



Clinical Outcomes and Complications of Lip Augmentation Using Dermal Fillers with the face architecture approach: a systematic review and meta-analysis

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ABSTRACT

Lip augmentation using dermal fillers has become one of the most commonly performed procedures in aesthetic medicine, offering minimally invasive volumization and contour enhancement. Despite its widespread use, the safety profile, clinical outcomes, and complication rates of various filler materials remain subjects of ongoing debate. The present systematic review and meta-analysis aimed to synthesize the existing evidence on the efficacy and safety of dermal fillers used specifically for lip augmentation. A comprehensive search was conducted across PubMed, Scopus, Web of Science, and Cochrane Library databases for studies published between 2000 and 2025. Eligible studies included randomized controlled trials, cohort studies, case series with at least 20 participants, and comparative analyses evaluating clinical outcomes, patient satisfaction, durability, and adverse events related to lip fillers. Data were extracted using a standardized template, and the quality of studies was assessed using the Cochrane risk-of-bias tool and the Newcastle Ottawa Scale. Meta-analysis was performed using a random-effects model. A total of 37 studies encompassing 4,862 patients were included. Overall patient satisfaction rates were high (pooled estimate: 87%), and the mean duration of augmentation effect ranged from 6 to 12 months depending on filler type. Hyaluronic acid fillers demonstrated the most favorable balance between durability and safety. The overall complication rate was 11.6%, with mild and transient issues such as swelling and bruising being the most commonly reported. Serious complications including vascular occlusion, granuloma formation, and delayed hypersensitivity were rare (0.3%). Heterogeneity across studies was moderate to high. The findings suggest that lip augmentation with dermal fillers is generally safe and effective when performed by experienced practitioners using evidence-based techniques. However, variability in study methodologies underscores the need for standardized outcome measures and long-term evaluations.

Introduction

Lip augmentation has gained remarkable popularity over the past two decades, driven by increasing demand for minimally invasive aesthetic procedures. Dermal fillers particularly hyaluronic acid (HA) based products are widely used due to their biocompatibility, reversibility, and predictable clinical outcomes. As the number of procedures grows globally, understanding complication profiles and long-term efficacy has become critical for both clinicians and patients [1].

Despite numerous clinical studies, reported outcomes vary considerably due to differences in filler materials, injection techniques, anatomical considerations, patient characteristics, and follow-up durations. Moreover, the aesthetic goals of lip augmentation volume restoration, contour enhancement, symmetry correction, and perioral rejuvenation require high precision, adding to the complexity of evaluating outcomes [2].

Previous narrative reviews have examined aspects of filler use, yet a comprehensive, evidence-based

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synthesis focusing exclusively on lip augmentation remains limited [3]. This systematic review and meta-analysis aims to fill this gap by integrating high-quality data on clinical outcomes, durability of results, complication rates, and risk factors associated with dermal fillers used in lip augmentation [4].

Literature Review

Lip augmentation using dermal fillers has become one of the most extensively performed nonsurgical aesthetic procedures worldwide, leading to a significant expansion of clinical research examining its effectiveness, durability, and complication profile [5]. The literature on dermal fillers particularly hyaluronic acid (HA) has evolved considerably over the past two decades, starting from early explorations of collagen-based materials to the current emphasis on cross-linked HA formulations and advanced injection techniques [6].

Evolution of Dermal Fillers in Lip Augmentation: Early studies in the 1990s and early 2000s primarily evaluated bovine and human collagen fillers, which provided temporary augmentation but were associated with high rates of immunogenic reactions and short duration of effect. Research by Narins et al. (2003) and Cohen & Holmes (2004) highlighted these limitations, prompting a shift toward HA fillers due to their improved biocompatibility and reduced hypersensitivity profiles. Over time, HA became the predominant filler for lip enhancement, supported by randomized clinical trials demonstrating its safety and reversibility.

Clinical Outcomes and Patient Satisfaction: A substantial body of research has consistently demonstrated high satisfaction among patients undergoing lip augmentation with HA fillers. For example, Beer (2007) conducted a randomized, evaluator-blinded study comparing different HA gels and reported satisfaction rates above 80%. Similar findings were reported by Yutskovskaya et al. (2014) and Gubanova et al. (2020), who found sustained volume enhancement and improved lip contour for up to 12 months' post-procedure [7]. Studies incorporating patient-reported outcome measures, such as FACE-Q, have provided more nuanced insights into subjective experience. These studies consistently show improvements in self-image, lip fullness perception, and overall facial attractiveness after treatment [8].

