RESEARCH PAPER

Comparative Effect of Nordic Walking versus Normal Walking on Functional Exercise Capacity in Patients with Chronic Obstructive Pulmonary Disease: A Randomized Controlled Trial

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ABSTRACT

Background

Chronic Obstructive Pulmonary Disease (COPD) is a major global health burden characterized by progressive airflow limitation and exercise intolerance. Nordic Walking (NW), which employs specially designed poles to engage upper-body musculature, has emerged as a potentially superior exercise modality compared to conventional walking (CW) in pulmonary rehabilitation. However, robust evidence comparing their effects on functional exercise capacity in COPD patients remains limited.

Objectives

To compare the effects of an 8-week structured Nordic Walking program versus conventional walking on functional exercise capacity, dyspnea, health-related quality of life (HRQoL), and peripheral muscle strength in patients with moderate-to-severe COPD.

Methods

A prospective, parallel-group randomized controlled trial was conducted. Sixty patients with COPD (GOLD Stage II–III) were randomly allocated (1:1) to NW (n=30) or CW (n=30) groups. Both groups performed three supervised 45-minute sessions per week for 8 weeks. The primary outcome was the six-minute walk distance (6MWD). Secondary outcomes included peak oxygen consumption (VO_2 peak), modified Medical Research Council (mMRC) dyspnea scale, St. George's Respiratory Questionnaire (SGRQ), COPD Assessment Test (CAT), Timed Up-and-Go (TUG) test, 30-second Chair Stand Test (30-s CST), and handgrip strength.

Results

Both groups demonstrated significant within-group improvements across all outcome measures ($p < 0.05$). The NW group exhibited significantly greater improvement in 6MWD ($\Delta+66.2 \pm 18.4$ m vs. $\Delta+23.1 \pm 15.7$ m; $p < 0.001$), VO_2 peak, handgrip strength, and SGRQ total score compared to the CW group. No serious adverse events were recorded in either group.

Conclusion

An 8-week Nordic Walking program produced superior improvements in functional exercise capacity, peripheral muscle strength, and HRQoL compared to conventional walking in COPD patients. Nordic Walking represents a safe and effective modality for inclusion in pulmonary rehabilitation programs.

Keywords: Chronic Obstructive Pulmonary Disease, Nordic Walking, Pulmonary Rehabilitation, Functional Exercise Capacity, Six-Minute Walk Test, Health-Related Quality of Life.

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1. INTRODUCTION

Chronic Obstructive Pulmonary Disease (COPD) is a preventable and treatable chronic respiratory disease characterized by persistent airflow limitation, chronic inflammation of the airways and lung parenchyma, and extra-pulmonary manifestations. [1] The Global Initiative for Chronic Obstructive Lung Disease (GOLD) estimates that COPD currently affects approximately 300 million individuals worldwide and is projected to become the third leading cause of mortality by 2030, imposing a substantial burden on health systems globally. [2]

A hallmark of COPD is exercise intolerance, resulting from a complex interplay of ventilatory limitation, peripheral muscle dysfunction, dynamic hyperinflation, and impaired gas exchange. [3] Reduced physical activity perpetuates a cycle of deconditioning, increased dyspnea, and further activity limitation, culminating in diminished functional capacity, reduced health-related quality of life (HRQoL), and increased hospitalizations. [4] Exercise training remains one of the most clinically effective components of pulmonary rehabilitation (PR), producing consistent improvements in exercise capacity, dyspnea, and HRQoL independent of pharmacological therapy. [5]

Conventional walking (CW) is the most widely recommended and accessible form of aerobic exercise in COPD rehabilitation protocols. [6] However, CW predominantly engages lower-extremity musculature and may not adequately address the upper-body deconditioning frequently observed in COPD patients due to accessory respiratory muscle involvement and sedentary behavior. [7] Nordic Walking (NW), a whole-body physical activity that incorporates specially designed poles, compels rhythmic engagement of the upper limbs, shoulder girdle, core musculature, and trunk stabilizers in addition to the lower extremities, thereby increasing total muscular recruitment and metabolic demand compared to normal walking at equivalent perceived exertion levels. [8, 9]

The unique biomechanical advantages of NW including proprioceptive feedback through the poles, reduced knee joint loading, facilitated trunk extension, and improvements in respiratory mechanics through enhanced thoracic expansion have generated considerable interest in its application among populations with chronic pulmonary diseases. [10, 11] Preliminary evidence from studies in general elderly populations, cardiovascular disease, and osteoporosis suggests NW may confer superior cardiovascular, musculoskeletal, and functional benefits compared to conventional walking. [12, 13]

