

REVIEW / DERLEME

The Imbalance of Breathing: Recognizing and Assessing Dysfunctional Breathing

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ABSTRACT

Dysfunctional breathing (DB) is a collective term referring to chronic changes in breathing patterns that occur with or without the presence of a disease, resulting in dyspnea and other symptoms. While shortness of breath is the most common symptom, additional symptoms such as dizziness and palpitations are also observed. There is no definitive diagnosis or isolated assessment method for DB. A review of the literature on DB evaluation indicates that clinical anamnesis, respiratory function tests, and musculoskeletal system assessments are considered collectively. These uncertainties in the diagnosis and evaluation process of DB make it difficult to determine effective treatment and negatively affect quality of life. In addition, the high rate of misdiagnosis reveals that DB is not adequately defined and that the level of awareness among health professionals needs to be increased. However, the high rate of misdiagnosis suggests that health professionals do not fully comprehend the condition. This review aims to provide clearer information about DB and summarize the assessment methods.

Keywords: Dyspnea, respiration disorders, respiratory function.

Solunumun Dengesizliği: Bozulmuş Solunumu Tanıma ve Değerlendirme

ÖZ

Disfonksiyonel solunum (DS), solunum düzeninde (bir hastalığın yokluğunda/varlığında) meydana gelen kronik değişikliklerin dispne ve diğer çeşitli semptomlarla sonlandığı kolektif bir terim olarak tanımlanmaktadır. Nefes darlığı en yaygın semptomu olmakla birlikte, baş dönmesi, çarpıntı gibi ek semptomlarda görülmektedir. DS'nin kesin bir tanı ve izole bir değerlendirme yöntemi bulunmamaktadır. DS değerlendirilmesi için literatürü incelediğimizde; klinik anamnez, solunum fonksiyonları ve kas-iskelet sistemi değerlendirmeleri bir bütün olarak ele alınmaktadır. DS'nin tanı ve değerlendirme sürecindeki bu belirsizlikler, etkili tedavi stratejilerinin belirlenmesini zorlaştırmakta ve yaşam kalitesini olumsuz etkilemektedir. Ayrıca yanlış teşhis oranlarının yüksek olması, DS'nin yeterince tanımlanmadığını ve sağlık profesyonelleri arasındaki farkındalık düzeyinin artırılması gerektiğini ortaya koymaktadır. Bu derleme, DS hakkında daha anlaşılır bilgiler vermek ve değerlendirme yöntemlerini özetlemek amacıyla hazırlanmıştır.

Anahtar Kelimeler: Dispne, solunum bozuklukları, solunum fonksiyonu.

1. Introduction

Dysfunctional breathing (DB) is a umbrella term that refers to a chronic alteration in the biomechanical respiratory pattern, leading to dyspnea and non-respiratory symptoms that cannot be fully explained by disease pathophysiology. DS can affect individuals without underlying disease and even those who are trained (1). It is believed that DB is associated with various signs and symptoms of biochemical, biomechanical, and psychological origins. Hyperventilation syndrome (HVS), the most common form of DB, is used synonymously with DB, but HVS is not seen in every individual with DB (2). HVS refers to biochemical abnormalities in respiratory function, biomechanical issues, and cognitive/emotional factors related to their interactions with psychophysiological dimensions (3). While dyspnea due to non-organic causes is the core symptom of DB, increased minute ventilation and respiratory alkalosis are not specific to DB (2).

Although its prevalence in the general population is approximately 8%, this rate increases in individuals with accompanying respiratory diseases (such as asthma and COPD). Reports indicate that the prevalence of DB in asthmatic individuals can be as high as 29% (4).

Hyperventilation is observed in some individuals with DB who tend to breathe independently of their metabolic or respiratory needs, resulting in decreased arterial partial CO₂ pressure. DB is generally classified as primary or secondary. If it arises from psychogenic causes, such as anxiety, in the absence of organic disease, it is classified as primary. Conversely, if it occurs in the presence of cardiopulmonary or neurological diseases, it is classified as secondary (5). Recently, other classifications have gained preference. According to Barker and Everard's classification, DB is divided into two categories: thoracic and extrathoracic. Thoracic DB is characterized by an inefficient

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respiratory pattern dominated by apical respiration, regardless of accessory muscle activity. This condition is often accompanied by frequent inhalation, irregular respiratory effort, and increased residual capacity. In some cases, hyperventilation syndrome may also be present. Extrathoracic DB, on the other hand, is an upper respiratory tract disorder associated with paradoxical vocal cord dysfunction and supraglottic laryngomalacia (6).

