OPEN ACCESS Freely available online

Anatomy & Physiology: Current Research

Commentary

Respiratory Muscle Physiology in Chronic Pulmonary Diseases

Ibrahim Hassan*

Department of Cardiovascular Physiology, Nile Valley Medical University, Khartoum, Khartoum State, Sudan

DESCRIPTION

Respiratory muscles are fundamental to the maintenance of effective ventilation and gas exchange, enabling the continuous movement of air between the external environment and the lungs. While pulmonary diseases are traditionally associated with airway obstruction, impaired lung mechanics, or parenchymal damage, growing evidence indicates that respiratory muscle dysfunction is a major contributor to symptom severity, exercise intolerance and reduced quality of life in patients with chronic pulmonary diseases. Advances in respiratory physiology have shifted attention toward understanding how respiratory muscles adapt to chronic disease and how targeted interventions may improve both functional capacity and clinical outcomes. The diaphragm is the principal muscle of inspiration, supported by the intercostal muscles, abdominal muscles and accessory muscles of respiration, including the sternocleidomastoid and scalene muscles. Under normal physiological conditions, these muscles function in a coordinated manner to generate adequate tidal ventilation while minimizing energy expenditure. Efficient respiratory muscle performance depends on intact neuromuscular control, sufficient oxygen delivery, balanced metabolic activity and optimal thoracic mechanics. Chronic pulmonary diseases disturb this delicate balance, increasing respiratory workload and gradually impairing muscle performance.

Chronic Obstructive Pulmonary Disease (COPD) provides one of the clearest examples of respiratory muscle adaptation. Progressive airflow limitation leads to lung hyperinflation, flattening of the diaphragm and shortening of muscle fibers, thereby reducing the mechanical efficiency of diaphragmatic contraction. As inspiratory muscles become disadvantaged, patients increasingly rely on accessory respiratory muscles to maintain ventilation. Although these compensatory mechanisms initially preserve breathing, prolonged overuse contributes to muscle fatigue, dyspnea and reduced exercise tolerance. Understanding these physiological adaptations has become essential for improving disease management. Respiratory muscle dysfunction is also observed in interstitial lung diseases, pulmonary fibrosis, severe asthma, cystic fibrosis and neuromuscular disorders affecting respiratory function. Increased work of breathing, chronic hypoxemia, systemic inflammation, nutritional deficiencies and corticosteroid therapy all contribute to muscle weakness and reduced endurance. Furthermore, aging frequently coexists with chronic pulmonary disease, accelerating sarcopenia and further compromising respiratory muscle strength. These interacting factors emphasize that pulmonary diseases extend well beyond the lungs and involve complex systemic physiological alterations.

Recent advances have highlighted the influence of systemic inflammation on respiratory muscle physiology. Elevated inflammatory cytokines promote protein degradation, mitochondrial dysfunction, oxidative stress and impaired muscle regeneration, reducing contractile efficiency and endurance. Simultaneously, chronic hypoxia alters cellular metabolism and energy production within respiratory muscles, further limiting functional capacity. These observations demonstrate that respiratory muscle dysfunction results not only from altered biomechanics but also from widespread metabolic and inflammatory changes that affect skeletal muscle throughout the body. Modern diagnostic approaches have significantly improved the assessment of respiratory muscle function. Measurements of maximal inspiratory and expiratory pressures, diaphragm ultrasonography, transdiaphragmatic pressure monitoring, electromyography and magnetic stimulation techniques provide valuable information regarding muscle strength, endurance and neural activation. High resolution imaging has also enhanced visualization of diaphragmatic movement and structural adaptations, allowing clinicians to identify dysfunction earlier and monitor treatment responses more accurately. These technologies support more comprehensive evaluation of respiratory physiology beyond conventional pulmonary function testing alone. Therapeutic strategies increasingly recognize respiratory muscle training as an important component of pulmonary rehabilitation. Inspiratory muscle training strengthens diaphragmatic function, reduces dyspnea, improves exercise capacity and enhances overall quality of life in many patients with chronic respiratory diseases. Combined rehabilitation programs incorporating aerobic exercise, resistance training, nutritional support, breathing retraining and patient education have demonstrated greater benefits than pharmacological treatment alone. Such multidisciplinary

Correspondence to: Ibrahim Hassan, Department of Cardiovascular Physiology, Nile Valley Medical University, Khartoum, Khartoum State, Sudan, E-mail: ibrahim.hassan@nvmu.sd

Received: 03-Mar-2025, Manuscript No. APCR-25-43570; **Editor assigned:** 05-Mar-2025, PreQC No. APCR-25-43570 (PQ); **Reviewed:** 19-Mar-2025, QC No. APCR-25-43570; **Revised:** 26-Mar-2025, Manuscript No. APCR-25-43570 (R); **Published:** 02-Apr-2025, DOI: 10.35248/2161-0940.25.15.534

Citation: Hassan I (2025). Respiratory Muscle Physiology in Chronic Pulmonary Diseases. Anat Physiol. 15:534.

Copyright: © 2025 Hassan I. This is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

interventions address both pulmonary pathology and the systemic physiological consequences of chronic disease. Technological innovation is further advancing the field. Wearable monitoring devices, artificial intelligence, and advanced digital assessment tools may enable continuous evaluation of respiratory muscle performance and support personalized rehabilitation programs. These emerging technologies hold promise for improving early diagnosis, optimizing treatment strategies, and enhancing long-term clinical outcomes in patients with respiratory muscle dysfunction.