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INJECTABLE FILLERS AND THE ORAL MICROENVIRONMENT: FROM MUCOSAL REACTIONS TO IMPLANT HEALING FAILURE: A NARRATIVE REVIEW

Narrative Review

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ABSTRACT

Background: Dermal fillers have become an integral part of facial aesthetics and are increasingly relevant to dental practice, particularly in the peri-oral region. While these agents restore volume and improve soft tissue contours, their interaction with oral tissues and dental implants presents important clinical challenges. Complications such as mucosal inflammation, delayed granulomatous reactions, filler migration, and biofilm-associated infections have been reported, with growing evidence that filler-induced reactions may mimic or exacerbate peri-implant diseases. Understanding these mechanisms is vital as the demand for combined restorative and aesthetic procedures continues to rise.

Objective: This narrative review aims to explore the interplay between dermal fillers and the oral microenvironment, with a focus on short- and long-term complications, the role of oral microbiota and biofilm in infection risk, and their potential to compromise implant osseointegration and peri-implant health.

Main Discussion Points: The review synthesizes evidence on filler classification, pathophysiological mechanisms of adverse events, and common oral/perioral complications. It further examines how biofilm formation contributes to persistent infection and delayed healing, and highlights diagnostic difficulties when filler-induced inflammation overlaps with peri-implantitis. Emerging management strategies, including ultrasound guidance and photodynamic therapy, are discussed alongside preventive measures such as careful patient selection, dental screening, and appropriate procedure timing.

Conclusion: Dermal fillers, though effective in enhancing facial aesthetics, may adversely impact oral tissues and implant success through inflammatory and infectious pathways. Multidisciplinary collaboration between dental and aesthetic specialists, combined with long-term surveillance and evidence-based protocols, is essential to improve safety, optimize treatment outcomes, and guide future research in this evolving field.

Keywords: Dermal fillers; Dental implants; Peri-implantitis; Oral microbiota; Biofilm; Narrative review.

INTRODUCTION

Dermal fillers, also known as soft tissue fillers, wrinkle fillers, or injectable implants, have become an important component of modern aesthetic medicine. These agents are primarily employed to restore volume lost due to pathological conditions and natural skin aging, while also addressing wrinkles and facial folds (1). With the growing demand for minimally invasive cosmetic procedures, their use has expanded beyond dermatologists and plastic surgeons to include dentists and maxillofacial surgeons, making these treatments increasingly accessible in routine clinical practice (2,3). Notably, women constitute the majority of individuals seeking such procedures and, consequently, experience the majority of treatment-related complications (4,5). Regulatory classification highlights the clinical importance and potential risks associated with these agents. The United States Food and Drug Administration (FDA) categorizes dermal fillers as “medical devices” rather than drugs, while in Europe they are similarly regulated as class III medical devices under the Medical Devices Regulation (MDR). This designation represents the highest risk category and applies particularly to absorbable products such as collagen and hyaluronic acid-based fillers (6,7). Such stringent classification underscores the balance between their therapeutic and cosmetic benefits and the possibility of adverse events that may complicate treatment outcomes. Despite their widespread application, gaps remain in understanding the biological interactions between dermal fillers and the oral microenvironment, as well as their potential impact on long-term tissue healing and implant success. While clinical reports continue to expand, systematic exploration of these interactions remains limited. The present study is therefore designed to critically examine the relationship between dermal fillers and the oral environment, with a specific focus on mucosal reactions and implant healing. The objective is to provide evidence-based insights that may guide safer clinical practice and inform future research directions.

Classification of filler based on material

Dermal fillers are broadly classified into biodegradable (temporary), non-biodegradable (permanent), and hybrid types, with each category defined by the material composition and degradation profile. Biodegradable fillers, such as hyaluronic acid (HA), collagen, poly-L-lactic acid (PLLA), and calcium hydroxylapatite (CaHA), provide temporary results lasting from several months to two years. In contrast, non-biodegradable fillers, including polymethylmethacrylate (PMMA), silicone, polyacrylamide gel, and expanded polytetrafluoroethylene (ePTFE), offer more permanent outcomes but are associated with higher risks of chronic inflammation and fibrosis. Hybrid formulations, which combine absorbable and non-absorbable components, attempt to balance longevity with safety, though evidence regarding their long-term outcomes remains limited (1,2).

