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Nicotine dependence and physical function: a comparison between current smokers with and without chronic obstructive pulmonary disease who seek cognitive-behavioral therapy

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Abstract

Smoking is a chronic disease characterized by nicotine dependence that affects the physical and mental health of millions of people worldwide. This study compared the degree of nicotine dependence, general fatigue, lung function, functional exercise capacity (FEC), and quality of life (QoL) in smokers with and without chronic obstructive pulmonary disease (COPD) who were seeking cognitive-behavioral therapy (CBT). This cross-sectional study involved 53 smokers (27 in the COPD group and 26 in the noCOPD group). Participants underwent a FEC assessment using the Glittre-ADL test (TGlittre), as well as pulmonary function analysis *via* spirometry and impulse oscillometry (IOS) to detect small airway disease (SAD). Participants also completed the following assessments: the Fagerström test for nicotine dependence (FTND), the Richmond test for motivation to quit smoking, the Functional Assessment of Chronic Illness Therapy-Fatigue (FACIT-F) scale, and the Short Form 36 (SF-36). When the two groups were compared, the noCOPD group had a slightly higher median FTND and Richmond test scores, though the differences were not statistically significant ($p=0.537$ and $p=0.449$, respectively). The COPD group showed lower values for all evaluated parameters ($p\leq 0.008$), but no difference was detected between the groups regarding IOS. SAD was present in 74% of COPD group participants and 73% of noCOPD group participants, with no statistically significant difference ($p=0.934$, Cramer's $V=0.01$). Participants with COPD took longer to complete the TGlittre tasks ($p=0.011$). There were no significant differences between the groups on the FACIT-F scale ($p=0.964$) or the SF-36, except for the "physical functioning" domain, which was worse in the COPD group ($p=0.018$). In conclusion, individuals seeking CBT exhibit a high degree of nicotine dependence, regardless of COPD status. SAD is detected in approximately three-quarters of these individuals, regardless of COPD status. Furthermore, low FEC is more common in people with COPD, though general fatigue and QoL are impaired in smokers with and without COPD.

Key words: smoking, chronic obstructive pulmonary disease, functional capacity, small airway disease.

Introduction

Smoking is the most common avoidable health risk [1]. It is the leading risk factor for chronic obstructive pulmonary disease (COPD), exacerbating symptoms and accelerating disease progression. However, quitting smoking improves outcomes [2]. Nicotine dependence and increased tobacco exposure influence smoking patterns and predispose individuals to a decline in lung function [3]. Approximately 40% of individuals with COPD are smokers. They are less likely to quit than smokers without COPD, suggesting higher nicotine dependence [4,5]. The Fagerström test for nicotine dependence (FTND) is one tool for assessing nicotine dependence. It has been widely used to guide nicotine replacement therapy and inform treatment planning [6]. In smokers, the FTND can indicate a higher likelihood of COPD and lung function deterioration when assessed alongside age. In fact, the likelihood of developing COPD increases by 11% for each additional point on the FTND [7].

Current smoking markedly accelerates lung aging and the decline in lung function in individuals with and without COPD, though the decline appears to be more rapid in individuals with COPD [8]. Due to the significant timeframe between the onset of respiratory symptoms and the beginning of a clinically relevant decline in forced expiratory volume in one second (FEV_1) among smokers without COPD, identifying functional changes in patients with early-stage COPD and heavy smokers is crucial for ensuring an early diagnosis [9]. Among smokers without COPD, small airway disease (SAD) is associated with a faster decline in spirometric parameters and a higher rate of progression to COPD [10]. A reduced maximum mid-expiratory flow (MMEF)—a flow rate determined by small airway resistance and lung elastic recoil pressure—can detect early pulmonary abnormalities and identify a subgroup of symptomatic smokers with pathological changes that may lead to COPD [11]. Spirometry is still used to assess SAD; however, the impulse oscillometry system (IOS) is increasingly being incorporated into clinical practice for SAD detection [12]. IOS can detect SAD even when spirometry results are normal. Furthermore, SAD assessed via IOS is associated with wheezing in symptomatic smokers with normal spirometry results [13].

