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Effects of Nordic walking on Parkinson's disease: a systematic review of randomized clinical trials

Efeitos da caminhada nórdica na doença de Parkinson: uma revisão sistemática de ensaios clínicos randomizados

Los beneficios de la caminata nórdica en la enfermedad de Parkinson: estudio clínico sistemático aleatorio

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ABSTRACT | Several exercise modalities improve the symptoms of Parkinson's Disease (PD). Among the variety of physical exercises, Nordic walking has been used. The aim of this study was to summarize scientific literature on effects of Nordic walking on patients with PD by a systematic review of randomized clinical trials. The following electronic databases were selected: MEDLINE by Pubmed, Cochrane, PEDro, SCOPUS and Web of Science and articles identified by manual search, without restriction of date and language. The reviewers evaluated the articles and selected studies according to the eligibility criteria. The following data were extracted from the selected studies: publication identification, participants' characteristics (sex, age, disease stage, duration of disease), experimental intervention characteristics, control group characteristics, duration, follow-up time, outcome measures and main results. Nordic walking programs with moderate and high intensities, with a minimum of 12 sessions of 60 minutes in a period from 6 to 24 weeks promoted positive effects on the severity, gait, balance, quality of life, functional capacity and motor function in patients with PD.

Keywords | Parkinson's Disease; Walking; Review; Randomized Controlled Trial.

RESUMO | Várias modalidades de exercício melhoram os sintomas da Doença de Parkinson. Dentre a variedade de exercícios físicos, a caminhada nórdica tem sido utilizada. O objetivo do estudo foi sintetizar a produção científica sobre os efeitos da caminhada nórdica na doença de Parkinson por meio de uma revisão sistemática de ensaios clínicos randomizados. Foram selecionadas as seguintes bases de dados eletrônicas: *MEDLINE* via Pubmed, *Cochrane, PEDro, SCOPUS e Web of Science,* e artigos identificados por meio de busca manual, sem restrição de data e idioma. Os revisores avaliaram os artigos completos e os estudos selecionados de acordo com os critérios de elegibilidade. Os dados extraídos foram: identificação da publicação, características dos participantes (sexo, idade, estágio da doença, duração da doença), características da intervenção experimental, características do grupo controle, duração, seguimento, desfechos avaliados e principais resultados. Um programa de caminhada nórdica, realizado com intensidades moderada e alta, com mínimo de 12 sessões de 60 minutos em um período de 6 a 24 semanas promove efeitos positivos na

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gravidade da doença, marcha, equilíbrio, qualidade de vida, aptidão funcional e função motora em pacientes com doença de Parkinson.
Descritores | Doença de Parkinson; Caminhada; Revisão; Ensaio Clínico Controlado Aleatório.

RESUMEN | Hay varias modalidades de ejercicios físicos que mejoran los síntomas de la enfermedad de Parkinson. Entre las modalidades, se destaca la caminata nórdica. El propósito de este estudio es sintetizar la producción científica sobre los beneficios de la caminata nórdica en la enfermedad de Parkinson a través de una revisión sistemática de los estudios clínicos aleatorios. Se eligieron las bases de datos electrónicas *MEDLINE* por PubMed, *Cochrane, PEDro, SCOPUS y Web of Science,* de las cuales se identificaron textos a través de búsqueda manual, sin restricción de fecha e idioma. Los revisores evaluaron los textos completos y los elegidos según criterios. Se obtuvieron los datos: identificación de la publicación, características de los participantes (sexo, edad, etapa de la enfermedad, duración de la enfermedad), características de la intervención experimental, características del grupo control, duración, seguimiento, resultados evaluados y principales resultados. Un programa de caminata nórdica, realizado con intensidades moderada y alta, con el mínimo de 12 sesiones de 60 minutos en el periodo de 6 a 24 semanas les proporciona resultados positivos en la gravedad de la enfermedad, la marcha, el equilibrio, la calidad de vida, la aptitud funcional y la función motora de pacientes con esta enfermedad.
Palabras clave | Enfermedad de Parkinson; Caminata; Revisión; Ensayo Clínico Controlado Aleatorio.