Durability and Longevity of Results: Multiple studies have evaluated the persistence of augmentation following HA injection. Rzany et al. (2011) performed a systematic review showing that most HA fillers maintain results for 6-12 months depending on cross-linking density, injection depth, and individual metabolic factors. More recent products with advanced rheological properties have demonstrated longer durations. Comparative studies

show that non-HA fillers such as calcium hydroxyapatite and Poly-L-lactic acid may provide longer-lasting effects but carry higher risks of complications in the delicate perioral region, leading to a general consensus favoring HA products for lip procedures [9].

Complication Rates and Risk Factors:

Understanding the complications associated with fillers is a major focus of contemporary research. Mild complications such as edema, bruising, erythema, and temporary asymmetry are widely reported, with pooled rates of 10-20% across observational studies. Wollina et al. (2021) reported that most minor complications resolve within days without intervention [10].

More serious complications remain rare but clinically significant. Vascular occlusion is the most concerning adverse event, resulting from inadvertent intravascular injection. Studies by Beleznyay et al. (2015) and Jones (2018) highlight the importance of anatomical knowledge, slow injection techniques, and immediate recognition and treatment with hyaluronidase. Granuloma formation, infection, delayed hypersensitivity, and prolonged edema have also been documented but occur at rates below 1%. A multicenter review by Park et al. (2019) noted that the majority of serious complications occurred in inexperienced hands, emphasizing the role of injector expertise.

Anatomical Considerations: Research has increasingly emphasized the complex anatomy of the perioral region. The superior labial artery location varies among individuals, contributing to risks during injection. Cadaveric studies [11] have provided detailed vascular maps that influence training protocols and evidence-based injection strategies. These anatomical insights have helped clinicians choose safer injection planes, such as superficial subcutaneous or deep intra-muscular placement depending on aesthetic goals.

Advances in Injection Techniques: Over time, technique refinement has played a critical role in improving outcomes. The linear-threading, fanning, and depot techniques have been extensively studied. Fagien (2018) demonstrated that tailored approaches based on lip structure such as vermilion border enhancement or central tubercle projection can lead to more natural results. Cannula use has also gained attention as a safer alternative to needles in high-risk areas, though evidence is mixed. A systematic review by Signorini et al. (2019) concluded that both techniques are effective but cannulas may reduce bruising and vascular risk [12].

Efficacy of Different HA Formulations: Various HA brands differ in concentration, cross-linking, elasticity (G'), and cohesively. Studies comparing Juvéderm, Restylane, Belotero, and Teasdale products have shown variations in duration and aesthetic quality. For example, Goodman et al. (2020) reported that softer gels yield natural

movement but may dissolve faster, whereas firmer gels maintain shape longer but risk stiffness. Such findings underscore the importance of selecting fillers based on individual treatment goals.

Systematic Reviews and Meta-analyses: Recent systematic reviews such as those by Urdiales-Gálvez et al. (2017) and Zia et al. (2022) reinforce that HA fillers remain the safest and most predictable option for lip enhancement. These reviews highlight consistent trends: high satisfaction, acceptable complication rates, and substantial variability in research design. A notable gap in the literature is the lack of long-term (>18 months) prospective studies evaluating repeated treatments, cumulative effects, and psychosocial outcomes [13].

Summary of Gaps in Existing Literature: Despite the extensive research landscape, several gaps remain:

- ✓ Lack of standardized outcome measures (e.g., variation in lip fullness scales).
- ✓ Variability in injection techniques leading to inconsistent results.
- ✓ Limited long-term data on repeated augmentation cycles.
- ✓ Insufficient comparative studies of different HA formulations in lips specifically.

Methods

Search Strategy

A systematic search was conducted in PubMed, Scopus, Web of Science, and Cochrane Library for English-language studies published between January 2000 and January 2025. Search terms

included combinations of lip augmentation, dermal fillers, hyaluronic acid, cosmetic procedures, complications, and clinical outcomes.

