Nordic walking versus ordinary walking for people with Parkinson's disease: a single case design

Sandra Bassett, *PhD, DipPhty*

Senior Lecturer, School of Rehabilitation and Occupation Studies, Auckland University of Technology, Auckland, New Zealand.

Jenny Stewart, *MPH, DipPhty*

Senior Lecturer, School of Rehabilitation and Occupation Studies, Auckland University of Technology, Auckland, New Zealand.

Lynne Giddings, *RN, PhD*

Associate Professor, School of Health Care Practice, Auckland University of Technology, Auckland, New Zealand.

ABSTRACT

This single case repeated measures mixed methods design tested the feasibility of protocols for a larger investigation of the effect of Nordic and ordinary walking on physical function and wellbeing in people with Parkinson's disease. There were five six week phases (ABACA); A = baseline/washout, B = ordinary walking, C = Nordic walking. A 64 year old female with an 11 year history of Parkinson's disease participated. Physical function was measured weekly with the six-minute walk test, Timed Up and Go test, and 10-metre walk test. The mobility and activities of daily living subscales of the Parkinson's Disease Questionnaire were answered at the beginning of the study and end of each phase. At the end of the study the participant was interviewed about her experiences of the walking and the physical and psychological effects. Repeated measures analysis of variance analysed the statistical physical function data and the transcribed interview data were analysed using content analysis. No significant results occurred in the expected direction for the physical function analyses. Interview analysis revealed the participant considered Nordic walking more beneficial than ordinary walking; her general health improved, and she coped better with daily activities. Future similar research should include objective measures of daily functional activities and aerobic fitness.

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Key words: Single case design, mixed methods, Nordic Walking, Parkinson's disease, physical function

INTRODUCTION

Nordic walking is an increasingly popular activity undertaken by people with Parkinson's disease. It involves walking with two poles using a reciprocal arm leg action, and is reputed to improve aerobic fitness, body strength, mobility, and coordination (van Eijkeren et al 2008). Thus far the findings of the small body of Nordic walking research show it improves physical function in people who have mild to moderate Parkinson's disease (Reuter et al 2006, van Eijkeren et al 2008).

Baatile et al (2000) and van Eijkeren et al (2008) used single group designs to examine the effects of Nordic walking on people with Parkinson's disease. Baatile et al (2000) found that by the end of an eight week course of Nordic walking participants had significantly better function ($p < 0.03$) as measured by the Parkinson's Disease Questionnaire-39 item (PDQ-39) and the Unified Parkinson's Disease Rating Scale (UPDRS). Anecdotally participants reported feeling stronger, and being able to undertake daily activities with greater ease. van Eijkeren et al (2008) had similar findings with the participants having significantly better physical function ($p < 0.01$) on the PDQ-39, the Timed Up and Go test (TUG), 10 metre walk test (10MWT) and the six minute walk test (6MWT) at the end of the Nordic walking. While both studies used reliable and valid measures of function for people with Parkinson's disease they lacked a control group and had small sample sizes of six and 19, respectively (Baatile et al 2000, van Eijkeren et al 2008).

The other two Nordic walking studies were prospective trials with comparison groups (Ebersbach et al 2010, Reuter et al 2006). Ebersbach et al (2010) randomly allocated participants to one of three groups; eight week Nordic walking programme, four week LSVT®BIG exercise programme (comprising whole body high amplitude movements), or a home programme of stretching and endurance exercises. At the end of the study the LSVT®BIG group scored significantly better ($p < 0.05$) than the other two groups on the motor performance sub-scale of the UPDRS and the TUG, but did not differ significantly on the 10MWT and the PDQ-39 scores. Reuter et al (2006) compared 12 weeks of relaxation exercises and Nordic walking, with only the latter group being significantly faster ($p < 0.05$) on the 12MWT and treadmill test, and having increased step length and step frequency. These studies' main strengths were the inclusion of comparison groups, and their large sample sizes 60 (Ebersbach et al 2010) and 68 (Reuter et al 2006). A limitation of all the Nordic walking studies of people with Parkinson's disease (Baatile et al 2000, Ebersbach et al 2010, Reuter et al 2006, van Eijkeren et al 2008) is that there was no comparison with ordinary walking.

