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The Quick Dementia Rating System (QDRS): A rapid dementia staging tool

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Abstract

Introduction: Test the validity and reliability of the Quick Dementia Rating System (QDRS), a rapid dementia staging tool.

Methods: The QDRS was tested in 267 patient-caregiver dyads compared with Clinical Dementia Ratings (CDR), neuropsychological testing, and gold standard measures of function, mood, and behavior. Psychometric properties including, item variability, floor and ceiling effects, concurrent and construct validity, and internal consistency were determined. The QDRS was used to derive an independent CDR and sum-of-boxes (SB). Interscale reliability between QDRS and CDR was tested using intraclass correlation coefficients (ICC). Area under the receiver operator characteristic curves (AUC) tested discrimination properties of QDRS across CDR stages.

Results: QDRS scores increased with higher CDR staging and poorer neuropsychological performance (*P*s $<$ .001). The QDRS demonstrated low floor and ceiling effects; excellent known-groups validity across CDR stages (*P*s $<$ .001); construct validity against cognitive, behavioral, and functional measures (*P*s 0.004 to $<$0.001); and reliability (Cronbach α: 0.86–0.93). The QDRS demonstrated differential scores across different dementia etiologies. The AUC for the QDRS was 0.911 (95% confidence interval or CI 0.86–0.96) and for the CDR-SB was 0.996 (95% CI 0.99–1.0) demonstrating comparable ability to discriminate normal controls from dementia. The QDRS-generated CDR demonstrated excellent correspondence with the CDR (ICC = 0.90) and SB (ICC = 0.92).

Discussion: The QDRS validly and reliably differentiates individuals with and without dementia and accurately stages dementia without extensive training or clinician input, and is highly correlated with our gold standard measures. The QDRS provides a rapid method to determine study eligibility, stage patients in clinical practice, and improve case ascertainment in population studies.

Keywords: Dementia; Neurocognitive disorders; Clinical dementia rating; Staging; Clinical trials

1. Background

Detection of mild cognitive impairment (MCI) [1,2] and mild Alzheimer's disease (AD) [3] in community samples of older adults may be limited in part due to the lack of brief tests that capture and characterize the earliest signs of impairment and monitor response to therapies and interventions [4,5]. This may affect eligibility determination for care and services, impede case ascertainment in epidemiologic studies, and inhibit the ability to identify eligible individuals for clinical trial recruitment. Informant-based assessments of intraindividual change such as the AD8 [4,6] may be more sensitive to identify individuals with mild impairments and better detect functional interference than brief performance-based measures that rely on interindividual norms [7,8]. However, all brief screening methods, whether informant-based (i.e., the AD8 [4,9]) or performance-based (i.e., the Mini-Cog [10]), have limited

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ability to stage individuals. Gold standard evaluations (i.e., Clinical Dementia Rating or CDR [11]) used in many clinical, translational, and health services research projects require a trained clinician to administer, interpret, and score; and an extended period of time with the patient and informant. Although feasible in the setting of a clinical trial, the CDR is more difficult to apply in screening procedures for inclusion/exclusion criteria or for case ascertainment in community-based research, and is impractical in most clinical practices. We developed the Quick Dementia Rating System (QDRS)—a rapid dementia staging tool to meet these needs.

The QDRS (Table 1) is a 10-item questionnaire completed by an informant without the need for a trained clinician or rater, and takes 3 to 5 minutes to complete. Scores range from 0 to 30 with higher scores representing greater cognitive impairment. Ten domains, derived from an empiric review of the literature and the clinical experience of the author caring for patients at memory disorder clinics, cover (1) memory and recall, (2) orientation, (3) decision-making and problem-solving abilities, (4) activities outside the home, (5) function at home and hobbies, (6) toileting and personal hygiene, (7) behavior and personality changes, (8) language and communication abilities, (9) mood, and (10) attention and concentration. These domains capture prominent symptoms of MCI, AD, and non-Alzheimer neurocognitive disorders including Lewy body dementia, frontotemporal degeneration, vascular dementia, chronic traumatic encephalopathy, and depression. Each domain has five possible answers increasing in severity of symptoms. A particular advantage of the QDRS is the rapid and accurate generation a valid (CDR) and its sum-of-boxes (SB) [11]. Here we present the psychometric evaluation of the QDRS.

2. Methods

2.1. Formative development of the QDRS

The QDRS (Table 1) was first developed in a sample of 50 patients-caregiver dyads coming to evaluation at the Pearl I Barlow Center for Memory Evaluation and Treatment, a dementia specialty practice. The QDRS was collected independent of the clinical evaluation conducted by the author and compared with the CDR and CDR-SB. Questions were checked for the ease of understanding by the caregivers and revised accordingly. We then conducted an Internet survey of 736 dementia caregivers comparing QDRS to other validated dementia scales including Revised Memory-Behavior Problem Checklist (RMBP) [12], patient- and caregiver-reported Quality of Life (QoL) [13], and the Zarit Burden Inventory (ZBI) [14]. QDRS scores increased with dementia severity corresponding with increases in reporting of increasing memory and behavior problems by RMBP, increased caregiver burden by ZBI, and decreases in patient- and caregiver-reported QoL (all $Ps < .001$). Principle component analysis using Varimax rotation of the QDRS from this sample revealed two domains: Cognitive (Eigenvalue 4.8; 48.4% variance) and Behavioral (Eigenvalue 1.6; 15.9% variance). This final version of the QDRS was used in this study.

2.2. Study participants

Participants were drawn from a consecutive series of 239 new patient referrals from September 2013 to November 2014. An additional cohort of 28 healthy controls and their informants was recruited from the community during this same time period and underwent identical assessments as the cases. Assessments were completed by a transdisciplinary team of a neurologist, geriatric nurse practitioner, social worker, and psychometrician. The QDRS was completed by the caregiver before the visit. During the visit, the patient and caregiver underwent a comprehensive evaluation including the CDR-SB [11], mood, neuropsychological testing, caregiver ratings of behavior and function, and caregiver burden and depression. All components of the assessment were part of standard of care at our center [15]. The study was approved by the NYU Langone Medical Center Institutional Review Board.

