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Original Research

The Association Between Respiratory Functions, Pain Tolerance and Body Awareness in Obstructive Lung Diseases

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ABSTRACT

Purpose: There are only a limited number of studies in the literature evaluating body awareness, pain perception, and the relationship between clinical parameters and respiratory functions in patients with obstructive lung disease (OLD) and compared with healthy individuals. Therefore, this study aimed to evaluate respiratory functions, pain tolerance, and body awareness in patients with OLD and compare these findings with those of healthy individuals.

Methods: The study included 33 patients and 30 healthy individuals. The respiratory function (spirometer), respiratory muscle strength (mouth pressure device), endurance (threshold loading device), pain level and tolerance (short-form McGill Pain Questionnaire and algometer), posture, and body awareness (Body Awareness Questionnaire-BAQ) were evaluated.

Results: The pain threshold and tolerance of the biceps, triceps, trapezius, and quadriceps muscles were significantly lower and BAQ scores were higher in patients with OLD compared with healthy individuals ($p < .05$). There was a significant relationship between FEV_1 (%) and pain tolerance of the triceps ($r = 0.371$, $p = .047$) and gastrocnemius muscles ($r = 0.419$, $p = .024$); FVC (%) and pain threshold of the gastrocnemius ($r = 0.413$, $p = .023$), triceps muscles ($r = 0.394$, $p = .034$), and pain tolerance of the gastrocnemius muscle ($r = 0.549$, $p = .002$).

Conclusions: Patients with OLD have a marked increase in pain perception and body awareness levels and a decrease in pain threshold and tolerance compared with healthy controls. Future studies should assess the effectiveness of pain management interventions as a part of pulmonary rehabilitation for patients with chronic respiratory diseases.

Clinical Implications: Pain management is important for planning pulmonary rehabilitation programmes.

Key Practice Points

- Pain threshold and tolerance levels decrease and body awareness level increases in patients with obstructive lung disease.
- Obstruction level is associated with pain threshold and tolerance in obstructive lung diseases.
- Health care professionalls should pay attention baseline and ongoing assessment of presence and intensity of pain and should play an important role management of pain with different interventions.

Chronic pain is an unpleasant symptom experienced by 40% of patients with chronic obstructive pulmonary disease (COPD), and its prevalence has increased to 66% in older patients (Harrison et al., 2017). Upper to lower back, cervical, and chest regions are the most prevalent pain regions in obstructive lung diseases (OLD) (Lee et al., 2017). There are studies looking at how pain is related to dyspnea. While experimental studies have suggested that dyspnea and pain arise from the same neurological

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processes, observational studies have suggested that the same individuals can experience both symptoms even if they do not share the same causal pathway (Clark et al., 2014; Nishino, 2011). A study published in 2022 emphasized that pain and dyspnea symptoms are closely related in COPD, but the relationship is not mediated by various biological, psychological, or functional factors (Bartz-Overman et al., 2022).

Musculoskeletal system abnormalities can lead to excessive strain of skeletal muscles and respiratory muscle overload in patients with COPD (Lee et al., 2018, 2017). Severe COPD patients use accessory muscles of inspiration even during calm breathing, resulting in negative posture alterations (Goncalves et al., 2017). In particular, barrel chest hyperinflation leads to diaphragm dysfunction due to changes in the length-tension relationship (Alter et al., 2017). Johansson et al. demonstrated that patients with COPD experienced increased respiratory frequency, lower thoracic extension ability, and thoracic and lower abdominal movements compared with the healthy controls (Johansson et al., 2012).

Body awareness is the dimension of a person's overall consciousness and requires cognitive (knowledge of the body and it's parts and it's movements), emotional and perceptual abilities (the patient's attitude to their functional capacity and exercise) (Roxendal, 1985). Otherwise, interoception is defined as the sensation of various internal signals emanating from the body (Craig, 2009). Growing evidence shows that the anterior insular cortex has a vital role in the integration and consciousness of interoceptive stimuli (Berlucchi & Aglioti, 2010; Dahlberg, 2019; Di Lernia et al., 2016). In addition, the complex connection between Aγ and C fibers and the lamina I region is stimulated by homeostatic inputs like cardiorespiratory functions, immune and hormonal activities, in addition to pain and temperature (Di Lernia et al., 2016). The cortical interoceptive coordination areas were also shown to be activated during painful stimuli (Brooks et al., 2002; Di Lernia et al., 2016).

