Music, A “Body-Mind Medicine” In Rehabilitation Programs of Patients with Chronic Obstructive Pulmonary Disease

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Abstract
Chronic obstructive pulmonary disease (COPD) is a progressive disease characterized by dyspnea and chronic cough. The main risk factor is cigarette smoking, but there are other ones implicated in the COPD etiology such as air pollution, childhood asthma, aging, chemical exposure, dietary factors, and genetic predisposition. Besides, COPD is associated with several comorbidities that influence prognostic and management, like asthma, lung cancer, obstructive sleep apnea, cardiovascular disease, metabolic syndrome, and depression or anxiety. The management is multidisciplinary and its role is to ease symptoms, prevent complications, slow disease progression, and improve the quality of life. In the last years, many alternative techniques have been implemented such as speleotherapy, halotherapy, muscular training, neuromuscular electrostimulation, acupuncture, thermotherapy, and music therapy. From those, music therapy has become a form of “mind-body medicine” indispensable in rehabilitation programs, whether used actively or passively, and has gained a lot of interest in alternative medicine.

Keywords: COPD, music therapy, alternative medicine,

Introduction
Chronic obstructive pulmonary disease (COPD) is a common and preventable disease characterized by shortness of breath and chronic cough due to airways narrowing over time. If not treated properly, this condition evolves, has a worse prognostic and becomes difficult to reverse. The main cause of COPD is cigarette smoking but other factors can increase the risk, such as airway pollution, genetics and asbestos exposure. Spirometry is required to confirm the diagnosis of COPD, by calculating the ratio of the forced expiratory volume in the first second (FEV1) and the forced vital capacity (FVC) (1-3).

In the last years, COPD has become an important public health challenge that affects the daily living and the quality of life of patients. This is the reason why a multidisciplinary approach that includes an integrative intervention is required. The management of COPD patients should follow three steps: smoking cessation, reduction of acute exacerbation and comorbidity management. Besides these three cornerstones, the clinicians should take into consideration other alternative therapies, such as speleotherapy, halotherapy, muscle training, soft tissue manual therapy intervention, neuromuscular electrostimulation and music therapy, to improve outcomes for patients with COPD (4-6).

The development of alternative therapies has become a solution to multiple health concerns and in the last years, it has been integrated into various treatment plans. Recently, music therapy gained a role as an addition to the treatment of the chronic condition (7).

Prevalence
COPD has a rise in prevalence in the last decades is more common in ex-smokers and higher smokers compared to non-smokers and in men compared to women, reaching in 2020 a global prevalence of 11.8% in men and 8.5% in women. Also, the aging of the population increases the prevalence of COPD, in those over 40 years old compared to those under 40 years (2). Globally, there are 3 million deaths annually and the World Health Organization (WHO) predicts that COPD will become the third leading cause of death worldwide in 2030 (2.8).

This disease represents a serious economic burden, with direct healthcare costs due to the higher number of exacerbation-related hospitalizations and indirect costs because of loss of home productivity (8,9).

Pathophysiology
Cigarette smoking represents the primary cause of COPD worldwide but many other risk factors have been identified, such as atmospheric pollution, passive smoking, excessive exposure to fumes (mainly charcoal used for domestic cooking and wood) and other inhaled gases and noxious particles (10-12).

The lung abnormalities characteristic of COPD is produced by the inhalation of these products that cause a chronic inflammatory response and oxidative stress.
Moreover, after the inhalation of the offending agent ends, other pathobiological processes are included in the progression of the disease, like genetically determined responses, accelerated lung aging, alteration of the microbiome, inappropriate control of programmed cell death, imbalance of proteinases and anti-proteinases, an abnormal interaction between environment and microbiome, abnormal ion transport and pulmonary endothelial cell dysfunction (11,13).

Together, all these mechanisms can cause pathological modifications in the individual’s lung compartments: lung parenchyma, pulmonary vasculature, peripheral airways and central airways. These changes lead to the specific characteristics of COPD which include excessive mucus secretion, ciliary dysfunction, emphysema, airflow limitation, abnormal gas exchange, pulmonary hypertension, hyperinflation and numerous systemic effects (11).