2.3. Administration of the QDRS

Before the office visit, a welcome packet was mailed to the patient and caregiver to collect demographics. The caregiver was asked to complete the QDRS and bring it with them to the office visit. The study team was blinded to the QDRS, and it was not considered during the clinical assessment, diagnosis, or staging. The QDRS total score is derived by summing up the 10 domains. Two subdomains cognitive (questions 1, 2, 3, and 8) and behavioral (questions 4, 5, 6, 7, 9, and 10) were derived from the formative work. The first six domains of the QDRS were used to generate a QDRS-derived global CDR and CDR-SB using the published CDR scoring rules [11].

2.4. Clinical assessment

The neurologist conducted independent semistructured interviews with the patient and a collateral source. The CDR [11] was used to determine the presence or absence of dementia and to stage its severity. The CDR rates cognitive function in six categories (memory, orientation, judgment and problem solving, and performance in community affairs, home and hobbies, and personal care); a global CDR 0 indicates no dementia; CDR 0.5 represents MCI or very mild dementia; CDR 1, 2, or 3 corresponds to mild, moderate, or severe dementia. Diagnoses were determined using standard criteria for MCI due to AD [1], MCI possibly due to other disorders [2], AD [3], dementia with Lewy Bodies (DLB) [16], frontotemporal degeneration (FTD) [17,18], and vascular dementia (VaD) [19]. In addition to the CDR, the Global Deterioration Scale (GDS) [20] was

Table 1
The QDRS, Quick Dementia Rating System

1. Memory and recall	
0	No obvious memory loss or inconsistent forgetfulness that does not interfere with function in everyday activities
0.5	Consistent mild forgetfulness or partial recollection of events that may interfere with performing everyday activities; repeats questions/statements, misplaces items, forgets appointments
1	Mild to moderate memory loss; more noticeable for recent events; interferes with performing everyday activities
2	Moderate to severe memory loss; only highly learned information remembered; new information rapidly forgotten
3	Severe memory loss, almost impossible to recall new information; long-term memory may be affected
2. Orientation	
0	Fully oriented to person, place, and time nearly all the time
0.5	Slight difficulty in keeping track of time; may forget day or date more frequently than in the past
1	Mild to moderate difficulty in keeping track of time and sequence of events; forgets month or year; oriented to familiar places but gets confused outside familiar areas; gets lost or wanders
2	Moderate to severe difficulty, usually disoriented to time and place (familiar and unfamiliar); frequently dwells in past
3	Only oriented to their name, although may recognize family members
3. Decision making and problem-solving abilities	
0	Solves everyday problems without difficulty; handles personal business and financial matters well; decision-making abilities consistent with past performance
0.5	Slight impairment or takes longer to solve problems; trouble with abstract concepts; decisions still sound
1	Moderate difficulty with handling problems and making decisions; defers many decisions to others; social judgment and behavior may be slightly impaired; loss of insight
2	Severely impaired in handling problems, making only simple personal decisions; social judgment and behavior often impaired; lacks insight
3	Unable to make decisions or solve problems; others make nearly all decisions for patient
4. Activities outside the home	
0	Independent in function at the usual level of performance in profession, shopping, community and religious activities, volunteering, or social groups
0.5	Slight impairment in these activities compared with previous performance; slight change in driving skills; still able to handle emergency situations
1	Unable to function independently but still may attend and be engaged; appears "normal" to others; notable changes in driving skills; concern about ability to handle emergency situations
2	No pretense of independent function outside the home; appears well enough to be taken to activities outside the family home but generally needs to be accompanied
3	No independent function or activities; appear too ill to be taken to activities outside the home
5. Function at home and hobby activities	
0	Chores at home, hobbies and personal interests are well maintained compared with past performance
0.5	Slight impairment or less interest in these activities; trouble operating appliances (particularly new purchases)
1	Mild but definite impairment in home and hobby function; more difficult chores or tasks abandoned; more complicated hobbies and interests given up
2	Only simple chores preserved, very restricted interest in hobbies which are poorly maintained
3	No meaningful function in household chores or with prior hobbies
6. Toileting and personal hygeine	
0	Fully capable of self-care (dressing, grooming, washing, bathing, toileting)
0.5	Slight changes in abilities and attention to these activities
1	Needs prompting to complete these activities but may still complete independently
2	Requires some assistance in dressing, hygiene, keeping of personal items; occasionally incontinent
3	Requires significant help with personal care and hygiene; frequent incontinence
7. Behavior and personality changes	
0	Socially appropriate behavior in public and private; no changes in personality
0.5	Questionable or very mild changes in behavior, personality, emotional control, appropriateness of choices
1	Mild changes in behavior or personality
2	Moderate behavior or personality changes, affects interactions with others; may be avoided by friends, neighbors, or distant relatives
3	Severe behavior or personality changes; making interactions with others often unpleasant or avoided
8. Language and communication abilities	
0	No language difficulty or occasional word searching; reads and writes as in the past
0.5	Consistent mild word finding difficulties, using descriptive terms or takes longer to get point across, mild problems with comprehension, decreased conversation; may affect reading and writing
1	Moderate word finding difficulty in speech, cannot name objects, marked reduction in work production; reduced comprehension, conversation, writing, and/or reading
2	Moderate to severe impairments in speech production or comprehension; has difficulty in communicating thoughts to others; limited ability to read or write
3	Severe deficits in language and communication; little to no understandable speech is produced
9. Mood	
0	No changes in mood, interest, or motivation level
0.5	Occasional sadness, depression, anxiety, nervousness, or loss of interest/motivation
1	Daily mild issues with sadness, depression, anxiety, nervousness, or loss of interest/motivation
2	Moderate issues with sadness, depression, anxiety, nervousness, or loss of interest/motivation

(*Continued*)

Table 1
The QDRS, Quick Dementia Rating System (*Continued*)

3	Severe issues with sadness, depression, anxiety, nervousness, or loss of interest/motivation
10. Attention and concentration	
0	Normal attention, concentration, and interaction with his or her environment and surroundings
0.5	Mild problems with attention, concentration, and interaction with environment and surroundings, may appear drowsy during day
1	Moderate problems with attention and concentration, may have staring spells or spend time with eyes closed, increased daytime sleepiness
2	Significant portion of the day is spend sleeping, not paying attention to environment, when having a conversation may say things that are illogical or not consistent with topic
3	Limited to no ability to pay attention to external environment or surroundings
Cognitive subtotal (questions 1, 2, 3, 8)	
Behavioral subtotal (questions 4, 5, 6, 7, 9, 10)	
Total QDRS score	

NOTE. The following descriptions characterize changes in the patient's cognitive and functional abilities. You are asked to compare the patient now to how they used to be—the key feature is ***change***. Choose ***one answer*** for each category that best fits the patient—***NOTE***, not all descriptions need to be present to choose an answer.

completed for each patient providing the additional construct of subjective cognitive impairment (SCI). Extrapyramidal features were assessed with the Movement Disorders Society-Unified Parkinson's Disease Rating Scale, motor subscale part III [21].

