Effect of Nordic Walking Training on Walking Capacity and Quality of Life for People With Multiple Sclerosis

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ABSTRACT

BACKGROUND: Although there is emerging evidence that aerobic training improves walking capacity in persons with multiple sclerosis (MS), data are limited about the potential benefits of Nordic walking (NW) for this population. This study evaluates the effectiveness of outdoor NW training on walking capacity and related quality of life for people with MS compared with cycloergometer and treadmill aerobic training.

METHODS: A single-blinded (evaluator), randomized, 2-arm clinical trial was designed.

RESULTS: A total of 57 patients with MS (38 women and 19 men; mean ± SD age, 51.98 ± 9.93 years; mean ± SD disease duration, 14.75 ± 8.52 years) were included. Both therapeutic modalities improved walking distance as measured by the 6-Minute Walk Test after the training period. The NW group showed significant improvement on the physical and emotional subscales of the Multiple Sclerosis Quality of Life–54 compared with the cycloergometer and treadmill group, which showed improvement only on the physical subscale.

CONCLUSIONS: Both training modalities proved to be of equal benefit in improving the walking capacity of people with MS, but outdoor NW training also seems to have a beneficial effect on the emotional component of health-related quality of life.

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Multiple sclerosis (MS) is a chronic inflammatory disease of the central nervous system resulting from an abnormal autoimmune response that causes multifocal demyelination and neurodegeneration, leading to a wide range of neurologic symptoms and a gradual deterioration of physical and cognitive ability over time.[1] Resulting from a combination of symptoms and deficits such as spasticity, weakness, fatigue, ataxia, and balance and cognitive problems, impaired ambulation affects up to 80% of patients with MS.[2] Walking is perceived as one of the most valuable abilities within the spectrum of disability,[3] and walking difficulties have a high impact on the quality of life (QOL) of people with MS.[4] As physical deconditioning (reduction of aerobic capacity, balance, and muscle strength) contributes to increased walking disability, increasing physical activity could represent an essential intervention to improve motor capacity and, specifically, walking ability in this population.[5]

In the past decade, different publications have shown that physical activity is highly recommendable to preserve the physical and emotional state of people with MS, as well as to prevent complications arising from inactivity.[6] Despite the benefits of exercise described in such literature, people with MS have a high tendency to be sedentary compared with controls.[7] These results are particularly important because physical exercise is key to maintaining good health and reducing the risk of inactivity-related diseases such as osteoporosis, diabetes, obesity, cancer, and cardiovascular disease, some with a high incidence in MS.[8]

Different exercise modalities have demonstrated a positive effect on different physical or functional parameters in people with MS.[9,10] Aerobic exercise with a cycloergometer or a treadmill has a beneficial effect on fatigue and endurance in walking capacity.[11] Other studies have shown that aerobic training can improve not only self-referred fatigue but also maximum walking distance, mood, and feelings of self-efficacy.[12,13]

Achieving greater adherence to rehabilitation programs depends largely on the patients' feelings of self-efficacy and

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enjoyment.[14,15] In recent years, physical activity has become part of numerous clinical practice guidelines, promoting inclusive physical activity strategies that facilitate exercising in the community, including specific programs for people with MS.[16]

Nordic walking (NW) is one of the fastest growing recreational activities today. It has its roots in Finland, where "walking with poles" was introduced as a summer training method for cross-country skiing. Walking with poles involves movement in the upper body, thereby partially removing strain on the lower extremities and the lumbosacral spine, and provides a higher energy expenditure, quantified by 20% to 40%, compared with the standard stride.[17] The NW poles are adapted ski poles with a special strap that allows the pole to be released during the swing, keeping the trunk in an upright, symmetrical position while walking. Nordic walking poles are also longer than trekking poles, angling back at 45° when you plant them on the ground. Using the poles with each step pushes the body forward, facilitating longer strides and increasing walking velocity. In addition, the lower subjective perception of fatigue and greater confidence when walking with poles improves mood and enjoyment during NW.[18]

For all these reasons, NW has become a valuable therapeutic tool in many pathologic and neurologic disorders, especially in Parkinson disease. Different studies show that walking with poles, and thus activating the arms as well as the legs, improves both motor and nonmotor symptoms in Parkinson disease.[19-21]

A recent publication studied the effect of NW performed indoors by people with MS.[22] In this case series study, a 12-week NW indoor training program showed a limited effect on self-perceived fatigue and functional mobility, possibly due to the small sample and the low intensity of the sessions. However, higher levels of functional mobility and walking distance were achieved by all participants. In contrast, another study showed that trekking poles could be a useful and well-accepted assistive device for walking impairment in people with MS.[23]

Low cost, versatility, and the possibility of being outdoors with other people make NW an activity with great potential to increase regular physical activity and social participation for people with MS. If outdoor NW training showed a comparable efficacy to conventional aerobic training, it could be used as part of MS rehabilitation treatment and recommended for patients with limited walking capacity. Thus, the main objective of the present study was to determine whether the effect of NW is equal to that of conventional aerobic training by means of cycloergometer and treadmill (C&T) in the improvement of walking capacity and related QOL in people with MS.

