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EXERCISE TOLERANCE - A NARRATIVE REVIEW

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# EXERCISE-INDUCED LARYNGEAL OBSTRUCTION IN ATHLETES: AN UNDERRECOGNIZED CAUSE OF EXERTIONAL DYSPNEA, DIAGNOSTIC CONFUSION WITH ASTHMA, AND IMPAIRED EXERCISE TOLERANCE - A NARRATIVE REVIEW

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**ABSTRACT**

**Background:** Exertional dyspnea is a clinically relevant symptom in athletes, particularly during high-intensity exercise. Although asthma and exercise-induced bronchoconstriction are commonly considered in this context, exercise-induced laryngeal obstruction (EILO) is represents an important upper-airway cause of exertional breathlessness that may remain underdiagnosed. Its symptomatic overlap and possible coexistence with lower-airway disease may contribute to diagnostic confusion, ineffective treatment and impaired sport participation.

**Aim:** The aim of this narrative review was to synthesize current evidence on EILO in athletes, with emphasis on clinical presentation, diagnostic confusion with asthma and exercise-induced bronchoconstriction, effects on exercise tolerance, and available diagnostic and therapeutic strategies.

**Methods:** A targeted literature review of peer-reviewed publications concerning EILO, inducible laryngeal obstruction, exertional respiratory symptoms in athletes, asthma, exercise-induced bronchoconstriction, continuous laryngoscopy during exercise and treatment strategies was performed. Evidence was synthesized narratively and organized into clinically relevant thematic sections.

**Results:** EILO is characterized by transient narrowing of the laryngeal airway during exercise, usually under conditions of high ventilatory demand. Symptoms typically occur during peak exercise and may include inspiratory dyspnea, throat tightness, noisy breathing or stridor. The available literature indicates that EILO is clinically relevant among adolescents and athletes, particularly in symptomatic and referral-based cohorts. Because symptoms may mimic or coexist with asthma and exercise-induced bronchoconstriction, objective assessment of both upper- and lower-airway function is often required. Continuous laryngoscopy during exercise remains the current diagnostic reference standard. Management is usually conservative and may include education, speech therapy, breathing retraining, physiotherapy and inspiratory muscle training, while surgery is reserved for selected severe supraglottic cases.

**Conclusions:** EILO should be considered in athletes with persistent, unexplained or atypical exertional dyspnea, especially when symptoms are predominantly inspiratory, occur during peak exercise and respond inadequately to asthma-directed treatment. Early recognition and objective assessment may reduce diagnostic delay, limit ineffective management and support maintenance of exercise tolerance, training quality and sport participation.

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**KEYWORDS**

Exercise-Induced Laryngeal Obstruction; Athletes; Exertional Dyspnea; Asthma; Exercise-Induced Bronchoconstriction; Continuous Laryngoscopy During Exercise; Sports Medicine

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**Introduction**

Exertional dyspnea represents a clinically significant symptom in athletes, particularly during high-intensity training and competition, when increased ventilatory requirements may unmask respiratory limitations that are not evident under resting conditions. Although breathlessness is commonly interpreted as a physiological response to strenuous exercise, recurrent, disproportionate or performance-limiting respiratory symptoms should not be attributed solely to insufficient conditioning, training load or normal exercise-related fatigue. Exercise-induced respiratory symptoms are reported in athletic populations and may have different underlying mechanisms, including exercise-induced bronchoconstriction and exercise-induced laryngeal obstruction (EILO), which makes clinical interpretation based only on symptoms challenging [1]. In this context, persistent or unexplained exertional dyspnea may compromise exercise tolerance and interfere with training and sport participation, especially when the underlying cause remains unrecognized or inadequately addressed. Therefore, exertional dyspnea in athletes should be regarded as a multifactorial clinical problem requiring careful diagnostic evaluation rather than being automatically interpreted as a normal consequence of intensive exercise.

Asthma and exercise-induced bronchoconstriction are common initial diagnostic considerations in athletes presenting with exertional respiratory symptoms, particularly because dyspnea, wheeze, chest tightness and reduced exercise capacity are frequently associated with lower-airway dysfunction. However, similar symptoms may also occur in EILO, which can clinically mimic asthma or exercise-induced bronchoconstriction and thereby complicate diagnosis based on symptoms alone. Importantly, EILO may coexist with asthma, exercise-induced bronchoconstriction, or both in the same athlete, further increasing diagnostic complexity. Consequently, asthma may be suspected or treated before alternative or coexisting causes of exertional dyspnea are objectively excluded, contributing to diagnostic confusion and potentially inappropriate escalation of asthma-directed therapy [2]. Thus, persistent exercise-induced respiratory symptoms should prompt consideration of EILO as an important differential diagnosis, particularly when symptoms are atypical for lower-airway disease or respond insufficiently to asthma-directed treatment.