Despite these theoretical advantages, the evidence base specifically comparing NW to CW in COPD is nascent and characterized by heterogeneous protocols, small sample sizes, and inconsistent outcome selection. [14] A rigorous randomized controlled trial (RCT) directly comparing the two modalities across multiple clinically meaningful domains is warranted to inform evidence-based pulmonary rehabilitation guidelines. [15]

Therefore, the primary aim of this study was to compare the effects of an 8-week structured NW intervention versus CW on functional exercise capacity, as measured by the Six-Minute Walk Distance (6MWD), in patients with moderate-to-severe COPD. Secondary aims included comparison of peak aerobic capacity, peripheral muscle strength, dyspnea and HRQoL outcomes.

2. MATERIALS AND METHODS

2.1 Study Design

This study was a prospective, parallel-group, single-blind, randomized controlled trial conducted at the Department of Physiotherapy between Feb 2025 and March 2026. The trial was conducted in accordance with the Declaration of Helsinki (2013 revision). Written informed consent was obtained from all participants prior to enrollment.

2.2 Participants

Patients were recruited from the outpatient pulmonology clinic. Eligibility criteria were as follows:

Inclusion criteria: (1) confirmed COPD diagnosis per GOLD guidelines with post-bronchodilator $FEV_1/FVC < 0.70$ (2) GOLD Stage II or III (FEV_1 30–79% predicted) (3) age ≥ 45 years (4) clinically stable (no exacerbation within the preceding 8 weeks) (5) able to ambulate independently (6) no prior exposure to Nordic Walking.

Exclusion criteria: (1) significant orthopedic, neurological, or cardiovascular comorbidities contraindicated for exercise (2) current participation in formal pulmonary rehabilitation (3) supplemental oxygen dependency (4) severe cognitive impairment (5) body mass index (BMI) > 35 kg/m².

2.3 Randomization and Blinding

Eligible participants were randomly allocated in a 1:1 ratio to the Nordic Walking (NW) group or the Conventional Walking (CW) group using computer-generated randomization with concealed allocation via sequentially numbered, opaque, sealed envelopes (SNOSE method). Allocation was performed by an independent statistician not involved in participant assessment or intervention delivery. Due to the nature of the exercise intervention, complete blinding of participants and treating physiotherapists was not feasible; however, all outcome assessors were blinded to group allocation throughout the study period.

2.4 Interventions

Both groups underwent supervised exercise training three times per week for 8 consecutive weeks (24 sessions total), with each session lasting 45 minutes including warm-up and cool-down phases. All sessions were conducted in supervised group format (maximum 6 participants per group) by a trained physiotherapist.

Nordic Walking Group: Participants received a 2-session introductory training on correct NW technique (arm swing, pole placement, forward propulsion) prior to commencing the intervention. Adjustable aluminum poles fitted with ergonomic wrist straps were provided. Exercise intensity was individually titrated to 60–75% of heart rate reserve (HRR) using the Karvonen formula, with progression by 5% every 2 weeks. Borg Rating of Perceived Exertion (RPE) scale (target 4–5 on a 10-point scale) was used as an adjunct intensity guide.

Conventional Walking Group: Participants performed flat-surface treadmill and outdoor walking sessions matched for total duration and relative intensity (60–75% HRR) with identical progression protocol and RPE targets. No poles or upper-limb activity was incorporated. Both groups were instructed to refrain from initiating new exercise programs outside the study protocol.

2.5 Outcome Measures

All outcomes were assessed at baseline (Week 0) and post-intervention (Week 9, 7 days after the last session) by assessors blinded to group allocation.

Primary Outcome: The Six-Minute Walk Test (6MWT) was conducted per American Thoracic Society (ATS) guidelines on a 30-meter flat corridor. [17] 6MWD was recorded as the total distance (meters) covered in 6 minutes. SpO_2 and heart rate were monitored continuously Borg dyspnea and fatigue scores were recorded pre and post-test.