Inhaling cigarette smoke increases blood levels of carbon monoxide, which competes with oxygen for binding to hemoglobin. This reduces the capacity to transport and deliver oxygen to cells, which can lead to decreased metabolic activity and increased general fatigue [14]. Therefore, it is crucial to assess functional exercise capacity (FEC) in smokers because it can predict an individual's future functional status, including the development of COPD [15]. For some time, exercise performance has most commonly been assessed using data from field

tests, particularly the six-minute walk test (6MWT) [16]. Recently, the Glittre-ADL test (TGlittre) was proposed as an easy-to-administer field test to evaluate COPD patients. It assesses common activities of daily living (ADLs), such as sitting, standing, climbing stairs, descending stairs, and moving objects between shelves at different heights [17]. Compared to the 6MWT, the TGlittre more accurately measures the exertion experienced by smokers, including those with COPD, because it better simulates situations encountered in daily life activities (ADLs) [16].

Walking ability reflects a patient's capacity to perform ADLs and is therefore an important component of quality of life (QoL). Disability, the psychosocial impact of chronic disease, can be objectively assessed by evaluating QoL or physical activity levels [8]. The tobacco use profoundly impacts individuals' QoL, primarily due to its adverse effects on physical and mental health. Chronic bronchitis significantly affects symptoms, QoL, and survival in smokers without COPD, highlighting the need to recognize and appropriately treat the condition [18]. Furthermore, the financial burden of treating tobacco-related conditions, along with lost productivity, exacerbates the socioeconomic impact, which undermines the stability and QoL of these individuals [19].

Tobacco dependence hinders smoking cessation and can affect consumption patterns, thereby increasing tobacco exposure and impairing lung function [6]. For current smokers, quitting smoking is the only evidence-based intervention that reduces the risk of COPD, slows the decline in lung function, and decreases mortality. A knowledge gap exists regarding the differences in physical function and QoL between smokers with and without COPD who are seeking CBT. We hypothesized that factors associated with COPD, such as alterations in the cardiorespiratory and vascular systems and myopathy, might result in poorer functional performance and QoL in individuals with COPD compared to those without. Thus, the aim of this study was to compare the degree of nicotine dependence, general fatigue, lung function, FEC, and QoL between smokers with and without COPD seeking cognitive-behavioral therapy (CBT).

Materials and Methods

Study design, participants and ethics

A cross-sectional study was conducted from September 2025 to August 2026. The study included adult smokers with or without COPD who sought care at the Piquet Carneiro University Polyclinic at the State University of Rio de Janeiro, Brazil. Individuals were smokers

seeking CBT who had smoked for at least 10 pack-years [20]. COPD was defined as a post-bronchodilator FEV₁ to forced vital capacity (FVC) ratio of less than 70% as measured by spirometry [2]. The following exclusion criteria were applied: a diagnosis of other pulmonary diseases (including asthma and pulmonary fibrosis); a diagnosis of extrapulmonary diseases that affect the lungs (such as sarcoidosis and collagen vascular diseases); upper or lower limb dysfunction that could impair performance of the TGlitter; and an inability to perform the TGlitter. Individuals were consecutively recruited as they presented to our outpatient clinic seeking to quit smoking. All assessments were performed on the first day of the patient's visit, before the initiation of CBT.

Participants were classified into two groups based on spirometry parameters: the COPD group (post-bronchodilator FEV₁/FVC ratio less than 70%) and the noCOPD group. The sample size was calculated using JASP (Jeffreys' Amazing Statistics Program) software from the University of Amsterdam, the Netherlands. The primary outcome was a comparison of the time it took to complete the test between the two groups. The mean values used for the calculation were based on a previous study [21]. With a significance level (α) of 5%, statistical power ($1-\beta$) of 80%, Cohen's d of 0.5, and a 95% confidence interval and margin of error of $\pm 5\%$, the minimum sample size was 26 participants per group.

The Research Ethics Committee of the Augusto Motta University Centre in Rio de Janeiro, Brazil, approved the project under number CAAE-90474125.3.0000.5235. All study participants signed informed consent forms in accordance with the Declaration of Helsinki. The protocol was registered with ClinicalTrials.gov under the reference number NCT07186049.