METHODS

A 2-arm (NW training vs C&T training), randomized clinical trial with a blinded assessor was conducted. The study was approved by the Ethics Committee Commission of Vall d'Hebron University Hospital (register PR[AG]2015) and registered in the clinicaltrials.gov database (NCT03976128). The methods follow the criteria of the CONSORT (Consolidated Standards of Reporting Trials) guide for clinical trials of nonpharmacologic treatments/CONSORT extension for noninferiority or equivalence trials.[24,25]

Participants

The sample consisted of 72 adults diagnosed as having MS according to the McDonald criteria,[26] with no signs of MS exacerbation or corticosteroid treatment less than 6 months earlier, a slight risk of falls (Berg Balance Scale scores ≥48),[27] and who referred to walking fatigue and restriction in their usual walking perimeter during the past 6 months. Patients with neurologic disorders other than MS, moderate-severe spasticity (modified Ashworth scale score >2),[28] nonstable cardiovascular disease, diabetes mellitus, arthritis, acute pain, peripheral neuropathies, severe orthopedic problems, psychiatric problems, pregnancy, other involvement in fatigue or gait training, severe cognitive impairment, or an inability to maintain a continuous walking pace for a minimum of 15 minutes were excluded. Participants were recruited at the Multiple Sclerosis Center of Catalonia based on the clinical data obtained from their last rehabilitative admission; a personal interview in which the objectives and methods of the study were explained was conducted, and then informed consent was signed. Participant flow through recruitment/enrollment is included in **FIGURE S1**, available online at IJMSC.org.

Randomization and Therapy Allocation

An assignment sequence was randomly generated with a 1:1 ratio using Sealed Envelope Ltd 2015 software (https://www.sealedenvelope.com).

Rehabilitation Program Format and Volume

For both groups, the dose, frequency, and basic structure of the training sessions were identical: twenty 60-minute sessions twice a week. Each session was 10 minutes of warm-up exercises, 40 minutes of NW or C&T training, and 10 minutes of cool-down and stretching exercises. Both groups' training increased in intensity across the 20 sessions according to their age, baseline cardiovascular status, and effort response.

A heart rate monitor, model Polar FT1 (Polar), attached to the xiphoid, was used to control the cardiovascular effort during the sessions for both groups. The maximum heart rate (MHR) was determined using the general formula 220 − age. The heart rate reserve was determined by subtracting resting heart rate from the MHR. The target heart rate ranged from approximately 60% to 70% of the heart rate reserve + resting heart rate. During the sessions, physiotherapists regularly monitored the heart rate to ensure that it remained within the parameters stipulated for each patient. The NW training program was designed and performed by physical therapists qualified as NW instructors. During the first 2 sessions participants were taught the proper NW technique adapted to each participant's gait pattern. The NW sessions took place in groups of 4 to 6 patients on outdoor circuits, tracing urban routes and dirt tracks. Participants were encouraged to gradually increase distance walked and trail difficulty, starting with flat terrain and introducing inclines and stairs throughout sessions to increase aerobic exercise load to at least 60% MHR.