INTRODUCTION

Parkinson's disease (PD) is the second most common neurodegenerative disease, and affects millions of people worldwide[1]. In 2005, 4 million people were affected by PD, and it is estimated that between approximately 8.7 and 9.3 million will have PD in 2030[2]. Studies also showed that more than 40 million people worldwide will have secondary motor disorders with PD in 2020[2-4]. The motor disorders (e.g., bradykinesia, tremor, rigidity, impaired postural reactions and fatigue) make PD patients less active than healthy people, and the physical condition of PD patients is affected gradually as the disease progresses[5]. The combination of motor and non-motor manifestations (e.g., depression, apathy and dementia) interferes with the individual's level of disability, and these factors negatively influence quality of life (QOL), which leads to isolation and low participation in social activities[6,7].

Distinct exercise modalities improve the symptoms of PD[8-12]. Exercise promotes plasticity of the central nervous system (CNS)[13]; improves balance, gait, physical function and quality of life[8,9,14], delays cognitive impairment[15,16], dementia[17,18], depression[19,20]; and slows the progression of PD[21]. Among the variety of physical exercises, Nordic walking (NW) is trending as an aerobic activity because it includes the aid of two sticks that favor interplay of arms and legs[22]. Recent evidence suggests that NW is a therapeutic modality for several conditions such as peripheral arterial disease[23], chronic low back pain[24], type 2 diabetes mellitus[25], heart failure[26] and PD[27]. The effects of NW on patients with PD are related primarily to increased aerobic fitness, increased muscle strength and improved motor coordination[28].

The increasing research interest in exercise in PD is driven by the need to establish sustainable therapeutic strategies that are cost-effective, easy to apply, promote an active lifestyle and offer the best treatment available for the various conditions that are associated with PD[29]. However, a lack of methodological control in previous studies has hindered stronger inferences of the role of physical exercise in PD, such as the use of non-blinded assessors, the absence of a control group, inadequate sample size[30], and insufficient information related to the elements that compose the training program[31], which supports the importance of revision studies. Therefore, our study summarized the scientific literature on the effects of NW in PD using a systematic review of randomized clinical trials.

METHODOLOGY

This systematic review was registered under the number CRD42014014800 in the International Prospective Register of Systematic Reviews – PROSPERO, and it followed the proposed Preferred Reporting Items for Systematic Review and Meta-analyses: The PRISMA Statement[32].

Eligibility criteria

Randomized clinical trials were included in this review. All included studies approached the theme of Nordic Walking in PD, and the studies were indexed in previously selected databases with available abstracts showing full online access and no year and language restrictions. A manual search of reference articles in identified preliminary studies was also conducted, and appropriate studies were included in this review.

Search strategy

MEDLINE (Medical Literature Analysis and Retrieval System on-line) by Pubmed, SCOPUS (Elsevier), Cochrane, PEDro and Web of Science were the electronic databases selected for this study. A manual search of the references of published studies on this theme was also conducted. The search strategy included the proposed descriptors in the *Medical Subject Headings* (MeSH) related to the following topics: the study population – "Parkinson's Disease", "Idiopathic Parkinson's Disease", "Lewy Body Parkinson Disease", "Lewy Body Parkinson's Disease", "Primary Parkinsonism", "Parkinsonism, Primary", "Parkinson's Disease, Idiopathic", "Parkinson's Disease", "Parkinson's Disease, Idiopathic", "Parkinson's Disease, Lewy Body", "Idiopathic Parkinson's Disease", "Paralysis Agitans"; the intervention – "Nordic Walking", "Pole walking", "Pole striding", "Exerstriders"; and the study type – "Randomized controlled trial[pt]", "Controlled clinical trial[pt]", "Randomized controlled trials[mh]", "Random allocation[mh]", "Double-blind method[mh]", "Single-blind method[mh]", "Clinical trial[pt]", "Clinical trials[mh]", "Clinical trial[tw]", "Singl*[tw]", "Doubl*[tw]", "Trebl*[tw]", "Tripl*[tw]", "Mask*[tw]", "Blind*[tw]", "Latin square[tw]", "Placebos[mh]", "Placebo*[tw]", "Random*[tw]", "Research design[mh:noexp]", "Follow-up studies[mh]", "Prospective studies[mh]", "Cross-over studies[mh]", "Control*[tw]", "Prospectiv*[tw]", "volunteer*[tw]". All search operations were performed in October 2014.

