

BRONCHIAL ASTHMA: EARLY CARDIOPULMONARY DYSFUNCTION

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Abstract: Bronchial asthma (BA) is a chronic inflammatory disease of the airways, often associated with systemic manifestations affecting the cardiopulmonary system. The present study aimed to identify and evaluate early functional disturbances in the cardiopulmonary system of patients with BA. A cohort of patients with mild to moderate asthma underwent comprehensive assessments, including spirometry, electrocardiography, arterial blood pressure monitoring, and hemodynamic evaluation. Results revealed subclinical impairments in pulmonary ventilation, manifested by reductions in Forced Expiratory Volume in 1 second (FEV₁) and Peak Expiratory Flow (PEF), as well as early cardiac dysrhythmias and increased hemodynamic load. Correlation analyses demonstrated significant associations between disease duration, symptom severity, and functional alterations in both pulmonary and cardiac parameters. These findings underscore the systemic nature of BA, highlighting the importance of early detection, continuous monitoring, and individualized management strategies. Early interventions may prevent the progression of cardiopulmonary dysfunction, reduce the risk of complications, and improve overall patient outcomes. The study emphasizes the need for integrated cardiopulmonary evaluation in routine asthma care to optimize disease control and enhance quality of life.

Keywords: Bronchial asthma; cardiopulmonary function; early functional disturbances; spirometry; electrocardiography; subclinical airway obstruction; cardiac dysrhythmia; hemodynamic load; individualized therapy; disease management

Relevance of the Topic: According to the updated definition provided by the GINA 2014 Working Group, bronchial asthma (BA) is a chronic inflammatory disease of the airways, characterized by variable airflow limitation during exhalation and intermittent respiratory symptoms such as wheezing, coughing, chest tightness, and shortness of breath. These symptoms may fluctuate in intensity and frequency, reflecting the underlying dynamic inflammatory processes. Despite the widespread implementation of national and international guidelines for asthma management and significant advances in pharmacotherapy, BA prevalence remains persistently high. It is estimated that approximately 250,000 patients die from asthma annually. Current World Health Organization (WHO) data indicate that nearly 300 million people worldwide suffer from BA, and forecasts suggest that by 2025 this number may increase by an additional 100 million individuals. Uncontrolled BA not only increases morbidity and mortality but also leads to inefficient use of healthcare resources, temporary loss of work capacity, permanent disability, and fatal outcomes [Bazueva E.V., 2013; Gadzhieva T.A., 2011; Demko I.A., 2007; Ivanova E.V., 2015].

In patients with BA, the development of pulmonary hypertension is frequently accompanied by cardiovascular system dysfunction, including chronic cor pulmonale, myocardial ischemia, and various cardiac arrhythmias. The relationship between cardiovascular diseases (CVDs) and BA has been a subject of active discussion in the literature. Some studies suggest that BA does not

constitute an independent risk factor for CVDs, while other research indicates a potentially synergistic or mutually aggravating interaction, particularly in the context of metabolic syndrome [Belan O.V., 2014; Grinberg N.B., 2012; Ryabova A.Yu., 2013; Solovyeva I.A., 2016; Yakovleva O.A., 2016; Bubnova M.G., 2014; Vasilieva T.S., 2013].

Moreover, the autonomic nervous system (ANS) plays a significant role in the pathogenesis of bronchial obstructive syndromes, affecting airway tone, bronchial responsiveness, and the cardiovascular regulation associated with asthma [Pashkova O., 2011]. Despite the recognition of these interactions, there remains a scarcity of comprehensive studies that simultaneously evaluate circadian variations in cardiac rhythm and the structural-functional state of the cardiopulmonary system in patients with obstructive lung diseases. Such integrated assessments are crucial for understanding the complex cardio-respiratory interplay in BA and for developing personalized management and therapeutic strategies.

The relevance of this topic is further underscored by the growing global burden of asthma, its impact on quality of life, and the substantial socio-economic consequences of disease exacerbations and complications. Investigating the early functional changes in the cardiopulmonary system associated with BA will provide critical insights for early diagnosis, risk stratification, and optimization of clinical and pharmacological interventions.

Aim of the Study: To investigate early functional alterations in the cardiopulmonary system of patients with bronchial asthma and to assess their clinical significance, in order to improve preventive and therapeutic strategies during the initial stages of the disease.

Materials and Methods: The study was conducted at the Multidisciplinary Medical Center of Bukhara region. The primary study group included 60 patients diagnosed with bronchial asthma, while the control group comprised 20 healthy volunteers matched by age and sex.

The methodological approach encompassed a combination of clinical, laboratory, and instrumental techniques, including:

Clinical and anamnesis assessment: Detailed history-taking and physical examination to document symptoms, disease duration, exacerbation frequency, and comorbidities.

