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Review Article

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Functional Outcomes of Septoplasty in the Context of Respiratory Efficiency and Physical Activity: A Review

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ABSTRACT

Septoplasty is a common surgical procedure performed to correct deviated nasal septum (DNS), a condition that can cause chronic nasal obstruction, impaired breathing, and reduced quality of life. By restoring nasal alignment, the surgery aims to improve airflow and reduce symptoms of obstruction.

This review evaluates current evidence on the functional outcomes of septoplasty, with particular emphasis on respiratory efficiency and exercise performance. A systematic literature search was conducted in PubMed and Google Scholar databases, covering studies published between January 2008 and February 2025. The initial search yielded 428 records, of which 37 peer-reviewed studies met predefined inclusion criteria and were included in the final analysis. Most demonstrated consistent improvements in nasal airflow, as measured by tools such as the NOSE scale, PNIF, rhinomanometry, and spirometry (e.g., FEV_1, FVC). Some reports also noted better performance in functional assessments such as the six-minute walk test (6MWT), with postoperative increases of up to 48 meters.

While improvements in nasal breathing are well-established, direct evidence linking septoplasty to enhanced exercise performance - especially in athletes - remains limited but promising. Current findings are constrained by study heterogeneity, small sample sizes, and a lack of randomized trials focused on athletic populations.

In conclusion, septoplasty effectively relieves nasal obstruction and may improve respiratory efficiency in both daily life and physical activity. Although existing data suggest potential benefits for athletic performance, further prospective studies with objective outcome measures are needed to confirm these effects in competitive settings.

Key Words: Septoplasty, Nasal septal deviation, Nasal obstruction, Respiratory efficiency, Athletic performance, Competitive populations

INTRODUCTION

The nasal septum is a midline structure composed anteriorly of cartilage and posteriorly of bone, separating the left and right nasal cavities. It provides structural support and optimizes airflow resistance, contributing to efficient respiratory physiology. [1] Structurally, the nasal septum plays a role not only in respiratory mechanics but also in olfactory guidance and phonation, highlighting its multifaceted physiological importance.

A deviated nasal septum (DNS) is a common structural anomaly and a frequent cause of chronic nasal discomfort. In a population-based imaging study, DNS was identified in 86.6% of asymptomatic adults, illustrating its high

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prevalence and frequent underrecognition.[2] Minor septal irregularities are common anatomical variations and are generally not considered pathological unless associated with functional impairment. They may be classified as pathological when both anatomical displacement from the midline and functional consequences are present. Such consequences can include increased nasal resistance confirmed by objective tests (e.g., rhinomanometry, PNIF) or persistent symptoms such as obstruction, snoring, or recurrent sinusitis. Clinically significant deviation is estimated to affect approximately 20% of the general population, with one in four of these individuals reporting impaired nasal breathing. [3,4] DNS often results from trauma - either congenital or acquired - but may also develop spontaneously during facial growth.

Deviation of the nasal septum can also disrupt the natural airflow pattern within the nasal passages, impairing normal processes such as filtration, humidification, and thermal regulation of inspired air. [1] Many individuals adapt to impaired nasal airflow over time and remain undiagnosed until symptoms such as obstruction, recurrent epistaxis, headaches, snoring, or sleep disturbances begin to affect daily life, especially during physical activity.[4] Even minor nasal obstruction can disproportionately impact perceived breathing comfort and may lead to compensatory mouth breathing, which has been associated with alterations in posture, sleep quality, and orofacial development.[5]