Comparisons of Nordic walking with ordinary walking in other areas of health research have found significant improvements in physical fitness following both forms of walking in middle-aged women (Kukkonen-Harjula et al 2007) and men following acute coronary syndrome (Kocur et al 2009). In light of these findings the next step in the research of Nordic walking for people with Parkinson's disease would be to compare it with ordinary walking. It would also be useful to explore these

peoples' personal experiences of the two forms of walking and the effects on physical and psychological wellbeing.

Therefore, the purpose of this single case mixed methods, repeated measures study was to pilot the protocols in preparation for a larger investigation into Nordic walking for people with Parkinson's disease. We predicted that the participant would score significantly better on function tests at the end of the Nordic walking phase than the washout and ordinary walking phases. We also predicted that the participant's perceptions and experiences of Nordic walking and its effects on her physical and psychological well-being would be more positive than ordinary walking.

METHODS

Study Design

This mixed methods, single subject repeated measures ABACA design consisted of five six-week phases. The sequential order of the phases were: initial baseline (A), ordinary walking programme (B), ordinary walking washout (A), the Nordic walking programme (C), and Nordic walking washout (A). During the A phases (baseline and washout) the participant did not undertake a formal walking programme but no other restrictions were placed on her normal daily activities and exercise. Physical function was measured repeatedly throughout the study, and at the end of the study a semi-structured interview explored the participant's experiences and effects of the two types of walking.

Participant

The 64 year old female participant was diagnosed with Parkinson's disease 11 years ago. At the time of recruitment she was in fulltime employment, taking Sinemet medications, had no other medical disorders, and not involved in regular physical activity. Her Hoehn and Yahr score was 2.5 and the Mini Mental Score Examination (MMSE) was 29. Prior to diagnosis she was involved in competitive individual sports. During the study the participant's medications were not altered and she remained in good general health.

Walking Interventions

Ordinary and Nordic walking followed the same protocol, with the participant walking twice weekly for six weeks on predominantly flat pathways, commencing in a local park and progressing to roadside footpaths. Each session lasted an hour and consisted of a warm up, ordinary or Nordic walking and a cool down. A physiotherapist trained as a Nordic walking instructor, supervised the participant during the Nordic and ordinary walking sessions. For both the ordinary and Nordic walking, the participant walked with a reciprocal arm leg pattern. Nordic walking also involved the use of the specifically designed Nordic walking poles measured to suit the participant. For the last two weeks of the walking phases, the participant was encouraged to undertake one additional walking session per week without the supervisor, but accompanied by another person.

Measures

The 6MWT measured walking endurance, by recording the distance (metres) walked as quickly and safely as possible during the six minutes and the number of rests required (Hill et al 2005). The test has been shown to have high test-retest reliability (ICC=0.95) in people with mild to moderate Parkinson's disease (Canning et al 2006, Schenkman et al 1997).

The TUG test measured the ability to carry out sequential locomotor tasks, by timing how long it took for the participant to rise from sitting in a chair, walk three metres at a comfortable speed, turn, and return to the sitting position (Hill et al 2005). The test has high inter-rater reliability (ICC (3,1) = 0.999), and high test-retest reliability ($F(4,44) = 0.67$, $p = 0.613$) (Morris et al 2001).

The 10MWT measured timing and spatial aspects of walking. The participant walked as quickly as possible along a 12 metre flat walkway, with the middle 10 metres being timed. This test has high test-retest reliability in people with Parkinson's disease when tested seven days apart (ICC = 0.93) (Urquhart et al 1999).

