



CORRELATION OF THE BODY WEIGHT-WALKING DISTANCE WITH HEALTH-RELATED QUALITY OF LIFE IN PATIENTS WITH COPD: A COMPARATIVE STUDY WITH THE 6-MINUTE WALK DISTANCE

KOAH HASTALARINDA VÜCUT AĞIRLIĞI-YÜRÜME MESAFESİNİN SAĞLIKLA İLİŞKİLİ YAŞAM KALİTESİ İLE İLİŞKİSİ: 6 DAKİKALIK YÜRÜME MESAFESİ İLE KARŞILAŞTIRMALI BİR ÇALIŞMA

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ABSTRACT

Objective: This study aimed to examine the relationship between the 6-minute walk test distance – body weight product (i.e. 6-minute walk work-6MWORK) as an improved outcome measure with health-related quality of life and to compare this relationship with the 6-minute walk test distance.

Method: A total of 81 patients (mean age: 61.0±4.6 years) with moderate-to-severe COPD were included in this retrospective cross-sectional study. This study conducted between January 2025 and March 2025. The patients' clinic characteristics, lung function tests, 6-minute walk test distance, and health-related quality of life measured by Saint George Respiratory Questionnaire (SGRQ) outcomes were recorded. The 6MWORK was calculated as product of 6-minute walk test distance and body weight by multiplying each other and recorded as kg.meters (kg.m). Correlation coefficients and simple linear regressions were evaluated between SGRQ with 6-minute walk test distance and 6MWORK.

Results: The mean 6-minute walk test distance and 6MWORK of patients were 441.5±83.3 m and 33176.2±9865.8 kg.m, respectively. The 6MWORK showed stronger correlations with SGRQ sub-domains ($r=-.582$ to $-.641$, $p<.001$) compared to the 6-minute walk test distance ($r=-.381$ to $-.455$, $p<.001$). Moreover, according to simple linear regression analysis, the coefficient of determination (R²) between SGRQ total score and the 6-minute walk test distance was .207, whereas it was .411 with 6MWORK.

Conclusion: Our findings suggest that the use of 6MWORK instead of simple distance covered in a 6-minute walk test is more advantageous in patients with moderate-to-severe COPD due to its relationship with quality of life. Thus, the 6MWORK may be a more effective outcome for estimating functional capacity in patients with moderate-to-severe COPD. Future studies with larger, more diverse populations and longitudinal designs are needed.

Key Words: COPD, Quality Of Life, Six-Minute Walk Test, Body Weight

ÖZ

Amaç: Bu çalışmanın amacı, geliştirilmiş bir sonuç ölçütü olarak 6 dakika yürüme testi mesafesi-vücut ağırlığı çarpımı (yani 6 dakikalık yürüme işi-6DK-İŞİ) ile sağlıkla ilişkili yaşam kalitesi arasındaki ilişkiyi incelemek ve bu ilişkiyi 6 dakika yürüme testi mesafesi ile karşılaştırmaktır.

Yöntem: Bu retrospektif kesitsel çalışmaya orta-ağır KOAH'lı toplam 81 hasta (ortalama yaş: 61.0±4.6 yıl) dahil edildi. Çalışma Ocak 2025 ile Mart 2025 tarihleri arasında gerçekleştirildi. Hastaların klinik özellikleri, akciğer fonksiyon testleri, 6 dakika yürüme testi mesafeleri ve Saint George Solunum Anketi (SGRQ) ile ölçülen sağlıkla ilişkili yaşam kalitesi sonuçları kaydedildi. 6DK-İŞİ, 6 dakika yürüme testi mesafesi ve vücut ağırlığının birbiriyle çarpımı olarak hesaplandı ve kg.metre (kg.m) olarak kaydedildi. SGRQ ile 6 dakika yürüme testi mesafesi ve 6DK-İŞİ arasındaki korelasyon katsayıları ve basit doğrusal regresyonlar değerlendirildi.

