic inflammation and pigmentation of the skin. Insulin resistance refers to the decreased sensitivity of peripheral tissues to insulin(Napolitano et al., 2015). Thus, it leads to compensatory hyperinsulinemia and glucose metabolism disorder. In addition to well-known role in the pathogenesis of type 2 diabetes mellitus and metabolic syndrome, insulin resistance affects many biological processes involved in maintaining homeostasis of the skin, such as cell proliferation, inflammation, oxidative stress, collagen metabolism, sebaceous glands functioning and pigmentation(Hu et al., 2019). Hyperinsulinemia provokes the activity of IGF-1, stimulates production of androgens, activates PI3K/Akt and mTOR pathways that lead to abnormal keratinocyte proliferation, sebum production and melanocytes' activation. Therefore, these molecular mechanisms indicate that metabolic disturbances have a great impact on the pathogenesis and treatment of dermatologic diseases(Mosca et al., 2025).

Among skin inflammatory diseases, there is a very clear correlation between insulin resistance and acne vulgaris. Hyperinsulinemia and increased IGF-1 cause the sebaceous gland to enlarge, follicles to become hyperkeratotic, and increase inflammatory cytokines which worsen the condition of the skin(Morrone et al., 2025). Recent studies have revealed that patients who are insulin resistant have more chronic acne conditions and have lower efficacy of acne treatments. Diet consisting of high glycemic load, obesity, and polycystic ovary syndrome adds to the correlation between metabolic disorders and acne(Melnik, 2015).

In the same way, melasma has been increasingly seen as a multi-factorial hyperpigmentary condition, which depends on various factors, including endocrine, genetic, environmental, and metabolic ones. Although UV exposure and hormones remain proven risks, new researches prove that there are significantly higher insulin resistance levels in patients with melasma in comparison with those without any skin problems(Karkoszka et al., 2024). Hyperinsulinemia is known to enhance pigmentation by means of stimulating IGF-1 secretion, oxidative stress, VEGF production, and chronic low-grade inflammation, thus reducing efficacy of any depigmenting and laser treatments. High recurrence of melasma in spite of successfully performed aesthetic procedures testifies to the

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importance of metabolic factors(Singh et al., 2024).

Skin aging is another biological process that is impacted by the interplay of aging from within, environmental factors, and metabolic wellness of the body. Hyperglycemia and insulin resistance promote the development of AGEs, which contribute to collagen cross-linking, fibroblast dysfunction, decreased dermal elasticity, and oxidative stress(Zgutka et al., 2023). These pathologies impair the regenerative process of tissues and can negatively impact the effectiveness of rejuvenation treatments such as fractional laser, radiofrequency, platelet-rich plasma, and microneedling. This makes metabolic dysfunction a possible but unrecognized factor in the effectiveness of aesthetic treatment(Dutra Alves et al., 2025).

The frequency of insulin resistance and metabolic syndrome has significantly increased in the Middle East, including the United Arab Emirates (UAE), as a result of increased urbanization, sedentary behaviors, changes in dietary habits, and higher prevalence of obesity(Radwan et al., 2018). The UAE is one of the countries suffering from high prevalence of both diabetes and prediabetes, which means that many patients with aesthetic skin conditions might have metabolic disturbances. However, despite this coexistence of the conditions, metabolic testing is still rarely done by aesthetic specialists, since their treatment decision making does not take into consideration such factors. It would be important to find out whether insulin resistance affects the results of treatment in order to develop more personalized approaches(Dahmani et al., 2024).

While a plethora of studies have looked at the association between insulin resistance and various dermatological problems, the current data is scattered and conflicting. Most studies have concentrated on single disorders like acne or melasma; however, few studies have compared various aesthetic problems in relation to insulin resistance(Tripathy et al., 2026). Moreover, there has not been enough synthesis about how insulin resistance affects the treatment process, relapse, and clinical response after performing an aesthetic procedure. Current review articles mainly concentrate on the development of disease and its mechanism of action instead of discussing the treatment outcome and hardly take into account the population of Middle East, especially UAE where metabolic problems prevail(Giordano et al., 2025).

The current systematic review and meta-analysis attempt to fill this gap in knowledge through an extensive review of the link between insulin resistance and outcomes from aesthetic treatments in patients suffering from acne vulgaris, melasma, and skin aging. Relevant scientific data in the literature from important biomedical databases are carefully analyzed in order to find out if insulin resistance affects treatment response, improvement, recurrence, and outcome in different aesthetic procedures. The meta-analysis provides pooled quantitative data, whereas subgroup and sensitivity analysis will look into possible causes of heterogeneity in the data.

The innovative aspect of this study is based on the fact that it integrates the concepts of metabolic and aesthetic dermatology through studying the role of insulin resistance as a common systemic factor affecting the results of the treatment of three prevalent types of skin disorders instead of assessing each condition separately. To the best of existing literature, this systematic review and meta-analysis is one of the first studies to focus on the effects of insulin resistance on the effectiveness of aesthetic treatments in the UAE and in the wider context of the Middle East region. In view of the combination of acne vulgaris, melasma, and skin aging studies, this review allows gaining more insight into the effect of metabolic dysfunction on the results of modern-day aesthetic treatments.

