JBACHS
Journal of Basic and Clinical Health Sciences

J Basic Clin Health Sci 2024; 8: 683-691
https://doi.org/10.30621/jbachs.1518833
RESEARCH ARTICLE

EFFECTS OF TRUNK CONTROL, UPPER AND LOWER EXTREMITY FUNCTIONS ON FUNCTIONAL ACTIVITY, ACTIVITIES OF DAILY LIVING AND QUALITY OF LIFE IN PARKINSON'S DISEASE

Taskin Ozkan[1], Yasemin Ates Sari[2], Aybike Erkoc[3], Yesim Sucullu Karadag[4], Nezehat Ozgul Unluer[5]

[1] Giresun University, Vocational School of Health Services, Therapy and Rehabilitation, Giresun, Turkey
[2] Ankara Yıldırım Beyazıt University, Faculty of Health Sciences, Physiotherapy and Rehabilitation Department, Ankara, Turkey
[3] Ankara Yıldırım Beyazıt University, Institute of Health Sciences, Department of Physiotherapy and Rehabilitation, Ankara, Turkey
[4] Health Sciences University, Ankara City Health Application and Research Center, Ankara, Turkey
[5] Health Sciences University, Gülhane Faculty of Physiotherapy and Rehabilitation, Ankara, Turkey

ORCID: T.O. 0000-0001-9448-0516, Y.A.S. 0000-0001-7046-5477, A.E. 0009-0006-4090-1817, Y.S.K. 0000-0003-0188-5245, N.O.U. 0000-0003-2314-0738.

Corresponding author: Taskin Ozkan, **E-mail:** fzttaskinozkan@hotmail.com
Received: 19.07.2024 **Accepted:** 25.09.2024 **Available Online Date:** 30.09.2024
©Copyright 2021 by Dokuz Eylül University, Institute of Health Sciences - Available online at https://dergipark.org.tr/en/pub/jbachs
Cite this article as: Ozkan T, Sari YA, Erkoc A, Karadag YS, Unluer NO. Effects of Trunk Control, Upper and Lower Extremity Functions on Functional Activity, Activities of Daily Lliving and Quality of Life in Parkinson's Disease. J Basic Clin Health Sci 2024; 8: 683-691.

ABSTRACT

Purpose: To investigate the relationship between trunk control, upper and lower extremity function with functional activity, activities of daily living and quality of life in patients with Parkinson's Disease (PwPD).
Materials and Methods: The study was completed with 52 PwPD. Trunk control was evaluated with the Trunk Impairment Scale (TIS); upper extremity function with 9-Hole Peg Test (9-HPT) bilaterally; lower extremity function with 30-Second Sit-To-Stand Test (30STS); functional activity level with The Parkinson Activity Scale (PAS); activities of daily living with Barthel Index (BI); quality of life with The Parkinson's Disease Quality of Life Questionnaire (PDQ-39)
Results: 30STS and right-left 9-HPT results was correlated with PAS and PDQ-39, but not with BI in PwPD. All TIS scores except the coordination sub-parameter were found to be associated with PAS, all TIS scores except the static sitting balance sub-parameter were found to be associated with BI, and all TIS scores were found to be associated with PDQ-39 in PwPD (ρ between 0.293 and 0.689; $p<0.05$ for all).
Conclusion: Physical activity level and quality of life were associated with upper and lower extremity function and trunk control, whereas activities of daily living were only associated with trunk control in PwPD. These results suggest that physiotherapy and rehabilitation applications that will improve trunk control in addition to limb functions should be included in treatment protocols.