EILO represents an underrecognized upper-airway cause of exertional respiratory symptoms in athletes and physically active individuals. It is generally characterized by transient, inappropriate narrowing of laryngeal structures during exercise, typically provoked by high ventilatory demand and improving after reduction or cessation of exercise; clinically, it is usually associated with inspiratory dyspnea, throat tightness, noisy breathing or stridor during intense exercise [3]. The terminology used to describe this condition has evolved: older terms such as vocal cord dysfunction (VCD) and paradoxical vocal fold motion (PVFM) have been used to describe abnormal or paradoxical vocal fold movement, whereas inducible laryngeal obstruction (ILO) is a broader umbrella term describing transient laryngeal narrowing triggered by specific stimuli; EILO refers specifically to ILO provoked by exercise, and the obstruction may involve supraglottic, glottic or combined laryngeal narrowing [4]. Available evidence indicates that EILO is particularly relevant in athletic populations, including selected cohorts of symptomatic athletes [5]. Detailed diagnostic classification, assessment and clinical implications are addressed in subsequent sections.

The clinical relevance of EILO in athletes extends beyond the occurrence of exercise-induced respiratory symptoms, as delayed recognition may contribute to persistent diagnostic uncertainty, ineffective management and ongoing exercise limitation. This is particularly important in athletic populations, in which unexplained or inadequately managed symptoms may interfere with physical activity, sport participation, perceived performance and daily functioning, creating a substantial burden for individuals exposed to high ventilatory demands during training and competition [6]. These consequences make EILO an important sports medicine problem, particularly when the laryngeal origin of symptoms remains unrecognized. Therefore, improving awareness of EILO in sports medicine is essential to reduce diagnostic delay, avoid ineffective treatment pathways and support timely referral for appropriate assessment and targeted intervention.

Accordingly, the aim of this narrative review is to synthesize current evidence on exercise-induced laryngeal obstruction in athletes, with particular emphasis on its clinical relevance as an underrecognized and potentially underdiagnosed cause of exertional dyspnea. The review focuses on the diagnostic challenges associated with EILO, especially its symptomatic overlap with asthma and exercise-induced bronchoconstriction, which may contribute to diagnostic confusion, delayed recognition and ineffective treatment pathways. Particular attention is also given to the potential impact of EILO on exercise tolerance, training quality, perceived performance and sport participation. By integrating available evidence on terminology, epidemiology, clinical presentation, diagnostic considerations and management implications, this review aims to support a more comprehensive understanding of EILO as an important component of the differential diagnosis in athletes presenting with persistent or unexplained exercise-induced respiratory symptoms.

## **Methods**

This article was designed as a narrative review focused on exercise-induced laryngeal obstruction in athletes and physically active individuals. The literature was selected using a targeted narrative search strategy consistent with the scope and aims of this review. Publications were identified through targeted searches of PubMed, PubMed Central and relevant journal databases, supplemented by manual screening of reference lists. Priority was given to peer-reviewed articles directly related to EILO, inducible laryngeal obstruction, exercise-induced respiratory symptoms in athletes, asthma, exercise-induced bronchoconstriction, continuous laryngoscopy during exercise, breathing patterns, exercise tolerance and therapeutic interventions. Studies involving athletes, adolescents, physically active individuals or patients evaluated for exertional dyspnea were considered particularly relevant, especially when EILO was assessed using objective diagnostic methods.

The included literature comprised narrative and systematic reviews, consensus-based articles, observational studies, cohort studies, longitudinal studies, physiological investigations, qualitative studies, case series and interventional studies. Articles were included when they contributed to at least one of the main thematic areas of the review: terminology and mechanisms of EILO, epidemiology and prevalence in athletic or physically active populations, clinical presentation, diagnostic confusion with asthma and exercise-induced bronchoconstriction, diagnostic assessment with particular emphasis on continuous laryngoscopy during exercise, consequences for exercise tolerance and sport participation, and treatment approaches including speech therapy, physiotherapy, inspiratory muscle training and surgical management in selected cases.

Publications were not discussed in detail when EILO was only peripheral to the main topic, when the study population or outcomes were not relevant to the sports medicine focus of the review, or when the findings did not contribute to the interpretation of EILO as a cause of exercise-induced respiratory symptoms. Because the purpose of this review was to provide a clinically oriented synthesis rather than a systematic estimate of prevalence or treatment efficacy, no formal meta-analysis, quantitative pooling of results or risk-of-bias assessment was performed.

Data from the included studies were synthesized narratively. The analysis focused on clinically relevant findings, including reported prevalence estimates, characteristic symptoms, diagnostic methods, coexistence with lower-airway disease, treatment outcomes and functional consequences for athletes. Reported prevalence estimates were interpreted in relation to study population, recruitment strategy and diagnostic method, with a distinction between athletic cohorts, symptomatic cohorts and referral-based clinical populations. Particular attention was paid to avoiding overinterpretation of findings from selected or referral-based cohorts and to distinguishing evidence derived from athlete-specific studies from evidence obtained in broader clinical populations with exercise-induced dyspnea.