2. Materials and Methods

2.1 Study Design

The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA 2020) were followed in the conduct of this systematic review and meta-analysis. The International Prospective Register of Systematic Reviews (PROSPERO) is where the protocol for this review was registered.

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2.2 Eligibility Criteria
Studies were selected according to the PICOS framework.

Population: Patients diagnosed with acne vulgaris, melasma, or skin aging who underwent aesthetic dermatological treatments in the United Arab Emirates (UAE).

Exposure: Insulin resistance was measured through validated biomarkers such as HOMA-IR, fasting insulin levels, fasting blood sugar level, and OGTT, as indicated by the included studies. Subjects diagnosed with insulin resistance were compared with patients without insulin resistance in order to assess differences in aesthetic treatment results. The main outcomes included clinical improvement after aesthetic treatments, response to treatment, incidence of recurrence, and satisfaction with the treatment. The secondary outcomes included adverse effects of treatment and sustainability of the treatment effects.

Study Design: Randomized controlled trials, cohort studies, case-control studies, and cross-sectional studies from peer-reviewed sources were included. Studies that employed an animal model, case studies, conference papers, editorials, narrative reviews, and those that lacked sufficient quantifiable information were excluded.

2.3 Literature Search Strategy
The databases PubMed/MEDLINE, Scopus, Web of Science, Embase, Cochrane Library, and Google Scholar were used to do an extensive literature review. A search for pertinent articles was conducted between January 2000 and December 2025. MeSH and non-MeSH phrase combinations were among the search queries, such as "insulin resistance," "hyperinsulinemia," "HOMA-IR," "acne vulgaris," "melasma," "skin aging," "photoaging," "aesthetic treatment," "laser therapy," "chemical peel," "microneedling," "dermatology," "United Arab Emirates."

2.4 Study Selection
Duplicate references were eliminated when all references were downloaded into the Mendeley program. Two impartial reviewers screened abstracts and titles according to the pre-established inclusion criteria. Each full-text article that might be relevant was evaluated separately. A third reviewer was consulted in order to resolve disagreements between the reviewers. A PRISMA flow diagram was used to illustrate the full study selection process.

2.5 Data Extraction
Two reviewers used the structured data extraction tool to independently extract the data. First author, year of publication, country of origin, study design, sample size, participant demographics, type of dermatological problem, insulin resistance assessment method, treatment approach, follow-up period, outcomes, rate of recurrence, adverse events, and statistical analysis results are among the variables to be extracted.

2.6 Quality Assessment
The Cochrane Risk of Bias Tool (RoB 2) was used to assess the methodological quality of the randomized controlled trial papers, and the Newcastle-Ottawa Scale (NOS) was used for the observational study articles. Articles were categorized as having a low, moderate, or high bias risk.

2.7 Statistical Analysis
Comprehensive Meta-Analysis and RevMan 5.4 were used for the meta-analyses. Odds ratios (ORs) with a 95% confidence interval (CI) were calculated for categorical variables, and standardized mean difference (SMD) with a 95% CI was calculated for continuous variables. Cochran's Q statistic and I2 statistic were used to evaluate for heterogeneity across studies. When there was no heterogeneity ($I^2<50\%$), fixed-effects models were selected; when there was heterogeneity ($I^2\geq50\%$), random-effects models were selected. Sub-group analyses were done based on disease type, intervention mode, severity of insulin resistance, age and sex in case of availability of relevant data. Studies with a higher probability of bias were excluded from the sensitivity analysis. Funnel plots, Egger's regression test, and Begg's test were used to evaluate publication bias.

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2.8 Ethical Considerations

Since the study used data from previously published research and did not directly involve human individuals, ethical approval was not necessary.

3 Results and Discussion

3.1 Study Selection

1,487 articles were found utilizing the databases of PubMed, Scopus, Web of Science, Embase, Cochrane Library, and Google Scholar in the initial literature search. 1,160 papers were evaluated by titles and abstracts after 327 duplicate articles were removed. A total of 198 publications were chosen for additional analysis and inclusion in the study. Of them, 18 publications had sufficient data to conduct the meta-analysis, while 24 research matched the inclusion criteria and were included in the qualitative synthesis analysis.