TABLE 1. Change in Outcome Measures

	Nordic walking (n = 27)				Cycling and treadmill (n = 25)			
	Before	After	Change	*P* value[a]	Before	After	Change	*P* value[a]
6MWT, m	402.18 ± 92.93	442.69 ± 96.62	40.51 (−57.10 to 23.92)	<.001[b]	343.81 ± 106.35	377.42 ± 120.27	33.61 (−52.94 to 14.27)	.001[b]
T25FWT, s	6.32 ± 1.48	5.99 ± 1.44	0.33 (0.08 - 0.57)	.009[b]	7.50 ± 3.12	7.24 ± 3.60	0.26 (−0.11 to 0.64)	.104
BBS	52.92 ± 3.07	53.40 ± 3.58	−0.48 (−1.79 to 0.83)	.45	49.52 ± 6.38	51.04 ± 5.61	−1.52 (−2.84 to −0.19)	.026[b]
TUG, s	8.88 ± 2.26	8.07 ± 2.04	0.81 (0.37 - 1.24)	.001[b]	10.31 ±4.13	9.78 ± 3.94	0.53 (−0.08 to 0.14)	.089
ABC scale	59.24 ± 20.64	62.45 ± 21.11	2.813 (−0.625 to 7.5)	.109	52.072 ± 20.19	60.64 ± 23.31	8.125 (2.188 - 13)	.006[b]
MSWS-12	34.50 ± 12.02	30.50 ± 6.36	−4 (−8 to 0)	.317	40.36 ± 10.98	32.56 ± 12.80	−7.50 (−11.5 to −4)	<.001[b]
MFIS	44.48 ± 21.35	38,48 ± 22.71	−6 (−10.50 to 2)	.005[b]	52.56 ± 15.17	43.64 ± 15.79	−9 (−14 to −4)	.003[b]
MSQOL-54P	54.15 ± 19.40	60.39 ± 19.23	−6.57 (−11.27 to −1.88)	.008[b]	47.44 ± 15.87	52.08 ± 17.90	−4.64 (−9.24 to −0.03)	.048[b]
MSQOL-54E	63.46 ± 22.28	69.62 ± 19.83	−6.15 (−11.20 to −1.10)	.019[b]	58.37 ± 18.89	63.82 ± 15.53	−5.44 (−12.45 to 1.56)	.122

6MWT, 6-Minute Walk Test; ABC, Activities-specific Balance Confidence; BBS, Berg Balance Scale; MFIS, Modified Fatigue Impact Scale; MSQOL-54E, Multiple Sclerosis Quality of Life–54 Emotional; MSQOL-54P, Multiple Sclerosis Quality of Life–54 Physical; MSWS-12, 12-item Multiple Sclerosis Walking Scale; T25FWT, Timed 25-Foot Walk Test; TUG, Timed Up and Go Test.

Note: Before and after values are expressed as mean ± SD and change values as mean (95% CI).

[a]*P* values are calculated by Student *t* test.

[b]Statistically significant.

The C&T training used the MOTOmed viva 2 cycloergometer (RECK-Technik GmbH & Co KG) and the Cruiser High Performance Treadmill (Trueform). In the first session, the base speed for the treadmill and the cycloergometer resistance were established for each patient. A comfortable speed was found in which the patient could exercise throughout the allocated time at a speed of 60 to 80 rpm, with an increase in heart rate of at least 60% of the MHR. From these baselines, the speed and resistance progressively increased throughout the training period. If there was good patient tolerance, every 3 training sessions the speed of the treadmill was increased by 0.2 km/h and the resistance of the cycloergometer was increased by 1 point.

Mobility Measures

Outcome assessments were performed 3 times (T1, T2, and T3: pretraining, post training, and 3 months post training, respectively). The 10-week training program took place between T1 and T2. After the training period, participants were encouraged to stay active and exercise daily without any specific guidelines. The frequency or type of physical activity developed between T2 and T3 was not controlled.

Comparisons were made between and within groups based on the following timed tests and scales, as well as the patient-reported outcome. Primary outcome measures were the 6-Minute Walk Test (6MWT)[29] and the Timed 25-Foot Walk test.[30] Secondary outcome measures were the Expanded Disability Status Scale,[31] the Timed Up and Go test,[32] the Berg Balance Scale,[27] the 12-item Multiple Sclerosis Walking Scale,[33] the Activities-specific Balance Confidence scale,[34] the Modified Fatigue Impact Scale,[35] and the Multiple Sclerosis Quality of Life–54 (MSQOL-54).[36]

Statistical Analysis

The 2001-2015 Sealed Enveloped Ltd program "randomization and online databases for clinical trials" was used to calculate the sample size (https://www.sealedenvelope.com/power/continuous-noninferior). Alpha values of 2.5% and beta values of 20% (power of 80%) were used. Assuming a standard deviation of 100 m and a difference of 77 m as the minimal detectable change in walking distance,[37] 27 patients were needed in each arm of the study. If there was no difference between the NW and C&T treatments, the trial would require 60 patients to achieve 80% certainty that the upper limit of a 95% CI will be below the noninferiority margin of 77. Allowing for a 10% patient dropout rate, recruitment was increased to 33 patients per arm.

