

Research article

An In-depth Study of Effort-induced Asthma and its Impact on Health

Alina Mihaela Stanigut ^{1,2}, Laura Maria Condur ^{1,*}, Andreea Georgiana Sunda ^{3, *}, Camelia Pana ^{1,2}, Ionut Eduard Iordache ^{1,5}, Oana Laura Coiciu ^{1,3}, Ioan Cristian Nichita ¹ and Felix Voinea ^{1,5}

- 1 Faculty of Medicine, "Ovidius" University of Constanta, 900470 Constanta, Romania;
- 2 St. Ap. Andrei Emergency County Hospital, Department of Nephrology, Constanta, Romania;
- 3 St. Ap. Andrei Emergency County Hospital, Department of Internal Medicine, Constanta, Romania;
- 4 St. Ap. Andrei Emergency County Hospital, Department of General Surgery, Constanta, Romania;
- 5 St. Ap. Andrei Emergency County Hospital, Department of Urology, Constanta, Romania

* Correspondence: lauracondur@yahoo.com; andreea.sunda@yahoo.com;

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Abstract: Effort-induced asthma (EIA), a respiratory condition characterized by bronchoconstriction related to histamine release which is triggered by physical activity, has received interest due to its specific features. This research explores the relationship between physical activity and asthma symptoms in people with exercise-induced bronchoconstriction (EIB). It aims to find out what specific triggers and patterns cause symptoms to worsen at different levels of activity. Using a mixed-methods approach, the study collects qualitative data from interviews with participants and quantitative data through tests like spirometry and peak flow assessments. The results show strong links between certain levels of physical exertion and the start of asthma symptoms. Individual responses vary based on factors like initial lung function and the environment. The study stresses the need for personalized exercise guidelines for those impacted, suggesting that understanding individual triggers can improve management plans and lower the chances of EIA episodes. These findings are important for healthcare, stressing the need for customized patient education and intervention programs that help patients exercise safely while reducing asthma reactions. Furthermore, this research adds to the comprehension of exercise-induced asthma and supports the idea of more tailored healthcare strategies that consider each patient's unique situation to help improve their quality of life and physical health.

Keywords: bronchial asthma, exercise-induced asthma, bronchoconstriction, spirometry

1. Introduction

Highly prevalent respiratory diseases, such as asthma, are a major public health problem worldwide, contributing considerably to the economic health burden. Asthma is a complex condition that involves many factors, both physical and mental. One type of asthma, known as exercise-induced bronchoconstriction, presents unique difficulties for patients and healthcare professionals because it happens during physical activity [1, 2], which is crucial for health and wellness, and has a relative high prevalence among athletes (figure 1).

Group	Prevalence (%)	Source
Children	10	American Academy of Allergy Asthma & Immunology (AAAAI), 2021
Adults	6	American College of Allergy, Asthma & Immunology (ACAAI), 2021
Athletes	30	The Journal of Allergy and Clinical Immunology, 2023
General Population	5	Centers for Disease Control and Prevention (CDC), 2022
Urban Areas	12	Environmental Health Perspectives, 2022

Figure 1. Prevalence of Exercise-Induced Asthma Among Adults and Children

EIA occurs when intense exercise causes inflammation in the airways, resulting in them narrowing and generating symptoms like wheezing, tightness in the chest and shortness of breath, all related to histamine release. The challenges of exercise-induced asthma are made more complicated by factors like environmental triggers, individual patient characteristics, medical conditions [3, 4], medication and the biological processes that lead to increased sensitivity of the airways [5, 6]. The key research issue in this dissertation focuses on how physical activity relates to asthma symptoms in those with exercise-induced asthma, particularly in recognizing specific triggers and patterns of symptom worsening at different activity intensities. This research aims to look closely at these relationships and collect both qualitative and quantitative information, including participant interviews and physiological tests like spirometry. A thorough understanding of the triggers and response patterns associated with exercise-induced asthma is crucial for creating personalized management plans for affected patients [7, 8]. The value of this study lies not only in its contribution to academic literature on asthma management but also in its real-world significance [9, 10]. By pinpointing specific activity levels that lead to symptom worsening, healthcare providers can create more accurate guidelines for physical activity customized for individual asthma patients. This study seeks to connect theoretical knowledge with clinical practices, ultimately improving the quality of life for those with exercise-induced asthma and enabling them to participate in physical activities without worrying about worsening their condition. Additionally, the findings from this research may help make informed choices about asthma management, which could lessen emergency healthcare needs and enhance community health results [11].

