QUALITY IN SPORT
eISSN 2450-3118 · Open Access · Peer-reviewed
apcz.umk.pl/QS Nicolaus Copernicus University in Toruń

Cite as: BANASIK, Aleksandra, FRYSZER, Gabriela, AFRYKAŃSKA, Gabriela, POMYKAŁA, Bernard, MIRKOWSKA, Oliwia, LECIEJ, Zuzanna, LUBKOWSKI, Michal, ORZEŁ, Krzysztof, SKWARNA, Hubert and KRZYSZTOFIK, Kinga Anna. Exercise-Induced Laryngeal Obstruction (EILO) Mimicking Asthma in Athletes: A Comprehensive Clinical Review. Quality in Sport. 2026;63:73155. https://doi.org/10.12775/QS.2026.63.73155

ARTICLE TIMELINE
Received: 08.06.2026. Revised: 10.07.2026. Accepted: 13.07.2026. Published: 13.07.2026.

The journal has been awarded 20 points in the parametric evaluation by the Polish Ministry of Higher Education and Science (Annex to the announcement of 05.01.2024, No. 32553). Unique Journal Identifier: 201398. Scientific disciplines assigned: Economics and finance (Field of social sciences); Management and Quality Sciences (Field of social sciences).
Punkty Ministerialne z 2019 – aktualny rok 20 punktów. Załącznik do komunikatu Ministra Szkolnictwa Wyższego i Nauki z dnia 05.01.2024 Lp. 32553. Posiada Unikatowy Identyfikator Czasopisma: 201398. Przypisane dyscypliny naukowe: Ekonomia i finanse (Dziedzina nauk społecznych); Nauki o zarządzaniu i jakości (Dziedzina nauk społecznych).

Exercise-Induced Laryngeal Obstruction (EILO) Mimicking Asthma in Athletes: A Comprehensive Clinical Review

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Abstract

Background. Exercise-Induced Laryngeal Obstruction (EILO) is a significant yet frequently misdiagnosed cause of respiratory distress in athletes. Due to symptomatic overlap, it is routinely mistaken for bronchial asthma or exercise-induced bronchoconstriction (EIB). This diagnostic confusion leads to ineffective pharmacological treatment and impaired athletic performance.

Aim. The aim of this review is to evaluate the clinical relationship between EILO and asthma, focusing on the physiological differences, diagnostic imperatives, and management strategies in competitive sports.

Material and Methods. A comprehensive search of electronic databases, including PubMed, ScienceDirect, and Google Scholar, was conducted. The search strategy involved keywords such as "EILO", "exercise-induced laryngeal obstruction", "laryngeal obstruction", "asthma", and "CLE test". The analysis focused on peer-reviewed clinical trials and consensus statements. Sources were selected based on their relevance to pathophysiology, diagnostic accuracy, and therapeutic efficacy in the athletic population.

Results. The study demonstrates that while EIB involves inflammatory narrowing of the lower airways, EILO is a mechanical event at the laryngeal level driven by Bernoulli's principle. Differentiation depends on the timing of symptoms: EILO occurs during peak effort, whereas EIB typically presents post-exercise. The Continuous Laryngoscopy Exercise (CLE) test is confirmed as the gold standard for real-time visualization. Management is predominantly non-pharmacological, with respiratory retraining and biofeedback showing high efficacy.

Conclusions. EILO should be considered a primary differential diagnosis in athletes unresponsive to asthma therapy. Objective endoscopic evaluation is essential to prevent medical errors. A multidisciplinary approach, prioritizing respiratory physiotherapy over pharmacology, is necessary to restore optimal breathing patterns and performance.

Key words: EILO, exercise-induced laryngeal obstruction, bronchial asthma, differential diagnosis, exertional dyspnea, CLE test, respiratory retraining, sports medicine.

1. Introduction

In elite sports, respiratory limitations often dictate the boundary between success and failure. While exercise-induced bronchoconstriction (EIB) - the clinical hallmark of asthma in athletes - has long been the primary diagnostic focus, the 2013 international consensus established Exercise-Induced Laryngeal Obstruction (EILO) as a distinct and critical entity [1, 2]. Distinguishing EILO from asthma is essential, as it represents a specific mechanical obstruction of the upper airway rather than the bronchial inflammation typical of lower airway diseases [3, 4].

