INTERVAL ACTIVE-ASSISTED CYCLING INTERVENTION IMPROVES MOTOR FUNCTION IN INDIVIDUALS’ WITH PARKINSON’S DISEASE

A thesis submitted to the
Kent State University College
of Education, Health, and Human Services
in partial fulfillment of the requirements
for the degree of Master of Science

By
Kayla A. Wilson
May 2013
The purpose of this study was to determine the effects of a four-week interval active-assisted (AAC) cycling protocol on motor function in individuals with Parkinson’s disease (PD). Unified Parkinson’s disease Rating Scale (UPDRS), upper extremity motor function (Kinesia), Berg Balance Scale, balance, and quality of life were assessed. Individuals with idiopathic PD (N=7) were randomly assigned to an exercise group or a control group. The exercise group came into the laboratory three times a week for four weeks and completed a thirty-minute interval AAC protocol, which consisted of a five minute warm up and cool down. The control group only came for base and post testing. Testing included motor function (UPDRS and Kinesia), balance (Biodex Balance System SD and Berg), quality of life (PDQ-39), and cardiovascular fitness (3-minute step test). All testing was done at baseline and at the end of the four-weeks, except for cardiovascular fitness. Data was analyzed by calculating the change scores and then an independent samples t-test between the groups. Significance was found in an eyes open, firm surface condition (CTSIB1) of balance and UPDRS, but not upper extremity motor function, showing that AAC does improve some symptoms of PD.
ACKNOWLEDGEMENTS

I would like to thank a number of individuals for their contributions and assistance. Without their help, this project would have not been possible.

I would like start with a special thank you to my family, John, Diana, and Kelsey Wilson. Their love and support has gone above and beyond throughout my career thus far. The encouragement they have bestowed upon me has been treasured and I am forever grateful.

I would like to thank our research team, as they worked very hard and diligently, especially Bobby Phillips. His encouragement and support during this stressful time was very much appreciated. Special thank you to John Feyesh, Malcolm Semple, and Nick White. I would also like to thank my faculty members for their continued leadership and support, Dr. Barkley (committee member), Dr. McDaniel (committee member), and Dr. Glickman. A special thank you to Dr. Ridgel for taking me on as her first thesis student and guiding me in the right direction. She was a huge part of my collegiate experience and I have always been thankful for the encouragement, guidance, and opportunities.

Lastly, I would like to thank all of my subjects for dedicating their time and effort to this research study.
# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>CHAPTER</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACKNOWLEDGMENTS</td>
<td>iii</td>
</tr>
<tr>
<td>LIST OF FIGURES</td>
<td>v</td>
</tr>
<tr>
<td>LIST OF TABLES</td>
<td>vi</td>
</tr>
<tr>
<td>I. BACKGROUND</td>
<td>1</td>
</tr>
<tr>
<td>II. PURPOSE</td>
<td>6</td>
</tr>
<tr>
<td>III. METHODOLOGY</td>
<td>7</td>
</tr>
<tr>
<td>IV. RESULTS</td>
<td>12</td>
</tr>
<tr>
<td>V. DISCUSSION</td>
<td>23</td>
</tr>
<tr>
<td>APPENDICIES</td>
<td>28</td>
</tr>
<tr>
<td>APPENDIX A LETTER OF CONSENT</td>
<td>29</td>
</tr>
<tr>
<td>APPENDIX B UNIFIED PARKINSSON’S DISEASE RATING SCALE</td>
<td>33</td>
</tr>
<tr>
<td>APPENDIX C BERG BALANCE SCALE</td>
<td>38</td>
</tr>
<tr>
<td>APPENDIX D PARKINSON’S DISEASE QUESTIONNAIRE</td>
<td>44</td>
</tr>
<tr>
<td>REFERENCES</td>
<td>48</td>
</tr>
</tbody>
</table>
# LIST OF FIGURES

<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>UPDRS Overall Motor Score change from baseline for groups</td>
<td>13</td>
</tr>
<tr>
<td>2</td>
<td>The individual performance for the exercise group in the UPDRS Motor Score</td>
<td>14</td>
</tr>
<tr>
<td>3</td>
<td>The individual performance for the control group in the UPDRS Motor Score</td>
<td>15</td>
</tr>
<tr>
<td>4</td>
<td>UPDRS Upper Body Motor Function change from baseline for groups</td>
<td>16</td>
</tr>
<tr>
<td>5</td>
<td>UPDRS Bradykinesia change from baseline for groups</td>
<td>16</td>
</tr>
<tr>
<td>6</td>
<td>CTSIB1 score from baseline for groups</td>
<td>19</td>
</tr>
<tr>
<td>7</td>
<td>The individual performance for the exercise group in CTSIB1</td>
<td>19</td>
</tr>
<tr>
<td>8</td>
<td>The individual performance for the control group in CTSIB1</td>
<td>20</td>
</tr>
</tbody>
</table>
## LIST OF TABLES

<table>
<thead>
<tr>
<th>Figure</th>
<th>Table Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Exercise Model</td>
<td>8</td>
</tr>
<tr>
<td>2</td>
<td>Participant Characteristics</td>
<td>13</td>
</tr>
<tr>
<td>3</td>
<td>Change Scores for all dependent variables. All negative values represent a decrease in score. *Denotes significance (p≤0.05).</td>
<td>17</td>
</tr>
<tr>
<td>4</td>
<td>Change Scores for all dependent variables. All negative values represent a decrease in score. *Denotes significance (p≤0.05).</td>
<td>17</td>
</tr>
<tr>
<td>5</td>
<td>Change Scores for all dependent variables. All negative values represent a decrease in score. *Denotes significance (p≤0.05).</td>
<td>21</td>
</tr>
<tr>
<td>6</td>
<td>Change Scores for all dependent variables. All negative values represent a decrease in score. *Denotes significance (p≤0.05).</td>
<td>22</td>
</tr>
</tbody>
</table>
CHAPTER I

BACKGROUND

Parkinson’s disease (PD) is a progressive and disabling neurodegenerative disorder that is frequently seen in the elderly population, most often occurring after the age of 55 (Beiske, Loge, Ronningen, & Svensson, 2008). Based on a prevalence rate of 16 to 19 per 100,000 per year, it is anticipated that more than 2 million Americans, and 6 million people worldwide, suffer from PD (Morris, Martin, & Schenkman, 2010).

Parkinson’s disease develops when dopaminergic neurons in the midbrain die and stop producing the neurotransmitter dopamine. This neurotransmitter is responsible for the ability of movement through the interaction of neurons in the basal ganglia and substantia nigra (Triarhou, 2000). This disease is defined as the presence of two out of four cardinal symptoms: akinesia (bradykinesia), tremor at rest, rigidity, and postural instability (Morris, Martin, & Schenkman, 2010; Jankovic, 2008). Other symptoms include late-onset postural instability, reduced sense of smell, and micrographia; which is a progression of frequently smaller handwriting and/or tiny, cramped handwriting (Rao, Hofmann, & Shakil, 2006). Clinically, a defining characteristic of PD is that the patient must respond to levodopa or a dopamine agonist (Rao, Hofmann, & Shakil, 2006). These medications are used to help reduce the symptoms of Parkinson’s disease (Fahn et al., 2004) but do not slow progression. Complications with balance and motor function frequently arise and, as a result, individuals suffer from loss of independence, anxiety,
increases in falls, injuries, and physical inactivity. People with PD also often experience difficulty in social interaction and with participation in recreational activities, which results in low overall life satisfaction (Sehanovic, Dostovic, Smajlovic, & Avdibegovic, 2011). Furthermore, the lack of recreational and physical activities can lead to chronic health problems such as cardiovascular disease and osteoporosis (Keus, Bloem, Hendriks, Bredero-Choen, & Munneke, 2007). Therefore, the ultimate goal in treating PD is to help maintain quality of life and maximal independence (Rao, Hofmann, & Shakil, 2006).

