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The Reliability and Validity of the Manual Ability Measure-36 in Patients with Parkinson's Disease

Parkinson Hastalarında El Beceri Ölçümü-36'nın Güvenilirlik ve Geçerliliği

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Abstract

Objective: Although impaired manual dexterity is one of the most disabling symptoms in patients with Parkinson's disease (PD), there is no reliable and valid patient-reported outcome measure (PROM) for assessing dexterity. Therefore, this study aimed to investigate: (1) The test-retest reliability of the manual ability measure-36 (MAM-36) in patients with PD; (2) the minimum detectable change (MDC) in the MAM-36 scores; (3) the concurrent and known-groups validity of the MAM-36 scores; and (4) the cut-off score that best discriminates patients with PD from healthy individuals.

Materials and Methods: This was a cross-sectional study. The MAM-36 was repeated after 4 weeks to determine the test-retest reliability which was calculated with the intraclass correlation coefficient (ICC), Bland-Altman plots, and MDC. The concurrent validity was assessed using correlations between the MAM-36 and nine-hole peg test, Movement Disorders Society Unified Parkinson's Disease Rating scale (MDS-UPDRS), MDS-UPDRS II, MDS-UPDRS III, Hoehn and Yahr stage, and 8-item PD questionnaire. The known-groups validity was determined by comparing the MAM-36 scores between patients with PD and healthy individuals. Receiver operating characteristic analysis was used to determine the cut-off score for the MAM-36 to best discriminate patients with PD from healthy individuals.

Results: Thirty six patients with PD and 32 healthy individuals were included. Excellent test-retest reliability was found (ICC: 0.953). The Bland-Altman plot demonstrated a high agreement. The MDC was 2.33. The MAM-36 had fair to high correlations with the other outcome measurements (correlation coefficients ranged from -0.473 to -0.763, $p<0.05$ for all). Patients with PD had lower scores than healthy individuals in terms of the MAM-36 ($p<0.001$). The cut-off score of 76.50 best distinguished patients with PD from healthy individuals.

Conclusion: The MAM-36 is a reliable and valid measurement for assessing manual dexterity in patients with PD. It is also the only clinically available PROM in assessing manual dexterity for patients with PD in the Turkish population.

Keywords: Manual ability measure-36, manual dexterity, Parkinson's disease, reliability, validity

Öz

Amaç: El becerisinde bozulma, Parkinson hastalığı (PH) olan bireylerde en fazla engelleyici semptomlardan biri olmasına rağmen, el becerisini değerlendirmek için güvenilir ve geçerli hasta tarafından bildirilen sonuç ölçümü (PROM) bulunmamaktadır. Bu nedenle, bu çalışma: (1) PH'de el beceri ölçümü-36'nın (EBÖ-36) test-tekrar test güvenilirliğini; (2) EBÖ-36 puanlarındaki minimal saptanabilir değişimi (MSD); (3) EBÖ-36 puanlarının eşzamanlı ve bilinen gruplar geçerliliğini; ve (4) sağlıklı bireylerden PH'leri en iyi ayıran kesme puanını araştırmayı amaçladı.

Gereç ve Yöntem: Bu kesitsel bir çalışmaydı. EBÖ-36, sınıf içi korelasyon katsayısı (ICC), Bland-Altman grafikleri ve MSD ile hesaplanan test-tekrar test güvenilirliğini belirlemek için 4 hafta sonra tekrarlandı. Eş zamanlı geçerlilik, EBÖ-36 ve dokuz delikli peg testi, Hareket Bozuklukları Derneği Birleşik Parkinson Hastalığı Derecelendirme ölçeği (HBD-BPHDÖ), HBD-BPHDÖ II, HBD-BPHDÖ III, Hoehn ve Yahr evresi ve 8 maddelik PH anketi arasındaki

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korelasyonlar kullanılarak değerlendirildi. Bilinen gruplar geçerliliği, Parkinson hastaları ve sağlıklı bireyler arasında EBÖ-36 puanlarının karşılaştırılmasıyla belirlendi. Alıcı işletim karakteristiği analizi Parkinson hastalarını sağlıklı bireylerden en iyi ayırt eden EBÖ-36'nın kesme puanını belirlemek için kullanıldı.