Bulgular: Hastaların ortalama 6 dakika yürüme testi mesafesi ve 6DK-İŞİ sırasıyla 441.5±83.3 m ve 33176.2±9865.8 kg.m idi. 6DK-İŞİ SGRQ alt alanlarıyla ($r=-.582$ ile $-.641$ arasında, $p<.001$) 6 dakika yürüme testi mesafesine ($r=-.381$ ile $-.455$ arasında, $p<.001$) kıyasla daha güçlü korelasyonlar gösterdi. Ayrıca basit doğrusal regresyon analizine göre, SGRQ toplam puanı ile 6 dakika yürüme testi mesafesi arasındaki belirleme katsayısı (R²) .207 iken 6DK-İŞİ ise .411 idi.

Sonuç: Bulgularımız 6 dakika yürüme testinde kat edilen basit mesafe yerine 6DK-İŞİ'nin kullanılmasının, yaşam kalitesi ile ilişkisi nedeniyle orta-ağır KOAH'lı hastalarda daha avantajlı olduğunu göstermektedir. Bu nedenle 6DK-İŞİ orta-ağır KOAH'lı hastalarda fonksiyonel kapasiteyi tahmin etmek için daha etkili bir sonuç parametresi olabilir. Daha geniş, daha çeşitli popülasyonlarla ve uzunlamasına tasarımlarla gelecek çalışmalara ihtiyaç vardır.

Anahtar Kelimeler: KOAH, Yaşam Kalitesi, Altı Dakika Yürüme Testi, Vücut Ağırlığı

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INTRODUCTION

The assessment of functional capacity has played an increasingly important role in understanding the impact of the disease and in the development of disease management methods for patients with chronic obstructive pulmonary disease (COPD). The measurement of functional capacity in COPD patients and its relationship to quality of life has led to an increasing emphasis on these parameters in patient management [1]. However, laboratory tests to determine functional capacity are often expensive and require a lot of time [2]. Moreover, these tests are not always well tolerated by patients, especially when a significant number of tests are required during the study. Thus, alternative walking tests have been developed and used to measure functional capacity over the last four decades.

First, McGavin et al. developed the 12-minute walk test to assess disability in patients with chronic bronchitis [3]. Approximately ten years later, this test was modified to the 6-minute walk test by Guyatt et al. [4] and applied to patients with chronic heart failure. The most widely reported endpoint is the distance walked in six minutes, referred to as the 6-minute walk distance (6MWD), which has proved good reliability and validity [5-7]. Its clinical usefulness was further improved by the availability of established reference values derived from healthy populations [8,9]. However, when compared with other validated measures of functional capacity, 6MWD has been observed to be inconsistent [10,11].

These inconsistencies can be explained by various factors. The height of the subject has been demonstrated to affect stride length. This, in turn, has the capacity to influence the distance covered and the efficiency of the gait [12]. In addition, the body weight of the patient has a direct impact on the work/energy expenditure used to perform the test [12,13]. The 6MWD is designed to reflect work considering the distance covered in six minutes. However, in order to accurately measure functional capacity, it is important to take into account the physiological changes caused by the disease, as well as the work/energy expenditure affected by exacerbations and/or benefiting from treatment interventions, including exercise training. Therefore, it is logical to consider factors such as body weight and walking distance in combination when assessing functional capacity. It would be contradictory to assume that different individuals covering the same distance but carrying different body weights are performing the same amount of work. This calculation is known as the 6-minute walking work (6MWORK) and provides an estimate of not only work but also energy expenditure, represented as the product of force (i.e. body weight) and distance, while accounting for variations in body weight. Chuang et al. explored 6MWORK (i.e. body weight X 6MWD) as a developed approach to measure functional capacity in patients with COPD [14]. Carter et al. investigated the association between the 6MWORK parameter and lung function in patients with COPD. Both studies concluded that 6MWORK is a more decisive and robust measure of functional capacity compared to the 6MWD [2]. However, to the best of our knowledge, no previous study has examined the relationship between 6MWORK and health outcomes, such as health-related quality of life. The aim of this study was to evaluate 6MWORK, calculated by taking body weight into account, as an improved outcome measure to assess functional capacity in relation to quality of life.