A healthy individual's need to eliminate carbon dioxide (CO_2) and obtain sufficient oxygen (O_2) during breathing is one of the most important respiratory stimulants. Changes in CO_2 levels due to hyperventilation can cause a decrease in end-tidal carbon dioxide pressure (PETCO_2), or fluctuating CO_2 levels may return slowly to normal. As a result of respiratory alkalosis, the sympathetic nervous system becomes dominant, triggering the 'fight-or-flight' response. Consequently, symptoms such as paresthesia, variations in the depth and speed of breathing, increased muscle tone, excessive use of accessory respiratory muscles, decreased chest wall movement, postural disorders, and alterations in the optimal position of the diaphragm may occur. Disorders in the respiratory system can impact psychological characteristics, such as anxiety, as well as lead to increased sympathetic activity, fatigue, and muscle pain (7).

During movement, incomplete exhalation combined with the next breath's air volume causes the lungs to fill further. This limitation of airflow results in an increase in dead space and a decrease in the amount of oxygen (O_2) reaching the alveoli, leading to inefficient ventilation and increased dead space (6). Studies investigating the pathophysiology, classification, and symptoms of DB are lacking in the literature. Additionally, the symptoms observed in DB are similar to those of many cardiopulmonary diseases, leading to misdiagnosis (7). More than thirty symptoms have been identified in the literature, spanning gastrointestinal, neurological, psychological, and musculoskeletal domains. This broad spectrum of symptoms should be carefully considered during the evaluation of dysfunctional breathing (6).

1.1. Diagnostic Approach

Currently, there is no gold standard diagnostic method for DB. Diagnosis is made by utilizing several evaluation methods in conjunction and excluding possible conditions (5). The first of these is the Nijmegen Questionnaire (NQ), which consists of 16 questions addressing cardiovascular, neurological, respiratory, gastrointestinal, and psychological factors, evaluated on a 5-point Likert scale. The total score ranges from 0 to 64, with high scores indicating respiratory dysfunction and the possibility of hyperventilation. Studies have shown that individuals with elevated NQ scores exhibit abnormal respiratory patterns, making the NQ the preferred questionnaire for diagnosing DB (8). Another commonly used clinical measurement for diagnosing DB is capnography (Figure 1). This reliable and time-sensitive assessment measures the partial pressure of CO_2 in the expiratory air, known as end-tidal CO_2 (ETCO_2), and correlates well with direct blood measurements. A cut-off value of 35 mmHg is accepted, with values below this threshold indicating hypocapnia (9).

Cardiopulmonary exercise testing (CPET) is frequently employed to identify metabolic, cardiac, respiratory, and muscular abnormalities and is also used for diagnosing DB to rule out other conditions (10). In DB patients undergoing CPET, irregularities in respiratory frequency or both respiratory frequency and tidal volume may be noted in response to exercise. Additionally, patients may report symptoms consistent with DB

during the test, such as chest tightness, dizziness, dyspnea at low workloads, and/or tingling sensations in the lips and fingers (1).