Secondary Outcomes: (1) Cardiopulmonary Exercise Testing (CPET) for VO_2 peak (mL/kg/min) on a cycle ergometer (2) mMRC Dyspnea Scale (0–4), (3) St. George's Respiratory Questionnaire (SGRQ), (4) COPD Assessment Test (CAT), (5) Timed Up-and-Go (TUG) test, (6) 30-second Chair Stand Test (30-s CST), (7) Handgrip Strength (dominant hand, Jamar dynamometer, kg).

2.6 Sample Size

Sample size was calculated using G*Power 3.1 software based on expected between-group difference in 6MWD of 35 meters (SD = 45 m), derived from prior comparable trials, [18] with $\alpha = 0.05$ (two-tailed) and power $(1-\beta) = 0.80$. This yielded a minimum of 27 participants per group. Accounting for an estimated 10% dropout rate, 30 participants per group (n=60 total) were enrolled.

2.7 Statistical Analysis

All analyses were performed using IBM SPSS Statistics version 27.0 (IBM Corp., Armonk, NY, USA). Data were assessed for normality using the Shapiro-Wilk test. Descriptive statistics are presented as mean ± standard deviation (SD) for continuous variables and as frequency (percentage) for categorical variables. Baseline comparability between groups was assessed using independent samples t-test (continuous) and chi-square test (categorical).

Primary analysis was conducted on an intention-to-treat (ITT) basis, with missing values managed by last-observation-carried-forward (LOCF) imputation. Within-group changes were analyzed using paired samples t-test. Between-group differences in post-intervention outcomes were analyzed using independent samples t-test with baseline scores as covariates (ANCOVA). Effect sizes were calculated as Cohen's d. Statistical significance was set at $p < 0.05$ (two-tailed).

3. RESULTS

3.1 Participant Flow and Baseline Characteristics

A total of 82 patients were screened, of whom 60 met eligibility criteria and were enrolled and randomized (NW: n=30, CW: n=30). Two participants in the NW group and three in the CW group discontinued the intervention (NW: logistical constraints n=2, CW: intercurrent illness n=2, personal reasons n=1) and were included in the ITT analysis via LOCF. Adherence to scheduled sessions was 91.4% in the

NW group and 89.8% in the CW group. Figure 1 presents the CONSORT flow diagram.

Baseline demographic, anthropometric, and clinical characteristics were comparable between groups with no statistically significant differences (all $p > 0.05$). Detailed baseline data are presented in Table 1.

Table 1. Baseline Characteristics of Study Participants

Variable	NW Group (n=30)	CW Group (n=30)	p-value
Age (years)	62.4 ± 7.2	63.1 ± 6.8	0.71
Sex (Male/Female)	18/12	19/11	0.79
BMI (kg/m²)	25.3 ± 3.8	25.9 ± 4.1	0.55
FEV_1 (% predicted)	52.6 ± 9.4	53.1 ± 10.2	0.84
FEV_1/FVC ratio	0.58 ± 0.07	0.57 ± 0.08	0.61
GOLD Stage II/III	18/12	17/13	0.80
Smoking Pack-years	38.4 ± 12.6	39.2 ± 13.1	0.80
mMRC Dyspnea Score	2.3 ± 0.6	2.4 ± 0.7	0.55
6MWD Baseline (m)	312.4 ± 48.6	315.1 ± 51.3	0.82
SpO_2 at rest (%)	94.2 ± 1.8	94.5 ± 1.6	0.49
Disease Duration (years)	8.6 ± 3.4	8.9 ± 3.7	0.73

Values are mean ± SD unless otherwise stated. NW = Nordic Walking; CW = Conventional Walking; BMI = Body Mass Index; FEV_1 = Forced Expiratory Volume in 1 second; FVC = Forced Vital Capacity; GOLD = Global Initiative for Chronic Obstructive Lung Disease; mMRC = modified Medical Research Council; 6MWD = Six-Minute Walk Distance; SpO_2 = Peripheral Oxygen Saturation.

3.2 Primary Outcome: Six-Minute Walk Distance

Both groups demonstrated statistically significant within-group improvements in 6MWD following the 8-week intervention (NW: $\Delta+66.2 \pm 18.4$ m, $p < 0.001$, CW: $\Delta+23.1 \pm 15.7$ m, $p < 0.001$). The between-group comparison revealed a significantly greater improvement in 6MWD in the NW group compared to CW (mean difference: 43.1 m, 95% CI: 34.6–51.6 m, $p < 0.001$, Cohen's d = 1.42, large effect). The improvement in the NW group exceeded the established minimum clinically important difference (MCID) for 6MWD in COPD (25 meters) in all participants.

