Arch Rheumatol 2022;37(3):315-325
doi: 10.46497/ArchRheumatol.2022.9051

ORIGINAL ARTICLE

Validity and reliability of the Duruöz Hand Index in patients with lateral epicondylitis

İbrahim Taka[1], Berat M. Alkan[2], Fatma F. Yıldız[2]

[1]*Department of Physical Medicine and Rehabilitation, Ankara Training and Research Hospital, Ankara, Türkiye*
[2]*Department of Physical Medicine and Rehabilitation, Ankara City Hospital, Ankara, Türkiye*

ABSTRACT

Objectives: This study aims to investigate the validity, reliability and clinimetric features of the Duruöz Hand Index (DHI) in patients with lateral epicondylitis.

Patients and methods: Between October 2019 and January 2020, a total of 78 patients (28 males, 50 females; mean age: 46.4±9.4 years; range, 20 to 65 years) who presented with pain in the forearm and were diagnosed with lateral epicondylitis were included in the study. The patients were evaluated using the Visual Analog Scale (VAS), Health Assessment Questionnaire (HAQ), the Patient-Rated Tennis Elbow Evaluation Questionnaire (PRTEEQ), the Disabilities of the Arm, Shoulder and Hand (DASH) Questionnaire at Weeks 0, 1 and 4. The DHI reliability (Cronbach alpha, intraclass correlation [ICC]), validity and factor analyses were performed with the data of 70 and 49 patients who attended to follow-up visit at Weeks 1 and 4. The effect size (ES), standard response mean (SRM), and minimum detectable change (MDC) values of the DHI were calculated.

Results: Of the patients, 84.6% were right-handed. The ICC coefficients of DHI were found to be perfect with the test-retest method (ICC; total=0.943). It showed a well-excellent consistency with the internal consistency method (Cronbach alpha; total=0.90). In the structural validity of the DHI, it was very strongly correlated with the DASH (r=0.801; p<0.01), strongly correlated with the PRTEEQ and HAQ total scores (r=0.793; p<0.01; r=0.785; p<0.01), and acceptably correlated with PRTEEQ pain score (r=0.570; p<0.01). The DHI was acceptably correlated with the VAS and grip strength as measured by the hand dynamometer (p<0.05). In our study, three main factors were obtained and MDC and responsiveness sensitivity were found to be moderate (MDC=4.4; SEM=1.61; ES=0.246 p<0.001; SRM=0.538 p<0.001).

Conclusion: Duruöz Hand Index is a reliable, valid, and practical functional assessment scale in patients with lateral epicondylitis.

Keywords: Duruöz Hand Index, factor analysis, lateral epicondylitis, reliability, validity.

Lateral epicondylitis is a degenerative disease characterized by pain around the lateral epicondyle, often due to overuse of the forearm. In the general population, its incidence has been reported as 0.5% with a prevalence of 3%, often affecting individuals aged between 30 and 60 years.[1,2]

For the elbow joint, which has a complex structure, correct positioning in space for fine movements of the hand, strong grip and substantial support for forearm functions are important.[3] Due to pain and deformation in lateral epicondylitis, elbow-forearm functions, hand grip strength, and activities requiring fine skills are affected. Considering the impact to the quality of life, it is critical to measure the level of exposure with objective daily living activities and disability tests. The Health Assessment Questionnaire

Received: June 20, 2021 ***Accepted:*** September 17, 2021 ***Published online:*** September 06, 2022

Correspondence: İbrahim Taka, MD. Ankara Eğitim ve Araştırma Hastanesi Fiziksel Tıp ve Rehabilitasyon Kliniği, 06230 Altındağ, Ankara, Türkiye.
Tel: +90 507 - 207 52 18 e-mail: drtaka@yandex.com

Citation:
Taka İ, Alkan BM, Yıldız FF. Validity and reliability of the Duruöz Hand Index in patients with lateral epicondylitis. Arch Rheumatol 2022;37(3):315-325.

©2022 Turkish League Against Rheumatism. All rights reserved.

This is an open access article under the terms of the Creative Commons Attribution-NonCommercial License, which permits use, distribution and reproduction in any medium, provided the original work is properly cited and is not used for commercial purposes (http://creativecommons.org/licenses/by-nc/4.0/).

(HAQ), the Patient-Rated Tennis Elbow Evaluation Questionnaire (PRTEEQ), the Disabilities of the Arm, Shoulder and Hand (DASH) Questionnaire are commonly used assessment scales in cases of lateral epicondylitis.

The validity and reliability of the Duruöz Hand Index (DHI) has been proven in many diseases related to upper extremity; however, it has not been studied in patients with lateral epicondylitis. This test does not require any additional training or equipment and can be performed easily and rapidly. In the present study, we aimed to investigate the validity, reliability, and clinimetric features of the DHI in patients with lateral epicondylitis.