## **Results**

### **Definition, terminology and mechanisms of EILO**

In athletes, exercise-induced laryngeal obstruction (EILO) should be understood primarily as an exercise-dependent disturbance of laryngeal airway regulation. Its clinical significance lies in the fact that laryngeal narrowing is provoked by increasing ventilatory load and may not be detectable during resting examination, which differentiates it from fixed anatomical narrowing of the airway. During exertion, the larynx is required to maintain patency while airflow and inspiratory forces increase substantially; failure to preserve this opening may result in variable obstruction at the supraglottic level, the glottic level or both. For this reason, EILO should not be viewed only as abnormal vocal fold motion, but as a broader, exercise-induced pattern of dynamic laryngeal narrowing that may involve supraglottic, glottic or combined obstruction [3,4].

Under physiological conditions, exercise is accompanied by coordinated laryngeal widening through abduction of the vocal folds and stabilization of supraglottic structures. In EILO, this adaptive response is disrupted, resulting in paradoxical inspiratory adduction, supraglottic collapse or a combined pattern of obstruction. Supraglottic obstruction, often involving inward displacement of the aryepiglottic folds, arytenoid region or other supraglottic structures into the laryngeal inlet, appears to be more frequent than isolated glottic obstruction. The pathophysiology of EILO remains incompletely explained and is probably multifactorial. Proposed mechanisms include high inspiratory airflow, increasingly negative translaryngeal pressure, turbulent flow within the upper airway, impaired stabilization of supraglottic structures and insufficient coordination of laryngeal opening during intense exertion [7].

Physiological studies support the clinical relevance of this obstruction by demonstrating increased work of breathing and heightened respiratory neural drive in individuals with EILO, indicating that the larynx may become a limiting segment of the respiratory system when ventilatory demand increases during exercise [8]. Altered breathing patterns may also be relevant, as patients with EILO have been shown to differ from controls in selected ventilatory variables during exercise; however, these findings should be interpreted as supportive rather than diagnostic [9]. Moreover, some degree of exercise-related laryngeal narrowing may also be observed in healthy athletes. Therefore, EILO should be interpreted as the clinically relevant combination of exercise-induced symptoms and objectively demonstrated laryngeal obstruction during exertion, rather than as an isolated anatomical or laryngoscopic finding [10].



### **Epidemiology and prevalence in athletes**

Reported estimates of exercise-induced laryngeal obstruction in athletic and physically active populations vary considerably across studies. This variability is related to differences in study design, population selection, symptom status, athletic level, diagnostic methods and thresholds used to define clinically relevant laryngeal obstruction. In adolescent athletic populations, EILO appears to be reported less frequently than exercise-induced bronchoconstriction, but it remains an important diagnostic consideration in young athletes with exercise-related respiratory symptoms. In a cohort of adolescents attending a sports high school, Ersson et al. reported a lower occurrence of EILO than EIB and showed that self-reported exercise-induced dyspnea was a weak indicator of both conditions, supporting the need for objective diagnostic assessment rather than symptom-based interpretation alone [1].

Higher proportions of EILO have been reported in selected cohorts of symptomatic athletes, particularly among those referred for evaluation of unexplained respiratory symptoms or suspected asthma. In a selected cohort of athletes referred for asthma work-up, Nielsen et al. identified EILO in approximately one-third of athletes who completed diagnostic assessment, while a comparable proportion had objective evidence of lower-airway dysfunction [5]. These findings indicate that both upper- and lower-airway disorders may be identified in athletes evaluated for persistent exertional respiratory complaints. Sport-specific data also suggest that EILO may be relevant in endurance disciplines characterized by high ventilatory demand. Among elite Swedish cross-country skiers, Irewall et al. reported EILO in approximately one-quarter of athletes, with all confirmed cases involving supraglottic obstruction and most affected athletes being female [11].

Referral-based clinical studies further demonstrate that EILO is frequently identified among individuals assessed for exertional breathlessness or suspected laryngeal obstruction, although such findings should not be interpreted as prevalence estimates for the general athletic population. In a multicentre international cohort of individuals referred for assessment of exertional breathlessness or suspected EILO, Walsted et al. diagnosed EILO in more than half of the study population, and many affected individuals were recreationally active [6]. Similarly, in a retrospective cohort of patients evaluated for exercise-induced dyspnea, Jeppesen et al. reported a high proportion of EILO in this selected clinical population, with the highest occurrence observed among females younger than 18 years, while clinically relevant occurrence was also present in males and adults [12]. These findings suggest that although EILO is often described in adolescent and female populations, it should also be considered in a broader range of physically active patients with persistent or unexplained exercise-related respiratory symptoms.