METHOD

Study Design and Participants

In this cross-sectional retrospective study, 81 patients with COPD were included. The study conducted between January 2025 and March 2025 at the Department of Chest Diseases of Dokuz Eylül University Hospital, included patients who were diagnosed with moderate-to-severe COPD according to Global Initiative for Chronic Obstructive Lung Disease (GOLD) [1], and follow-up at the same hospital. The exclusion criteria as follows; history of any cardiac disease (i.e. coronary artery bypass graft surgery, atrial fibrillation, aortic stenosis,

heart failure, etc.), patients with orthopedic or neurological conditions that affect walking performance, diagnosed with asthma, having any thoracic surgery. Further, patients who met the inclusion criteria but were missing questionnaires and other assessment data were also excluded. We followed the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guideline for reporting this study [15].

Outcome Measures

The age, height, weight, body mass index (BMI), disease duration, cigarette consumption (pack.years), dyspnea perception, lung function test parameters, 6MWD, and St. George's Respiratory Questionnaire (SGRQ) health-related quality of life questionnaire data of patients were recorded. For 6MWORK, 6MWD and weight were calculated by multiplying each other and recorded as kg.meters (kg.m). Lung function tests were performed with a computer-compatible spirometer (Sensor Medics Vmax 22 machine, SensorMedics Inc., Anaheim, CA) in accordance with the ATS/ERS criteria [16]. In lung function tests, the forced expiratory volume in 1 second (FEV₁) and forced vital capacity (FVC) were measured with three satisfactory maneuvers by measuring the total volume of air exhaled from a total lung capacity to maximal expiration, and the highest values were recorded. All tests were performed by the same technician in a seated position, wearing nose clips and using a standard mouthpiece suitable during the maneuvers. All parameters are presented as percentages (%) of predicted values [17,18]. The modified Medical Research Scale (mMRC) dyspnea scale was used to determine the severity of dyspnea [19]. It consists of a 5-item (0-4) indicating worse dyspnea with a high score. The six-minute walk test was performed by the same trained medical staff in a straight 30 m indoor corridor marked with 2 cones at the chest disease department following the ATS guidelines [20]. The test was performed in a setting where the unit's medical staff could be called upon if necessary. Heart rate (HR), blood pressure, peripheral oxygen saturation (SpO₂), and the modified Borg Scale [21] for perceived exertion were measured at baseline and immediately after test. The performance was recorded in meters as a 6-min walking test distance (6MWD). SGRQ is a disease-specific questionnaire developed to assess general health, daily living and perceived well-being in patients with respiratory disease. It consists of 50 items with three sub-domains (symptom, activity and impact) and a total score. The scores obtained from the questionnaire are in the range of 0-100 and a high score indicates poor quality of life [22].

Ethical Approval

This study was conducted in accordance with the Declaration of Helsinki and its later amendments ethical standards and approved by the Dokuz Eylül University Non-Interventional Research Ethics Committee (date:25.12.2024, approval number:2024/43-14).

Statistical Analysis

Data was analyzed using SPSS for Windows version 21.0 software (SPSS Inc., Chicago, IL, USA). Data were checked for distribution and presented as mean±SD. Categorical variables were presented in percentages (%). The relationship between 6MWD and 6MWORK with SGRQ subdomains parameters was analyzed with Pearson correlation coefficient (r), and simple linear regressions between SGRQ_{total} and functional capacity parameters (i.e. 6MWD and 6MWORK) were carried out. The significance was considered as p<.05 for all analyses.

We calculated the minimum required sample size using the G*Power program [23], estimating that at least 75 participants were needed to detect a moderate correlation (r=.3) between 6MWORK and the total score of the SGRQ, with a 5% margin of error (α=.05) and 85% power (1-β=.85). This calculation was based on a previous study that reported a correlation between 6MWD and SGRQ [24]. To account for an anticipated 20% exclusion rate due to ineligibility, a total of 95 patients were initially screened.

RESULTS

Ninety-five patients with COPD were screened to participate in the study. Fourteen of them were excluded, therefore, the study was completed with a total of 81 (male=70, female=11) patients with moderate-to-severe COPD. The mean age and BMI of the study population was 61.0±4.6 y and 26.1±4.6 kg/m², respectively. In the population, 64.2% of them were diagnosed with moderate COPD and 35.8% of them were diagnosed with severe COPD. The demographic and clinical characteristics of patients are presented in Table 1.