Measurements

The FTND was used to evaluate the extent of nicotine dependence among the participants. The test consists of six questions that address cigarette consumption patterns. These questions cover topics such as the difficulty of refraining from smoking in prohibited areas, how long it takes to smoke the first cigarette after waking up, and how many cigarettes are smoked per day [22]. Each question has a specific score, and the total score ranges from 0 to 10 points. Nicotine dependence is classified as follows: 0–2 points: very low dependence; 3–4 points: low dependence; 5 points: moderate dependence; 6–7 points: high dependence; 8–10 points: very high dependence [23].

The level of motivation to quit smoking was analyzed using the Richmond test. Motivation to quit was categorized from 0–5 points: poor motivation; 6–8 points: moderate motivation; and >8 points: high motivation [24].

The Short Form-36 (SF-36) was used to assess QoL. It is the most widely used scale worldwide, has been validated for the Portuguese language, and demonstrates high intra- and interobserver reproducibility [25]. This multidimensional, self-administered tool consists of 36 items grouped into eight dimensions: physical functioning, physical role limitations, bodily pain, general health perceptions, vitality, social functioning, emotional role limitations, and mental health [26]. The results are presented as scores ranging from 0 to 100, which are derived from a set of questions that cover various aspects of QoL. Higher scores indicate better QoL.

We used the Functional Assessment of Chronic Illness Therapy-Fatigue (FACIT-F) scale to assess general fatigue. This scale consists of 13 items that are rated from 0 to 4. A higher score indicates lower fatigue. The total score ranges from 0 to 52. The FACIT-F is a fatigue-specific assessment scale that effectively reflects an individual's condition. It is also considered an easy-to-administer instrument [27]. Furthermore, the FACIT-F scale has been extensively used in clinical populations and has been validated for use in Portuguese. The scale's internal consistency reliability is good, with a Cronbach's alpha of 0.93 [28].

Spirometry was performed using Vitatrace VT 130 SL equipment (Codax Ltda., Rio de Janeiro, Brazil) according to established standards [29]. We used reference equations for the Brazilian population [30] to interpret the spirometry results. IOS was performed using the Quark i2m device (Cosmed, Rome, Italy) to diagnose small airway disease (SAD), following established standards [12]. The following resistive and reactive parameters were evaluated: respiratory system resistance (R_{rs}) at 5 Hz (R_5) and 20 Hz (R_{20}); resistance heterogeneity between 5 and 20 Hz (R_5 – R_{20}), which indicates small airway caliber and ventilation heterogeneity; resonance frequency (F_{res}), which reflects airway inertial properties and peripheral lung capacitance; respiratory system reactance (X_{rs}) at 5 Hz (X_5); and the area under the reactance curve (A_x) [9]. Values of $F_{res} > 12$ Hz, $A_x \geq 8.66$ cm H₂O/L/s, and/or R_5 – $R_{20} > 2$ cm H₂O/L/s were considered abnormal [31,32].

The TGlitter was performed as previously proposed [17]. Briefly, the test involves carrying a 2.5-kg backpack for women and a 5-kg backpack for men while traversing a circuit comprising the following activities. Starting from a seated position, the individual walks along a 10-meter flat course that includes a staircase positioned halfway along the route with two steps up and two steps down. The 2.5 kg weight simulates the weight of a supplemental oxygen unit, which

can be replaced with the actual unit in future tests without compromising the integrity of the test. After completing the remainder of the course, the individual encounters a shelving unit with three 1-kg objects on the top shelf (shoulder height). The individual must move the objects one by one to the bottom shelf (waist height) and then to the floor. Then, the objects must be returned to the bottom shelf and subsequently to the top shelf. The individual then retraces the route in reverse and immediately begins another lap, traversing the same circuit. To complete the test, the individual must cover five laps in the shortest time possible [21].

Statistical analysis

Statistical analyses were conducted in the R environment (R Core Team, 2025). The distribution of each quantitative variable was assessed separately for each group using the Shapiro–Wilk test. This was complemented by examining skewness and kurtosis, counting values exceeding 1.5 times the interquartile range (IQR), and inspecting histograms and Q-Q plots. Homogeneity of variances was assessed using the Brown–Forsythe test. The pre-specified criterion for test selection was as follows: A Student's *t*-test was used for non-ordinal variables with a Shapiro–Wilk test *p*-value of at least 0.05 and a skewness of less than 1 in both groups. The Mann–Whitney test was used for all other variables and ordinal scales.