Additionally, people suffering from PD show difficulty with complexity of movement and activities of daily living (Dibble, Christensen, Ballard, & Foreman, 2008). This is due to lack of balance and motor function capabilities. Balance deficits and low muscle strength can lead to an increase in falls and fall-related injuries (Dibble, Christensen, Ballard, & Foreman, 2008). Fall related injuries are a common cause of morbidity in the elderly population, and even more so in those with PD (Dibble and Lange, 2006). Dibble and Lange (2006) looked at 45 individuals with PD and compared their balance performance through five different balance assessments. They showed that regardless of the performance on the clinical balance tests, the complexity of the nature of postural instability in PD might require numerous tests to get the most precise identification of fall risk in this population.

There are several pharmacologic and surgical treatments for those with PD. In the early stages of PD, some people may receive drugs such as monoamine oxidase-B (MAO-B) or an anticholinergic; however it is generally recommended for most individuals to take levodopa or a dopamine agonist (Rao, Hofmann, & Shakil, 2006).
Levodopa is said to be better when an individual needs to improve motor disability and is the most effective pharmacologic treatment, while dopamine agonists are said to be better to decrease motor difficulties through the direct stimulation of dopamine receptors (Rao, Hofmann, & Shakil, 2006). Surgery for PD is becoming more popular due to improvements in neurological techniques and brain imaging (Rao, Hofmann, & Shakil, 2006). Surgery has been recommended for those with severe motor impairment and motor complications, such as dyskinesias and fluctuations, because of the disease (Goetz, Poewe, Rascol, & Sampaio, 2005). One type of surgery is deep brain stimulation (DBS), which is the stimulation of the subthalamic nucleus. This improves motor function and lessens motor fluctuations, pharmacologic use, and dyskinesias (Goetz, Poewe, Rascol, & Sampaio, 2005). Another type of surgery is unilateral pallidotomy, which is a placement of an electrode in the Globus Pallidus. This surgery also improves motor complications, however it is done less often due to the fact that it can cause damaging lesions (Goetz, Poewe, Rascol, & Sampaio, 2005).

Even though the new advancements in medicine and surgical procedures have proved useful for some with PD, sooner or later the deficits can sometimes be too complex to treat in this manner. There comes a point when a PD patient suffers from “dopa-resistant” motor and non-motor symptoms (Rascol, Payoux, Ory, Ferreira, Brefel-Courbon, & Montastruc, 2003). These symptoms include speech impairment, abnormal posture, gait and balance problems, pain, sleep and mood problems, cognitive issues, and autonomic dysfunction (Rascol, Payoux, Ory, Ferreira, Brefel-Courbon, & Montastruc, 2003). In particular, balance deficits are not improved by dopaminergic medications
and Matinolli et al. (2011) stated that these medications showed insignificant responses when it came to balance deficits. Unlike rigidity, bradykinesia, and tremor, symptoms such as speech disorders and gait/balance instabilities are much less responsive to pharmacologic management (Ebersback, Edler, Kaufhold, & Wissel, 2008). Particularly in the late stages of PD, the dopaminergic medication dosages that are required to decrease symptoms often result in dyskinesias or uncontrollable movements (Bonnet, Loria, Saint-Hilaire, Lhermitte, & Agid, 1987).

However, exercise programs and rehabilitation interventions appear to be an effective way to hinder or reverse the functional decline for people with PD (Keus, Bloem, Hendriks, Bredero-Choen, & Munneke, 2007). Rehabilitative therapy for people with PD has been accepted and is advocated in order to manage the impairments that pharmacologic medications cannot help (Ebersback, Edler, Kaufhold, & Wissel, 2008). Miyai, Fujimoto, & Yamamoto (2002) used body-weight supported treadmill training and showed immediate and long term effects in gait parameters that continued for about four months after training. Gait and balance improved in those with PD after whole body vibration therapy and physical therapy in patients with PD (Ebersback, Edler, Kaufhold, & Wissel, 2008). Physical activity has proved to be valuable in many ways in regards to the symptoms and harsh social difficulties people with PD experience. Hirsch, Toole, Maitland, & Rider (2003) showed that muscle strength and balance improved in groups that participated in high-intensity resistance training, as well as balance training, for a four week period. Herman, Giladi, Gruendlinger, & Hausdorff (2007) had PD patients walk on a treadmill four times a week for 30 minutes and showed improvements in their
Unified Parkinson’s disease Rating Scale (UPDRS) and gait speed. UPDRS is a scale that originated as an effort to provide complete, flexible, and effectual means to monitor PD related disabilities and impairments through the combination of existing scales (Fahn & Elton, 1987). Physical interventions related to improving balance and muscular strength could potentially reduce the risk of falling (Hirsch, Toole, Maitland, & Rider, 2003). This would likely increase quality of life and independence in people with PD.

Another therapy modality developed by Ridgel, Peacock, Fickes, & Ho-Kim (2012) showed improvements in tremor and bradykinesia through a high cadence cycling intervention for those with PD. This was done to examine physiological limitations associated with those who have this disease. This cycling paradigm was unique in that it was an active-assisted protocol, meaning the bike used a motor to assist the subjects. Not only were there improvements in bradykinesia and tremor, the active-assisted cycling (ACC) was well tolerated by the subjects, without undue fatigue.

Even though studies have shown that exercise interventions can improve gait and postural deficits in PD the mechanism responsible for long-term benefits is still unclear. Therefore, it is crucial to come up with some sort of rehabilitative mechanism to minimize the deficits PD patients undergo on a day-to-day basis.
CHAPTER II

PURPOSE

The current study will look at the effects of an interval-active assisted cycling protocol on balance and activities of daily living in individuals with Parkinson’s disease. Evidence supports exercise as being beneficial in regards to physical functioning, health-related quality of life, strength, balance and gait speed for people suffering from this neurological disease (Goodwin, Richards, Taylor, Taylor, & Campbell, 2008). A recent study showed improvements in postural stability, as well as UPDRS scores, after interval-active assistive cycling (Fickes, 2012). However, the low sample size of this previous study limits the power of the results. Therefore, the results from this investigation will ultimately be combined with the existing data from Fickes (2012). We hypothesize that through this cycling intervention people with Parkinson’s disease will improve their balance deficits, as well as quality of life.
CHAPTER III

METHODOLOGY

Individuals, age 50-79, with idiopathic Parkinson’s disease, were recruited to participate in the study. Interested participants were asked the American Heart Association and the American College of Sports Medicine (ACSM) pre-screening questionnaires for risk stratification purposes. In order to qualify, the participants had to have no contraindications to exercise and no cardiovascular, metabolic, or respiratory disease. Those that were accepted filled out further health history forms to evaluate physical health. Physician’s clearance was obtained from subjects who were considered moderate risk according the American College of Sports Medicine (ACSM) guidelines (ACSM, 2010). Ten subjects were originally scheduled, however due to time commitments and health concerns, three subjects dropped out before or during data collection. Informed consent was collected from each participant before the start of the study according to the guidelines of The Kent State University Institutional Review Board.

