JOURNAL OF EDUCATION, HEALTH AND SPORT
eISSN 2391-8306 · Open Access · Peer-reviewed
apcz.umk.pl/JEHS · Nicolaus Copernicus University in Toruń



KUCZYŃSKA, Karolina, GANCZARENKO, Klaudia, PUŁA, Oliwia, ZIELIŃSKA, Marta, LIPIŃSKI, Damian, MISZKIN, Natalia, ŁYSOŃ, Zuzanna, KLATA, Zofia, WOLNIAK, Martyna and PRZENAJKOWSKA, Maja. Physical Performance, Exercise Capacity and Physical Activity Following Nasal Septal Surgery: A Narrative Review.Journal of Education, Health and Sport. 2026;95:76672. https://doi.org/10.12775/JEHS.2026.95.76672

ARTICLE TIMELINE
Received: 13.10.2026.
Accepted: 10.11.2026.
Published: 18.11.2026.

INDEXING & EVALUATION
MEiN points: 40 Unique ID: 201159
Disciplines: Physical culture sciences (Field of medical and health sciences); Health Sciences (Field of medical and health sciences).

The journal has been awarded 40 points in the parametric evaluation by the Polish Ministry of Higher Education and Science (Annex to the announcement of 05.01.2024, No. 32318). Unique Journal Identifier: 201159. Scientific disciplines: Physical culture sciences (Field of medical and health sciences); Health Sciences (Field of medical and health sciences).

Punkty Ministerialne z 2019 – aktualny rok 40 punktów. Załącznik do komunikatu Ministra Szkolnictwa Wyższego i Nauki z dnia 05.01.2024 L.p. 32318. Posiada Unikatowy Identyfikator Czasopisma: 201159. Przypisane dyscypliny naukowe: Nauki o kulturze fizycznej (Dziedzina nauk medycznych i nauk o zdrowiu); Nauki o zdrowiu (Dziedzina nauk medycznych i nauk o zdrowiu). © The Authors 2026.

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Physical Performance, Exercise Capacity and Physical Activity Following Nasal Septal Surgery: A Narrative Review

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ABSTRACT

Introduction. Septoplasty is one of the highest-volume operations in otorhinolaryngology and difficulty exercising is among the complaints that bring patients to it. Yet the two randomised trials establishing the operation's effectiveness measured no exercise outcome, and it is unclear whether restoring nasal patency changes what patients can physically do.

Aim. To synthesise evidence published between 2016 and 2026 on physical performance, exercise capacity and physical activity following nasal septal surgery, with explicit attention to how nasal airflow and performance were measured, and to establish whether any improvement in performance is attributable to measured gains in nasal airflow.

Material and methods. Narrative, non-systematic review. PubMed/MEDLINE and Google Scholar were searched from January 2016 to August 2026, restricted to English-language publications. Case reports and narrative reviews were excluded. Forty-nine studies were included.

Results. Septal surgery improves symptoms on randomised evidence, and alters measured airflow - most reliably its distribution between the nostrils rather than total flow. Objective exercise measures improve only at submaximal intensity: oxygen cost, heart rate and blood lactate fall at a given workload, while maximal aerobic capacity does not rise in any study. Only three studies used an exercise endpoint and only one included a comparison group. Change in airflow does not predict change in patient outcome, and symptom control achieved without surgery reproduces the same gains in fitness and habitual activity.

Conclusions. Septal surgery improves the efficiency of submaximal effort rather than maximal capacity, and the benefit is not attributable to measured airflow gain. Septoplasty should be indicated for symptomatic obstruction and quality of life, not presented as a means of improving performance.

Key words: septoplasty; nasal obstruction; exercise tolerance; oxygen consumption; peak nasal inspiratory flow; athletes; patient-reported outcome measures

1. Introduction

Nasal septal deviation is among the most common structural causes of chronic nasal obstruction, and septoplasty usually performed with concurrent inferior turbinate reduction - is one of the highest-volume operations in otorhinolaryngology [1]. Its indications are symptomatic, and they rest on randomised evidence: the NAIROS trial reported a 20.0-point advantage in SNOT-22 score over medical management at six months (95% CI 16.4–23.6) [2], a Dutch pragmatic trial found a Glasgow Health Status Inventory difference of 8.3 points sustained to 24 months [3], and two meta-analyses concur [4,5].

Among the symptoms the NAIROS investigators identified as driving patients to surgery was difficulty exercising, recorded in the trial's qualitative part as a theme in patients' own words [6]. Yet neither trial measured any exercise outcome. That gap - between what patients seek from the operation and what has been tested - is the subject of this review.

The physiological rationale for expecting benefit is real but bounded: the nasal contribution to total ventilation falls steeply as exercise intensity rises, and exercise itself lowers nasal resistance without any intervention [7]. Any benefit of restoring nasal patency would therefore be expected at submaximal rather than maximal intensity. Experimental work agrees: comparisons of nasal and oral breathing show no difference in power output or muscle oxygenation, but faster post-exercise recovery and improved flow-mediated dilation during nasal breathing [8,9].

The clinical literature is correspondingly asymmetric. Uncontrolled series report improvement in spirometry and in six-minute walk distance [10-13], and meta-analysis finds moderate pooled effects while grading the certainty of the evidence as low [14]. Only three studies have employed a genuine exercise endpoint; all are small, and only one includes a comparison group [15-17]. Meanwhile, improvements in nasal airflow and improvements in patient outcome do not reliably track one another - a dissociation this review examines directly.

Research Objective. To synthesise the evidence published between 2016 and 2026 on physical performance following nasal septal surgery, with explicit attention to how nasal airflow and physical performance were measured, and to establish whether any improvement in performance is attributable to measured gains in nasal airflow.

Four questions are addressed:

1. Does septal surgery improve physical performance?

2. Does it improve exercise tolerance and habitual physical activity?

3. Are changes in physical performance associated with measured improvement in nasal airflow?

4. Do benefits differ in athletes and highly physically active individuals from everyday patients?

Eligibility criteria and the search strategy are described in the following section.

2. Materials and methods

This narrative review was conducted to collect and synthesise current evidence on physical performance, exercise capacity and physical activity following nasal septal surgery. Literature searches were performed in the PubMed/MEDLINE and Google Scholar databases.

The search covered publications from January 2016 to August 2026 in order to capture contemporary surgical practice and current approaches to outcome measurement, and was restricted to publications in English. Reference lists of retrieved articles were hand-searched for further sources.

The keywords included combinations of: "septoplasty", "nasal septal deviation", "nasal obstruction", "nasal surgery", "nasal valve", "exercise", "exercise capacity", "physical performance", "maximal oxygen uptake", "running economy", "physical activity", "six-minute walk test", "spirometry", "athlete", "peak nasal inspiratory flow", "rhinomanometry", and "acoustic rhinometry". Boolean operators AND and OR were used to refine the search results.