Physiologically, EILO is driven by fluid dynamics. Unlike the inflammatory nature of asthma, laryngeal obstruction occurs when the upper airway becomes an unstable "bottleneck" during intense effort [5, 6]. According to the Bernoulli principle, peak inspiratory airflow velocity causes a drop in lateral pressure, triggering a suction-driven collapse of laryngeal tissues [6, 7]. This creates a paradox where increased breathing effort only intensifies the obstruction.

Epidemiological data indicate that EILO affects 5% to 10% of adolescents, with significantly higher prevalence in elite athletes due to extreme ventilatory demands [8, 9]. Environmental stressors, such as chlorine in swimming or cold air in winter sports, further irritate the larynx, often leading to a complex overlap between EILO and EIB/asthma [10, 11].

The persistent "diagnostic gap" remains the greatest clinical challenge. EILO is frequently mismanaged as refractory asthma, leading to years of ineffective pharmacological treatment [12, 13]. Resolving this "conundrum" is vital. While asthma symptoms are typically post-exertional, EILO peaks at the height of inspiratory load during exercise [13, 14].

The aim of this study is to evaluate EILO as a primary differential diagnosis of asthma in athletes. By reviewing current diagnostic standards and therapeutic outcomes, this work provides a framework for identifying this "diagnostic trap" and optimizing care for the breathless athlete.

2. Material and Methods

This comprehensive clinical review is based on a narrative synthesis of literature identified through the PubMed, ScienceDirect, and Google Scholar databases. The search focused on identifying key literature regarding EILO pathophysiology, diagnostic protocols, and management in athletes. Relevant studies were identified using keywords such as "EILO", "exercise-induced laryngeal obstruction", "asthma", "CLE test", "differential diagnosis of asthma", "exercise-induced bronchoconstriction", "athletes", and "sports medicine".

The selection of literature was centered on high-impact peer-reviewed articles, consensus statements, and clinical reviews published in English. Priority was given to papers discussing competitive athletes and those utilizing the Continuous Laryngoscopy Exercise (CLE) test as a diagnostic gold standard. To ensure a focused discussion, sources were excluded if they pertained to pediatric laryngomalacia or non-exercise-related vocal cord dysfunction. The final synthesis integrates evidence from selected sources to provide a clinical overview of the current EILO landscape.

3. Comparative Pathophysiology and Epidemiology: Laryngeal versus Bronchial Obstruction

3.1. Normal Laryngeal Anatomy and Function

At the height of physical effort, the larynx operates as far more than a simple passageway; it is a critical valve that fundamentally determines breathing efficiency. The structural integrity of the organ is maintained by a specialized framework of thyroid, cricoid, and paired arytenoid cartilages, which provide the mechanical stiffness necessary to prevent airway collapse under extreme stress [2]. Notably, Griffin et al. [4] describe this area as the primary "chokepoint" within the respiratory system. In this context, keeping airflow resistance to an absolute minimum is a decisive factor in sustaining peak physical performance.

In general clinical discourse, the scale of air movement during training is frequently underestimated - standard textbooks often cite significantly lower figures than those found in studies of high-performance athletes. These specialized sources demonstrate that minute ventilation (V_E) can exceed 200 L/min [1], with certain cohorts of athletes with exercise-induced laryngeal obstruction (EILO) reaching peaks of 198 L/min [3]. To move such a massive volume of air, the posterior cricoarytenoid (PCA) muscles play an immense role by forcefully pulling the vocal folds apart. In a healthy physiological state, these muscles are supported by the passive stability of supraglottic structures, specifically the aryepiglottic folds. These tissues must resist being drawn medially by the massive negative pressure that builds up during rapid inhalation [6]. Ultimately, it is the fine balance between a rigid cartilaginous frame and intense muscular recruitment that keeps the airway patent when the body needs it most.