Study selection and data extraction

Two independent reviewers initially evaluated studies that were identified by the search strategy according to titles and abstracts. The reviewers evaluated the complete articles and selected studies according to the eligibility criteria previously specified. Studies that were not in accordance with the adopted criteria were excluded according to the boundaries imposed by the search strategy. Disagreements between reviewers were resolved by consensus.

The following data were extracted from the selected studies: identification of the publication, participants' characteristics (sex, age, disease stage, duration of disease), experimental intervention characteristics, control group characteristics, duration, follow-up time, outcome measures and main results.

Most studies did not show the results as means and standard deviations, therefore the meta-analysis and the calculation of the effect size of intervention could not be performed. After analyzing the articles, data were categorized, interpreted and grouped according to the similarity of the data shown in the sub-section Nordic Walking Effects.

Quality assessment

Two reviewers (FCS and RRI) independently assessed the methodological quality of randomized clinical trials (RCTs) using the PEDro scale[33]. The PEDro score ranges from 0 to 10 points. A cut point of 6 on the PEDro scale was used to indicate high-quality studies because this point sufficiently determined high-quality versus low-quality studies[34]. Disagreements were resolved by discussion between the reviewers. PEDro scores were all settled by consensus.

RESULTS

Literature search

This search resulted in the identification of 36 articles. One additional study was added after manual evaluation of the references of these articles. Thirteen studies were excluded after a general evaluation that the studies were duplicated, and thirteen studies were excluded because their titles and abstracts did not address the theme investigated in the present article. Two studies were systematic reviews, one was a case study, and three were presented as abstracts at conferences. Our detailed review showed that five studies were potentially relevant, and these were included in this systematic review. The flow diagram summarizes the search strategy.