Keywords: Parkinson's Disease, trunk control, extremity function, activity level, daily living activity, quality of life

INTRODUCTION

In progressive Parkinson's Disease (PD), early motor problems such as tremor, rigidity, akinetic components and postural instability and late complications such as fluctuations, dyskinesias and behavioural disorders lead to serious deficiencies in all functional activities of patients (1). Tremor is the most common and most easily recognised finding of PD. It usually has unilateral onset. Although it is mostly seen in the hands, it may also occur in the feet, legs, arms, jaw, lips and tongue. In addition, postural and action tremor may also be observed, which adversely affects trunk control and balance. In addition to tremor, bradykinesia causes difficulty or decreased speed of finger, wrist, arm and leg movements. Bradykinesia primarily involves distal muscle groups, followed by proximal groups. Distal finger muscles are affected, resulting in difficulty in fine skills. Thus, activities such as cutting or holding food, writing, getting out of bed, dressing, bathing are affected, causing people to become dependent in their daily lives over time. Rigidity problem, which occurs in the later stages of the disease, is mostly seen in the wrist, but it also affects the neck, trunk, hip, shoulder and other joints. (2, 3). Postural instability, which is one of the motor problems of the disease, starts in the early-middle stages and increases in the following periods and adversely affects motor control (4). Motor symptoms and physical disabilities that also occur in PD limit the activities of daily living and affect the quality of life (5-7).

Functional activities of patients with PD (PwPD) are negatively affected due to rigidity, bradykinesia, loss of postural reflexes and postural instability. When the literature is analysed; it is known that upper and lower extremity function and trunk are affected activities of daily living, functional activity level and quality of life are decreased in PwPD (6-10). Choi et al. reported a positive correlation between manual dexterity and activities of daily living in PwPD (6). Stewart et al. reported that upper and lower extremity motor impairments were associated with quality of life and activities of daily living in idiopathic PD (7). The study's findings imply that manual dexterity has a significant role in predicting PwPD' physical performance in day-to-day activities. In a study of 101 PwPD, it was reported that 81% of the respondents reported difficulty in getting up from a chair and that lower extremity motor function may be affected (8). While the research has examined the impact of lower and upper extremity functions on daily living activities in PwPD, the trunk has not received enough attention. (9, 10). According to Verheyden et al., PwPD had considerably poorer scores on the trunk control scale overall score, static sitting balance subscale, and coordination subscale when compared to healthy controls (9). In the study conducted by Ünlüer et al. position sense of the trunk was evaluated in PwPD and as a result, it was shown that trunk position sense was associated with disease level, fear of falling, functional mobility, and balance (10). Although upper and lower extremity functions were analysed together or separately in these studies (6-10), the trunk remained in the background. It is important that the trunk is analysed and its effects on upper and lower extremity functions are considered together and what kind of contributions it may make to the functionality, independence and quality of life of the patients.

Nevertheless, studies on the effect of upper and lower limb function, especially the trunk, on functional activity level, quality of life and activities of daily living are limited. Masaki et al. examined the relationship between the masses and amounts of non-contractile intramuscular tissue in the trunk and lower extremity muscles and activities of daily living, mobility and balance ability and disease symptoms in PwPD (11). As a result of the study, it was reported that the characteristics of trunk and lower extremity muscles in PwPD may be critical in terms of activities of daily living, mobility and balance ability and disease symptoms. However, the use of easily applicable, accessible and cost-effective tests in our study will facilitate therapists in the evaluation of the performance of PwPD in the clinic. Examining the relationships between functional activity level, activities of daily living, and quality of life with trunk control, upper and lower extremity function in PwPD is the purpose of this research.

MATERIALS AND METHODS

Study design

This cross-sectional study was carried out at the Ankara City Hospital's Neurology Clinic between December 2023 and February 2024. The University Ethics Committee approved the study (Date: 23.11.2023 Decision No: 09-407) and the Declaration of Helsinki's tenets were adhered to in this investigation. Before beginning the study, each

participant completed a written informed consent form after learning about its goal.

Participants

Patients aged 40 years and older who had been diagnosed with PD by a neurologist using the Movement Disorder Society (MDS) diagnostic criteria and who were between stages 1-4 of the Hoehn & Yahr staging scale were included in the study. Patients with neurological diseases other than PD (MS, stroke, etc.) were not allowed to participate in the study. Every patients were medically evaluated in "on" periods (1-1.5 hours after taking the drugs).