2.5. Caregiver evaluation

Caregivers completed evaluations to determine the presence and severity of noncognitive symptoms observed in the patient and their impact on the caregiver. The Neuropsychiatric Inventory (NPI) [22] assessed behavior, Mayo Fluctuation Questionnaire [23] assessed the presence of cognitive fluctuations, and Epworth Sleepiness scale [24] assessed daytime sleepiness. The Functional Activities Questionnaire (FAQ) [25] was used to rate the performance of activities of daily living. The ZBI [14] evaluated caregiver burden and the Personal Health Questionnaire [26] assessed caregiver depression.

2.6. Neuropsychological evaluation

Each patient was administered a 30-minute test battery at the time of the office visit to assess their cognitive status. The psychometrician was unaware of the diagnosis, QDRS, or CDR. A brief global assessment was performed using the Mini-Mental State Examination (MMSE) [27]. The test battery included measures of episodic memory (Hopkins Verbal Learning Task [28]; semantic memory (Animal Fluency) [29] and 15-item Boston Naming Test [30]); and working memory (Letter-Number Sequencing) [31]. Two timed measures addressed psychomotor and executive abilities: Trailmaking A [32] and Trailmaking B [32]. Construction was assessed with the Clock Drawing Task [33]. Mood was assessed with the Hospital Anxiety Depression Scale [34] providing subscale scores for depression and anxiety.

2.7. Statistical analyses

Analyses were conducted using SPSS v21 (Armonk, NY). Descriptive statistics were used to present clinical characteristics of patients, informant ratings, QDRS, CDR, CDR-SB, and neuropsychological testing. One-way analysis of variance (ANOVA) with Tukey-Kramer post-hoc tests were used for continuous data and chi-squared analyses were used for categorical data. Eta-squared data from the omnibus ANOVA were used to estimate effect size. Data completeness was assessed by calculating the missing data rates for each QDRS item. To assess item variability, the item frequency distributions, range, and standard deviations were calculated. Item and subscale scores were examined for floor and ceiling effects. Concurrent (criterion) validity was assessed comparing the mean performance on each Gold Standard measure of cognition (e.g., CDR, CDR-SB, neuropsych testing), function (i.e., FAQ), and behavior (e.g., NPI, Hospital Anxiety and Depression Scale) with the QDRS using Pearson correlation coefficients [9,35,36]. Convergent and discriminative construct validity was assessed with Spearman correlation coefficients. For convergent validity, moderate correlations ($\rho > 0.4$) between items in each domain and between similar constructs in rating scales or neuropsychological tests were accepted as evidence. For discriminant validity, low correlation ($\rho < 0.3$) between items in different domains and between nonsimilar rating scales and neuropsychological tests was accepted [9,35,36]. Internal consistency was examined as the proportion of the variability in the responses that is the result of differences in the respondents, reported as the Cronbach alpha reliability coefficient. Coefficients greater than 0.7 are good measures of internal consistency [9,35,36]. The intraclass correlation coefficient (ICC) assessed interscale reliability comparing CDR domains, SB, and global scores with the QDRS correcting for chance agreement [9,35,36]. Simple agreement (i.e., the proportion of responses in which two observations agree such as a Pearson or Spearman correlation coefficient) is strongly influenced by the distribution of positive and negative responses, and the agreement by chance alone. The ICC instead examines the proportion of responses in agreement in relation to the agreement expected by

Table 2
Sample characteristics

	CDR 0, controls, N = 32	CDR 0, SCI, N = 8	CDR 0.5, MCI, N = 65	CDR 0.5, dementia, N = 60	CDR 1, dementia, N = 60	CDR 2, dementia, N = 31	CDR 3, dementia, N = 11	*P*-value	Partial eta
Age, yrs	70.1 (7.6)	70.5 (10.0)	76.2 (8.9)	78.4 (7.1)	77.1 (7.9)	81.6 (7.6)	78.8 (12.3)	.05	
Education, yrs	16.7 (2.4)	18.1 (1.8)	15.9 (3.0)	15.5 (4.0)	15.4 (3.9)	14.5 (3.0)	14.1 (3.7)	.07	
Gender, % female	57.9	50.0	51.5	50.9	50.0	71.0	45.5	.45	
Race, % white	93.0	100.0	89.4	93.0	82.3	93.5	100.0	.76	
Charlson Comorbidity Index	1.7 (1.9)	1.5 (1.8)	1.9 (1.3)	2.3 (1.6)	2.1 (1.1)	2.7 (1.8)	2.5 (1.3)	.128	
MMSE	26.3 (2.4)*	28.7 (1.6)	26.1 (3.3)	23.4 (2.9)	20.5 (5.1)	14.3 (5.5)	4.3 (5.4)	<.001	
GDS	1.0 (0.0)	2.0 (0.0)	3.0 (0.0)	3.9 (0.2)	4.2 (0.5)	5.4 (0.5)	6.2 (0.4)	<.001	
FAQ	0.0 (0.0)	2.6 (2.9)	3.6 (4.2)	4.3 (5.1)	12.7 (6.9)	21.8 (7.5)	29.8 (0.4)	<.001	
NPI	0.9 (1.6)	4.1 (5.3)	5.6 (4.7)	6.4 (5.3)	9.6 (6.3)	10.7 (5.2)	14.4 (6.1)	<.001	
QDRS total	0.3 (0.5)	2.5 (1.7)	3.5 (2.7)	4.1 (2.9)	8.7 (4.1)	13.5 (4.7)	23.7 (3.1)	<.001	0.653
QDRS cognitive	0.2 (0.3)	1.1 (0.6)	1.5 (0.9)	2.1 (1.3)	3.3 (1.7)	4.6 (2.1)	8.5 (1.7)	<.001	0.553
QDRS behavioral	0.2 (0.3)	1.5 (0.6)	2.0 (2.0)	2.0 (1.9)	5.4 (2.9)	8.8 (3.7)	15.2 (1.7)	<.001	0.628
QDRS sum box	0.2 (0.3)	1.1 (1.1)	1.9 (1.6)	2.4 (1.6)	4.9 (2.2)	8.9 (2.8)	14.9 (1.7)	<.001	0.733
QDRS CDR global	0.03 (0.1)	0.3 (0.2)	0.4 (0.3)	0.5 (0.3)	0.9 (0.4)	1.6 (0.6)	2.8 (0.4)	<.001	0.678