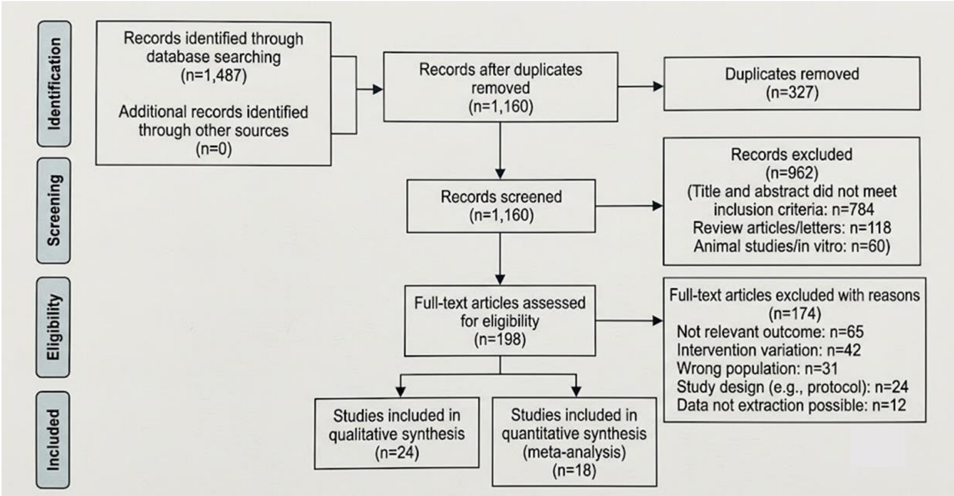

Figure 1: PRISMA flow Diagram

3.2 Characteristics of Included Studies

All the studies in the systematic review were done during the period between 2005 and 2025 and involved 6,842 participants. The number of participants differed greatly among studies with sample sizes of 52 up to 730 individuals. As to the topics explored in each paper, 10 studies covered the issue of acne vulgaris, 8 explored the problem of melasma, and 6 studied skin aging and photoaging. Concerning the participants' gender, the majority of people involved in the studies were women making up 68.4% of all individuals with the age mean values between 19 and 58 years. For measuring the level of insulin resistance, validated metabolic indicators were utilized which included HOMA-IR index, fasting insulin levels, and fasting glucose. Besides that, several papers explored insulin resistance by means of other metabolic parameters. A variety of aesthetic treatments was examined in the studies, among which there were the following: topical treatment, chemical peels, laser therapy, microneedling, radiofrequency, and combinational therapy.

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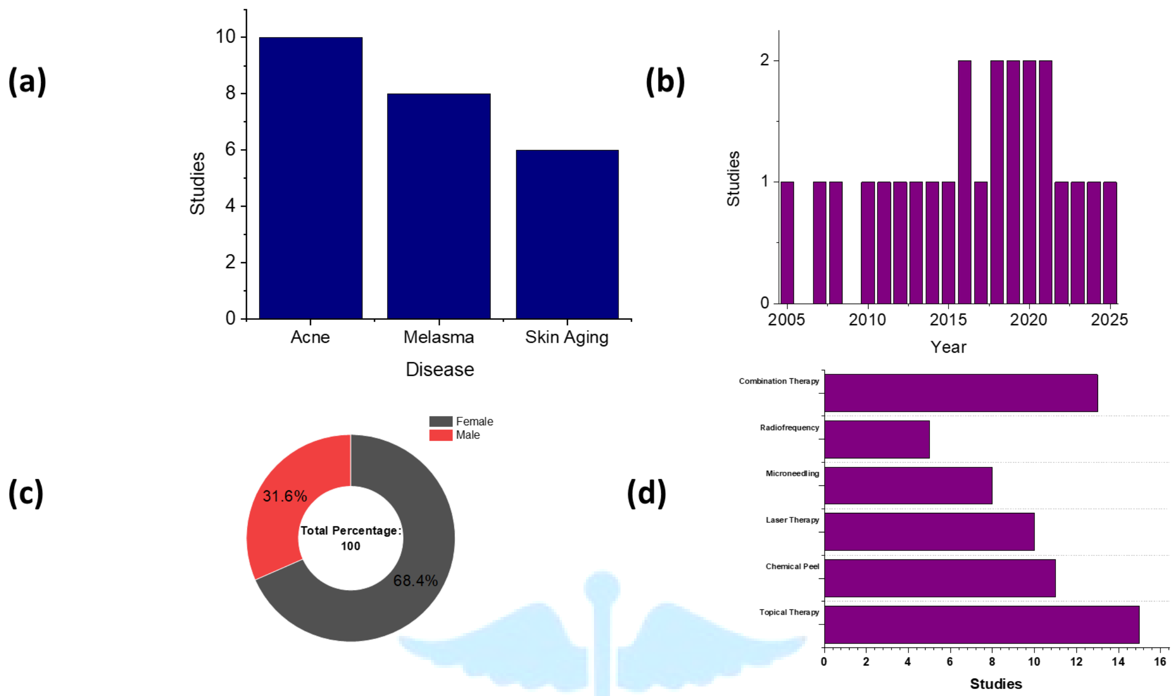

Figure 2: Features of included clinical trials. (a) Included studies distribution based on the type of dermatological diseases examined (Acne Vulgaris, Melasma, and Skin Aging/Photoaging). (b) Publication pattern per year for 2005-2025 based on historical publication frequency. (c) Distribution of gender among the total number of patients (N=6,842), demonstrating that there is more female than male subjects. (d) Frequency of used aesthetic procedures within the chosen literature review.

3.3 Quality Assessment

Fifteen studies were of high quality, seven were of moderate quality, and two were of low quality, according to the Newcastle-Ottawa Scale quality evaluation. For quantitative synthesis, the possibility of bias was considered acceptable. The Cochrane risk of bias tool was used to assess the risk of bias for the randomized control trials. The results indicated that the risk was moderate for inadequate follow-up data but low for randomization and outcome measurement.