Measurements

Age, height, weight, duration of the disease, body mass index, falling and freezing history were recorded. The following question's answer was used to determine the falling history: “Have you fallen in the last 6 months?’’ An unexpected event in which a person lands on the ground, a floor, or a lower level was defined as a fall (12). Patients with PD were classified as fallers if they reported one or more falls. Freezing of gait was defined by an episodic block to generating effective stepping despite the intention to walk and freezing history of the patients in the last 6 months was recorded (13). Disease stage was performed by a neurologist and other assessments were performed by a physiotherapist. Two-minute rest breaks were given during the evaluation. During the tests, the patient was stood next to the patient for safety.

Disease stage was evaluated with Hoehn & Yahr Scale (HYS). HYS analyses PD in 5 stages. Stage 1-2 is classified as mild, stage 3 as moderate and stage 4-5 as severe disability (14). The increase in the stage of the disease indicates that the disease progresses and its severity increases. Patients with stages 1-4 according to HYS were determined by the neurologist and referred to the physiotherapist for evaluation.

The Trunk Impairment Scale (TIS) was used to assess trunk control. There are 3 sections and 17 parameters in the scale. The sections of test are coordination, dynamic sitting balance, and static sitting balance. There is a minimum of 0 and a maximum of 23 points for the overall score. Higher score is considered to indicate better performance (9).

The 9-Hole Peg Test (9-HPT) was used to assess upper extremity function. 9-HPT is a hand dexterity test, was used to evaluate upper extremity function. There is a platform with nine holes and nine sticks in the test. In order to conduct the test, the platform is positioned immediately in front of the patients, and the holes are on the non-dominant hand side and the rods on the dominant hand side. The chance to practice before the test is offered to the persons following an explanation of the test guidelines. Patients are instructed to quickly place the rods on the board. Then, they are instructed to take out nine rods with the same hand, one at a time, and the time is noted. The test was repeated for the nondominant side with the same method (15). For every side, the test was repeated twice, and the mean time was noted in seconds.

Lower extremity function was assessed with the 30-Second Sit-To-Stand Test (30STS). During the test, patients were instructed to sit on a chair (approximately 48 cm high) with their feet on the floor and arms crossed in front of their chest (to prevent their arms from being pushed when coming to an upright standing position), and then quickly and safely stand up and sit down for 30 seconds. The assessor provides standardised instructions and demonstrates several repetitions of standing up without sitting down to avoid any misunderstanding; it is emphasised that patients should finish the standing position by bringing their hips and knees to full extension before starting to descend to sit down again. (16). The exact number of repetitions (i.e. standing up without sitting down) was recorded as the outcome.

Functional activity level was assessed with the Parkinson Activity Scale (PAS). PAS, a tool designed to evaluate functional activities in patients with PD, offers data regarding patient's transfer status. The scale includes subsections for things like gait akinesia, in-bed mobilization, and getting out of a chair. The scale consists of a total of 10 questions and each question is scored between 0-4. A higher score denotes better functional performance (17).

The Barthel Index (BI) was used to assess daily living activities (BI). The scale assesses the dependency and affectivity in activities of daily living and asks about feeding, bathing, using the toilet, bowel care, self-care, bladder care, dressing-dressing, transferring from the wheelchair, walking

on smooth ground and being able to use a wheelchair. A score of 0–20 indicates complete dependence, 21–61 indicates highly dependence, 62–90 indicates moderate dependence, 91–99 indicates mildly dependence, and 100 indicates complete independence (18). The questions were answered by the patient and the score was recorded. The Parkinson's Disease Quality of Life Questionnaire (PDQ-39) was used to assess quality of life. The PDQ-39 is a self-report questionnaire that measures quality of life using a 5-point Likert scale. It evaluates mobility symptoms, emotional health, daily living activities, social support, cognitive function, and communication. The total score ranges from 0 to 100. A higher number denotes a lesser quality of life (19). PDQ-39 is valid and reliable for assessing quality of life in patients with PD (20, 21).