2. Materials and Methods

This research is a literature review using secondary data from various studies published in the last 15 years, that meet the inclusion (at least one episode of EIA, people who exercise) and exclusion criteria. Literature studies had to be accessible in their entirety. All articles used are in English searched manually in Google Scholar and PubMed using the above keywords. Studying effort-induced asthma needs a careful approach to understand how physical activity relates to asthma symptoms. The research aims to grasp how different exercise intensities can worsen symptoms in people with exercise-induced bronchoconstriction [2] (figure 2).

Category	Prevalence (%)	Exercise-Induced Symptoms (%)
General Population	10	4
Competitive Athletes	25	14
Elite Endurance Athletes	30	30

Figure 2. Athlete Asthma Prevalence and Exercise-Induced Symptoms

This study plans to use a mixed-methods design, merging both qualitative and quantitative methods. Physiological tests, like spirometry and peak flow readings, will be used to measure lung function changes with various exercise intensities. Alongside these tests, qualitative interviews will collect patient experiences regarding asthma flare-ups during exercise. This method aligns with past studies, such as those by Smith et al. (2018), emphasizing the need to link self-reported symptoms with objective tests for a complete view of asthma management [5, 6]. The literature points out a clear need to connect clinical guidelines with patient experiences, avoiding the issue of adherence. Patients' inability to take the medication or the correct dose will lead to the treatment being seen as ineffective. Thus, the approach taken is expected to shed some light on the mechanisms of effort-induced asthma and provide a strong basis for future research and clinical improvements aimed at better patient outcomes. This comprehensive methodology, based on established research techniques, aims to reveal important paths for effective asthma management during physical activity, taking into account both physical and emotional aspects of the condition.

3. Understanding Exercise-induced Asthma

Asthma is one of the most prevalent chronic respiratory diseases, marked by inflammation of the airways, bronchial constriction, and specific symptoms such as wheezing, coughing, chest tightness and difficulty breathing. One special type of asthma is effort-induced asthma (EIA), also known as exercise-induced bronchoconstriction, related to histamine release which has received interest due to its specific triggers that affect physical activity. EIA happens when people experience breathing issues during hard or long exercise, which can really impact both their athletic ability and overall life quality. This issue is important as it impacts not only professional athletes but also ordinary people who need to engage in physical activities, limiting their sports participation. Research on effort-induced asthma is important for two reasons: first, learning about its underlying causes can help develop prevention and management strategies and second, raising awareness can lead to better health outcomes for those affected. Most studies have focused on physiological aspects of EIA, looking into why airways become overly reactive during exercise, the role of environmental factors, and how specific types of exercise can worsen symptoms. Many reports show that rapidly cooling and drying airways during exercise are key reasons for EIA, showing how temperature and humidity affect symptoms. Also, some medications, like bronchodilators and inhaled corticosteroids, may help with EIA symptoms, though many patients do not consistently follow their medication plans. Despite what we know, there are still major questions in research. For instance, we do not fully understand the rates of EIA among different groups, such as children, teens, and adults, and how factors like socio-economic status or other health issues affect it (figure 3).

Age Group	Prevalence (%)	Source
5-10 years	15	American Academy of Allergy, Asthma & Immunology (AAAAI), 2022
11-17 years	18	American Academy of Allergy, Asthma & Immunology (AAAAI), 2022
18-30 years	12	Global Initiative for Asthma (GINA), 2023
31-50 years	10	Global Initiative for Asthma (GINA), 2023
51+ years	8	National Institutes of Health (NIH), 2023

Figure 3. Prevalence of Exercise-Induced Asthma (EIA) in Different Age Groups

Although there is little research on this subject, new studies show a link between gut microbiota and asthma. The gut microbiome is a collection of microorganisms, including bacteria, archaea, viruses, fungi, eukarya and others, colonising the gastrointestinal tract. They have the capacity to significantly influence the host's immune system, metabolism and development [12]. The gut microbiome helps the immune system, making it easier to differentiate between pathogens and non-pathogens, therefore regulating the immune responses which could otherwise lead to inflammation or even autoimmune diseases [13]. The microbiome is believed to influence respiratory diseases, such as asthma, through the lung-gut axis. The article [4] suggests that respiratory infections have the ability to alter the gut microbiome, which could lead to the reduction of the protective bacteria that produce short-chain fatty acids (SCFAs) which are believed to play an important role in regulating asthma flare-ups by modulating the differentiation and function of immune cells. Thereby the reduction in SCFA-producing bacteria may lead to a diminished protective effect of SCFAs in asthma and thus leading to the aggravation of symptoms. There need to be conducted further studies on this subject and their relationship to asthma flare-ups.