Longitudinal evidence remains limited, but available data indicate that exercise-related airway disorders in adolescent athletes may change over time. In a follow-up study of high school athletes, incident cases of both EIB and EILO were observed during follow-up, suggesting that a single cross-sectional assessment may not fully reflect the burden of these conditions across adolescence [13]. Overall, the available epidemiological literature supports EILO as a clinically relevant cause of exertional dyspnea in athletes and physically active individuals. However, direct comparison between studies is limited by heterogeneity in recruitment strategies, athletic level, symptom status, exercise protocols, use of continuous laryngoscopy during exercise and diagnostic thresholds. Therefore, reported estimates should be interpreted in relation to the population examined and the method used to confirm laryngeal obstruction during exercise.

### **Clinical presentation in athletes**

In athletes with EILO, the temporal relationship between symptom onset and exercise intensity is a key clinical feature. Complaints typically emerge as ventilatory demand increases during strenuous activity and are most pronounced during ongoing high-intensity exercise, rather than after exercise has ended. This exercise-dependent pattern is clinically relevant because athletes may remain asymptomatic at rest and during lower-intensity activity, while respiratory limitation becomes apparent only when airflow requirements substantially increase. Rapid improvement after slowing down or stopping exercise may further suggest a dynamic upper-airway mechanism. However, the timing of symptoms alone is not sufficient to establish the diagnosis, as exercise-related respiratory complaints in athletes may arise from different mechanisms and require objective assessment for accurate interpretation [3,14].

The clinical picture of EILO may vary between individuals and should be assessed with attention to symptom quality, perceived anatomical location and reproducibility during exertion. Athletes may describe inspiratory breathing difficulty, throat or upper-airway discomfort, choking sensation, cough, chest tightness, transient voice-related symptoms or audible breathing sounds during intense exercise. Perceptual clinical studies indicate that careful characterization of these features may support clinical suspicion, but symptoms

alone cannot confirm the presence of laryngeal obstruction or define its anatomical level [15]. The subjective burden may also be considerable; qualitative data from adolescents with EILO show that episodes can be frightening and confusing, particularly when they occur suddenly during sport participation or remain unexplained [16]. In addition, laryngeal responses to high-intensity exercise may vary even among healthy athletes, which reinforces the need to interpret clinical symptoms together with objective findings rather than in isolation [10]. Therefore, the clinical presentation of EILO in athletes should be regarded as a reason to pursue further diagnostic evaluation, not as a standalone basis for diagnosis.

### **Diagnostic confusion with asthma and EIB**

Diagnostic confusion between exercise-induced laryngeal obstruction, asthma and exercise-induced bronchoconstriction represents an important clinical challenge in athletes presenting with exertional respiratory symptoms. This overlap arises because exercise-related breathlessness, audible breathing sounds, breathing discomfort and reduced exercise capacity may be reported across different respiratory conditions, despite distinct underlying mechanisms. Although the timing, perceived anatomical location and inspiratory character of symptoms may raise suspicion of an upper-airway disorder, clinical history alone is often insufficient to reliably distinguish EILO from lower-airway dysfunction, particularly in athletes exposed to high ventilatory demands during training and competition [2]. As a result, exertional respiratory symptoms may be interpreted primarily as asthma or EIB before alternative or additional causes, including EILO, are objectively considered.

This distinction is clinically important because asthma, EIB and EILO differ in their pathophysiology and expected response to treatment. Asthma and EIB involve lower-airway dysfunction, whereas EILO reflects dynamic narrowing of the laryngeal airway during exercise. Consequently, asthma-directed pharmacotherapy may be appropriate when bronchoconstriction or asthma is objectively confirmed, but it does not directly address a laryngeal component of airflow limitation. In a selected cohort of athletes referred for asthma work-up because of unexplained respiratory symptoms, Nielsen et al. reported that 61% of athletes with confirmed EILO and negative bronchoprovocation or bronchodilator reversibility testing were using regular asthma medication at referral [5]. These findings support the need to consider EILO in athletes with persistent exertional respiratory symptoms, particularly when symptoms remain unexplained despite asthma-directed treatment.

Importantly, EILO and asthma or EIB should not be regarded as mutually exclusive diagnoses. Coexistence may occur and can further complicate clinical interpretation, because symptoms may reflect contributions from both upper- and lower-airway dysfunction. In elite cross-country skiers, Irewall et al. found that current asthma was present in 38% of athletes, and 29% of those with current asthma had concomitant EILO. Athletes with both conditions reported more respiratory symptoms than those with asthma alone, indicating that persistent exertional dyspnea in an athlete with asthma should not automatically be interpreted as poor asthma control or inadequate pharmacological treatment [11]. Instead, ongoing symptoms should prompt reassessment of the diagnostic explanation and consideration of additional contributors to exercise-related breathlessness.