The PDQ-39 is a list of potential difficulties people with Parkinson's disease may have encountered in their daily lives over the past month (Marinus et al 2002). It consists of eight subscales, but only the 10-item mobility and six-item activities of daily living scales were used, because they evaluate physical function. The participant responded to the items using a five point Likert scale to indicate the extent of difficulty she experienced with each activity (*never* = 1 to *always* = 5). Examples of the items were *had difficulty doing the leisure activities which you would like to do* (mobility subscale) and *had difficulty dressing yourself* (activities of daily living). The PDQ-39 mobility and activities of daily living subscales have high internal consistency with Cronbach alphas of 0.89 and 0.83 respectively (Peto et al 1995).

The participant's age, sex, employment status, history of Parkinson's disease, current Parkinson's disease medications, other medical disorders, her current level of physical activity and that prior to her diagnosis of Parkinson's disease were recorded. The participant's cognitive mental status was tested using the MMSE (Crum et al 1993), and the level of her Parkinson's disease related disability was scored using the Hoehn and Yahr staging scale (Stebbings and Goetz 1998).

Procedure

Ethical approval was obtained from the Auckland University of Technology Ethics Committee. Prior to giving written informed consent, the participant was provided with verbal and written information about the study procedures and her role in it.

Initially the participant completed the demographic and Parkinson's disease characteristics questionnaire. She was tested on the MMSE and the Hoehn and Yahr scale, and completed the PDQ-39 mobility and physical activity sub-scales, the TUG, 10MWT and the 6MWT. Then the six week phases commenced with the participant being measured weekly on the TUG, 10MWT and the 6MWT. These measurements were conducted at the same time of day, and along the same carpeted walking track. At the end of each study phase she completed the two PDQ-39 sub-scales. The number of walking sessions was recorded at the end of each walking phase.

Following the Nordic walking washout phase, a semi-structured interview (45 minutes) was held, that used an interview schedule to explore the participant's experiences with both forms of

walking, and her perceptions of how each affected her physical and psychological well-being. Open ended questions were the triggers for discussion, such as 'How did you find it walking with the Nordic poles as compared with ordinary walking?', 'What other aspects of your life have been influenced by Nordic walking?' and 'What do you think that contributed most to your continuing to Nordic walk?'. The participant's interview was digitally recorded and transcribed by one of the researchers.

Data Analysis

Statistical data were analysed descriptively using SPSS version 17, with the study-wise alpha set at 0.05. The number of completed sessions for each form of walking was compared with the number of prescribed walking sessions. Means and standard deviations were calculated for the TUG, 10MWT, the 6MWT and the PDQ-39 mobility and activities of daily living subscales for each of the study phases.

To test the prediction that the participant would score significantly better on physical function tests during and following the Nordic walking phase than the washout and ordinary walking phases, repeated measures within subjects analysis of variance (ANOVA) were undertaken. When significant differences were found for these analyses, post-hoc paired *t*-tests were conducted. Bonferroni corrections were used to reduce Type 1 errors, with the test-wise alpha level being set at 0.01 for the analysis of the TUG, 10MWT and 6MWT as there were five comparisons. These comparisons were between sequential phases, baseline with ordinary walking, ordinary walking with its washout, ordinary walking washout with Nordic walking, and Nordic walking with its washout; and between ordinary and Nordic walking. The TUG, 10MWT and 6MWT data for each phase were graphed with the inclusion of trend lines.

The adjusted test-wise alpha level for the PDQ-39 subscale analyses was set at 0.008 because there were six comparisons between beginning and end of baseline, end of baseline and ordinary walking, end of ordinary walking and ordinary walking washout, end of ordinary walking washout and Nordic walking, and end of Nordic walking and Nordic walking washout; and between the end of the ordinary walking and Nordic walking phases.

Initially the three researchers independently read the interview transcript, and then used content analysis to identify meaningful units that explained the participant's perceptions and experiences of Nordic and ordinary walking. Then the researchers met to compare their individual analyses looking for similarities and differences. Where there were differences these were discussed to reach a consensus. Finally the resultant themes and descriptions were validated in discussion with the participant.