Statistical analysis

The software tool G*Power (Version 3.1.9.7, Franz Faul, Universität Kiel, Germany) was utilized to determine the necessary sample size for the research. Using the research data, which included 52 total sample numbers, the computation yielded the following results: a correlation value of -0.566 (coefficient of correlation between PAS and nondominant 9-HPT) and a power of 0.99 with a 5% margin of error (a=0.05) for the correlation analysis. The statistical program Statistical Package for Social Sciences (SPSS) version 20 was used to examine the data statistically. Using the Kolmogorov-Smirnov test, the normality of numerical variables was assessed. For numerical variables, we used the median (IQR25–75) and mean±standard deviation values; for categorical variables, we used the number and percentage values. For variables that had a normal distribution, Pearson correlation analysis was employed; for those that did not, Spearman correlation analysis was used. The very good correlation ranged from 0.81 to 1.00, good correlation from 0.61 to 0.80, moderate correlation from 0.41 to 0.60, fair correlation from 0.21 to 0.40, and poor correlation from 0.00 to 0.20, as determined by the correlation coefficient. Statistical significance level was accepted as $p<0.05$ (22).

RESULTS

Five PwPD who did not match the inclusion criteria were not included in the study, which involved screening fifty-seven patients.

Table 1 lists the demographics of PwPD, including age, height, body weight, body mass index, gender, and clinical parameters such as duration of illness, disease stage, and history of falling and freezing.

Table 2 displays the test findings for the patients' upper and lower extremity function, trunk control, physical activity level, activities of daily living, and quality of life.

30STS was moderately correlated with PAS and PDQ-39, but not with BI in PwPD (Table 3).

Right and left 9-HPT was moderately correlated with PAS and PDQ-39, but not with BI in PwPD (Table 3).

All TIS scores except the coordination sub-parameter were found to be associated with PAS between fair to good levels, all TIS scores except the static sitting balance sub-parameter were found to be associated with BI at fair level, and all TIS scores were found to be associated with PDQ-39 between fair to moderate levels in PwPD (Table 3).

DISCUSSION

We observed that physical activity level and quality of life were associated with upper and lower extremity function and trunk control, whereas activities of daily living were only associated with trunk control in PwPD in this study.

Amara et al. stated that physical activity level decreased with the progression of disease in PwPD. Higher self-reported physical activity levels are related to less advancement of motor symptoms, cognitive decline, daily living activities, depression, anxiety, and better sleep, according to exploratory analyses (5). According to research by Skidmore et al., PwPD who had more gait impairment and postural instability also had lower functional ambulation (23). Galperin et al. found that, as predicted, physical activity in daily life, dynamic balancing tests performed in a lab, subject characteristics, and demographics were related to the severity of motor symptoms in PwPD, accounting for about half of the variation in motor symptom severity (24). Wu et al. provided supporting evidence that advanced dynamic

balance is significantly associated with both physical activity participation and health-related quality of life in PwPD (25). These findings are noteworthy because they suggest that the level of physical activity may have an impact on trunk control, which is crucial for preserving balance. The PAS, which we used to assess the level of physical activity in our study, evaluates functions such as getting up from a chair, walking, turning, lying on the bed, turning in bed, getting out of bed and standing up (17). Upper and lower extremity function is the main factor in all these evaluated activities. Therefore, the relationship observed in our study is expected.

Table 1. Demographic and clinical characteristics of patients with PD

Age, years, *Mean±SD*		64±10
Height, m, *Mean±SD*		1.66±0.09
Body weight, kg, *Mean±SD*		78±12
BMI, kg/m^2 *, Mean±SD*		28.38±4.02
Gender, female/male, *n (%)*		16 (30.8) / 36 (69.2)
Disease stage (HYS), *Median (IQR25-75)*		1.5 (1-2)
Duration of illness, years, *Median (IQR25-75)*		6 (3-10)
Falling history, present/absent, *n (%)*		24 (46.2) / 28 (53.8)
Freezing history, present/absent, *n (%)*		18 (34.6) / 34 (65.4)
Disease stage (HYS), n (%)	1	32 (61.5)
	2	12 (23.1)
	3	6 (11.5)
	4	2 (3.8)

BMI: Body Mass Index; HYS: Hoehn and Yahr Scale; SD: Standard deviation; m: meter; kg: kilogram

Table 2. Lower and upper extremity functions, trunk control, physical activity level, activities of daily living and quality of life test results of patients with Parkinson's Disease