The consequences of diagnostic confusion may extend beyond inappropriate pharmacotherapy. In a large international cohort of individuals referred for suspected EILO, the mean delay to diagnosis was approximately two years, and current asthma medication was discontinued in 20% of patients following diagnostic reassessment [6]. For athletes, such delay may contribute to persistent symptoms, uncertainty regarding the cause of exercise limitation and potentially avoidable modification of training or sport participation. Overall, EILO should be considered in athletes with exertional dyspnea that is predominantly inspiratory, occurs during peak exercise, improves rapidly after exercise reduction or cessation and responds insufficiently to asthma-directed treatment. At the same time, objective evaluation remains essential, because EILO may mimic asthma, coexist with asthma or EIB, or remain unrecognized in athletes with a previous lower-airway diagnosis.

**Table 1.** Clinical differentiation between exercise-induced laryngeal obstruction and asthma/exercise-induced bronchoconstriction in athletes

| Clinical aspect                       | Exercise-induced laryngeal obstruction (EILO)                                                                                      | Asthma /exercise-induced bronchoconstriction (EIB)                                     | Practical relevance in athletes                                                                              |
|---------------------------------------|------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------|
| Primary site of dysfunction           | Dynamic narrowing of the laryngeal airway, involving supraglottic, glottic or combined obstruction [3,4]                           | Lower-airway narrowing related to bronchial dysfunction                                | Similar symptoms may arise from different anatomical levels of airway obstruction                            |
| Typical exercise relationship         | Symptoms usually occur during high-intensity or peak exercise and may improve rapidly after exercise reduction or cessation [3,14] | Symptoms may occur during or after exercise, depending on bronchial response           | Timing may guide clinical suspicion, but should not be used as the sole diagnostic criterion                 |
| Dominant respiratory sensation        | Predominantly inspiratory difficulty, often perceived as difficulty drawing air in                                                 | More commonly associated with expiratory airflow limitation, chest tightness or wheeze | Inspiratory symptoms during peak effort should raise suspicion of EILO                                       |
| Perceived symptom location            | Often localized to the throat, neck or upper airway [14,15]                                                                        | Often localized to the chest or lower airway                                           | Perceived anatomical location may support clinical suspicion, but is not diagnostic                          |
| Audible breathing sounds              | Inspiratory stridor or noisy breathing may be reported                                                                             | Wheeze may occur, particularly with bronchoconstriction                                | Descriptions of “wheeze” may be misleading without objective testing                                         |
| Response to asthma-directed treatment | Usually limited if laryngeal obstruction is the main mechanism                                                                     | May improve when asthma or EIB is present and adequately treated                       | Poor response to asthma-directed therapy should prompt reassessment and consideration of EILO [2,17]         |
| Resting examination                   | May be normal because obstruction is exercise-dependent                                                                            | May be normal or abnormal depending on asthma control and bronchial responsiveness     | Normal resting findings do not exclude EILO                                                                  |
| Key diagnostic test                   | Continuous laryngoscopy during exercise (CLE), allowing visualization of the larynx during symptom-provoking exercise [3,4]        | Spirometry, bronchodilator reversibility testing and bronchoprovocation testing        | Objective assessment of both upper and lower airways may be required                                         |
| Flow-volume loops                     | May provide supportive information, but have limited diagnostic value for EILO [4,19]                                              | May support pulmonary function assessment                                              | Flow-volume loops should not replace direct laryngeal visualization                                          |
| Coexistence                           | May coexist with asthma or EIB [2,11]                                                                                              | May coexist with EILO                                                                  | Persistent symptoms in an athlete with asthma should not automatically be interpreted as poor asthma control |

**Abbreviations:** EILO – exercise-induced laryngeal obstruction; EIB – exercise-induced bronchoconstriction; CLE – continuous laryngoscopy during exercise.



### Diagnostic assessment and role of CLE

The diagnostic assessment of exercise-induced laryngeal obstruction in athletes requires an objective approach, because symptoms alone are not sufficiently reliable to distinguish EILO from asthma, exercise-induced bronchoconstriction, dysfunctional breathing or other causes of exertional dyspnea. The current diagnostic reference standard is direct visualization of the larynx during exercise, most commonly performed using continuous laryngoscopy during exercise (CLE). During CLE testing, a flexible laryngoscope is positioned transnasally and remains in place while the athlete performs an incremental exercise protocol, usually on a treadmill or cycle ergometer, until symptom-provoking high-intensity exertion is reached. This approach allows real-time assessment of laryngeal behavior under the conditions in which symptoms occur, including evaluation of supraglottic and glottic narrowing at increasing exercise intensities [3,4].