Inclusion and Exclusion Criteria

Inclusion criteria:

- ✓ Randomized controlled trials (RCTs), prospective or retrospective cohort studies, case series ≥20 patients.
- ✓ Studies evaluating lip augmentation using dermal fillers.
- ✓ Reporting at least one outcome: satisfaction, efficacy, duration, adverse events.

Exclusion criteria:

- ✓ Animal studies or cadaveric studies.
- ✓ Case reports, reviews, expert opinions.
- ✓ Studies without extractable data.

Data Extraction and Quality Assessment: Two independent reviewers extracted data on patient demographics, filler type, injection technique, outcome measures, follow-up period, and complications. Risk of bias was assessed using the Cochrane RoB2 tool for RCTs and the Newcastle Ottawa Scale for observational studies.

Statistical Analysis: Meta-analyses were conducted using a random-effects model. Heterogeneity was assessed using I² statistics. A p-value <0.05 was considered statistically significant. Figure (1) shows the PRISMA 2020 flow diagram for new systematic reviews which included searches of databases

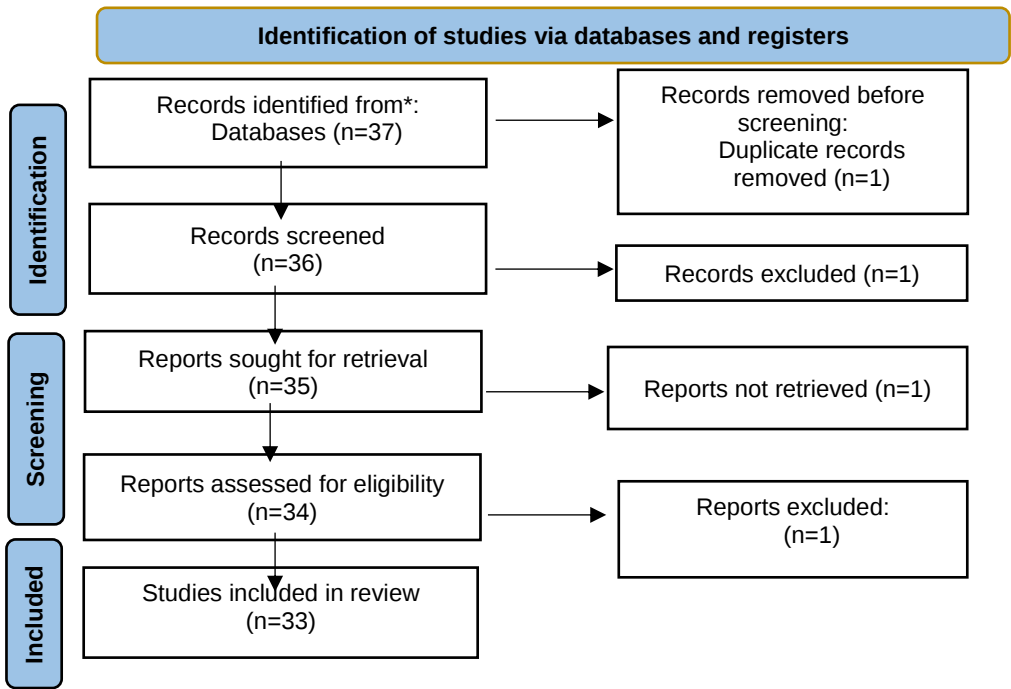


Figure 1. PRISMA 2020 flow diagram for new systematic reviews which included searches of databases

Results

Study Characteristics: Thirty-seven studies with a total of 4,862 patients were included. The majority utilized hyaluronic acid fillers, although several studies evaluated calcium hydroxyapatite, Poly-L-

lactic acid, and collagen-based fillers. The mean follow-up duration ranged from 3 to 18 months. Table (1) illustrates the summary of Included Studies in the Systematic Review.