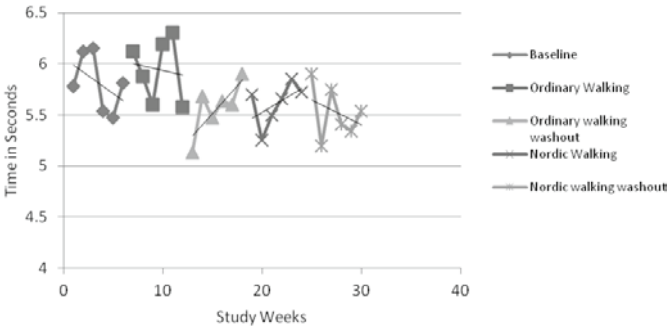
RESULTS

The participant attended all the prescribed sessions for each form of walking.

Physical Function

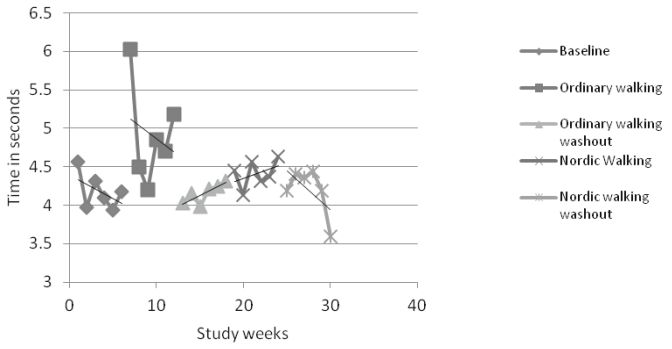
The scores for the TUG showed very little variation ranging from 5.20 seconds to 6.31 seconds (see Figure 1). There was very little difference in time taken to complete the TUG during each phase. The repeated measures ANOVA showed no significant differences for TUG between each of the phases ($F(4,2) = 3.36$, $p = 0.226$).

Figure 1: Weekly Timed Up and Go measurements during each study phase.



The scores for the 10MWT ranged from 6.31 seconds to 3.59 seconds, and as can be seen in Figure 2 the times for the ordinary walking phase were slightly longer than the other four phases. No significant differences were found between the scores on the 10MWT for each phase ($F(4,2) = 30.96$, $p = 0.032$).

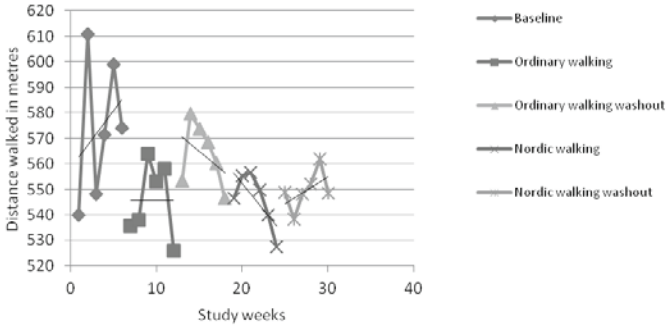
Figure 2: Weekly Ten Metre Walk Test times during each study phase.



The distances walked in the 6MWT ranged from 525.8 metres to 610.7 metres (Figure 3). While there was some variation within each phase for the distance walked, the trend line for the baseline data indicated slightly longer distances than the other four phases. The repeated measures ANOVA did not reveal any significant differences in the 6MWT scores ($F(4,2) = 24.76$, $p = 0.039$).

The repeated measures ANOVA revealed a significant difference in the PDQ-39 mobility scale scores ($F(5,5) = 19.00$, $p < 0.003$). Post-hoc paired *t*-tests identified only one significant difference, which occurred between the PDQ-39 mobility scores at the end of the Nordic walking and the Nordic walking washout phases ($t(9) = 1.22$, $p < 0.001$). The repeated measures ANOVA of the PDQ-39 activities of daily living subscale revealed no significant difference ($F(4,2) = 0.85$, $p = 0.605$).