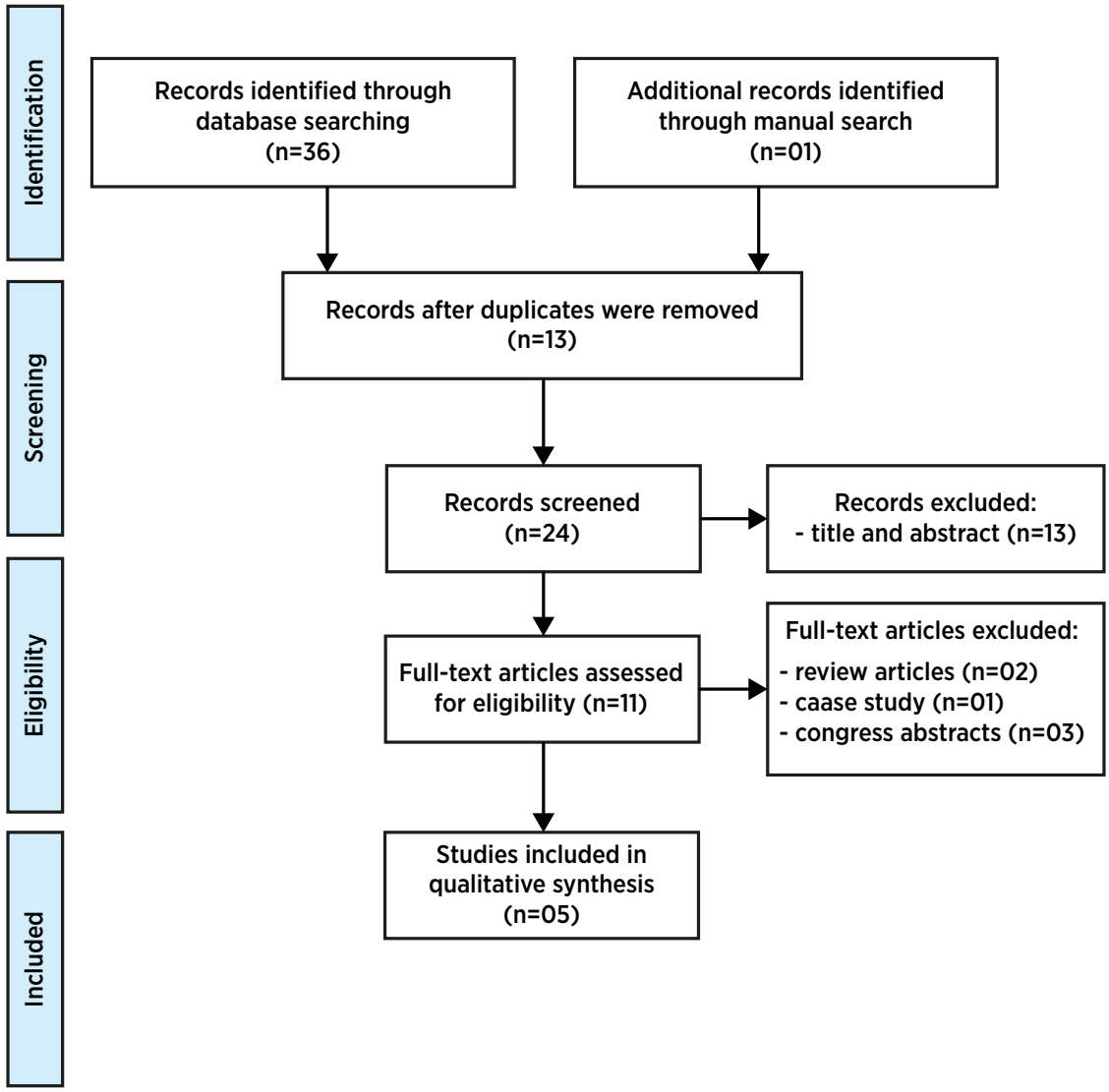

Figure 1. Flow diagram: summarized search strategy

Quality assessment

Table 1 summarizes the quality of the included studies. Three studies showed no random allocation[28,35,36], and four studies showed no concealed allocation[28,29,35]. No study used blinded subjects and therapists, or showed an intention to treat. Two studies included blinded evaluators[27,31]. Total scores for methodological quality ranged from 3 to 6 points. Therefore, three studies were classified as having low methodological quality, and two studies were classified as having high methodological quality[27,31].

Table 1. PEDro scale of quality for eligible randomized controlled trials

First author, year	Eligibility criteria	Random allocattion	Concealed allocation	Similar at baseline	Blinded subjects	Blinded therapists	Blinded assessors	< 15% dropouts	Intention-to-treat analysis	Between-group comparisons	Point measures and variability data	Total
Baatile, 2000[36]	1*	0	0	1	0	0	0	1	0	0	1	3
Van Eijkeren, 2008[28]	1*	0	0	1	0	0	0	0	0	1	1	3
Ebersbach, 2010[6]	1*	1	0	1	0	0	1	1	0	1	1	6
Reuter, 2011[31]	1*	1	1	1	0	0	1	0	0	1	1	6
Fritz, 2011[35]	1*	0	0	1	0	0	0	0	0	1	1	3

* Criterion 1 is not considered for the final score because it is an item that assesses the external validity[33]

Study characteristics

Table 2 shows primary characteristics of the included studies. Three studies were conducted in Germany[27,31,35]. One study involved only male patients[36]. The mean age of the participants ranged from 62[31] to 72.7 years[36]. The average stage of Parkinson's disease (Hoen and Yeahr) ranged from 1.6 (mild stage)[28] to 2.8 (moderate stage)[27], and the mean duration of disease ranged from 3.7[36] to 7.8 years[27].

