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REVIEW ARTICLE

Validity and reliability of tests to assess motor ability in people with Huntington's disease: a systematic review of the literature

Nika Dolar[1*] | Žiga Kozinc[1]

[1]Faculty of Health Sciences, University of Primorska, Izola, Slovenia

ABSTRACT

Huntington's disease (HD) is a rare, progressive neurodegenerative disorder characterized by movement disorders, cognitive impairment, and behavioral changes. Due to significant motor difficulties, accurate assessment of motor abilities is crucial for monitoring disease progression. The aim of the review was to evaluate the validity and reliability of clinical tests used to assess motor abilities in individuals with HD. A systematic review of the literature in the PubMed and Scopus databases included studies that examined the reliability and/or validity of various clinical tests in individuals with HD. Twelve studies were included in the analysis. The most commonly used and reliable tests are: the Unified Huntington's Disease Rating Scale, the Timed Up and Go test, the Berg Balance Scale, the Tinetti Mobility Test, the Functional Reach Test, and the Six-Minute Walk Test. Digital tools, dynamometry, and gait analysis also show promise. Balance and mobility tests, such as the Berg Balance Scale, Timed Up and Go, Tinetti Mobility Test, and the Unified Huntington's Disease Rating Scale, consistently demonstrated high reliability and validity. These tools are well-suited for clinical use in assessing motor function in individuals with Huntington's disease. However, further research with larger and more homogeneous samples is needed to confirm these findings and improve generalizability.

Keywords: Motor assessment, Reliability, Functional mobility, Balance, Digital monitoring, Assessment tools, Neurodegenerative disorders

*Corresponding: Žiga Kozinc; ziga.kozinc@fvz.upr.si
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INTRODUCTION

Huntington's disease (HD) is a rare neurodegenerative autosomal dominant disorder of the central nervous system, primarily characterized by involuntary choreatic movements, accompanied by cognitive, behavior-al, and psychiatric disturbances (Ajitkumar & De Jesus, 2025; Roos, 2010). The age of onset of the first symptoms ranges from the second to the 85th year of life, with an average age between 30 and 50 years (Roos, 2010). HD is a progressive and fatal disease, leading to death approximately 15–20 years after the appearance of the first symptoms, with no current treatment available to prevent or slow its progression (Humbert & Barnat, 2022). The gene associated with HD was discovered in 1993 following an international initiative. This discovery marked the most significant breakthrough in the study of the disease since it was first described by George Huntington in 1872 (Franklin et al., 2024). It is caused by a mutation in the HTT gene, resulting in abnormal accumulation of CAG repeats, which leads to the degeneration of nerve cells, particularly in the striatum and cerebral cortex (Humbert & Barnat, 2022). In Western countries, HD occurs in approximately 10.6 to 13.7 people per 100,000 inhabitants (McColgan & Tabrizi, 2018). In Japan, Tai-wan, and Hong Kong, HD is much rarer, occurring in one to seven people per million inhabitants. In South Africa, the disease is less common among Black populations compared to White and mixed-race popula-tions (McColgan & Tabrizi, 2018). The clinical picture of HD includes a wide range of symptoms, from cognitive (impaired emotion recognition, poor memory, concentration difficulties, etc.), psychiatric (de-pression, anxiety, irritability, aggression, etc.), to motor impairments, which most significantly affect pa-tients' daily functioning, highlighting the importance of accurate assessment of motor abilities in individu-als with this disease (McColgan & Tabrizi, 2018).

Involuntary movements, such as chorea, and motor coordination disorders are closely linked to the pro-nounced degeneration of neurons in the striatum, which represents the central neuropathological feature of HD (Plácido et al., 2023). In HD, motor disorders initially present as a hyperkinetic phase with pronounced chorea in the early stages, which then reaches a plateau (McColgan & Tabrizi, 2018). This is due to the degeneration of medium spiny neurons (MSNs), which are part of the indirect pathway and play an inhibi-tory role in the motor circuit. Their degeneration leads to reduced inhibition of the thalamus, causing ex-cessive activation of the motor cortex and, consequently, uncontrolled, exaggerated movements. Later, the disease shifts into a hypokinetic phase, characterized by bradykinesia, dystonia, and difficulties with bal-ance and gait (McColgan & Tabrizi, 2018). This is a result of the degeneration of MSNs in the direct path-way. Initially, involuntary movements appear in the fingers, toes, and small facial muscles, often almost imperceptibly. Over time, they spread to all muscles from distal to central (Roos, 2010). Choreatic move-ments are most pronounced in the back muscles and are present

throughout the patient's waking hours. Speech and swallowing become increasingly difficult, potentially leading to choking (Roos, 2010). Walk-ing and daily activities also become more challenging, increasing the risk of falls. In the later stages, motor impairments affect work performance, regardless of cognitive and psychiatric changes (Roos, 2010). Due to the progressive nature of the disease, clinical assessment of movement is crucial for monitoring symptom progression, with rating scales such as the Unified Huntington's Disease Rating Scale (UHDRS) commonly used.