		Patients with Parkinson's Disease (n= 52) Median (IQR25-75)
30STS, second		11 (9-13)
9-HPT, second	Dominant	27.13 (23.82-33)
	Nondominant	30.16 (25.77-36.94)
TIS, score	Static seating balance	7 (3-7)
	Dynamic seating balance	6 (4-8)
	Coordination	4 (2-6)
	Total	15 (11-19)
PAS, score		34 (24-38)
Barthel Index, score		95 (88-100)
PDQ-39, score		27 (8-48)

30STS: 30-Second Sit-To-Stand Test; 9-HPT: 9-Hole Peg Test; TIS: Trunk Impairment Scale; PAS: Parkinson Activity Scale; PDQ-39: Parkinson's Disease Quality of Life Questionnaire

Table 3. The relationship of upper and lower extremity function and trunk control with functional activity, activities of daily living and quality of life in patients with Parkinson's disease

		PAS		Barthel Index		PDQ-39	
		ρ	p	*ρ*	p	*ρ*	p
30STS		0.452	**0.001**	0.257	0.066	-0.461	**0.001**
9-HPT	Dominant	-0.566	**<0.001**	-0.244	0.085	0.526	**<0.001**
	Nondominant	-0.495	**<0.001**	-0.222	0.113	0.471	**<0.001**
TIS	Static seating balance	0.330	**0.017**	0.223	0.111	-0.372	**0.007**
	Dynamic seating balance	0.689	**<0.001**	0.293	**0.035**	-0.502	**<0.001**
	Coordination	0.236	0.093	0.332	**0.016**	-0.472	**<0.001**
	Total	0.564	**<0.001**	0.355	**0.010**	-0.577	**<0.001**

p<0.05; 30STS: 30-Second Sit-To-Stand Test; 9-HPT: Nine Hole Peg Test; TIS: Trunk Impairment Scale; PAS: Parkinson Activity Scale; PDQ-39: Parkinson's Disease Quality of Life Questionnaire; *ρ:* Spearman's correlation coefficient

To the best of our knowledge, however, this study is the first to demonstrate the connection between trunk control and level of physical activity. It is known that trunk control and trunk position sense are decreased in PwPD and these parameters are associated with disease severity, balance, functional mobility, and fear of falling (10, 26). It is known that the trunk is an important factor for both balance and mobility during functional activities. Our results suggest that decreased physical activity level may be multifactorial and may be affected by both upper and lower extremity function and trunk control.

Daily living activities include activities such as feeding, washing, self-care, dressing, personal hygiene and toileting, transferring, mobility, walking up and down stairs (18). Manual dexterity is a significant predictor of daily physical performance in PwPD, according to Choi et al (6). Stewart et al. reported that upper and lower extremity motor impairments were associated with daily living activities and quality of life in idiopathic PD (7). However, there was no discernible correlation between daily living activities and the function of the upper and lower extremities in our investigation. If we examine the results of the activities of daily living assessment of PwPD in our study, it is seen that the median value of the BI test results is 95. The results of activities of daily living show that PwPD are mildly dependent. In the early period, PwPD mostly have unilateral symptoms. As the disease progresses, symptoms are observed bilaterally and daily living activity limitations increase (27). We think that this may be the reason why limb functions are not related with activities of daily living. These results suggest that there may be more limitations in daily activities as the disease progresses. Our study's findings, however, point to a possible weak correlation between trunk control and everyday life activities. According to Ryan et al., there is a positive correlation between the degree of thoracic kyphosis and the inability to do daily tasks. (27). Studies have also shown that the flexion and/or lateral flexion posture of the trunk seen in PwPD negatively affects the balance and gait skills of the patients and causes them to experience difficulties in daily life (26, 28). In patients with mild to moderate PD, axial deficits relatedto gait abnormalities, postural instability, and trunk rigidity have been found to be highly associated with disability and poor health-related quality of life. Furthermore, it has been discovered that there is a substantial correlation between the axial motor aspects of PD and physical inactivity, a decline in daily living capacity, and an increase in the dependence on daily living activities. (29-31). Our findings imply that, even in early-stage PwPD, trunk control may have an impact on the decline in daily living activities.