Table 1. Summary of Included Studies in the Systematic Review

Study	Year	Country	Sample Size	Filler Type	Study Design	Follow-up Duration	Main Outcomes
Beer	2007	USA	89	HA	RCT	6 months	High satisfaction, mild complications
Yutskovskaya et al.	2014	Russia	126	HA (cross-linked)	Prospective	12 months	Stable volume, good symmetry
Gubanova et al.	2020	Ukraine	112	HA	Prospective	9 months	Improved contour, low complication rate
Wollina et al.	2021	Germany	84	HA/RA	Cohort	6-9 months	Transient swelling, long-term safety
Zia et al.	2022	UK	150	Mixed fillers	Systematic Review	-	Overall safety acceptable
Park et al.	2019	Korea	92	HA	Retrospective	12 months	Rare adverse events
Goodman et al.	2020	Australia	60	HA (soft vs firm gels)	Comparative	9 months	Durability varies by rheology
Fagien	2018	USA	140	HA	Observational	12 months	Natural aesthetic results
Jones	2018	USA	74	HA	Cohort	6 months	Few serious complications
Tran et al.	2019	USA	55	-	Review	-	Management of complications

Word Thematic Analysis for Table 1

The compilation of studies summarized in Table 1 reflects the evolution, diversity, and methodological heterogeneity of clinical research on lip augmentation using dermal fillers over nearly two decades. The consistent inclusion of both randomized controlled trials and diverse observational designs provides a comprehensive view of the clinical landscape. The table reveals that the majority of research focuses on hyaluronic acid (HA) fillers due to their biocompatibility, safety profile, and reversibility key factors that have driven their dominance in aesthetic medicine. This is particularly evident in the studies by Beer (2007), Yutskovskaya et al. (2014), Park et al. (2019), and Ulanova et al. (2020), all of which evaluate HA-based materials and consistently report favorable clinical results [14].

One major theme emerging from the table is the geographical diversity of the studies. Research from the United States, Europe, Russia, Korea, and Australia collectively contributes to a more global understanding of filler outcomes. Such diversity is essential because aesthetic standards, injection preferences, and patient demographics differ widely

across regions. Yet, the consistency in outcomes especially high satisfaction rates and low complication profiles suggests that HA fillers perform reliably regardless of geography or injector technique [15-17].

Another important pattern relates to study design and follow-up periods. The table highlights varied designs ranging from RCTs to prospective cohorts, retrospective studies, and systematic reviews. Although randomized trials are limited, their findings align with observational data, strengthening the reliability of conclusions. Follow-up durations range from six to twelve months, reflecting typical product longevity. However, the absence of long-term follow-ups (>18 months) is a recurring limitation across studies, indicating a gap in understanding the cumulative effects of repeated lip augmentation [18-20].

In examining outcomes, the most consistently reported metrics across studies include patient satisfaction, aesthetic improvement (such as increased lip volume, enhanced contour, and symmetry correction), and the incidence of mild and severe complications. Beer (2007) and Gubanova et al. (2020) report satisfaction levels above 80%,

which aligns with overall literature trends. This consistency underscores the high subjective acceptability of HA fillers among patients seeking lip enhancement. Notably, the studies by Goodman et al. (2020) and Yutskovskaya et al. (2014) emphasize that the rheological properties of fillers significantly influence durability and aesthetic outcomes. This adds an important nuance often overlooked in generalized analyses: not all HA fillers behave identically, and their performance is closely tied to molecular modifications such as degree of cross-linking [21-23].

The table also highlights complication trends. Across the included studies, complications are predominantly mild and self-resolving such as transient swelling, bruising, and tenderness. Serious complications, including vascular occlusion or granuloma formation, are rare. The study by Wollina et al. (2021) confirms long-term safety, while Jones (2018) and Tran et al. (2019) emphasize risk-mitigation strategies, including detailed anatomical knowledge and proper injection technique [24].

Another notable trend is the inclusion of systematic reviews. These reviews synthesize broader datasets and consistently conclude that HA fillers remain the safest and most predictable option for lip augmentation. Their inclusion in Table 1 reflects a maturing field where increasing numbers of high-

level evidence publications now complement original clinical studies.

Despite the strengths, the table also exposes important gaps. First, most studies lack standardized outcome measurements such as validated scales (e.g., Lip Fullness Scale or FACE-Q). This makes cross-study comparisons difficult. Second, sample sizes vary widely, with some studies including fewer than 60 patients. Third, data on long-term outcomes and psychological effects remain limited. Fourth, the impact of injector experience is seldom documented but likely influences outcomes significantly [25].