The review included prospective and retrospective clinical studies, randomised controlled trials, experimental and physiological studies, and evidence syntheses in the form of systematic reviews and meta-analyses. Case reports and non-English publications were excluded, as were narrative reviews. Consensus statements and society position papers were retained for contextual and definitional purposes only, are identified as such wherever cited, and were not treated as evidence bearing on the four review questions.

The selection process involved screening titles and abstracts, followed by full-text assessment of eligible articles. Structured queries returned 3,511 records, exploratory queries were being screened to a relevance-ranked cap. After removal of 28 duplicates, 162 records were

screened by title and abstract and 68 assessed in full, of which 19 were excluded: six narrative reviews, six whose full text could not be obtained, three whose outcomes could not be extracted, two case reports and two overlapping or superseded cohorts. Forty-nine studies were included.

3. Description of the state of knowledge

3.1. Nasal airway physiology during exercise

The nose is the default route of breathing at rest, but its contribution falls as ventilatory demand rises. Nasal respiration accounts for approximately 85% of total ventilation at rest and only 27% at 90% of maximal work capacity, as reported by Russel et al. [7]. Any benefit conferred by improved nasal patency is therefore bounded: the nasal airway matters least at the intensities that determine maximal performance, and most at the submaximal intensities at which most training is conducted.

Exercise also improves nasal patency without any intervention. Sympathetic vasoconstriction of the nasal capacitance vessels reduces mucosal blood flow and nasal resistance during exertion [7]. In allergic rhinitis, aerobic exercise reduced nasal blood flow and symptom scores and increased peak nasal inspiratory flow at both 25 °C and 34 °C, the reduction in blood flow being greater at the lower temperature [18]. Systematic review of nasal change in athletes has found no evidence that exercise narrows the nasal airway; the changes reported are mucosal and largely reversible with rest [19]. This carries a methodological consequence for the studies reviewed below: where nasal patency is measured around exertion, the exercise itself alters it. In endurance athletes, post-exercise peak nasal inspiratory flow exceeded pre-exercise values irrespective of whether a nasal dilator was worn [20].

What the breathing route does not appear to alter is capacity. Experimental comparisons of nasal and oral breathing found no difference in anaerobic power output [8], nor in peak power or muscle desaturation measured by near-infrared spectroscopy [9]. The difference was metabolic and vascular: respiratory exchange ratio was higher during oral breathing [8], and nasal breathing produced faster post-exercise muscle recovery together with improved flow-mediated dilation, from 107.4% to 110.3% ($p < 0.001$), consistent with greater nitric oxide bioavailability [9].

This is the pattern that recurs throughout the evidence reviewed below: the nasal route alters efficiency, recovery and vascular function without altering maximal capacity.

3.2. Septoplasty and the measurement of its outcomes

Nasal obstruction is the dominant presenting complaint in patients selected for septoplasty [1], and the operation's effectiveness for that complaint is established by two randomised trials and two meta-analyses [2-5]. The larger meta-analysis pooled 2,577 patients and reported a mean improvement of 48.8 points on the Nasal Obstruction Symptom Evaluation scale from a baseline of 68.1 [5] - an estimate that groups pre-operative with post-operative scores, rather than surgery with control, and so cannot separate the operation from natural history, regression to the mean, or expectancy.

Two features of this literature complicate any reading of it. The first is that septoplasty is frequently not performed alone. Concurrent inferior turbinate reduction is common enough that the larger randomised trial allocated patients to septoplasty "with or without concurrent turbinate surgery" [3], and the study that tested septoplasty most directly against exercise capacity examined the combined procedure [16]. The two operations are not equivalent. In a series of 5,639 patients divided almost evenly between septoplasty alone and septoplasty with turbinoplasty, septal haematoma, hyposmia, infection, adhesions and ocular complications were each significantly more frequent after the combined procedure [21]. Where benefit is found, the contribution of the septum cannot be isolated from that of the turbinates.

The second is measurement. Outcomes are reported on two scales that do not agree (Table 1). In a clinimetric comparison in 111 adults, correlations between subjective and objective instruments were low, and of all instruments tested only the subjective Glasgow Health Status Inventory proved responsive to surgery [22]. In 528 patients scheduled for nasal surgery, peak nasal inspiratory flow correlated significantly but weakly with patient-reported obstruction; bilateral and minimal-unilateral measurements performed equally, both correlating better with a targeted obstruction scale than with the broader Sino-Nasal Outcome Test-22, and topical decongestion weakened the correlation further [23].

Table 1. Instruments used to assess nasal patency and physical performance in the reviewed literature

Instrument	Type	What it measures	Documented limitation in this literature
Nasal Obstruction Symptom Evaluation (NOSE)	Subjective	Symptom-specific obstruction severity	Pooled estimates are pre-post rather than surgery-versus-control [5]

Sino-Nasal Outcome Test-22 (SNOT-22)	Subjective	Broad sinonasal quality of life	Correlates with peak nasal inspiratory flow less well than a targeted obstruction scale [23]
Visual analogue scale (VAS)	Subjective	Global obstruction	No anchor to a clinically meaningful difference in this literature
Glasgow Health Status Inventory (GHSI)	Subjective	General health status	The only instrument shown responsive to surgery in a clinimetric comparison of 111 adults [22]
Peak nasal inspiratory flow (PNIF)	Objective	Peak inspiratory flow through the nose	Correlates significantly but weakly with reported obstruction; decongestion weakens it further [23]
Rhinomanometry	Objective	Nasal airflow resistance	Low correlation with subjective instruments [22]
Acoustic rhinometry	Objective	Nasal cross-sectional area and volume	Anatomical rather than functional [15]
Spirometry	Performance (resting)	Lower-airway calibre	Not a performance measure; ceiling effects in healthy adults
Six-minute walk test (6MWT)	Performance (submaximal)	Functional walking capacity	Learning effect on repetition; baseline distances range from 425 to 702 m across studies [10,11,13]
Cardiopulmonary exercise testing	Performance (maximal)	Maximal aerobic capacity	Used in two studies only, both underpowered for it [15,16]
Running economy	Performance (submaximal)	Oxygen cost of a fixed workload	Measured once, in athletes [15]
Accelerometry	Performance	Habitual physical	Never measured following

	(free-living)	activity	septoplasty

Performance endpoints are similarly heterogeneous, ranging from spirometry and the six-minute walk test [10,11] through cardiopulmonary exercise testing and running economy [15] to free-living accelerometry. The first two are the most frequently reported and the least informative about athletic performance: both are submaximal, both are subject to ceiling effects in fit populations, and neither was designed to detect changes of the magnitude an athlete would notice. That heterogeneity is not merely descriptive: pooled analyses of pulmonary function across this literature are dominated by it [14].

3.3. Effects on physical performance

The uncontrolled literature is more mixed than it is usually represented (Table 2). Three prospective series measured six-minute walk distance, and their results diverge (Figure 1). In sixty patients reassessed three weeks after septoplasty performed alone, distance rose from 425 ± 30 to 460 ± 40 m [10]. In thirty patients reassessed at one month, it rose from 702.3 ± 68.2 to 753.2 ± 72.6 m, a gain of 7% [11]. In seventeen patients reassessed at six months with a full physical fitness battery, it rose from 666.5 ± 100.7 to 799.4 ± 90.6 m, a gain of 20% [13]. The baselines are as striking as the gains: three nominally similar populations began 277 m apart.