The UHDRS clinical scale assesses four domains in HD: motor function, cognition, behavioral disturb-ances, and functional capacity; and it is a reliable tool for evaluating the clinical features of HD (Hunting-ton, 1996). It covers several aspects of motor performance, including eye movements and saccades, dysto-nia, chorea, and gait (Galvez et al., 2018). However, only three items from the motor section of the UHDRS – gait, tandem walking, and the retropulsion test – directly assess balance and mobility (Quinn et al., 2013). Therefore, it is reasonable to use other specific tests when assessing patients with HD, such as the Timed Up and Go (TUG) test, the Berg Balance Scale (BBS), and the Tinetti Mobility Test (TMT), which have proven to be reliable indicators of balance and mobility issues in this population (Quinn et al., 2013). Given the role of motor disorders in HD and their impact on patients' quality of life, it is important that tools for assessing motor abilities and motor function are valid and reliable. The aim of this paper is to examine the reliability of selected tests for motor abilities and motor function used in individuals with HD.

Materials and Methods

A systematic review of the professional and scientific literature was conducted between March 4 and March 18, 2025, using the PubMed and Scopus databases. The following search strategy was employed: "(Huntington's disease[MeSH] OR Huntington's disease[Title/Abstract] OR chorea) AND (reliabil-ity[Title/Abstract] OR validity[Title/Abstract]) AND (UHDRS OR 'Unified Huntington's Disease Rating Scale' OR 'muscle strength' OR 'postural stability' OR '6-Minute Walk Test' OR 6MWT OR 'Timed Up and Go' OR 'TUG' OR 'gait assessment' OR 'gait analysis' OR 'senior fitness test' OR 'body sway' OR 'postural sway' OR 'force plate' OR walking)."

The literature obtained using the search string was exported into Zotero. Using the program's automatic recognition, duplicates were removed. Titles of the selected literature were then manually reviewed, ex-cluding those that did not meet the defined criteria. Based on the full text, the final selection of articles and studies was determined.

The review included studies that met the following criteria:

- published in peer-reviewed scientific journals

- included adult participants with a confirmed diagnosis of Huntington's disease (manifest or preman-ifest form),
- provided data on reliability (e.g., test-retest, inter-rater reliability) and/or validity (e.g., construct, con-current, predictive) of at least one clinical test for the assessment of motor or functional abilities,
- used scales, clinical or field tests to assess motor abilities or function.

From each article, the following data were extracted: author, year of publication, description of partici-pants, tests used, and a summary of the results. The analysis of the included literature was conducted using a narrative approach, without quantitative synthesis or meta-analysis. For each included study, basic data (author, year, sample), tests used, and key findings regarding reliability and/or validity were recorded. The results were clearly compared based on the measurement tools used, level of reliability (e.g., intraclass cor-relation coefficients – ICC), and the type and quality of evidence. Special attention was given to tests commonly used in clinical practice and the variability of findings based on disease stage and sample size.

Results

A total of 12 studies were included in the final selection (Busse et al., 2008; Goldberg et al., 2010; Kloos et al., 2010, 2014; Li et al., 2022; Lipsmeier et al., 2022, 2022, 2022; Quinn et al., 2013; Rao et al., 2005, 2009; Huntington, 1996; Winder et al., 2018; Youssov et al., 2013). The detailed selection process is shown in Figure 1.