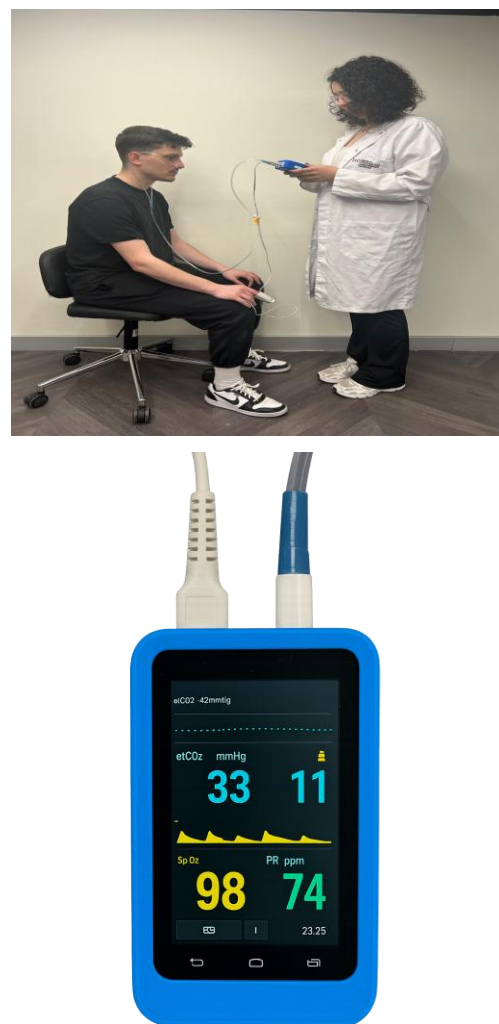


Figure 1. Capnograph device and capnography measurement

The Hyperventilation Provocation Test (HPT), commonly used to diagnose hyperventilation, can also aid in diagnosing dyspnea syndrome. During the test, the individual is required to breathe as quickly and deeply as possible for a specified duration (11). The clinician monitors whether the individual develops any symptoms during this time. If the individual reports symptoms they typically experience in daily life, the test is considered positive. However, some researchers argue that the HPT is not a valid tool for diagnosing DB, as it cannot determine whether hyperventilation is due to hypocapnia or symptoms related to anxiety or mechanical discomfort (5-12).

1.2. Assessment

Evaluating DB is the first step in physiotherapy treatment. There is currently no definitive diagnostic or evaluation method; most diagnoses are made through the process of elimination. Evaluation includes a thorough clinical history and observation of the individual's musculoskeletal and respiratory status (13).

The preferred evaluation tools for DB are as follows:

1.2.1. The Self-Evaluation of Breathing Questionnaire (SEBQ)

This survey aims to explore symptoms associated with hyperventilation syndrome that may not be assessed by other means and are frequently reported by individuals diagnosed with

DB. The 25-question survey seeks to gauge the individual's self-perception of respiratory dysfunction, focusing specifically on feelings of 'lack of air' and 'respiratory restriction.' The development of the SEBQ stemmed from the need to better understand and standardize the complex symptom profile of DD, based on clinical observations and literature reviews. The questionnaire's 25 questions were designed to encompass various aspects of breathing, physical sensations, emotional responses, and behavioral patterns.

The cut-off score for the survey is set at 11, with scores above this threshold indicating respiratory distress. The Turkish validity and reliability study of the survey was conducted by Ataş, Kızmaz and Mutlu. (14-15). The SEBQ is a valuable tool, particularly in the screening and assessment of conditions such as dysfunctional breathing and hyperventilation syndrome. In clinical practice, the SEBQ can be used to objectively measure individuals' respiratory complaints and monitor their response to treatment. Because symptoms such as air hunger and shortness of breath, which the questionnaire focuses on, can be associated with anxiety disorders, panic attacks, and other respiratory conditions, in addition to HVS, the SEBQ is believed to be useful in a wide range of clinical settings. This questionnaire provides healthcare professionals with an additional dimension to better understand patients' subjective experiences and develop personalized treatment plans (16).

1.2.2. Manual Assessment of Respiratory Movement (MARM)

This tool is a palpation procedure based on the interpretation and estimation of movement in the posterior and lateral parts of the lower ribs with the examiner's hands. The patient is positioned in front while the therapist stands behind. The therapist places their hands on both sides of the lower ribs, with the thumbs on the spine and fingers parallel to the ribs. The fourth and fifth fingers should be positioned under the ribs. During breathing, the therapist feels for lateral and vertical expansions and assesses the lateral movement in relation to the vertical movement. The evaluation examines the relative distribution of respiratory movement and pattern between the upper costal, lower costal and abdominal region. The MARM diagram aids in this assessment (Figure 2) (16-17).