Bulgular: Otuz altı Parkinson hastası ve 32 sağlıklı birey dahil edildi. Mükemmel test-tekrar test güvenilirliği bulundu (ICC: 0,953). Bland-Altman grafiği yüksek bir uyum gösterdi. MSD 2,33'tü. EBÖ-36 diğer sonuç ölçümleri ile orta ila yüksek korelasyonlara sahipti (korelasyon katsayıları -0,473 ile -0,763 arasındaydı, p<0,05 hepsi için). EBÖ-36'da; Parkinson hastaları sağlıklı bireylerden daha düşük puanlara sahipti (p<0,001). 76,50'lik kesme puanı, sağlıklı bireylerden Parkinson hastalarını en iyi ayırt eder.

Sonuç: EBÖ-36, Parkinson hastalarında el becerisini değerlendirmek için güvenilir ve geçerli bir ölçümdür. Ayrıca, Türk popülasyonunda Parkinson hastaları için el becerisinin değerlendirilmesinde klinik olarak kullanılabilir tek PROM'dur.

Anahtar Kelimeler: El beceri ölçümü-36, el becerisi, Parkinson hastalığı, güvenilirlik, geçerlilik

Introduction

Around 90% of patients with Parkinson's disease (PD) have impaired manual dexterity, and reported problems with fine manipulative skills (1). Patients with PD have difficulties in many activities of daily living such as using mobile phones, fastening buttons, and tying shoelaces even in the early stages of the disease (2,3). Impaired manual dexterity is indicated as the third crucial contributor to the burden of PD after impairments in ambulation and cognition, and decreased quality of life (4).

Evidence-based practice in the rehabilitation of movement disorders suggests that a range of measurement tools should be carefully selected and used for quantifying treatment outcomes, and these tools with strong clinimetric properties are required to assess treatment effects and determine changes in motor performance (5). Considering impaired manual dexterity, reliable and valid outcome measures are essential to observe disease progression and assess the effectiveness of any intervention (6). Manual dexterity is commonly evaluated by using performance outcome measures which have been established to have reliability and validity for patients with PD such as the nine-hole peg test (9-HPT) (7), purdue pegboard test (8), and Jebsen Taylor hand function test (9). On the other hand, patient-reported outcome measurements (PROMs) provide information that is claiming an increasingly crucial role in medical care about patients' experiences with symptoms, functional status, or quality of life (10,11). There are a few Turkish versions of PROMs, which assess manual impairments in PD; for instance the Movement Disorders Society Unified Parkinson's Disease Rating scale (MDS-UPDRS) (12) and the 8-item Parkinson's disease questionnaire (PDQ-8) (13) in PD. The MDS-UPDRS includes upper extremity test items as a part of motor experiences of daily living or motor symptoms (14), while the PDQ-8 only assesses difficulty in dressing as a part of the quality of life (15), which is not reflected in dexterity tasks according to perspectives of patients with PD. Therefore, the specific PROMs of manual dexterity are of considerable importance for patients with PD.

The manual ability measure-36 (MAM-36) is a generic PROM for different clinical diagnoses. It has 36 items that assess an individual's perceived ability to perform a wide variety of hand functions such as writing, drinking water, eating a sandwich, opening jars, using a fork or knife, washing hands, cutting nails, and handling money (16). The MAM-36 has demonstrated excellent test-retest reliability in Charcot-Marie-Tooth disease (CMT) (17) and multiple sclerosis (MS) (18) [intraclass correlation coefficient (ICC): 0.96 and ICC: 0.97, respectively]. The validity of the MAM-36 has been established in a wide range of musculoskeletal disorders, and neurological conditions including MS, spinal cord injury, traumatic brain injury (16), and CMT (17). Because of its universal applicability, the questionnaires for MS were developed in English (16) and translated into Italian (19) and Turkish (18). However, up to date, the reliability and validity of the MAM-36 have not been systematically investigated for PD. Moreover, no study has assessed manual dexterity by using PROM for patients with PD in the Turkish population.