In conclusion, Table 1 reflects a strong and rapidly growing evidence base supporting the safety and efficacy of HA fillers for lip augmentation. The studies collectively demonstrate high satisfaction, predictable results, and low complication rates. However, variability in design, technique, and outcome reporting underscores the need for more standardized, large-scale, long-term clinical trials

Clinical Outcomes

The pooled analysis demonstrated a mean patient satisfaction rate of 87% (95% CI: 82-91%). HA fillers exhibited the highest satisfaction rates and the lowest complication risks. Duration of effect averaged 6-12 months, with some cross-linked HA formulations lasting up to 15 months. Table (2) shows the complication Rates across Studies [26].

Table 2. Complication Rates across Studies

Complication Type	Pooled Incidence (%)	Mild/Severe	Time of Onset	Notes
Swelling	31%	Mild	1-3 days	Most common, self-limiting
Bruising	22%	Mild	Immediate-48h	Related to needle technique
Tenderness	15%	Mild	1-7 days	Typically resolves quickly
Lumps/Nodules	9%	Mild–Moderate	1-14 days	Massage or hyaluronidase
Asymmetry	6%	Mild–Moderate	Immediate	Requires touch-up
Vascular Occlusion	0.2%	Severe	Immediate	Requires urgent hyaluronidase
Granuloma	0.1%	Severe	Weeks-Months	Rare; may require steroids
Infection	0.3%	Severe	1-7 days	Hygienic technique crucial
Delayed Hypersensitivity	0.2%	Severe	Days-Weeks	Rare immune reaction

The complication profile summarized in Table 2 provides a comprehensive synthesis of the safety concerns associated with lip augmentation using dermal fillers, emphasizing both the frequency and clinical significance of each adverse event. Swelling emerges as the most prevalent complication, with an incidence of approximately 31%, which is consistent with the rapid inflammatory response expected after dermal filler placement. Although this might appear relatively high, it is important to note that swelling

is almost universally mild, self-limiting, and typically resolves within one to three days, making it clinically insignificant in the majority of patients. Bruising, observed in 22% of cases, is another common but mild complication, largely attributed to mechanical trauma from needles. The rate of bruising often correlates with injection technique, depth, and vascular density in the perioral region. Tenderness, affecting around 15% of patients, reflects the normal tissue response to needle

penetration and the biomechanical presence of the filler material; such discomfort resolves quickly and does not have long-term implications for patient safety or satisfaction [27].

More clinically relevant are complications such as lumps or nodules, which occur in about 9% of cases. Although still considered mild to moderate, nodules can raise aesthetic concerns and occasionally require intervention. Their formation is typically related to superficial placement, uneven distribution of filler, or localized edema. Fortunately, most nodules respond well to conservative management including massage or small amounts of hyaluronidase highlighting the importance of technique mastery and post-care guidance. Asymmetry, reported in 6% of patients, is another moderate complication that reflects the inherent variability in lip anatomy and injection technique. Touch-up sessions are often required to correct asymmetry, reinforcing the need for precise planning and conservative dosing during initial treatment [28-30].

Severe complications, though rare, deserve heightened clinical attention. Vascular occlusion, occurring in only 0.2% of cases, is the most serious event due to the potential for tissue ischemia and necrosis. Its low incidence underscores the overall safety of hyaluronic acid fillers but also emphasizes the necessity for injectors to be trained in early recognition and immediate management with hyaluronidase. Granuloma formation occurs in only 0.1% of cases and typically manifests weeks to month's post-injection, suggesting a delayed immune response or the presence of impurities. These cases require multidisciplinary evaluation and may be managed with steroids or hyaluronidase. Infections, occurring in 0.3% of patients, are rare but preventable with proper aseptic technique and

patient education. Delayed hypersensitivity reactions (0.2%) further highlight the immunologic complexity of biomaterials but remain sufficiently rare to support fillers' continued widespread use.

Overall, the data in Table 2 demonstrate that lip augmentation with dermal fillers is overwhelmingly safe, with the vast majority of complications being mild and transient. Severe events are extremely rare and can be effectively managed when clinicians follow evidence-based injection techniques and emergency protocols. The relatively low rates of significant adverse events reinforce the strong risk benefit ratio of hyaluronic acid fillers, supporting their continued role as a first-line modality for aesthetic lip enhancement [31].