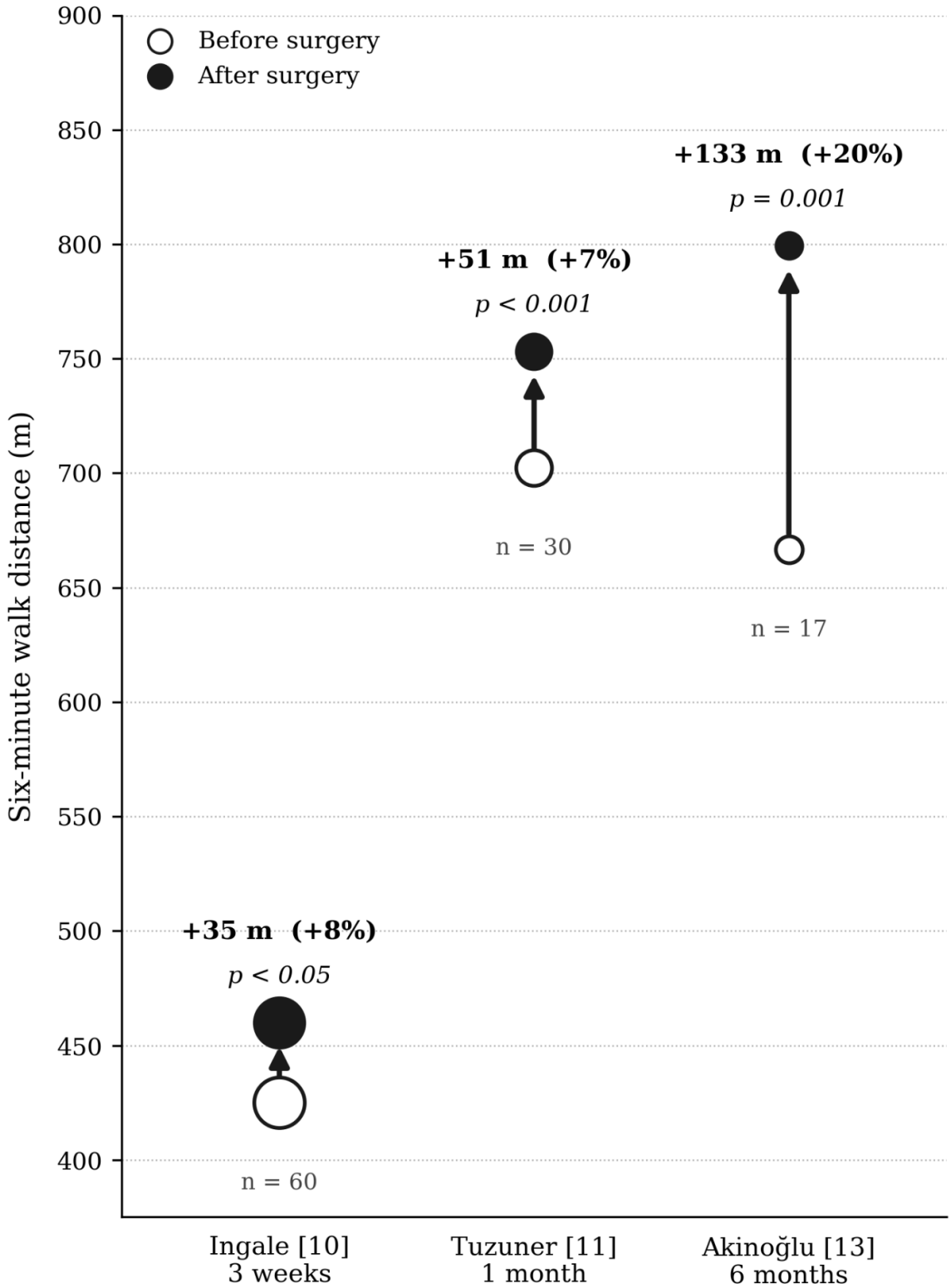
Elsewhere the gains are smaller, confined to isolated indices, or absent. In the first of those cohorts, forced expiratory volume rose only from 85.4% to 88.2% of predicted - statistically significant, clinically negligible [10]. In 88 patients undergoing septoplasty with or without turbinoplasty, every spirometric index improved, but heart rate during the walk test did not change and the distance walked was not reported [12]. Pulmonary function indices in 72 patients improved significantly at two months but not at one [24]. In 50 patients, significance was reached in isolated flow indices and only within one anatomical subtype of deviation [25]. A study pairing peak nasal inspiratory flow with spirometry found forced vital capacity, forced expiratory volume and peak expiratory flow unchanged, although peripheral airway function improved [26]. Across these series the largest apparent gain comes from the longest follow-up and the smallest sample - a combination that an uncontrolled design cannot separate from learning effects on a repeated walk test, altered training after recovery, and regression to the mean.

Table 2. Studies reporting a physical performance or exercise endpoint after nasal septal surgery

Study	Design and n	Procedure	Follow-up	Performance measure	Principal result
Melekoğlu 2026 [15]	Controlled, matched; 11 + 11 male athletes	Septoplasty	2–3 months	Running economy, incremental treadmill test	Group × Time interaction p = 0.005; lower oxygen cost at submaximal stages
Pearlman 2026 [16]	Single-arm prospective; n = 13	Septoplasty with inferior turbinate reduction	3 months	Cardiopulmonary exercise test; HR, lactate, RPE	Relative VO_2 and tidal volume unchanged; HR 177.3 → 171.7 bpm (p = 0.046); lactate 5.84 → 4.71 mmol/L (p = 0.004)
Yigit 2022 [17]	Prospective; n = 30	Septoplasty	3 months	Exercise treadmill test	Maximum effort capacity 11.8 → 13.1 METs (p = 0.010)
Ingale 2024 [10]	Prospective longitudinal; n = 60	Septoplasty alone (combined procedures excluded)	3 weeks	Spirometry, 6MWT	6MWT 425 → 460 m; FEV_1 85.4 → 88.2% predicted (both p < 0.05)
Tuzuner 2016 [11]	Prospective; n = 30	Septoplasty	1 month	Spirometry, 6MWT	6MWT 702.3 → 753.2 m (p < 0.001); PEF and FIF50% improved; heart rate rose 83.5 → 90.1 bpm (p = 0.017)
Arifa 2022 [12]	Prospective; n = 88	Septoplasty with or	1 month	Spirometry; physiological	FEV_1, FVC, FEV_1/FVC and

		without turbinoplasty		responses during 6MWT	PEFR all improved ($p < 0.001$); heart rate unchanged ($p = 0.79$); walk distance not reported
Akinoğlu 2017 [13]	Prospective; n = 17	Septoplasty	6 months	6MWT plus strength, endurance, flexibility, agility, speed and balance battery	6MWT 666.5 → 799.4 m; most fitness parameters improved ($p < 0.05$)
Chakraborty 2025 [24]	Prospective interventional; n = 72	Septal correction with or without turbinoplasty	1 and 2 months	Spirometry	All indices improved; not significant at 1 month, significant at 2 months
Singh 2022 [25]	Prospective; n = 50	Septoplasty	1 month	Spirometry	Significance in isolated flow indices only, and within one anatomical subtype
de Sousa 2025 [26]	Prospective; n = 37	Septoplasty with turbinate reduction	3 months	PNIF and spirometry	PNIF improved ($p < 0.001$); FVC, FEV_1 and PEF unchanged; peripheral airway function improved; ΔPNIF correlated with ΔPFT ($p < 0.05$)