The aim of the present study was to investigate: (1) the test-retest reliability of the MAM-36 in patients with PD; (2) the minimum detectable change (MDC) in the MAM-36 scores; (3) the concurrent and known-groups validity of the MAM-36 scores; and (4) the cut-off scores that best discriminated patients with PD from healthy individuals.

Materials and Methods

Study Design

This was a cross-sectional study that was carried out between April and July 2021. All participants were given detailed information and provided informed written consent. The study was approved by the Gazi University Clinical Research Ethics Committee (decision no: 354, date: 12.04.2021) and performed in line with the guidelines of the Declaration of Helsinki.

The MAM-36 had excellent test-retest reliability (ICC: 0.97) in patients with MS (18). Assuming that an ICC value for patients with PD was hypothesized to be approximately 0.90, a sample of 30 individuals was required to achieve 90% power to detect an ICC of 0.90 with a confidence level of 95%.

Participants

Patients with PD were consecutively recruited from the Department of Neurology, Gazi University Hospital, Ankara, Turkey. The inclusion criteria were (1) individuals with a clinical diagnosis of idiopathic PD based on the United Kingdom Parkinson Disease Society Brain Bank diagnostic criteria (20), (2) being 40 years of age or older, and (3) having Hoehn and Yahr (H&Y) stage between 1 and 4 (21). The exclusion criteria were (1) having other neurological disease or PD dementia, and (2) having any comorbid disabilities that would affect manual dexterity. Healthy individuals, who were 40 years old and over were recruited from a local community center via poster advertising to serve as controls.

Outcome Measures

The MAM-36 is a PROM of manual function and consists of 36 items that evaluate perceived ease or difficulty in performing common daily living tasks using one's hands, irrespective of which hand is used and without the use of adaptive equipment. Each item is scored on a 4-point scale from 1 (unable) to 4 (easy) to perform the task. There is also a zero option for indicating tasks

that are almost never performed with or without hand impairment. The raw scores are yielded from the sum of 36 items, and then transformed to MAM conversion scores ranging from 0 to 100. Higher scores correspond to better manual dexterity (16). The Turkish version of the MAM-36 has been demonstrated to be valid and reliable (ICC: 0.97) for the MS population (18).

The 9-HPT is a quantitative test for assessing manual dexterity. It consists of nine pegs and a pegboard with nine holes. The 9-HPT requires participants to pick up the pegs from a container, one by one, and place them into the holes on a board, as fast as possible, then remove the pegs from the holes, one by one, and replace them back into the container. The time in seconds is scored from when the first peg is touched to when the last peg is returned. Shorter times indicate better manual dexterity performance (22). The 9-HPT is a clinically available and highly reliable measurement tool for patients with PD (ICC: 0.88 for dominant hand, and ICC: 0.91 for non-dominant hand) (7). In this study, the 9-HPT was performed twice, and the mean of the two trials was recorded for each hand.

The MDS-UPDRS is an assessment tool routinely used to evaluate disease severity in PD. It includes four parts: Non-motor experiences of daily living (MDS-UPDRS-I); motor experiences of daily living (MDS-UPDRS-II); motor examination (MDS-UPDRS-III); and motor complications (MDS-UPDRS-IV). The MDS-UPDRS consists of 65 items with a possible range of 0-260. Higher scores reflect more severe disease (14).

The H&Y scale is a widely used clinical rating scale for PD. It ranges from 1 to 5, and higher stages indicate a higher level of functional disability and impairment (21).

The PDQ-8 is a specific instrument for measuring the quality of life in patients with PD. It contains 8 items and each one is scored from 0 (never) to 4 (always), and its possible score ranges from 0 to 32. The summed score is calculated as the total score for the 8-item divided by the maximum possible score and is expressed as a percentage score out of 100. Higher scores represent lower level of quality of life (23). The Turkish version of this questionnaire has been shown to be valid and reliable (ICC: 0.97) (13).