Abbreviations: CDR, Clinical Dementia Rating; SCI, subjective cognitive impairment; MCI, mild cognitive impairment; MMSE, Mini-Mental State Examination; GDS, Global Deterioration Scale; FAQ, Functional Activities Questionnaire; NPI, Neuropsychiatric Inventory; QDRS, Quick Dementia Rating System.
*CDR 0 controls completed the Montreal cognitive assessment instead of the MMSE.

chance [35]. An ICC between 0.55 and 0.75 is considered good agreement, whereas an ICC greater than 0.76 is considered excellent [37]. Receiver operator characteristic (ROC) curves were used to assess discrimination between groups using the CDR as a gold standard. Results are reported as area under the curve (AUC) with 95% confidence intervals (CIs).

3. Results

3.1. Sample characteristics

The mean age of the cohort was 77.7 ± 8.3 years (range 50–98) with a mean education of 15.5 ± 3.6 years (range 4–24); a mean Charlson Comorbidity Index [38] of 2.2 ± 1.4 (range 0–9); and mean MMSE of 21.8 ± 6.3 (range 0–30). The racial and ethnic make-up of the sample was 89.7% white, non-Hispanic, 4.3% African American, 4.7% Hispanic, and 1.2% Asian. The cohort diagnoses were 32 healthy controls, 8 SCI, 65 MCI, 91 AD, 48 DLB, 5 VaD, 10 FTD, and 8 other dementias. Informants consisted of 156 spouses/significant others, 76 adult children, 13 other relatives, 19 friends, and 3 paid caregivers. Sample characteristics and QDRS scores by diagnosis and stage are presented in Table 2. QDRS total and subdomain scores increased with higher CDR staging and poor performance on the MMSE, FAQ, GDS, and NPI (all *P*s < .001). The strength of association (concurrent validity) between the QDRS and the CDR was 0.801 ($P < .001$) and for the CDR-SB was 0.820 ($P < .001$). Table 3 demonstrates the strength of association between the QDRS and other indices of cognition, behavior, and function. The QDRS was not correlated with patient-reported anxiety (R = 0.121, $P = .09$) or caregiver depression (R = 0.163, $P = .08$).

3.2. QDRS data quality

Table 4 demonstrates that all items of the QDRS exhibited the full range of possible responses across the five-item response options. In general, the item responses were more heavily distributed between the CDR 0, 0.5, and 1 scores than the CDR 2 and 3 scores (means range from 0.5 to 0.9). Missing item rates were very low ranging from 0% to 1.7%. The item-level floor effects range from 14.5% (Memory and Recall) to 56.8% (Toileting and Personal Hygiene) with a median of 26.1%. The item-level ceiling effects range from 0.4% (Orientation) to 8.7% (Mood) with a median of 3.9%. The standard deviation was similar for all items, ranging from 0.6 to 0.9. There was no difference in QDRS scoring between spouse and nonspouse informants compared with gold standard ratings of cognition, function, or behavior (F = 0.032, $P = .86$). Thus, data quality for the QDRS were excellent.

3.3. Reliability and scale score features of QDRS

The degree to which the QDRS was free from random error by assessing the internal consistency with Cronbach alpha for Total QDRS scores and two subdomains: cognitive and behavioral. The internal consistency was excellent (0.86–0.93, Table 5). The QDRS covered the entire range of possible scores and the mean, median, and standard

Table 3
Mean performance on rating scales and neuropsychological tests and concurrent validity with QDRS

Measure	Mean (SD)	R	*P*-value	Covariance
CDR-SB	5.2 (4.4)	.820	<.001	20.4
CDR	0.9 (0.7)	.801	<.001	3.2
GDS	4.0 (1.0)	.699	<.001	4.0
FAQ	9.9 (9.5)	.830	<.001	46.3
UPDRS	12.5 (18.3)	.462	<.001	40.4
MMSE	21.8 (6.4)	−.599	<.001	−21.0
Animal naming	11.3 (6.1)	−.485	<.001	−15.4
BNT	9.3 (4.2)	−.329	<.001	−7.1
HVLT-total	12.4 (5.6)	−.454	<.001	−12.9
HVLT-delay	1.6 (2.4)	−.299	<.001	−3.7
L-N sequence	3.6 (1.4)	−.353	<.001	−2.3
Trailmaking A	68.8 (46.6)	.369	<.001	75.8
Trailmaking B	141.4 (44.2)	.275	.002	43.6
HADS-anxiety	5.9 (3.5)	.121	.09	2.0
HADS-depression	6.1 (3.8)	.239	.001	4.4
AD8-patient version	2.7 (1.9)	.207	.004	1.9
NPI	7.9 (5.9)	.561	<.001	19.7
MFQ	1.8 (1.2)	.554	<.001	4.0
Epworth Sleepiness Scale	7.3 (4.8)	.363	<.001	10.3
Alertness rating	7.0 (2.0)	−.511	<.001	−6.1
Caregiver burden	17.1 (10.2)	.315	<.001	18.9
Caregiver depression	2.2 (2.7)	.163	.08	2.0

Abbreviations: QDRS, Quick Dementia Rating System; SD, standard deviation; CDR, Clinical Dementia Rating; GDS, Global Deterioration Scale; FAQ, Functional Activities Questionnaire; UPDRS, Unified Parkinson Disease Rating Scale; MMSE, Mini-Mental State Examination; BNT, Boston Naming Test; HVLT, Hopkins Verbal Learning Test; L-N, Letter-Number Sequencing test; HADS, Hospital Anxiety and Depression Scale; NPI, Neuropsychiatric Inventory; MFQ, Mayo Fluctuations Questionnaire.

deviation demonstrated a sufficient dispersion of scores for the assessing and monitoring the presence and severity of dementia with low percentage of missing data. There were very low floor (2.5–8.7%) and ceiling (0.4%) effects, especially for cognitive domain questions. The two factors (cognitive and behavioral) were moderately correlated suggesting they are related but substantially distinct. The total QDRS was internally consistent with scale score features that demonstrated ample dispersion of scores for both the QDRS total score and subscales.