The following approaches were adopted for the group comparison: (1) Student's *t*-test (equal variances): The data were described as the mean $\pm$ standard deviation (SD), the estimation was made using the difference in means with a 95% confidence interval (95% CI), and the effect size was calculated using Cohen's *d* with a pooled SD; (2) Mann-Whitney test: The data were described as the median [P25; P75], the estimation was made using the Hodges-Lehmann estimator of the location shift with a 95% CI obtained via normal approximation (due to the presence of ties), and the effect size was calculated using the rank-biserial correlation (r_{rb}); and (3) Categorical variables: Pearson's chi-squared test was used when all expected frequencies were ≥ 5 ; otherwise, Fisher's exact test was used, though this did not occur in any of the comparisons; the effect size was calculated using Cramer's *V*.

All differences are expressed as COPD – no COPD. Tests were two-tailed with a significance level of 5%.

Results

Of the 56 individuals evaluated for inclusion in the study, three were excluded: two due to an asthma diagnosis, and one due to lower-limb dysfunction that prevented them from performing

the TGIITRE. Of the 53 participants, 27 belonged to the COPD group and 26 belonged to the noCOPD group. Six (22.2%) of the COPD group did not have a prior diagnosis of the disease. Among the COPD group, eight (29.6%) had hypertension, four (14.8%) had diabetes, and two (7.4%) had depression. Among the noCOPD group, five (19.2%) had hypertension, three (11.5%) had diabetes, and one (3.8%) had depression. In the COPD group, six (22.2%) individuals had no formal education and four (14.8%) had a high level of education; in the noCOPD group, three (11.5%) individuals had no formal education and five (19.2%) had a high level of education. In the COPD group, nine (33.3%) individuals were unemployed and five (18.5%) were financially independent. In the noCOPD group, three (11.5%) were unemployed and 11 (42.3%) were financially independent.

The main COPD medications in use were as follows: Five (18.5%) used long-acting beta2-agonists (LABA), four (14.8%) used long-acting muscarinic antagonists (LAMA), eight (29.6%) used LABA + LAMA, and four (14.8%) used LABA + LAMA + inhaled corticosteroids. The COPD group was older ($p<0.001$), had a lower body mass index ($p=0.024$), and had a higher smoking burden ($p=0.049$) compared to the noCOPD group. Although the noCOPD group had a slightly higher median FTND and Richmond test scores, no statistically significant differences were observed (6 [4.2–7] vs. 5 [5–6]; $p=0.537$ and 7 (6.5–8) vs. 8 (7–9); $p=0.449$, respectively). Two (7.4%) individuals in the COPD group reported prior use of bupropion, and four (14.8%) reported use of a nicotine patch. No individuals in the noCOPD group reported prior use of any smoking cessation medication. Table 1 shows a comparison of anthropometric data, smoking history, and nicotine dependence between smokers with and without COPD who sought smoking cessation treatment.

Regarding lung function, two (7.4%), 12 (44.4%), 12 (44.4%), and one (3.7%) of the 27 participants in the COPD group were classified as having mild, moderate, severe, and very severe disease, respectively, according to the GOLD criteria [2]. The COPD group showed lower values for all spirometry parameters evaluated ($p\leq0.008$). Regarding IOS, the COPD group exhibited higher resistance and reactance values; however, no statistically significant difference between the groups was detected. Using the R5–R20, Fres, and Ax parameters to diagnose SAD detected this condition in 20 (74%) and 19 (73%) participants in the COPD and noCOPD groups, respectively, with no statistically significant difference ($p=0.934$, Cramer's $V=0.01$). Table 2 presents a comparison of lung function results between smokers with and without COPD who sought CBT.

Regarding FEC, participants in the COPD group took longer to complete the TGlitter ($p=0.011$). Although COPD group participants exhibited greater general fatigue (lower FACIT-F scale scores), no statistically significant difference was observed between groups ($p=0.964$). Regarding QoL as assessed by the SF-36, no statistically significant differences were observed between the groups except for the "physical functioning" domain, which was worse in the COPD group ($p=0.018$). Table 3 and Figure 1 show comparisons of FEC, general fatigue, and QoL between smokers with and without COPD who sought CBT.