Procedure

Participants dominant hand is the preferred hand for performing skillful and unimanual tasks such as writing (24,25). The demographic variables of patients with PD included age, sex, height, weight, and disease duration. MAM-36, 9-HPT, MDS-UPDRS, H&Y scale, and PDQ-8 were administered to patients with PD at the time of initial evaluation, and MAM-36 was administered again 4 weeks later for test-retest reliability. All assessments were performed in the on state, between 1-2 hours after medication intake.

The demographic variables of healthy individuals included age, sex, height, and weight. They only completed the MAM-36 once because the scores of the MAM-36 were used to compare patients with PD and healthy individuals and to find the cut-off scores that would discriminate these two groups best.

Statistical Analysis

Statistical analyses were performed using the Statistical Package for Social Science (SPSS) (version 17 for Windows, SPSS Inc, Chicago, IL, USA). Shapiro-Wilk test and Levene test were used to determine the normality of the data and homogeneity of the variance, respectively. The chi-square and independent t-tests were used to compare demographic variables of patients with PD and healthy individuals.

Test-retest reliability was assessed using ICC with a 95% confidence interval (CI). Based on the established guidelines, ICC values were categorized as poor (<0.50), moderate (0.50-0.75), good (0.75-0.90), or excellent (>0.90) based on established guidelines (26). Bland-Altman plots were used to visualize the agreement between the two sessions and to rule out systematic differences between the results for the MAM-36 (27).

The 95% CI for the MDC (MDC_{95}) in the MAM-36 scores was calculated using the following formula:

$MDC_{95} = 1.96 \times \sqrt{2} \times SEM$.

Hereby, standard error of the mean (SEM) represents the SEM calculated from the test-retest reliability and the standard deviation (SD) of the MAM-36 scores using the following formula: $SEM = \sqrt{(1 - ICC_{test\text{-}retest})} \times SD$ (28).

To determine concurrent validity, the correlation between the MAM-36 and outcome measures including the 9-HPT, MDS-UPDRS II, MDS-UPDRS III, MDS-UPDRS total, H&Y scale, and PDQ-8 using Pearson's correlation coefficient (r) or Spearman correlation coefficient (r_s) were calculated. Correlation coefficients were interpreted as poor (0-0.25), fair (0.25-0.50), moderate (0.50-0.75), and high (0.75-1) (28). To determine known-groups validity, the independent t-test examined differences in the MAM-36 score between patients with PD and healthy individuals.

The Receiver operating characteristic (ROC) curve was used to determine the cut-off score of the MAM-36 that best discriminated patients with PD from healthy individuals. The ROC curve is defined as a plot of the true positive rate (sensitivity) versus the false-positive rate (1-specificity). The best cut-off value was found using the Youden's index [sensitivity + (specificity-1)]. The area under the ROC curve (AUC) was used to quantitatively analyse the ability of the MAM-36 to discriminate patients with PD from healthy individuals. When the AUC value was close to 1.0, it represented that the clinical test had a perfect discriminative ability, while a value of AUC close to 0.5 indicated a poor discriminative ability (28,29). The AUC values were interpreted as acceptable (0.70-0.79), excellent (0.80-0.89), and outstanding (0.90-1.00), while an AUC of 0.5 suggested no discriminative ability (29). Statistical significance was set at $p<0.05$ for all analyses.

Results

The present study included 36 patients with PD (20 men, 16 women; mean age, 67.78±7.57) and 32 healthy individuals (18 men, 14 women; mean age, 65.16±8.35). No drop-out was recorded. There were no significant differences between groups regarding demographic data. The participants' characteristics are presented in Table 1. During the study, no participant changed his/her medication between test sessions and had any adverse effects or changed health status.