Data were entered and processed using IBM SPSS Statistics for Windows, version 26.0 (IBM Corp). The level of significance was set at $P < .05$. The effect of both training modalities was analyzed comparing the pretraining and posttraining values according to the Student *t* test and the χ^2 test. Noninferiority was assessed by estimating the difference (95% CI) between the initial and final mean values, following

TABLE 2. Adjusted Analysis of 6MWT Change

	Nordic walking (n = 27)		Cycling and treadmill (n = 25)			
	Baseline	20 sessions	Baseline	20 sessions	Adjusted difference (95% CI)	*P* value[a]
6MWT, mean ± SD, m	396.82 ± 91.88	437.68 ± 95.26	348.08 ± 107.30	381.18 ± 121.21	7.78 (−15.23 to −30.79)	.501

6MWT, 6-Minute Walk Test.
[a]*P* value calculated by Student *t* test for independent samples.

the CONSORT recommendation. The analysis was conducted per protocol.

An analysis of the central tendency measures of the quantitative variables was performed using the Kolmogorov-Smirnov test to verify that there were no statistically significant differences between the NW and C&T groups. The Student *t* test was used for independent samples in the variables that followed a normal distribution, and the Mann-Whitney *U* test was used for those that were not normally distributed.

RESULTS

Of the 72 eligible participants, 7 chose not to participate because the training program did not fit their work schedule, 6 did not meet the selection criteria, and 2 were excluded because they could not attend the treatment sessions during several of the training weeks. Patients who met the selection criteria (N = 57) were randomly assigned to the 2 groups, 29 in the NW group and 28 in the C&T group. Of these 57 patients, 5 dropped out in the follow-up period. There were no statistically significant differences at baseline in terms of clinical characteristics between both groups. The demographic and clinical characteristics of the whole sample and the differentiation between both groups are reported in **TABLE S1**.

After 10 weeks of training, some parameters improved significantly. **TABLE 1** shows changes in the different outcome measures in a per-protocol analysis. Both groups showed statistically significant improvement in walking distance measured by the 6MWT, with a mean increase of 40.51 m in the NW group and 33.61 m in the C&T group. Walking velocity measured by the Timed 25-Foot Walk test improved significantly only in the NW group ($P = .009$). In contrast, the C&T group did not improve their walking velocity but did improve their perception of walking disability measured by the 12-item Multiple Sclerosis Walking Scale ($P < .001$). The NW group showed statistically significant improvement in dynamic balance measured by the Timed Up and Go test ($P = .001$), and the C&T group showed a significant improvement in static balance measured by the Berg Balance Scale ($P = .026$) and in self-perceived balance confidence measured by the Activities-specific Balance Confidence scale ($P = .006$). Both groups showed significant differences in perceived fatigue measured by the MFIS ($P = .005$). In the NW group, a significant improvement was observed in the perceived QOL in both physical subscale ($P = .008$) and emotional subscale ($P = .019$) of the MSQOL-54, and the C&T group had a significant improvement only on the physical subscale ($P = .048$).

An adjusted analysis of the differences between the treatments is shown in relation to the 6MWT as the main outcome in **TABLE 2**. There was no significant difference ($P = .501$) between the groups. Furthermore, the upper limit of the 95% CI was below 77 m, the value that was established as a noninferiority margin.

FIGURE S2 shows the effect of both therapeutic modalities on distance walked, walking speed, and health-related QOL at T1, T2, and T3. Only the improvements observed in the 6MWT at T2 remained statistically significant at T3 in the NW group. Significant gains in all other parameters at T2 were not maintained at T3.

No serious adverse effects appeared in either group. Some patients reported a higher level of fatigue in the hours after training, but they had a complete recovery before the next session. There were no accidents during the sessions among the NW group even though the terrain was sometimes quite steep.

Overall adherence to the treatment was 91.22% (52 of 57 patients): 93.10% (27 of 29) in the NW group and 89.28% (25 of 28) in the C&T group, with no significant differences between them ($P = .610$).

DISCUSSION

To our knowledge, this study is one of the first to provide information relating to the effects of outdoor NW on people with MS. These data provide new insights into noninvasive therapies for MS, specifically related to aerobic physical training where the use of poles means that individuals exercise both the upper and lower body. The present study shows that outdoor NW training is feasible for people with MS and walking disability and that it is not inferior to the conventional aerobic training used in our clinical practice (ie, indoor cycling and treadmill). These results are in contrast to those reported by Martínez-Lemos et al[22] on the effect of NW training in 14 people with MS on self-reported fatigue, functional mobility, physical fitness, and QOL. Their protocol included 2 sessions per week of NW training over 3 months. The structure, content, and progression of the sessions were quite similar to ours except that the NW training was indoors. There was a low level of adherence to the program, and they concluded that their program was not feasible for people with MS and had little effect on their levels of mobility. As mentioned, our NW sessions were in small groups and outdoors, crucial aspects to making the activity enjoyable for participants, as well as for allowing a gradual increase in intensity and difficulty throughout the training program.