3.4. Construct validity of the QDRS

Construct validity of the QDRS is the correspondence of how well each domain corresponds to a theorized trait. Table 6 lists the QDRS domains and the corresponding rating scales and neuropsychological tests. Demonstration of moderate to strong correlations (≥40%) between individual QDRS domains and rating scales and neuropsychological tests support convergent validity, suggest the QDRS domain and the corresponding test tap into similar constructs. Conversely, low correlations (≤30%) between individual QDRS domains and rating scales and neuropsychological tests support divergent validity, suggest there is no relationship between dissimilar constructs. For example, the Memory and Recall domain is convergent with tests of episodic and semantic memory, but not with mood, behavior, psychomotor, or executive function. Function within and outside the home is convergent with extrapyramidal signs, behavior, alertness, and episodic memory, but not with mood, semantic memory, or executive function. Toileting and Personal Hygiene is convergent with behavior, extrapyramidal signs, and alertness, but not with cognitive performance or mood. Attention and Concentration is convergent with alertness, behavior, and fluctuations, but not with mood or cognitive performance.

3.5. Known-groups validity of the QDRS

The extent to which the QDRS total and subscales separate the known groups of cognitive impairment, defined by CDR staging, is evidence of known group validity (Table 2) [34] Omnibus p-tests were significant for total QDRS, Cognitive and Behavioral subdomains, and QDRS-derived CDR and CDR-SB (all Ps < .001). Pairwise differences using Tukey-Kramer tests demonstrated that the CDR 0 group was different from all other groups (all Ps < .001). The two CDR 0.5 groups (MCI and Dementia) were different from all other groups (all Ps < .001) but were not different from each other. The CDR 1, 2, and 3 groups were different from each other (all Ps < .001). The effect size of the QDRS, based on the eta-squared values, demonstrated that group membership was robustly defined by total QDRS, Cognitive and Behavioral subdomains, and QDRS-derived CDR and CDR-SB scores. The characteristics of the QDRS questions, total QDRS, Cognitive and Behavioral subdomains, and QDRS-derived CDR and CDR-SB scores by different dementia etiologies is demonstrated in Table 7. The distribution of the total QDRS, Cognitive and Behavioral subdomains, and QDRS-derived CDR and CDR-SB scores by MMSE cut-offs defining controls, MCI, mild, moderate, and severe dementia is shown in Table 8.

3.6. Operating characteristics

The range of QDRS and CDR-SB scores by global CDR stages is shown in Table 9. Both the QDRS and CDR-SB demonstrate a range of scores within each global CDR stage reflecting the range of symptoms reported by the informant, and in the case of the CDR the performance of the patient. To aid in interpreting the QDRS scores, we performed ROC curves for the QDRS to derive cut-off scores that can assist clinicians and researchers (Table 9). For discriminating CDR 0 normal controls (with and without subjective complaints) from CDR 0.5 very mild impairment (which includes MCI and very mild dementia), a cut-off score of 1.5 provides the best sensitivity and specificity (AUC 0.846; 95% CI 0.76–0.93, P < .001). Cut-off scores of six discriminates CDR 0.5 very mild impairment from CDR 1 mild dementia; scores of 12.5 discriminate CDR 1 from CDR 2; and scores of 17.5 discriminate CDR 2 from CDR 3. Studies of diagnostic and screening instruments often report the findings for separating extreme groups (dementia and normal) because the results

Table 4
Item distributions, missing rates, factor loading, item-total, and interitem correlations

	Item distribution and missing rates									
	Item		Response counts (%)						Factor	Item-total
QDRS domain	Mean	SD	0	0.5	1	2	3	Miss	loading	Pearson R
Memory and recall (M/R)	0.8	0.6	14.5	41.9	28.2	13.3	1.2	0.8	.846	.703
Orientation (O)	0.6	0.6	24.9	41.5	24.1	9.1	0.4	0.0	.843	.737
Decision making and problem solving (DM)	0.9	0.7	15.4	36.5	31.1	11.2	5.4	0.4	.631	.877
Activities outside the home (AOH)	0.8	0.8	25.3	31.5	21.2	16.6	3.7	1.7	.784	.870
Function at home and hobby activities (FHH)	0.8	0.9	31.1	24.5	22.0	14.1	6.6	1.7	.708	.862
Toileting and personal hygiene (TPH)	0.5	0.8	56.8	18.3	10.0	9.1	5.8	0.0	.794	.860
Behavior and personality changes (B/P)	0.7	0.9	49.0	14.5	15.8	15.4	4.1	1.2	.691	.797
Language and communication (L/C)	0.5	0.6	37.3	34.4	20.3	6.6	0.8	0.4	.652	.672
Mood (M)	0.9	0.9	23.7	38.8	13.3	14.9	8.7	1.2	.857	.758
attention and concentration (A/C)	0.6	0.6	27.0	40.7	21.6	8.3	1.7	0.8	.710	.790
Interitem correlation matrix	M/R	O	DM	AOH	FHH	TPH	B/P	L/C	M	A/C
Memory and recall (M/R)	1									
Orientation (O)	.705	1								
Decision making and problem solving (DM)	.619	.713	1							
Activities outside the home (AOH)	.504	.578	.734	1						
Function at home and hobby activities (FHH)	.549	.599	.721	.755	1					
Toileting and personal hygiene (TPH)	.502	.565	.715	.805	.749	1				
Behavior and personality changes (B/P)	.495	.538	.644	.653	.617	.591	1			
Language and communication (L/C)	.504	.500	.584	.499	.521	.512	.471	1		
Mood (M)	.388	.365	.587	.615	.576	.643	.608	.346	1	
attention and concentration (A/C)	.445	.507	.654	.633	.638	.668	.588	.597	.583	1

Abbreviation: QDRS, Quick Dementia Rating System.

usually depict (perhaps inappropriately) inflated operating characteristics compared with when the mild cognitive impairment group is included, as would be the case in usual practice [36]. For purposes of comparison with studies that compare normal controls with dementia, we ran ROC curves for the QDRS and CDR-SB. The AUC for the QDRS was 0.911 (95% CI 0.86–0.96) and for the CDR-SB was 0.996 (95% CI 0.99–1.0) demonstrating comparable ability to discriminate normal controls from dementia.