The ICC for the MAM-36 was 0.953 (CI 95%: 0.907-0.976). Thus, the test-retest reliability for the MAM-36 was found to be excellent. The calculated SEM and MDC were 0.84 and 2.33, respectively (Table 2). The Bland-Altman plots showed a high level of agreement of the MAM-36 scores between two test sessions. In all cases, only 2 of 36 data pointed outside the mean ± 1.96 SD boundaries, which were considered to be clinically relevant (Figure 1).

Table 1. Participants' characteristics

Variables	Patients with PD (n=36)	Healthy individuals (n=32)	p
Age			
Mean ± SD	67.78±7.57	65.16±8.35	0.182
Sex, n (%)			
Male	20 (55.56)	18 (56.25)	0.954
Female	16 (44.44)	14 (43.25)	
Height, cm			
Mean ± SD	165.56±8.96	168.16±7.51	0.198
Weight, kg			
Mean ± SD	72±42±8.07	76.53±10.28	0.074
BMI, kg/m²			
Mean±SD	26.53±3.25	27.23±4.28	0.457
Disease duration, y			
Median (IQR)	5 (4.00-8.75)	NA	NA
H&Y stage			
Median (IQR)	2.50 (2.00-3.00)	NA	NA
H&Y stage, n (%)			
1	4 (11.1)		
2	14 (38.9)		
3	12 (33.3)	NA	NA
4	6 (16.7)		
MDS-UPDRS II			
Median (IQR)	5.50 (3.00-10.50)	NA	NA
MDS-UPDRS III			
Mean ± SD	18.56±7.63	NA	NA
MDS-UPDRS total			
Mean ± SD	35.69±14.91	NA	NA
9-HPT, s			
Dominant hand			
Median (IQR)	24.91 (21.95-31.38)		
Non-dominant hand		NA	NA
Median (IQR)	31.35 (25.87-35.94)		
PDQ-8			
Median (IQR)	30.00 (25.00-49.38)	NA	NA

9-HPT: 9-hole peg test, BMI: Body mass index, H&Y: Hoehn and Yahr, IQR: Interquartile range, MDS-UPDRS: Movement Disorders Society Unified Parkinson's Disease Rating scale, MDS-UPDRS II: Movement Disorders Society Unified Parkinson's Disease Rating scale motor experiences of daily living, MDS-UPDRS III: Movement Disorders Society Unified Parkinson's Disease Rating scale motor examination, NA: Not applicable, PDQ-8: 8-item Parkinson's disease questionnaire; SD: Standard deviation

The correlations between the MAM-36 scores and the other outcome measures are demonstrated in Table 3. The MAM-36 had a significant moderate negative correlation with the 9-HPT for the dominant hand and a significant fair negative correlation with the 9-HPT for the non-dominant hand (r_s: -0.697; p<0.001, and r_s: -0.473; p=0.004, respectively). A significant high negative correlation was found between the MAM-36 and MDS-UPDRS II (r_s: -0.763; p<0.001). The MAM-36 also showed significant moderate negative correlations with MDS-UPDRS-III, MDS-UPDRS-total, and PDQ-8 (r: -0.662; p<0.001, r: -0.696; p<0.001, and r_s: -0.666; p<0.001, respectively), while significant fair correlation with the H&Y stage (r_s: -0.493; p=0.002). According to the independent t-test result, patients with PD had a lower MAM-36 score compared to healthy individuals (p<0.001) (Table 4).

The ROC curve analysis demonstrated that the MAM-36 distinguished patients with PD and healthy individuals. The cut-off score of 76.50 (sensitivity, 86.1%; specificity, 84.4%; AUC: 0.933, p<0.001) was found best to discriminate the patients with PD from healthy individuals. The AUC is presented in Figure 2.

Discussion

This is the first study to investigate the test-retest reliability of the MAM-36, the MDC in the MAM-36 scores, and concurrent and known-groups validity of the MAM-36 scores in patients with PD. It is also the first study to determine the MAM-36 scores that best discriminate patients with PD from healthy individuals. Moreover, it is also important to note that no study has examined the upper extremity function by using PROM in a population of patients with PD in Turkey.