PATIENTS AND METHODS

This cross-sectional, prospective study was conducted at Physical Medicine and Rehabilitation outpatient clinic of Ankara City Hospital between October 2019 and January 2020. A total of 78 patients (28 males, 50 females; mean age: 46.4±9.4 years; range, 20 to 65 years) who presented with pain in the forearm and were diagnosed with lateral epicondylitis were included in the study. Inclusion criteria were as follows: pain in the forearm for at least three weeks, age range between 18 and 65 years, increased pain in the lateral epicondyle region with pressure and resistant extension of the wrist and at the same time, and positive Mill's test. Exclusion criteria were as follows: having bilateral lateral epicondylitis, signs of osteoarthritis in the elbow on X-ray, receiving treatment for lateral epicondylitis within the past six months, presence of cervical radiculopathy, history of surgery or trauma in the forearm, accompanying inflammatory arthritis, malignancy, myopathy, and common painful diseases such as fibromyalgia.

The flow of the study as seen in the flowchart (Figure 1); In the first evaluation, clinical and demographic data such as age, sex, education status, marital status, disease duration, tobacco/alcohol use, risk factors, dominant hand and pain levels of patients were recorded. Functionality, grip strength, and quality of life were also assessed. Necessary information was given to all patients, and rest, protection and exercise methods were also explained. All patients were advised to use non-steroidal anti-inflammatory drugs (NSAIDs) and elbow splints. The patients were re-evaluated after one and four weeks, and measured again DHI, DASH, and PRTEEQ for validity, reliability, and responsiveness.

Assessment scales

The Visual Analog Scale (VAS): The rest, activity, and night pain of the patients were evaluated with VAS. Zero corresponding to no pain, 10 corresponding to the most severe pain the patient has ever experienced in their life.

Grip force: Painless grip strength, which is commonly used in patients with tennis elbow and is more sensitive to change than maximum grip strength, was recorded.[4] The patients

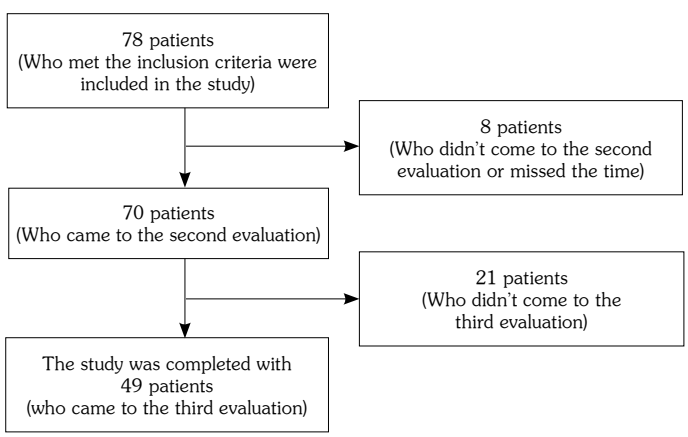

Figure 1. Summary flow chart of patients participation in the study.

were instructed to squeeze the Baseline® digital hydraulic hand dynamometer (Fabrication Enterprises Inc., New York, USA) as much as possible until experiencing pain and to stop when the pain starts. The assessment was performed, while the patient was in a sitting position with shoulder abduction, elbow flexion and the wrist in neutral. Three consecutive measurements were made from both the painful and the intact arm by allowing enough time to rest in between tests and the results were recorded and average values were considered.[4,5]

Health Assessment Questionnaire: The daily living activities of the patients and their level of disability were evaluated with the HAQ. The test consists of 20 questions in total. Activities of daily living are evaluated separately: dressing, standing up, eating, walking, hygiene, reaching, grasping, and daily chores. Questions are answered according to the Likert scale (0= No difficulty, 1= Some difficulty, 2= Much difficulty, 3= Unable to do). Minimum 0 maximum 60 points are divided by 20 and scored in the range of 0 to 3 points. Low scores on this test indicate better functional status.[6]

Disabilities of the Arm, Shoulder and Hand: This is a commonly used disability test with validity and reliability in arm, shoulder, and hand problems that cause pain and disability. The test consists of 30 questions and has two parts. The first 21 questions assess the effect of arm, shoulder and hand problems on daily living activities using the Likert scale. The remaining nine questions assess the effect of the current ailment on social life, sleep, work, and the level of pain-tingling-weakness-difficulty in movement. The score obtained is calculated by dividing the score by the number of questions answered with minimum of 0 to maximum of 100 points, and the lower score indicates the better functional status.[7]

Patient-Rated Tennis Elbow Evaluation Questionnaire: This scale consists of two parts with 15 questions each. The first part assesses pain in the forearm, and the second part assesses functionality. The second part is divided into specific functions (six questions) and general functions (four questions) and consists of a total of 10 questions. The questions are answered with a numerical evaluation scale ranging from 1 to 10. Score is calculated with the formula of pain score +1/2 (specific functions + general functions) to get a minimum of 10 and a maximum of 100 points. The average of the general functions score with the specific functions score creates the function score. Low scores on the test indicate better functional status.[8]

Duruöz Hand Index: The test consists of 18 questions. It is a simple questionnaire that separates daily living functions (kitchen work, getting dressed, cleaning, work, and other daily living activities), does not require an additional training or equipment, and takes approximately 5 min to complete. Lower scores indicate better functional status in a test that can be obtained from a minimum of 0 to a maximum of 90 points arranged using the Likert scale.