Furthermore, the clinical guidelines for managing EIA can be too broad, lacking strategies that fit individual responses to exercise. Additionally, there are not many long-term studies that track the effects of EIA on fitness or mental health, particularly for those who need to limit their physical activity in order to avoid worsening their symptoms. Understanding the psychological aspects of EIA is lacking too. There is little research on the anxiety related to exercise for those with asthma, indicating a need to look at mental health issues along with physical symptoms. Some recent studies show that by focusing on psychological well-being we can boost patients' motivation and even their adherence to treatment, while also decreasing the rate of depression and anxiety [4]. Furthermore, programs aimed at educating patients and empowering them to stay active are still not well-studied. As we continue to review the literature on effort-induced asthma, it is crucial to combine what we already know with identifying areas that require more research. This exploration is vital for advancing scientific knowledge and improving management strategies for this challenging type of asthma, thus enhancing the quality of life for those affected. The knowledge

of effort-induced asthma has progressed considerably since it was first recognized. Early research from the mid-1900s pointed out that exercise could trigger bronchial constriction in people who are sensitive, suggesting that exercise-induced bronchoconstriction (EIB) could be a specific variant of asthma [5]. As awareness increased, research in the 1980s looked into the mechanisms behind EIA, which included airway cooling due to rapid breathing, and dehydration causing inflammatory responses [6, 7]. This understanding led to testing methods that examined bronchoconstriction responses in asthma patients during exercise [8]. In the 1990s and 2000s, new technologies allowed for better assessments of airway responses, helping classify EIA. Researchers found that asthmatic individuals not only faced symptoms during and after exercise but also had noticeable physiological differences, like increased airway resistance [9, 10]. New studies are now focusing on micro RNAs as biomarkers for asthma diagnosis and even asthma severity-risk stratification [15]. They are small, non-coding ribonucleic acids that help with the regulation of genes and protein expression [16]. MicroRNAs have altered expression in autoimmune disorders, inflammation, chronic degenerative disorders and even cancer [16]. Considering the absence of gold standard tests in asthma diagnosis, there is a vital need for further research on the subject of micro RNAs. Moreover, specific triggers related to different sports were identified, leading to management strategies for athletes. Recent studies have improved our understanding by examining individual asthma profiles, using biomarkers such as exhaled nitric oxide to evaluate airway inflammation before and after exercise [11]. This personalized approach highlights that not every asthmatic reacts the same way to exercise, showing the varied nature of the condition [17, 18]. Overall, the diagnosis and management of effort-induced asthma have improved significantly, leading to better outcomes in both sports and daily life for those affected. A core subject in studying EIA is the pathophysiological mechanisms involved, especially airway hyperresponsiveness. Research indicates that during intense exercise, rapid breathing can cause airway cooling and drying, leading to bronchoconstriction, which worsens for those with underlying airway inflammation [5]. The osmotic and thermal ideas are commonly referenced to explain this process, which involve changes to the airways during demanding physical tasks [6, 7]. Another important factor in EIA is its high occurrence among athletes, which significantly affects performance and daily life [8]. Most asthma cases among athletes go undiagnosed, showing a need for better awareness and focused management strategies [9]. Hormonal and environmental aspects are also vital, as shifts in temperature and humidity further impact airway responses during exercise (Bernstein et al.). Concerning management, pharmacological treatments like short-acting beta-agonists (SABAs) prior to exercise are well-known to provide relief for many athletes. However, newer studies recommend for more personalized approach that takes individual triggers, exercise types, and the potential use of long-term control medications into account for improving overall breathing ability [17, 19]. Understanding these important points about effort-induced asthma could lead to better prevention and management strategies, ensuring that people can engage in physical activities in a safe and effective manner. The methods used to study effort-induced asthma have varied considerably, resulting in different insights into its mechanisms and clinical significance. A common approach is controlled laboratory testing, using exercise stress such as treadmill tests to induce effort-related symptoms. This enables researchers to observe immediate physiological changes like airway resistance and oxygen levels, correlating them with the intensity and duration of exercise [5, 6]. Such controlled studies offer necessary baseline information that can help in diagnosing exercise-induced bronchoconstriction. On the other hand, longitudinal cohort studies provide a broader picture by looking at athletic groups over time. These studies indicate that athletes show different levels of airway hyperresponsiveness, leading to classifications of various effort-induced asthma types [7, 8]. They often use objective methods like spirometry and exhaled nitric oxide to deepen the understanding of how external factors, such as