Discussion

Smoking cessation interventions may be more effective if treatable traits associated with successful cessation are identified in smokers with and without COPD. The main finding of this study was that individuals seeking CBT showed no significant differences in nicotine dependence based on COPD status. While significant differences in spirometric parameters were observed between individuals with and without COPD, no differences were found on IOS. Approximately three-quarters of the participants exhibited SAD in both the COPD group and the noCOPD group. Individuals with COPD demonstrated poorer FEC, as assessed by the TGlitter. However, no significant differences were observed between the COPD and noCOPD groups regarding general fatigue and QoL, except in the "physical functioning" domain. To our knowledge, this is the first study to comprehensively assess functionality, including TGlitter and IOS measures, in individuals with and without COPD seeking CBT.

The FTND is the most widely used scale worldwide for assessing nicotine dependence. It predicts the severity of withdrawal symptoms, the difficulty of quitting smoking, and the need for pharmacological therapy [4]. In our study, we found that most individuals exhibited moderate to severe nicotine dependence, as measured by the FTND, and moderate to high motivation to quit smoking, as measured by the Richmond test; however, no significant difference was observed between smokers with and without COPD. Consistent with our findings, Papadopoulou et al. [6] showed that smokers with and without COPD who were assessed using the FTND exhibited high tobacco dependence (6.1 ± 2.7 vs. 6.6 ± 2.7 points, respectively; $p=0.15$). These authors also found no correlation between FTND scores and FEV₁/FVC ratios in either the COPD ($r=0.05$, $p=0.66$) or noCOPD ($r=0.06$, $p=0.30$) groups. Consistent with these studies, Kim et al. [33] demonstrated that severe nicotine dependence did not differ between smokers with and without COPD. Several variables are associated with successful smoking cessation in patients with COPD, including previous smoking cessation

experiences, lower dependence levels, lower depression levels, greater motivation to quit, shorter smoking duration, and lower daily cigarette consumption [4]. Further studies are needed to better systematize assessment intervals and report time elapsed since the last cigarette. However, the FTND is a reliable tool for assessing smokers across different populations [23].

Pulmonary abnormalities in smokers are characterized by the narrowing of bronchial and bronchiolar lumens, mucous gland hypertrophy, collagen deposition, and fibrosis of the airway wall—changes that are most evident in small-caliber airways [9]. Our findings showed that although groups with and without COPD differed significantly in spirometric parameters, both groups exhibited SAD in approximately 75% of cases. Consistent with our results, Su et al. [9] demonstrated that 65% of heavy smokers exhibited SAD on IOS. $R5-R20$ are sensitive parameters that reliably reflect small-airway changes in heavy smokers and in the early stages of COPD. Similarly, Pisi et al. [13] investigated the utility of IOS in detecting SAD among asymptomatic smokers with preserved spirometry [13]. They found that the percentage of heavy smokers (≥ 30 pack-years) with elevated $R5-R20$ values was significantly higher than that of light smokers (< 30 pack-years) and nonsmokers ($p < 0.05$). For patients already diagnosed with COPD, persistent SAD can serve as a treatable trait signaling a poorer prognosis, thereby supporting personalized management approaches, such as pulmonary rehabilitation, or strategies to prevent exacerbations [10]. It is worth noting in this context that current diagnosis relies on an FEV_1/FVC ratio threshold of < 0.7 , which often fails to detect early disease progression, particularly within the pulmonary "silent zone." Since small-caliber airways contribute less than 20% of total respiratory resistance in the early stages of the disease, global flow metrics often appear normal, even when structural disintegration is widespread [34].

In addition to the limitations imposed by the lungs and heart, oxidative stress, inflammation, and apoptosis can ultimately impair smokers' performance, especially those with COPD [8]. In the present study, we observed poor TGittre performance in both the COPD and noCOPD groups. The time required to complete the TGittre tasks in our sample was well above the 2.84 ± 0.45 minutes reported by Reis et al. [21] for the Brazilian population. The median times were 4.87 and 4.22 minutes for the COPD and noCOPD groups, respectively; however, the COPD group performed worse than the noCOPD group (Figure 1). This suggests that factors other than altered lung mechanics, such as a more sedentary lifestyle and COPD-related myopathy resulting from the use of oral and inhaled corticosteroids, may be involved [8]. Consistent with

our findings, Ben Moussa et al. [8] observed that the COPD group exhibited a significantly shorter 6MWD than the noCOPD group (573 ± 63 m vs. 476 ± 53 m, $p < 0.001$). A recent systematic review and meta-analysis demonstrated that smoking cessation offers various benefits to patients with COPD by primarily improving key indicators of lung function, increasing exercise tolerance, alleviating symptoms, and reducing mortality [15].