Etiology
Cigarette smoking is the main factor involved in the development of COPD by increasing the lung and systemic inflammation, systemic oxidative stress and by affecting the endothelial and vasomotor function, predisposing to a pro-coagulant state. Habitual smoking does not influence only the airways, but also other systems, increasing the incidence of comorbidities in patients with COPD: skeletal muscle abnormalities, diabetes, ischemic heart disease, hypertension, heart failure and cancer (14,15).

However, smoking is not the only risk factor for COPD and many studies published in the last years documented COPD cases in individuals that never smoked. Therefore, there are other factors involved in the COPD etiology, such as air pollution, indoor pollution (biomass), childhood asthma, chemical exposure, aging, dietary factors and genetic predisposition (16,17).

Air pollution integrates the particulate matter (which includes acids, metals, soil or dust particles and organic chemicals), nitrogen dioxide and ozone, responsible for alveolar damage, changes in the chemical composition of lung lavage fluids and lung inflammation (12,18).

Comorbidities
Comorbidities are defined as being coexisting diseases or conditions that influence COPD severity, diagnosis or management and lead to multiple exacerbations and increased hospitalization risk. They are also associated with poor adherence to therapeutic interventions, higher mortality and reduced quality of life (19).

COPD is frequently associated with multiple comorbidities, the most common being asthma, bronchiectasis, lung cancer, cardiovascular diseases (CVDs), osteoporosis, skeletal muscle dysfunction, metabolic disorders (including obesity), depression and anxiety (14).

Asthma
Because COPD is a pathology that affects the small airways and causes a parenchymal injury, it is often a challenge to establish the differential diagnosis between COPD and asthma. Even if the symptomatology is very similar, an accurate diagnosis is important to establish the optimum treatment plan (19). Despite this, in a subset of subjects, older than 40 years old, which associate an airflow limitation and have a history of asthma or high bronchodilator reversibility, the clinicians could establish the diagnosis of asthma-COPD overlap syndrome (ACO).

ACO affects about a quarter of patients with COPD and almost a third of patients who previously had asthma and it is characterized by an increased risk of hospital admissions due to exacerbations, worse respiratory symptomatology and poorer quality of life. The management of ACO is very complex including therapy that targets neutrophilic, eosinophilic or paucigranulocytic airway inflammation and also specific interventions of respiratory rehabilitation (19,20).

Lung cancer
Large epidemiological studies revealed a high prevalence of lung cancer in COPD subjects moreover because both pathologies showed common risk factors, such as smoking and increasing age. Besides, the presence of the neoplasm is associated with the severity of airway obstruction, so subjects with severe stages of COPD have an important prevalence of lung cancer. At the time of histological diagnosis, COPD patients have a poorer prognostic with a 3-year survival rate of 15%, significantly lower than in patients without COPD, so smoking cessation and other rehabilitation techniques have gained a central role in the management plan. However, non-smoker subjects diagnosed with lung cancer, that associate emphysema or chronic bronchitis are at a higher risk of mortality (6,21,22).

Obstructive sleep apnea (OSA)
The overlap syndrome is represented by the association between COPD and obstructive sleep apnea (OSA) and has a prevalence between 1% and 3.6% in the general population, being responsible for hypoventilation episodes during sleep with nocturnal desaturation, poor sleep quality, increased nocturnal hypoxemia, daytime hypercapnia and a higher rate of mortality. In COPD patients, a low body mass index is protective against the development of OSA. Contrary, subjects with a high grade of the upper airway and systemic inflammation have a greater risk for OSA, an association that plays an additive or synergistic role in the development of cardiovascular comorbidities (22-24). In COPD patients with impaired gas exchange and diagnosed with pulmonary hypertension not explained by lung function, OSA should be suspected and treated when typical nocturnal symptoms such as poor sleep, snoring or witnessed apnea and daytime signs such as excessive
daytime sleepiness, headache and morning fatigue are present (22,25).

**Cardiovascular Diseases**

Vascular and heart diseases developed due to endothelial dysfunction and coagulopathy are among the most important comorbidities observed in COPD with a direct impact on patient survival and quality of life, being responsible for a greater depletion of health resources (22). The most common cardiovascular pathologies diagnosed in COPD patients are coronary heart disease, cardiac arrhythmias, arterial hypertension and heart failure (2). The most common cardiovascular pathologies diagnosed in COPD patients are coronary heart disease, cardiac arrhythmias, arterial hypertension and heart failure (2).