The DHI was first developed in 1996 for the evaluation of hand functions in patients with rheumatoid arthritis and subsequently its validity (face, criteria, content, construct) and reliability (inter-rater, intra-rater, test-retest, internal consistency) were investigated in many diseases. Normative data of DHI (5.8±9.58-50.88±27.25), standard error of measurement of the scale (SEM; 0.52-5.92), minimum detectable change value (MDC; 1.4-16.37), responsiveness values (SRM=standard response mean; 0.26-1.97, ES=effect size; 0.24-1.39) were identified in previous studies.[9]

DHI assessment

Reliability: The scale should be error-free and stable and it should be trusted that the same results would be obtained in a re-measurement. The test-retest method is an up-to-date and value-preserving method. In this method, after the questionnaire is applied once, the test is repeated at a date that is far enough not to disturb the measurement standards and is not too close to be remembered. The correlation coefficient between the two measurements is calculated. This calculation yields the reliability coefficient. A reliable and frequently used method for scales from internal consistency methods is Cronbach alpha internal consistency coefficient calculation method. The reliability of the DHI was evaluated using test- retest and internal consistency methods.[10,11] For the test-retest method, the patients completed the DHI twice with an interval of seven days.

Validity: Validity is the degree to which a scale can measure what is intended. The scale is examined in terms of face, content, criterion and construct for validity. For content validity, the gold-standard measurement method in that area, if any previously performed is compared with the tested measurement method. The validity coefficient is obtained with the correlation coefficient. Prediction and concurrent validity can be considered for criterion validity. Construct validity is based on the detection of certain items related to each other or the relationships between items.[10,11] In this study, the content, criteria and construct validity of the DHI were examined.

Exploratory factor analysis: The reliability of the measurement elements to represent factors or theoretical constructs is tested. It represents the grouping of observation variables in the principal component data set into linear composite variables by principal component analysis method and new unrelated variables are revealed. In order for the scale to be tested firstly the Kaiser-Meyer-Olkin (KMO) and Bartlett's test must be appropriate.[10,11]

Confirmatory factor analysis: Using this analysis, the compatibility of the model desired to be measured in theory with the data obtained as a result of the measurement is investigated. To perform the analysis, first a model of theoretically observed variables and patterned variables is drawn and, then, the interactions between the models are generated using the path diagram, finally appropriate analysis is performed.[10,11]

The MDC is the minimum amount of change that cannot be attributed to measurement error in a measurement to express a significant change in a test. It can be calculated using the formula (1,96X√2XSE), which is a method measured with the standard error (SE) of the measurement at 95% confidence interval (CI).[12]

Responsiveness is the sensitivity of the test to change over time in the patient, which may be an indicator of therapeutic effects. Responsiveness can be measured internally and externally. Internal measurement method can be measured by effect size calculation.[13]

Statistical analysis

Power analysis and sample size calculation were performed using the G*Power 3.1.9.4 software (Heinrich-Heine-Universität Düsseldorf, Düsseldorf, Germany). Accordingly, 45 patients were sufficient to be recruited for this study (effect size: 0.5; power[1-β]>0.95).

Statistical analysis was performed using the IBM SPSS version 22.0 (IBM Corp., Armonk, NY, USA) and Amos version 24.0 software (IBM Corp., Armonk, NY, USA). Descriptive data were expressed in mean ± standard deviation (SD), median (min-max) or number and frequency, where applicable. The distribution of the variables was measured using the Kolmogorov-Smirnov and Shapiro-Wilk tests. Repeated measurements were analyzed using the paired t-test for the parametric data and the Wilcoxon test for the non-parametric data. To show and verify the consistency between the factors, exploratory and confirmatory factor analyses were performed in accordance with the structural equation model. The KMO sampling fit measurement and Bartlett's test were used in exploratory factor analysis. A KMO test close to 1 shows high compatibility, and close to 0, it shows low compatibility. Correlation matrix analysis was performed using the Factor Analysis Principal Components method. In-factor weights of implicit variables were calculated using the Varimax rotation method. Factors with a total eigenvalue ≥1 were accepted and considered significant, if the cumulative variance was more than 50%. Factors with a total eigenvalue of ≥0.3 of implicit variables were considered significant in the intra-factor distribution. For confirmatory factor analysis, structural equality modeling was performed according to the scale. In the subsequent analysis, The goodness-of-fit Index, confirmatory fit index, and normed fit index values were considered higher than 0.90 for acceptable fit. The root mean square approximation error (RMSAE) values were considered very good, if ≤0.05, good if >0.05-0.08, and poor fit if ≥0.10. For validity analysis, Cronbach alpha values and intraclass correlation (ICC) coefficients were calculated for the entire index and individual subgroups. Cronbach alpha value was considered weak between 0.00-0.69,