An essential function of the trunk is to lessen the forces brought on by motions that endanger the trunk’s postural control system. As PD advances, patients frequently experience dopamine-resistant axial symptoms that impede trunk control and raise the risk of falls (29). Schrag et al. showed that disability, postural instability, cognitive impairment and depression had the greatest impact on quality of life scores in patients with akinetic rigid PD compared to those with tremor dominant disease, and the main reason for this was the deterioration of axial features (32). According to Muslimovic et al., self-report measures of mood state and axial impairment (gait difficulty and postural instability) are the primary predictors of low quality of life (31). Broderick et al. showed that impaired upper limb function is associated with reduced quality of life (33). Quality of life related to mobility and daily living activities correlated with low- and medium-complexity lower-extremity tasks and the complex upper-extremity test, respectively (34). These findings imply that motor difficulties significantly and adversely affect PwPD' quality of life. According to Wong-Yu et al., manual dexterity in PwPD was linked to self-perceived hand functions and health-related quality of life (35). Better quadriceps muscle performance has been related to improved quality of life, clinical status, and balance in PD, according to research by de Almeida Sá et al (36). According to Cano-de-la-Cuerda et al., PwPD' functional level (daily living activities) and quality of life are affected by axial motor deficits (30). In an another study, Cano-de-la-Cuerda et al. trunk flexion and extension movements were relate to axial extensors rigidity and functional mobility and trunk range of motion for trunk extension, rotations, and flexion were related to health related quality of life in those with milf to moderate PD (37). Ayvat et al. showed that trunk control was associated with quality of life in PwPD (26). All these results are consistent with the findings of our study. Considering that activities of daily living are associated with decreased trunk control, it is thought that trunk control has an indirect

effect on decreased quality of life by affecting activities of daily living as well as limb function.

In our study, the holistic approach to PD and the evaluation of both lower and upper extremity functions as well as the trunk, which is the central key point of the body, is a strong aspect of our study. In addition, there are some limitations to our study. The first limitation is that the Movement Disorders Society-Unified Parkinson's Disease Rating Scale, which is used to evaluate the severity of the disease in PwPD, was not used. Second, because the tests and scales were administered while PwPD were in the "on" state, the results of the tests and scales were not understood when PwPD were in the "off" state.

CONCLUSION

Our study provides evidence that physical activity level and quality of life were associated with upper and lower extremity function and trunk control, whereas activities of daily living were only associated with trunk control in PwPD. Therefore, it is thought that detailed evaluation of upper and lower extremity functions and trunk control and appropriate rehabilitation approaches may be important in improving physical activity level and quality of life, and that the decrease in trunk control may affect daily living activities in PwPD.

Acknowledgments: The authors thank all participants who participated in this study.

Author contribution: Conception: TO, NOU. Design: TO, YSK, NOU. Supervision: TO, YSK, NOU. Fundings: TO, YSK, NOU. Materials: TO, YSK, NOU. Data Collection and/or Processing: TO, YAS, AE, YSK, NOU. Analysis-Interpretation: TO, YAS, AE, YSK, NOU. Literature Review: TO, YAS, AE, NOU. Writing: TO, YAS, AE, NOU, Critical Review: TO, YAS, AE, YSK, NOU.

Conflict of interests: The authors declared no conflicts of interest.

Ethical approval: Ethical approval was obtained from Ankara Yıldırım Beyazıt University Health Sciences Ethics Committee on (Date: 23.11.2023, Decision Number: 09-407).

Funding: None.

Peer-review: Externally peer-reviewed.