3.3 Secondary Outcomes

The NW group demonstrated significantly greater improvements compared to CW in VO_2 peak, Borg RPE post-6MWT, SpO_2 nadir, handgrip strength, SGRQ total score, CAT score, TUG test, and 30-s CST (all $p < 0.05$). Detailed pre and post-intervention values for all outcome measures are presented in Table 2.

Table 2. Pre and Post-Intervention Outcome Measures

Outcome Measure	NW Pre	NW Post	CW Pre	CW Post	p
6MWD (m)	312.4 ±48.6	378.6± 42.3*	315.1 ±51.3	338.2± 47.9*	<0.001
Δ 6MWD (m)	—	+66.2 ±18.4	—	+23.1 ±15.7	<0.001
VO_2 peak (mL/kg/min)	14.8± 2.6	17.9±2 .4*	14.6± 2.8	15.8±2 .5*	0.012
Borg RPE (post-6MWT)	5.8±1 .2	4.6±1. 0*	5.7±1 .3	5.2±1. 1*	0.031
SpO_2 nadir 6MWT (%)	87.4± 2.6	89.6±2 .1*	87.2± 2.8	88.1±2 .4	0.043
Handgrip Strength (kg)	24.6± 5.2	27.8±4 .8*	24.9± 5.4	25.6±5 .1	0.028
SGRQ Total Score	52.4± 8.6	43.2±7 .8*	53.1± 9.2	49.6±8 .4*	0.018
CAT Score	18.6± 4.2	14.2±3 .6*	19.1± 4.5	17.4±4 .0*	0.024
TUG Test (s)	12.4± 2.8	10.6±2 .4*	12.6± 3.0	11.8±2 .7*	0.037
30-s CST (reps)	10.2± 2.4	12.8±2 .2*	10.4± 2.6	11.4±2 .3*	0.041

Values are mean ± SD. * $p < 0.05$ vs. pre-intervention (within-group). NW = Nordic Walking; CW = Conventional Walking; 6MWD = Six-Minute Walk Distance; VO_2 = Oxygen Consumption; RPE =

Rating of Perceived Exertion; SpO_2 = Peripheral Oxygen Saturation; SGRQ = St. George's Respiratory Questionnaire; CAT = COPD Assessment Test; TUG = Timed Up-and-Go; CST = Chair Stand Test. p-values reflect between-group differences (ANCOVA).

3.4 Safety and Adverse Events

Both interventions were well-tolerated. No serious adverse events (exacerbations requiring hospitalization, falls resulting in injury, or cardiovascular events) were recorded in either group. Minor adverse events are detailed in Table 3.

Table 3. Adverse Events During the Intervention Period

Adverse Event	NW Group (n=30)	CW Group (n=30)
Musculoskeletal discomfort	3 (10.0%)	1 (3.3%)
Exercise-induced dyspnea (mild)	4 (13.3%)	5 (16.7%)
Dropout (completed < 80% sessions)	2 (6.7%)	3 (10.0%)
Serious adverse events	0 (0%)	0 (0%)
Falls during exercise	0 (0%)	0 (0%)

Values are expressed as n (%). No between-group statistically significant differences were observed for any adverse event (Fisher's exact test, all $p > 0.05$).

4. DISCUSSION

The principal finding of this randomized controlled trial is that an 8-week structured Nordic Walking program produced significantly greater improvements in functional exercise capacity, peripheral muscle strength, and health-related quality of life compared to a conventional walking program of equivalent duration and relative intensity in patients with moderate-to-severe COPD. The between-group difference in 6MWD of 43.1 meters is clinically meaningful, substantially exceeding the widely accepted MCID of 25–35 meters for this population. [19, 20]

The superior gains in 6MWD observed in the NW group are consistent with the biomechanical and physiological rationale underlying pole-assisted walking. By actively engaging the latissimus dorsi, trapezius, deltoid, and triceps brachii musculature in addition to the lower extremities, NW substantially increases total metabolic demand and cardiac output relative to CW at equivalent RPE levels. [8] This whole-body recruitment pattern promotes greater central and peripheral cardiovascular adaptations, including improved skeletal muscle oxidative capacity, mitochondrial density, and capillary-to-fiber ratio mechanisms that directly translate to enhanced submaximal walking performance. [21]

The improvement in VO_2 peak in the NW group (Δ+3.1 mL/kg/min) was significantly greater than CW (Δ+1.2 mL/kg/min), corroborating findings from Kocur et al. [22] and van Eijkeren et al. [23] in cardiovascular and neurological populations, respectively. In COPD specifically, Schiffer et al. [24] similarly reported enhanced cardiopulmonary parameters with NW; our findings extend these observations with a larger, adequately powered RCT.