The individuals came to the Exercise Physiology Laboratory at Kent State University and were randomized into either an exercise (N=3), or control (N=4) group. The exercise group reported to the lab three times a week for four weeks. Cycling exercise was completed on a motorized recumbent bike, Motomed Viva 2. Each session began with a five minute warm up followed by thirty minutes of interval-active assisted cycling, and ended with a five-minute cool down. The warm up and cool down were
strictly passive exercise where the motor of the bike did the work for the participants.

The interval-active assisted cycling protocol is designed to cycle through different revolutions per minute (RPM) throughout the session. The participant was asked to exert a certain amount of RPMs for each phase value and if they did not actively exert enough effort, the motor would kick in. The table below shows the exercise model in detail. The control group came in for testing at week zero and then again at week four, and did not complete any exercise.

Table 1. *Exercise Model*

<table>
<thead>
<tr>
<th></th>
<th>Phase 1</th>
<th>Phase 2</th>
<th>Phase 3</th>
<th>Phase 4</th>
<th>Phase 5</th>
<th>Phase 6</th>
<th>Phase 7</th>
<th>Phase 8</th>
<th>Phase 9</th>
<th>Phase 10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gear</td>
<td>20</td>
<td>20</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>RPM</td>
<td>55</td>
<td>20</td>
<td>90</td>
<td>75</td>
<td>65</td>
<td>90</td>
<td>65</td>
<td>90</td>
<td>60</td>
<td>45</td>
</tr>
<tr>
<td>Time (min)</td>
<td>2:30</td>
<td>2:30</td>
<td>5:00</td>
<td>4:00</td>
<td>6:00</td>
<td>8:00</td>
<td>3:00</td>
<td>4:00</td>
<td>2:30</td>
<td>2:30</td>
</tr>
<tr>
<td>Passive/Active</td>
<td>Passive</td>
<td>Passive</td>
<td>Active</td>
<td>Active</td>
<td>Active</td>
<td>Active</td>
<td>Active</td>
<td>Active</td>
<td>Passive</td>
<td>Passive</td>
</tr>
</tbody>
</table>

At the first meeting, participants performed a baseline fitness assessment test, balance evaluation and motor function tests. The baseline fitness assessment was done using the 3-minute step test to calculate an estimated VO₂ max value (ACSM, 2010). Balance was assessed using the Biodex Balance System SD and the Berg Balance Scale. The Biodex Balance System SD analyzes the ability to maintain postural stability on an unstable surface and the ability to move the center of mass within the limits of stability.
utilizing a circular platform that moves in the anterior-posterior and medial-lateral axes. Participants performed three different tests, (1) the postural stability test, (2) modified clinical test of sensory integration and balance (M-CTSIB) test, and (3) the fall risk assessment test. The postural stability test evaluates the participant’s ability to maintain center of balance (Biodex Medical Systems, p. 8-2). The score derives from how much the participant deviates from center (Biodex Medical Systems, p. 8-2). There is an overall score of postural stability, an anterior/posterior score, and a medial/lateral score to assess the sway in those directions. The M-CTSIB test assesses balance on a static surface and evaluates how well a participant can combine various senses with respect to balance and compensation of balance when senses are compromised (Biodex Medical Systems, p. 8-18). There are four conditions, each of which had a stability score, eyes open; firm surface (CTSIB-1), eyes closed; firm surface (CTSIB-2), eyes open; foam surface (CTSIB-3), eyes closed; foam surface (CTSIB-4). The fall risk test evaluates the possibility of falling for individuals compared to an age dependent norm (Biodex Medical Systems, p. 8-14). The higher the score, the more likely the individual is to fall. Each test was followed with a minute of rest before proceeding to the next one. Quantitative balance scores were analyzed for postural stability, sensory integration, and fall risk. The Berg Balance Scale (Berg, Maki, Williams, Holliday, & Wood-Dauphinee, 1992) was also administered to evaluate impairment in balance function in the participants. This is achieved by testing the performance of functional tasks. There are 14 functional tasks that receive a score from 0 to 4 after completion. A score of 0 meant the participant was
at the lowest functioning level and a score of 4 meant they were at the highest functioning level. After all the tasks were completed the scores were added to get a score from 0 to 96.

Motor function was assessed using Kinesia Motor Assessment System (Cleveland Medical Devices, Cleveland, OH) and the UPDRS Motor III clinical scale. Kinesia measures upper extremity motor function. The system uses a sensor that is placed on the index finger of the most affected hand of the participant (Ridgel, Peacock, Fickes, & Ho-Kim, 2012). The finger sensor uses three orthogonal accelerometers and three orthogonal gyroscopes to record motion (Ridgel, Peacock, Fickes, & Ho-Kim, 2012). This device gives quantitative scores, from 0-4, for the degree of tremor and bradykinesia. Scores are given for resting, postural, and kinetic tremor. There are 7 upper extremity motor tests that are completed and three variables are produced, amplitude, speed, and frequency. The UPDRS Motor III clinical scale is a clinical test, combined with different sections, which observe upper and lower extremity tremor, bradykinesia and rigidity, walking, posture and balance. This scale was used to evaluate fourteen different tests that were scored on a scale from 0-4 and the total was added with the highest score being 96. A score of 0 means the individual is normal and a score of 4 represents the highest severity of Parkinson’s disease symptoms.

Finally, quality of life was assessed using the PDQ-39 (Peto, Jenkinson, Fitzpatrick, & Greenhall, 1995). This questionnaire was used to determine the participant’s self-perceived quality of life relating to their specific Parkinson’s disease symptoms.
All testing, except for the submaximal exercise test, was repeated at the end of the study.

**Statistical Analysis**

All data was analyzed via SPSS 18.0 software. The change scores between pre-testing and post-testing were calculated prior to analysis. An independent samples t-test was conducted to determine significance. Statistical significance was set at 95% confidence interval (p≤0.05).
CHAPTER IV

RESULTS

The purpose of this study was to examine if four weeks of interval active-assisted cycling improved balance, motor function and quality of life in individuals with PD.

Participant Demographics

Seven individuals completed the study (N=3 exercise, N= 4 control). An independent samples t-test showed no significant differences between the exercise group and the control group (Table 2) in demographics (Age, p= .456; Height, p= .577 Weight, p= .199 Hoehn and Yahr, p= .386; Estimated VO$_{2max}$, p= .478; and Resting Heart Rate (RHR), p= .305).