Table 1. Demographic and clinical characteristics of the patients

Variables	Combined	Male	Female
	(n=81)	(n=70)	(n=11)
Age, years	61.0±4.6	60.9±4.4	61.6±5.8
BMI, kg/m ²	26.1±4.6	36.0±4.9	25.9±2.9
Disease duration, years	10.4±1.6	10.4±1.4	10.0±2.6
Smoking, pack.years	36.6±18.8	37.8±19.7	29.1±10.2
mMRC dyspnea score	1.9±1.3	1.8±1.4	2.6±0.5
FEV ₁ , % predicted	55.0±12.6	53.4±12.8	64.8±4.1
FVC, % predicted	72.4±14.8	70.4±14.7	84.6±7.5
FEV1/FVC, %	58.4±7.8	58.4±8.1	58.6±6.3
GOLD class, n (%)			
GOLD class I	-	-	-
GOLD class II	52 (64.2)	41(58.6)	11 (100.0)
GOLD class III	29 (35.8)	29 (41.4)	-
GOLD class IV	-	-	-
6MWD, m	441.5±83.3	445.4±87.5	416.8±42.4
6MWORK, kg.m	33176.2±9865.8	33830.1±10286.4	29015±5150.2
SGRQ			
Symptom score	34.7±25.9	32.9±26.3	46.1±18.1
Impact score	44.7±24.7	42.5±25.0	58.8±17.2
Activity score	54.7±32.9	53.3±33.4	62.4±29.2
Total score	48.6±25.9	47.5±26.7	55.7±19.7

Data are expressed as Mean±Standard Deviation or n (%).BMI:Body mass index, 6MWD:6-min walk distance, 6MWORK:6-min distance x body weight product, SGRQ:Saint George's Respiratory Questionnaire

The mean 6MWD and 6MWORK were 441.5±83.3 m and 33176.2±9865.8 kg.m, respectively. The 6MWORK showed higher correlation coefficients (SGRQ_{symptom} r=-.605, p<.001; SGRQ_{impact} r=-.582, p<.001; SGRQ_{activity} r=-.617, p<.001; SGRQ_{total} r=-.641, p<.001) than 6MWD (SGRQ_{symptom} r=-.381, p<.001; SGRQ_{impact} r=-.399, p<.001; SGRQ_{activity} r=-.446, p<.001; SGRQ_{total} r=-.455, p<.001) with SGRQ sub-domains (Table 2). Moreover, according to

simple linear regression between SGRQ_{total} and 6MWORK had higher linear association than 6MWD (for 6MWD R²=.207, for 6MWORK R²=.411) (Figure 1).

Table 2. Correlation coefficients for 6MWD and 6MWORK with health-related quality of life domains determined by SGRQ

Variables	6MWD		6MWORK	
	r	P	r	p
SGRQ symptom score	-.381	<.001	-.605	<.001
SGRQ impact score	-.399	<.001	-.582	<.001
SGRQ activity score	-.446	<.001	-.617	<.001
SGRQ total score	-.455	<.001	-.641	<.001

6MWD:6-min walk distance, 6MWORK:6-min distance x body weight product, SGRQ:Saint George's Respiratory Questionnaire

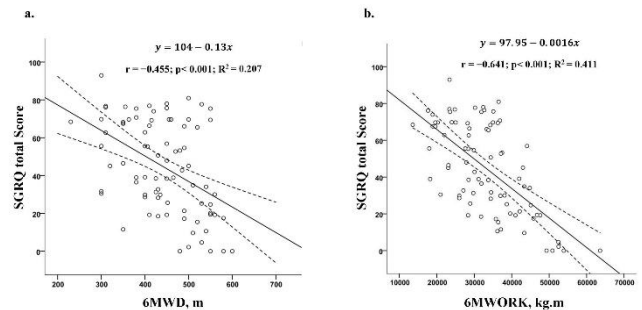


Figure 1. Correlations and simple linear regressions between health-related quality of life and functional exercise capacity parameters. **a.**6MWD and SGRQ total score. **b.**6MWORK and SGRQ total score. 6MWD:6-min walk distance, 6MWORK:6-min distance x body weight product, SGRQ:Saint George's Respiratory Questionnaire

DISCUSSION

To the best of our knowledge, this is the first study to investigate the associations of 6MWD and 6MWORK with quality of life in patients with COPD. The main finding of the present study is that the work performed during a 6-min walk test (i.e. 6MWORK) has a greater correlation with health-related quality of life than the distance alone.