Source: own elaboration. 6MWT - six-minute walk test; FEV_1 - forced expiratory volume in one second; FVC - forced vital capacity; PEF - peak expiratory flow; PEFR - peak expiratory flow rate; PNIF - peak nasal inspiratory flow; RPE - rating of perceived exertion; MET - metabolic equivalent of task.



Marker area is proportional to sample size. All three within-group changes were statistically significant. Studies are placed in ordinal order of follow-up interval, not on a continuous time axis; no trend is fitted.

Figure 1. Six-minute walk distance before and after nasal septal surgery, by interval to reassessment*Source: from data reported in [10], [11] and [13].*

Meta-analysis reflects this spread rather than resolving it. Pooled across three studies, six-minute walk distance increased by 62.40 m (95% CI 24.79–100.00), with standardised mean differences of 0.72 for forced expiratory volume, 0.63 for forced vital capacity and 0.64 for peak expiratory flow. But of the twelve studies contributing pulmonary function data, six showed significant improvement, three were mixed and three found none - heterogeneity on the strength of which the authors graded their own evidence as low [14].

Only three studies have used an exercise endpoint. The first is the only controlled study in this literature: eleven athletes with nasal obstruction and eleven matched athletes without were tested before and two to three months after surgery, yielding a significant Group × Time interaction for running economy ($p = 0.005$) and reduced oxygen cost at submaximal treadmill stages [15]. The second, a single-arm study of thirteen patients that its authors describe as underpowered, found no change in relative oxygen uptake or tidal volume; but heart rate at the highest exertional stage fell from 177.3 to 171.7 bpm ($p = 0.046$), blood lactate from 5.84 to 4.71 mmol/L ($p = 0.004$), and perceived exertion improved [16]. The third found maximum effort capacity on treadmill testing improved from 11.8 to 13.1 metabolic equivalents ($p = 0.010$) [17].

These three do not conflict. Each found the cost of a given workload reduced, and none found maximal aerobic capacity increased.

3.4. Exercise tolerance, physical activity, sleep and cardiopulmonary function

Capacity, tolerance and behaviour are not the same thing, and the literature separates them poorly (Table 3).

Sleep is where the evidence is strongest. In 32 patients undergoing septoplasty with inferior turbinate reduction, Epworth Sleepiness Scale scores improved by a mean of 2.7 ± 4.4 points ($p = 0.002$), and the proportion screening at high risk for sleep-disordered breathing on the Berlin Questionnaire fell from 50% to 25% [27]. Polysomnography in a separate series supplies the objective correlate: the apnoea–hypopnoea index fell from 11.6 ± 5.76 to 6.5 ± 2.88 ($p < 0.001$), with parallel improvement in snoring index and oxygen saturation [28]. The benefit may be confined to milder disease. That cohort had a baseline apnoea–hypopnoea index of 11.6; an earlier series with a baseline of 31.6, as reported by Mandour et al., showed no significant change in the apnoea–hypopnoea index or in oxygen desaturation after nasal surgery alone [28].

Two cautions attach to this. The sleepiness gain did not correlate with the gain in peak nasal inspiratory flow ($p = 0.516$) [27] - the dissociation examined in the following section. And an earlier, non-overlapping cohort recruited by the same unit, screened with the same instrument, found no significant change in sleep-apnoea risk [26].

What patients experience also shifts across recovery. In 65 patients, the predictors of comfort before surgery were use of sleeping medication, nasal obstruction, fatigue and subjective sleep quality; at four weeks they were daytime dysfunction and subjective sleep quality; and at twelve weeks, daytime dysfunction and working conditions [29]. The determinants of comfort are not fixed, which complicates the interpretation of any single post-operative timepoint.

Habitual physical activity is almost never measured, and the one study that measures it well lies outside septoplasty. In a randomised trial in 58 adults with chronic rhinosinusitis with nasal polyps, six months of mepolizumab increased daily step count and maximal oxygen uptake in both arms - by 1,117 steps and 1.95 mL/min/kg with sinus surgery, and by 1,087 steps and 1.50 mL/min/kg without it - while surgery conferred an additional quality-of-life benefit (SNOT-22 −42 versus −32 points, $p = 0.040$) but no additional gain in fitness [30]. Relieving the symptom, by whatever means, was sufficient.

Cardiopulmonary findings are consistent but indirect. Mean pulmonary artery pressure fell and tricuspid annular plane systolic excursion rose three months after septoplasty [31]; mean pulmonary artery pressure fell from 24.68 ± 5.26 to 20.75 ± 4.83 mmHg in a second series [32]; and the left ventricular myocardial performance index improved from 0.52 ± 0.06 to 0.41 ± 0.04 [33]. In that last study, however, the ejection fraction was unchanged ($63.8 \pm 2.8\%$ versus $64.6 \pm 3.2\%$, $p = 0.224$). These are surrogate endpoints, and no study in this literature links a haemodynamic change to a measured change in performance.

Table 3. Sleep, habitual physical activity and cardiopulmonary outcomes after nasal airway surgery

Study	Design and n	Domain	Measure	Principal result
de Sousa 2026 [27]	Prospective; n = 32	Sleep	Epworth Sleepiness Scale; Berlin	ESS improved 2.7 ± 4.4 points (p = 0.002); high-risk proportion 50% →

			Questionnaire; PNIF	25%; ESS gain did not correlate with PNIF gain (p = 0.516)
Mandour 2020 [28]	Prospective; polysomnography	Sleep	Apnoea–hypopnoea index; snoring index; oxygen saturation	AHI 11.6 ± 5.76 → 6.5 ± 2.88 (p < 0.001), with parallel improvement in snoring index and saturation
Taylan 2021 [29]	Prospective; n = 65	Comfort, sleep, fatigue	Short General Comfort Questionnaire; Pittsburgh Sleep Quality Index; Fatigue Severity Scale; NOSE	Predictors of comfort differ before surgery, at 4 weeks and at 12 weeks
Tidemandsen 2026 [30]	Randomised controlled trial; n = 58 (CRSwNP)	Habitual activity and fitness	Daily step count; VO_2max; SNOT-22	Steps +1,117 with surgery and +1,087 without; VO_2max +1.95 and +1.50 mL/min/kg; surgery added quality of life (p = 0.040) but no additional fitness gain
Ozkececi 2016 [31]	Prospective with control; n = 25 and a healthy control group	Cardiopulmonary	Mean pulmonary artery pressure; TAPSE; RVMPI	Mean PAP fell (p = 0.007) and TAPSE rose (p = 0.03) at 3 months
Kayapinar 2019 [32]	Prospective	Cardiopulmonary	Mean pulmonary artery pressure; atrial electromechanical delay	Mean PAP 24.68 ± 5.26 → 20.75 ± 4.83 mmHg; electromechanical delay shortened (p < 0.001)