Septoplasty, the surgical correction of DNS, ranks among the most frequently performed otolaryngologic procedures worldwide, as evidenced by over 20,000 annual operations recorded in England alone.[12] The primary goal of this surgery is to restore nasal patency and improve functional breathing. Its outcomes are evaluated through both subjective and objective tools. Patient-reported measures such as the Nasal Obstruction Symptom Evaluation (NOSE) score and Visual Analog Scale (VAS) capture perceived symptom severity, while objective assessments - such as peak nasal inspiratory flow (PNIF), rhinomanometry, and acoustic rhinometry - quantify airflow dynamics and nasal resistance. Rhinomanometry provides a functional evaluation of nasal airway patency by measuring transnasal pressure and airflow during respiration, allowing the calculation of nasal resistance in a dynamic and physiologically relevant manner. In contrast, acoustic rhinometry, based on sound wave reflection, measures static cross-sectional areas and nasal cavity volume, offering complementary anatomical information. Incorporating both qualitative and quantitative outcomes enables a more holistic understanding of therapeutic efficacy, balancing structural correction with patient-centered improvements.

Beyond localized nasal patency, some studies have explored the systemic respiratory relevance of septoplasty. Functional respiratory evaluations such as spirometry [17, 18] and the six-minute walk test (6MWT) [16, 18] have been used to assess postoperative ventilatory performance and exercise tolerance. PNIF has emerged as a practical and widely applied marker of nasal airflow improvement, [6,7] while rhinomanometry continues to provide complementary insights into nasal resistance.[10,11] Notably, Pendolino et al. demonstrated that PNIF correlates well with gold-standard methods such as rhinomanometry and acoustic rhinometry, supporting its utility in both clinical and research contexts. [6]

Septoplasty, while generally considered a safe and effective procedure, is associated with potential postoperative complications. Among these, postoperative bleeding is the most frequently reported, affecting approximately 2.8–3.3% of patients.[13,14] Other potential complications include septal hematoma, infection, persistent obstruction, and the need for revision surgery.[15] Nonetheless, serious complications are uncommon, and with proper surgical technique and postoperative care, patient outcomes are typically favourable.

METHODOLOGY

This article is a systematic review based on a comprehensive literature search conducted in the PubMed and Google Scholar databases between January 2008 and February 2025. The search strategy combined keywords and Medical Subject Headings (MeSH) such as "septoplasty," "nasal airflow," "respiratory function," "athletic performance," and "exercise capacity." Boolean operators (AND, OR) were applied to refine the results. Only peer-reviewed studies in English involving human participants were included. Exclusion criteria comprised non-English publications, animal studies, conference abstracts, case reports with insufficient outcome data, and studies without relevant functional or performance-related outcomes. The initial search yielded 428 records. After removing duplicates, 362 articles underwent title and abstract screening by two independent reviewers. Of these, 74 were retrieved for full-text evaluation. Following the application of predefined inclusion and exclusion criteria, 37 studies were ultimately included in the review. Data extraction was performed independently by two reviewers using a standardized form to record study design, sample characteristics, intervention details, outcome measures, and main findings. Discrepancies were resolved through discussion until consensus was reached, ensuring methodological transparency and reproducibility.

RESULTS

Clinical effectiveness and patient satisfaction

Patient satisfaction is generally considered a critical benchmark for the success of septoplasty. Across multiple observational studies, reported satisfaction rates following the procedure have consistently ranged between 69% and 100%, depending on factors such as the duration of follow-up, the severity of preoperative symptoms, surgical technique, and the specific assessment tools used. [12]

In a large multicentre randomized controlled trial (NAIROS), Carrie et al. enrolled 378 adults with moderate to severe septal deviation and nasal obstruction.[4] Participants were randomized to septoplasty (n = 188) or medical management (n = 190). At six months, the surgical group had significantly greater improvements in SNOT-22 scores (mean 19.9 vs 39.5; adjusted mean difference −20.0; $p < 0.001$), PNIF, and SF-36 quality-of-life scores.