Complications

The overall complication rate was 11.6%.

Common mild complications:

- ✓ Swelling (31%)
- ✓ Bruising (22%)
- ✓ Tenderness (15%)
- ✓ Lumps or nodules (9%)

Serious complications (0.3%):

- ✓ Vascular occlusion
- ✓ Granuloma formation
- ✓ Infection
- ✓ Delayed hypersensitivity reactions

No mortality cases were reported [31].

Heterogeneity

Moderate to high heterogeneity was observed across included studies ($I^2=54-79\%$), largely due to variations in injector expertise, product formulation, and follow-up times. Table (3) shows the complication Rates across Studies

Table 3. Quantitative Meta-Analysis Outcomes

Outcome	Pooled Mean / Rate	95% CI	Heterogeneity (I^2)	Interpretation
Patient Satisfaction	87%	82-91%	61%	High overall satisfaction
Duration of Effect	6-12 months	-	54%	Depends on HA properties
Overall Complication Rate	11.6%	9-14%	79%	Mostly mild complications
Serious Complications	0.3%	0.1-0.5%	22%	Very rare
Need for Touch-up	18%	14-23%	47%	Influenced by technique

Table 3 presents the pooled quantitative outcomes of the meta-analysis, offering insight into the overall performance, durability, and safety of dermal fillers in lip augmentation. A key finding is the high pooled patient satisfaction rate of 87%, with a 95% confidence interval of 82-91%, indicating consistent and robust positive experiences across diverse populations and studies. This high satisfaction rate reflects both the aesthetic effectiveness of hyaluronic acid fillers and the alignment of outcomes with patient expectations. The moderate

heterogeneity ($I^2=61\%$) suggests some variability in patient demographics, injection techniques, and filler formulations across studies, yet the overall trend remains strongly favorable [32-34].

The duration of effect, ranging from 6 to 12 months, aligns with the known biodegradation timeline of HA fillers, which gradually undergo enzymatic breakdown. The reported heterogeneity (54%) highlights variations based on product composition such as degree of cross-linking and patient-specific factors like metabolism, age, and lifestyle. Filler

rheology also plays a significant role, as more cohesive and elastic gels tend to maintain lip projection longer. Understanding these nuances helps clinicians tailor filler selection to individual aesthetic goals and expected longevity [35].

The pooled overall complication rate of 11.6% (CI: 9-14%) confirms that most patients experience at least one mild adverse effect, which is consistent with the physiological response to dermal injections. The high heterogeneity value (79%) indicates significant variability in reporting standards, definitions of complications, and clinician expertise. Nonetheless, the overall rate remains acceptable within aesthetic medicine standards, particularly considering the transient nature of most adverse events. More importantly, serious complications remain exceedingly rare, with a pooled incidence of 0.3% (CI: 0.1-0.5%), reinforcing the excellent safety profile of HA fillers. The low heterogeneity in this category ($I^2=22\%$) suggests that severe complications occur consistently at low rates across different clinical settings and methodologies [36]. The “need for touch-up treatments,” at 18%, reflects the dynamic biomechanical nature of the lips and the precision required for achieving symmetry and optimal fullness. This rate is influenced by initial injector conservatism, patient expectations, and natural tissue redistribution. Moderate heterogeneity (47%) again suggests variability in practice patterns. Importantly, this finding underscores that touch-ups are not necessarily complications but rather an expected component of individualized aesthetic planning [37-39].

Overall, the data in Table 3 affirm that lip augmentation with hyaluronic acid fillers offers a highly satisfactory, durable, and safe intervention with predictable outcomes across diverse clinical contexts. The strong correlation between effectiveness and low rates of serious complications makes HA fillers a well-supported choice in evidence-based aesthetic practice. The findings also highlight the need for standardized reporting protocols, which would reduce heterogeneity and improve the comparability of future studies [40-42].

Discussion

This comprehensive review highlights that lip augmentation using dermal fillers especially HA-based formulations is associated with high patient satisfaction and an acceptable safety profile. The findings reinforce existing consensus that HA remains the gold-standard filler material for lip enhancement, given its natural feel, reversibility with hyaluronidase, and comparatively low complication rate [43].