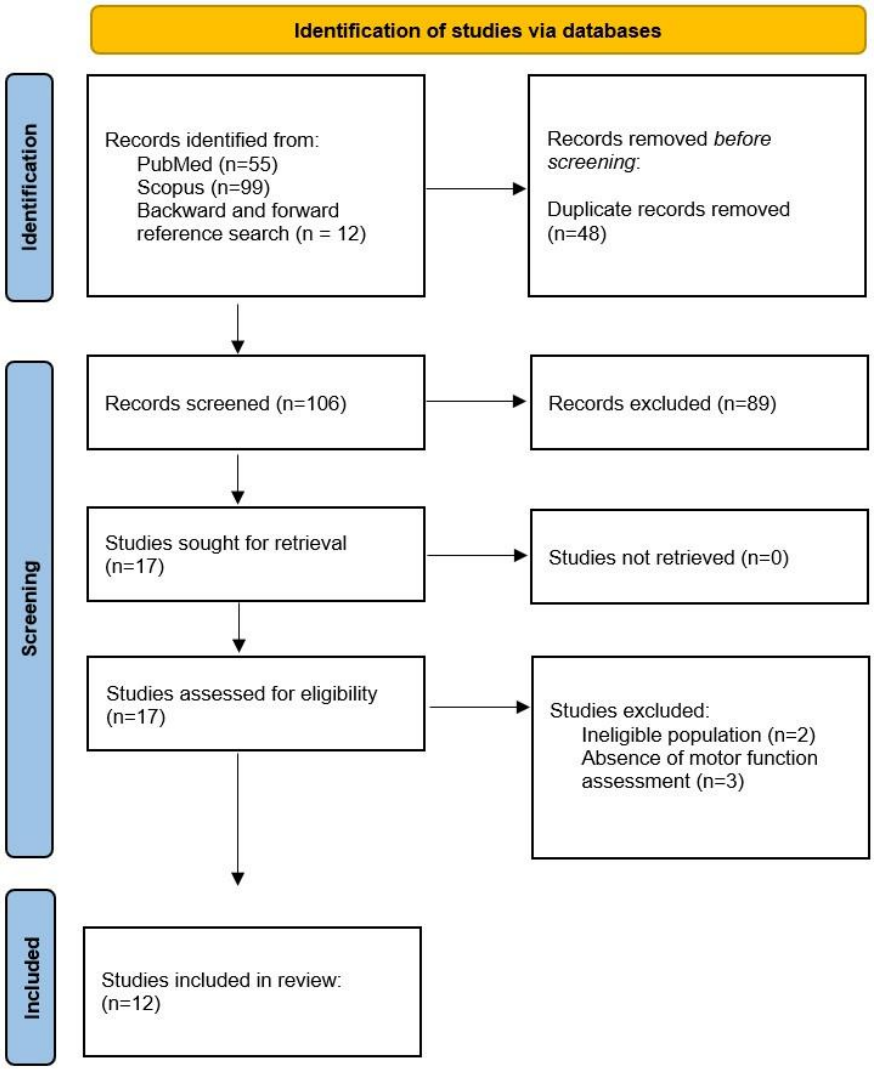

Figure 1. Summary of study identification and selection process.

The studies (Busse et al., 2008; Goldberg et al., 2010; Kloos et al., 2010, 2014; Li et al., 2022; Lipsmeier et al., 2022; Quinn et al., 2013; Rao et al., 2005, 2009; Huntington, 1996; Winder et al., 2018; Youssov et al., 2013) included 2290 participants, of which 2185 had HD and 105 were healthy controls. The time span among the studies was 26 years (1996-2022). Various tests were used in the studies, the most common being: the UHDRS scale, 6-Minute Walk Test (6MWT), TUG, 10-Meter Walk Test (10MWT), ABC scale, Functional Reach Test (FRT), TMT, and the BBS. An overview of the key study characteris-tics is shown in Table 1.