3.7. Using the QDRS to generate a valid CDR and CDR-SB

Lastly, we compared the interscale reliability between the QDRS and the CDR to determine whether the QDRS domains were able to generate an accurate CDR and CDR-SB (Table 10). The first six QDRS domains were compared with six CDR boxes with intraclass correlation coefficients (ICC). The QDRS domains were highly reliable in comparison to the longer CDR for each of the six individual boxes, the CDR-SB and CDR Global Score with ICCs ranging from 0.71 for QDRS Memory and Recall versus CDR Memory to 0.91 for QDRS Toileting and Personal Hygiene versus CDR Personal Care. There was excellent reliability using the 5-minute QDRS to generate a derived CDR global score (ICC = 0.90) and CDR-SB (ICC = 0.92). This supports that the QDRS could be used for inclusion/exclusion criteria for clinical trials and for population-based studies to quickly and accurately stage the presence and severity of dementia.

4. Discussion

The QDRS is a brief informant-based dementia staging system that validly and reliably differentiates individuals with and without dementia and provides the accurate staging of individuals without the need for a trained research staff. The QDRS provides an easy way to assess, stage, and monitor severity of dementia through the input of

Table 5
QDRS scale score features: internal-consistency reliability, score distributions, and interscore correlations

		Reliability	Score features and distribution						Interscale correlation, Spearman r		
Domain	Items	Cronbach alpha (95% CI)	Range	Mean	Median	SD	% Floor	% Ceiling	Cognitive	Behavioral	Total
Cognitive	4	0.861 (0.83–0.89)	0–12	2.8	2.0	2.1	3.7	0.4	1		
Behavioral	6	0.915 (0.89–0.93)	0–18	4.3	3.0	4.1	8.7	0.4	.771	1	
Total	10	0.932 (0.92–0.94)	0–30	7.2	5.2	5.9	2.5	0.4	.896	.973	1

Abbreviation: QDRS, Quick Dementia Rating System.
NOTE. % Floor is the percentage of caregivers who reported the lowest (best) possible score. % Ceiling is the percentage of caregivers who reported the highest (worst) possible score.

Table 6
Construct validity of the QDRS

QDRS domain	Assessment type	Convergent (R > 0.4)	Divergent (R < 0.3)
Memory and recall	Rating scales	CDR, GDS, FAQ	UPDRS, HADS-A, HADS-D, NPI, MFQ, ESS, alertness
	Neuropsych	MMSE, HVLT, BNT	L-N sequence, TMT-A, TMT-B, clock
Orientation	Rating scales	CDR, GDS, FAQ	HADS-A, HADS-D, NPI, ESS
	Neuropsych	MMSE, HVLT, Animals	L-N sequence, TMT-A, TMT-B, clock
Decision making and problem solving	Rating scales	CDR, GDS, FAQ, MFQ, Alertness	UPDRS, HADS-A, HADS-D
	Neuropsych	MMSE, HVLT, Animals, TMT-A	TMT-B, clock
Activities outside the home	Rating scales	CDR, GDS, FAQ, UPDRS, NPI, MFQ, Alertness	HADS-A, HADS-D
	Neuropsych	MMSE, HVLT, Animals, TMT-A	BNT, TMT-B, clock, Mini-Cog
Function at home and hobby activities	Rating scales	CDR, GDS, FAQ, UPDRS, NPI, MFQ, Alertness	HADS-A, HADS-D, ESS
	Neuropsych	MMSE, HVLT, Animals	BNT, TMT-B, clock, Mini-Cog
Toileting and personal hygiene	Rating scales	CDR, GDS, FAQ, UPDRS, NPI, MFQ, Alertness	HADS-A, HADS-D
	Neuropsych	MMSE	BNT, TMT-B, clock, Mini-Cog
Behavior and personality changes	Rating scales	CDR, GDS, FAQ, NPI, MFQ	UPDRS, HADS-A, HADS-D
	Neuropsych		HVLT, animals, BNT, L-N sequence, TMT-A, TMT-B, clock, Mini-Cog
Language and communication	Rating scales	CDR, GDS, FAQ, UPDRS	HADS-A, HADS-D, NPI, MFQ, ESS, alertness
	Neuropsych	MMSE	TMT-A, TMT-B, Clock, Mini-Cog
Mood	Rating scales	CDR, GDS, FAQ, HADS-A, NPI, MFQ	UPDRS, ESS, HADS-A, HADS-D
	Neuropsych		MMSE, HVLT, animals, BNT, L-N sequence, TMT-A, TMT-B, clock, Mini-Cog
Attention and concentration	Rating scales	CDR, GDS, FAQ, NPI, MFQ, ESS, Alertness	HADS-A, HADS-D
	Neuropsych		HVLT, animals, BNT, L-N sequence, TMT-A, TMT-B, clock, Mini-Cog

Abbreviations: CDR, clinical dementia rating; GDS, global deterioration scale; FAQ, functional activities questionnaire; UPDRS, unified Parkinson's disease rating scale; HADS-A, Hospital anxiety depression scale-anxiety subscale; HADS-D, hospital anxiety depression scale-depression subscale; NPI, neuropsychiatric inventory; MFQ, Mayo fluctuations questionnaire; ESS, Epworth sleepiness scale; MMSE, mini mental state exam; HVLT, Hopkins verbal learning task; BNT, Boston naming test; L-N, letter number; TMT-A, trailmaking A; TMT-B, trailmaking B.