Total intervention sessions ranged from 24[36] to 72[31], and the duration of each session varied from 60[27,28,35,36] to 70[31] minutes for a total of 6[28] to 24[31] weeks. Only two studies reported the intensity of Nordic walking[35,36] (moderate as evaluated by ratings of perceived exertion level, and high intensity measured by a heart rate monitor). Three studies included a control group[27,31,35], and two conducted follow-ups of 16[27] to 20[28] weeks. Outcome measures were disease severity, gait, balance, quality of life, functional fitness and motor function.

Table 2. Main characteristics of included studies

First author, year	Study location	Sample (n)	Sex	Mean age (years)	Disease stage average (Hoehn and Yahr)	Mean duration of disease (years)	Experimental intervention	Control Group intervention	Duration (weeks)	Follow-up (weeks)	Outcome measures
Baatile, 2000[36]	Chicago (EUA)	6	M	72.7	2.4	3.7	CN (60min/ 24 sessions, moderate intensity – Effort Perception Scale)	-	8	-	Parkinson's Disease Severity (UPDRS); quality of life (PDQ-39).
Van Eijkeren, 2008[28]	Netherlands (England)	19	M/F	67	1.6	5	CN (60min/ 12 sessions)	-	6	20	Gait; balance (Up-and-Go Test); functional fitness (Six Minute Walk Test); quality of life (PDQ-39).
Ebersbach, 2010[27]	Germany	58	M/F	LSVT® BIG: 67.10 NW: 65.5 Home: 69.3	LSVT® BIG: 2.8 NW: 2.6 Home: 2.5	LSVT® BIG: 6.1 NW: 7.8 Home: 7.4	LSVT® BIG (60min/ 16 sessions NW (60 min/ 16 sessions)	Home	LSVT® BIG: 4 NW: 8 Home: 4	16	Motor function (UPDRS III); quality of life (PDQ-39); balance (Up-and-Go Test); gait.
Reuter, 2011[31]	Germany	90	M/F	NW: 62 Walking: 63 Flexibility and relaxation: 62.1	2.5	NW: 5.34 Walking: 5.99 Flexibility and relaxation: 5.19	NW (70min/ 72 sessions) Walking (70min/ 72 sessions)	Flexibility and relaxation (70min/72 sessions	24	-	Gait; Parkinson's Disease Severity (UPDRS); quality of life (PDQ-39); balance (Berg Balance Scale).
Fritz, 2011[35]	Germany	22	M/F	UPDRS A and UPDRS B: 66 Healthy Controls: 67	-	-	NW (60min/ 36 sessions high intensity – 80 à 90% da FC)	NW (60min/36 sessions)	12	-	Transfer of the sitting position to a standing position (*sit-to-stand*)

M: male; F: female; NW: nordic walking; PD: Parkinson's disease; HR: heart rate; Min: minutes; UPDRS: Unified Parkinson's Disease Rating Scale; PDQ-39: Parkinson Disease Questionnaire-39

Nordic walking effects

Disease severity

A statistically significant difference was found for the total score of the Unified Parkinson's Disease Rating Scale (UPDRS) (p=0.026) and improvements in mental activity, activities of daily living, and motor skills domains after eight weeks of Nordic walking with moderate intensity[36]. The study by Reuter et al.[31] showed that the total score of the UPDRS motor score decreased significantly in the Walking and NW groups (p<0.05) between pre- and post-intervention.