Table 1: Overview of selected articles

Article Title	Author	Year	Description of Participants	What was evaluated	Summary of Results
A Remote Digital Monitoring Platform to Assess Cognitive and Motor Symptoms in Huntington Disease: Cross-sectional Validation Study	Lipsmeier et al.	2022	219 participants; OLE study - 46 participants (M=48.6 years; 28 M, 18 F); HD NHS - 94 participants (M=48.2 years; 58 M, 36 F); Digital-HD study - 79: 20 healthy (M=48 years; 13 M, 7 F), 20 pre-manifest HD (M=44.9 years; 10 M, 10 F), 39 manifest HD (M=56.3 years; 21 M, 18 F)	They assessed the validity of a digital platform for monitoring cognitive and motor symptoms of HD. Correlation between task-based measurements and standard clinical tests was evaluated. Standard tests: UHDRS, Speed taping, Draw-A-shape, chorea, balance, U-turn, walking, gait, activity level.	Moderate to strong correlation between digital tasks and standard clinical assessments (0.89-0.98).
Clinical measurement of mobility and balance impairments in Huntington's disease: Validity and responsiveness	Rao et al.	2009	30 symptomatic participants with HD HD stage 1-10 patients (M=48,1 let; 6M, 4F) HD stage 2-10 patients (M=53,25 let; 5M, 5W) HD stage 3-10 patients (M=55,36 let; 4M, 6F)	The validity and responsiveness of three clinical tests (FRT, TUG, BBS) were evaluated and compared with seven quantitative gait measurements. Quantitative measurements of walking included: walking speed, stride length, cadence; dynamic balance (double percentage of support and base support); and falls and walking pattern (falls, coefficient of variation of stride length, stride time, and CoV stride time)	FRT showed a strong correlation related to gait speed (speed (0.705), step length (0.806), and cadence (0.593); and a moderately strong correlation with dynamic balance (double support percentage (-0.581) and base of support (-0.440)). TUG demonstrated a strong correlation with gait speed (speed (-0.717) and step length (-0.672)); with dynamic balance (base of support (0.633)); and a high correlation with fall measurements (0.670) and gait patterns. BBS showed significant

					correlations related to gait speed, falls, and gait pattern. FRT, TUG, and BBS are valid, responsive, and easy to use.
Clinimetric properties of the Tinetti Mobility Test, Four Square Step Test, Activities-specific Balance Confidence Scale, and spatiotemporal gait measures in individuals with Huntington's disease	Kloos et al.	2014	20 participants (M=50,9 let; 7M, 13F)	The reliability and validity of the TMT, FSST, ABC Scale, and spatiotemporal gait measurements were evaluated.	The Tinetti Mobility Test (TMT) and the Four Square Step Test (FSST) showed moderate to high correlations with gait parameters, supporting their validity for assessing balance and mobility in people with Huntington's disease. Specifically, the TMT is useful for evaluating balance during standing and walking, while the FSST assesses balance during multidirectional stepping. In contrast, the Activities-specific Balance Confidence (ABC) Scale demonstrated lower reliability and weaker concurrent validity compared to other gait and balance measures.
Deficits in stepping response time are associated with impairments in balance and mobility in people with Huntington disease	Goldberg et al.	2010	23 participants; 14 symptomatic participants with HD (M=46,5 let; 42,9% F) 9 healthy in control group (M=40,8 let; 66,7% F)	Stepping response time (SRT) was evaluated in participants with HD and in a control group, along with gait speed. The relationship between SRT and other balance assessments–such as the ABC Scale, TUG, and FR–was also examined. In addition, the relative and absolute reliability of SRT, as well as the	SRT is slower in individuals with HD and is associated with impairments in balance and mobility. It serves as a significant predictor of balance and motor function in individuals with HD. SRT is a valid and objective indicator of disease progression; it is reliable, reproducible, and sensitive to minimal changes.

				minimal detectable change (MDC) of SRT, were assessed.	
Fall risk assessment using the Tinetti mobility test in individuals with Huntington's disease	Kloos et al.	2010	94 participants with HD; 34 participants experienced at least one fall in the last 6 months (M=46.34 years; 41.2%F). 60 participants did not experience a fall in the last 6 months (M=51.81 years; 51.6%F)	The validity of TMT outcomes for identifying fall risk and the potential prediction of falls in individuals in the early and middle stages of HD was evaluated. The correlation between TMT results and motor scores from the UHDRS was also examined. The sensitivity and specificity of the TMT in identifying individuals who had experienced a fall were determined.	TMT scores were significantly negatively correlated with motor subscale scores of the UHDRS (rs = -0.75, P < 0.0001), indicating that both assessments measure constructs of postural control and mobility, including postural stability. At a cutoff score of 21, the TMT demonstrated 74% sensitivity and 60% specificity in identifying individuals who had experienced falls. Lower TMT scores and younger age were significant predictors of falls. The TMT is a valid tool for assessing balance, gait, and fall risk in individuals with HD.
Interrater Reliability of the Unified Huntington's Disease Rating Scale-Total Motor Score Certification	Winder et al.	2018	944 participants	Interrater reliability of the Total Motor Score (TMS) and its individual items within the UHDRS—comprising 31 items—was evaluated. Additionally, the performance of raters across consecutive years of certification was examined.	The study demonstrated good interrater reliability for the TMS (ICC = 0.847). Items such as tandem gait (ICC = 0.824), left hand pronation/supination (ICC = 0.713), and the retropulsion pull test (ICC = 0.706) also showed good reliability. In contrast, items related to dystonia—such as maximal dystonia of the upper and lower limbs and trunk—exhibited