acceptable between 0.70-0.79, good between 0.80-0.89 and excellent between 0.90-1. The Spearman and Pearson correlation tests were used to evaluate both the internal consistency of the DHI and the relationship between the PRTEEQ and DASH Questionnaire. Effect size and standardized response mean values were calculated to determine the test's responsivity value. A p value of <0.05 was considered statistically significant.

Table 1. Demographic data of the patients

	n	%	Mean±SD	Min-Max
Age (year)			46.4±9.4	20-66
Body mass index (kg/m^2)			27.2±4.4	17.97-43.21
Sex				
Male	28	35.9		
Female	50	64.1		
Marital status				
Single	11	14.1		
Married	67	85.9		
Education status				
High School and below	56	71.8		
High School above	22	28.2		
Job				
Unemployed	7	8.9		
Employed	71	91.1		
Dominant side affected				
Yes	59	75.6		
No	19	24.4		

SD: Standard deviation.

Table 2. VAS, Dynamometer, PRTEEQ, HAQ, DASH measurements

	Mean±SD	Min-Max	p
VAS			
Resting	4.0±2.7	0-10	
Weight lifting	8.2±1.9	1-10	
At night	5.6±3.5	0-10	
Hand dynamometer			<0.01
Affected arm	19.7±8.2	4.00-42.67	
Healthy arm	28.2±10.6	10.00-51.00	
PRTEEQ Week 0			<0.01
Pain	30.4±9.9	5-50	
Function	30.1±14.5	6-60	
Daily activities	20.8±10.1	4-40	
Total	55.9±20.4	10.50-95.00	
PRTEEQ Week 4			
Total	45.1±20.9	5.50-84.50	
HAQ			
Total	11.4±9.6	0-37	
DASH Week 0			
Total	42.2±20.2	1.66-82.50	<0.01
DASH Week 4			
Total	34.2±21.4	2.50-89.66	

PRTEEQ: Patient-Rated Tennis Elbow Evaluation Questionnaire; DASH: Disabilities of the Arm, Shoulder and Hand Questionnaire; SD: Standard deviation; VAS: Visual Analog Scale; HAQ: Health Assessment Questionnaire.

Table 3. Duruöz Hand Index measurements

	Mean±SD
DHI Week 0	
Kitchen	11.0±7.4
Wearing	1.2±1.5
Cleaning	1.4±1.8
Work	2.2±2.4
Other	3.6±3.4
Total	19.3±14.2
DHI Week 1	
Kitchen	10.2±7.2
Wearing	1.1±1.5
Cleaning	1.2±1.6
Work	2.3±2.5
Other	3.5±3.6
Total	18.3±14.3
DHI Week 4	
Total	16.1±12.9

SD: Standard deviation; DHI: Duruöz Hand Index.

RESULTS

Demographic characteristics of patients are shown in Table 1. The mean values of the hand dynamometer results in the unaffected arm were significantly higher ($p<0.01$). Table 2 shows the patients' resting pain, movement pain with heavy lifting, and night pain measured with a VAS, and hand the dynamometer measurements. The HAQ was used in the initial evaluation of the patients, and the quality of life results are shown in Table 2. The DASH and PRTEEQ were measured twice at Weeks 0 and 4 (Table 2). The difference between the first and second values was found to be significant compared to the paired t-test ($p<0.01$). The DHI was repeated three times at Weeks 0, 1 (for reliability), and 4 (for responsiveness) of the study (Table 3).

Table 4. Intraclass correlation coefficient and Cronbach alpha values

	Test- re-test (ICC)		Cronbach's alpha	
	r	*p*	Alpha	n
Kitchen	0.950	<0.001	0.900	8
Wearing	0.888	<0.001	0.757	2
Cleaning	0.837	<0.001	0.705	2
Work	0.942	<0.001	0.881	2
Other	0.937	<0.001	0.855	4
Total	0.943	<0.001	0.940	18

ICC: Intraclass Correlation Coefficient; n: Number of questions.

Reliability: In this study, the test-retest method and the Cronbach's alpha method were used for the reproductivity and internal consistency of the Duruöz Hand Index. Intraclass correlation coefficients (ICC) values between 0.00-0.39 indicates weak, between 0.4-0.74 indicates adequate and between 0.75-1 indicates excellent agreement. Cronbach's alpha values between 0.00-0.69 indicates weak, between 0.70-0.79 indicates acceptable, between 0.80-0.89 indicates strong and between 0.90-1 indicates excellent fit. Intraclass correlation coefficients and Cronbach's alpha values obtained as a result are shown in Table 4.