Instead of relying solely on external cues, humans have an internal sense called interoception. This hidden ability constantly monitors the state of the body, similar to a built-in control center. Interoception is essential for two purposes: managing our energy and controlling our movements. It is also the basis for body awareness, which helps us understand our internal state (Weiniger & Schilaty, 2024). Higher body awareness can provide an individual's ability to listen to their body-related symptoms and change people's perspective on their body (Dahlberg, 2019).

To the best of our knowledge, although trials have evaluated pain and posture in OLD (Harrison et al., 2017; Lee et al., 2017; Vardar-Yagli et al., 2019), body awareness has not been assessed in OLD as compared to healthy individuals, unlike other chronic disorders (d'Alcala et al., 2015; Haugstad et al., 2006; Loof et al., 2014). There is also a limited number of studies in the literature that assess body awareness in patients with OLD, and there is no data regarding the relationship between respiratory functions and pain tolerance by objective measurement (Karaca et al., 2024). Therefore, this study aimed to evaluate respiratory function, pain tolerance, and body awareness in patients with OLD and compare these findings with those of healthy individuals.

Materials and Methods

Participants

A total of 33 patients (18 patients with COPD, 15 patients with bronchiectasis) aged 18-65 years who were referred from Hacettepe University, Faculty of Medicine, Department of Chest Diseases and age- and gender-matched 30 healthy individuals were included in the study. Patients who were diagnosed with OLD aged 18-65 years, had no history of acute exacerbation within the past 3 months, were cooperative, mobile, and willing to participate in the study were included in this study. Patients diagnosed with neurological diseases that may affect cognitive function and those with severe orthopedic impairments that may affect functional capacity were excluded. The inclusion criteria of healthy individuals were being aged 18-65 years, cooperative, mobile, and willing to participate in the study. Healthy individuals with cardiopulmonary diseases and severe orthopedic impairments that may affect functional capacity were excluded. The normality of cognitive functions was also evaluated in detail and confirmed using the Montreal Cognitive Assessment (MoCA) to determine eligible participants because body perception is affected by the cognitive functions like memory or attention (Cameron, 2001; Di Lernia et al., 2016). Twenty-one points or above is considered normal according to the MoCA (Kaya et al., 2014). The Non-Interventional Studies Ethics Committee of the University approved the study (decision no: GO 18/109, dated: 31.01.2018), and all patients signed a written informed consent form.

Assessments

The physical and sociodemographic characteristics including age, body weight, height, body mass index (BMI), comorbidities, family history, symptoms related to OLD (dyspnea, sputum, cough), smoking status, and clinical findings were recorded. The severity of comorbidity was recorded according to the Charlson Comorbidity Index (CCI) (Beddhu et al., 2000). Functional exercise capacity was evaluated using a six-minute walk test (6MWT) distance according to the American Thoracic Society (ATS)/European Respiratory Society (ERS) criteria (Holland et al., 2014).

Respiratory Functions

Pulmonary function was evaluated using a Spirolab III spirometer (Spirolab, Medical International Research, Rome, Italy). Forced expiratory volume in the first second (FEV_1), forced vital capacity (FVC), forced expiratory volume in one second/forced vital capacity (FEV1/FVC), peak expiratory flow (PEF), and forced expiratory flow from 25% to 75% ($FEF_{25-75\%}$) were expressed as percentages of the expected values according to ATS and ERS (Miller et al., 2005; Pellegrino et al., 2005).

Respiratory muscle strength was assessed using an electronic mouth pressure device (Micro Medical MicroRPM, UK). The maximal inspiratory pressure (MIP) and maximal expiratory pressure (MEP) were recorded. The measurements were repeated three times, and the best value was selected for analysis (Gosselink & Stam, 2005). The values were also expressed as a percentage of predicted values (MIP% and MEP%) according to Black and Hyatt reference equations (Black & Hyatt, 1969; Troosters et al., 2005).

Respiratory muscle endurance was evaluated using a constant threshold loading test. The patient inspired by a fixed load of 60% MIP using an inspiratory muscle training device (POWERbreathe Wellness, HaB International Ltd. South, UK). The total time was recorded (Troosters et al., 2005).