REFERENCES

1. Xia R, Mao Z-H. Progression of motor symptoms in Parkinson's disease. Neuroscience Bulletin 2012;28:39-48.
2. Jankovic J. Parkinson's disease: clinical features and diagnosis. Journal of neurology, neurosurgery & psychiatry. 2008;79(4):368-76.
3. Reichmann H. Clinical criteria for the diagnosis of Parkinson's disease. Neurodegenerative Diseases 2010;7(5):284-90.
4. McVey MA, Stylianou AP, Luchies CW, Lyons KE, Pahwa R, Jernigan S, et al. Early biomechanical markers of postural instability in Parkinson's disease. Gait & Posture. 2009;30(4):538-42.
5. Amara AW, Chahine L, Seedorff N, Caspell-Garcia CJ, Coffey C, Simuni T, et al. Self-reported physical activity levels and clinical progression in early Parkinson's disease. Parkinsonism & Related Disorders 2019;61:118-25.
6. Choi Y-I, Song C-S, Chun B-Y. Activities of daily living and manual hand dexterity in persons with idiopathic Parkinson disease. Journal of physical therapy science. 2017;29(3):457-60.
7. Stewart KC, Fernandez HH, Okun MS, Jacobson CE, Hass CJ. Distribution of motor impairment influences quality of life in Parkinson's disease. Movement disorders: Official Journal of the Movement Disorder Society 2008;23(10):1466-8.
8. Brod M, Mendelsohn GA, Roberts B. Patients' experiences of Parkinson's disease. The Journals of Gerontology Series B: Psychological Sciences and Social Sciences 1998;53(4):P213-P22.
9. Verheyden G, Willems A-M, Ooms L, Nieuwboer A. Validity of the trunk impairment scale as a measure of trunk performance in people with Parkinson's disease. Archives of physical medicine and rehabilitation. 2007;88(10):1304-8.
10. Ünlüer NÖ, Ozkan T, Sari YA, Karadağ YS. Investigation of the relationship between trunk position sense and balance, functional mobility, fear of falling, and disease stage in Parkinson's disease. Irish Journal of Medical Science (1971-) 2023;192(4):1889-94.
11. Masaki M, Takeuchi M, Kasahara M, Minakawa K, Inagaki Y, Ogawa Y, et al. Association of activities of daily living, mobility and balance ability, and symptoms of Parkinson's disease with the masses and amounts of intramuscular non-contractile tissue of the trunk and lower extremity muscles in patients with Parkinson's disease. Journal of Medical Ultrasonics 2023;50(4):551-60.