Validity: In this study, the content, criteria, and construct validity were examined. Correlation values between -0.2; +0.2 indicates weak, between -0.59; -0.21 and +0.21; +0.59 are

Table 5. Duruöz Hand Index convergent construct validity test

	Kitchen	Wearing	Cleaning	Work	Other	Total
PRTEEQ						
Pain	0.518	0.446	0.390	0.496	0.449	0.570
Function	0.740	0.543	0.533	0.597	0.738	0.793
Daily activities	0.660	0.530	0.477	0.580	0.740	0.744
Total	0.712	0.560	0.526	0.620	0.729	0.784
DASH						
Total	0.772	0.563	0.472	0.621	0.719	0.801
HAQ						
Total	0.722	0.459	0.571	0.716	0.717	0.785

PRTEEQ: Patient-Rated Tennis Elbow Evaluation Questionnaire; DASH: Disabilities of the Arm, Shoulder and Hand Questionnaire; HAQ: Health Assessment Questionnaire; Spearman correlation analysis ($p<0.01$).

Table 6. Duruöz Hand Index divergent construct validity test

	Kitchen	Wearing	Cleaning	Work	Other	Total
VAS						
Rest	0.235*	0.237*	0.305**	0.297**	0.203	0.290*
Weight lifting	0.384**	0.445**	0.318**	0.423**	0.429**	0.473**
Night	0.310**	0.319**	0.249*	0.389**	0.259*	0.374**
Hand dynamometers						
Mean	-0.305**	-0.125	-0.070	-0.073	-0.128	-0.224*

VAS: Visual Analog Scale; * p<0.05; ** p<0.01; Spearman correlation analysis.

indicates acceptable, between -0.79; -0.6 and between +0.6; +0.79 indicates strong, and between -0.99; -0.8 and between +0.8; +0.99 indicates very strong. A value of -1 or +1 indicates perfect concordance. Tables 5 and 6 show the Spearman correlations for the content, criteria, and construct validity tests of the DHI.

Factor analysis: In this study, two types of factor analysis were performed. The results of exploratory factor analysis (factors and components on the scale are revealed) and confirmatory factor analysis (tests the compatibility of the model with the theory) are given in Table 7. Figure 2 shows the structural

Table 7. Components of exploratory factor analysis (Eigenvalues)

	Components					
	Factor 1	%	Factor 2	%	Factor 3	%
Kitchen 2	0.822					
Kitchen 3	0.816					
Kitchen 4	0.785					
Kitchen 1	0.766				0.367	
Kitchen 5	0.636					
Kitchen 8	0.584		0.380		0.419	
Cleaning 12	0.539		0.436			
Work 14	0.329		0.849			
Work 13			0.831			
Other 15	0.506		0.674			
Other 16	0.465		0.572		0.430	
Wearing 9					0.833	
Kitchen 7	0.407				0.692	
Wearing 10			0.509		0.667	
Other 18	0.306		0.522		0.557	
Other 17			0.462		0.523	
Cleaning 11			0.417		0.504	
Kitchen 6	0.453				0.482	
Eigenvalue (Variance)	9,236	51.30	1,599	8.89	1,152	6.40
Kaiser-Meyer-Olkin test	0.880					
Bartlett's Sphericity test						
Chi-square					1,003.851	
Df					153	
P					<0.01	

The questions are listed according to their factor weights. Values with factor loadings less than 0.3 are not written