Common oral/perioral reactions to fillers

Adverse reactions in the oral and perioral regions range from mild, transient erythema and edema to severe vascular complications that may culminate in necrosis or vision loss. The oral environment presents unique challenges because filler material may interact with peri-implant tissues, periodontal structures, or oral mucosa. Clinical reports demonstrate that most diagnoses rely on symptoms rather than biopsy, due to the recognizable presentation of swelling, nodularity, or tissue discoloration (3,4).

Long-term outcome of dermal fillers

While most complications occur within days to weeks of injection, delayed reactions months or even years later are well documented. Chronic nodules, granulomatous inflammation, biofilm-associated infections, and filler migration remain the most concerning. These outcomes often mimic oral or peri-implant pathologies, complicating diagnosis and treatment planning. Moreover, the migration of filler material from the injection site to adjacent or distant tissues has been observed, raising concerns about its potential to interfere with dental implant osseointegration and long-term peri-implant health (5,6).

BIODEGRADABLE FILLERS AND THEIR COMPLICATIONS

Hyaluronic Acid

Hyaluronic acid constitutes the majority of dermal filler use globally, primarily due to its safety, reversibility with hyaluronidase, and favorable tissue integration. Despite these advantages, delayed complications such as inflammatory nodules, edema, and granulomatous

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reactions are reported. HA's interaction with macrophages through CD44 signaling influences immune polarization, potentially promoting a pro-inflammatory microenvironment. Reports also describe migration of HA nodules, underscoring the need for precise injection techniques (7,8).

Calcium hydroxylapatite

CaHA fillers are valued for their ability to stimulate collagen synthesis, though they present risks of nodule formation, especially when injected superficially or in high volumes. Distinct "early" and "late" nodules have been described, with the latter associated with foreign body reactions and capsular fibrosis. Interestingly, the crystalline phase of calcium phosphates influences macrophage polarization, with certain forms favoring pro-inflammatory M1 activation, a mechanism linked to chronic inflammation (9,10).

PLLA

PLLA fillers act by inducing collagen regeneration through a controlled foreign-body response. Their clinical benefits are long-lasting, but delayed inflammatory nodules, granulomas, and edema have been observed months to years after injection. While overall safety is considered acceptable, complications often result from injection technique or improper dilution. Studies highlight the persistence of collagen remodeling even after PLLA degradation, which supports its efficacy but also contributes to unpredictable inflammatory outcomes (11,12).

NON-BIODEGRADABLE (PERMANENT FILLERS) AND THEIR COMPLICATIONS

Silicon gel

Liquid silicone remains controversial due to frequent reports of chronic inflammatory nodules and siliconomas, sometimes decades after injection. Severe fibrotic reactions and foreign body granulomas are more common with non-medical grade silicone. Such complications often resist treatment, even with steroids or excision, leading to cosmetic deformity and functional impairment (13,14).

Polyacrylamide gel

Polyacrylamide gel (PAAG) is generally well tolerated, but complications include infection, late-onset inflammation, and filler migration, which occurs in about 3% of cases. Migration to sensitive areas, such as the eyelids, can cause both aesthetic and functional impairment. Evidence suggests that PAAG acts as a scaffold for bacterial biofilm colonization, complicating eradication and leading to chronic low-grade infections (15,16).

Autologous fat (fat taken from the patient's own body)

Autologous fat transfer offers high biocompatibility and potential permanence, though variability in resorption rates can lead to over- or underfilling. While safer than synthetic permanent fillers, complications include cyst formation, fat necrosis, and volume unpredictability. Fat grafting remains attractive due to its autologous nature but requires technical expertise for reliable outcomes (17).

Gore-Tex/Polytetrafluoroethylene

Expanded PTFE (Gore-Tex) is a biocompatible, microporous polymer that allows tissue ingrowth while remaining removable if necessary. It has been widely used in reconstructive surgery, though its rigidity and potential for localized fibrosis limit its use in dynamic perioral regions. Nonetheless, it is considered one of the safer permanent fillers in terms of reversibility and long-term tissue tolerance (18).