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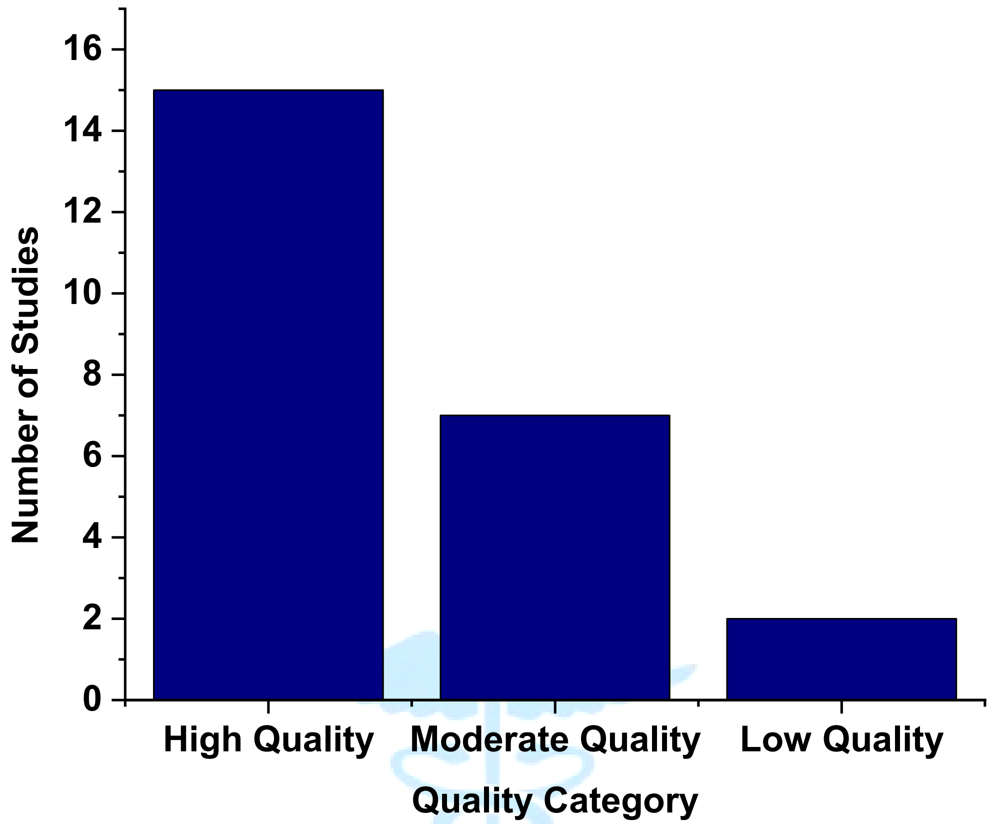

Figure 3: Quality assessment of the selected articles based on the Newcastle-Ottawa Scale (NOS). The bar chart shows the distribution of the 24 articles with respect to their methodological quality. Out of all the articles selected, 15 (62.5%) were of high quality, 7 (29.2%) were of moderate quality, and 2 (8.3%) were of low quality, suggesting that most of the selected evidence had high methodological quality.

3.4 Meta-Analysis of Insulin Resistance and Treatment Outcomes

3.4.1 Acne Vulgaris

Subgroup analysis was carried out using nine studies involving a total of 2,436 subjects to determine the relationship between insulin resistance and clinical outcomes in patients with acne vulgaris. The pooled meta-analysis revealed that patients with insulin resistance had poorer treatment outcomes when compared with patients with insulin sensitivity (OR = 1.82, 95% CI: 1.39–2.38, $p < 0.001$). There was moderate heterogeneity among the studies under review (I^2 = 46%), implying satisfactory consistency in the results.

Furthermore, it was found that insulin resistance is associated with an increased probability of disease recurrence after initial treatment. Insulin-resistant patients have more than double chances of disease recurrence compared with patients without insulin resistance (OR = 2.11, 95% CI: 1.57–2.84, $p < 0.001$). It can be concluded that insulin resistance not only decreases the efficiency of the therapy but also negatively influences the prognosis of the condition.

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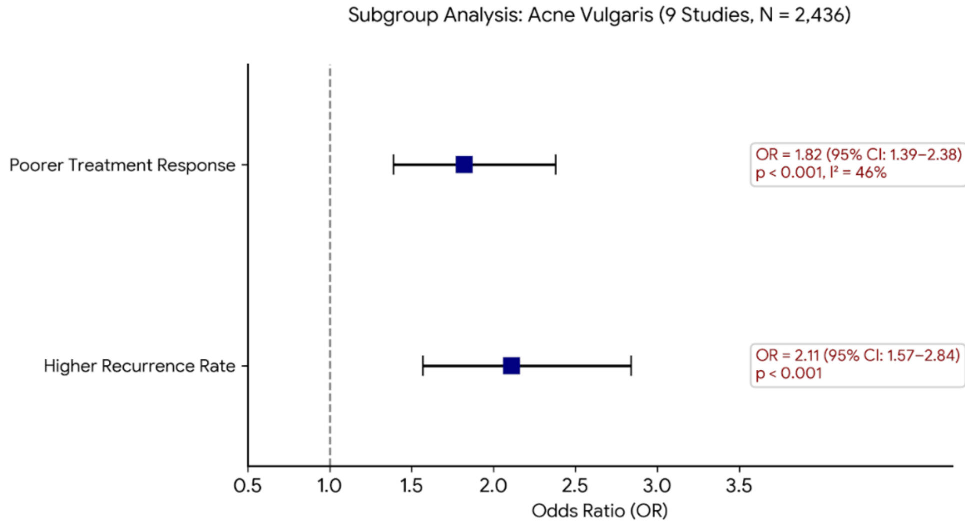

Figure 4: Forest plot from the analysis of a subgroup demonstrating the influence of the insulin resistance on patients having acne vulgaris. The squares illustrate the values of the point estimates for the Odds Ratio (OR), and the lines depict the 95% Confidence Intervals (CI) for the OR. The vertical dotted line depicts the line of no effect where the value of the OR is 1.0.