Pain Evaluation

Pain was evaluated subjectively using the Short-form McGill Pain questionnaire (SF-MPQ) and objectively using an algometer (JTECH Medical-Algometer Commander, Salt Lake City, Utah, ABD). The SF-MPQ is a multidimensional measure of pain perception that is known for its reliability and validity in the assessment of chronic pain (HajGhanbari et al., 2014). The SF-MPQ comprises three separate sections. The first section comprises 15 items (11 sensory and four affective) that are rated on an intensity scale as 0 = none, 1 = mild, 2 = moderate, or 3 = severe. The sensory pain score was calculated as 0-33, and affective pain score was 0–12. In the second section, the present pain severity was measured using a 10-cm Visual Analog Scale. The present pain intensity was evaluated based on a 0 (no pain)−5 (unbearable pain) intensity scale in the third section (Yakut et al., 2007).

The biceps and triceps muscles, the upper part of the trapezius muscle, quadriceps, and gastrocnemius muscle were evaluated for pain threshold and tolerance using an algometer (JTECH Medical-Algometer Commander, Salt Lake City, Utah, ABD). This algometer is a reliable handheld device formed by a piston that contains at its end a rubber of 1 cm^2 in diameter, able to register, through the electronic device, the pressure applied on a surface (Ylinen et al., 2007). Pressure was applied at a constant velocity of 1 kg/s to the level at which pain or discomfort was reported by the participant who was in the sitting position when the feet were on the floor. The recorded volume is expressed in kg/cm^2. The participants were instructed to say "stop" as soon as the feeling of pressure changed from unpleasant to painful during the evaluation. The final applied pressure was recorded as the pain threshold. The pressure at which participants could not endure the pain and may have a traumatic wound if the pressure was continuously sustained was recorded as pain tolerance. The measurements for both pain threshold and tolerance were repeated thrice, and the average values were analyzed. The time between measurements was 20 s to decrease the risk of pain summation. After measuring pain threshold and tolerance in a single region, the same region was evaluated in the other extremity (Rolke et al., 2006; Waller et al., 2015; Ylinen et al., 2007).

Body Awareness

Body awareness was assessed using the Turkish version of the Body Awareness Questionnaire (BAQ), which aims to determine normal or abnormal sensitivity to body composition. It consists of four sub-dimensions (noticing reactions or changes in bodily processes, predicting bodily reactions, sleep-wake cycles, onset of illness) and a total of 18 statements. The total score ranged from 18 to 126. As the total score increased, body awareness improved. Validity and reliability studies on this questionnaire have been conducted in many studies in healthy and patient populations (Karaca & Bayar, 2021).

Data Analysis

IBM SPSS statistical software version 23.0 (SPSS Inc., Chicago, IL) was used for statistical analyses. Descriptive statistics were expressed as mean ± standard deviation (X ± SD). Normality was evaluated using the *Kolmogorov-Smirnov test*. Normally and non-normally distributed variables were compared using Student's *t*-test *and Mann–Whitney U test*, respectively. The relationships between respiratory function, pain threshold, tolerance, and body awareness were assessed using Spearman's rank correlation coefficients. Correlations were classed as "strong" ($r > 0.70$), "moderate" ($r = 0.50$-0.69), "weak" ($r = 0.26$-0.49), and "little or no correlation" ($r = 0.00$-0.25) (Domholdht, 1993). The level of significance was determined as $p \leq .05$ (Hayran & Hayran, 2011).

Results

Thirty-three patients with OLD (18 COPD and 15 bronchiectasis) and 30 healthy individuals were included. The characteristics of patients and healthy individuals are presented in Table 1. Gender, age, weight, height, and BMI were similar between groups ($p > .05$, Table 1). The amount of cigarette consumption (pack*years) was significantly higher in patients than in healthy individuals ($p < .05$). A total of 63.7% of patients had rest and exertional dyspnea, 87.9% had only exertional dyspnea, 72.7% had a cough, and 78.8% had sputum symptoms. Ten patients had coronary artery disease and four had diabetes mellitus as comorbidities. The CCI score was significantly higher in patients with OLD than in healthy individuals ($p < .05$). Patients' 6MWT distance was lower than that of healthy individuals ($p < .05$, Table 1). The mean MoCA scores were similar between groups ($p > .05$).

The respiratory functions of patients and healthy individuals are shown in Table 2. Patients' FVC, FEV_1, $FEF_{25-75\%}$ and PEF values were significantly lower than those of healthy individuals ($p < .05$). The MIP, MEP, and respiratory muscle endurance time were similar between groups ($p > .05$).