Figure 3: Weekly Six Minute Walk Test distances measured during each study phase.



As can be seen in Table 1 the means for the PDQ-39 mobility and activities of daily living scales were low with very little variation amongst them.

Table 1: Descriptive statistics for the PDQ-39 mobility and activities of daily living subscales

	PDQ-39 Mobility Subscale	PDQ-39 Activities of Daily Living
Beginning of study	1.50 SD 0.53	1.50 SD 0.84
End of baseline	1.10 SD 0.32	1.50 SD 1.22
End of ordinary walking	1.10 SD 0.32	1.50 SD 0.55
End of ordinary walking washout	1.40 SD 0.70	1.33 SD 0.82
End of Nordic walking	0.90 SD 0.32	1.67 SD 1.21
End of Nordic walking washout	0.20 SD 0.42	1.00 SD 1.26

Participant's Experiences of the Walking and the Effects on her Health and Wellbeing

The interview content formed three categories.

Experiences of the Nordic walking programme: The participant reported that it was important for her to undertake the Nordic walking programme with a trained instructor with clinical knowledge of Parkinson's disease, because she did not have to justify her symptoms. The progressive manner in which the walking phases were implemented gave the participant confidence with her walking:

> *Starting on flat surfaces first, that are not near road traffic - like at the park and university grounds, meant I could concentrate on Nordic walking; I didn't need to think about where I was going... That helped with my confidence so that I was not distracted by all the road noises and people going past. After six weeks, I became less conscious of the poles; I did not need to think all the time about how to walk with them. The poles became an extension of my arms. Once I had mastered all of what is involved, I found I was self-correcting and walking quite confidently.*

She also noted that it was easier for her if the supporting person walked in front rather than beside or behind: *"Then I could match their stride and focus on walking 'right' and not be distracted as so easily happens when one has PD"*. In addition, walking with a designated person meant that the participant was committed to undertake the prescribed programme:

> *I think having a commitment to meet someone at a specific planned time was most important. Let's face it; what I really felt like doing some mornings was to stay in bed! It would have been easy to make excuses to myself if I did not know I had to meet you.*

General health: The participant noted that over the Nordic walking phase, changes occurred in her general wellbeing especially with her appetite, sleep and energy levels. With regard to appetite, the participant commented: *After a couple of weeks of Nordic walking I actually felt hungry again! ... I hadn't realized that I had not felt that for a while.* Changes occurred with her sleep: *I had been worried about having to use sedatives to sleep. A few weeks into the programme... I cut my dose and found I was able to get back to sleep after waking in the night.* Four months after completing the programme, the participant was not taking sedatives and was sleeping better.

The participant reported improved energy levels:

> *Initially when I started the walking phase of the programme I came back to work feeling quite tired. So I would rest and even go to sleep for 20 minutes or so. By the last two weeks of the Nordic walking phase I actually felt more energized! I would ... get through an afternoon of work without needing a rest. My mind functioned better.*

Physical and psychological wellbeing: When using the poles the participant found she could overcome some of her physical and psychological limitations due to Parkinson's disease:

> *I am surprised at how much it has helped with my walking and balance. ... It helped me regain things I didn't know I had lost. ... I started feeling my body again. Before, when I was walking, I had to stay inside my body to make sure I didn't slip and so on. Now I am actually using my body again. So instead of being trapped inside myself, I feel freer. With my poles I feel more confident. I stride more and am not so tempted to take those Parkinsonian small steps. ... Now I am not thinking 'Oh oh, I am going to slip' or 'Oh oh, I am going to fall over'.*

The participant was able to go to places that she could not previously, which broadened her social participation:

> *The poles opened up my world again. I am not so overwhelmed on social occasions. I used to hesitate going where I knew there was going to be a crowd – especially if there was a possibility that there would not be seats provided. Now I just take my poles and use them as supports and that helps. ... When I have my poles, I am more confident to try walking on surfaces that would have made me hesitate before. Even gravel tracks on hills... I am also more confident to look around me when I am walking. Not just at my feet and the path right in front of me. Instead of just hearing the birds, I can now look at them.*

When not using the poles, improvements were also found in everyday activities:

> *Nordic walking changed the way I do things – the way I move without the poles – getting out of bed or up from a chair, walking up and down stairs, and getting dressed. I do these things more easily and quicker now.*

She also reported that her general fitness improved and her competitive nature was rekindled as a consequence of the Nordic walking:

> *It made my body work harder – it got me fitter. I guess the swinging of my arms, conscious movement of my hips and striding out more. I puff more too. I don't get so dizzy either...During the walking programme I found myself constantly competing with myself – could I walk further and walk faster and so on. I like the feeling of being challenged and challenging myself.*

DISCUSSION

Our findings did not support the prediction that the participant would score significantly better on the function tests (TUG, 10MWT, 6MWT and the PDQ-39 mobility and activities of daily living subscales) during and following the Nordic walking

phase than the washout and ordinary walking phases. The only comparison that did show a significant difference was between the PDQ-39 mobility subscale scores at the end of the Nordic walking and Nordic walking washout phases, but this was not in the anticipated direction. The graphed data revealed that in comparison to the two walking phases, the participant was slightly quicker on the TUG and the 10MWT, and she walked further in the 6MWT in the washout phases. Conversely, she had positive perceptions of Nordic walking, both physically and psychologically. There are aspects of our study and its contradictory findings that warrant discussion.

The use of a mixed methods design provided an insight into the participant's experiences of Nordic walking and its effects on her wellbeing that would not have been possible by using solely quantitative measures. van Eijkeren et al (2008) suggested that the positive effects of Nordic walking on people with Parkinson's disease could be due to an improvement in their general health, and the provision of rhythmic cueing. Our participant's interview comments support these notions. She noticed an improvement in her general health during the Nordic walking because she felt she had more energy, over time she did not need to rest after the Nordic walking sessions, and her quality of sleeping improved.

The benefits of Nordic walking also extended into her everyday activities, with her reporting that she was able to get out of bed more easily, which is a known difficulty for people with Parkinson's disease (Levine et al 2000). By walking behind the supervisor, she was able to match her stride which could be indicative of either imitation or external cueing (Kukkonen-Harjula et al 2007). Further, by the end of the six weeks of Nordic walking she realised that she did not have to think about walking with poles, suggesting that Nordic walking became a more automatic behaviour with practice. However, this automaticity could also have been caused by the progressive manner in which she was introduced to Nordic walking (Magill 2011). The participant found that commencing the Nordic walking on flat surfaces in quiet areas, such as parks, allowed her to concentrate on learning this form of walking, which in time enabled her to progress to walking on uneven terrain and in busier areas. In addition, walking with the supervisor had a positive effect on her adherence to the walking programmes, because she had committed to meeting with a person at a specified time, which is a known facilitator of exercise adherence (Sniehotta et al 2005).

Our study's measures were chosen because they had previously shown differences in physical function following physical activity interventions for people with Parkinson's disease (Ebersbach et al 2010, Kluding and McGinnis 2006, Reuter et al 2006, van Eijkeren et al 2008). Nonetheless our participant's scores on the TUG, 10MWT and the 6MWT did not differ significantly between the study phases. Her scores on each of these measures were either better than or within the norms for people of her age; the TUG times were quicker than those of community dwelling women of her age (8 SD 2 seconds) (Steffen et al 2002); her 6MWT distances were within the range (53 SD 92 metres) for healthy community dwelling females aged 60 to 69 years (Steffen et al 2002); and her 10MWT times were faster than the mean group scores (7.90 to 6.58 seconds) in the Ebersbach et al (2010) study. Similarly, our participant's PDQ-39 mobility and activities of daily living subscales scores were low, indicating that she experienced few problems with these activities.

