

Case Study Report on Asthma

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Module Code: BMHP5023

Module Title: Introduction to Physiology

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Managing Asthma: Respiratory Function Monitoring and Lifestyle Interventions for Adolescents

Introduction

Asthma is a long-term condition that causes inflammation and narrowing of the airways, making it hard to breathe and leading to symptoms like wheezing, coughing and chest tightness. Adolescents with asthma can face worsening symptoms, especially if they start smoking or vaping, or spend time in places with lots of people like bars and clubs, which expose them to irritants and infections.(Golding, 2024)Understanding how smoking or vaping damages the lungs and tracking changes in lung function using tools like peak flow meters can help patients better manage their condition.(DeVrieze, 2024) Keeping track of peak flow readings allows them to spot early signs of flare-ups and adjust their treatments in time.(Thamjamratsri, 2024) Making lifestyle changes such as avoiding smoking, reducing exposure to allergens, staying active and following prescribed treatments can greatly improve asthma control and overall respiratory health. Golding, 2024)

Asthma: Definition and Risk Factors for Adolescents

Asthma is a long-lasting condition that often first appears in childhood or adolescence, though anyone can develop it. People with asthma experience repeated bouts of symptoms such as difficulty breathing, wheezing, tightness in the chest and coughing which occur when the airways inside the lungs become swollen and narrow in reaction to certain triggers like allergens, smoke or infections. (Goldin, 2024) What makes asthma unique is that the airways are extra sensitive and so when they are exposed to things like dust, pollution or even cold air, the lining of the air passages becomes inflamed, the surrounding muscles tighten up (bronchoconstriction) and more mucus is produced, making it tougher to get air in and out. Most of the time, this narrowing can be relieved with the right medication or after the trigger passes. However, if asthma is not properly managed and flare-ups keep happening the constant inflammation can cause permanent changes to the airway walls leading to more severe breathing problems over time. (National Asthma Education and Prevention Program, 2007)

Adolescents face elevated risk for asthma complications through multiple intersecting factors spanning genetic, environmental, and behavioural domains. Those with a family history of asthma or atopic conditions demonstrate increased disease susceptibility. (Koppelman, 2025) The initiation of smoking or vaping during teenage years substantially augments airway

reactivity and precipitates recurrent disease exacerbations. (Golder, 2025) Residence in regions characterised by elevated air pollution concentrations, coupled with recurrent respiratory infections, significantly compromises asthma management. Expanding social engagement within crowded settings increases exposure to respiratory irritants and infectious agents. (Creese, 2021) The developmental shift toward autonomy frequently results in suboptimal medication compliance, adversely affecting disease control. Concurrent factors such as elevated stress levels, overweight status and sedentary behaviour represent additional contributors to symptomatic deterioration. These multifactorial influences underscore the necessity of comprehensive education and consistent clinical support to enable adolescents to develop competencies in disease self-management and achieve improved clinical outcomes. (Jayasooriya, 2025)

Structure of the Respiratory System and Mechanical Respiration

The respiratory system enables the vital exchange of gases necessary for life. With each inhalation, air is drawn through the nose or mouth, where it is filtered, warmed and humidified to ensure a safe transition to the delicate structures within the lungs. This conditioned air flows through the trachea, maintained by cartilaginous rings that keep the airway open and enters the primary bronchi which direct airflow to each lung. Within the lungs, these bronchi divide into a network of smaller bronchioles that guide air to the alveoli. Alveoli are tiny, thin-walled sacs enveloped by capillaries where oxygen transfers from the air into the bloodstream, while carbon dioxide moves from the blood into the alveolar space for eventual exhalation. Through this continuous cycle, the body receives oxygen for metabolic needs and effectively expels carbon dioxide, maintaining essential physiological balance. (Goldin, 2024)