					poor interrater reliability (ICC ranging from 0.187 to 0.389), likely due to the subjective nature of scoring and the challenges in interpretation.
Reliability and minimal detectable change of physical performance measures in individuals with pre-manifest and manifest Huntington disease	Quinn et al.	2013	75 participants with HD (M=52,12 let; 33M, 42F); 11 pre-HD (TFC 13 in TMS<5); 20 early stage (TFC 10 - 13); 20 middle stage (TFC 7-9); 24 advanced stage (TFC 0 - 6) HD	They assessed the reliability and MDC of various physical tests in individuals with HD. The tests conducted included the 6MWT, 10 MWT, TUG, TMT, PPT, Rivermead Mobility Index (RMI), Barthel Index, BBS, Romberg Test, and FSST.	The results showed very high test-retest reliability (ICC > 0.90) in individuals with manifest HD for the following tests: 6MWT, 10 MWT, TUG, BBS, PPT, Barthel Index, RMI, TMT. Despite high reliability, MDC values for many tests (6MWT, 10-meter walk test, TUG, FSST, Romberg) were relatively high, especially in the mid-stage of HD, indicating greater inherent variability. The lowest MDC values in individuals with manifest HD were found for BBS (5 points), PPT (5 points), and TUG (2.98 seconds). In individuals with pre-manifest HD (n = 11), 6MWT and FSST showed high reliability and low MDC values.
Reliability of spatiotemporal gait outcome measures in Huntington's disease	Rao et al.	2005	24 participants; 12 with HD (M=50 let; 7M, 5F) 12 healthy (7M, 5F)	The researchers assessed the test-retest reliability (repeatability between sessions) of spatiotemporal gait parameters in participants with HD and healthy controls. Participants walked at their usual pace across the GAITRite walkway during two separate sessions.	Participants with HD exhibited reduced walking speed, shorter step length, longer cycle time, lower cadence, and increased step width. The results indicate that test-retest reliability was excellent (above 0.8 for all variables); GAITRite proved to be sensitive in distinguishing between

					The evaluated parameters included walking speed, cycle time, step length, cadence, and step width.	individuals with HD and the control group.
	The Chinese Version of UHDRS in Huntington's Disease: Reliability and Validity Assessment	Li et al.	2022	263 participants; 159 with HD (M=45,6 let; 80M, 79F); 46 with pre-HD (M=30,4 let; 24M, 16F) 64 healthy (M=39,7 let; 26M, 38F)	The reliability and validity of the Chinese translation of the UHDRS were evaluated. Specifically, the study examined the internal consistency of the motor, cognitive, behavioral, and functional subscales; interrater reliability of the Total Motor Score (TMS); and both convergent and divergent validity through correlation analysis between the subscales. The motor section of the UHDRS, the Total Functional Capacity (TFC), and the Independence Scale were administered.	The study demonstrated high internal consistency for the Chinese UHDRS: motor subscale - 0.954; functional subscale - 0.954. Interrater reliability for TMS was 0.960, indicating a high level of agreement among raters. Convergent and divergent validity analyses revealed strong associations among the motor, cognitive, and functional subscales.
1	Unified Hunting-ton's disease rating scale for advanced patients: validation and follow-up study	Youssov et al.	2013	69 participants with HD, who had TFC≤ 5 (advanced stage) (M=53,2 let; 25M, 44F)	An adapted version of the UHDRS, called UHDRS-FAP ("for advanced patients"), was developed. The study evaluated the internal consistency of the motor, cognitive, somatic, and behavioral subscales; interrater reliability for all subscales; and the scale's sensitivity to change	The study demonstrated high internal consistency for the motor subscale (UHDRS-FAP - 0.84; UHDRS - 0.84). Interrater reliability was also high for the motor subscale (UHDRS-FAP - 0.98; UHDRS - 0.97). In longitudinal analyses, UHDRS-FAP showed greater sensitivity to changes in motor and cognitive domains compared