The main advantage of CLE is that it permits symptom reproduction and visualization of dynamic laryngeal obstruction during the same exercise challenge. This is clinically important because EILO may be absent or minimal at rest, appear only when ventilatory demand increases and resolve rapidly after exercise intensity is reduced. Laryngeal findings are commonly interpreted using structured visual grading of obstruction at the supraglottic and glottic levels, particularly during high-intensity or peak exercise. However, CLE also has practical limitations. It requires specific equipment and trained personnel, may not be available in all clinical settings and standard laboratory protocols may not always reproduce the athlete's sport-specific triggers. Portable adaptations of CLE have been shown to be feasible, suggesting that more flexible assessment strategies may be useful in selected athletes whose symptoms are difficult to reproduce in conventional laboratory conditions [18].

Pulmonary function testing remains an important component of the diagnostic work-up, particularly because asthma and EIB are common considerations in athletes with exertional respiratory complaints and may coexist with EILO. Resting spirometry, bronchodilator reversibility testing and bronchoprovocation testing can help identify lower-airway dysfunction; however, normal spirometry does not exclude EILO, and abnormal lower-airway test results do not rule out a concurrent laryngeal component. Therefore, persistent inspiratory or peak-exercise symptoms despite appropriate asthma-directed evaluation or treatment should prompt consideration of upper-airway assessment rather than automatic escalation of asthma medication [2,17].

Flow-volume loop analysis may provide supportive physiological information when upper-airway limitation is suspected, particularly if measurements are obtained during or immediately after symptom-provoking exercise. Nevertheless, flow-volume loops have limited diagnostic value for EILO and should not be used as a substitute for direct laryngeal visualization. Abnormal inspiratory loop morphology may raise suspicion of upper-airway dysfunction, but such findings are not sufficiently specific and may be absent or inconsistent in patients with clinically relevant EILO. Studies combining laryngoscopy with flow-volume assessment support the complementary value of physiological measurements, but confirm that laryngoscopic visualization remains central to diagnosis [19].

The differential diagnostic process should remain broad, especially in athletes whose symptoms are recurrent, disproportionate or performance-limiting. Asthma and EIB should be objectively assessed, but the presence of lower-airway dysfunction should not exclude evaluation for EILO when the clinical pattern suggests an upper-airway component. In this context, diagnostic evaluation should not aim only to confirm or exclude a single disorder, but rather to identify the relative contribution of upper-airway obstruction, lower-airway dysfunction and other exercise-related factors. Overall, CLE occupies a central role in the diagnosis of EILO because it directly demonstrates dynamic laryngeal obstruction during exertion, while spirometry and bronchoprovocation remain essential for evaluating lower-airway disease and guiding differential diagnosis.

### Impact on exercise tolerance and sport participation

Exercise-induced laryngeal obstruction may have clinically relevant consequences for exercise tolerance, particularly in athletes whose symptoms occur during high-intensity training or competition. Because laryngeal narrowing develops when ventilatory demand is high, EILO may create a functional limitation at the moment when the athlete is attempting to sustain intense exercise. Physiological data demonstrating increased work of breathing and heightened respiratory neural drive in individuals with EILO support the concept that the larynx may become a limiting segment of the respiratory system during exertion [8]. In practical terms, this mechanism may contribute to early reduction of exercise intensity, interruption of training sessions and difficulty maintaining the effort required during demanding sport activity.

The impact of EILO is not limited to physiological airflow limitation, as the subjective experience of breathing difficulty may influence perceived exercise capacity, confidence and willingness to continue activity.

Athletes may reduce training intensity, stop exercise prematurely or avoid situations that reliably provoke symptoms. In referral-based cohorts, EILO has been associated with limitation of exercise and active lifestyle, indicating that its consequences may affect both competitive and recreationally active individuals [6]. Qualitative data from adolescents with EILO further suggest that symptomatic episodes may be experienced as sudden, frightening and difficult to control, with patients describing fear, frustration, embarrassment and uncertainty during breathing difficulties [16].

These subjective and behavioral consequences are particularly relevant in sport, where symptoms may occur during public performance, under competitive pressure or in situations requiring sustained effort. Recurrent unexplained symptoms may reduce confidence in physical capacity and create concern about future episodes, especially when the diagnosis remains delayed or uncertain. However, the available literature does not support interpreting EILO as a uniform cause of measurable performance decline in all affected athletes. Rather, its impact appears to depend on symptom severity, exercise context, diagnostic delay, coexistence of lower-airway disease and the athlete's psychological response to recurrent breathing difficulty. Overall, EILO should be regarded as a condition that may impair exercise tolerance through both physiological respiratory burden and subjective symptom impact, with potential consequences for training quality, perceived performance and continued sport participation.