Kaya 2022 [33]	Prospective; n = 50	Cardiopul monary	Left ventricular myocardial performance index; ejection fraction	MPI 0.52 ± 0.06 → 0.41 ± 0.04 ($p < 0.001$); ejection fraction unchanged ($p = 0.224$)

Source: own elaboration. AHI - apnoea–hypopnoea index; CRSwNP - chronic rhinosinusitis with nasal polyps; ESS - Epworth Sleepiness Scale; MPI - myocardial performance index; PAP - pulmonary artery pressure; PNIF - peak nasal inspiratory flow; RVMPI - right ventricular myocardial performance index; TAPSE - tricuspid annular plane systolic excursion.

3.5. The relationship between airflow gain and benefit

Nasal airflow does improve after septoplasty, but what improves is more specific than it is usually reported to be. In the NAIROS trial, objective assessment revealed a substantial treatment-related shift from predominantly unilateral airflow towards equal airflow through both nostrils, more marked in the surgical group [2]. In 70 patients assessed three months after septoplasty, total and both unilateral peak nasal inspiratory flow measurements increased significantly, including on the side that was not deviated [34]. Yet pooled across randomised trials, peak nasal inspiratory flow showed no significant difference between septoplasty and medical management, while Nasal Obstruction Symptom Evaluation and Sino-Nasal Outcome Test-22 scores both did; the reviewers attributed the discrepancy to decongestant use and to inconsistent measurement technique between studies [4]. What surgery reliably alters, then, is the distribution of airflow between the nostrils rather than total flow as conventionally measured.

Whether airflow improves or not, its change does not predict the patient's. In the same 70-patient series, no significant correlation was found between objective and subjective outcomes, either before or after surgery [34]. In the clinimetric comparison of 111 adults, correlations between the two classes of instrument were low throughout [22]. And in 32 patients followed to three months, the improvement in daytime sleepiness bore no relation to the improvement in peak nasal inspiratory flow ($p = 0.516$) [27].

There are two exceptions, and they are instructive (Figure 2). In 37 patients, the change in peak nasal inspiratory flow correlated significantly with the change in pulmonary function (p

< 0.05) [26]; and in 38 endurance athletes, peak nasal inspiratory flow correlated with maximal oxygen uptake at rho = 0.40 [35]. The first pairs one airway measurement with another. The second is an acute mechanical manipulation - an internal dilator applied and removed within a single session - rather than an operation followed over months. Where the outcome is something the patient reports, the association is absent. The alternative reading - that airflow does predict benefit and that the null results reflect insufficient power - cannot be excluded on this evidence.

Study, design and outcome measured	Airflow improved	Outcome improved	Change in airflow predicts change in outcome
Taha 2025 [4] Meta-analysis of RCTs Outcome: symptom (NOSE, SNOT-22)	✗	✓	*not tested*
Carrie 2023 [2] RCT (NAIROS) Outcome: symptom (SNOT-22)	✓	✓	*not tested*
van Egmond 2017 [22] Clinimetric study, n = 111 Outcome: symptom / health status	✓	✓	✗
Vølstad 2019 [23] Cross-sectional, n = 528 Outcome: symptom (NOSE, SNOT-22)	–	–	~
Pearlman 2026 [16] Single-arm, n = 13 Outcome: exercise (VO_2, HR, lactate)	✓	~	*not tested*
de Sousa 2026 [27] Prospective, n = 32 Outcome: symptom (Epworth)	✓	✓	✗
de Sousa 2025 [26] Prospective, n = 37 Outcome: airway (spirometry)	✓	~	✓

✓ improved / association present
✗ no improvement / no association
~ partial or weak
– not applicable

Figure 2. Whether measured nasal airflow, patient outcome, and the association between the two, improved in each study that assessed them

Source: from data reported in [2], [4], [16], [22], [23], [26] and [27].

The most direct evidence comes from outside septoplasty altogether. In the randomised trial of mepolizumab, maximal oxygen uptake and daily step count improved in both arms, whether sinus surgery was performed [30]. Symptom control alone reproduced the gains, with no structural change to the airway.

No study in this literature has demonstrated a dose–response relationship between the magnitude of airflow gain and the magnitude of performance gain after surgery.

3.6. Athletes and non-surgical airflow interventions

Nasal and airway symptoms are common in athletes, and an International Olympic Committee consensus statement treats them as a distinct clinical concern rather than an incidental one [36]. On screening 95 competitive swimmers, 81.1% were positive on the Allergy Questionnaire for Athletes, with nasal obstruction the single most frequent complaint at 63.2% [37]. Among 560 German competitive athletes, 28% reported an allergic condition and 46% an allergic predisposition [38]. What is harder to establish is an excess over the general population. In 47 adolescent elite swimmers, the prevalence of exercise-induced bronchoconstriction was 8.5% - within the 5% to 20% range the same authors cite for the general population - and swimming increased nasal discharge without altering the nasal passages themselves [39].

Some of that obstruction originates in sport itself. In a Finnish series of 2,465 nasal fractures, 24% were sport-related, and where the setting was recorded 65% occurred in competition rather than in training [40]. The usual acute management does not address the septum: after closed nasal reduction, 53.6% of patients with a septal fracture disagreed that the procedure had improved their breathing, against 24.1% of those without one ($p = 0.0025$) [41]. A proportion of obstructed athletes are therefore patients whose septum was injured and left uncorrected.

Endurance competition degrades pulmonary function in its own right. In nine professional cyclists followed through a Grand Tour, forced expiratory volume in one second fell by 5.7% from before the race to its late stages ($p < 0.001$), forced vital capacity by 3.7% and mid-

expiratory flow by 11%; eight of the nine showed a clinically meaningful decline [42]. Whatever the structure of the nasal airway contributes it overlaps with the effects of endurance exercise making it hard to determine separately.

Non-surgical dilation supplies the closest thing to a controlled experiment in this literature. In a double-blind, placebo-controlled crossover trial in 71 adolescent athletes, an external nasal dilator improved peak nasal inspiratory flow (177.4 versus 172.8 L/min, $p = 0.020$), reduced nasal resistance (0.24 versus 0.27, $p = 0.007$) and increased maximal oxygen uptake (39.5 versus 37.5 mL/kg/min, $p < 0.001$) [43]. It is the only placebo-controlled demonstration anywhere in this review that opening the nasal airway raises measured aerobic capacity.