3.2. Pathophysiology: Aerodynamic Forces and Biological Vulnerability

EILO is a complex, functional disorder rather than a static anatomical defect. The condition arises when the larynx cannot maintain patency against surging aerodynamic forces during exercise [6]. This collapse follows Bernoulli's Principle: as airflow velocity increases, internal pressure drops. Since the larynx is the narrowest point of the tract - a structural "bottleneck" [1, 6] - peak ventilatory demand (V_E) during maximal exertion forces inspired air to reach extreme speeds. This acceleration generates a medially-directed suction. It physically drags laryngeal tissues inward.

Staying open under such stress requires a functional "scaffolding" [4]. It is a synergy between cartilaginous rigidity and active muscle recruitment. In susceptible athletes, this protection is often insufficient. Research indicates the failure is twofold: anatomical flaccidity (resembling exercise-specific laryngomalacia) and impaired neuromuscular coordination [6, 15]. If the posterior cricoarytenoid (PCA) muscles do not fire in perfect sync with the diaphragm, the vacuum wins. Soft tissues, particularly the aryepiglottic folds, begin their inward drift. This triggers a feedback loop: narrowing increases air velocity, which intensifies the suction and hastens structural collapse [5, 6].

Environmental factors often aggravate this biological vulnerability. Elite athletes train in "hostile" conditions - chlorinated air for swimmers or cold, dry air for winter sports [10, 11]. These irritants cause mucosal irritability and lower the threshold for laryngeal closure. Distinguishing this mechanical failure from the inflammatory nature of bronchial asthma is critical. EILO is a purely dynamic failure of the upper airway [7]. This mechanical etiology explains why asthma drugs fail. Pharmacological intervention with anti-inflammatory inhalers is ineffective for a structural, suction-driven collapse [12, 13].

3.3 Prevalence and Diagnostic Bias: EIB vs. EILO

EIB commands a much larger epidemiological footprint than EILO. This imbalance directly affects clinical screening. Among elite athletes (especially swimmers and skiers exposed to chlorine or cold air) EIB prevalence often hits 30-50% [10, 11]. Adolescent screenings confirm this gap: EIB rates of 19.2% effectively triple the 5.7% documented for EILO [8].

This statistical dominance creates a diagnostic bias. Clinicians reflexively blame the lower airway for any exertional wheeze. However, the real challenge is synchronous comorbidity. Data shows a substantial 20%-33% overlap in athletes who suffer from both bronchial hyperreactivity and laryngeal collapse [8, 12]. Such patients often show a "partial treatment response." Their bronchial inflammation is managed, but the unaddressed laryngeal bottleneck remains a barrier to peak performance.

The danger here is the automatic application of asthma protocols without objective testing. Many athletes end up labeled with “refractory” asthma simply because their symptoms - driven by the less common EILO - are mechanical failures. These failures are fundamentally unresponsive to standard inhalers [3, 13].

3.4. The Impact of Environmental Irritants on Laryngeal Stability

The physical environment in which an athlete trains is a critical cofactor in the development and exacerbation of EILO. In elite swimming, chronic exposure to trichloramines—byproducts of chlorine disinfection—acts as a potent mucosal irritant. These chemicals induce a state of laryngeal hypersensitivity, which lowers the threshold for the suction-driven tissue collapse described by Bernoulli’s principle [6, 10]. Repeated exposure to these irritants can trigger neurogenic inflammation and sensory nerve remodeling, causing the larynx to respond with excessive adduction even at lower ventilatory demands. Similarly, winter sports athletes are exposed to massive volumes of cold, dry air. This causes rapid cooling of the laryngeal mucosa, leading to localized micro-edema and altered neuromuscular responsiveness. The resulting osmotic shift and mucosal dehydration further impair the stability of the supraglottic structures during high-velocity airflow. These stressors explain why many athletes remain asymptomatic in clinical settings but experience severe distress during field-based training in "hostile" environments [11].