Table 7
Performance of QDRS across different dementia etiologies

	AD, N = 91	DLB, N = 48	VaD, N = 5	FTD, N = 10	Other, N = 8	*P*-value
Age	79.8 (7.5)	78.4 (7.7)	77.2 (6.2)	72.7 (8.2)	70.2 (7.5)	.001
Education	15.2 (2.9)	14.5 (3.6)	14.8 (3.4)	16.8 (3.3)	16.9 (3.4)	.28
Gender	58.7	38.9	100.0	30.0	55.6	.02
CDR	1.0 (0.6)	1.5 (0.9)	1.7 (0.9)	0.8 (0.8)	1.0 (0.8)	<.001
CDR-SB	5.7 (3.3)	8.8 (5.2)	9.3 (6.3)	5.2 (4.7)	5.0 (4.4)	<.001
Charlson comorbidity	2.3 (1.3)	2.4 (1.5)	2.6 (1.1)	2.0 (1.3)	2.3 (2.6)	.93
MMSE	19.6 (5.5)	18.2 (7.7)	19.7 (6.0)	23.6 (1.4)	26.1 (2.2)	.005
FAQ	10.5 (8.5)	17.1 (10.1)	16.6 (13.9)	8.1 (9.9)	12.1 (9.9)	.001
NPI	7.7 (5.7)	11.6 (5.7)	11.4 (5.6)	10.5 (9.1)	6.9 (4.5)	.002
QDRS-memory and recall	0.9 (0.6)	1.1 (0.7)	0.6 (0.4)	0.7 (0.8)	0.7 (0.3)	.06
QDRS-orientation	0.7 (0.5)	1.1 (0.7)*	0.6 (0.4)	0.3 (0.4)*	0.5 (0.6)*	<.001
QDRS-decision making and problem solving	0.9 (0.7)	1.4 (0.8)*	0.9 (1.2)	0.9 (0.8)	0.9 (0.8)	.002
QDRS-activities outside the home	0.8 (0.6)	1.4 (0.8)*	1.8 (1.3)*	0.7 (0.7)	0.9 (0.8)	<.001
QDRS-function at home and hobby activities	0.8 (0.7)	1.4 (0.9)*	2.0 (1.4)*	0.9 (0.9)	0.8 (0.6)	<.001
QDRS-toileting and personal hygiene	0.5 (0.7)	1.1 (1.1)*	1.9 (1.5)*	0.3 (0.7)*	0.9 (1.1)	<.001
QDRS-behavior and personality changes	0.7 (0.8)	1.2 (1.0)*	0.9 (1.0)	1.0 (0.9)	0.5 (0.9)	.02
QDRS-language and communication	0.5 (0.5)	0.9 (0.7)*	0.7 (1.3)	0.6 (0.6)	0.5 (0.2)	.02
QDRS-mood	0.8 (0.8)	1.4 (1.1)*	1.3 (1.1)	1.2 (0.8)	1.2 (0.8)	.005
QDRS-attention and concentration	0.6 (0.5)	1.0 (0.7)*	1.1 (1.3)	0.7 (0.5)	0.7 (0.6)	.001
QDRS total	7.2 (5.1)	11.7 (6.9)*	11.6 (7.8)	7.4 (6.3)	7.4 (5.8)	<.001
QDRS cognitive	3.1 (1.9)	4.5 (2.6)*	2.8 (2.3)	2.7 (2.4)	2.5 (1.9)	.005
QDRS behavioral	4.2 (3.5)	7.5 (4.9)*	8.8 (5.9)	5.4 (4.8)	4.4 (4.3)	<.001
QDRS sum box	4.4 (3.1)	7.5 (4.5)*	7.7 (5.0)	3.9 (3.8)	4.5 (4.0)	<.001
QDRS CDR global	0.8 (0.5)	1.4 (0.8)*	1.7 (1.1)*	0.7 (0.5)	0.8 (0.9)	<.001

Abbreviations: QDRS, Quick Dementia Rating System; AD, Alzheimer's disease; DLB, Dementia with Lewy bodies; VaD, Vascular dementia; FTD, frontotemporal degeneration; CDR, Clinical Dementia Rating; CDR-SB, Clinical Dementia Rating; SB, sum-of-boxes; MMSE, Mini-Mental State Examination; FAQ, Functional Activities Questionnaire; NPI, Neuropsychiatric Inventory.

*Post-hoc differences <0.05.

Table 8
Performance of QDRS by MMSE classification

	MMSE (28–30)	MMSE (24–27)	MMSE (18–23)	MMSE (10–17)	MMSE (0–9)	*P*-value
QDRS total	3.9 (2.9)	4.5 (3.2)	8.7 (5.6)	8.4 (5.4)	17.1 (7.3)	<.001
QDRS cognitive	1.6 (1.0)	1.9 (1.1)	3.2 (1.8)	3.5 (2.2)	6.4 (2.9)	<.001
QDRS behavioral	2.4 (2.1)	2.6 (2.6)	5.4 (4.2)	5.0 (3.6)	10.7 (4.8)	<.001
QDRS-derived CDR sum box	2.1 (1.7)	2.5 (1.8)	5.1 (3.2)	5.8 (3.9)	10.8 (4.3)	<.001
QDRS-derived CDR global	0.5 (0.3)	0.5 (0.3)	0.9 (0.6)	1.0 (0.7)	1.9 (0.8)	<.001

Abbreviations: MMSE, Mini-Mental State Examination; QDRS, Quick Dementia Rating System; CDR, Clinical Dementia Rating.

informants. The QDRS does this while maintaining brevity (3–5 minutes) and simple format for use in clinical practice, clinical research, and epidemiological projects. Most patients never receive an evaluation by a neurologist, geriatric psychiatrist, or geriatrician skilled in dementia diagnoses and staging. The QDRS has the potential to provide a clearer, more accurate staging for those patients who are unable to receive these more specialized services.