**Coronary heart disease and essential hypertension** are pathologies often diagnosed in patients with COPD, due to the presence of systemic inflammatory response and C-reactive protein (CRP) elevation. A study that evaluated 897 COPD patients showed that in 27.6% of patients were found sequelae of myocardial infarction and also 30% of subjects had a known history of myocardial infarction, with a negative impact on survival (22,26,27).

**Cardiac arrhythmias** also represent a common disease associated with COPD and there is a bidirectional relationship between the acute exacerbation of COPD and the development of atrial fibrillation (AF), mostly because AF is often associated with lower FEV1. The presence of AF does not influence the COPD treatment, but in this case, the patient needs short-acting beta2-agonists and caution is advised because the administration of these drugs may trigger AF, which becomes harder to control (28,29).

**Heart failure and COPD.** COPD and heart failure are pathologies that show the same risk factors like smoking and often the same symptomatology, the reason why both pathologies remain frequently undiagnosed. Both have similar pathophysiological mechanisms like systemic inflammation, skeletal muscle dysfunction and pump failure. Also, both diseases have to be taken into consideration in the elderly patients presenting for dyspnea, moreover because their clinical presentation can be very similar (22,30).

**Metabolic syndrome**

The metabolic syndrome is a challenge in COPD subjects and includes high blood glucose levels and/ or insulin resistance, central obesity, atherogenic dyslipidemia, elevated triglycerides and higher blood pressure. The pro-inflammatory and the pro-thrombotic state are responsible for the increase of acute-phase reactants, fibrinogen and plasminogen activator inhibitors causing a higher grade of systemic inflammation. In addition, both COPD and metabolic syndrome have similar risk factors such as smoking and some common pathophysiological mechanisms. Between these comorbidities there is a complex relation, so type 2 diabetes subjects often associate hypertension, cardiovascular diseases and obesity. COPD patients with diabetes and obesity have a reduced lung function, higher levels of CRP (C-reactive protein), IL-6 (Interleukin-6) and TNF-α (Tumor Necrosis Factor-α) compared to non-COPD patients, modifications known to be risk factors for major cardiovascular events (14,31,32). In recent years, in literature, a COPD patient paradox was described, showing that patients with higher body mass index (BMI) had longer survival. This paradox is no longer valid in patients with higher carbon dioxide levels and impaired exercise capacity, mostly because these two modifications impact the survival rate (33).

**Depression and anxiety**

Depression is considered a mental state characterized by pessimism, lassitude and reduced self-esteem. In COPD patients, clinical depression is found in about 40% of cases, but the pathology is more common in subjects that do not meet diagnostic criteria and in the elderly (22,34). On the other hand, anxiety is diagnosed in patients with indefinable insecurity and its prevalence among people with COPD is about 10% - 30% (22).

Both anxiety and depression have a synergistic role and are associated with lower self-efficacy of symptom management and consecutively with a poor health-related quality of life. It was stipulated that there is a higher rate of treatment failure and mortality in patients with acute exacerbation of COPD if they were diagnosed previously with depression or anxiety and also a greater risk of readmission in the following 30 days (35-37). Regvat et al. demonstrated that patients with anxiety and/or depression perceived dyspnea more often and intensely, the reason why in their medical history the first hospitalization for COPD occurs sooner (38). In addition, in patients with anxiety or panic disorder, it was proven that the airway obstruction is more important, the reason why specific questionnaires, careful monitoring and pulmonary rehabilitation with an integrated approach show significant improvement (39).

**Diagnostic**

The diagnosis of COPD should be taken into consideration in individuals with a history of exposure to risk factors such as cigarette smoke, occupational or environmental pollutants and/or a positive family history of obstructive lung diseases which present in pulmonology medical services with symptoms like dyspnea, chronic cough or sputum production lasting more than usually. Many subjects, especially women and young people underestimate their symptoms and limit their physical activity in order to minimize them, the reason why the diagnostic of COPD is delayed (40). The clinicians must perform spirometry tests that measure the forced expiratory volume in first second (FEV1), and the forced vital capacity (FVC) and to calculate the ratio between these values (Tiffeneau Index
It is a well-known fact that COPD patients develop dynamic hyperinflation due to changes in the anatomy of the airways and lung parenchyma, modification responsible for an increase of end expiratory lung volume that limits tidal volume and respiratory capacity. For these reasons, respiratory muscle training is important in stable COPD patients since it has benefits on pulmonary function and respiratory muscle strength. Inspiratory muscle training can reduce the dyspnea, improve the functional capacity, the quality of life and the six-minute walking distance (47-49). In obese COPD patients the association between caloric restriction and resistance exercise training showed an improvement on symptoms, health status and functional capacity. In addition, recent studies proved that respiratory muscle weakness is a risk factor for frequent exacerbations that lead to hospitalizations, so expiratory muscle training should be introduced in order to increase exercise performance (50-52).