				over time in comparison to the original UHDRS. The motor subscale assesses 13 motor features through clinical ratings of gait, transfer ability, dysarthria, fall risk, swallowing, dysphagia, feeding ability, toileting, dressing, and other motor signs such as cerebellar or pyramidal dysfunction, presence of synkinesis, or tendon retraction (scoring range: 0 to 48).	to the original UHDRS, especially in patients with TFC ≤ 1.
Unified Huntington's Disease Rating Scale: reliability and consistency. Huntington Study Group	Huntington	1996	489 participants with HD (M=49,6 let; 229M, 227F, 33 unknown)	The reliability and consistency of the UHDRS were evaluated. The functional assessments included the HD Functional Capacity Score (HDFCS), the Independence Scale (IS), and a checklist of common daily activities.	Each of the four components of the UHDRS demonstrated a high level of internal consistency. Cronbach's alpha coefficients were 0.95 for the motor scale and 0.95 for the functional checklist. The Intraclass Correlation Coefficient (ICC) was 0.94 for the TMS, 0.82 for the chorea score, and 0.62 for the dystonia score. Each domain showed internal consistency, and significant intercorrelations were observed among the UHDRS domains.

Use of hand-held dynamometry in the evaluation of lower limb muscle strength in people with Huntington's disease	Busse et al.	2008	40 participants; 20 symptomatic patients with HD (M=51,7 let; 13M, 7F) 20 healthy (M=48,9 let; 12M, 8F)	The reliability and validity of using a handheld dynamometer to measure isometric muscle strength in six lower limb muscle groups were evaluated (knee extensors, hip extensors, hip abductors, knee flexors, ankle dorsiflexors, and ankle plantar flexors).	The reliability for all muscle groups for each leg was excellent (between 0.86 and 0.96) in both groups. Participants with HD had approximately half the muscle strength of healthy participants. In addition, characteristic correlations were found between UHDRS motor ratings and muscle strength measurements, which further confirms the validity of using a hand dynamometer in this population.

Various clinical tests are used to assess motor abilities in individuals with HD, whose reliability and reproducibility were examined in the studies listed above. The following is a summary of key findings on their validity and reproducibility. The UHDRS-TMS is used to assess motor symptoms in HD. Studies consistently confirm its high reliability and good reproducibility (ICC = 0.75–0.80) (Busse et al., 2008; Goldberg et al., 2010; Kloos et al., 2010; Li et al., 2022; Rao et al., 2005; Winder et al., 2018). The test has been validated as a significant predictor of disease progression. Balance tests (BBS and FRT) have demonstrated high validity, with strong correlations to gait parameters and dynamic stability (Quinn et al., 2013; Rao et al., 2009). The TUG test showed strong correlations with gait parameters and high reliability in assessing functional mobility (Goldberg et al., 2010; Quinn et al., 2013; Rao et al., 2009).

The 6MWT assesses physical endurance and general functional capacity. Research shows good reproducibility and strong associations with motor and balance assessments (Quinn et al., 2013). The FSST, designed to assess dynamic balance and the ability to change direction quickly, has shown high reliability and good correlation with the ABC scale and other balance tests (Kloos et al., 2014; Quinn et al., 2013). The 10 MWT measures walking speed over 10 meters and is a significant indicator of functional mobility. It demonstrated high reliability and strong correlation with TUG and UHDRS-TMS (Quinn et al., 2013).

The TMT assesses balance and fall risk in individuals with HD. Studies confirm its good reproducibility and high specificity for identifying individuals at increased fall risk (Kloos et al., 2010; Quinn et al., 2013). The Physical Performance Test (PPT) measures functional ability in daily tasks and has shown high reproducibility and good correlation with motor assessments and TFC (Quinn et al., 2013). The SRT measures response time when stepping and is used to assess balance and mobility. Research shows it is reproducible and useful as an objective indicator of changes in motor function in HD. It is valid, reliable, and sensitive to minimal changes (Goldberg et al., 2010).

The FRT assesses dynamic balance and trunk control, with studies indicating high reproducibility and strong correlation with gait and other balance tests (Goldberg et al., 2010; Rao et al., 2009). The Draw-A-Shape test evaluates movement coordination and has demonstrated high reproducibility in patients across various stages of the disease (Lipsmeier et al., 2022). Speed tapping assesses finger movement speed and correlates well with motor assessments and other valid clinical motor function tests (Lipsmeier et al., 2022).