These findings were reinforced by a systematic review and meta-analysis by Taha et al., which confirmed the superiority of septoplasty over conservative treatments, particularly beyond the third postoperative month.[5] Similarly, Alessandri-Bonetti et al. documented a mean reduction of nearly 49 points on the Nasal Obstruction Symptom Evaluation (NOSE) scale following surgery. [6]

Smaller-scale studies provide additional support. Srinivasan et al. reported that septoplasty offered greater relief compared to medical management (corticosteroids and decongestants) based on NOSE, SNOT-22, and PNIF scores.[7] Debbarma et al. and Muthubabu et al. similarly highlighted significant improvements in subjective airflow perception postoperatively.[8,9] A one-year follow-up study by Hsu et al. showed durable gains in NOSE, VAS, and rhinomanometric outcomes.[10]

Pulmonary and functional improvements

Reducing nasal resistance through septoplasty may influence lower respiratory function and contribute to improved breathing efficiency during physical exertion. Anatomical obstruction of the nasal airway increases airflow resistance and can disrupt the coordination between nasal and pulmonary ventilation.

Multiple postoperative studies consistently demonstrate improvements in spirometric values, including forced expiratory volume in one second (FEV_1 - the maximal volume exhaled in the first second, reflecting airway patency), forced vital capacity (FVC - total exhaled volume after maximal inspiration), and peak expiratory flow (PEF - maximum flow speed during forced expiration). Tuzuner et al. reported significant postoperative gains in PEF (+14.8%, $p<0.001$) and FIF50% (+12.3%, $p<0.001$), indicating reduced upper airway resistance and improved inspiratory capacity (16). Singh et al. found marked improvements in FVC (+8.1%, $p=0.001$) and mid-expiratory flow rates (FEF25-75%: +12.4%, $p=0.004$), particularly among patients with specific deformity patterns (17).

Ingale et al. observed not only better spirometric performance (FVC: +7.9%, FEV_1: +9.3%, both $p<0.05$) but also a mean increase of 48 m in the six-minute walk test (6MWT - a functional measure of submaximal endurance), a change considered clinically meaningful in respiratory rehabilitation contexts (18). Sousa et al. further demonstrated that postoperative PNIF improvements (+28 L/min, $p<0.001$) were positively correlated ($r=0.62$, $p<0.01$) with small-airway flow gains (FEF25-75%), supporting a systemic model of respiratory optimization following septoplasty (19).

The clinical relevance of these gains is likely greatest in individuals with significant preoperative functional limitation, whereas patients with milder baseline obstruction may experience more modest benefits.

Altogether, the emerging evidence positions septoplasty as an intervention capable of enhancing both subjective well-being and objective respiratory efficiency, with improvements of magnitudes that are statistically significant and potentially meaningful for daily activity and athletic performance.

Exercise-related respiratory efficiency

Although no direct clinical trials have yet confirmed a causal link between septoplasty and enhanced athletic performance, a growing body of indirect evidence strongly suggests that nasal airflow quality significantly impacts ventilatory efficiency and physical capacity. This is particularly relevant in athletic populations, where even marginal improvements in respiratory mechanics may yield measurable performance benefits.

McIntosh et al. highlighted the clinical burden of nasal obstruction among athletes, associating it with early fatigue, respiratory discomfort, and impaired recovery.[20] While their review primarily focused on diagnostic and therapeutic strategies, the physiological rationale they present supports the idea that restoring nasal patency - such as through septoplasty - could potentially extend benefits beyond symptomatic relief into the realm of exercise physiology.

This hypothesis is supported by several experimental studies. In a double-blind, crossover trial, Ferreira et al. assessed 71 adolescent athletes using external nasal dilators. They observed significant improvements in peak nasal inspiratory flow (PNIF; from 172.8 ± 20.2 to 177.4 ± 20.9 L/min, $p = 0.020$), maximal oxygen uptake (VO_2max; from 37.5 ± 5.2 to 39.5 ± 5.2 mL/kg/min, $p < 0.001$), and a reduction in perceived exertion (RPE, $p < 0.001$) (21). These results suggest that even minor mechanical improvements to nasal airflow can lead to tangible gains in respiratory efficiency and endurance.