The respiratory system facilitates the essential exchange of gases required for cellular metabolism and homeostasis. Upon inhalation, air enters through the nasal or oral cavity, where it undergoes filtration, temperature regulation and humidification before progressing distally. This conditioned air descends through the trachea, a structure reinforced by cartilaginous rings that maintain airway patency, then bifurcates into the primary bronchi, each supplying one pulmonary lobe. The bronchi subdivide into progressively smaller bronchioles that terminate in the alveoli, microscopic sacs with exceptionally thin walls encircled by pulmonary capillaries. At this interface, oxygen diffuses from the alveolar lumen into the blood for systemic distribution whilst carbon dioxide a metabolic byproduct, transfers from the bloodstream into the alveolar space for subsequent exhalation. This bidirectional gas exchange mechanism represents a fundamental physiological process essential for sustaining aerobic metabolism and maintaining acid-base balance throughout the body. (Goldin, 2024)

Respiratory Irritants and Their Effects on Lung Function

When harmful irritants such as allergens, environmental pollutants or infectious agents encounter the airway epithelium, they initiate a complex inflammatory cascade. (Koppelman, 2025) Resident immune cells, including mast cells and tissue macrophages, become activated upon exposure to these irritants and release inflammatory mediators including histamine, interleukins and tumour necrosis factor. (Jayasooriya, 2025) These mediators induce vasodilation and increased vascular permeability, permitting fluid extravasation into the airway tissue and resulting in mucosal oedema. (Goldin, 2024) Simultaneously, epithelial cells respond to irritants by increasing mucus production, further reducing the patent airway lumen. (Koppelman, 2025) The airway smooth muscle, sensitised by the inflammatory environment becomes hyperresponsive and undergoes bronchoconstriction in reaction to irritants, further restricting airflow. (Goldin, 2024)

The airway narrowing and inflammation induced by irritants substantially compromises respiratory and gas exchange function. The increased airway resistance necessitates greater effort for both inspiration and expiration. Reduced airway calibre limits the volume of air delivered to the alveoli per breath cycle, impairing overall ventilation. Since gas exchange is dependent upon adequate alveolar ventilation, the reduced airflow results in diminished oxygen uptake and impaired carbon dioxide clearance. (Goldin, 2024) Additionally, inflammatory injury to the alveolar-capillary membrane may further compromise the efficiency of oxygen diffusion and carbon dioxide removal. In individuals with asthma, the response to irritants becomes amplified and persistent, establishing a chronic cycle of airway inflammation, heightened reactivity to irritants, and recurring symptoms. (Jayasooriya, 2025)

Monitoring Airway Function through Peak Flow Measurement

Monitoring respiratory function through peak flow measurement constitutes an essential element of asthma management and clinical surveillance. (Jayasooriya, 2025) The peak flow meter quantifies peak expiratory flow, the maximum velocity of air expelled from the lungs, thereby providing an objective indicator of airway status and pulmonary function. (DeVrieze, 2024) Establishing a personal baseline peak flow value during periods of optimal respiratory health creates a reference standard against which subsequent measurements can be compared to detect functional deterioration. Systematic peak flow tracking, typically performed twice daily and interpreted using a standardised colour-coding scheme (green indicating adequate control, yellow signalling caution, and red denoting critical airway obstruction),

enables patients to recognise deviations from their baseline performance. (SmartAsthma, 2023)

The predictive value of peak flow measurement in identifying impending asthma exacerbations represents a significant clinical advantage. (Jayasooriya, 2025) Evidence indicates that reductions in peak flow may manifest before obvious clinical symptoms emerge, potentially occurring hours to days prior to acute deterioration. This advance warning capability permits patients to implement preventive measures including medication escalation, trigger avoidance and timely medical consultation, thereby mitigating exacerbation severity and frequency. Continuous peak flow monitoring facilitates the development of individualised asthma action plans, supports rational medication titration decisions and furnishes objective documentation of treatment response for clinician assessment. (DeFrieze, 2024) Particularly for patients with diminished symptom perception, objective peak flow data represents a crucial tool for detecting airway dysfunction, promoting patient-directed disease management, and optimising long-term asthma control and functional outcomes. (Jayasooriya, 2025)