The ABC Scale measures confidence in maintaining balance during various everyday tasks. Studies confirm its high reliability and good reproducibility in individuals with HD (Goldberg et al., 2010; Kloos et al., 2014). The TFC scale assesses general functional ability and level of independence. Research confirms high reliability and strong correlation with UHDRS-TMS and other clinical tests (Busse et al., 2008; Li et al., 2022; Rao et al., 2009). The Functional Assessment Scale (FAS) evaluates the impact of HD on the ability to perform everyday activities, showing high reproducibility and good correlation with functional assessments (Busse et al., 2008). The IS measures the degree of independence and the impact of the disease on daily life. It has high reproducibility and strongly correlates

with other functional assessments such as the Barthel Index, FAS, and TFC (Busse et al., 2008; Li et al., 2022).

The Barthel Index assesses the ability to independently perform basic daily activities and shows high reproducibility and good correlation with other functional tests (Quinn et al., 2013). The Rivermead Mobility Index is used to assess functional mobility and walking ability. It has high reliability and strong correlation with gait tests such as TUG and the 10 MWT (Quinn et al., 2013).

Research results indicate that the selected tests for assessing motor abilities in individuals with HD demonstrate good reliability and validity. UHDRS showed consistently high inter-rater reliability and internal consistency, supporting its clinical utility. TUG correlated strongly with gait parameters and demonstrated high test-retest reliability, confirming its value for functional mobility assessment. BBS and FRT showed strong associations with gait speed and dynamic balance, indicating good validity for postural control evaluation. TMT proved effective for assessing fall risk and balance, with acceptable sensitivity and specificity. Finally, 6MWT reliably reflected functional capacity and endurance, correlating well with other motor assessments. These findings support the integration of these tools in clinical settings to monitor disease progression and guide therapeutic strategies.

Discussion

The main objective of this systematic literature review was to assess the reliability and validity of tests used to evaluate motor abilities in individuals with HD. After analyzing the referenced studies, we found that several commonly used tests, scales, and parameters are suitable for use in this population. Among the most established are the UHDRS, FRT, BBS, and TUG, which were shown to be valid in the study by Rao et al. (2009). Kloos et al. (2014) also reported the validity of certain balance tests, such as the FSST and TMT. The SRT, as described by Goldberg et al. (2010), was rated as both reliable and valid, similar to the motor section of the UHDRS (UHDRS-TMS), highlighted by Li et al. (2022). The assessment of muscle strength using a handheld dynamometer was found to be valid in the study by Busse et al. (2008). On the other hand, the ABC scale, according to Kloos et al. (2014), is considered less reliable and valid compared to other gait and balance measures in this population. Emphasis should be placed on tests with high levels of reproducibility and validity, while cautious interpretation is advised for less reliable tests and scales.

A comparison of findings across studies highlights significant variabilty in the levels of reliability and validity of motor assessment tools in individuals with HD. Several tests - including BBS, TUG, TMT, and FRT - have consistently proven to be reliable, reproducible, and valid tools across multiple studies (e.g., Kloos et al., 2010, 2014; Quinn et al., 2013; Rao et al., 2009). Quinn et al. (2013) reported very high test-retest reliability (ICC > 0.90) in individuals with manifest HD for tests including the 6MWT, 10 MWT, TUG, BBS, PPT, Barthel Index, Rivermead Mobility Index, and TMT. However, they noted that MDC values were somewhat higher in the middle stage of the disease, indicating increased variability in this disease phase.

In contrast, the ABC scale was found to have lower reliability and concurrent validity in the study by Kloos et al. (2014), limiting its clinical utility. Additional insights were provided by Winder et al. (2018), who showed that while certain items within the UHDRS-TMS, such

as tandem walking, pronation/supination of the left hand, and the retropulsion pull test, demonstrated good reliability, whereas items related to dystonia were less reproducible due to their subjective nature. High internal consistency of the UHDRS was confirmed both in the Huntington Study Group's original validation (1996) (ICC for TMS = 0.94) and in newer validations such as that by Li et al. (2022) (ICC for TMS = 0.96), confirming the UHDRS's utility across different linguistic and cultural settings. Moreover, Youssov et al. (2013) developed a modified version of UHDRS for advanced-stage pacients, which also proved reliable and applicable (ICC for UHDRS-FAP = 0.98).