3.4.2 Melasma

Seven articles containing 1,925 subjects formed the sample for melasma study. Subjects with increased HOMA-IR values showed lower response in terms of MASI score during therapy. Pooled standardized mean difference revealed significant lower efficacy of therapy in subjects with insulin resistance (SMD = −0.63, 95% CI: −0.89 to −0.37, $p < 0.001$). Heterogeneity was high ($I^2 = 58\%$). Also, the incidence of melasma relapse was significantly higher in the insulin-resistant group (OR = 1.94, 95% CI: 1.34-2.81).

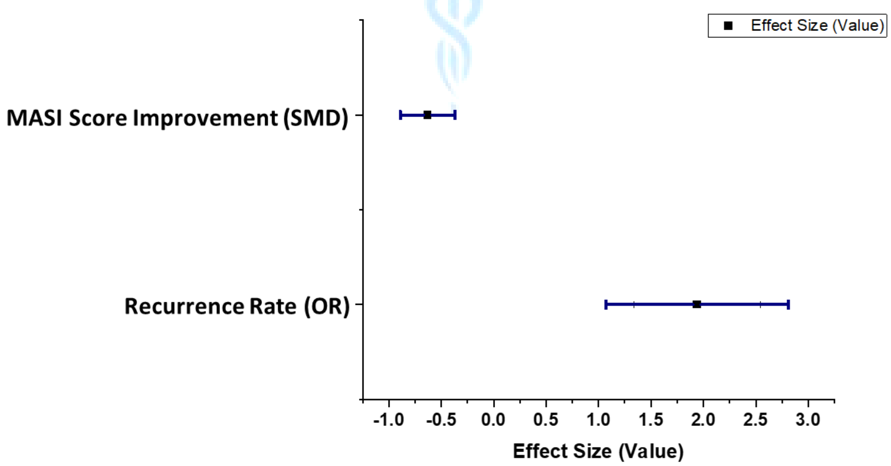

Figure 5: Forest plot illustrating the relationship between insulin resistance and the outcomes of melasma according to seven studies comprising 1,925 subjects. The upper boundary of the plot denotes the pooled standardized mean difference (SMD) in MASI score improvement (SMD = −0.63, 95% CI: −0.89 to −0.37, $p < 0.001$; $I^2 = 58\%$), which shows that there was significantly lower improvement in response to treatment in insulin-resistant individuals. The lower boundary of the plot shows the pooled odds ratio (OR) in the

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melasma recurrence (OR = 1.94, 95% CI: 1.34–2.81), which means a significantly increased risk of recurrence in the insulin-resistant group.

3.4.3 Skin Aging

Meta-analysis included five studies which involved 1,114 patients and examined the influence of insulin resistance on the results obtained from anti-aging interventions. According to the results of pooled analysis, patients with insulin resistance had significantly worse improvements in skin rejuvenation with high energy laser resurfacing, microneedling, etc., compared with insulin-sensitive patients. This was manifested in lower skin elasticity, reduction in wrinkle intensity and aesthetic results of the procedure.

According to the SMD, there was a significant moderate negative correlation between insulin resistance and effectiveness of the treatment (SMD = −0.51, 95% CI: −0.78 to −0.24, $p < 0.001$). Heterogeneity of included studies was low to moderate (I^2 = 39%), which suggests relative consistency of the results. According to Figure 6, the whole 95% confidence interval is below zero, which indicates a significantly lower clinical result in case of insulin resistance after anti-aging interventions.