Pathophysiology of short term and long-term lesions

The pathophysiology of filler complications reflects both immune and infectious mechanisms. Short-term complications often arise from poor injection technique, hypersensitivity reactions, or contamination. Long-term complications involve delayed immune responses, foreign body granulomas, or persistent biofilm-related infections. Cutibacterium acnes, Staphylococcus epidermidis, and Staphylococcus aureus are the most commonly implicated pathogens, and their ability to form biofilms around filler material complicates eradication (19,20).

Role of oral biofilm in inducing infections/microbiome impact on infectious risk

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Biofilms represent a critical risk factor in dermal filler complications, particularly in the oral and peri-implant environment. Bacteria introduced during injection can colonize filler material, forming resistant biofilm micro-niches that drive chronic inflammation. Studies demonstrate that Staphylococcus aureus, Mycobacterium abscessus, and Pseudomonas aeruginosa persist in filler matrices, reducing antibiotic susceptibility. This mechanism explains delayed-onset infections and the overlap of filler complications with peri-implant disease (21). Comparable strategies to counter biofilm colonization have been explored in dentistry, such as the application of silver nanoparticles in periodontal therapy, which highlights the translational potential of antimicrobial nanotechnology in managing filler-related infections (22).

Advanced tech to manage biofilm related issues

Photodynamic therapy (PDT) has emerged as a promising adjunctive treatment for filler-associated biofilm infections. By generating reactive oxygen species, PDT disrupts biofilm architecture and reduces bacterial viability. Early studies suggest its utility in both dental and dermatologic applications, though standardized protocols are lacking. PDT may also offer synergistic benefits in aesthetic rejuvenation by stimulating collagen remodeling (23).

Dental implant failure and filler complication

Clinical reports highlight cases where filler injections interfered with dental implant healing, particularly when administered within three months of implant placement. Filler-induced inflammation or infection may compromise osseointegration, resulting in early implant failure. Radiographic detection is further complicated by filler-induced tissue changes that mimic peri-implant pathologies (15,16).

Perivascular Injection Effects on Osseointegration

Filler-related vascular compromise through extravascular compression or intravascular occlusion can cause ischemia at implant sites. These vascular insults may impair osseointegration and contribute to soft tissue necrosis. In severe cases, intravascular filler embolization can result in catastrophic outcomes such as vision loss or stroke (17).

Possible Aggravator or Mimic of Peri-Implantitis: Inflammatory Reactions Associated with Dermal Fillers

Filler-induced delayed inflammatory reactions, including T-cell mediated hypersensitivity and granulomatous responses, may mimic peri-implantitis. Biofilm contamination during filler placement further complicates this overlap, potentially exacerbating peri-implant tissue destruction. Distinguishing filler-induced pathology from peri-implantitis remains a diagnostic challenge in clinical practice (18,19).

Dermal fillers' effects on implant planning and peri-oral aesthetics in contemporary dentistry

Beyond complications, fillers play an evolving role in dental aesthetics. HA fillers are increasingly used to enhance perioral soft tissues, harmonize lip and chin contours, and improve implant esthetics in the anterior maxilla. However, filler placement may alter gingival contour perception and complicate implant planning. Consideration of filler use is therefore essential for optimal prosthetic design and soft tissue stability (20).

Filler Migration and Misplacement: A Hidden Threat to Dental Structures

Filler migration or misplacement can present as radiopaque lesions on dental imaging, sometimes mimicking cystic or neoplastic pathology. Cone-beam computed tomography (CBCT) studies reveal variable radiodensities depending on filler composition and duration since injection. Recognition of these imaging characteristics is crucial to avoid misdiagnosis and unnecessary interventions (21).

Prevention strategies in dental and filler procedures

Prevention of complications requires comprehensive pre-procedure screening, informed consent, and meticulous injection technique. Patients should be evaluated for dental infections, periodontal disease, or systemic inflammatory conditions prior to filler use. Anatomical risk zones should be avoided, and filler procedures delayed in proximity to implant placement. Patient education is equally important, as many remain unaware of risks or rely on non-medical sources for information (23).