Gait

Van Eijkeren et al.[28] found a significant difference in gait speed between pre- and post-intervention using a Nordic Walking Program (NW) (p<0.001). Ebersbach et al.[27] demonstrated a significant difference between LSVT® BIG intervention groups (characterized by repetitive, wide range movements of high intensity and increasing complexity) and an unsupervised Home Exercise group (p=0.015). The LSVT® BIG consists of standardized whole-body movements with maximal amplitude, repetitive multidirectional movements (e.g., stepping and reaching), and stretching. The second half of exercise includes goal-directed activities of daily living (ADL) according to individual's needs and preferences. Patients assigned home received a 1-hour instruction of domestic training with practical demonstration and training. Exercises included stretching, high-amplitude movements as well as active workouts for muscular power and posture. Participants in all groups were encouraged to exercise regularly at home.

Reuter et al.[31] reported that all groups (Flexibility and Relaxation Program, Walking, and NW) improved in gait speed after six months of exercise. The flexibility and relaxation program focused on stretching, improving balance and range of movements. The walking training consisted of a warming up, technique training, endurance training and cooling down. Instructors emphasized arm swing and coordination of upper and lower limbs. The NW consisted of a warming up including some flexibility and strength exercises with and without poles. Patients were encouraged to increase training intensity by walking faster and to increase the distance walked. Each training session finished with a cooling down program.

The time required for the distance of 12 meters was significantly lower for NW and Walking groups ($p<0.001$). The same study demonstrated an increase in stride length by increasing the running speed in all groups ($p<0.001$), but only Walking and NW groups showed an increase in step length after the training period compared with the initial assessment. Improvement in stride length variability was significant between the Walking group and the normal Control group ($p<0.001$), and this improvement was greater in the NW group than in the Flexibility and Relaxation group ($p<0.001$) and in the Walking group ($p<0.001$). A decrease in the stride time in the NW group was higher than that in the Walking group and the Flexibility and Relaxation group ($p<0.005$)[31].

Balance

Studies showed a difference in balance by comparing pre- and post-program NW ($p<0.001$)[28] and between LSVT® BIG and NW groups ($p=0.036$) and between LSVT® BIG and Home groups ($p=0.024$)[27] as measured by using the Up-and-Go test. Reuter et al.[31] reported that the Nordic Walking group and the Walking group exhibited improved balance ($p<0.001$) as measured using the Berg Balance Scale.

Quality of life

The overall score of quality of life (Parkinson's Disease Questionnaire – PDQ-39) showed a statistically significant difference ($p=0.028$) before and after eight weeks of NW. The scores of emotional well-being subscales, communication, bodily discomfort, cognition and decreased stigma were also different in some subjects[36]. Van Eijkeren et all.[28] found no significant difference in quality of life before and after six weeks of a NW program ($p=0.008$) for the subgroup of 9 patients, but was significant for the entire group ($p<0.001$). Ebersbach et al.[27] found no significant difference between LSVT® BIG, NW and Home groups. However, Reuter et al.[31] reported that the Parkinson's Disease Questionnaire (PDQ_39) score decreased in all groups (NW, Hiking and flexibility and relaxation), which indicates a better quality of life related to health ($p<0.001$) after 24 weeks of intervention.

Motor function

There were significant differences in motor function (UPDRS III – motor score) between the LSVT® BIG and NW groups ($p<0.001$) and between the LSVT® BIG and Home groups ($p<0.001$) and between the NW and Home groups ($p=0.470$)[27].

Reuter et al.[31] showed differences between the Walking and NW groups during the final evaluation of the UPDRS motor score ($p<0.005$). Patients who underwent Walking or NW had better posture ($p<0.001$), less episodes of freezing ($p<0.001$), and were faster alternating movements ($p<0.003$) in the final evaluation. The NW group improved postural stability ($p<0.004$) and gait pattern ($p<0.001$).

Fritz et al.[35] evaluated motor function using the sit-to-stand test. Results showed positive effects of NW after high intensity training ($p=0.005$). There was a significant difference between patients with PD and healthy controls in the time required to complete the sit-to-stand movement ($p=0.002$), the maximum speed of the center of gravity in the vertical direction ($p=0.001$) and the maximum speed of the center of gravity in the horizontal direction ($p=0.002$).