In COPD patients a peripheral muscle dysfunction characterized by weakness, atrophy, metabolic and structural changes of the limb muscles has a negative impact on exercise capacity. Several studies reported various benefits of pulmonary rehabilitation including neuromuscular electrostimulation (NMES) in six-minute walking distance, exercise tolerance due to the increasing of endurance and strength of lower limbs skeletal muscles (53,54).

Acupuncture therapy has been widely used in the treatment of a variety of chronic conditions. In people with COPD, acupuncture may reduce bronchial inflammation and promote the release of immunomodulatory and vascular factors (55). Jungfei et al. showed, in a multicenter study that included 72 subjects, that acupuncture is associated with a decrease of the Borg scale after six-minute walking test and with an increased six-minute walking distance. In addition, the same study stipulated that there was an increase in the lowest oxygen saturation measured while performing six-minute walking test and also the subjects had an improvement in health-related quality of life (56).

Thermotherapy includes thermal and mineral bath therapy, near infrared hyperthermia treatment and hydroelectric bath therapy. Lin et al observed a positive effect of thermoerthmia and balneotherapy in COPD patients with an improvement in pulmonary function and quality of life (57).

Taking into account that COPD patients associate a high proportion of physical comorbidities such as cerebrovascular disease, obesity, muscle abnormalities and arthrosis that limit their ability to participate in common exercise training, McNamara et al. proposed water-based exercise training. This method showed improvement in endurance, dyspnea, six-minute walking distance and fatigue (58).
Music Therapy

Music therapy is a form of “body-mind medicine” conducted along with rehabilitation programs in order to bring a clinical change. There are two ways for clinicians to use music, as active or passive therapy, in the management of chronic respiratory conditions. Active mode involves subjects singing or playing a musical instrument while passive therapy involves listening to various type of music. Previous studies showed that live music provided by a music therapist is more efficient than recorded music (59,60).

Active music therapy

Singing is a complex activity which involves the use of the lungs for air supply in order to create large lung volumes. In this procedure, exhalation becomes an active process which requires good posture and active diaphragm contraction (61). Singing implies rhythmical, strong and fast inhalations followed by active and regulated exhalations which demands focused control of breathing in order to reduce hyperventilation and alter irregular breathing. In addition, music therapy can involve some respiratory techniques such as Pursed Lips Breathing or Blowing against resistance that may reduce hyperinflation, modify the respiratory pattern, enhance diaphragmatic movement and reinforce respiratory muscles (62,63). Pursed lips breathing is represented by a nasal inhalation followed by a slow expiratory blowing against partially closed lips. This technique is used when playing wind instruments like harmonica, recorder, melodica, to assess a diaphragmatic breathing, body posture and to achieve expiratory airways pressure (7).

Singing increases the use of vital capacity up to 90% in order to increase the tidal volume, modification that can minimize atelectasis, helping to clear secretions through airway oscillations and increase the force of cough reflex (63). Bonilha et al. observed that after singing classes, in COPD patients, there was an improvement in both maximal inspiratory and expiratory pressure, a decrease in expiratory reserve volume, a transitory elevation in dyspnea, with no statistically significant differences on pulmonary function. However, routine singing in subjects with dyspnea cause desensitization of breathlessness by improving the breathing coordination and by reducing the anxiety associated with respiratory symptoms (64).

Moreover, Engen et al. observed a change of the clavicular breathing pattern to a diaphragmatic one in just one week of singing intervention (65). COPD subjects which participated in therapeutic singing activities noted positive effects on wellbeing, an improvement in quality of life, amelioration of depression and a better mood (66-68). Holland et al. assessed the role of music therapy in COPD and found no improvements in exercise capacity, appreciated by six-minute walking test, even if short programs of singing may ameliorate single breath counting and possibly maximum expiratory capacity (69).