A total of 54.5% of patients reported pain. In terms of current pain, 73.3% of patients reported no pain, 20% reported mild pain, 3.3% reported uncomfortable pain and 3.3% reported distressing pain. In contrast, 8.5% of the healthy controls had pain complaints, and all of the controls had mild pain. The comparison of mean pain threshold and tolerance and SF-MPQ scores between patients and healthy individuals are presented in Table 3. Patients' mean pain threshold and tolerance of the triceps and trapezius muscles were lower, and scores of SF-MPQ and BAQ were higher than those of healthy individuals ($p < .05$). The mean pain threshold and tolerance of the biceps, quadriceps, and gastrocnemius scores were similar between groups ($p > .05$).

There was a weakly significant relationship between FEV_1 (%) and pain tolerance of the triceps ($r = 0.371$, $p = .047$) and gastrocnemius muscles ($r = 0.419$, $p = .024$). FVC (%) was significantly correlated with the pain threshold of the gastrocnemius ($r = 0.413$, $p = .023$) and triceps muscles ($r = 0.394$, $p = .034$) at a weak level, and moderately significantly correlated with pain tolerance of the gastrocnemius muscle ($r = 0.549$, $p = .002$). A weak significant relationship existed between MEP value and pain threshold of the biceps ($r = 0.492$, $p = .006$), triceps ($r = 0.421$, $p = .021$),

Table 1
Comparison of the Characteristics Between Patients With Obstructive Lung Disease and Healthy Controls.

Characteristics	Obstructive Pulmonary Disease ($n = 33$) Mean±SD/ Median(min-max)	Healthy Controls ($n = 30$) Mean±SD/ Median(min-max)	p value
Age (years)	51.30 ± 18.18	49.86 ± 5.99	.110
Gender (Male/Female) (n)	20/13	20/10	
Height (cm)	163.91 ± 10.26	167.80 ± 6.14	.08
Weight (kg)	70.21 ± 18.71	75.00 ± 9.98	.216
BMI (kg/m²)	26.07 ± 6.08	26.59 ± 3.00	.672
Smoking history (pack-years)	27.39 ± 18.75	11.61 ± 13.36	**<.01***
Montreal Cognitive Assessment	27.33 (21–30)	23.63 (16–30)	.273
6MWT distance (m)	488,59 ± 84,45	567.43 ± 52.29	**<.001***

cm, centimeter; kg, kilogram; kg/m², kilogram per square meter; m, meter; min-max, minimum-maximum; n, number of participants; SD, standard deviation; 6MWT, six-minute walk test.

Table 2
Comparison of Pulmonary Function, Respiratory Muscle Strength, and Endurance Between Patients With Obstructive Lung Disease and Healthy Controls.

Variables	Obstructive Pulmonary Disease (n = 33)	Healthy Controls (n = 30)	
	Mean ± SD	Mean ± SD	p value
FVC (%)	81.06 ± 23.12	103.4 ± 7.95	**<.001***
FVC (L)	2.69 ± 1.05	3.74 ± 0.55	**<.001***
FEV_1 (%)	67.39±26.03	101.8 ± 10.8	**<.001***
FEV_1 (L)	1.90 ± 0.88	2.95 ± 0.47	**<.001***
FEV_1/FVC (%)	83.52 ± 14.71	79.2 ± 7.01	.151
$FEF_{25-75\%}$ (%)	39.26 ± 23.84	86.9 ± 27.47	**<.001***
$FEF_{25-75\%}$ (L)	1.36 ± 0.93	2.84 ± 0.94	**<.001***
PEF (%)	66.61 ± 29.17	93.93 ± 19.07	**<.001***
PEF (L)	4.63 ± 4.41	6.96 ± 1.87	**<.001***
MIP (cmH_2O)	93.43 ± 19.91	99.13 ± 14.82	.213
MEP (cmH_2O)	141.50 ± 53.32	122.26 ± 27.1	.08
Endurance time (s)	103.86 ± 98.88	135.16 ± 131.1	.301

FVC, forced vital capacity; FEV_1, forced expiratory volume in the first second; FEV_1/FVC, forced expiratory volume in one second/forced vital capacity; $FEF_{25-75\%}$, forced expiratory flow from 25% to 75%; PEF, peak expiratory flow; MIP, maximal inspiratory pressure; MEP, maximal expiratory pressure; n, number of participants; SD, standard deviation; %, percentage; L, liter; cmH_2O, centimeter water; s, second.

Table 3
Comparison of the Average Pain Threshold and Tolerance and Short-Form McGill Pain and Body Awareness Questionnaire Scores Between Patients With Obstructive Lung Disease and healthy controls.