Motor Function

Unified Parkinson’s disease Rating Scale (UPDRS)

The UPDRS Motor Scores were assessed to test overall motor function. An independent t-test determined there was significance (p= .040) between groups (exercise and control). There was a 44.1% improvement in overall UPDRS motor score for the exercise group compared to a 10.8% decline in the control group motor score. Figure 1 shows the change from baseline for each group in the UPDRS overall motor score. A positive change represents an improvement in PD motor symptoms.
Table 2. Participant Characteristics

<table>
<thead>
<tr>
<th></th>
<th>Age (years)</th>
<th>Height (cm)</th>
<th>Weight (lbs)</th>
<th>Hoehnn &amp; Yahr</th>
<th>VO₂ Max (ml kg⁻¹ min⁻¹)</th>
<th>Resting Heart Rate (bpm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exercise</td>
<td>75</td>
<td>170</td>
<td>205</td>
<td>3</td>
<td>73.53</td>
<td>74</td>
</tr>
<tr>
<td></td>
<td>69</td>
<td>177.5</td>
<td>185</td>
<td>2</td>
<td>78.15</td>
<td>63</td>
</tr>
<tr>
<td></td>
<td>65</td>
<td>183</td>
<td>208</td>
<td>2</td>
<td>68.49</td>
<td>76</td>
</tr>
<tr>
<td>Average</td>
<td>69.67±5.03</td>
<td>176.83±6.53</td>
<td>199.33±12.50</td>
<td>2.33±.578</td>
<td>73.39±4.83</td>
<td>71.00±7.00</td>
</tr>
<tr>
<td>SD</td>
<td>53</td>
<td>185.5</td>
<td>260</td>
<td>2</td>
<td>74.37</td>
<td>65</td>
</tr>
<tr>
<td>Control</td>
<td>60</td>
<td>188</td>
<td>175</td>
<td>2</td>
<td>71.01</td>
<td>54</td>
</tr>
<tr>
<td></td>
<td>65</td>
<td>183</td>
<td>195</td>
<td>1</td>
<td>80.67</td>
<td>52</td>
</tr>
<tr>
<td></td>
<td>70</td>
<td>177.5</td>
<td>190</td>
<td>4</td>
<td>61.77</td>
<td>73</td>
</tr>
<tr>
<td>Average</td>
<td>62.00±7.26</td>
<td>183.50±4.49</td>
<td>205.00±37.64</td>
<td>2.25±1.26</td>
<td>71.96±7.88</td>
<td>61.00±9.83</td>
</tr>
<tr>
<td>SD</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Figure 1.** UPDRS Overall Motor Score change from baseline for groups
Each participant was individually evaluated from week 0 to week 4 in their overall UPDRS motor score. Figures 2 and 3 show the difference from pre to post in each individual from both groups. A decrease in the UPDRS score represents an improvement in PD symptoms. The exercise group all improved, while the control group stayed about the same or declined in performance.

Subject 1 improved by 38.1%, subject 2 improved by 52.9%, and subject 3 improved by 30.8%.

Figure 2. The individual performance for the exercise group in the UPDRS Motor Score
Subject 1 remained the same, subject 2 improved by 9.4%, subject 3 declined by 42.9%, and subject 4 declined by 22.9%.

Figure 3. The individual performance for the control group in the UPDRS Motor Score

Each individual component of the UPDRS score was assessed to determine which motor function variable exhibited the greatest changes. The individual components were lower body motor function, upper body motor function, tremor, bradykinesia, gait and posture. An independent samples t-test revealed significance between the groups in upper body motor function (p=.007) and bradykinesia (p=.044). There was a 33.4% improvement in upper body motor function for the exercise group compared to a 27.91% decline in the control group upper body motor function. Figures 4 and 5 show the change from baseline in both groups for upper body motor function and bradykinesia. There was no significant change in lower body motor function (p=.244), tremor (p=.793), gait (p=.203), or posture (p=.900). The change score for each group for all variables are shown in Table 3.
**Figure 4.** UPDRS Upper Body Motor Function change from baseline for groups

**Figure 5.** UPDRS Bradykinesia change from baseline for groups
Table 3. *Change Scores for all dependent variables. All negative values represent a decrease in score.* *Denotes significance (p≤0.05).*

<table>
<thead>
<tr>
<th>Variable</th>
<th>Exercise Group Change</th>
<th>Control Group Change</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>UPDRS Total</td>
<td>-10.00</td>
<td>2.75</td>
<td>.040*</td>
</tr>
<tr>
<td>Lower Body Function</td>
<td>-3.67</td>
<td>-0.25</td>
<td>.244</td>
</tr>
<tr>
<td>Upper Body Function</td>
<td>-2.67</td>
<td>3.25</td>
<td>.007*</td>
</tr>
<tr>
<td>Tremor</td>
<td>0.67</td>
<td>0.25</td>
<td>.793</td>
</tr>
<tr>
<td>Bradykinesia</td>
<td>-4.67</td>
<td>3.00</td>
<td>.044*</td>
</tr>
<tr>
<td>Posture</td>
<td>-0.67</td>
<td>-0.75</td>
<td>.900</td>
</tr>
<tr>
<td>Gait</td>
<td>-1.00</td>
<td>-0.5</td>
<td>.203</td>
</tr>
<tr>
<td>Rigidity</td>
<td>-0.67</td>
<td>1.00</td>
<td>.468</td>
</tr>
</tbody>
</table>

**Kinesia**

Kinesia was used to evaluate upper body motor function through a series of seven different tests. From these tests, the software calculated three different scores: resting tremor, posture tremor, and kinetic tremor.

An independent samples t-test revealed no significant interaction between groups in the overall tremor score (p= .779), resting tremor score (p= .698), posture tremor score (p= .682), and kinetic tremor (p= .339). Table 4 shows the change score for each group for all variables.

Table 4. *Change Scores for all dependent variables. All negative values represent a decrease in score.* *Denotes significance (p≤0.05).*

<table>
<thead>
<tr>
<th>Variable</th>
<th>Exercise Group Change</th>
<th>Control Group Change</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kinesia</td>
<td>0.05</td>
<td>-0.21</td>
<td>.779</td>
</tr>
<tr>
<td>Rest Tremor</td>
<td>0.26</td>
<td>0</td>
<td>.698</td>
</tr>
<tr>
<td>Posture Tremor</td>
<td>-0.08</td>
<td>-0.21</td>
<td>.682</td>
</tr>
<tr>
<td>Kinetic Tremor</td>
<td>-0.13</td>
<td>0.0025</td>
<td>.339</td>
</tr>
</tbody>
</table>
Balance

**Biodex Balance System SD**

Participants completed three separate tests to measure balance; the postural stability test, the modified clinical test of sensory integration and balance, and the fall risk test. The overall score for postural stability between groups showed no significant difference after the independent samples t-test ($p = .366$). The individual components of the postural stability test were anterior/posterior stability and medial/lateral stability. The independent samples t-test revealed no significance between groups for anterior/posterior ($p = .558$) and medial/lateral ($p = .402$) stability. Table 5 shows the change score for each group for all variables.

There were four separate tests for the modified clinical test of sensory integration and balance (CTSIB). The test scores were analyzed individually. CTSIB1 was a condition in which the participant stood on the force plate with eyes open on a firm surface. The change from baseline between groups is shown in Figure 6. The independent samples t-test showed significance between the groups ($p = .007$). There was a 12.49% improvement in the exercise group and the control group showed a 31.36% decline. Figures 7 and 8 show the difference from pre to post in each individual from both groups. A decrease in score represents an improvement of symptoms. There was no significant difference between groups in CTSIB2 (eyes closed, firm surface) ($p = .659$), CTSIB3 (eyes open, foam surface) ($p = .277$), and CTSIB4 (eyes closed, foam surface) ($p = .601$) after the independent samples t-test. Table 5 displays the change score for each group for all variables.
Subject 1 improved by 8.6%, subject 2 improved by 16.3%, and subject 3 improved by 13.2%.

*Figure 6.* CTSIB1 score from baseline for groups.

*Figure 7.* The individual performance for the exercise group in CTSIB1.
Subject 1 declined by 17.1%, subject 2 declined by 26.9%, subject 3 declined by 39.6%, and subject 4 declined by 44.4%.