General fatigue may reduce the likelihood of quitting smoking by affecting known risk factors for relapse, such as abstinence self-efficacy, mood, and smoking cravings, or by diminishing the perceived value of future rewards while increasing the perception of barriers or risks associated with quitting [35]. Using the FACIT-F scale, we observed no significant difference between groups with and without COPD. This suggests that general fatigue may be more closely linked to smoking burden, which was similar across groups, than to lung function and FEC. A recent study showed that greater severity of general fatigue is associated with a stronger urge to smoke, more barriers to quitting, and a higher perception of risks associated with quitting [36]. Regarding QoL, we observed no statistically significant differences between groups with and without COPD, except in the "physical functioning" domain of the SF-36. However, it is worth noting that both groups in our sample had low SF-36 scores. This is consistent with studies by Ben Moussa et al. [8] and Agustí et al. [37], which indicate low QoL among smokers with and without COPD.

There are some limitations that should be noted. First, the sample size is small, and we excluded groups that did not seek CBT. Second, the cross-sectional study design prevented us from assessing the long-term impact of CBT or predicting whether smokers with SAD would develop COPD. Long-term follow-up studies are needed to investigate the relationship between SAD, as assessed via IOS, and the development of COPD. Third, we did not measure the diffusing capacity of the lungs for carbon monoxide (DLco). Reduced DLco is a common abnormality among smokers without COPD. In these individuals, it is associated with low FEC and computed tomography findings suggestive of early, smoking-induced vascular damage [20]. Despite these limitations, our study may serve as a starting point for incorporating IOS and the TGlitter into the assessment of smokers undergoing CBT.

Conclusions

Our study shows that individuals seeking CBT exhibit a high degree of nicotine dependence, regardless of whether they have an established diagnosis of COPD. SAD is a common abnormality in this group of individuals, even among those without an established COPD

diagnosis. Furthermore, low FEC is a more frequent finding in people with COPD, although general fatigue and QoL are impaired in smokers regardless of whether they have an established COPD diagnosis. Although these results are promising, randomized controlled trials with larger sample sizes are needed to demonstrate the role of IOS and the TGlitter in smokers seeking CBT, including the impact of these measurements on exercise interventions combined with CBT.

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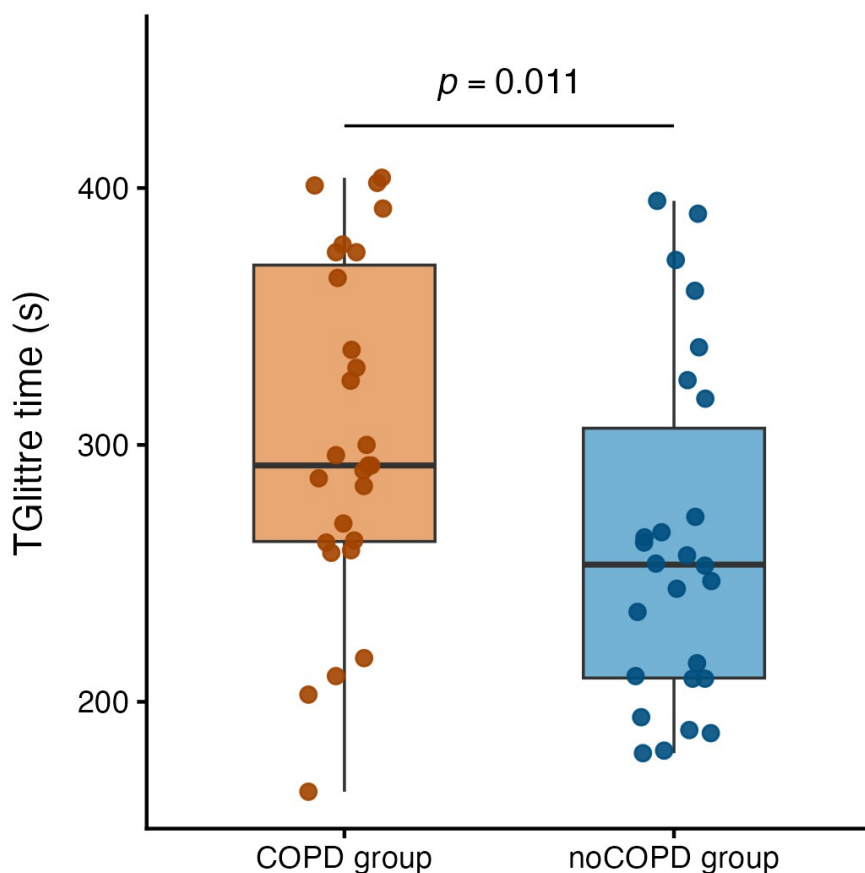