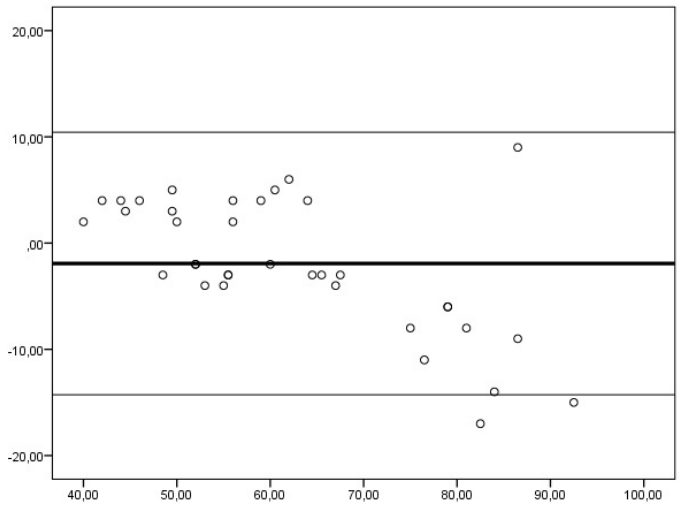

Figure 1. The bland-altman plot for the test-retest reliability of the manual ability measure-36 in patients with Parkinson's disease. The mean values of the difference is represented by the thick line and the 95% limits of agreement (±1.96 standard deviations) are represented by the two thin lines

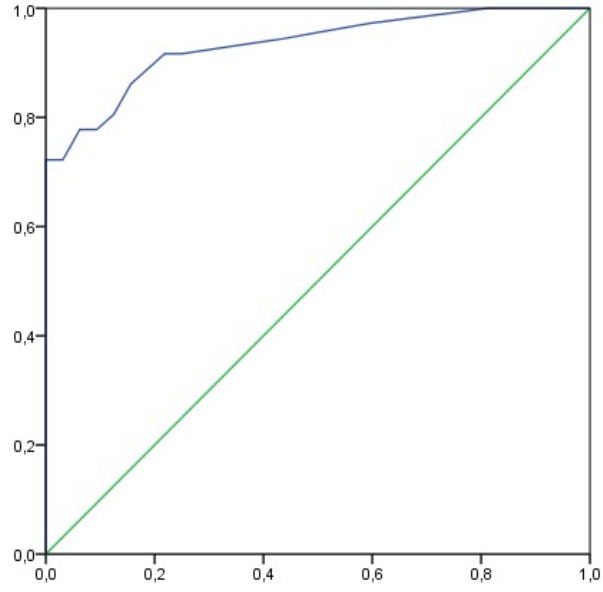

Figure 2. Receiver operating characteristic curve for the manual ability measure-36 to discriminate between patients with Parkinson's disease and healthy individuals (sensitivity, 86.1%; specificity, 84.4%; AUC: 0.933, p<0.001)
AUC: Area under the curve

Test-retest reliability is considered as the reproducibility of the observed value when the measurement tool is repeated in a stable population. The study showed an ICC of 0.953 indicating excellent test-retest reliability of the MAM-36 for PD, which was similar to the findings in MS (18) and CMT disease (17). This test-retest result ensures the stability of the MAM-36 to measure upper extremity function over time. Additionally, the Bland-Altman plot indicated excellent agreement between test-retest measurements

Table 2. Reliability measures of the Turkish version of the MAM-36 in patients with PD

Variable	ICC (95% CI)	SEM	MDC
Test-retest reliability	0.953 (0.907-0.976)	0.84	2.33

CI: Confidence interval, ICC: Intraclass correlation coefficient, PD: Parkinson's disease, SEM: Standard error of the mean, MAM-36: Manual ability measure-36

Table 3. Correlation between the MAM-36 and other outcome measures in patients with PD

Measures	Correlation coefficients	p
9-HPT, s		
Dominant hand	r_s: -0.697	p<0.001*
Non-dominant hand	r_s: -0.473	p=0.004*
MDS-UPDRS II	r_s: -0.763	p<0.001*
MDS-UPDRS III	r: -0.662	p<0.001*
MDS-UPDRS total	r: -0.696	p<0.001*
H&Y stage	r_s: -0.493	p=0.002*
PDQ-8	r_s: -0.666	p<0.001*