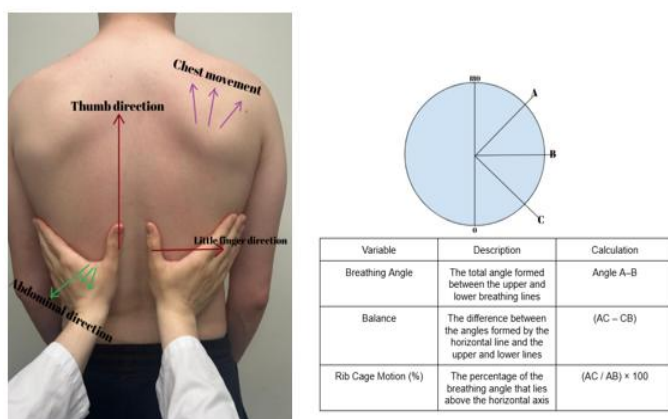


Figure 2. The MARM test and diagram (12,13)

1.2.3. Respiratory Pattern Assessment Tool (BPAT)

In respiratory disorders, an observer evaluates the respiratory rate and pattern rather than relying on subjectively obtained data from the patient. After the patient rests for 5 minutes, the respiratory rate and pattern are monitored for 1 minute. The

evaluation considers the type of breathing (apical, abdominal, or mixed), any prolongation in inspiratory or expiratory flow times, the presence of wheezing, the mode of breathing (mouth, nose, or both), signs of air hunger such as yawning or sighing, and whether the breathing is rhythmic or irregular (1). BPAT has been found to have 89.5% sensitivity and 73.5% specificity in patients who have had COVID-19 (19). BPAT is an important tool for physical therapists and other healthcare professionals to objectively assess breathing pattern abnormalities, personalize treatment plans, and monitor response to treatment. Its observational nature provides concrete data in addition to patient subjective reports and supports clinical decision-making. Adaptation of BPAT to other languages is also ongoing.

1.2.4. Hi-Lo Respiratory Evaluation

This evaluation determines whether the patient is breathing in an abnormal pattern or a normal diaphragmatic pattern. While the patient is seated or in a long sitting position, the therapist places one hand on the upper chest and the other on the abdomen. If upper chest movement is observed, it is scored as DB; if not, the evaluation continues. If paradoxical breathing is present, it is scored as DB; if absent, the evaluation continues. If diaphragmatic breathing is noted, it is scored as functional; if not, it is scored as DB (20). The Hi-Lo Respiratory Assessment provides clinicians with valuable information to quickly and easily screen for respiratory pattern disorders. This test is used to assess respiratory mechanics, particularly in individuals with chronic hyperventilation, anxiety disorders, asthma, and other respiratory conditions. The test's simplicity and non-invasiveness have made it a widely used tool in clinical practice. A study by Courtney et al. (2009) demonstrated that the Hi-Lo test can be used reliably by clinicians experienced in assessing respiratory patterns (17).

1.2.5. Respiratory Induction Plethysmography (RIP) and Magnetometry

RIP involves acquiring respiratory movement data using a cost-effective, non-invasive, and easy-to-use transducer. It is utilized to estimate pulmonary volume and consists of two sinusoidal wire coils, one placed around the abdomen and the other in the thoracic region. The inspired air volume is determined by converting the frequencies from the coils into a digital waveform (21). Changes in the volume of the chest and abdomen during breathing cause these bands to stretch or relax. This stretching and relaxing alters the inductance of the wire coils within the bands. These changes in inductance are converted into frequency changes by a high-frequency oscillator circuit. The resulting frequency signals are then converted into a digital waveform, and using specialized algorithms, inspired air volume (tidal volume) and other respiratory parameters (respiratory rate, minute ventilation) are calculated (21).

Magnetometry is another non-invasive technique that measures respiratory movements through changes in magnetic fields. This method typically uses two pairs of magnetic coils placed over the chest and abdomen. The variation in the magnetic field between the coils is directly related to respiratory movements, and these changes are used to estimate respiratory volumes. Magnetometry can be particularly useful in assessing respiratory muscle action and diaphragm function (22).

A Turkish validity and reliability study of this scale, developed to assess the self-efficacy of individuals with respiratory disorders in managing or controlling respiratory symptoms, has not yet been conducted. The cut-off score for the questionnaire is 75 out of 90 (23). Because respiratory symptoms can significantly impact an individual's activities of daily living, social participation, and overall quality of life, determining their level of self-efficacy in coping with these symptoms is of paramount clinical importance (24). When used in conjunction with other respiratory assessment tools, such as the Respiratory Self-Assessment Questionnaire (SEBQ) and the Breathing Pattern Assessment Tool (BPAT), the RoBE scale provides a more holistic perspective on an individual's respiratory health. This combination assesses both objective respiratory patterns and an individual's subjective beliefs about their ability to cope with symptoms, allowing for a more comprehensive and personalized treatment approach.