Figure 1. Comparison of the time taken to perform the Glittre-ADL test (TGlitre) tasks between smokers with and without COPD who sought cognitive-behavioral therapy.

Table 1. Comparison of anthropometric data, smoking history, and nicotine dependence between smokers with and without COPD who sought cognitive-behavioral therapy.

Variable	COPD group	noCOPD group	Test	Difference* (95% CI)	<i>p</i> -value	Effect size
Anthropometric data						
Female/male ratio	17/10	17/9	Pcs	NA	0.854	Cramer's <i>V</i> = 0.03
Age (years)	69 (64–71.5)	58.5 (49.5–63)	MW	11 [7–15]	<0.001	<i>r_{rb}</i> = 0.71
BMI (kg/m ²)	23.6 ± 4.7	26.9 ± 5.8	<i>t</i>	−3.36 [−6.25–−0.46]	0.024	<i>d</i> = −0.64
Smoking history						
Smoking load (pack-years)	30 (20–38)	20 (15–34.5)	MW	7 [0–15]	0.049	<i>r_{rb}</i> = 0.31
Nicotine dependence						
FTND (points)	5 (5–6)	6 (4.2–7)	MW	0 [−1–1]	0.537	<i>r_{rb}</i> = −0.10
Motivation to quit smoking						
Richmond test	7 (6.5–8)	8 (7–9)	MW	0 [−1–1]	0.449	<i>r_{rb}</i> = −0.12

BMI, body mass index; FTND, Fagerström test for nicotine dependence; Pcs, Pearson's chi-squared test; MW, *t*, Student's *t*-test; Mann–Whitney test; NA, not applicable; *r_{rb}*, rank-biserial correlation; *d*, Cohen's *d*. Data represent mean ± SD or median (interquartile range). The values in bold refer to significant differences. *COPD – noCOPD difference: difference in means (Student's *t*-test) or Hodges-Lehmann (Mann–Whitney test).

Table 2. Comparison of pulmonary function tests results between smokers with and without COPD who sought cognitive-behavioral therapy.

Variable	COPD group	noCOPD group	Test	Difference (95% CI)	<i>p</i> -value	Effect size
Spirometry						
FVC (% predicted)	75.5 ± 16.4	88.5 ± 18.2	<i>t</i>	−13.7 [−22.6–−3.50]	0.008	<i>d</i> = −0.75
FEV ₁ (% predicted)	54.2 ± 15.9	83.2 ± 18.7	<i>t</i>	−28.9 [−38.5–−19.4]	<0.001	<i>d</i> = −1.67
FEV ₁ /FVC ratio (%)	58.9 (52–67.1)	77.1 (72.8–80.2)	MW	−17.6 [−22.3–−13]	<0.001	<i>r_{rb}</i> = −1
MMEF (% predicted)	22.9 (17.3–28.9)	67.8 (50.3–80.4)	MW	−42.9 [−52.6–−30.9]	<0.001	<i>r_{rb}</i> = −0.91
PEF (% predicted)	49.2 (38–65.8)	77.2 (65.8–90.1)	MW	−29.1 [−40.6–−18.2]	<0.001	<i>r_{rb}</i> = −0.69
IOS						
R5 (cm H ₂ O/L/s)	6.8 (4.9–8.7)	6.4 (5.2–8.2)	MW	0.02 [−1.59–1.76]	0.979	<i>r_{rb}</i> = 0.01
R20 (cm H ₂ O/L/s)	5.9 (4.3–6.4)	5.4 (4.3–6.2)	MW	0.09 [−1.01–0.92]	0.776	<i>r_{rb}</i> = 0.05
R5–R20 (cm H ₂ O/L/s)	1.7 (0.3–3.7)	0.8 (0.4–2.1)	MW	0.43 [0.07–1.63]	0.259	<i>r_{rb}</i> = 0.18
Fres (Hz)	5.6 (4.6–6.4)	5.1 (4.1–6.3)	MW	0.20 [−0.66–1.13]	0.581	<i>r_{rb}</i> = 0.09
X5 (cm H ₂ O/L/s)	−2.7 (−6–−1.3)	−2.3 (−3–−1.6)	MW	−0.07 [−1.42–0.82]	0.852	<i>r_{rb}</i> = −0.03
Ax (cm H ₂ O/L/s)	21.6 (5.5–40.8)	14.4 (7–27.9)	MW	1.90 [−5.39–15.9]	0.625	<i>r_{rb}</i> = 0.08