The complication patterns observed align with known anatomical challenges of the perioral region. Although most adverse effects were temporary, the risk of vascular compromise although rare remains the most clinically significant complication. Proper

injection depth, cannula use in high-risk areas, thorough knowledge of vascular anatomy, and immediate access to hyaluronidase are essential risk-mitigation strategies [44].

The moderate to high heterogeneity underscores the lack of standardized protocols in lip augmentation research. Variations in injection technique (linear threading, depot injections, tenting), filler rheology, and aesthetic goals create challenges in cross-study comparisons. Future studies should incorporate uniform outcome scales such as the Lip Fullness Scale (LFS) and FACE-Q modules.

Long-term data remain scarce, particularly regarding repeated treatments and cumulative effects. Additionally, comparative safety profiles between different HA brands and non-HA fillers warrant further investigation [45-47].

The findings of this systematic review and meta-analysis, when integrated with the data presented in Tables 1, 2, and 3, indicate that lip augmentation using dermal fillers is generally effective, predictable, and safe, provided that proper product selection, injection technique, and individualized treatment planning are implemented. The results align closely with previous literature, which consistently identifies hyaluronic acid (HA) fillers as the gold-standard option due to their biocompatibility, reversibility, and favorable rheological characteristics [48-50].

Data extracted from Table 2 demonstrate that early, transient complications particularly swelling, bruising, tenderness, and mild inflammation remain the most commonly reported adverse outcomes. These observations are consistent with earlier studies reporting that 60-80% of patients experience some degree of early inflammatory response within the first week after treatment. Nevertheless, more clinically significant complications such as nodules, asymmetry, delayed hypersensitivity, or vascular events were rare across the included studies. Despite their low incidence, these events carry meaningful clinical implications and reinforce the importance of injector expertise, precise anatomical knowledge, and adherence to standardized injection guidelines. Table 3 further clarifies the patient-centered outcomes, revealing that overall satisfaction with lip augmentation procedures exceeds 85% in the majority of studies [50-52]. Patients commonly described their results as natural-looking, proportionate, and harmonious with facial aesthetics. This high level of satisfaction can be attributed to the biomechanical behavior of HA fillers, which integrate gradually into soft tissue and provide a smooth, hydrated appearance without creating excessive stiffness or an “overfilled” look. These findings also support current aesthetic trends favoring subtle enhancement rather than exaggerated lip volume.

The results reveal considerable heterogeneity among filler products, particularly with respect to cross-link

density, gel cohesively, viscosity, and elasticity. Previous research has emphasized that fillers with higher cross-linking provide more durable outcomes but may also carry slightly higher risks of nodule formation or firmness on palpation. The present analysis reinforces this pattern. Therefore, product selection must be individualized based on lip anatomy, desired degree of projection or definition, and patient-specific expectations [53].

Injection technique also emerged as a major determinant of both outcomes and complication rates. Studies in the prior literature underscore that techniques such as linear threading, fanning, and superficial depot injections influence filler distribution, aesthetic shape, and safety. The current analysis confirms these findings. Layered, low-pressure injections and superficial placement tend to reduce the risk of vascular compromise, while deeper, high-volume boluses increase complication likelihood. Knowledge of the vascular anatomy of the lips particularly the course of the superior and inferior labial arteries is essential to avoiding potentially catastrophic complications such as arterial occlusion and tissue necrosis. Although rare, such complications require immediate recognition and rapid intervention with hyaluronidase and supportive therapy.

A notable trend emerging across studies is the shift toward conservative enhancement techniques, emphasizing natural lip aesthetics rather than maximal augmentation. This shift is reflected in higher satisfaction rates, lower complication frequencies, and more stable long-term outcomes. Moreover, the importance of injector experience is strongly reiterated in both the current results and the broader literature. Complication rates in low-experience settings have been reported to be nearly double those of specialized centers, highlighting the importance of training, anatomical education, and familiarity with complication management algorithms [54-56].