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Table 1: Comparative Properties of Common Dermal Fillers and Their Oral/Peri -Implant Complications

Filler Type	Estimated Complication Rate (%)	Composition	biodegradation time	Typical Use Areas	Reported Complications in Oral Tissues
Hyaluronic Acid (HA)	0.02–0.4%	Cross-linked hyaluronic acid (natural glycosaminoglycan)	6–18 months	Nasolabial folds, lips, peri-oral region	Edema, mucosal swelling, delayed fistula, inflammation near implants
Calcium Hydroxylapatite (CaHA)	0.01–0.4%	Calcium-based particles in gel carrier	12–18 months	Midface, chin, jawline	Local inflammation, granulomatous reactions, radiographic confusion near bone
Poly-L-lactic Acid (PLLA)	0.1–1%	Synthetic polymer that stimulates collagen	12–24 months	Cheeks, temples, marionette lines	Foreign body granuloma, delayed-onset nodules, potential chronic inflammation
Polymethylmethacrylate (PMMA)	1–3%	Non-biodegradable microspheres in collagen gel	Permanent	Deep folds, chin augmentation	Chronic fibrosis, nodule formation, possible migration, hardening near mucosa

Table 2: Overlapping Features and Clinical Considerations When Evaluating Filler Complications Vs Peri-Implantitis.

Category	Injectable Filler Complications	Potential Overlap in Oral Environment	Dental Implant Failure
Timing of Onset	Immediate (hours to days), Delayed (months)	Filler complications during early osseointegration phase may mimic or trigger implant failure	Early (weeks to months), Late (years)
Common Symptoms	Swelling, nodules, skin discoloration, necrosis	Shared symptoms: swelling, fistula formation, tissue breakdown	Pain, mobility, swelling, fistula, radiolucency
Primary Cause	Inflammation disrupting healing, tissue necrosis	Vascular occlusion, granuloma formation, inflammation	Lack of osseointegration, infection, biomechanical overload
Risk Factors	Poor injection technique, high filler volume, superficial placement	Anatomical proximity (e.g., nasolabial fold injections near canine fossa)	Poor bone quality, smoking, uncontrolled diabetes
Diagnostic Tools	Difficulty distinguishing causes on imaging; need for high suspicion	Difficulty distinguishing causes on imaging; need for high suspicion	Clinical exam, radiography, CBCT, probing
Histopathology	Clinical exam, ultrasound, MRI	Filler-induced inflammation may resemble peri-implantitis histologically	Inflammatory infiltrate, bone resorption, fibrous tissue
Management	Hyaluronidase (HA), corticosteroids, surgical removal	Need to delay reimplantation if filler was involved	Debridement, antibiotics, implant removal/replacement
Preventive Strategies	Trained injector, correct depth and volume, avoid danger zones	Educate patients to avoid fillers near implants during healing (3+ months)	Atraumatic technique, adequate healing time, load control

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CRITICAL ANALYSIS AND LIMITATIONS

The current literature on dermal fillers—particularly in the oral and perioral context and at the dentistry–aesthetics interface—remains dominated by observational designs, retrospective case series, expert consensus, and device-sponsored registries. Across filler classes, most safety and outcome claims are derived from nonrandomized cohorts with limited comparator arms, making causal inference difficult and inflating apparent effectiveness and safety through selection effects (1,2). For bio-stimulators such as PLLA and particulate fillers like CaHA, much of the evidence base aggregates heterogenous small studies; recent syntheses explicitly note high risk of bias in a substantial fraction of included trials and quasi-experiments, often with inadequate allocation concealment and no blinding of participants, injectors, or outcome assessors (3-5). Rigorously controlled RCTs—especially those powered to detect uncommon but high-impact harms such as vascular occlusion, vision loss, or delayed granulomatous reactions—are scarce, leaving clinicians dependent on case reports, pharmacovigilance signals, and expert algorithms rather than definitive comparative data (6,7). Follow-up horizons are frequently short (weeks to months) relative to the latency of delayed inflammatory nodules, biofilm-mediated complications, or migration phenomena that can emerge years after injection, limiting the field's capacity to quantify true long-term risk and to separate transient injection-site reactions from persistent pathology (8,9). Methodological biases are pervasive. Convenience sampling in aesthetic practices systematically skews toward younger, healthier, and female patients with lighter Fitzpatrick phenotypes, constraining external validity to populations at higher peri-implant or oral disease risk (2,10). Performance bias is common: injector experience, device choice, cannula vs needle technique, and dilution schemes are rarely standardized or blinded, and these technical variables correlate with both efficacy and adverse events—particularly for PLLA and CaHA where dilution, depth, and vectoring influence nodule rates (4,5). Detection bias further intrudes because outcome assessment often relies on unblinded clinician scales or patient-reported global aesthetic improvement, with limited use of validated, dentistry-relevant endpoints (e.g., peri-implant soft-tissue indices, standardized mucosal edema scoring, or ultrasound-verified filler localization) (9,10). Confounding is pronounced in peri-oral settings: concurrent dental therapy, periodontal inflammation, implant stage, and oral hygiene are infrequently measured and almost never adjusted for, despite plausible links to infection risk and immune priming that may modulate filler complications (8,10).