The result stated in the previous paragraph does not apply broadly. In 38 endurance athletes, an internal dilator improved patency and aerobic performance only in the 23 with nasal valve compromise, and not in the 15 without [35]. In 13 triathletes without nasal symptoms, dilator strips raised nasal maximal oxygen uptake and the time spent breathing nasally - but nasal maximal oxygen uptake is the outcome most directly entailed by the intervention, since a wider airway permits nasal breathing to higher intensities almost by construction [20]. An intranasal stent altered nitric oxide exhalation and red-cell deformability without effect on oxygen uptake or performance [44]. And in 19 athletes, an internal dilator significantly reduced fatigue perception, though the authors note the absence of validated objective parameters, the small sample and the lack of follow-up [45].

The two procedural studies in athletes reproduce the pattern of the surgical literature. Radiofrequency treatment of the internal nasal valve improved the Nasal Obstruction Symptom Evaluation score substantially ($p < 0.001$, Cohen's $dz = 1.03$) while producing no significant change in either rhinomanometry or spiroergometry [46]. And the largest meta-analysis of functional rhinoplasty, covering 2,024 patients across 43 studies, reports large symptom improvements sustained to twelve months alongside heterogeneity between 69% and 98% [47].

The apparent conflict between the two dilator trials is reconcilable. The subgroup showing no benefit numbered 15 [35], against 71 with a placebo control [43]; underpowering is at least as plausible an explanation as a true absence of effect in the unobstructed.

4. Discussion, including risks and limitations

Five propositions come out of this review, and they do not exclude one another. Septoplasty improves the symptom for which it is indicated, on randomised evidence [2,3]. Measured nasal airflow also changes, though what changes most reliably is its distribution between the nostrils rather than total flow [2,4]. Objective exercise measures do improve, but only at submaximal intensity, never at maximal capacity, and in only one study against a comparison group [15-17]. The magnitude of airflow gain does not predict the magnitude of benefit, except where the outcome is itself an airway measurement [22,27,34]. And symptom control achieved without surgery reproduces the gains in fitness and habitual activity [30]. No controlled trial of septoplasty against an exercise endpoint exists anywhere in the searched literature.

The designs that produce the most encouraging numbers are the least able to support them. Almost every study is single-arm; follow-up is short and inconsistent; the exposure mixes septoplasty with turbinate reduction; and expectancy after elective surgery is unmeasured throughout. Two patterns illustrate the difficulty. Baseline six-minute walk distances range from 425 to 702 m across nominally similar cohorts [10,11,13] - a spread wider than any treatment effect reported in them. And the largest walk-distance gain comes from the smallest sample at the longest follow-up [13], a combination that learning effects on a repeated test, altered training during recovery and regression to the mean could produce without any surgical benefit at all. The same signature appears in the airflow literature: peak nasal inspiratory flow rises reliably in single-arm series but shows no significant difference against a control arm when randomised trials are pooled [4]. It is a property of the designs rather than of exercise measurement. Similar caution applies to procedures adjacent to septoplasty: an outcomes study of nasal valve reconstruction reports uniformly high satisfaction among its fifteen respondents, but measured no objective endpoint [48].

Against uncertain benefits sit quantified complications. The NAIROS trial reported bleeding requiring readmission in 4% of the 174 patients who underwent septoplasty, infection requiring antibiotics in 12%, and altered sense of smell in 11% [2]. Retrospective series report lower figures - an overall complication rate of 3.42% in 5,639 patients [21], and long-term complications in 2.8% of 359 patients followed for a mean of 23 months, most often revision septoplasty [49]. The difference reflects how harms are captured rather than how often they occur. Either way, the harms of septoplasty are quantified and its performance benefit is not.

What the field could benefit from are not further single-arm series. It needs a non-operated symptomatic comparator; paired airflow and cardiopulmonary endpoints in the same participants, for which the placebo-controlled dilator crossover is an available template [43]; submaximal efficiency rather than maximal oxygen uptake alone as the primary outcome; free-living accelerometry; follow-up extending beyond the detraining window; and a core outcome set, without which the heterogeneity documented throughout this review will continue to defeat synthesis.

5. Conclusions

Septal surgery improves the efficiency with which a given workload is performed - lower oxygen cost, lower heart rate and lower blood lactate at submaximal intensity. Maximal aerobic capacity is a different matter: no study has shown it to rise, and only one employed a comparison group.

Tolerance responds more consistently than capacity. Daytime sleepiness, fatigue, perceived exertion and sleep-disordered breathing all improve, and most reliably where the underlying disease is mild. Habitual physical activity, by contrast, has almost never been measured at all.

What none of this can be attributed to is measured airflow. Change in nasal airflow predicts change in other airflow measurements and little else, and symptom control achieved pharmacologically, without any structural change to the airway, reproduces the same gains in fitness and daily activity.

Whether athletes differ remains unsettled: benefit may be confined to those genuinely obstructed, but that evidence is contested, underpowered and drawn largely from nasal dilators rather than from surgery.

Septoplasty should therefore be offered for symptomatic nasal obstruction and for the quality of life that follows from relieving it. On present evidence it should not be presented to a patient, or to an athlete, as an intervention that will improve performance.

DISCLOSURE

Authors Contributions: Conceptualization: K.K.; Methodology: K.K. and K.G.; Literature search and screening: K.K., O.P. and Z.K.; Data extraction and verification: K.K., Z.Ł., N.M. and M.W.; Formal analysis: M.Z. and D.L.; Writing – original draft preparation: K.K.; Writing – review and editing: M.P., K.G., D.L., M.W., Z.Ł. and M.Z.; Visualization: K.K.; Supervision: K.G.; Project administration: K.K.

All authors have read and agreed to the published version of the manuscript.

Funding Statement: This research received no external funding.

Institutional Review Board Statement: Not applicable. This article is a narrative review based on previously published literature and does not involve original research with human subjects.

Informed Consent Statement: Not applicable.

Data Availability Statement: Not applicable. All data discussed in this review are available in the cited publications.

Acknowledgements: Not applicable.

Conflicts of Interest: The authors declare no conflicts of interest.

Originality: The submission has not been previously published, nor is it under consideration by another journal.

Declaration of the use of AI and AI-assisted Technologies in the Writing Process: During the preparation of this work, the authors used artificial intelligence tools (Claude, Anthropic) to edit the text and refine it linguistically and prepare the figures, and then reviewed and edited the content as necessary, taking full responsibility for the substantive content of the publication.