4. Diagnostic Challenges and the Gold Standard: From Spirometry to CLE Test

4.1. Clinical Presentation: Symptom Overlap and Divergence

Differentiating EILO from exercise-induced bronchoconstriction (EIB) based on patient history alone is notoriously difficult. Both conditions present with exertional dyspnea, chest tightness, and audible respiratory noises [13, 16]. However, the timing and nature of these symptoms provide critical diagnostic clues.

In EIB, the bronchial obstruction typically peaks 10-15 minutes after exercise has ceased. It is driven by inflammatory mediators [10]. Conversely, EILO is a strictly effort-dependent phenomenon. The symptoms reach their maximum intensity during peak physical strain - precisely when ventilatory demand is highest and often resolve within minutes of stopping [17,18].

To clarify these differences, the following table summarizes the key clinical discriminators:

Table 1. Differential Diagnosis: EILO vs. EIB [14, 16, 18, 19]

Feature	Exercise-Induced Laryngeal Obstruction (EILO)	Exercise-Induced Bronchoconstriction (EIB)
Primary Sound	Inspiratory stridor (high-pitched)	Expiratory wheeze (whistling)
Timing of Peak	During maximal effort	10–15 minutes after exercise
Onset on Attack	Sudden (within seconds)	Gradual (minutes into exercise)
Symptom Resolution	Rapid (1–5 minutes after stopping)	Slower (20–60 minutes without inhaler)
Location of Sensation	Throat or upper chest	Mid-to-lower chest
Response to Albuterol	Minimal or none	Usually significant
Associated Factors	Panic/Anxiety common due to acute onset	Less common; progressive distress

The quality of respiratory sound is a focal point. EIB manifests as an expiratory wheeze, originating from the lower airways. EILO produces an inspiratory stridor, as air forces through the narrowed laryngeal aperture [14, 16]. Despite this, athletes often struggle to localize the sensation. Many report throat constriction and chest tightness interchangeably. This subjective ambiguity leads to the frequent misclassification of EILO as "treatment-resistant asthma" [19].

4.2. Limitations of Standard Diagnostic Tools

In routine clinical practice, spirometry is the first-line investigation for exertional breathlessness. However, its utility in diagnosing EILO is severely limited. Resting spirometry typically yields normal results in these athletes, as laryngeal obstruction is a strictly dynamic phenomenon [12, 20]. The absence of airflow limitation in a quiet, clinical setting often leads to the erroneous conclusion that symptoms must be psychosomatic or "atypical."

The flow-volume loop can sometimes provide a clue. A flattening of the inspiratory limb may suggest an extrathoracic obstruction, but this sign is frequently absent unless the patient is symptomatic during the test [7, 18]. Standard bronchial provocation tests, such as the methacholine challenge, also add to the confusion. Because EILO and asthma often coexist, a positive methacholine test might confirm bronchial hyperreactivity but completely miss the laryngeal component [10, 14].

Furthermore, many athletes with EILO perform remarkably well on standard exercise stress tests. Their FEV_1 (forced expiratory volume in one second) remains stable post-exercise, leading clinicians to rule out asthma. Yet, the patient remains symptomatic [3, 19]. This "diagnostic gap" between normal lung function tests and severe exertional distress is the primary reason why a direct, visual assessment of the larynx is mandatory for a definitive diagnosis [1, 15].

4.3. Continuous Laryngoscopy Exercise (CLE) Test: The Gold Standard

EILO is a dynamic phenomenon. Its transient nature makes resting examinations largely ineffective. Consequently, the Continuous Laryngeal Exercise (CLE) test has emerged as the diagnostic gold standard [1, 21]. This procedure, pioneered by Heimdal et al. [21], utilizes a flexible fiberoptic laryngoscope passed transnasally. The device is secured via a specialized head-mounted harness. This configuration allows for uninterrupted visualization of the larynx while the athlete performs a maximal provocation test on a treadmill or cycle ergometer.

Standard post-exercise laryngoscopy is inherently limited. The laryngeal aperture frequently reverts to a normal state within seconds of ceasing effort [21,22]. In contrast, the CLE test enables real-time observation of the obstruction as it evolves. Every respiratory sound and physiological sign of distress is correlated directly with structural movements of the airway.