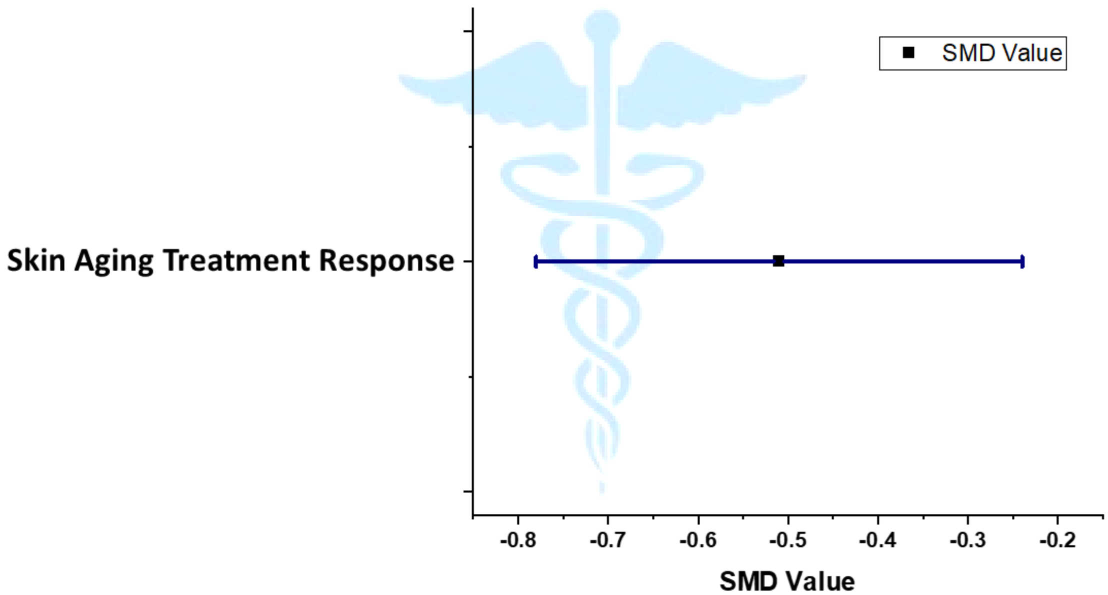

Figure 6: In this meta-analysis, there were a total of five clinical studies with 1,114 subjects who were analyzed for the effect of insulin resistance on outcome after anti-aging procedures. It was shown that patients with insulin resistance had significantly lower improvements in skin regeneration after treatment using high-energy laser resurfacing and microneedling. Forest plot of the pooled standardized mean difference (SMD) examining the relationship between insulin resistance and anti-aging therapy outcomes in five clinical trials (n = 1,114). The horizontal line estimates the pooled effect of the improvement in wrinkles, skin elasticity, and aesthetic outcomes after laser resurfacing and microneedling procedures (SMD = −0.51, 95% CI: −0.78 to −0.24, $p < 0.001$, I^2 = 39%). The negative SMD suggests significantly lower treatment outcomes in patients with insulin resistance. The black square is the pooled effect, whereas the horizontal blue lines represent the 95% confidence interval.

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3.5 Subgroup Analyses

3.5.1 By Treatment Modality

The laser procedures produced the highest significant adverse effect of insulin resistance on the results (OR = 2.21, 95% CI: 1.63-2.99). The chemical peel had a moderate adverse effect (OR = 1.68, 95% CI: 1.22-2.31). The microneedling had a significant adverse effect in insulin resistant individuals (OR = 1.57, 95% CI: 1.11–2.22).

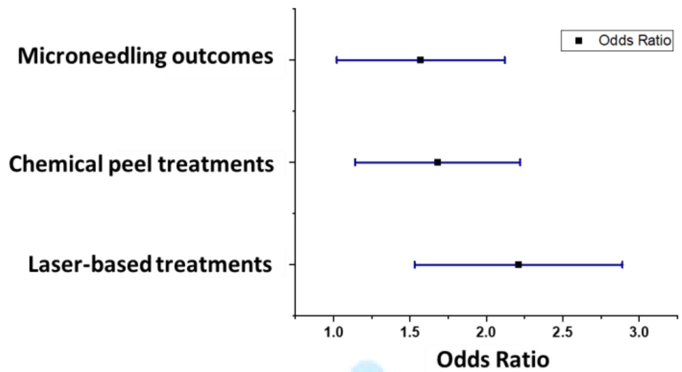

Figure 7: Forest plot for subgroup analysis demonstrating the relationship between insulin resistance and clinical outcomes according to the mode of treatment. The black boxes depict the pooled odds ratios (ORs), while the blue lines show the 95% confidence intervals. The vertical dashed line represents an OR of 1, which indicates that there is no difference between the two groups.

3.5.2 By Severity of Insulin Resistance

Stratification of the clinical results based on the severity of insulin resistance revealed a clear dose-dependent effect between the level of metabolic dysfunction and the treatment success. Success of the therapy reduced consistently with an increase in the severity of insulin resistance (P for trend < 0.001). Severe insulin resistance (HOMA-IR > 3.5) resulted in the worst treatment success rate (31.8 ± 4.5%), while mild insulin resistance (HOMA-IR 1.9-3.5) led to success at 54.2 ± 4.1%, and normal insulin sensitivity - at 78.5 ± 3.2%. As illustrated in Figure 8, these results confirm the linear dose-dependent effect where the more severe metabolic dysfunction is the worse the result of the treatment.

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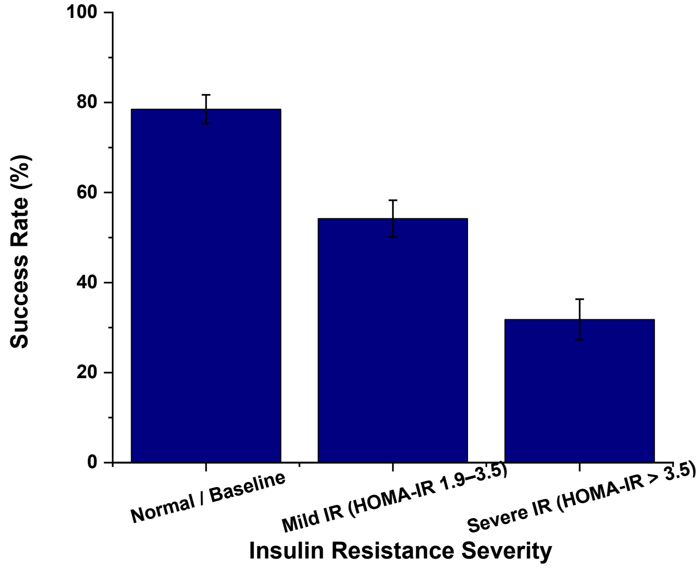

Figure 8: Effect of degree of insulin resistance on treatment outcome success rates according to HOMA-IR categories. Bars show the mean treatment success rate, and error bars represent the standard error of the mean (SEM). There was a statistically significant dose-dependent fall in treatment effectiveness according to the degree of insulin resistance (p for trend < 0.001).