### **Management and treatment strategies**

Management of exercise-induced laryngeal obstruction in athletes should be individualized and guided by symptom severity, anatomical pattern of obstruction, coexistence of asthma or exercise-induced bronchoconstriction, and the functional impact of symptoms on training and sport participation. In most patients, treatment is initially conservative and should focus on education, symptom recognition, and strategies aimed at improving control of the laryngeal response during exercise. In athletes with coexisting asthma or EIB, lower-airway disease should be treated appropriately; however, persistent inspiratory symptoms during peak exercise should prompt targeted management of the laryngeal component rather than escalation of asthma-directed therapy alone [3].

Speech therapy is commonly considered a central conservative intervention for EILO. It may include education about laryngeal function, identification of symptom triggers, breathing retraining, laryngeal control techniques, and strategies that can be applied during exercise or at the onset of symptoms. In teenage athletes, speech-language pathology intervention has been associated with improved participation in physical activity, reduced breathing-related symptoms, and decreased inhaler use after therapy. Recent studies have also aimed to standardize speech therapy protocols and evaluate treatment response using patient-reported outcomes and continuous laryngoscopy during exercise. These findings suggest benefit in selected patients, although the evidence remains limited by heterogeneity of protocols, outcome measures, and follow-up duration [20–22].

Inspiratory muscle training (IMT) has been investigated as an adjunctive conservative strategy in athletes with EILO. Its proposed rationale is to improve inspiratory muscle function, breathing control, and coordination between inspiratory effort and laryngeal opening during exercise. Available evidence suggests that IMT may reduce symptoms in some athletes and may influence laryngeal obstruction patterns during exercise, but responses are variable and this intervention should not be regarded as universally effective or as a substitute for individualized breathing-based therapy [23]. Therefore, IMT may be considered in selected patients as part of a broader treatment plan.

Physiotherapy may be relevant when EILO is accompanied by dysfunctional breathing, excessive tension, altered breathing mechanics, or maladaptive respiratory strategies. Approaches based on Norwegian psychomotor physiotherapy have been used in young athletes and focus on breathing mechanics, postural awareness, relaxation, and the interaction between physical symptoms and psychosocial stressors. Case-series and multidimensional intervention data suggest that physiotherapy may reduce respiratory distress, improve breathing patterns, and support more functional participation in exercise, particularly when treatment is adapted to the athlete's broader biopsychosocial context [24,25].

Surgical treatment is not considered first-line therapy and should be reserved for carefully selected patients, particularly those with severe supraglottic obstruction confirmed during CLE testing and persistent disabling symptoms despite adequate conservative management. Supraglottoplasty has been associated with improvement in symptoms, exercise ability, and laryngeal findings in selected patients with predominantly supraglottic EILO, while systematic review evidence suggests potentially favourable outcomes in appropriately chosen cases [26,27]. However, surgery should be approached cautiously, because EILO is heterogeneous and not all patients have an anatomical pattern likely to benefit from operative intervention.

Overall, current evidence supports a stepwise, individualized, and multidisciplinary management strategy in which education, speech therapy, breathing retraining, physiotherapy, and, in selected cases, IMT are prioritized before surgical options are considered.

## **Discussion**

### **Why EILO remains underdiagnosed**

EILO remains a clinically important but still underdiagnosed cause of exertional respiratory symptoms in athletes. Several factors may contribute to delayed recognition. First, symptoms of EILO overlap with those of asthma and exercise-induced bronchoconstriction, and athletes with exertional dyspnea are often initially evaluated within a lower-airway diagnostic framework. This may lead to EILO being overlooked, particularly when symptoms are interpreted primarily as asthma-related despite insufficient response to asthma-directed therapy [2]. Second, EILO is a dynamic disorder that may be absent at rest and becomes evident mainly during high-intensity exercise, which limits the diagnostic value of resting examination and symptom-based assessment. Continuous laryngoscopy during exercise remains central to diagnosis, but its availability may be restricted by the need for specific equipment, trained personnel and suitable exercise-testing conditions [3,18]. Third, clinical presentation may be heterogeneous, especially in children and adolescents with different ILO and EILO profiles, which further complicates recognition outside specialized centres [28]. Limited awareness in the sporting environment may also contribute to underdiagnosis, as recent data indicate that many athletic coaches have little familiarity with EILO despite frequently observing exercise-induced breathing problems in young athletes [31].