Quantitative assessment is achieved through a grade scoring system [15, 23]. This method evaluates laryngeal behavior at two distinct anatomical levels:

- The glottic level: Monitoring the abduction and adduction of the vocal folds.
- The supraglottic level: Monitoring the medial collapse of the aryepiglottic folds and the posterior displacement of the epiglottis.

A scoring scale from 0 to 3 is applied. Findings exceeding grade 1 during peak ventilatory demand are considered clinically significant. Recent methodological shifts have introduced field-based laryngoscopy [24, 25]. Testing in sport-specific environments, such as swimming pools or ice rinks is often necessary to trigger the obstruction. Specific environmental stressors, particularly chlorine and cold air, remain primary catalysts for laryngeal closure in elite cohorts [6, 7].

Table 2. The CLE Scoring System for Exercise-Induced Laryngeal Obstruction [15, 17, 19]

Grade	Glottic Level (Vocal Folds)	Supraglottic Level (Aryepiglottic Folds)
0	Normal abduction; wide glottic aperture during inspiration.	Normal position; no medial movement of supraglottic structures.
1	Mild adduction; slight narrowing of the posterior glottis.	Mild medial inward movement or flickering of the aryepiglottic folds.
2	Moderate adduction; vocal folds occupy approximately 50% of the airway.	Significant medial collapse; aryepiglottic folds obscure the vocal folds.

3	Severe/Complete adduction; near-total closure of the glottic space.	Total collapse; supraglottic tissues meet in the midline, blocking the view of the glottis.

Note: The scoring system (0–3) represents the degree of medial inward movement of laryngeal structures observed during peak exercise. Clinical significance is typically assigned to findings of Grade 2 or higher. All endoscopic findings must be correlated with clinical symptoms and flow-volume loop morphology to ensure diagnostic accuracy [15, 17, 23].

4.4. Beyond Asthma: Differentiating EILO from VCD and BPD

Accurate diagnosis requires distinguishing EILO not only from asthma but also from Vocal Cord Dysfunction (VCD) and Breathing Pattern Disorders (BPD). While VCD is often used interchangeably with EILO, current consensus suggests that VCD is frequently triggered by non-exercise stimuli, such as odors or psychological stress, whereas EILO is strictly effort-dependent [14, 15]. Furthermore, BPD which is characterized by apical, rapid breathing can coexist with EILO. In these cases, the excessive recruitment of accessory neck muscles increases extrinsic tension on the laryngeal framework, making the airway structurally more vulnerable to collapse during peak inspiratory load [18, 19, 20]. Identifying these co-morbidities is vital, as a "partial response" to treatment often stems from unaddressed breathing pattern issues.

5. Management and Treatment Strategies

5.1. Non-Pharmacological Interventions: Speech Therapy and Biofeedback

The treatment of EILO is primarily non-pharmacological, focusing on active laryngeal control. Unlike asthma, which responds to chemical agents, EILO requires behavioral modification to override the maladaptive laryngeal closure [26]. The first line of defense is specialized Speech and Language Therapy (SLT).

These interventions aim to shift the patient’s breathing pattern from high-chest accessory muscle use to diaphragmatic breathing. This transition reduces the negative pressure gradient across the larynx during high-intensity exercise [27, 28]. A critical component of this process is biofeedback. During a CLE test, athletes observe their own laryngeal movements on a monitor. Seeing the collapse in real-time allows them to consciously apply "open-throat" techniques, such as the sniff maneuver or pursed-lip breathing, to abort the obstruction as it begins [29, 30].

5.2. Respiratory Muscle Training and Psychological Support

Recent evidence supports the use of Inspiratory Muscle Training (IMT). By using resistive loading devices, athletes can strengthen the diaphragm and external intercostals. This increased strength improves the mechanical stability of the upper airway under stress [24]. Furthermore, addressing the psychological component is essential. Many athletes experience significant anxiety due to the sudden nature of laryngeal closure. Performance psychology interventions help patients manage the "panic-loop" that often exacerbates the physical obstruction [23, 29].