*Significant difference at p<0.05. 9-HPT: Nine-hole peg test, H&Y: Hoehn and Yahr, MAM-36: Manual ability measure-36, MDS-UPDRS: Movement Disorders Society Unified Parkinson's Disease Rating scale, MDS-UPDRS II: Movement Disorders Society Unified Parkinson's Disease Rating scale motor experiences of daily living, MDS-UPDRS III: Movement Disorders Society Unified Parkinson's Disease Rating scale motor examination, PD: Parkinson's disease, PDQ-8: 8-item Parkinson's disease questionnaire; r: Pearson's correlation coefficient; r_s: Spearman's correlation coefficient

Table 4. Known-groups validity of the MAM-36 in patients with PD

Measure	Patients with PD (n=36)	Healthy individuals (n=32)	p*
The MAM-36 Mean ± SD	61.31±12.67	85.94±9.14	<0.001

*Significant difference at p<0.05. MAM-36: Manual ability measure-36, PD: Parkinson's disease, SD: Standard deviation

for MAM-36. Patients with PD demonstrated a homogeneous distribution in scores around the mean. It was displayed that the mean difference between the test-retest scores was considerably low, and the 95% CI covered zero. These findings showed that patients with PD scored their upper extremity function similarly on both sessions, that is to say, there was no systematic bias between sessions in the mean scores of the MAM-36.

Considering its clinical implications, the MDC value of the MAM-36 score was 2.33 in patients with PD. This is valuable information that can assist in interpreting upper extremity function for patients with PD when one is measured with MAM-36 across time. A score change for an individual with PD greater than the MDC value can be observed as a real change. Thus, both clinicians and researchers may thus accurately use the MDC value to explain the scores of patients with PD. Moreover, the treatment effect can be examined by using the MDC value as a threshold to determine the MDC proportion that is described as the proportion of individuals' score change greater than the MDC value (30). For

instance, a sample size of 100 demonstrated that 25 individuals had a score change >2.33 in the MAM-36 score, which indicated that the MDC proportion was 25% in an intervention protocol for improving the ability in upper extremity function. Comparing the MDC proportions between experimental and control groups, the group with a higher MDC proportion has more treatment effect. The MDC proportion can be an investigation in a clinical study in addition to reporting a statistically significant difference.

The MAM-36 score had a good correlation with the dominant hand and a moderate correlation with the non-dominant hand on the 9-HPT times. Previous studies demonstrated that the MAM-36 correlated with the 9-HPT in MS (r: -0.58 for the dominant hand and r: -0.51 for the non-dominant hand, respectively) (18). The items included in the MAM-36 were mostly scored individuals' performance according to the dominant hand, which could result in a higher correlation for dominant hand compared to non-dominant hand in this study. These findings indicated that both PROM and performance-based tests, which assessed manual dexterity, might give similar results in PD. In clinical practice, the MAM-36 may be more useful with regard to reflecting the manual disability because a PROM can focus on impairments in daily life from the perspective of the individuals. On the other hand, a PROM may have several disadvantages that lead to limiting its reliability and possibility. For example, it is a subjective assessment and is affected by other factors such as illiteracy and mental deterioration (31). Clinically, the MAM-36; thus, should be used to assess manual dexterity together with performance-based tests for patients with PD.

The moderate to good correlations between the MAM-36 and MDS-UPDRS II, MDS-UPDRS III, MDS-UPDRS total, H&Y stage, and PDQ-8, support the relationship between perception of manual dexterity and PD-specific impairments. The significant relationship, with the MDS-UPDRS II, reflects that both PROMs are close concepts with respect to assessing motor disabilities and consist of similar items such as writing. However, the MAM-36 is a more specific and comprehensive tool due to focusing on only different activities related to manual skills. Probably, decreased manual dexterity could deteriorate the ability of daily living for patients with PD, which can result in reduced quality of life. Moreover, the MAM-36 is correlated with motor symptoms, disease severity, and disease stage that are clinician-rated and performance-based measures. This is important because although the clinical impairments of the disease do not directly address the manual disabilities, they can be associated with perspectives of patients with PD on the ability of manual functions in daily life.