There are four possible reasons for our participant's better than expected test scores. First, she exhibited a competitive attitude to the tests, which may have been a reason for the lack of stability in the 6MWT distances during the baseline phase. Second, the six week duration of the two walking programmes may not have been long enough to show any significant differences between them. Third, the TUG and the 10MWT may not be able to show the full effect of Nordic walking on the physical function of people with mild to moderate Parkinson's disease. Instead, the assessment of these peoples' physical fitness might be more suitable. While the 6MWT does measure physical fitness, the use of the Åstrand-Rhyming test would provide more precise information about the participants' cardiovascular fitness. This test has been successfully used for this purpose with people with Parkinson's disease (Levine et al 2000), and would further strengthen the measurement of endurance. Moreover, the TUG and 10MWT only assess a single task, and are not designed to evaluate the physical abilities required to perform everyday activities (Schenkman et al 2002). An observational measure, such as the Continuous Scale Physical Functional Performance 10-item version (CS-PFP-10, Cress et al 2005) may be more appropriate. This measure consists of 10 daily activities, presented in an incremental order, and has been successfully used in the community (Cress et al 2005). Fourth, weekly measuring of the TUG, 10MWT and 6MWT throughout the entire duration of the study may have led to a practice effect, which may have been responsible in part for these tests' high scores.

This study's strengths were the mixed methods design which provided a broad perspective of the effects of Nordic walking, and the repeated measurement of physical function throughout each phase of the study which enabled robust statistical analysis of these data. The limitations were the sample size of one, the use of single task measures of physical function, and the short duration of the walking programmes.

In light of the limitations of this study the findings should be applied clinically with caution. Nonetheless, the increasing popularity of Nordic walking for people with Parkinson's disease and its reputed beneficial effects point to it being appropriate for inclusion in physiotherapy programmes. Physiotherapists' knowledge of clinical and exercise science makes them ideally suited to become involved in Nordic walking, and to use it to improve the physical fitness of people with mild to moderate Parkinson's disease.

As a pilot study it has highlighted a number of areas that should be addressed in future research into Nordic walking for people with mild to moderate Parkinson's disease. Using a mixed methods design that involves comparing ordinary and Nordic walking over a period of two to three months should enable the true worth of the intervention to be shown. Measurements should be taken at the beginning and end the walking programmes, and at a follow-up time. The measures should include objective tests of daily activities and physical fitness; and the use of a semi-structured interview to explore physical and psychological wellbeing. To ensure that participants are walking at a maximal yet safe intensity, they should base their perceived exertion on the aerobic capacity test results (Levine et al 2000).

In conclusion, no significant differences in the predicted direction were found on the physical function tests between any

of the sequential study phases and the two forms of walking, which may be due in part to the measures used and their timing. However the participant perceived Nordic walking was beneficial physically and psychologically, and that these benefits extended into her everyday activities. Finally future research should compare Nordic walking with ordinary walking using a mixed methods design, and include objective observational measures of daily functional activity and physical fitness.

KEY POINTS

- No significant improvements in physical function were found following either ordinary walking or Nordic walking.
- The participant reported that during the Nordic walking phase her general health and physical and psychological wellbeing improved, but this did not occur during the ordinary walking phase.
- The non-significant findings may be due to the physical function tests not being comprehensive enough to show change in activities of daily living.
- Nordic walking could be part of physiotherapy exercise programmes designed to maintain physical fitness in people with Parkinson's disease.

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ADDRESS FOR CORRESPONDENCE

Dr Sandra Bassett, Senior Lecturer, School of Rehabilitation and Occupation Studies, Auckland University of Technology, Auckland, New Zealand. Email: sandra.bassett@aut.ac.nz

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