Functional fitness

Van Eijkeren et al.[28] reported a significant difference in functional capacity (Six Minute Walk Test) between pre- and post-six weeks of NW ($p<0.001$).

DISCUSSION

Our literature search did not show any review-type studies that assessed randomized clinical trials to verify the effects of Nordic walking on PD.

Most of the included studies presented low methodological quality according to the PEDro scale and the cutoff point cited by Shu et al.[34] Shulman et al.[30] noted that studies involving exercise present

methodological problems, including the lack of blinded assessors, controls and inadequate sample sizes. Most of the studies in this review did not use random allocation, concealed allocation or blinding of subjects, therapists and assessors.

Results suggest that a NW program of moderate to high intensity of a minimum of 12 sessions of 60 minutes from 6 to 24 weeks may be an effective strategy for diseased patients to improve walking, flexibility and relaxation. It is also possible as an unsupervised exercise program to be performed at home.

This review provides evidence that NW reduces the motor score of the UPDRS[31,36] and shows the positive effects on the severity of PD as a result of the specific activities of the Nordic walking program. We also observed an increase in walking speed[27,28], improvement in stride length variability, and a decrease in stride time after completion of training[31]. These improvements have major impact on mobility and functional capacity in PD patients. Such improvements may occur because of physiological responses as improvement in the physical sphere provided by NW show muscle groups recruitment and greater body awareness. The use of walking sticks also facilitates the promotion of this activity because of the stability provided by the equipment[37].

Similarly, NW improved balance, motor function and functional fitness of PD patients. These improvements are likely due to the significant involvement of the muscles of the upper limbs, shoulder and torso and the postural muscles, spinal stabilizers and abdominal muscles during NW, which allows greater flexibility and mobility of the spine[38]. These data are relevant because patients with PD who have trouble walking have lower survival rates compared to patients who can preserve these functions[39]. Gait impairment, sex (male), cognitive decline, postural instability or the presence of psychotic symptoms are important markers for the decreased survival of PD patients.

The results of NW practice provided good responses related to specific training in PD. However, other parameters related to the disease including behavioral measures, such as depressive symptoms, and cognitive parameters, such as executive function, attention and memory, were not measured.

Quality of life improved[27,28,31,36], but Van Ebersbach et al.[27], reported no significant differences between LSVT® BIG, NW and Home groups. These results are probably related to the length of the experimental protocols because improvement in quality of life occurred in exercise programs of longer duration, including eight[27] and 24[31] weeks of training, respectively.

The neurological symptoms of PD are progressive and incurable. Therefore, these results emphasize that an active lifestyle and a better quality and perception of life are extremely important for patients with PD. Nordic walking provides a safe and effective way to enhance physical activity and to improve both motor and non-motor symptoms in PD patients[40,41].

Despite the limitations of this systematic review (e.g., few randomized clinical trials, low methodological quality of many of the included studies and the absence of meta-analysis), we observed positive effects of NW on disease severity, gait, balance, quality of life, functional fitness and motor function in patients with PD.

The aforementioned results suggest that the practice of NW is an important approach for PD treatment. However, implications of this approach should be thoroughly investigated and the methodological control should be rigorously enhanced to improve the outcomes.

CONCLUSIONS

Nordic walking programs of moderate to high intensity for a minimum of 12 sessions of 60 minutes from 6 to 24 weeks promoted positive effects on disease severity, gait, balance, quality of life, functional ability and motor function in patients with PD. However, only five randomized controlled trials met the eligibility criteria and were analyzed, and three studies showed low methodological quality. Therefore, randomized long-term clinical trials of better methodological quality should be performed.

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AUTHORS' CONTRIBUTIONS

FCS was responsible for identifying the research question, the design of the study, and data collection.

FCS, RRI were responsible for data collection and correcting the article. FCS, RRI, EGF, BAVA and SSSH contributed to the fine-tuning of the methodology and to correcting the article. RS was responsible for the review and revision of the manuscript. All authors helped to revise the manuscript and approved the final version.

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