1.3. DB and Pulmonary Function/Respiratory Muscle Function

PFT parameters such as FEV1 and FVC are commonly used to diagnose and classify respiratory diseases. However, they may not be sufficient for distinguishing diagnoses in individuals with DB. Some studies indicate that PFT findings in individuals with DB are normal, while others report FEV1 and FVC values that are 10–15% below normal (18–19). A 12-month follow-up study on asthmatic individuals revealed that FEV1 decreased more rapidly in those with DB compared to individuals with asthma alone (26). In individuals with hyperventilation syndrome, abnormal respiratory muscle function is indicated by increased reliance on accessory respiratory muscles. These muscles support postural control and facilitate breathing during exercise or stressful situations. In individuals without other underlying conditions, such as emotional stress, apical breathing becomes dominant, leading to abdominal distension and inhibition of diaphragm movement. Consequently, respiratory muscle effort increases, respiration shifts to the thoracic region, and this results in dyspnea, increased respiratory workload, and respiratory muscle fatigue (5–27).

1.4. DB and the Musculoskeletal System

As resting muscle tone increases, the oblique muscles are also affected, preventing the diaphragm from returning to its optimal position and causing respiration to shift apically. The contraction of the pectoralis minor is countered by the trapezius, leading to anterior head tilt, temporomandibular joint compression, and mouth breathing. This increases respiratory workload (24). If hypocapnia is present, changes in motor patterns can occur due to increased excitability in the nervous and musculoskeletal systems (4).

The upper portion of the body's pressure system is formed by the vocal cords and surrounding muscles. The primary function of the larynx is to act as a valve for air entering and exiting the lungs. It also contributes to the mobility of fluid-based systems in the body, such as lymphatic drainage and gastrointestinal, venous, and arterial circulation (4).

The diaphragm, located in the middle of this system, plays a crucial role in creating intra-abdominal pressure by working in harmony with the transversus abdominis, multifidus, and pelvic floor muscles. In individuals with DB, the accessory respiratory muscles shorten (functioning at a disadvantage), preventing the diaphragm from returning to its optimal position. This alters the muscle length-tension relationship, leading to pressure changes that contribute to dynamic hyperinflation (4–27).

2. Conclusion and Recommendations

In general, the absence of a gold standard for diagnosing dysfunctional breathing (DB) and the reliance on the elimination method complicate the diagnosis and contribute to confusion with other diseases. This situation hinders appropriate treatment for affected individuals. Various factors—biomechanical, biochemical, and psychophysiological—can contribute to the manifestation of symptoms, necessitating a multidisciplinary approach to address the condition. These factors are not independent of one another; rather, they often intertwine and interact to produce symptoms. This ambiguity in diagnosis creates a significant clinical gap in patient management, preventing access to accurate classification and effective treatment protocols. Unilateral interventions that fail to address the underlying causes are inadequate and can lead to chronic symptoms. Consequently, the health-related quality of life for those unable to access effective treatment is adversely affected. The literature review demonstrates the need for high-quality, large-sample, comparative studies on the diagnosis and assessment processes of dysfunctional breathing. Additionally, the presence of dysfunctional breathing in various disease groups, regardless of whether they are cardiopulmonary in nature, has not been thoroughly investigated. Furthermore, there is a lack of research regarding how dysfunctional breathing impacts cerebral functions. As a result, more comprehensive, multidisciplinary, and advanced research is needed to understand the pathophysiological basis of dysfunctional breathing, its clinical subtypes, and its multifaceted impact on the individual. Such studies will both refine clinicians' diagnostic decisions and enable the development of effective interventions that will improve individuals' quality of life.

3. Contribution to the Field

This study aims to provide a comprehensive overview of the diagnosis and evaluation of dysfunctional breathing. Early diagnosis and accurate evaluation are of great importance as it directly affects the quality of life and functional capacity of individuals. The evaluation strategies presented in the study aim to provide support for clinical decision-making processes by serving as a guide for health professionals.

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Conflict of Interest

There is no conflict of interest with any person and/or institution.

Authorship Contribution

Concept: YET, EK; Design: YET, EK; Supervision: YET, EK; Funding: None; Materials: None; Data Collection/Processing: None; Analysis/Interpretation: None; Literature Review: YET, EK; Manuscript Writing: YET, EK; Critical Review: YET, EK.

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