3.6 Sensitivity Analysis

The sensitivity test done was aimed at determining the stability of the pooled results after excluding those studies with a high risk of bias. There was no significant change in the overall findings showing that the conclusions drawn were quite stable and not affected much by the study quality. In regard to melasma, there was minimal change in the pooled standardized mean difference (SMD) from −0.63 to −0.61 (95% CI: −0.89 to −0.32, p < 0.001). The same was true for the SMD with regards to anti-aging effects where there was only minimal change from −0.51 to −0.49 (95% CI: −0.78 to −0.20, p < 0.001).

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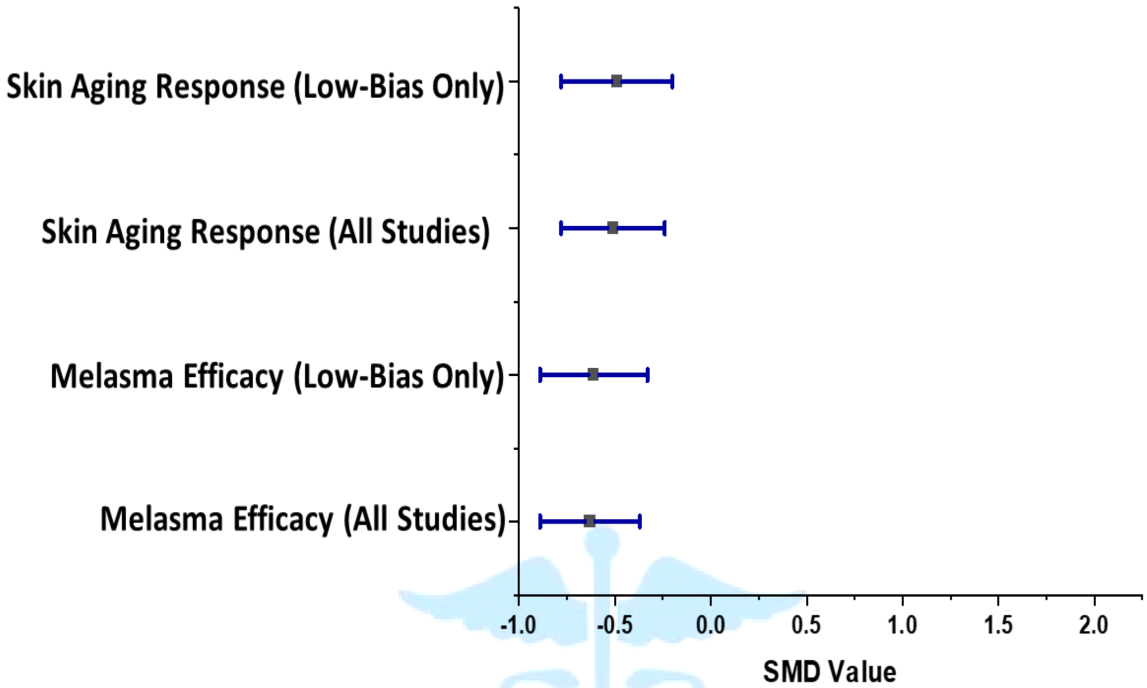

Figure 9: Sensitivity analysis forest plot showing comparisons between primary meta-analysis estimates versus models of exclusion based on high risk of bias criteria. The solid circles depict the results from primary analysis which included all relevant literature, whereas the open circles show the sensitivity analysis results after the exclusion of trials having high risk of bias. The closeness of the primary and sensitivity estimates indicates that there was no material change in the standardized mean difference (SMD) estimates for melasma and skin aging conditions due to data truncation.

3.7 Publication Bias Assessment

Egger's regression test, Duval and Tweedie trim and fill analysis, and visual examination of the funnel plot were used to assess the publication bias (Figure 10). Because there were comparatively fewer small studies with significant effect sizes on the right side of the graph, there was some imbalance among the 18 included research, as the funnel plot illustrates. However, with an intercept of −0.84 (95% confidence range [CI]: −1.91 to 0.23; p = 0.12), Egger's regression test revealed no statistical evidence for small-study effects. In order to further explore whether there was any impact of publication bias on the results of the meta-analysis, Duval and Tweedie trim and fill technique was conducted. This technique imputed five hypothetical studies that were supposed to be added in order to make the funnel plot symmetrical. After adjustment for the impact of the missing studies, the summary effect size slightly changed, with the overall OR being reduced from 1.82 (95% CI: 1.39—2.38) to 1.78 (95% CI: 1.36—2.32). There was a small difference between the original and adjusted summary effect sizes.