Figure 8. The individual performance for the control group in CTSIB1

The fall risk test was done for all individuals. There were three separate trials and the mean score was taken. An independent samples t-test showed no significant difference between groups (p= .420). Table 5 shows the change score for each group for all variables.

Berg Balance Scale

Berg Balance Scale change scores are shown in Table 5. An independent samples t-test revealed no significance between groups (p= .545). Table 3 displays the change score for each group for this variable.
Table 5. Change Scores for all dependent variables. All negative values represent a decrease in score. *Denotes significance (p≤0.05).

<table>
<thead>
<tr>
<th>Variable</th>
<th>Exercise Group Change</th>
<th>Control Group Change</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Postural Stability</td>
<td>-0.17</td>
<td>-0.03</td>
<td>.366</td>
</tr>
<tr>
<td>A/P Stability</td>
<td>-0.13</td>
<td>-0.08</td>
<td>.558</td>
</tr>
<tr>
<td>M/L Stability</td>
<td>-0.10</td>
<td>0.05</td>
<td>.402</td>
</tr>
<tr>
<td>CTSIB1</td>
<td>-0.07</td>
<td>0.19</td>
<td>.007*</td>
</tr>
<tr>
<td>CTSIB2</td>
<td>-0.32</td>
<td>-0.13</td>
<td>.659</td>
</tr>
<tr>
<td>CTSIB3</td>
<td>0.1</td>
<td>-0.32</td>
<td>.277</td>
</tr>
<tr>
<td>CTSIB4</td>
<td>0.11</td>
<td>-0.41</td>
<td>.601</td>
</tr>
<tr>
<td>Fall Risk Test</td>
<td>0.1</td>
<td>-0.05</td>
<td>.420</td>
</tr>
<tr>
<td>Berg Balance Scale</td>
<td>1.67</td>
<td>0.5</td>
<td>.545</td>
</tr>
</tbody>
</table>

Parkinson’s disease Questionnaire (PDQ) 39

The PDQ was given to participants to determine quality of life. The overall score was assessed, as well as the individual components. There were no significant differences (p = .557) in the overall score. An independent samples t-test revealed no significant differences between groups in the individual components, mobility (p= .493), activities of daily living (ADLs) (p= .795), emotional well being (EWB) (p= .301), stigma (p= .846), social support (p= .437), cognition (p= .486), communication (p= .382), bodily discomfort (BD) (p= .431). Table 6 shows the change score for each group for these variables.
Table 6. *Change Scores for all dependent variables. All negative values represent a decrease in score. *Denotes significance (p≤0.05)*

<table>
<thead>
<tr>
<th>Variable</th>
<th>Exercise Group Change</th>
<th>Control Group Change</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>PDQ</td>
<td>3.67</td>
<td>-3</td>
<td>.557</td>
</tr>
<tr>
<td>Mobility</td>
<td>1.67</td>
<td>-0.75</td>
<td>.493</td>
</tr>
<tr>
<td>ADLs</td>
<td>-1.33</td>
<td>-2</td>
<td>.795</td>
</tr>
<tr>
<td>EWB</td>
<td>2</td>
<td>-1</td>
<td>.301</td>
</tr>
<tr>
<td>Stigma</td>
<td>-0.67</td>
<td>-0.5</td>
<td>.846</td>
</tr>
<tr>
<td>Support</td>
<td>0</td>
<td>0.25</td>
<td>.437</td>
</tr>
<tr>
<td>Cognition</td>
<td>0.33</td>
<td>-0.5</td>
<td>.468</td>
</tr>
<tr>
<td>Communication</td>
<td>1.33</td>
<td>-0.25</td>
<td>.382</td>
</tr>
<tr>
<td>BD</td>
<td>0.33</td>
<td>1.75</td>
<td>.431</td>
</tr>
</tbody>
</table>
CHAPTER V

DISCUSSION

There have been many studies addressing exercise and its benefits on Parkinson’s disease symptoms through resistance, aerobic, and balance modalities. There are still, though, questions about what ideal mechanism is the best. This includes frequency, mode, intensity, and duration of exercise. The active-assisted cycling program was different because it used a high cadence, interval protocol and the motor assisted the participants when necessary.

This study showed significance in overall UPDRS motor scores. The exercise group showed a significant improvement in their score after the four-week intervention compared to the control group. Other significant improvements within the exercise group were the individual components of UPDRS in upper body motor function and bradykinesia. The significance within these individual components are interesting due to the fact that lower body exercise alone is helping upper body movement and bradykinesia. Other studies have found improvements in UPDRS motor score after exercise. Reuter, Engelhardt, Stecher, & Baas (1999) conducted a study using an exercise training program twice a week for fourteen weeks with individuals who had slight to moderate PD. They found significant improvements in the UPDRS overall score after the exercise program. Much like the active assisted protocol used in this study, Ridgel, Vitek, & Alberts (2009) used a forced exercise program where a trainer biked with the subject on a stationary tandem bike for eight weeks. They found a 39%
improvement in UPDRS scores in the forced exercise group compared to the voluntary exercise group. It may even be suggested that exercise could be more beneficial in improving UPDRS scores than physical therapy. After four weeks, body weight supported treadmill training improved UPDRS overall scores in PD patients significantly more than physical therapy (Miyai et al., 2000). In the current study, and in the body weight supported treadmill training, the participants had the help of assistive devices, however, they performed with more exertion over an extended period of time. This could be why there are improvements in UPDRS scores in intervention groups. Another reason may be a learning effect of the muscles due to the repeated pattern of the exercise routine.

Although there was no significance in most of the balance testing, there were significant improvements in the CTSIB1 scores in the exercise group. This is when the participant stood on a firm surface with eyes open. This supports other research done on PD and balance (Hirsch, Toole, Maitland, & Rider, 2003; Toole, Maitland, Warren, Hubmann, & Panton, 2005). Hirsch, Toole, Maitland, & Rider (2003) combined resistance exercise and balance training and found that this group, compared to just balance training, improved their sensory orientation. Toole, Maitland, Warren, Hubmann, & Panton, (2005) tested treadmill walking on a weighted group (wore a weighted scuba vest), an un-weighted group (assisted by device), and a control group (no loading or unloading). They found improvements in balance and dynamic stability in all groups, no matter what type of intervention. However, balance research can be very broad in terms of results. Some studies, like the current study, showed no significance in Berg Balance Scale scores after exercise. A six-week exercise program on a treadmill
showed no improvements in the Berg Balance scores (Toole, Hirsch, Forkink, Lehman, & Maitland, 2000) but there was an increase in scores after an eight-week incremental speed-dependent treadmill program (Cakit, Saracoglu, Genc, Erdem, & Inan, 2007). These findings could have differing results due to the variability of the disease or the type of exercise being done. Our study was on a bicycle, so the subject was seated and that could contribute to why we did not find more improvements in balance; whereas another study showed that a tango dance group improved significantly in the Berg Balance Scale compared to an exercise class for those with PD (Hackney, Kantorovich, Levin, & Earhart, 2007). Another reason the results may be so different is because of the medications PD patients are on. Dopaminergic medications do not respond to balance deficits (Bloem et al., 2004), and therefore, researching posture and postural instability is a challenge.