Evidence-Based Strategies for Improving Asthma Outcomes

Current clinical practice guidelines highlight the critical importance of minimising exposure to tobacco smoke through active smoking or environmental sources as a primary approach for both preventing asthma and optimising outcomes for those living with the condition. Recent systematic reviews informing the European Academy of Allergy and Clinical Immunology (EAACI) recommendations present strong, longitudinal data that reinforce these priorities. (Agache, 2024)

Research demonstrates a clear relationship between tobacco smoke exposure during prenatal development and early childhood and a heightened risk of asthma and recurrent wheezing. Maternal smoking during pregnancy is particularly associated with increased odds of asthma onset (OR $\approx$ 1.28) and poorer lung function in children. Early life exposure after birth, as well as combined exposure before and after birth, further elevates the chances of developing asthma, with risk estimates between 1.12 and 1.49 depending on subgroup. Where both parents smoke, children are more likely to face continued respiratory symptoms and reduced lung function. (Agache, 2024)

In those already diagnosed with asthma, both active smoking and secondhand smoke exposure are linked to more severe exacerbations, worse symptom control and additional declines in lung function. Moderate-certainty evidence suggests that environmental tobacco

smoke can double or triple the risk for emergency hospital visits and greatly impairs asthma management (OR $\approx$ 2.24). People with asthma who smoke also face higher odds of exacerbations (RR $\approx$ 1.44) and further reductions in FEV₁. (Agache, 2024)

The underlying causes are driven by the multitude of toxic chemicals in tobacco smoke such as formaldehyde, acrolein and nicotine, which trigger inflammation, oxidative damage and disruption of the immune system. Nicotine directly affects lung development and airway responsiveness, in part through acetylcholine receptor signalling pathways. (Agache, 2024)

Evidence on the harms of electronic cigarettes remains limited, but early EAACI findings suggest they may likewise impact respiratory and heart health, particularly in those with asthma. (Agache, 2024)

Based on current evidence, EAACI guidelines and other authorities recommend a coordinated strategy to reduce asthma linked to tobacco exposure. (Agache, 2024)

Firstly, avoiding all tobacco smoke exposure is crucial, both in private and public spaces. This is particularly important for pregnant women and children because of their heightened vulnerability. (Agache, 2024)

Secondly, strong support for quitting smoking is essential. Education, counselling and resources should be provided to families, caregivers and healthcare professionals to help prevent and manage asthma. (Agache, 2024)

Additionally, policy measures such as smoke-free laws, clear labelling and restrictions on tobacco advertising are critical to protect at-risk populations and improve community air quality. (Agache, 2024)

Finally, objective tools such as cotinine testing and air quality monitoring should be used to identify and address risks from tobacco smoke, especially where children and asthma patients live and spend time. (Agache, 2024)

Conclusion

Asthma management in adolescents is most successful when it combines a clear understanding of respiratory health with practical self-care strategies. Young people are particularly at risk from the harmful effects of smoking, vaping, air pollution and allergens all of which can aggravate symptoms or cause lasting damage to the airways.

Regular use of peak flow meters and monitoring tools enables early detection of declining asthma control. This allows for prompt adjustments in treatment and more personalised care plans. Following medical guidelines such as staying active, avoiding exposure to tobacco smoke, limiting contact with respiratory irritants and ensuring consistent use of asthma medications can significantly reduce flare-ups and improve daily well-being.

Support and education from families, schools and healthcare professionals play a vital role in helping teenagers build the knowledge and habits needed for effective asthma self-management. By combining ongoing monitoring, informed lifestyle choices and professional guidance, adolescents can better control their asthma, lower their risk of severe exacerbations and maintain better long-term lung health.

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