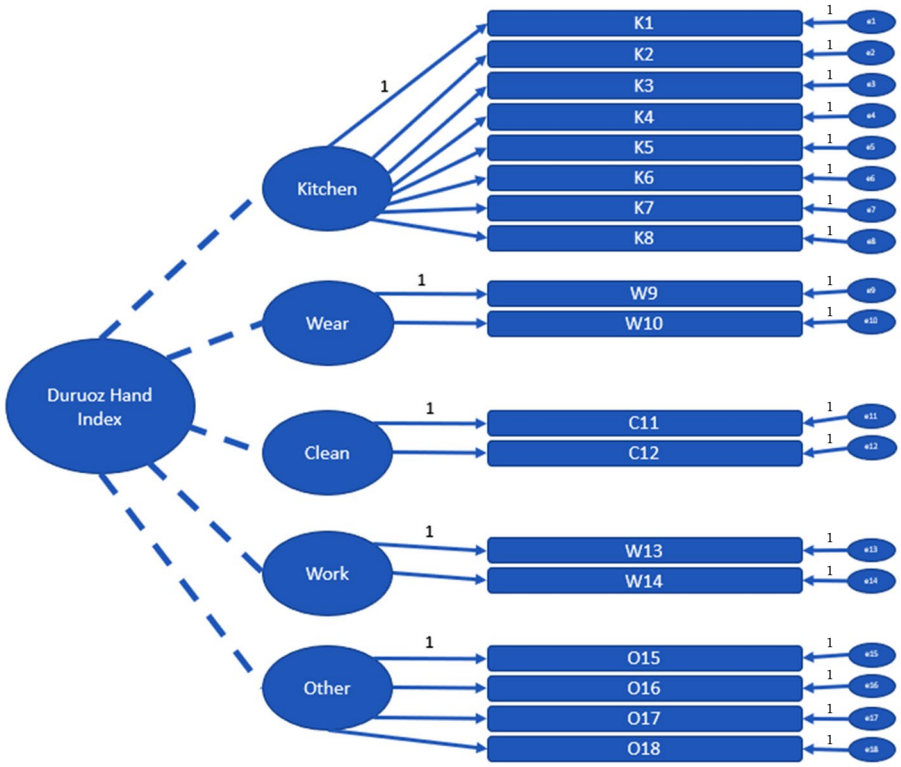

Figure 2. Structural equation model.

equality model. The results of confirmatory factor analysis are shown in Table 8.

Other analyses: The MDC value is the minimum amount of change that must be in a measurement that cannot be attributed to a measurement error to express a significant change in the test. In this study, the MDC value was calculated as 4.46 using the formula 1, 96X√2XSE, including SE in the 95% CI (SE=1.61). In our study, ES was known as the classical Glass' method; obtained by dividing the difference between the first and second measurement by the standard deviation

Table 8. Confirmatory factor analysis data

	p	df	χ^2/df	GFI	CFI	NFI	RMSEA
DHI	<0.01	125	2.025	0.74	0.865	0.77	0.115

p: Chi-square p value; df: Free distribution; GFI: Goodness-of-fit index; CFI: Comparative fit index; NFI: Normed fit index; RMSEA: Root mean square error of approximation.

Table 9. Effect size, SRM, MDC values

	Mean±SD	Glass' Δ	SRM	MDC
DHI Week 0	19.3205±14.19209	0.246	0.538	4.46
DHI Week 4	16.0612±12.93317			
Difference	3.6735±6.82638			

SRM: Standard response mean; MDC: Minimum detectable change; SD: Standard deviation; SE=1.61. SEM: Standard error of measurement.

of the first measurement and SRM method found by dividing the difference between the first and second measurement by the standard deviation of this difference values were calculated. The effect size and SRM values were considered clinically meaningless, if <0.2, low sensitivity if 0.21-0.50, medium sensitivity between 0.51-0.79, and high sensitivity if >0.80. The ES and SRM values are shown in Table 9.

DISCUSSION

In order to be effective to patients in clinical practice, it is necessary to develop robust scales or to demonstrate the validity of existing powerful scales in definite patient groups. In this study, DHI was shown to be a reliable and valid scale in patients with lateral epicondylitis.

In order for the scale used in the collection of scientific data to be a standard measurement, it must have some psychometric strength. The psychometric integrity of the test depends on whether the test is valid and reliable and whether the norms are formed in a similar group. These concepts indicate whether the test measures what it is intended to measure and whether the result of the test changes across different measurements.[11] When the data of 78 patients with lateral epicondylitis were examined by the test-retest method, it was found that the DHI was perfectly correlated for the total score and subtitle separately (ICC coefficients; total=0.943).

In order to check reliability, inter-rater reliability is measured by checking the correlation between the two applicators and the application of a single form. Intra-rater reliability is the degree of compatibility between multiple measurements made by a single reviewer. The ICC coefficients are used in these measurements. Intra-rater ICC of test-retest validity in the DHI was studied by Duruöz et al.[15] in patients with rheumatoid arthritis (ICC=0.97-excellent) and by Poiraudeau et al.[14] in patients with hand osteoarthritis (ICC=0.96-excellent) and found to be excellent. The DHI has been previously studied in patients with rheumatoid arthritis, stroke, scleroderma, cerebral palsy, carpal tunnel syndrome, and tendon injury. In these studies, similar to our study, the ICC coefficients of the total score of the DHI and the observable variables in all subscales were also interpreted as excellent.[14-23]

When the data of the patients with lateral epicondylitis were examined, the DHI showed good-excellent consistency with the internal consistency (Cronbach alpha; total=0.90; kitchen=0.94; wearing=0.75; cleaning=0.70; work=0.88; other=0.85) method and, in general, the DHI was reliable in patients with lateral epicondylitis. Similar to our results, Sezer et al.[17] studied Cronbach alpha internal consistency coefficients for DHI found to be excellent within the structure and in all patterns (0.91-0.97). In another study, Goksenoglu et al.[22] showed an excellent consistency in the structure and patterns (0.91-0.97) without activities at work section and a good consistency for activities at work (0.828). Erçalık et al.[21] showed a good consistency in the structure and patterns outside the department of activities at work (0.834-0.879) and an excellent consistency for activities at work (0.977).[17,21,22]