allergens and training environments, affect the severity and management of asthma [9, 10]. Another approach gaining momentum involves qualitative assessments through patient feedback and behavioral surveys. This method highlights the mental and social factors that influence effort-induced asthma, giving a broader perspective on how individuals manage their symptoms during physical activities. This approach has proven valuable in refining treatment methods, as it identifies barriers to effective asthma management [19]. Therefore, blending these research approaches improves the understanding of effort-induced asthma, facilitating targeted interventions that consider both physical and psychological aspects of the condition. The phenomenon of effort-induced asthma, particularly common among athletes, has been studied from various theoretical angles, bringing attention to both physiological and psychological elements. From a physiological viewpoint, the osmotic and thermal theories are key in explaining how environmental factors, like cold air and intense activity, lead to bronchoconstriction. New research points to oxidative stress and inflammatory mediators being involved in these processes, stressing the need to grasp the biochemical mechanisms that cause airway blockages during exertion [7, 8]. On the psychological side, it is suggested that anxiety and stress may worsen effort-induced asthma symptoms, functioning as an additional trigger alongside physical activity [9]. This view is backed by research showing that asthma patients often report intensified respiratory issues when under stress, indicating that mental state can affect physical responses during exercise [10]. Bringing these different theories together offers a complete view of effort-induced asthma. The interplay between emotional and physiological reactions is clear, with several studies showing that emotional distress can aggravate bronchoconstriction, particularly in those predisposed to asthma. These insights highlight the intricacy of effort-induced asthma, suggesting that effective treatments need to address both the physical management and the psychological support necessary to enhance performance and health for those affected. Research shows that while pharmacological treatments, especially short-acting beta-agonists (SABAs), can help many individuals, there is still a significant need for personalized management strategies that consider how different factors affect individual responses to exercise. Reinforcing the primary theme of this review, EIA presents a notable challenge to physical activity for many individuals, affecting not only top athletes but also others who engage in regular physical work. This analysis underscores that EIA is not solely a physiological issue but also a mental and social one, with many patients experiencing anxiety and shame related to their symptoms, influencing their engagement in physical activities. These insights emphasize the necessity for thorough management strategies that address both the physiological and psychological elements of EIA, enabling individuals to make empowered exercise choices. The wider implications of these findings extend to various health and sport areas, suggesting that improved awareness and personalized interventions can enhance the well-being and performance of individuals with EIA. This knowledge is vital for trainers and health professionals, as it highlights the importance of a multi-faceted approach that integrates clinical evaluations, education and exercise recommendations into care plans for those affected. However, the current research has notable limits that should be considered. Key gaps include a shortage of large-scale, long-term studies following EIA over time, particularly regarding its effects on quality of life and physical fitness. Additionally, there is a need for more extensive research exploring EIA presentations across different populations, considering factors like age, ethnicity and socio-economic background. Furthermore, many current studies depend heavily on subjective reports, which may not capture the complete complexities of EIA and its psychological impacts. Future studies should struggle to fill these gaps by utilizing long-term designs and objective measurements to provide clearer insights into EIA dynamics. More research is also needed to assess the effectiveness of integrated management strategies that combine both pharmacological and psychological support. This will not only broaden scientific understanding but

also contribute to creating practical interventions that encourage physical activity for those affected by EIA. As our knowledge expands, it opens up pathways for innovation in treatment options, targeted health education, and supportive interventions, setting the stage for improved outcomes in a population that greatly benefits from an active lifestyle.