5.3. Surgical Options: Supraglottoplasty

Surgical intervention remains a last resort, reserved for severe, refractory cases where conservative modalities fail to provide symptomatic relief. The primary procedure, supraglottoplasty (or laser-assisted aryepiglottoplasty), targets the anatomical components of the supraglottic airway. It is most effective when the CLE test identifies a clear medial collapse of the aryepiglottic folds or excessive mucosal redundancy over the arytenoid cartilages [31].

The surgery involves the microsurgical resection of this redundant tissue, often performed with a CO_2 laser. The goal is to "tension" the laryngeal entrance and making it more resistant to the Bernoulli-induced suction generated during high-intensity ventilation [1, 15]. Recent longitudinal studies indicate that elite athletes undergoing this procedure show significant improvements in peak oxygen uptake and a marked reduction in exertional stridor [21, 24].

However, patient selection is the most critical factor for surgical success. Surgery is strictly a second-line treatment. It is generally considered only when the collapse is attributed to anatomical flaccidity (resembling exercise-induced laryngomalacia) rather than purely functional discoordination [17, 21]. Post-operative rehabilitation is usually required to "re-learn" optimal breathing patterns, as the brain may still trigger defensive, maladaptive laryngeal movements even after the physical obstruction has been surgically removed [25].

5.4. Current Limitations and Future Perspectives

Despite the clinical efficacy of the CLE test, several challenges remain in the routine management of EILO. The primary limitation is the lack of standardized access to real-time laryngoscopy outside of specialized tertiary centers. Most diagnostic protocols are currently confined to stationary treadmill or cycle ergometer tests, which may not fully replicate the mechanical and environmental stressors encountered during sport-specific movements, such as swimming or field sprints [15, 24].

Future clinical efforts should focus on the development of portable, wireless endoscopic systems to facilitate field-based testing. Furthermore, there is a clear need for broader educational initiatives targeting coaching staff and athletic trainers. Since EILO is often first observed during training sessions, early recognition of inspiratory stridor by non-medical personnel could drastically shorten the diagnostic delay and prevent the unnecessary long-term use of asthma medications [13, 16]. Finally, more longitudinal data is required to establish definitive criteria for surgical intervention, ensuring that supraglottoplasty is reserved for patients with clear anatomical flaccidity rather than functional, behavioral discoordination [1, 21, 31].

6. Conclusions

Exercise-Induced Laryngeal Obstruction (EILO) remains a frequently underdiagnosed condition that significantly impairs the performance and quality of life of athletes. The primary diagnostic challenge lies in its symptomatic overlap with exercise-induced bronchoconstriction (EIB). As demonstrated, relying solely on clinical history or resting spirometry often leads to the misclassification of EILO as "refractory asthma" [19]. This diagnostic failure results in unnecessary pharmacological interventions and prolonged respiratory distress for the competitor [12, 13].

The implementation of the Continuous Laryngoscopy Exercise (CLE) test has revolutionized the field, providing the objective, real-time visualization necessary for an accurate diagnosis [15, 1]. Understanding that EILO is a dynamic, mechanical failure driven by aerodynamic forces and neuromuscular discoordination is essential for clinical success [32].

Therapeutic outcomes are highest when a multidisciplinary approach is adopted. Most athletes respond well to non-invasive strategies, particularly respiratory retraining and biofeedback, which allow for conscious control over laryngeal patency [24, 26]. Surgery, specifically supraglottoplasty, offers a viable secondary option for those with severe anatomical flaccidity [21].

In conclusion, increasing awareness among sports medicine professionals regarding the mechanical nature of EILO is crucial. Early identification through gold-standard testing not only prevents medical errors but also ensures that athletes receive the specific, functional training required to reach their physiological potential.

7. Disclosure

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

Funding: This study has not received any external funding.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: Not applicable.

Acknowledgements: Not applicable.

Conflicts of Interest: The authors deny any conflict of interest.

Declaration of the use of generative AI and AI-assisted technologies in the writing process:

In preparing this work, the authors used Gemini (Google) for the purpose of language refinement and stylistic improvement. After using this tool, the authors reviewed and edited the content as needed and accept full responsibility for the substantive content of the publication.

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