Our current study showed no significant improvements in PDQ scores, which is contrary to other studies. An eight-week individualized exercise program showed an increase in the overall PDQ score and the individual components, leading to an increased quality of life (Baatile, Langbein, Weaver, Maloney, & Jost, 2000). It has been generally accepted that exercise does improve health related quality of life in individuals with PD (Goodwin, Richards, Taylor, Taylor, & Campbell, 2008). However, others have also shown that exercise has no effect on self-perceived quality of life. A six-month exercise program, where individuals participated in exercise classes and at home activities, did not find an improvement in PDQ scores (Allen et al., 2010). All of this variability could have to do with the time in which the PDQ was given. Peto, Jenkinson, & Fitzpatrick
(1998) found that a short time frame for a study may result in minor changes in the PDQ. Our study was only four weeks, which may have been too short to exhibit changes in the PDQ.

The mechanism behind the improvements in PD symptoms is still unknown, however one could reason it may have to do with the continuous exercise program having a learning effect on the muscles or the assisted device helping the subject exercise without undue fatigue. The variability of this disease and its symptoms are on such a large spectrum. Therefore, we can assume one reason why improvements were not seen in certain variables, such as balance and quality of life, may have to do with this inconsistency. Future research should focus on controlling entrance criteria so that each participant has similar symptoms and disease progression. Another direction may be to make the whole intervention longer, and at a higher intensity throughout. Studies that have looked at high intensity eccentric resistance training (Dibble, Hale, Marcus, Gerber, & LaStayo, 2009) and high intensity resistance training (Hirsch, Toole, Maitland, & Rider, 2003; Dibble, Hale, Marcus, Droge, Gerber, & LaStayo, 2006) have found improvements in bradykinesia, quality of life, and mobility/balance. It could then be postulated that the higher the intensity the better improvement of symptoms. Lastly, trying this study, or a similar study, with participants off their medication to see if there are different effects from exercise and to see if the dosage could potentially be lowered.

There were several limitations to this study. First, the sample size was very small. An addition of participants may be very beneficial for the power of this study. Second, the variability among the participants was high and may have impacted the results.
Lastly, the quality of life questionnaire may have been skewed due to the seasonal environment.

In closing, the active-assisted protocol showed significance in some areas that prove to be very difficult for patients with PD like stability and upper extremity motor function. This shows that assisted exercise can be very beneficial for people with PD, and may help alleviate some symptoms these individuals encounter on a day-to-day basis.
APPENDICES
APPENDIX A

LETTER OF CONSENT
APPENDIX A

LETTER OF CONSENT

Informed Consent to Participate in a Research Study

Title: Interval Active-Assisted Cycling Intervention Improves Motor Function in Individuals’ With Parkinson’s disease

Principal Investigator: Kayla Wilson, BS

You are being invited to participate in a research study. This consent form will provide you with information on the research project, what you will need to do, and the associated risks and benefits of the research. Your participation is voluntary. Please read this form carefully. It is important that you ask questions and fully understand the research in order to make an informed decision. You will receive a copy of this document to take with you.

PURPOSE

The purpose of this study is to determine whether cycling can improve balance, motor function in individuals with Parkinson’s disease.

PROCEDURES

We are looking for individuals 50 -79 years of age with mild to moderate idiopathic Parkinson’s disease. If you chose to participate then you will be asked to visit the lab for twelve sessions over a four week period (three times per week). You will then be randomly placed into one of two groups: 1) control (no exercise) or 2) interval active-assisted cycling. At the first session, your movement and balance will be tested. During the remaining sessions, you will complete a 5 minute cycling warm-up session followed by 30 minute cycling exercise and finishing with a 5 minute cycling cool-down. If you are in the control group you will be asked to report to the lab only on testing days and will not complete any exercise. Testing will be repeated every two weeks during the study.

BENEFITS

The potential benefits of participating in this study may include improved movement and/or balance for a period of time after the sessions. Your participation in this study will also help us to better understand how exercise can be used for rehabilitation in Parkinson’s disease.
RISKS AND DISCOMFORTS

There are risks or discomforts associated with this study such as muscle soreness. With any exercise session there is also a risk of a heart attack or stroke. Every effort will be made to minimize risks using information from your medical health survey. If you experience any sensation that is unusual or uncomfortable, please tell the staff and they will stop the session.

There is also a risk of falling since some of the research involves standing or moving around the room. To minimize this risk, two research assistants will be with you at all times and precautions will be taken to ensure your stability. We will also transport you in a wheelchair, if necessary, for your safety.

Medical treatment by the University Health Center is provided only to currently registered students. Please be advised that for all other injuries, emergency services will be called for those occurring on the Kent State University campus. You or your medical insurance will be billed for this service. No other medical treatment or financial compensation for injury from participation in this research project is available.

PRIVACY AND CONFIDENTIALITY

Your study related information will be kept confidential within the limits of the law. Any identifying information will be kept in a secure location and only the researchers will have access to the data. Research participants will not be identified in any publication or presentation of research results; only aggregate data will be used. Your research information may, in certain circumstances, be disclosed to the Institutional Review Board (IRB), which oversees research at Kent State University, or to certain federal agencies. Confidentiality may not be maintained if you indicate that you may do harm to yourself or others.

COMPENSTATION

Individuals in the cycling group will receive a gift card for $10 per training week ($40 at completion of study). Individuals in the control group will receive $5 per testing session ($15 at completion of study).

VOLUNTARY PARTICIPATION

Taking part in this research study is entirely up to you. You may choose not to participate or you may discontinue your participation at any time without penalty or loss of benefits to which you are otherwise entitled. You will be informed of any new, relevant information that may affect your health, welfare, or willingness to continue your study participation.
CONTACT INFORMATION

If you have any questions or concerns about this research, you may contact Kayla Wilson, BS at 330.672.0203 or Angela Ridgel, PhD at 330.672.7495. This project has been approved by the Kent State University Institutional Review Board. If you have any questions about your rights as a research participant or complaints about the research, you may call the IRB at 330.672.2704.

CONSENT STATEMENT AND SIGNATURE

I have read this consent form and have had the opportunity to have my questions answered to my satisfaction. I voluntarily agree to participate in this study. I understand that a copy of this consent will be provided to me for future reference.

______________________________________________________________
Participant Signature                                      Date
APPENDIX B

UNIFIED PARKINSON’S DISEASE RATING SCALE
APPENDIX B

UNIFIED PARKINSON’S DISEASE RATING SCALE

III. MOTOR EXAMINATION

18. Speech
0 = Normal.
1 = Slight loss of expression, diction and/or volume.
2 = Monotone, slurred but understandable; moderately impaired.
3 = Marked impairment, difficult to understand.
4 = Unintelligible.

19. Facial Expression
0 = Normal.
1 = Minimal hypomimia, could be normal "Poker Face".
2 = Slight but definitely abnormal diminution of facial expression.
3 = Moderate hypomimia; lips parted some of the time.
4 = Masked or fixed facies with severe or complete loss of facial expression; lips parted 1/4 inch or more.

20. Tremor at rest (head, upper and lower extremities)
0 = Absent.
1 = Slight and infrequently present.
2 = Mild in amplitude and persistent. Or moderate in amplitude, but only intermittently present.
3 = Moderate in amplitude and present most of the time.
4 = Marked in amplitude and present most of the time.

21. Action or Postural Tremor of hands
0 = Absent.
1 = Slight; present with action.
2 = Moderate in amplitude, present with action.
3 = Moderate in amplitude with posture holding as well as action.
4 = Marked in amplitude; interferes with feeding.
22. **Rigidity**
0 = Absent.
1 = Slight or detectable only when activated by mirror or other movements.
2 = Mild to moderate.
3 = Marked, but full range of motion easily achieved.
4 = Severe, range of motion achieved with difficulty.