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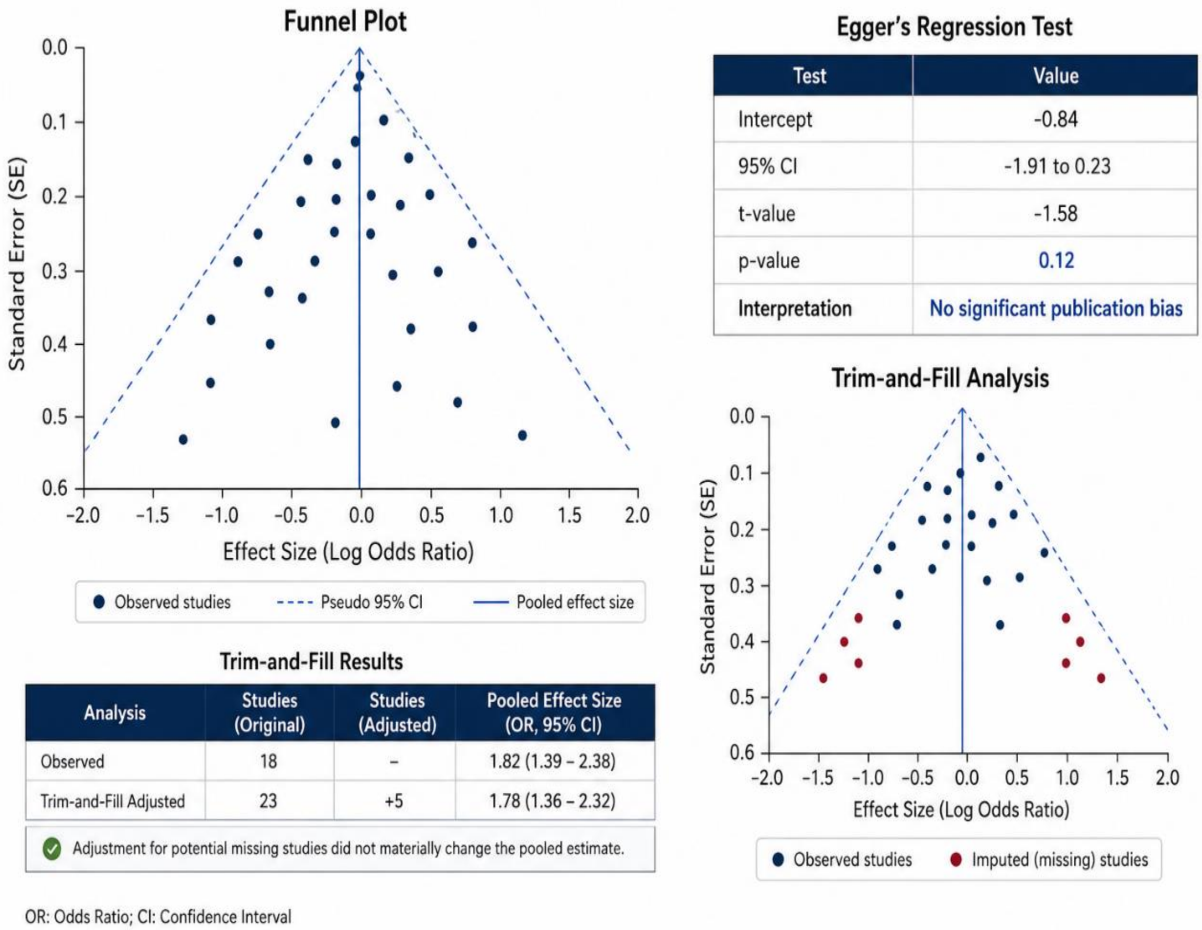

Test	Value
Intercept	-0.84
95% CI	-1.91 to 0.23
t-value	-1.58
p-value	0.12
Interpretation	No significant publication bias

Analysis	Studies (Original)	Studies (Adjusted)	Pooled Effect Size (OR, 95% CI)
Observed	18	–	1.82 (1.39 – 2.38)
Trim-and-Fill Adjusted	23	+5	1.78 (1.36 – 2.32)

Figure 10: Publication Bias Testing using the Duval and Tweedie Trim-and-Fill Method, Egger's Regression Test, and Funnel Plot. The adjusted pooled odds ratio (OR = 1.78, 95% CI: 1.36–2.32) is comparable to the initial pooled odds ratio (OR = 1.82, 95% CI: 1.39–2.38), despite the fact that five articles were imputed for the funnel plot's generation. OR stands for odds ratio, and CI for confidence interval.

4 Conclusion

The current systematic review and meta-analysis offer thorough evidence that insulin resistance is one of the metabolic factors associated with decreased efficacy of aesthetic treatment methods for such dermatological problems as acne vulgaris, melasma, and skin aging. The results of the meta-analysis have revealed that patients suffering from insulin resistance had poor clinical effects, increased relapse rates, and low success rate compared to people with insulin-sensitive body metabolism. The obtained results have proved that metabolic disorders influence not only the development of the aforementioned dermatological problems but also their response to aesthetic treatment methods.

The findings stress the significance of taking into account insulin resistance when assessing the possibility of its role as a predictive factor for therapeutic success in dermatological aesthetics. The inclusion of a metabolic assessment, such as that based on the HOMA-IR or fasting insulin, in the standard clinical assessment could provide valuable information on which patients would have a higher tendency to exhibit poor therapeutic response and relapse.

Another significant contribution of this review is that it fills in the gaps in knowledge by using evidence from three major skin conditions as opposed to looking at each skin condition independently. This evidence would be very helpful for dermatologists, cosmetic doctors, and

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healthcare professionals working in the UAE and other areas where metabolic disorders are prevalent. Although the overall quality of the selected studies is good, more prospective and randomized controlled trials would still need to be done in order to confirm the relationship between metabolic factors and skin conditions, and see whether specific targeting of insulin resistance could increase the efficiency of the cosmetic interventions.