FVC, forced vital capacity; FEV₁, forced expiratory volume in one second; MMEF, maximum mid-expiratory flow; PEF, peak expiratory flow; R5, respiratory system resistance at 5 Hz; R20, respiratory system resistance at 20 Hz; R5–R20, heterogeneity of resistance between 5 and 20 Hz; Fres, resonance frequency; X5, respiratory system reactance at 5 Hz; R20, respiratory system reactance at 20 Hz; Ax, area under the reactance curve; *t*, Student's *t*-test; MW, Mann–Whitney test; *d*, Cohen's *d*; *r_{rb}*, rank-biserial correlation. Data represent mean ± SD or median (interquartile range). The values in bold refer to significant differences. *COPD – noCOPD difference: difference in means (Student's *t*-test) or Hodges-Lehmann estimator (Mann–Whitney test).

Table 3. Comparison of functional exercise capacity, general fatigue, and quality of life between smokers with and without COPD who sought cognitive-behavioral therapy.

Variable	COPD group	noCOPD group	Test	Difference (95% CI)	<i>p</i> -value	Effect size
Functional capacity						
TGlittre time (s)	292 (262.4–370)	253.4 (209–307)	MW	45 [9–82]	0.011	$r_{rb} = 0.41$
General fatigue						
FACIT-F scale (points)	35 (27–40.5)	38 (21.2–43)	MW	0 [–7–8]	0.964	$r_{rb} = -0.01$
Short Form-36						
Physical functioning (points)	40 (27.5–65)	65 (45–98.8)	MW	–25 [–40–0]	0.018	$r_{rb} = -0.38$
Physical role limitations (points)	50 (0–87.5)	62.5 (6.2–100)	MW	0 [–25–0]	0.386	$r_{rb} = -0.14$
Body pain (points)	50.9 ± 24	54.4 ± 26.7	<i>t</i>	–3.46 [–17.5–10.5]	0.622	$d = -0.14$
General health perceptions (points)	57.9 ± 23.4	57.1 ± 23	<i>t</i>	0.81 [–11.9–13.6]	0.899	$d = -0.03$
Vitality (points)	51.5 ± 27.3	53.1 ± 28.3	<i>t</i>	–1.6 [–16.9–13.7]	0.835	$d = -0.06$
Social functioning (points)	60.6 ± 23.7	68.8 ± 20.4	<i>t</i>	–8.1 [–20.3–4.1]	0.189	$d = -0.37$
Emotional role limitations (points)	33.3 (0–100)	33.3 (0–100)	MW	0 [0–0]	0.939	$r_{rb} = -0.01$
Mental health (points)	48 (42–86)	60 (44–75)	MW	–3.25 [–16–12]	0.768	$r_{rb} = -0.05$

TGlittre, Glittre-ADL test; FACIT-F, Functional Assessment of Chronic Illness Therapy-Fatigue; MW, Mann–Whitney test; *t*, Student's *t*-test; r_{rb} , rank-biserial correlation; *d*, Cohen's. Data represent mean ± SD or median (interquartile range). The values in bold refer to significant differences. *COPD – noCOPD difference: difference in means (Student's *t*-test) or Hodges-Lehmann estimator (Mann–Whitney test).