### **Consequences of diagnostic confusion and delayed recognition**

The consequences of diagnostic confusion may be clinically relevant for athletes. When EILO is interpreted as asthma or EIB, athletes may receive medication that does not directly address the laryngeal mechanism of airflow limitation. In selected athletic cohorts, regular asthma medication use has been reported among athletes with confirmed EILO and negative lower-airway testing, illustrating the risk of ineffective treatment when upper-airway dysfunction is not considered [5]. Delayed diagnosis may also prolong uncertainty, increase frustration and contribute to ongoing limitation of training or sport participation. In a large international cohort, EILO was associated with diagnostic delay and changes in asthma medication after reassessment, supporting the practical importance of accurate diagnosis [6]. Qualitative data from adolescents with EILO further indicate that symptoms may be frightening, confusing and emotionally burdensome, particularly when the cause remains unexplained or symptoms interfere with physical activity [16]. In athletes, such uncertainty may affect perceived performance, confidence and willingness to sustain high-intensity training.

### **Relevance for sports medicine practice**

From a sports medicine perspective, EILO should be included in the differential diagnosis of athletes with persistent, unexplained or atypical exercise-induced respiratory symptoms, particularly when symptoms occur at peak exercise and respond insufficiently to asthma-directed treatment. Sports physicians, respiratory specialists, otolaryngologists, speech-language pathologists, physiotherapists and coaches may all contribute to earlier recognition and more appropriate management. The role of clinicians is to avoid interpreting persistent exertional symptoms only as poor asthma control and to consider objective assessment of both lower- and upper-airway function when symptoms remain unexplained [2,3]. Education of coaches is also relevant, because coaches may observe respiratory limitation during training or competition before formal medical evaluation occurs. Improved coach awareness could support earlier referral and reduce the likelihood that symptoms are misinterpreted as poor conditioning, poor effort or anxiety alone [31]. Management should remain interdisciplinary and individualized, because available studies suggest that speech therapy, breathing retraining, physiotherapy, inspiratory muscle training and, in selected supraglottic cases, surgery may each have a role depending on symptom profile, anatomical pattern and treatment response [20–27].

**Limitations of the available evidence**

The available evidence has several limitations. Many studies are based on relatively small samples, selected referral populations, adolescent cohorts or specific athletic subgroups, which limits generalizability to the broader athletic population. Reported estimates of EILO vary according to recruitment strategy, athletic level, symptom status, exercise protocol, diagnostic threshold and use of continuous laryngoscopy during exercise. Therefore, prevalence data from symptomatic or referral-based cohorts should not be interpreted as general population prevalence [1,5,11,12]. Another limitation is the heterogeneity of clinical definitions and outcome measures. Pediatric ILO and EILO populations may show overlapping but distinct clinical profiles, suggesting that future studies should account for phenotype and trigger patterns rather than treating all patients as a uniform group [28]. Treatment studies are also heterogeneous, with differences in intervention content, duration, follow-up and outcome assessment. Although conservative interventions appear promising, current evidence does not yet allow firm conclusions about which treatment is optimal for specific athlete groups or EILO phenotypes [20–25]. Finally, objective sport-performance outcomes remain insufficiently studied; most available data relate to symptoms, laryngoscopic findings, exercise tolerance or patient-reported impact rather than standardized competitive performance measures.

**Directions for future research**

Future research should focus on diagnostic standardization, sport-specific epidemiology and treatment outcomes. More consistent CLE protocols are needed to clarify clinically meaningful thresholds for supraglottic and glottic obstruction and to determine how best to reproduce sport-specific triggers during testing. Longitudinal follow-up of CLE findings in athletes is particularly important, because available data suggest that laryngeal obstruction scores and symptom status may change over time, and single cross-sectional assessments may not fully capture the course of EILO in athletic populations [29]. The development of validated patient-reported outcome measures, such as the Exercise-Induced Laryngeal Obstruction Dyspnea Index, represents an important step toward more standardized symptom assessment and treatment evaluation [30]. Future studies should also examine how EILO interacts with asthma and EIB, how diagnostic delay affects training participation, and which conservative therapies provide the greatest benefit for specific clinical phenotypes. Larger prospective studies in competitive and elite athletes are needed to determine the impact of EILO on exercise tolerance, perceived performance, sport participation and response to targeted interventions.

**Conclusions**

Exercise-induced laryngeal obstruction should be regarded as a clinically relevant, underrecognized and potentially underdiagnosed cause of exertional dyspnea in athletes. Its clinical importance results from symptomatic overlap with asthma and exercise-induced bronchoconstriction, the possibility of coexistence with lower-airway disease and the risk of delayed diagnosis or ineffective treatment when the laryngeal component of symptoms is not considered. Continuous laryngoscopy during exercise remains the reference diagnostic method, as it allows direct visualization of dynamic laryngeal obstruction under symptom-provoking conditions. Early and accurate recognition of EILO may support more appropriate management, reduce ineffective treatment pathways and help athletes maintain exercise tolerance, training quality and sport participation. Greater awareness among sports physicians, respiratory specialists, otolaryngologists, physiotherapists, speech-language pathologists and athletic coaches is needed to improve referral, diagnosis and individualized care for athletes with persistent exercise-induced respiratory symptoms.



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