Contrary, McNaughton et al. conducted a study in COPD patients which had completed a program of pulmonary rehabilitation and were included in singing groups for one year. They observed a significant increase of six-minute walking distance in the singing group and also an increased sense of social connection which may explain the reduction of the anxiety (70). In another study, Lord et al. noticed a reduction of anxiety symptoms and also an improvement of physical component score of the Saint George health related quality of life short form questionnaire (SGRQ) (71).

Ho et al. proved that COPD subjects that follow a home exercise plan accompanied by music achieved the desired exercise intensity (72). In addition, Thaunt et al. observed that by adding rhythmic auditory stimulation to increase the rhythm of the music, the patients with stroke had an increased walking speed, step cadence, velocity and stride length (73). Moreover, music is responsible for affecting a person’s mood, decreasing perceived breathlessness and improving the walking distance (74).

Another study that used music with different speeds during an upper extremity training program observed a decrease of the dyspnea sensation in COPD subjects. Still, it is difficult to determine the effects of certain types of music on the outcomes, because many subjects included in various studies selected their favorite music while exercising in order to achieve a pleasant environment to keep them motivated (72).

Brooks et al. concluded that in some COPD subjects, moderate tempo music prevents the level of breathlessness from getting worse after a 10 minutes walk, even if the music did not affect anxiety or tolerance for physical activity (75). Contrary, Thornbi et al. reported lower levels of perceived dyspnea, an increase of 22% of the six-minute walking distance and with 53% more steps while listening to music (76). Reychler et al. studied the effects of listening to ambient music during pulmonary rehabilitation session and showed that there was no influence on the perceived exertion, dyspnea, fatigue or cardiorespiratory parameters, but a decrease of anxiety symptoms (77).

Moreover, listening to music during high intensity exercise had a positive effect on COPD symptoms, by reducing the dyspnea and increasing the endurance time (78). Some data from literature highlighted the effect of wind instrument playing on the respiratory system. Results showed higher lung function values in wind musicians and a higher prevalence of mild respiratory infection than in the control group (7). Alexander et al. examined the role of a harmonica playing in COPD subjects during the rehabilitation program and found that they had improvements in the quality of life, shortness of breath and walking distance (79). Moreover, Hart. et al observed that after a 12-week harmonica program for two hours a week, the patients had an increase in maximum
expiratory pressure and in six-minute walking distance (80).

**Passive music therapy**

Listening to music is associated with numerous mental and physical benefits for people who are diagnosed with COPD including relaxation, improved mood, reduced perceived exertion and improved exercise capacity. Because of its ability to affect emotional changes, listening to music may be a powerful tool in the rehabilitation program of COPD patients. Quick paced music is generally invigorating and it facilitates movement and expression, while slower paced music has a calming effect, reducing anxiety levels and it physiologically correlates with a decrease of blood pressure (81). In a study conducted by Lee et al. dyspnea was significantly reduced, with more than 1 point in the Borg dyspnea scale, during exercise training while listening to music. Another study showed that there was a notable increase in endurance time with 1:10 minutes when listening to music compared to the group that did not benefit from that. Also, a reduction in dyspnea was reported in those who listened self-selected music, including individual preference in artist and style, compared to those who listened investigator-selected music. In contrast, music had no effect on oxygen saturation, leg fatigue and heart rate (82).

**Dance**

Physical activity is one of the most important and effective components of pulmonary rehabilitation programs in patients with pulmonary chronic diseases. Despite its benefits, completion rates are poor and access is variable. However, there are other forms of physical activity that should be taken into consideration, such as dance. Some studies in COPD subjects included dance sessions, both community and during hospital admission and their preliminary results proved that it can improve a range of health outcomes (83,84). Moreover, dance and music were included in a pulmonary rehabilitation program and showed improvements in interest and enthusiasm, with a reduction of anxiety and depression, both in participants and staff delivering the programs (81).

**Conclusion**

COPD is a leading cause of morbidity, mortality, and resource use worldwide. Although pharmaceuticals have been extensively studied and utilized, their disease-modifying effects are limited and dependent on patient adherence. Pulmonary Rehabilitation has emerged over the last decade as an essential component to an integrated approach in the management of COPD. The treatment of this disease has expanded to include a variety of rehabilitative practices, including music therapy. Music therapy applied both in active or passive way is a promising and effective method to reduce anxiety, depression, perceived dyspnea, enhance sense of control and increase the quality of life of patients suffering from COPD.

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