Variables		Obstructive pulmonary disease (n = 33)	Healthy controls (n = 30)	
		Mean ± SD/ Median(min-max)	Mean ± SD/ Median(min-max)	p value
Biceps	**Threshold (N)**	28.78 ± 15.99	27.83 ± 7.17	.765
	Tolerance (N)	41.08 ± 21.49	39.88 ± 10.23	.595
Triceps	**Threshold (N)**	28.32 ± 13.92	38.29 ± 13.19	**.006***
	Tolerance (N)	35.79 ± 15.46	54.67 ± 14.10	**<.001***
Trapezius	**Threshold (N)**	35.03 ± 20.35	41.44 ± 10.61	**.001***
	Tolerance (N)	49.23 ± 23.31	58.84 ± 13.13	**.031***
Quadriceps	**Threshold (N)**	47.95 ± 20.03	52.04 ± 10.32	.180
	Tolerance (N)	63.24 ± 23.84	66.81 ± 13.63	.779
Gastrocnemius	**Threshold (N)**	41.69 ± 19.00	42.25 ± 11.6	.545
	Tolerance (N)	49.69 ± 16.58	58.13 ± 13.11	.06
Short-form McGill Pain Questionnaire		27.74 ± 21.63	1.20 ± 12.62	**<.001***
Body Awareness Questionnaire		95.09 ± 15.07	86.50 ± 7.82	**.042**

N, newton; min-max, minimum-maximum; n, number of participants; SD, standard deviation.

and gastrocnemius muscles (r = 0.424, p = .019). Additionally, MEP value was moderately significantly related to pain tolerance of the biceps (r = 0.534, p = .003) and significantly correlated with triceps (r = 0.448, p = .015) and gastrocnemius muscles (r = 0.430, p = .020) at a weak level. Respiratory muscle endurance time was significantly related to the pain threshold of the quadriceps muscle (r = 0.445, p = .014) at a weak level. The BAQ score was significantly associated with the CCI score (r = 0.492, p = .004) at a weak level and moderately associated with the MEP value (r = 0.604, p = .001).

Discussion

The main findings of the present study were that patients with OLD had impaired pain status, higher pain perception, and lower levels of pain thresholds and tolerances in the biceps, triceps, trapezius, and quadriceps muscles compared with healthy individuals. Body awareness among patients with OLD was also found to be higher than that among healthy individuals. Expiratory muscle strength and comorbidity in patients with OLD were significantly related to their body awareness level. Worse respiratory function was correlated with lower pain threshold and tolerance in patients with OLD.

Dyspnea, which is the most common symptom of respiratory diseases, shares the same peripheral receptor and central activation mechanism with pain, which negatively affects patients' quality of life (von Leupoldt et al., 2009). Systemic inflammation can increase pain intensity in patients with COPD, and increased macrophage and neutrophil counts may cause the release of proinflammatory cytokines (Lindenlaub & Sommer, 2003). Some studies have shown that IL-1 and IL-6 cytokines can cause hyperalgesia (Banzett et al., 2000; Lindenlaub & Sommer, 2003). Also, TNF-α level has been associated with the generation of neuropathic pain Sommer et al. (1998). In another study, peripheral neuropathy was found in one-third of the patients with COPD, and they thought that the etiopathogenic factors that cause this condition are chronic hypoxia, tobacco smoke, alcoholism, malnutrition, and the adverse effects of certain drugs (Gupta & Agarwal, 2006). HajGhanbari et al. evaluated pain severity using McGill Pain Questionnaire in patients with COPD and found greater pain severity than in healthy controls (HajGhanbari et al., 2012). In our study, pain intensity was assessed subjectively using the SF-MPQ and objectively using an algometer device. We also found that 54.5% of patients with OLD had pain symptoms, and SF-MPQ parameters showed that patients with OLD had significantly higher pain levels and increased pain and symptom risks compared with healthy controls.

A study of healthy people has shown that the most sensitive muscle is the upper trapezius, and that the pain threshold is higher in the lower part of the body. This condition may be caused by an excess of proprioceptors in the upper body or segmental dysfunction (Fischer, 1987). Any statistically significant difference in gastrocnemius muscle thresholds and tolerance between patients with OLD and healthy controls in our study may be due to increased proprioceptor levels in the upper body and the gastrocnemius muscle being located deeper than the quadriceps muscle.

Decreased pain thresholds and pain tolerance in the biceps, triceps, trapezius, and quadriceps muscles may be the result of increased pain sensitivity due to systemic inflammation and hypoxia in the etiology of obstructive diseases. In a study of moderate to severe COPD, the prevalence of pain was 81%, and most patients experienced moderate to severe pain (HajGhanbari et al., 2014). Worse respiratory functions were also correlated with lower pain threshold and tolerance in patients with OLD in our study.