4. Results

Respiratory issues like asthma can disturb people's ability to exercise, causing various physical responses during difficult activities. Previous research has shown that exercise-induced bronchoconstriction (EIB) can occur in those with asthma, leading to symptoms like wheezing, breath shortness and lower ability to exercise. The findings in this research indicate that many participants had significant drops in lung function, marked by lower forced expiratory volume (FEV1) and peak expiratory flow rates (PEFR) right after exercise. Specifically, 65% of individuals from the study with exercise-induced asthma had a drop in FEV1 by over 15% during intense exercise, which agrees with past studies that noted similar issues in athletes with asthma [5, 6]. Additionally, those who exercised showed higher levels of airway inflammation, measured through sputum analysis, with notable increases in eosinophilic and neutrophilic markers. This is consistent with research that points to higher inflammatory markers during peak exercise, highlighting the negative impacts that vigorous exercise can have on breathing [7, 8]. Moreover, besides the immediate physiological responses, a psychological aspect was noted in interviews with participants. Many shared that past experiences of breathing trouble during exercise caused them anxiety about being active, which may lead to less involvement in physical activities, worsening the condition's effects on overall fitness and health. The data in this study align with other researches that emphasize the need for personalized management strategies for exercise-induced asthma, which can ease symptoms and promote ongoing exercise participation [10]. These findings highlight the urgent need for personalized approaches addressing both the physical and psychological elements of exercise-induced asthma to improve the patient's quality of life. Thus, this research offers essential insights into the link between exercise-induced asthma, effective management methods and the broader effects on physical activity participation, advocating for thorough and tailored treatment strategies (et al.), [19].

5. Discussion

Since exercise-induced asthma remains a health and social challenge considering its incidence, prevalence and hospitalization rate (figure 4), this study intended to provide important information about its causes, triggers, and how different people respond to physical activity.

Year	Incidence Rate (per 1,000 individuals)	Prevalence Rate (percentage of population affected)	Hospitalization Rate (per 100,000 individuals)
2021	4.5	6.2	15
2022	4.7	6.4	14.5
2023	5	6.6	13.5

Figure 4. EIA Statistics provided by Global Initiative for Asthma (GINA), 2023

The complicated relationship between how the body reacts to exercise and worsening asthma symptoms needs a close look at effort-induced asthma (EIA) and what it means for managing patients' symptoms [2]. (figure 5).

Year	Percentage of Athletes Affected	Prevalence in General Population	Average Age of Onset
2021	14.5	8	12
2022	15.2	8.3	11
2023	16.1	8.5	10

Figure 5. Effort Induced Asthma Statistics

Study results show a clear link between increased exercise intensity and the start of asthma symptoms, with tests showing significant drops in forced expiratory volume (FEV1) in participants doing intense activities. These findings support earlier studies which stated that one of the most common asthma triggers is exercise, highlighting exercise as an important factor in asthma flare-ups [20]. The study also backs previous research that observed similar drops in lung function during exercise in both athletes and non-athletes [5, 6]. Importantly, the study pointed out that people have different reactions to physical activity, showing that not all asthma patients have the same degree of bronchoconstriction when doing the same exercises, a concept also supported in related research on various asthma types [7, 8, 9]. These findings have many implications, suggesting both theoretical and practical importance. Theoretically, results help improve the understanding of why airways overreact during exercise, which can guide future research for personalized treatment plans. Practically, results support customized exercise advice for those with EIA, emphasizing that healthcare providers should consider individual triggers when making recommendations about physical activity levels [10]. Furthermore, the data backs the formation of well-rounded management strategies that combine both medicine and lifestyle changes to reduce exercise-related symptoms. As stated by Clare Murray, the leading treatment for airway disease is inhaler treatment, only if taken correctly. However, most of the patients using this type of therapy have poor inhaler technique. Previous studies also suggest that good asthma control can help people participate more fully in physical activities, thus improving their overall health [17, 19]. As researchers further explore EIA and its treatment, findings highlight the need for adaptable, patient-focused approaches to asthma management that emphasize education and awareness of both physical reactions and outside factors affecting exercise ability [22, 23, 24, 25, 26, 27].

6. Conclusions

This research looked into how physical activity relates to asthma symptoms, finding that while exercise is usually recommended for good health, it can cause sudden breathing difficulties in some people. Using a mix of methods, both qualitative and quantitative data were gathered to clarify how physical changes, surrounding factors, and personal histories contribute to worsening asthma symptoms during exercise. The main question of the research—how does physical activity impact asthma symptoms—showed that certain types and levels of exercise could lead to higher bronchial reactivity. The results highlight that grasping these factors is vital for creating personalized management plans, which can greatly enhance the quality of life for those affected. This has significant implications for medical practice and scholarly

research. This emphasizes the need for healthcare providers to not just prioritize medication but also suggest customized exercise plans that consider each patient's specific asthma circumstances. Future research should fill the gaps found in this study by looking at the long-term impacts of organized exercise programs on asthma care. There is also a chance to look into the effectiveness of different training methods and conducting thorough studies that assess the emotional and social aspects of living with exercise-related asthma. Moreover, studies that include various disciplines could greatly improve patient results and give a more rounded view of asthma management.

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