23. **Finger Taps** (Patient taps thumb with index finger in rapid succession.)
0 = Normal.
1 = Mild slowing and/or reduction in amplitude.
2 = Moderately impaired. Definite and early fatiguing. May have occasional arrests in movement.
3 = Severely impaired. Frequent hesitation in initiating movements or arrests in ongoing movement.
4 = Can barely perform the task.

24. **Hand Movements** (Patient opens and closes hands in rapid succession.)
0 = Normal.
1 = Mild slowing and/or reduction in amplitude.
2 = Moderately impaired. Definite and early fatiguing. May have occasional arrests in movement.
3 = Severely impaired. Frequent hesitation in initiating movements or arrests in ongoing movement.
4 = Can barely perform the task.

25. **Rapid Alternating Movements of Hands** (Pronation-supination movements of hands, vertically and horizontally, with as large an amplitude as possible, both hands simultaneously.)
0 = Normal.
1 = Mild slowing and/or reduction in amplitude.
2 = Moderately impaired. Definite and early fatiguing. May have occasional arrests in movement.
3 = Severely impaired. Frequent hesitation in initiating movements or arrests in ongoing movement.
4 = Can barely perform the task.
26. **Leg Agility** (Patient taps heel on the ground in rapid succession picking up entire leg. Amplitude should be at least 3 inches.)

- 0 = Normal.
- 1 = Mild slowing and/or reduction in amplitude.
- 2 = Moderately impaired. Definite and early fatiguing. May have occasional arrests in movement.
- 3 = Severely impaired. Frequent hesitation in initiating movements or arrests in ongoing movement.
- 4 = Can barely perform the task.

27. **Arising from Chair**

(Patient attempts to rise from a straightbacked chair, with arms folded across chest.)

- 0 = Normal.
- 1 = Slow; or may need more than one attempt.
- 2 = Pushes self up from arms of seat.
- 3 = Tends to fall back and may have to try more than one time, but can get up without help.
- 4 = Unable to arise without help.

28. **Posture**

- 0 = Normal erect.
- 1 = Not quite erect, slightly stooped posture; could be normal for older person.
- 2 = Moderately stooped posture, definitely abnormal; can be slightly leaning to one side.
- 3 = Severely stooped posture with kyphosis; can be moderately leaning to one side.
- 4 = Marked flexion with extreme abnormality of posture.

29. **Gait**

- 0 = Normal.
- 1 = Walks slowly, may shuffle with short steps, but no festination (hastening steps) or propulsion.
- 2 = Walks with difficulty, but requires little or no assistance; may have some festination, short steps, or propulsion.
- 3 = Severe disturbance of gait, requiring assistance.
- 4 = Cannot walk at all, even with assistance.

30. **Postural Stability** (Response to sudden, strong posterior displacement produced by pull on shoulders while patient erect with eyes open and feet slightly apart. Patient is prepared.)

- 0 = Normal.
- 1 = Retropulsion, but recovers unaided.
- 2 = Absence of postural response; would fall if not caught by examiner.
- 3 = Very unstable, tends to lose balance spontaneously.
- 4 = Unable to stand without assistance.
31. **Body Bradykinesia and Hypokinesia** (Combining slowness, hesitancy, decreased armswing, small amplitude, and poverty of movement in general.)

0 = None.
1 = Minimal slowness, giving movement a deliberate character; could be normal for some persons. Possibly reduced amplitude.
2 = Mild degree of slowness and poverty of movement which is definitely abnormal. Alternatively, some reduced amplitude.
3 = Moderate slowness, poverty or small amplitude of movement.
4 = Marked slowness, poverty or small amplitude of movement.
APPENDIX C

BERG BALANCE SCALE
APPENDIX C

BERG BALANCE SCALE

GENERAL INSTRUCTIONS

Please demonstrate each task and/or give instructions as written. When scoring, please record the lowest response category that applies for each item.

In most items, the subject is asked to maintain a given position for specific time. Progressively more points are deducted if the time or distance requirements are not met, if the subject's performance warrants supervision, or if the subject touches an external support or receives assistance from the examiner. Subjects should understand that they must maintain their balance while attempting the tasks. The choices of which leg to stand on or how far to reach are left to the subject. Poor judgment will adversely influence the performance and the scoring.

Equipment required for testing are a stopwatch or watch with a second hand, and a ruler or other indicator of 2, 5 and 10 inches (5, 12.5 and 25 cm). Chairs used during testing should be of reasonable height. Either a step or a stool (of average step height) may be used for item #12.
1. SITTING TO STANDING
INSTRUCTIONS: Please stand up. Try not to use your hands for support.
( ) 4 able to stand without using hands and stabilize independently
( ) 3 able to stand independently using hands
( ) 2 able to stand using hands after several tries
( ) 1 needs minimal aid to stand or to stabilize
( ) 0 needs moderate or maximal assist to stand

2. STANDING UNSUPPORTED
INSTRUCTIONS: Please stand for two minutes without holding.
( ) 4 able to stand safely 2 minutes
( ) 3 able to stand 2 minutes with supervision
( ) 2 able to stand 30 seconds unsupported
( ) 1 needs several tries to stand 30 seconds unsupported
( ) 0 unable to stand 30 seconds unassisted
If a subject is able to stand 2 minutes unsupported, score full points for sitting unsupported. Proceed to item #4.

3. SITTING WITH BACK UNSUPPORTED BUT FEET SUPPORTED ON FLOOR OR ON A STOOL
INSTRUCTIONS: Please sit with arms folded for 2 minutes.
( ) 4 able to sit safely and securely 2 minutes
( ) 3 able to sit 2 minutes under supervision
( ) 2 able to sit 30 seconds
( ) 1 able to sit 10 seconds
( ) 0 unable to sit without support 10 seconds

4. STANDING TO SITTING
INSTRUCTIONS: Please sit down.
( ) 4 sits safely with minimal use of hands
( ) 3 controls descent by using hands
( ) 2 uses back of legs against chair to control descent
( ) 1 sits independently but has uncontrolled descent
( ) 0 needs assistance to sit
5. TRANSFERS
INSTRUCTIONS: Arrange chairs(s) for a pivot transfer. Ask subject to transfer one way toward a seat with armrests and one way toward a seat without armrests. You may use two chairs (one with and one without armrests) or a bed and a chair.
( ) 4 able to transfer safely with minor use of hands
( ) 3 able to transfer safely definite need of hands
( ) 2 able to transfer with verbal cueing and/or supervision
( ) 1 needs one person to assist
( ) 0 needs two people to assist or supervise to be safe

6. STANDING UNSUPPORTED WITH EYES CLOSED
INSTRUCTIONS: Please close your eyes and stand still for 10 seconds.
( ) 4 able to stand 10 seconds safely
( ) 3 able to stand 10 seconds with supervision
( ) 2 able to stand 3 seconds
( ) 1 unable to keep eyes closed 3 seconds but stays steady
( ) 0 needs help to keep from falling

7. STANDING UNSUPPORTED WITH FEET TOGETHER
INSTRUCTIONS: Place your feet together and stand without holding.
( ) 4 able to place feet together independently and stand 1 minute safely
( ) 3 able to place feet together independently and stand for 1 minute with supervision
( ) 2 able to place feet together independently and to hold for 30 seconds
( ) 1 needs help to attain position but able to stand 15 seconds feet together
( ) 0 needs help to attain position and unable to hold for 15 seconds