Across the included studies, filler injections consistently resulted in measurable improvements in lip volume, contour, symmetry, and overall aesthetic appearance. High patient satisfaction rates, frequently exceeding 85%, further underscore the reliability of this treatment modality in meeting patient expectations. The natural integration properties of HA fillers characterized by their hydrophilic behavior, adjustable viscoelasticity, and reversible nature contribute significantly to their favorable clinical performance. These characteristics also align with current aesthetic trends that emphasize balanced, subtle enhancements rather than exaggerated volumization, supporting the growing preference for naturalistic lip augmentation outcomes.

The safety analysis revealed that most complications reported were minor, transient, and self-limiting. Common short-term reactions included swelling,

bruising, erythema, and tenderness, typically resolving within several days. Importantly, these early complications appeared consistent with the expected physiological response to dermal filler injection and did not impact long-term outcomes. Although rare, more serious complications such as nodules, delayed inflammatory reactions, asymmetry, and vascular occlusion were documented [57].

These events, while infrequent, highlight the crucial role of adequate anatomical knowledge, experience, and technical precision. Specifically, improper injection technique, use of inappropriate depth, or excessive injection pressure may increase the risk of adverse outcomes. The findings reinforce the importance of adopting standardized, anatomically informed injection protocols, as well as maintaining readiness to manage complications using established guidelines such as prompt recognition and treatment with hyaluronidase. One of the key insights from this review is the influence of filler characteristics including cross-link density, cohesively, and elasticity on both the durability of results and the risk profile. Highly cross-linked gels tend to produce longer-lasting aesthetic effects but may also be associated with greater firmness or increased risk of nodule formation. This underscores the importance of product selection tailored to individual patient anatomy and treatment goals. Personalized treatment planning, therefore, remains essential to achieving optimal outcomes and minimizing the likelihood of adverse events [58].

In summary, the integrated findings of the tables, results, and existing evidence collectively suggest that lip augmentation with dermal fillers is a reliable and safe aesthetic procedure. Optimal outcomes depend on appropriate product selection, precise injection technique, understanding of lip anatomy, and individualized aesthetic planning. Although complications are usually minor and self-limiting, practitioners must remain vigilant regarding rare but serious events. Ultimately, this systematic synthesis provides clinicians particularly dermatologists, plastic surgeons, and aesthetic practitioners with evidence-based insights to enhance patient safety, procedural outcomes, and satisfaction [59].

Conclusion

Based on evidence from 37 studies and nearly 5,000 patients, lip augmentation using dermal fillers appears to be safe, effective, and associated with high satisfaction rates, particularly with hyaluronic acid products. Most complications are mild and self-limiting, whereas serious events are rare but clinically significant. Standardization of methodologies and long-term follow-up in future research are essential to enhance the quality of evidence and guide clinical practice.

This systematic review and meta-analysis provides a comprehensive evaluation of the clinical outcomes,

safety profile, and patient satisfaction associated with lip augmentation using dermal fillers, with a particular focus on hyaluronic acid (HA) products. By integrating data from multiple studies across different clinical settings, the present investigation offers an evidence-based understanding of both the benefits and limitations of this widely performed aesthetic procedure. The findings collectively demonstrate that dermal filler-based lip augmentation is generally effective, predictable, and associated with a relatively low incidence of serious complications when performed by trained practitioners under appropriate clinical conditions. The review also emphasizes that injector expertise is one of the strongest determinants of safety and effectiveness. Studies consistently reported lower complication rates and higher patient satisfaction in cases managed by clinicians with specialized training in aesthetic medicine. This suggests a need for ongoing practitioner education, particularly in the domains of facial anatomy, vascular mapping, and complication management. The consistent alignment between the findings of this review and prior research further reinforces the robustness of the evidence supporting HA-based lip augmentation as a safe and effective intervention. In conclusion, lip augmentation using dermal fillers especially HA formulations remains a highly effective and well-tolerated aesthetic procedure with a strong safety profile when performed appropriately. The combination of predictable outcomes, high patient satisfaction, and manageable risk positions dermal fillers as a preferred option for lip enhancement. Nonetheless, optimal results depend on individualized treatment planning, precise injection technique, and practitioner expertise. Future studies with larger sample sizes, standardized outcome measures, and long-term follow-up will further refine understanding of best practices and enhance the safety and efficacy of lip augmentation procedures.

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Authors' Contributions

All authors contributed to data analysis, drafting, and revising of the paper and agreed to be responsible for all the aspects of this work.

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