Publication bias likely favors positive or "uneventful" aesthetic outcomes. Large single-center experiences and industry-affiliated series often emphasize satisfaction metrics while underreporting late-onset nodules, biofilm-related infection, or radiographically evident migration; when harms are described, denominators and exposure windows are inconsistently stated, hindering accurate incidence estimation (2,7). Meta-analyses of vascular occlusion reflect this asymmetry: despite pooling thousands of injections, event capture depends on voluntary reporting and lacks uniform case definitions, producing heterogeneity and probable underestimation of true risk, particularly in high-risk angiosomes (7). Outcome variability further limits cross-study comparison. "Success" is measured through disparate scales (GAIS, photonumeric wrinkle scores, center-specific satisfaction scales), whereas "complications" range from transient edema to ultrasound-confirmed intravascular events, with pooling that obscures clinical relevance (6,9). Imaging endpoints—which could harmonize definitions of migration, intravascular filler, or peri-implant spread—are applied unevenly; only a minority of studies employ point-of-care ultrasound or CBCT in a standardized fashion, and radiologic readers are seldom blinded (5,10). Even within a single material class, heterogeneity in rheology, particle size, cross-linking chemistry, or carrier gels produces non-exchangeable exposures, yet studies rarely stratify by product lot or formulation, blurring dose–response relationships and complicating safety attribution (4,6).

Generalizability is constrained by geography, practice setting, and phenotype. Most contemporary series come from specialized dermatology or plastic surgery clinics rather than dental or maxillofacial centers; consequently, peri-implant and mucosal endpoints are underrepresented, and co-management with dentistry is not protocolized (2,10). Evidence in older adults, individuals with metabolic disease, smokers, and patients with existing peri-implant mucositis or peri-implantitis remains limited, though these groups plausibly carry higher risks for infection, impaired osseointegration, and exaggerated inflammatory responses (1,8). Data on interaction with oral biofilms are emerging but still preliminary; mechanistic and translational studies implicate biofilm persistence within filler matrices and reduced antibiotic susceptibility, yet clinical trials testing standardized antimicrobial or photodynamic protocols against filler-associated infections are lacking, leaving clinicians to extrapolate from dental and wound-care literatures (8,9). Taken together, the field would benefit from adequately powered, multicenter RCTs and pragmatic comparative-effectiveness studies with standardized injection protocols, core outcome sets that include peri-oral and implant-relevant endpoints, prespecified imaging criteria, and long-term surveillance beyond 24 months. Mandatory adverse-event reporting with harmonized definitions for vascular events, delayed nodules, biofilm-related infections, and migration—paired with routine ultrasound documentation—would reduce heterogeneity and curb

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publication bias. Until then, clinicians should interpret safety claims cautiously, apply ultrasound-guided techniques, and tailor risk counseling in collaboration with dental teams, particularly when treating patients with recent implants or active oral inflammation (2,7).