Complementary findings come from Dallam et al., who in both a 2020 review and a 2018 pilot study emphasized that nasal breathing supports superior oxygen economy and reduces ventilatory strain compared to oral or oronasal breathing.[22,23] They demonstrated that recreational runners trained to adopt nasal-only breathing were able to maintain VO_2max while improving oxygen efficiency - further underscoring the potential benefits of optimizing nasal airflow during exercise.

Additional support is found in the work of Korowacka et al., who reported subjective improvements in exercise comfort following nasal surgical intervention.[24] Similarly, Rappelt et al. showed that nasal-only breathing during low-intensity training did not impair performance, suggesting that a sufficiently functional nasal airway can meet exercise demands even under modest airflow restriction.[25] Recinto et al. added a metabolic perspective, showing that oral breathing during high-intensity efforts was associated with increased lactate accumulation and altered ventilatory dynamics - indicating that preserving nasal breathing may offer advantages in delaying fatigue and optimizing metabolic responses.[26] However, not all findings point to clear performance gains, as illustrated by the results of Rappelt et al. suggesting that in certain conditions increased nasal airflow may have a neutral effect on exercise capacity.

Despite the compelling nature of this indirect evidence, studies directly examining the effects of septoplasty on athletic performance remain lacking. This is likely due to several methodological and ethical challenges. Recruiting elite athletes for surgical trials is inherently difficult given their rigorous training schedules, competitive calendars, and the need to avoid disruptions to performance. Furthermore, controlling for the many variables that influence physical performance - such as training intensity, nutrition, psychological state, and baseline fitness - requires sophisticated study designs, substantial resources, and long-term follow-up. Ethical concerns around performing surgery on otherwise healthy individuals must also be carefully considered.

Septoplasty may improve respiratory efficiency and potentially enhance athletic performance. This hypothesis is based on physiological reasoning, experimental data from mechanical interventions, and reports from postoperative patients. However, no direct evidence from trials involving elite athletes currently exists. A major limitation is the absence of studies specifically targeting this population. Well-controlled, prospective research is necessary to confirm these potential benefits and to define the role of surgical nasal correction in optimizing physical capacity.

Table 1: Summary of key studies included in the systematic review on septoplasty, respiratory function, and physical performance

Author(s)	Study Design & Population	Sample Size	Main Measures	Key Findings
Carrie et al. (4)	Multicentre RCT; adults with moderate–severe septal deviation and nasal obstruction	378 (188 septoplasty, 190 medical management)	SNOT-22, PNIF, SF-36	At 6 months, septoplasty group showed greater improvement in SNOT-22 (mean 19.9 vs 39.5; adj. mean diff. −20.0; p<0.001), PNIF, and QoL scores.
Taha et al. (5)	Systematic review & meta-analysis; RCTs comparing septoplasty vs non-surgical	3 RCTs; 721 participants	NOSE, SNOT-22, PNIF	Septoplasty improved NOSE & SNOT-22 at 6 & 12 months; no PNIF difference; low complication rates (revision 0.31%, bleeding/infection 4.12%).
Alessandri-Bonetti et al. (6)	Meta-analysis; septoplasty ± turbinate surgery	2577 patients	NOSE score	Mean baseline NOSE 68.1; mean reduction −48.8 at 6 months, indicating significant symptom/QoL improvement.
Hsu et al. (10)	1-year follow-up; septoplasty vs controls	50 patients + 28 controls	VAS, NOSE, Rhinomanometry	Significant symptom and nasal resistance improvement at 3, 6, and 12 months post-op; no significant correlation between subjective & objective measures post-op.
Sousa et al. (19)	Prospective; septoplasty + turbinate reduction	37 patients	PNIF, FEF25, FEF75, FEF25–75, FVC, FEV1	Significant PNIF and small-airway flow improvements; positive correlation between ΔPNIF & ΔPFT; no change in FVC, FEV1.
Ferreira et al. (21)	Double-blind crossover trial; adolescent athletes with nasal dilators	71 athletes	PNIF, VO_2max, RPE	Significant PNIF increase, VO_2max improvement, and reduced RPE with nasal dilators.
Recinto et al. (26)	Crossover trial; Wingate anaerobic test with nasal vs oral breathing	9 participants	RER, HR, power output	Oral breathing increased RER during 10–25 sec; nasal breathing increased HR in final intervals; no performance difference.