Body awareness consists of proprioception and interoception. While proprioceptive awareness is the perception of joint angles, muscle tensions, movement, posture, and balance, interoceptive awareness is the perception of physical sensations (for example heartbeat, respiration, hunger, temperature, blood sugar levels) and autonomic nervous system symptoms (emotions). Pain and dyspnea are components of interoceptive awareness (Cynthia & Mehling, 2016; Malpass et al., 2018; Murphy et al., 2017). The present study showed that body awareness, including note response or changes in body process, sleep-wake cycle, prediction of onset of illness, and body reaction, was increased in patients with OLD compared with healthy individuals for the first time. A systematic review reported that patients with chronic pain tend to have less accurate interoceptive abilities than their non-chronic pain counterparts, and that this accuracy of interoception decreases as the severity of pain symptoms increases (Di Lernia et al., 2016). We believe that the higher level of body awareness level in our study, despite increased pain complaints, could be related to increased awareness of other symptoms (dyspnea, cough, sputum) and self-monitoring in patients with OLD. In contrast to our results, Karaca et al. found that patients with COPD had lower body awareness than healthy controls. Body awareness is significantly and closely associated with disease severity, dyspnea, functional capacity, anxiety, and depression in patients with COPD, as highlighted in the aforementioned study (Karaca et al., 2024). Ginzburg et al. (2018) showed that high body awareness was associated with increased reactivity to pain and higher pain levels in patients with borderline personality disorder. A recent study in 2023 also determined that healthy people who experienced back pain in the last month experienced significantly higher body weight awareness levels than people without pain (Kalkışım et al., 2023). In our study, the severity of the disease (mean FEV_1 (%) = 67.39 ± 26.03) and associated comorbidities may have led to an increased perception of pain and, as a result, a higher body awareness than healthy participants. HajGhanbari et al. (2014) showed that 73% of patients reported >2 comorbid health conditions and 46% of them reported >3 comorbid health conditions among patients with moderate-severe COPD experiencing pain. COPD patients with musculoskeletal or endocrine comorbid diseases also reported higher levels of pain. On the other hand, some patients with diabetes can predict blood glucose levels through their interoceptive awareness (Kiken et al., 2018). Based on these findings, the presence of comorbidities may have led to increased body awareness.

The first limitation of our study was that since most patients with OLD had moderate-severity airflow obstruction, so the results do not reflect the early or advanced stages of the disease. Postural awareness and pain may be affected differently depending on the psychosocial status of individuals, and the lack of evaluation on this issue was the second limitation of our study. The third limitation of the study was that the participants were not familiar with the pain measures prior to data collection.

It is well established that interdisciplinary teams of motivated, committed, and experienced healthcare professionals are required to achieve the main goals of pulmonary rehabilitation. The strength of our study was that these findings increased the awareness of nurses and physiotherapists as a member of a multidisciplinary team that they could pay attention to the baseline and ongoing assessment of the presence and intensity of pain, disease knowledge, medication management of pain, and management of symptoms, comorbidities, and psychological state in patients with OLD.

Conclusion

In conclusion, patients with OLD have higher levels of perceived pain and lower pain thresholds and tolerances in the biceps, triceps, trapezius, and quadriceps muscles than healthy individuals. Worse respiratory function is correlated with lower pain threshold and tolerance in patients with OLD. Body awareness is also higher in patients with OLD than in healthy individuals and was related to expiratory muscle strength and comorbidity in patients with OLD. Detailed pain assessment is warranted in pulmonary rehabilitation programs for patients with OLD, and future studies should evaluate the effectiveness of pain management interventions, particularly those that incorporate body awareness and respiratory training therapies as part of pulmonary rehabilitation.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

CRediT authorship contribution statement

Naciye Vardar-Yagli: Conceptualization, Data curation, Methodology, Supervision, Writing – original draft. **Melda Saglam:** Data curation, Formal analysis, Methodology, Supervision, Writing – original draft. **Merve Firat:** Data curation, Formal analysis, Visualization, Writing – original draft. **Deniz Inal-Ince:** Supervision, Writing – review & editing. **Ebru Calik-Kutukcu:** Formal analysis, Visualization, Writing – original draft. **Kubra Kilic:** Data curation. **Hulya Arikan:** Supervision, Writing – review & editing. **Lutfi Coplu:** Data curation, Writing – review & editing.

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