In this study, the validity of the DHI in terms of coverage, criteria, and structure in patients with lateral epicondylitis were analyzed. The relationship between structure validity and elements was investigated which forms the basis of the validity of the scale. It was examined under divergent and convergent validity. Convergent validity investigates the existence of a relationship between questionnaires that evaluate the prespecified situation, while divergent validity examines the existence of a relationship between measurements that evaluate a prespecified situation. In convergent structure validity, DHI was found to be very strongly correlated with DASH, PRTEEQ function score, daily activities score, total score, and HAQ total score, and to be acceptably correlated with PRTEEQ pain score. In the validity of the divergent structure, VAS rest pain, activity pain, night pain, and the grip force of the hand dynamometer were found to be acceptable correlated with DHI. Our observations during our study also showed that the patients understood the questions well. Similar to our study, the construct validity was found to be strong in many DHI validity studies.[15,17,19-25] As a consequence, the DHI indicates that it is a valid (content, construct, criterion, and face) and reliable (norm-reference

and internal consistency) functional assessment scale in patients with lateral epicondylitis.

The DHI was evaluated by factor analysis in the development study and in subsequent studies.[15,16,24] In this study, when the data of the patients with lateral epicondylitis were examined by principal component analysis method, DHI questioned three basic factors and these factors were associated with activities that require strength of the hand and forearm, flexibility with grip strength of the hand, and activities requiring fine dexterity of the hand (KMO value=0.880; Bartlett's test $p<0.01$). In the study conducted by Duruöz et al.[15] which is the main study, in patients with rheumatoid arthritis, principal component analysis method and correlation matrix were used and varimax method, which brings the variance to the highest value, was preferred. As a result of the analysis, three basic factors were obtained. The first factor was associated with the power and rotation movements of the hand, the second factor was associated with the dexterity of the hand, and the third factor was associated with the flexibility of the first three fingers of the hand. In the study of Poiraudeau et al.,[24] four main factors were identified. The first factor was associated with grip strength, the second factor with dexterity, the third factor with grip strength, and the fourth factor with grip skill.

The fact that the basic factors obtained were different in this study and in other studies can be explained by the fact that the same questions may have different meanings in different diseases. Already, the goal of factor analysis is to attempt to detect this condition. The inability to show a good fit in the fit indexes with the maximum likelihood estimation method in this study can be explained by the low number of participants, the fact that the test was not developed for this disease, and the results were incorrect or misinterpreted, as the corrections that could be suggested with the structural equation model were not made for these diseases. The DHI MDC (4,4) value and SEM (1,61) values in patients with lateral epicondylitis were examined and, when evaluated together with the ES (0.246; $p<0.001$) and SRM values (0.538; $p<0.001$), the MDC value and responsiveness sensitivity were found to be moderate.

The fact that our study is not multi-center, small number of patients participating for further statistical measurements, the absence of a gold-standard test to compare our study, the lack of inter-observer test-retest validity, the absence of a determined and significant predictive criteria in patients with lateral epicondyle are the main limitations of this study.

In conclusion, the DHI is a reliable, valid, and practical functional assessment scale in patients with lateral epicondylitis. The use of the DHI would be useful in the follow-up of patients and in clinical studies. In addition, the fact that factor analyses caused by a small number of patients do not give clear results suggests that further large-scale studies are needed to draw more reliable conclusions on this subject.

Ethics Committee Approval: The study protocol was approved by the Yildirim Beyazit University Faculty of Medicine Ethics Committee (Date: 09/10/2019; No: 101). The study was conducted in accordance with the principles of the Declaration of Helsinki.

Patient Consent for Publication: A written informed consent was obtained from each patient.

Data Sharing Statement: The data that support the findings of this study are available from the corresponding author upon reasonable request.

Author Contributions: Gathering data, Data analysis, writing the manuscript: İ.T.; Study plan, data analysis, revising the manuscript: B.M.A.; Gathering data: F.F.Y.

Conflict of Interest: The authors declared no conflicts of interest with respect to the authorship and/or publication of this article.

Funding: The authors received no financial support for the research and/or authorship of this article.

REFERENCES

1. Vicenzino B, Wright A. Lateral epicondylalgia I: Epidemiology, pathophysiology, aetiology and natural history. Physical Therapy Reviews 1996;1:23-34.
2. Thiele S, Thiele R, Gerdesmeyer L. Lateral epicondylitis: This is still a main indication for extracorporeal shockwave therapy. Int J Surg 2015;24:165-70.
3. Fornalski S, Gupta R, Lee TQ. Anatomy and biomechanics of the elbow joint. Tech Hand Up Extrem Surg 2003;7:168-78.
4. Morrey BF, Sanchez-Sotelo J, Morrey ME, editor. Morrey's the elbow and its disorders. 5th ed. Netherlands: Elsevier; 2009. p. 626-56.