REFERENCES:

1. Alotaibi AD, Almutlaq BA, Alshammari FN, Gadelkarim Ahmed H. The common clinical presentation of patients selected for septoplasty in Northern Saudi Arabia. Int J Otolaryngol. 2018;2018:8536387. https://doi.org/10.1155/2018/8536387

2. Carrie S, O'Hara J, Fouweather T, Homer T, Rousseau N, Rooshenas L, et al. Clinical effectiveness of septoplasty versus medical management for nasal airways obstruction: multicentre, open label, randomised controlled trial. BMJ. 2023;383:e075445. https://doi.org/10.1136/bmj-2023-075445
3. van Egmond MMHT, Rovers MM, Hannink G, Hendriks CTM, van Heerbeek N. Septoplasty with or without concurrent turbinate surgery versus non-surgical management for nasal obstruction in adults with a deviated septum: a pragmatic, randomised controlled trial. Lancet. 2019;394(10195):314–21. https://doi.org/10.1016/S0140-6736(19)30354-X
4. Taha HI, Elgendy MS, Ezz MR, Tolba K, El Safty M, Al Azzawi MAD, et al. Septoplasty versus non-surgical management for deviated nasal septum: a systematic review and meta-analysis of randomized controlled trials. Eur Arch Otorhinolaryngol. 2025;282:597–610. https://doi.org/10.1007/s00405-024-08937-x
5. Alessandri-Bonetti M, Costantino A, Cottone G, Carbonaro R, Cardone F, Amendola F, et al. Efficacy of septoplasty in patients with nasal obstruction: a systematic review and meta-analysis. Laryngoscope. 2023;133(12):3237–46. https://doi.org/10.1002/lary.30684
6. Carrie S, Fouweather T, Homer T, O'Hara J, Rousseau N, Rooshenas L, et al. Effectiveness of septoplasty compared to medical management in adults with obstruction associated with a deviated nasal septum: the NAIROS RCT. Health Technol Assess. 2024;28(10):1–213. https://doi.org/10.3310/MVFR4028
7. Russel SM, Gosman RE, Gonzalez K, Wright J, Frank-Ito DO. Insights into exercise-induced rhinitis based on nasal aerodynamics induced by airway morphology. Respir Physiol Neurobiol. 2024;319:104171. https://doi.org/10.1016/j.resp.2023.104171
8. Recinto C, Efthemeou T, Boffelli PT, Navalta JW. Effects of nasal or oral breathing on anaerobic power output and metabolic responses. Int J Exerc Sci. 2017;10(4):506–14.
9. Lévénez M, Lévêque C, Lafère C, Guerrero F, Balestra C, Lafère P. Effect of oral versus nasal breathing on muscular performance, muscle oxygenation, and post-exercise recovery. Sports (Basel). 2025;13(10):368. https://doi.org/10.3390/sports13100368

10. Ingale M, Kalra Y, Shinde V, Jarandikar A, Rajashekhar RP. Improvement in pulmonary function tests after septoplasty: a longitudinal study. Cureus. 2024;16(7):e65492. https://doi.org/10.7759/cureus.65492
11. Tuzuner A, Bilgin G, Demirci S, Darilmaz Yuce G, Acikgoz C, Samim EE. Improvement of pulmonary functions following septoplasty: how are lower airways affected? Clin Exp Otorhinolaryngol. 2016;9(1):51–5. https://doi.org/10.21053/ceo.2016.9.1.51
12. Arifa KA, Nayana VG, Irfan KM. Can upper airway surgeries improve lower airway function? A prospective study. Indian J Otolaryngol Head Neck Surg. 2022;74(Suppl 3):S4500–6. https://doi.org/10.1007/s12070-020-02311-z
13. Akinoğlu B, Mutlu M, Kocahan T. Effect of septoplasty on functional outcomes and physical fitness level. Med J Islam World Acad Sci. 2017;25(3):67–71. https://doi.org/10.5505/ias.2017.86658
14. Baharmand I, Sheikh-Oleslami S, Pascual Rodríguez A, Hernaiz-Leonardo JC, Alim BM, Javer AR. The effects of nasal surgery on pulmonary function: a systematic review and meta-analysis. Laryngoscope. 2023;133(11):2837–45. https://doi.org/10.1002/lary.30651
15. Melekoğlu T, Arslan B, Işın A, Türk A, Akdağ M, Turhan M. Effects of surgical correction of nasal obstruction on running economy. Eur J Appl Physiol. 2026;126:1601–20. https://doi.org/10.1007/s00421-025-06009-4
16. Pearlman AN, Chung S, Caplan IF, de Mille P. The effect of septoplasty and inferior turbinate reduction on measures of exercise capacity. Laryngoscope. 2026. https://doi.org/10.1002/lary.70532
17. Yigit E, Manav A, Ture M, Karabag T. The impact of septoplasty on cardiopulmonary functions in patients with nasal septal deviation: a prospective comprehensive analysis of echocardiographic outcome and serum N-terminal pro BNP levels. J Craniofac Surg. 2022;33:35–40. https://doi.org/10.1097/SCS.0000000000007801
18. Kerdkaew K, Tongtako W. Acute effects of exercise at different temperatures on clinical symptoms and nasal blood flow in patient with allergic rhinitis: a randomized crossover trial. Int J Exerc Sci. 2024;17(3):779–93.
19. Surda P, Walker A, Limpens J, Fokkens W, Putala M. Nasal changes associated with exercise in athletes: systematic review. J Laryngol Otol. 2018;132:191–7. https://doi.org/10.1017/S0022215118000026

20. Ottaviano G, Ermolao A, Nardello E, Muci F, Favero V, Zaccaria M, et al. Breathing parameters associated to two different external nasal dilator strips in endurance athletes. Auris Nasus Larynx. 2017;44(6):713–8. https://doi.org/10.1016/j.anl.2017.01.006
21. Dąbrowska-Bień J, Skarżyński PH, Gwizdalska I, Łazęcka K, Skarżyński H. Complications in septoplasty based on a large group of 5639 patients. Eur Arch Otorhinolaryngol. 2018;275:1789–94. https://doi.org/10.1007/s00405-018-4990-8
22. van Egmond MMHT, van Heerbeek N, ter Haar ELM, Rovers MM. Clinimetric properties of the Glasgow Health Status Inventory, Glasgow Benefit Inventory, peak nasal inspiratory flow, and 4-phase rhinomanometry in adults with nasal obstruction. Rhinology. 2017;55:126–34. https://doi.org/10.4193/Rhino16.296
23. Vølstad I, Olafsson T, Steinsvik EA, Dahl FA, Skrindo I, Bachmann-Harildstad G. Minimal unilateral peak nasal inspiratory flow correlates with patient reported nasal obstruction. Rhinology. 2019;57(6):436–43. https://doi.org/10.4193/Rhin19.178
24. Chakraborty S, Sarma N, Das S, Nongpiur VN, Balakrishnan MC, Lynrah Z, et al. The effect of septoplasty and turbinoplasty on pulmonary function test - a hospital-based interventional study. Iran J Otorhinolaryngol. 2025;37(6):303–9. https://doi.org/10.22038/ijorl.2025.83789.3825
25. Singh A, Garg LN, Singh G, Singh A, Puri A. To assess the effect of septoplasty on pulmonary function tests: a prospective study. Indian J Otolaryngol Head Neck Surg. 2022;74(Suppl 2):S967–71. https://doi.org/10.1007/s12070-020-02041-2
26. de Sousa FA, Correia JT, Azevedo SR, Almeida JC, Ferreira MG. Septoplasty-mediated improvements in nasal patency and pulmonary function: a prospective study. Laryngoscope Investig Otolaryngol. 2025;10:e70065. https://doi.org/10.1002/lio2.70065
27. de Sousa FA, Correia JT, Rios M, Ferreira MG, Magalhães M, Santos M. Beyond the airway: the impact of septoplasty and turbinate reduction on somnolence and sleep disordered breathing risk - a prospective study. Front Surg. 2026;13:1828614. https://doi.org/10.3389/fsurg.2026.1828614
28. Mandour YMH, Abo Youssef SM, Moussa HH. Polysomnographic and pulmonary function changes in patients with sleep problems after septoplasty with turbinectomy. Am J Otolaryngol. 2019;40(2):187–90. https://doi.org/10.1016/j.amjoto.2018.12.003