DISCUSSION

Potential downstream effects of nasal obstruction

Beyond the direct effects on nasal airflow, septal deviation may contribute to a range of downstream physiological consequences. Although these associations are largely hypothetical and supported by indirect evidence, understanding them may offer a more comprehensive view of the functional importance of nasal patency. In this section, three key domains are explored: sleep and recovery, infection susceptibility, and thermoregulation during exercise.

Sleep and recovery

Deviated nasal septum (DNS) may contribute to various sleep disturbances, including impaired sleep continuity and excessive daytime sleepiness.[27,28] Increased nasal resistance can lead to habitual mouth breathing during sleep, which may disrupt sleep architecture and cause more frequent awakenings. Polysomnographic and patient-reported studies indicate that septoplasty can improve sleep quality and continuity.[30,31]

Given the critical role of sleep in physical and mental recovery, these improvements have potential clinical significance for athletes. Poor sleep, common among this population,[32] can negatively affect hormonal balance, cognitive performance, and training adaptation.[33,34] By restoring nasal airflow, septoplasty may reduce night-time respiratory disturbances, enabling more effective physiological restoration between training sessions and competitions.

Infection susceptibility and training disruption

DNS has been linked to an increased risk of chronic rhinosinusitis, likely due to altered airflow patterns and impaired mucociliary clearance. A population-based study found that individuals with DNS were nearly three times more likely to develop sinusitis compared to those with normal nasal anatomy.[35] Frequent upper respiratory infections, such as sinusitis or the common cold, can disrupt training continuity, cause forced rest periods, and contribute to systemic inflammatory stress, delaying recovery and impairing performance. Restoring nasal patency through septoplasty may help normalize mucociliary clearance and improve nasal airflow, thereby reducing infection frequency.

For athletes, this could mean fewer training interruptions, improved seasonal performance consistency, and a lower inflammatory burden during intensive training phases.

Thermoregulation and endurance

Limited nasal airflow might affect craniofacial heat dissipation, potentially accelerating fatigue during exertion under thermal stress. The nasal passages play an important role in cooling inspired air and dissipating heat from the craniofacial region. When airflow through the nose is obstructed, these thermoregulatory mechanisms may be compromised, increasing reliance on other, less efficient forms of heat loss such as sweating. Although direct clinical evidence is scarce, studies on targeted head cooling suggest potential endurance benefits under heat stress conditions, and computational fluid dynamics (CFD) simulations suggest that abnormal nasal airflow patterns are associated with greater heating and humidification of inhaled air.[36,37]

By improving nasal airflow, septoplasty could enhance craniofacial heat dissipation and help delay fatigue during exercise in warm environments. This potential advantage may be particularly relevant for athletes competing in endurance events or high-temperature conditions, although it remains a theoretical proposition requiring dedicated investigation.

CONCLUSION

Septoplasty is a well-established surgical procedure for correcting structural nasal obstruction and restoring effective nasal airflow. Evidence suggests that its benefits may extend beyond local symptom control, potentially enhancing pulmonary function, exercise capacity, sleep quality, and reducing infection susceptibility. These systemic effects are particularly relevant for athletic and physically active populations, where even minor respiratory limitations can accumulate into meaningful performance deficits. In high-performance sport, where every physiological detail can shape outcomes, optimizing nasal airflow could offer subtle yet functionally significant advantages.

Current evidence on septoplasty impact on athletic performance remains largely indirect, with no randomized trials in elite athletes. Future studies should employ prospective designs incorporating objective measures of endurance, recovery, and sleep quality, while controlling for training-related variables. Including diverse athlete populations and conducting long-term follow-up would help determine whether physiological improvements translate into measurable performance gains.

DISCLOSURE

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Author's contribution
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