Laboratory analyses: Complete blood count, urinalysis, and fecal examination; biochemical blood analysis including alanine aminotransferase (ALT), aspartate aminotransferase (AST), bilirubin, cholesterol, high-density lipoprotein (HDL), low-density lipoprotein (LDL), and triglycerides.

Instrumental evaluations: Echocardiography (EchoCG) for structural and functional cardiac assessment; Doppler ultrasonography of the pulmonary arteries to evaluate pulmonary hemodynamics and detect early vascular remodeling.

Statistical analysis: Appropriate parametric and non-parametric tests were applied to evaluate correlations between clinical, laboratory, and instrumental findings, as well as to determine predictive indicators of disease progression.

This integrated methodological approach allows for a comprehensive assessment of early cardiopulmonary dysfunction in patients with bronchial asthma, providing the basis for individualized clinical management and targeted preventive strategies.

Results and Analysis: The present study revealed a high prevalence of early functional disturbances in the cardiopulmonary system among patients with bronchial asthma, underscoring the systemic impact of this chronic respiratory disorder beyond overt pulmonary symptoms. Spirometric assessments consistently demonstrated subclinical limitations in pulmonary

ventilation, characterized by significant reductions in Forced Expiratory Volume in 1 second (FEV_1) and Peak Expiratory Flow (PEF). These findings indicate that even patients with mild or moderate asthma may experience early airway obstruction, suggesting that structural and functional alterations in the bronchial tree may precede clinically apparent airflow limitation. Such subclinical changes emphasize the importance of sensitive functional testing, including spirometry and potentially advanced imaging techniques, for the early identification of patients at risk for progressive airway remodeling.

Cardiovascular evaluations, including electrocardiography (ECG) and arterial blood pressure monitoring, identified early cardiac dysrhythmias, fluctuations in heart rate, and evidence of increased hemodynamic load. Remarkably, these changes were observed even in patients without preexisting cardiovascular disease, suggesting a direct pathophysiological influence of bronchial asthma on cardiac function. Mechanistically, chronic airway inflammation, intermittent hypoxia during exacerbations, and autonomic nervous system dysregulation may contribute to the observed early cardiac alterations. Correlation analysis further demonstrated a significant association between asthma duration, symptom severity, and the magnitude of functional impairment in both pulmonary and cardiac parameters, indicating a cumulative effect of chronic respiratory inflammation on cardiopulmonary performance.

These results highlight the clinical significance of early detection of cardiopulmonary dysfunction in bronchial asthma. Timely identification allows for stratification of patients based on risk, enabling individualized therapeutic approaches that integrate optimized pharmacological management, lifestyle modification, and potentially targeted rehabilitation strategies. Regular monitoring of cardiopulmonary function can facilitate early interventions aimed at slowing disease progression, preventing the onset of secondary cardiovascular complications, and improving overall quality of life. Additionally, these findings underscore the need for a multidisciplinary approach in asthma management, integrating pulmonology and cardiology expertise to address the systemic implications of chronic airway disease comprehensively.

In summary, the study demonstrates that bronchial asthma exerts measurable subclinical effects on both pulmonary ventilation and cardiac function even in early or mild disease stages. Recognition of these early functional alterations is essential for proactive disease management, reducing morbidity, and preventing long-term cardiopulmonary complications. This underscores the importance of incorporating routine cardiopulmonary evaluation into standard asthma care protocols.

Conclusion: The present study demonstrates that early functional disturbances in the cardiopulmonary system are prevalent among patients with bronchial asthma, including those at the initial or mild stages of the disease. These disturbances are characterized by subclinical impairments in pulmonary ventilation—reflected in reductions in Forced Expiratory Volume in 1 second (FEV_1) and Peak Expiratory Flow (PEF)—as well as early cardiac dysrhythmias, heart rate variability, and signs of increased hemodynamic load. The presence of such subclinical alterations underscores the systemic nature of bronchial asthma, extending beyond the respiratory tract to influence cardiovascular function.

Early identification of these functional changes through sensitive diagnostic methods, including spirometry, electrocardiography, and hemodynamic monitoring, is essential for risk stratification and the development of individualized management plans. Continuous monitoring and timely intervention, encompassing optimized pharmacotherapy, lifestyle modification, and targeted rehabilitation strategies, may mitigate the progression of both pulmonary and cardiac dysfunction. Furthermore, early detection allows clinicians to anticipate potential complications,

such as cardiovascular remodeling and secondary hemodynamic stress, thereby improving long-term patient outcomes.

Overall, the findings highlight the critical importance of integrating routine cardiopulmonary evaluation into standard asthma care protocols. Recognition and management of early functional impairments not only facilitate more precise disease control but also provide a foundation for personalized therapeutic approaches, ultimately reducing morbidity, preventing long-term cardiopulmonary complications, and enhancing the quality of life for patients with bronchial asthma.

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