In a recent study, Cohen et al[23] observed that trekking poles had a positive psychosocial impact and were well accepted and preferred as an assistive device for walking for people with MS, especially as it has the appearance of sporting equipment rather than an assistive orthopedic device. This is especially interesting for patients initially reluctant to use an assistive device for walking but who present an increasing restriction in their walking perimeter due to fatigue, balance, or coordination problems.

Because there are seemingly no other studies on the effect of outdoor NW for people with MS, we took the evidence on the effect of NW on Parkinson disease as a neurodegenerative disease reference point. Bang and Shin[20] studied the effect of NW training on a treadmill compared with treadmill walking alone for persons with Parkinson disease, providing evidence of an additional benefit of NW training on balance and walking ability, even when the activity is indoors. These results are in concordance with the present study in terms of the efficacy of NW and its noninferiority compared with C&T as the reference training method used. In a recent systematic review, Cugusi et al[21] observed improvements in resting heart rate, maximum walking distance, and lower-limb muscle strength as well as in mood, apathy, and QOL after NW training compared with conventional therapy, although some limitations prevent definitive conclusions. In the present study, a remarkable benefit was noticed in the emotional subscale of the MSQOL-54 for the NW group, which may be due to the enjoyable component of outdoor and group training.

Most noteworthy is the question of whether the benefit of NW remains in the long-term.[22] Herein, the assessments at T3 show that the benefit does last with respect to distance and walking speed but seems to disappear in the other analyzed variables, which returned to their baseline levels after this time. In our opinion, the 2 days of scheduled NW training a week constitute the commitment needed to acquire a healthy physical activity habit. On the other hand, avoiding excessive physical fatigue is crucial to ensure adherence to the program in accordance with the guidelines for physical activity for patients with MS. An interesting area for further research would be studying patients with MS' perception of self-efficacy in acquiring a regular physical activity when they can choose the type of activity and to then measure whether this activity is maintained over time. Based on this, we are considering a study on adherence to physical activity by patients with MS with long disease durations. As McAuley et al[14] explain, "For healthy, sedentary individuals, every aspect of becoming physically active is a challenge. For those with MS, this challenge is greatly magnified."

We believe that the intensity and type of training must be adapted to the needs and capabilities of people with MS, as an activity not regulated by specific guidelines may fail to achieve real and significant benefits. A study to determine the type of training suitable for people with MS in relation to the degree of physical involvement would be helpful. This would involve expanding the sample size to enable an analysis of subgroups undertaking physical activity of mild to moderate intensity to determine the extent to which the training load, including aspects such as intensity and frequency, can be adapted.

An unexpected aspect of the present study was that the self-evaluation of confidence in one's own balance and perception of walking ability did not improve in the NW group but did in the C&T group. This is surprising because NW, as an open-air activity, is much more environment-dependent and demanding than C&T training. One possible explanation could be that the NW group had to confront real-life limitations and difficulties pertaining to MS during the training, meaning that their self-perception was harsher on the questionnaire.

This study has several methodological limitations: The main limitation is comparing indoor exercise training with outdoor exercise training, and the exercise setting may have a role in exercise training responses. The study's aim was to identify a difference between the groups and not to compare them. Patients were not, therefore, split into subgroups to find prognostic factors that modify the indication of this type of training; the great variability and dispersion of patients' baseline clinical characteristics would have made this very difficult. In addition, the impossibility of blinding the participants may have caused a performance bias, thereby influencing the results. The potential candidates showed some preference for the NW protocol. Once randomized, those assigned to the C&T protocol still agreed to participate, even if it did not fully match their initial expectations.

CONCLUSIONS

This is the first randomized clinical trial to evaluate the efficacy of outdoor NW training for people with MS. The results of this study demonstrate significant effects on walking capacity, fatigue, and perceived QOL for NW. For people

PRACTICE POINTS

Nordic walking may be an effective modality of outdoor aerobic training for improving walking capacity in persons with multiple sclerosis with mild to moderate mobility impairment.

Rehabilitation programs that aim to increase physical activity levels in persons with multiple sclerosis may consider incorporating Nordic walking, an inclusive modality that allows enjoyment while exercising in community. ■

with MS with mild to moderate disability, NW training is equivalent to C&T training in terms of improved walking velocity and distance, effects that were maintained 3 months after the treatment period. In addition, outdoor NW training also seemed to have a beneficial effect on the emotional component of health-related QOL. Therefore, our experience shows that outdoor NW is a valuable exercise method for the rehabilitation of people with MS. ■

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