IMPLICATIONS AND FUTURE DIRECTIONS

The synthesis of current evidence highlights several important implications for clinical practice in both aesthetic medicine and dentistry. For practitioners, the recognition that dermal fillers may interact with the oral environment, particularly peri-implant tissues, necessitates more cautious patient selection and procedural planning. Delayed inflammatory nodules, biofilm-associated infections, and filler migration should not only be considered cosmetic complications but also potential risks for implant integration and oral health. Incorporating ultrasound-guided injections and comprehensive dental screening prior to filler placement may reduce adverse outcomes and improve early recognition of complications (1,2). Patient education emerges as another critical priority, given the persistent underreporting of risks and the reliance of many patients on non-medical information sources. Informed consent should therefore be strengthened to include discussions of potential oral complications, long-term risks, and the overlap between filler-related inflammation and peri-implant disease (3). From a policy and guideline perspective, there is an evident need for harmonized standards regarding filler use in the perioral region, particularly for patients with existing or planned dental implants. Current aesthetic practice guidelines focus primarily on dermatologic outcomes and lack integration with oral and maxillofacial considerations. Development of interdisciplinary protocols—jointly authored by dermatology, dentistry, and maxillofacial surgery societies—would help reduce variability in practice and establish consensus on topics such as safe timing of filler procedures relative to implant surgery, prophylactic antibiotic use, and the role of imaging in monitoring filler placement (4,5). Regulatory bodies may also need to expand adverse event reporting frameworks to ensure systematic capture of filler complications that present in dental or oral care settings.

Despite the expanding literature, many unanswered questions remain. The mechanisms underlying delayed-onset complications, particularly the interaction between filler materials and oral biofilms, are incompletely understood and require deeper investigation. The long-term effects of filler proximity to dental implants, the contribution of systemic diseases such as diabetes to complication risk, and the potential role of filler-induced immune dysregulation in peri-implantitis represent major research gaps (6,7). Additionally, there is insufficient evidence on the comparative safety of hybrid fillers, which combine biodegradable and non-biodegradable components, and their potential to both extend longevity and increase complication risk. Future research must prioritize robust methodological designs that can address these gaps. Well-powered, multicenter randomized controlled trials are needed to compare filler types, injection techniques, and complication rates with standardized follow-up of at least two years. Pragmatic trials embedded in real-world dental and aesthetic practices may offer valuable insights into complication management across diverse populations. Furthermore, prospective registries with mandatory adverse event reporting could mitigate publication bias and provide a more accurate estimation of rare but severe outcomes such as vascular occlusion and filler migration (1,8). Mechanistic studies integrating microbiology, immunology, and advanced imaging should also be expanded to better elucidate how biofilms and immune responses contribute to chronic filler complications. In parallel, the use of innovative technologies such as photodynamic therapy and ultrasound monitoring warrants systematic evaluation through controlled clinical studies. By integrating these recommendations into practice, research, and policy, the field can move toward safer, evidence-based use of dermal fillers while addressing their complex interactions with oral and peri-implant tissues. This will ultimately strengthen patient safety, guide interdisciplinary clinical decision-making, and ensure that aesthetic outcomes are achieved without compromising oral health.

CONCLUSION

This review underscores that dermal fillers, while widely used for aesthetic enhancement, carry significant implications for oral and peri-implant health, with complications ranging from transient edema and erythema to delayed granulomatous reactions, biofilm-associated infections, and interference with implant osseointegration. Evidence consistently highlights hyaluronic acid as the most frequently employed filler, though even biodegradable materials can provoke long-term inflammatory responses, while permanent fillers such as silicone and polyacrylamide gels present greater risks of migration and fibrosis. The strength of the current literature is limited by small sample sizes, short follow-up periods, and methodological variability, making long-term safety data less reliable. Clinicians should adopt cautious patient selection, integrate dental assessments into pre-procedure planning, and employ ultrasound-guided techniques to minimize risks, while researchers must prioritize multicenter randomized controlled trials, long-term registries, and mechanistic studies to better understand filler–biofilm interactions and peri-implant outcomes. Ultimately, advancing both clinical

practice and research in this area requires an interdisciplinary approach that bridges aesthetic medicine and dentistry, ensuring patient safety without compromising functional or aesthetic results.

AUTHOR CONTRIBUTION

Author	Contribution
Sabika Fatima*	Substantial Contribution to study design, analysis, acquisition of Data Manuscript Writing Has given Final Approval of the version to be published
Safia Khatoon	Substantial Contribution to study design, acquisition and interpretation of Data Critical Review and Manuscript Writing Has given Final Approval of the version to be published
Muhammad Ilyas Shaikh	Substantial Contribution to acquisition and interpretation of Data Has given Final Approval of the version to be published
Noreen	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Manahil Farooque Arbab	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Muqaddas Amjad	Substantial Contribution to study design and Data Analysis Has given Final Approval of the version to be published

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