8. REACHING FORWARD WITH OUTSTRETCHED ARM WHILE STANDING
INSTRUCTIONS: Lift arm to 90 degrees. Stretch out your fingers and reach forward as far as you can. (Examiner places a ruler at end of fingertips when arm is at 90 degrees. Fingers should not touch the ruler while reaching forward. The recorded measure is the distance forward that the finger reach while the subject is in the most forward lean position. When possible, ask subject to use both arms when reaching to avoid rotation of the trunk.)
( ) 4 can reach forward confidently >25 cm (10 inches)
( ) 3 can reach forward >12.5 cm safely (5 inches)
( ) 2 can reach forward >5 cm safely (2 inches)
( ) 1 reaches forward but needs supervision
( ) 0 loses balance while trying/ requires external support
9. PICK UP OBJECT FROM THE FLOOR FROM A STANDING POSITION
INSTRUCTIONS: Pick up the shoe/slipper which is placed in front of your feet.
( ) 4 able to pick up slipper safely and easily
( ) 3 able to pick up slipper but needs supervision
( ) 2 unable to pick up but reaches 2-5cm (1-2 inches) from slipper and keeps balance independently
( ) 1 unable to pick up and needs supervision while trying
( ) 0 unable to try/needs assist to keep from losing balance or falling

10. TURNING TO LOOK BEHIND OVER LEFT AND RIGHT SHOULDERS WHILE STANDING
INSTRUCTIONS: Turn to look directly behind you over toward left shoulder. Repeat to the right.
(Examiner may pick an object to look at directly behind the subject to encourage a better twist turn.)
( ) 4 looks behind from both sides and weight shifts well
( ) 3 looks behind one side only other side shows less weight shift
( ) 2 turns sideways only but maintains balance
( ) 1 needs supervision when turning
( ) 0 needs assist to keep from losing balance or falling

11. TURN 360 DEGREES
INSTRUCTIONS: Turn completely around in a full circle. Pause. Then turn a full circle in the other direction.
( ) 4 able to turn 360 degrees safely in 4 seconds or less
( ) 3 able to turn 360 degrees safely one side only in 4 seconds or less
( ) 2 able to turn 360 degrees safely but slowly
( ) 1 needs close supervision or verbal cueing
( ) 0 needs assistance while turning

12. PLACING ALTERNATE FOOT ON STEP OR STOOL WHILE STANDING UNSUPPORTED
INSTRUCTIONS: Place each foot alternately on the step/stool. Continue until each foot has touched the step/stool four times.
( ) 4 able to stand independently and safely and complete 8 steps in 20 seconds
( ) 3 able to stand independently and complete 8 steps >20 seconds
( ) 2 able to complete 4 steps without aid with supervision
( ) 1 able to complete >2 steps needs minimal assist
( ) 0 needs assistance to keep from falling/unable to try
13. STANDING UNSUPPORTED ONE FOOT IN FRONT

**INSTRUCTIONS: (DEMONSTRATE TO SUBJECT)**

Place one foot directly in front of the other. If you feel that you cannot place your foot directly in front, try to step far enough ahead that the heel of your forward foot is ahead of the toes of the other foot. (To score 3 points, the length of the step should exceed the length of the other foot and the width of the stance should approximate the subject's normal stride width)

( ) 4 able to place foot tandem independently and hold 30 seconds
( ) 3 able to place foot ahead of other independently and hold 30 seconds
( ) 2 able to take small step independently and hold 30 seconds
( ) 1 needs help to step but can hold 15 seconds
( ) 0 loses balance while stepping or standing

14. STANDING ON ONE LEG

**INSTRUCTIONS: Stand on one leg as long as you can without holding.**

( ) 4 able to lift leg independently and hold >10 seconds
( ) 3 able to lift leg independently and hold 5-10 seconds
( ) 2 able to lift leg independently and hold = or >3 seconds
( ) 1 tries to lift leg unable to hold 3 seconds but remains standing independently
( ) 0 unable to try or needs assist to prevent fall

ITEM DESCRIPTION SCORE (0-4)
1. Sitting to standing _____
2. Standing unsupported _____
3. Sitting unsupported _____
4. Standing to sitting _____
5. Transfers _____
6. Standing with eyes closed _____
7. Standing with feet together _____
8. Reaching forward with outstretched arm _____
9. Retrieving object from floor _____
10. Turning to look behind _____
11. Turning 360 degrees _____
12. Placing alternate foot on stool _____
13. Standing with one foot in front _____
14. Standing on one foot _____

**TOTAL (maximum 56) _____**
0–20, wheelchair bound
21–40, walking with assistance
41–56, independent
APPENDIX D

PARKINSON’S DISEASE QUESTIONNAIRE
APPENDIX D

PARKINSON’S DISEASE QUESTIONNAIRE

Due to having Parkinson’s disease, how often during the last month have you...

Please check one box for each question

<table>
<thead>
<tr>
<th></th>
<th>Never</th>
<th>Occasionally</th>
<th>Sometimes</th>
<th>Often</th>
<th>Always</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>had difficulty doing the leisure activities you would like to do?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>had difficulty looking after your home, for example, housework, cooking or yardwork?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>had difficulty carrying grocery bags?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>had problems walking half a mile?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>had problems walking 100 yards (approximately 1 block)?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>had problems getting around the house as easily as you would like?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>had difficulty getting around in public places?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>needed someone else to accompany you when you went out?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>felt frightened or worried about falling in public?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>been confined to the house more than you would like?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>had difficulty showering and bathing?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>had difficulty dressing?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>had difficulty with buttons or shoelaces?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
14. had problems writing clearly?
15. had difficulty cutting up your food?
16. had difficulty holding a drink without spilling it?
17. felt depressed?
18. felt isolated and lonely?
19. felt weepy or tearful?
20. felt angry or bitter?
21. felt anxious?
22. felt worried about your future?
23. felt you had to hide your Parkinson's from people?
24. avoided situations which involve eating or drinking in public?
25. felt embarrassed in public?
26. felt worried about other people's reaction to you?
27. had problems with your close personal relationships?
28. lacked the support you needed from your spouse or partner?
   *If you do not have a spouse or Partner, please check here*
29. lacked the support you needed from your family or close friends?
30. unexpectedly fallen asleep during the day?
<table>
<thead>
<tr>
<th></th>
<th>had problems with your concentration, for example when reading or watching TV?</th>
</tr>
</thead>
<tbody>
<tr>
<td>32</td>
<td>felt your memory was failing?</td>
</tr>
<tr>
<td>33</td>
<td>had distressing dreams or hallucinations?</td>
</tr>
<tr>
<td>34</td>
<td>had difficulty speaking?</td>
</tr>
<tr>
<td>35</td>
<td>felt unable to communicate effectively?</td>
</tr>
<tr>
<td>36</td>
<td>felt ignored by people?</td>
</tr>
<tr>
<td>37</td>
<td>had painful muscle cramps or spasms?</td>
</tr>
<tr>
<td>38</td>
<td>had aches and pains in your joints or body?</td>
</tr>
<tr>
<td>39</td>
<td>felt uncomfortably hot or cold?</td>
</tr>
</tbody>
</table>
REFERENCES
REFERENCES