Our findings suggest that the use of work calculation instead of simple distance covered in a 6-minute straight walk is more advantageous in patients with COPD due to its relationship with quality of life. The calculation of work includes the weight of the moving body, and the energy required to move this weight in space. As the body weight of each person varies, the expected effort associated with walking will also vary. By incorporating body weight into the calculation of 6-minute walk work, an important source of variation is accounted for, allowing for a more accurate assessment of functional capacity [2].

Kawaguchi et al. found a significant relationship between the 6MWD and various HRQOL components measured by scales such as the SF-36 and SGRQ [25]. This interplay between walking and quality of life is reinforced by the findings of various studies highlighting a correlation between walking activities and higher scores on HRQOL indices [26]. Egoshi et al. support this by revealing that a greater 6MWD is associated with improved HRQOL [26]. Esteban et al. identified physical activity as the most substantial predictor of HRQOL, linking walking distance and overall functional status directly to patient outcomes [27]. Moreover, the superiority of 6MWORK over 6MWD has been supported by various studies [28,14,2]. Previous studies demonstrated that the 6MWORK showed

better correlation with peak aerobic capacity from cardiopulmonary exercise testing (CPET) in patients with moderate-to-severe COPD compared with the 6MWD [29,14,2]. In a study, Poersch et al. evaluated the correlation between the 6MWD and body weight-walking distance product (i.e. 6MWORK), with peak oxygen uptake from a treadmill CPET. They showed a better association between the 6MWORK and peak oxygen uptake during CPET than the 6MWD alone [28]. These findings are consistent with the data obtained from a previous study involving thirty-three male patients with COPD [14]. Furthermore, 6MWORK was identified as a predictor of hospitalization [2], and was more correlated to diffusing capacity of the lungs for carbon monoxide (DLCO) than 6MWD in patients with COPD. Therefore, the use of the 6MWORK may assist healthcare providers in better interpreting an individual's 6-min walk test results and facilitate the integration of this outcome measure into clinical practice.

Although there are no previous studies examining the relationship between 6MWORK and HRQOL, there are some limited studies examining the relationship with other health outcomes such as lung functions and comparing it with 6MWD. Chuang et al. found a correlation between vital capacity and 6MWORK in COPD patients, but no significant correlation with the other respiratory function parameters obtained [14]. Conversely, Carter et al. investigated the association between the 6MWORK parameter and lung function in patients with COPD, concluding that 6MWORK is a more determinant measure than the 6MWD [2]. Chuang et al. recommended evaluating 6MWD due to its correlation with CPET results, a finding later confirmed by Carter et al. [2,14]. These authors showed that there were strong correlations between 6MWORK and lung function parameters and found that 6MWORK had greater sensitivity and specificity for indicating functional capacity in patients with COPD. In our study we found greater significant correlations between 6MWORK and all subdomains of HRQOL than 6MWD. Therefore, the interplay between body weight, walking distance, and HRQOL in COPD patients underscores the importance of accounting for body weight when assessing functional capacity.

Limitations

There are some limitations to be considered in this study. This is a single-centered retrospective study. Although the study is retrospective in nature, the limitation is partially mitigated by the fact that all evaluation parameters were assessed by the same examiner. Besides, according to GOLD criteria, only moderate and severe COPD patients were included in the study. Another limitation is that most of the patients included in the study were male and all the women included in the study had severe COPD. Due to these limitations, the results cannot be extrapolated to all COPD patients. Therefore, studies with more diverse participation and generalizable to all patients are needed.

CONCLUSION

In conclusion, the 6MWORK appears to be more closely associated with health-related quality of life than the 6MWD. Therefore, 6MWORK may serve as a more effective outcome measure for estimating functional capacity in patients with moderate-to-severe COPD. Further studies are needed to confirm these findings and explore their clinical implications.

Ethical Approval: 2024/43-14 Dokuz Eylül University Non-Interventional Research Ethics Committee

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