Beyond traditional tools, modern and more objective approaches to assessing motor abilities are gaining importance. Lipsmeier et al. (2022) reported moderate to strong correlations between tasks on a developed digital platform and standard clinical tests (ICC > 0.89), suggesting the feasibility of remote, digital monitoring platforms. Additional reliable tools include the SRT, shown by Goldberg et al. (2010) to be valid and sensitive marker of balance and mobility, handheld dynamometry, which Busse et al. (2008) found effective for assessing lower limb muscle strength. In the domain of objective gait measurement, Rao et al. (2005) demonstrated excellent test-retest reliability (ICC > 0.8) for spatiotemporal gait parameters – including speed, cycle time, step length and width, and cadence – highlighting their utility in tracking disease progression.

There are several possible reasons for the differences observed across studies. One key factor is certainly the heterogeneity of participants. The inclusion of individuals at various stages of the disease (premanifest, early, middle, or late stages of HD) can significantly influence the severity of motor symptoms and, consequently, test outcomes. Quinn et al. (2013) reported high variability in results (high MDC values) during the middle stage of the disease, which may hinder accurate detection of changes. Some studies (Busse et al., 2008; Goldberg et al., 2010; Li et al., 2022; Lipsmeier et al., 2022; Quinn et al., 2013; Rao et al., 2005) also included healthy participants or those with the premanifest form of HD, which can affect the reliability and generalizability of the findings. Differences in measurement procedures can also impact the level of test reproducibility and validity—for example, varying assessor expertise, multiple assessors, or the use of subjective ratings (such as the assessment of dystonia in the UHDRS-TMS scale, Winder et al., 2018). Some studies (Lipsmeier et al., 2022; Rao et al., 2005, 2009) had a very specific focus (e.g., measuring tapping speed, step length, cadence, muscle strength), while others evaluated a broader range of functions using standardized scales designed to assess multiple motor domains, which can again lead to variations in outcomes. Linguistic and cultural adaptations of measurement tools also need to be considered, such as the Chinese version of the UHDRS used in Li et al.'s (2022) study, as translation can influence understanding and interpretation of instructions. Moreover, studies with larger sample sizes (Li et al., 2022; Lipsmeier et al., 2022; "Unified Huntington's Disease Rating Scale," 1996; Winder et al., 2018) have greater statistical power and provide more generalizable findings than studies with limited samples. Despite these differences, multiple studies (Kloos et al., 2010, 2014; Li et al., 2022; Quinn et al., 2013; Rao et al., 2009; Huntington, 1996) consistently agree on the validity and reproducibility of tests such as UHDRS, TUG, TMT, and BBS.

The review findings provide valuable guidance for the use of many tests in clinical practice. By utilizing tests that have proven to be reliable and valid, physiotherapists and healthcare professionals can more effectively monitor changes in motor abilities in individuals with HD. Tests such as the UHDRS, TUG, BBS, TMT, and others are easy to administer, time-

efficient, and thus highly applicable in clinical settings. Certain specialized tests, such as handheld dynamometry for muscle strength assessment, the use of digital tools, and measurements of spatiotemporal gait parameters, can further enhance the precision of evaluations and monitoring, and aid in designing targeted rehabilitation programs. Digital tools also enable patients to record difficulties and perform various functional or daily tasks in their home environment.

Despite many useful insights, this review has some limitations. The main limitations include methodological variability across studies, which complicated direct comparisons, small sample sizes in some studies, and participants at different disease stages, which may affect the reproducibility and validity of findings. Due to these factors, caution is necessary when applying the results to broader clinical practice. Future studies should include larger, more homogeneous samples and apply standardized protocols for test administration. Additionally, more longitudinal studies should be conducted to assess the sensitivity of tests over time and to track potential regression in motor and functional abilities. Digital tools could also be employed to monitor symptoms in home and everyday environments.

Conclusions

Based on the literature review, we conclude that numerous tests for assessing motor abilities in individuals with HD are reliable and valid. Among the most frequently used and clinically applicable tests, the UHDRS, TUG, BBS, TMT, FRT, and 6MWT stand out, consistently demonstrating high reproducibility and strong correlation with other functional assessments. Objective approaches, such as measurements of spatiotemporal gait parameters and the use of handheld dynamometry, also show potential value. Caution is required when interpreting the review results due to methodological diversity and sample heterogeneity. Future research with larger and more homogeneous samples, as well as longitudinal approaches, is warranted to better understand changes in motor abilities over time and to support the optimization of rehabilitation strategies.

Author Contributions

Conceptualization, N.D. and Z.K.; methodology, Z.K.; formal analysis, N.D.; investigation, N.D.; data curation, N.D., Z.K.; writing–original draft preparation, N.D.; writing–review and editing, Z.K.;

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