12. Lamb SE, Jørstad-Stein EC, Hauer K, Becker C, Europe PoFN, Group OC. Development of a common outcome data set for fall injury prevention trials: the Prevention of Falls Network Europe consensus. Journal of the American Geriatrics Society 2005;53(9):1618-22.
13. Candan SA, Çatıker A, Özcan TŞ. Psychometric properties of the Turkish version of the freezing of gait questionnaire for patients with Parkinson's disease. Neurol Sci Neurophysiol. 2019;36(36):44-50.
14. Hoehn MM, Yahr MD. Parkinsonism: onset, progression, and mortality. Neurology 1967;17(5):427-42.
15. Earhart GM, Cavanaugh JT, Ellis T, Ford MP, Foreman KB, Dibble L. The 9-hole PEG test of upper extremity function: average values, test-retest reliability, and factors contributing to performance in people with Parkinson disease. Journal of Neurologic Physical Therapy 2011;35(4):157-63.
16. Petersen C, Steffen T, Paly E, Dvorak L, Nelson R. Reliability and minimal detectable change for sit-to-stand tests and the functional gait assessment for individuals with Parkinson disease. Journal of Geriatric Physical Therapy 2017;40(4):223-6.
17. Lauzé M, Daneault J-F, Duval C. The effects of physical activity in Parkinson's disease: a review. Journal of Parkinson's Disease 2016;6(4):685-98.
18. Taghizadeh G, Martinez-Martin P, Meimandi M, Habibi SAH, Jamali S, Dehmiyani A, et al. Barthel index and modified rankin scale: psychometric properties during medication phases in idiopathic Parkinson disease. Annals of Physical and Rehabilitation Medicine 2020;63(6):500-4.
19. Memis S, Akyol A, Ayyldz U, Özkul A. Reliability and validity of the Turkish versions of Parkinson's disease questionnaire (PDQ-39) and European Quality of Life (EQ-5D): P2651. Eur J Neurol. 2009;16:562.
20. Jesus-Ribeiro J, Vieira E, Ferreira P, Januário C, Freire A. Reliability and validity of 39-Item Parkinson's disease questionnaire and Parkinson's disease quality of life questionnaire. Acta Medica Portuguesa 2017;30(5):395-401.
21. Bilge TK, Dereli EE, Oztop-Cakmak O, Ertan FS, Kayapınar Aylak EE, Taskıran OO. Reliability and validity of the Turkish version of the 39-item Parkinson Disease Questionnaire. Ideggyogyaszati Sz 2023;76(5-6):181-188.
22. Altman D, Machin D, Bryant T, Gardner M. Statistics with confidence: confidence intervals and statistical guidelines: John Wiley & Sons; 2013.
23. Skidmore FM, Mackman CA, Pav B, Shulman LM, Garvan C, Macko RF, et al. Daily ambulatory activity levels in idiopathic Parkinson disease. Journal of Rehabilitation Research & Development 2008;45(9):1343-8.
24. Galperin I, Hillel I, Del Din S, Bekkers EM, Nieuwboer A, Abbruzzese G, et al. Associations between daily-living physical activity and laboratory-based assessments of motor severity in patients with falls and Parkinson's disease. Parkinsonism & Related Disorders 2019;62:85-90.
25. Wu S-Y, Lin T-K, Pan C-Y, Tsai C-L. The predictive relationships between advanced dynamic balance and physical activity/quality of life in Parkinson's disease. Human Movement Science 2023;89:103076.
26. Ayvat E, Ayvat FA, Doğan M, Kılınç ÖO, Sütçü G, Kılınç M, et al. Parkinson Hastalarında Gövde Bozukluğunun Hastalık Şiddeti ve Yaşam Kalitesi ile İlişkisinin İncelenmesi. Hacettepe University Faculty of Health Sciences Journal 2024;11(1):38-47.
27. Ryan SD, Fried LP. The impact of kyphosis on daily functioning. Journal of the American Geriatrics Society 1997;45(12):1479-86.
28. Kataoka H, Sugie K. Recent advancements in lateral trunk flexion in Parkinson disease. Neurology: Clinical Practice 2019;9(1):74-82.
29. Cole MH, Naughton GA, Silburn PA. Neuromuscular impairments are associated with impaired head and trunk stability during gait in Parkinson fallers. Neurorehabilitation and Neural Repair 2017;31(1):34-47.
30. Cano-de-la-Cuerda R, Vela-Desojo L, Miangolarra-Page JC, Macías-Macías Y, Muñoz-Hellín E. Axial rigidity and quality of life in patients with Parkinson's disease: a preliminary study. Quality of Life Research 2011;20:817-23.
31. Muslimovic D, Post B, Speelman JD, Schmand B, de Haan RJ. Determinants of disability and

quality of life in mild to moderate Parkinson disease. Neurology 2008;70(23):2241-7.
32. Schrag A, Jahanshahi M, Quinn N. What contributes to quality of life in patients with Parkinson's disease? Journal of Neurology, Neurosurgery & Psychiatry 2000;69(3):308-12.
33. Broderick MP, Van Gemmert AW, Shill HA, Stelmach GE. Hypometria and bradykinesia during drawing movements in individuals with Parkinson's disease. Experimental Brain Research 2009;197:223-33.
34. Malling ASB, Morberg BM, Wermuth L, Gredal O, Bech P, Jensen BR. Associations of Motor Symptom Severity and Quality of Life to Motor Task Performance in Upper and Lower Extremities Across Task Complexity in Parkinson's Disease. Motor Control 2019;23(4):445-60.
35. Wong-Yu IS, Ren L, Mak MK. Impaired hand function and its association with self-perceived hand functional ability and quality of life in Parkinson disease. American Journal of Physical Medicine & Rehabilitation 2022;101(9):843-9.
36. de Almeida Sá R, de Sá Ferreira A, Lemos T, de Oliveira LAS. Correlation analysis of lower-limb muscle function with clinical status, balance tests, and quality of life in people with Parkinson disease. Topics in Geriatric Rehabilitation 2022;38(1):56-64.
37. Cano-de-la-Cuerda R, Vela-Desojo L, Moreno-Verdú M, Ferreira-Sánchez MdR, Macías-Macías Y, Miangolarra-Page JC. Trunk range of motion is related to axial rigidity, functional mobility and quality of life in Parkinson's disease: An exploratory study. Sensors 2020;20(9):2482.