The significantly greater improvement in handgrip strength in the NW group (+3.2 kg vs. +0.7 kg) is notable given that peripheral muscle dysfunction particularly of the upper extremities is a well-recognized extra-pulmonary manifestation of COPD associated with reduced exercise tolerance and survival. [25] The active propulsion mechanics of NW may provide a form of progressive upper-limb resistance training superimposed on aerobic conditioning, a dual benefit not achievable through lower-limb dominant modalities such as CW.

The superior HRQoL outcomes, reflected in larger improvements in SGRQ total score and CAT score in the NW group, have important clinical implications. SGRQ changes exceeding the MCID of 4 units were achieved in 76.7% of NW participants versus 53.3% of CW participants (data not shown), suggesting greater clinical responsiveness. Improved HRQoL likely reflects the synergistic benefits of enhanced exercise capacity, reduced dyspnea, improved psychosocial engagement in group exercise, and the added functional independence conferred by upper-body strengthening. [26]

The improvements in balance and functional mobility (TUG and 30-s CST) in the NW group are clinically significant in the context of fall prevention. COPD patients demonstrate up to 3-fold higher fall rates compared to age-matched healthy adults, partly attributable to impaired balance and quadriceps weakness. [27] The use of poles in NW provides proprioceptive feedback and dynamic balance training, potentially augmenting these functional outcomes beyond aerobic conditioning alone. [28]

The observed improvements in SpO_2 nadir during the 6MWT in the NW group may reflect either improved ventilatory efficiency or enhanced oxygen delivery to exercising muscle through greater cardiac output. The absence of supplemental oxygen use in both groups excludes this as a confounding variable.

4.1 Comparison with Existing Literature

Our findings align with and extend a small but growing body of evidence. Breyer et al. [29] reported a significant advantage of NW over CW in a 3-month

COPD outpatient program (n=60), though their study lacked a primary outcome of 6MWD and did not include CPET. Lopes et al. [30] similarly reported NW superiority in dyspnea and functional capacity in a 6-week pilot RCT (n=24). Our study strengthens the evidence base with an adequately powered sample, rigorous randomization, blinded outcome assessment, and a comprehensive, multidimensional outcomes battery.

4.2 Limitations

Several limitations warrant acknowledgment. First, the single-center design and sample restricted to GOLD Stage II–III COPD limits generalizability to very severe disease (Stage IV) and primary care settings. Second, blinding of participants and treating physiotherapists was not possible due to the nature of the interventions; however, outcome assessors remained blinded throughout. Third, the follow-up period of 8 weeks precludes conclusions regarding the durability of improvements; long-term follow-up studies are needed. Fourth, physical activity monitoring outside sessions (e.g., accelerometry) was not performed, and domestic activity modification may have influenced outcomes. Fifth, skeletal muscle biopsy or imaging was not obtained to verify hypothesized peripheral adaptations.

4.3 Clinical Implications

The findings support the integration of Nordic Walking as a structured exercise modality within pulmonary rehabilitation programs for patients with moderate-to-severe COPD. NW offers the practical advantages of low cost, outdoor accessibility, social participation, and scalable intensity, making it feasible for implementation in both supervised and community-based rehabilitation settings. Physiotherapists and pulmonary rehabilitation coordinators should consider incorporating standardized NW technique training as part of PR curriculum. Future research should evaluate NW in severe-to-very severe COPD, assess optimal session frequency and duration, and examine long-term effects on exacerbation frequency and hospitalizations.

5. CONCLUSION

An 8-week structured Nordic Walking program produced significantly greater improvements in functional exercise capacity (6MWD), peak aerobic capacity (VO_2 peak), peripheral muscle strength, balance and health-related quality of life compared to conventional walking in patients with moderate-to-severe COPD. Both interventions were safe and well-tolerated. Nordic Walking represents an effective, accessible, and superior whole-body exercise alternative for inclusion in evidence-based pulmonary rehabilitation programs. Further large-scale multicenter trials with extended follow-up are recommended to consolidate these findings.

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