Not surprisingly, patients with PD had lower upper extremity function than healthy individuals. This finding is in good agreement with previous studies comparing the ability of patients with PD with healthy individuals by using performance-based measurement tools such as 9-HPT (7) and Jebsen Taylor hand function test (9). PD may adversely affect upper limb movement, reach-to-grasp function (32), fine motor control (33), hand pre-shaping (34), finger control (35), speed and amplitude of movements (36), sequential tasks (37), discriminative sensory dysfunction, and consequent abnormal sensorimotor integration (38), which probably lead to impaired upper extremity function. It is also shown that impaired upper extremity function may get worse not only in performance on clinical test scores but in the perception of daily living activities.

The MAM-36 scores discriminated well between patients with PD and healthy individuals with a high AUC of 0.933. The cut-off score of 76.50 was found to discriminate between patients with PD and healthy individuals. Changes in hand function could be the first sign of the disease for about 80% of patients with PD (39). Therefore, patients with PD could have difficulty in a wide variety of daily living activities related to upper extremity function including buttoning clothing, tying shoelaces, using mobile phones and remote controls (3), and handwriting (40). The MAM-36 consists of all of these activities together with many daily living activities that require manual dexterity, which may explain the good discriminative ability. Clinically, the cut-off score of the MAM-36 may be used to make decisions about the management of rehabilitation programs, and thus, patients with PD whose MAM-36 score <76.50 should receive any early interventions to prevent subsequent disabilities related to impairments of manual dexterity.

Study Limitations

There are some limitations to this study. Most of our participants (83.3%) were in mild to moderate stage of PD, which might limit the generalizability of the findings. Considering the predictive validity, further studies should be focused on determining scores on the MAM-36 that could predict perspectives of patients with PD to perform manual dexterity related to daily living on the long term evaluation. Research is also needed to investigate the responsiveness of the MAM-36 to assess changes in manual dexterity following interventions. All testing was done while patients with PD were "on" medication; therefore, we could not draw conclusions on the associations of the MAM-36 with performance-based measurement tools including the 9HPT, MDS-UPDRS III, MDS-UPDRS, and H&Y stage when they were "off" medication.

Conclusion

The MAM-36 had excellent test-retest reliability and was also the only available PROM in Turkey to assess manual dexterity for patients with PD. The MDC value was 2.33, which could be used to determine the benefit from an intervention protocol. The MAM-36 was correlated with 9-HPT, MDS-UPDRS II, MDS-UPDRS III, MDS-UPDRS total, H&Y stage, and PDQ-8. Patients with PD had lower scores than healthy individuals on the MAM-36, representing disabilities in the perception of manual dexterity. The MAM-36 score could discriminate between patients with PD and the age-matched healthy elderly, with the cut-off score being 76.50. Therefore, the MAM-36 might be performed for measuring manual dexterity from a perspective of patients with PD in research and clinical assessment besides performance-based manual dexterity tests.

Ethics

Ethics Committee Approval: The study was approved by the Gazi University Clinical Research Ethics Committee (decision no: 354, date: 12.04.2021) and performed in line with the guidelines of the Declaration of Helsinki.

Informed Consent: Provided informed written consent.

Peer-review: Internally peer-reviewed.

Authorship Contributions

Concept: F.S., E.Ö.G., A.B.T., Design: F.S., N.E.E.A., A.B.T., Data Collection or Processing: F.S., E.Ö.G., N.E.E.A., B.K.,

A.B.T., Analysis or Interpretation: F.S., Ç.G., Literature Search: F.S., E.Ö.G., N.E.E.A., B.K., A.B.T., Writing: F.S., E.Ö.G., A.B.T.

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