5. Sluiter JK, Rest KM, Frings-Dresen MH. Criteria document for evaluating the work-relatedness of upper-extremity musculoskeletal disorders. Scand J Work Environ Health 2001;27 Suppl 1:1-102.
6. Bruce B, Fries JF. The health assessment questionnaire (HAQ). Clin Exp Rheumatol 2005;23(5 Suppl 39):S14-8.
7. Düger T, Yakut E, Öksüz Ç, Yörükan S, Semin Bilgütay B, Ayhan Ç, et al. Kol, omuz ve el sorunları (Disabilities of the arm, shoulder and hand - DASH) anketi Türkçe uyarlamasının güvenirliği ve geçerliği. Fizyoterapi Rehabilitasyon 2006;17:99-107.
8. Altan L, Ercan I, Konur S. Reliability and validity of Turkish version of the patient rated tennis elbow evaluation. Rheumatol Int 2010;30:1049-54.
9. Index DH. An 18-item self-report questionnaire designed Chicago: AbilityLab; 09/01/2020. Available at: https://www.sralab.org/rehabilitation-measures/duruoz-hand-index.
10. Ercan İ, Kan İ. Ölçeklerde güvenirlik ve geçerlik. Uludağ Tıp Derg 2004;30:211-6.
11. Şencan H. Sosyal ve Davranışsal Ölçümlerde Güvenilirlik ve geçerlilik. Ankara: Seçkin Yayıncılık; 2005.
12. Johnston BC, Patrick DL, Devji T, Maxwell LJ, Bingham III CO, Beaton DE, et al. Patient-reported outcomes. In: Julian PT, Thomas HJ, Chandler J, Cumpston M, Li T, Page MJ, editors. Cochrane Handbook for Systematic Reviews of Interventions. 2nd ed. New York: Wiley; 2019. p. 479-92.
13. Husted JA, Cook RJ, Farewell VT, Gladman DD. Methods for assessing responsiveness: A critical review and recommendations. J Clin Epidemiol 2000;53:459-68.
14. Poiraudeau S, Lefevre-Colau MM, Fermanian J, Revel M. The ability of the Cochin rheumatoid arthritis hand functional scale to detect change during the course of disease. Arthritis Care Res 2000;13:296-303.
15. Duruöz MT, Poiraudeau S, Fermanian J, Menkes CJ, Amor B, Dougados M, et al. Development and validation of a rheumatoid hand functional disability scale that assesses functional handicap. J Rheumatol 1996;23:1167-72.
16. Misirlioglu TO, Unalan H, Karamehmetoglu SS. Validation of Duruöz Hand Index in patients with tetraplegia. J Hand Ther 2016;29:269-74.
17. Sezer N, Yavuzer G, Sivrioglu K, Basaran P, Koseoglu BF. Clinimetric properties of the Duruoz Hand Index in patients with stroke. Arch Phys Med Rehabil 2007;88:309-14.
18. Sanal-Top C, Karadag-Saygi E, Saçaklıdır R, Duruöz MT. Duruöz Hand Index: Is it valid and reliable in children with unilateral cerebral palsy? Dev Neurorehabil 2019;22:75-9.
19. Turan Y, Duruöz MT, Aksakalli E, Gürgan A. Validation of Duruöz Hand Index for diabetic hand dysfunction. J Investig Med 2009;57:887-91.
20. Brower LM, Poole JL. Reliability and validity of the Duruoz Hand Index in persons with systemic sclerosis (scleroderma). Arthritis Rheum 2004;51:805-9.
21. Erçalik T, Şahin F, Erçalik C, Doğu B, Dalgiç S, Kuran B. Psychometric characteristics of Duruoz Hand Index in patients with traumatic hand flexor tendon injuries. Disabil Rehabil 2011;33:1521-7.
22. Gökşenoğlu G, Paker N, Çelik B, Buğdaycı D, Demircioğlu D, Kesiktaş N. Reliability and validity of Duruoz Hand Index in carpal tunnel syndrome. Turk J Phys Med Rehabil 2018;64:277-83.
23. Duruöz MT, Cerrahoglu L, Dincer-Turhan Y, Kürsat S. Hand function assessment in patients receiving haemodialysis. Swiss Med Wkly 2003;133:433-8.
24. Poiraudeau S, Chevalier X, Conrozier T, Flippo RM, Lioté F, Noël E, et al. Reliability, validity, and sensitivity to change of the Cochin hand functional disability scale in hand osteoarthritis. Osteoarthritis Cartilage 2001;9:570-7.
25. Ünsal E, Makay B, Duruöz T. Hand function assessment in patients with juvenile idiopathic arthritis: Usefulness of duruöz hand index. Pediatr Rheumatol 2014;12:P202.