29. Taylan S, Özkan İ, Kar M. The relationship of preseptoplasty and postseptoplasty early period comfort level with nasal obstruction, sleep quality, and fatigue severity: a prospective study. J Perianesth Nurs. 2021;36(3):268–74. https://doi.org/10.1016/j.jopan.2020.09.005
30. Tidemandsen J, Hostrup M, Homøe AS, Moesgaard L, Aanæs K, Meteran H, et al. Mepolizumab treatment is associated with physical activity and cardiorespiratory fitness irrespective of endoscopic sinus surgery in patients with chronic rhinosinusitis with nasal polyps: a randomised controlled trial. Eur Clin Respir J. 2026;13:2604365. https://doi.org/10.1080/20018525.2025.2604365
31. Özkeçeci G, Akci Ö, Bucak A, Ulu Ş, Yalım Z, Ayçiçek A, et al. The effect of septoplasty on pulmonary artery pressure and right ventricular function in nasal septum deviation. Eur Arch Otorhinolaryngol. 2016;273:3747–52. https://doi.org/10.1007/s00405-016-4042-1
32. Kayapınar O, Kaya A, Özde C, Cebeci D, Ünlü İ. Evaluating the effect of nasal septoplasty on atrial electromechanical features. Am J Otolaryngol. 2019;40(2):179–82. https://doi.org/10.1016/j.amjoto.2018.12.007
33. Kaya H, Kurt E, Koparal M, Tibilli H, Hosoglu Y, Kafadar S, et al. Effect of septoplasty on left ventricular myocardial performance in patients with nasal septum deviation. Braz J Otorhinolaryngol. 2022;88(4):589–93. https://doi.org/10.1016/j.bjorl.2020.08.004
34. Schalek P, Guha A, Ondrová T, Svoboda M. Total and unilateral peak nasal inspiratory flow and unilateral visual analogue scale: rationale in indication and outcomes of septoplasty? J Craniofac Surg. 2019;30:2004–7. https://doi.org/10.1097/SCS.0000000000005664
35. Valsamidis K, Printza A, Valsamidis N, Constantinidis J, Triaridis S. Improvement of the aerobic performance in endurance athletes presenting nasal valve compromise with the application of an internal nasal dilator. Am J Otolaryngol. 2024;45:104059. https://doi.org/10.1016/j.amjoto.2023.104059
36. Schwellnus M, Adami PE, Bougault V, Budgett R, Clemm HH, Derman W, et al. International Olympic Committee (IOC) consensus statement on acute respiratory illness in athletes part 2: non-infective acute respiratory illness. Br J Sports Med. 2022;56(19):1089–103. https://doi.org/10.1136/bjsports-2022-105567

37. Ramos M, Neiva HP, Lourenço O. Allergy-compatible symptoms among federated swimmers in Portugal: a cross-sectional study using the AQUA questionnaire. Front Public Health. 2026;13:1731628. https://doi.org/10.3389/fpubh.2025.1731628
38. Dornquast C, Rotter G, Schollbach L, Binting S, Scherr J, Pfab F, et al. Allergic diseases in German competitive athletes: results of a cross-sectional study. J Sports Med Phys Fitness. 2023;63(4):588–95. https://doi.org/10.23736/S0022-4707.22.13825-9
39. Ekşi N, Batur Çalış ZA, Seyhun N, Özkarafakili A, Uslu Coşkun B. Evaluation of exercise-induced bronchoconstriction and rhinitis in adolescent elite swimmers. North Clin Istanb. 2021;8(5):493–9. https://doi.org/10.14744/nci.2021.99327
40. Manninen IK, Klockars T, Mäkinen LK, Blomgren K. Epidemiology and aetiology of sport-related nasal fractures: analysis of 599 Finnish patients. Clin Otolaryngol. 2023;48(1):70–4. https://doi.org/10.1111/coa.13976
41. Arnold MA, Yanik SC, Suryadevara AC. Septal fractures predict poor outcomes after closed nasal reduction: retrospective review and survey. Laryngoscope. 2019;129:1784–90. https://doi.org/10.1002/lary.27781
42. Allen H, Price OJ, Greenwell J, Hull JH. Respiratory impact of a grand tour: insight from professional cycling. Eur J Appl Physiol. 2021;121:1027–36. https://doi.org/10.1007/s00421-020-04587-z
43. Ferreira CHS, Dinardi RR, Ibiapina C da C, de Andrade CR. Nasal function and cardio-respiratory capacity of adolescent with external nasal dilator. Int J Pediatr Otorhinolaryngol. 2020;139:110430. https://doi.org/10.1016/j.ijporl.2020.110430
44. Bizjak DA, Schams P, Bloch W, Grau M, Latsch J. The intranasal AlaxoLito Plus Nasal Stent: improvement of NO-induced microrheology and oxygen uptake during exercise? Respir Physiol Neurobiol. 2019;269:103260. https://doi.org/10.1016/j.resp.2019.103260
45. Gelardi M, Porro G, Accettura D, Quaranta VN, Quaranta N, Ciprandi G. The role of an internal nasal dilator in athletes. Acta Biomed. 2019;90(Suppl 2):28–30. https://doi.org/10.23750/abm.v90i2-S.8101
46. Seuthe IMC, Van Ackeren K, Dazert S, Eichhorn S, Veleva T, Park JJH. The effect of radiofrequency therapy for nasal valve collapse in endurance athletes: a STROBE analysis. Eur Ann Otorhinolaryngol Head Neck Dis. 2025;142:129–34. https://doi.org/10.1016/j.anorl.2024.12.004

47. Zhao R, Chen K, Tang Y. Effects of functional rhinoplasty on nasal obstruction: a meta-analysis. Aesthetic Plast Surg. 2022;46:873–85. https://doi.org/10.1007/s00266-021-02741-2
48. Goldman ND, Alexander R, Sandoval LF, Feldman SR. Nasal valve reconstruction using a titanium implant: an outcomes study. Craniomaxillofac Trauma Reconstr. 2017;10:175–82. https://doi.org/10.1055/s-0037-1600900
49. Joshi RR, Riley CA, Kacker A. Complication rates following septoplasty with inferior turbinate reduction. Ochsner J. 2019;19:353–6. https://doi.org/10.31486/toj.19.0002