The QDRS exhibits excellent data quality including item and scale score variability with ample dispersion of scores and low missing data supporting that caregivers were able to complete the QDRS without assistance. The QDRS demonstrated excellent known-group validity defined by our "Gold Standard" CDR and performance of global rating scales of cognition (i.e., MMSE [27]), behavior (i.e., NPI [22]), and function (i.e., FAQ [25]). The QDRS discriminated healthy controls from all other groups and each impaired group from another. Based on post-hoc tests, the cognitive and behavioral subdomains equally discriminated group membership. The QDRS demonstrated excellent internal consistency, construct, concurrent, and criterion validity with cognitive domains corresponding closely with related cognitive tasks and behavioral domains corresponding closely with global ratings. The correspondence of the QDRS to validated measures of dementia severity, behavior, and caregiver concerns shows similar strong correlations regardless of whether the QDRS was completed by paper or via the Internet, however, no direct testing of paper and internet versions was performed.

Table 9
Discrimination ability of the QDRS by clinical dementia rating stages

CDR	QDRS total	Range	CDR-SB	Range
0	1.0 (1.3)	0–4	0.1 (0.2)	0–0.5
0.5	3.8 (2.8)	0–15	2.4 (1.0)	0.5–6
1	8.7 (4.1)	2–21	5.8 (1.3)	3.5–9
2	13.5 (4.7)	6.5–23	11.5 (1.8)	9–15
3	23.7 (3.1)	17–30	17.4 (0.9)	16–18
Comparison	**Cut-off**	**Sensitivity**	**Specificity**	**AUC (95% CI)**
0 vs. 0.5	1.5	0.84	0.75	0.846 (0.76–0.93)
0.5 vs. 1	6.0	0.84	0.66	0.837 (0.78–0.89)
1 vs. 2	12.5	0.83	0.54	0.800 (0.71–0.89)
2 vs. 3	17.5	0.81	0.90	0.932 (0.86–1.0)

Abbreviations: QDRS, Quick Dementia Rating System; CDR, Clinical Dementia Rating; AUC, area under the curve; 95% CI, 95% confidence intervals.

A number of "Gold Standard" evaluations for staging dementia exist including the CDR [11] and GDS [20]. Other global informant-based ratings of dementia severity include the Clinician's Global Impression of Change (CGIC) [39] and Clinician's Interview Based Impression of Change plus Caregiver Input (CIBIC-Plus) [40]. Although commonly used as outcomes for clinical trials, the CDR, GDS, CGIC, and CIBIC-Plus all require a well-trained clinician and ample time to conduct the interview making their use in inclusion/exclusion criteria for clinical trial screening, intermittent monitoring of research participants, or use in the community challenging. As opposed to performance-based assessments such as the MMSE [27] or Montreal Cognitive Assessment [41], informant-based assessments use intraindividual measures of change to characterize whether cognitive decline has occurred and how that decline interferes with social and occupational functioning. As such, intraindividual assessments are less subject to age, gender, racial, ethnic, cultural, educational, or socioeconomic biases because each person serves as their own control [6–8]. A potential drawback of the QDRS and other informant ratings is the availability of an observant informant. However, no difference in QDRS scoring and Gold Standard ratings of cognition, function, or behavior was detected between spouse informants who are more likely to be living with the patient and nonspouse informants who included adult children, other relatives, friends, and paid caregivers.

The QDRS was developed and validated in the context of a memory disorders clinic where the prevalence of MCI and dementia is high. Validation of the QDRS in other settings where dementia prevalence is lower (e.g., community samples, primary care practices) is a reasonable next step. As this is a cross-sectional study, another next step is to demonstrate the longitudinal properties of the QDRS and examine its sensitivity to change, response to treatments and interventions, and as a prognostic tool (e.g., hospice certification). Like the CDR, the QDRS does not provide specific diagnoses or etiologic causes for cognitive impairment, but rather provides an evidence of presence of impairment, and if present, the stage of severity. However, the QDRS domains differentially change depending on dementia etiology. A strength of this study is that the comprehensive evaluation occurred within 2 weeks of the informant completing the QDRS, and that the investigator was blinded to the results of the

Table 10
Interscale reliability between QDRS and CDR domains

QDRS domain	CDR domain	ICC (95%CI)	*P*-value
Memory and recall	Memory	0.715 (0.63–0.78)	<.001
Orientation	Orientation	0.751 (0.67–0.81)	<.001
Decision making and problem solving	Judgment and problem solving	0.853 (0.81–0.89)	<.001
Activities outside the home	Community affairs	0.899 (0.87–0.92)	<.001
Function at home and hobby activities	Home and hobbies	0.830 (0.78–0.87)	<.001
Toileting and personal hygiene	Personal care	0.908 (0.88–0.93)	<.001
QDRS derived SB	CDR-SB	0.924 (0.90–0.94)	<.001
QDRS derived global score	CDR global score	0.902 (0.87–0.93)	<.001

Abbreviations: CDR, Clinical Dementia Rating; CDR-SB, Clinical Dementia Rating; SB, sum-of-boxes; QDRS , Quick Dementia Rating System; ICC, intraclass correlation coefficient.

QDRS when completing the evaluations. Another advantage of the QDRS is that it is brief enough to be printed on one piece of paper or viewed in a single screenshot which should maximize its clinical utility. In establishing the validity and reliability of the QDRS, we wanted to test its performance in a "real-world" clinic setting with patients who are referred from the community rather than in a research sample. Our clinic sample had an admixture of gender, education, comorbidities, cognitive, behavioral, affective, and motor symptoms, and diagnoses. A disadvantage was that the cohort was largely Caucasian. We have not yet examined whether two different raters would score the QDRS similarly (inter-rater reliability).

The QDRS may serve as an effective clinical research tool for inclusion/exclusion into clinical trials and as an intermittent assessment in the home setting improving retention in research studies. In this study, the QDRS performed as validly and reliably in staging individuals as the much longer CDR. Early detection will be important to enable future interventions at the earliest stages when they are likely to be most effective. This study provides evidence-based methodology to use the QDRS to identify and stage individuals in clinical practice and for participation in clinical trials, prevention studies, community surveys, and biomarker research.

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Access to data: Dr. Galvin takes full responsibility for the data, the analyses and interpretation, and the conduct of the research; has full access to all the data; and has the right to publish any and all data, separate and apart from the guidance of any sponsor. Dr. Galvin conducted all statistical analyses.

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RESEARCH IN CONTEXT

1. Systematic review: The author reviewed the literature using traditional (e.g., PubMed) sources. Gold standard dementia staging scales such as the Clinical Dementia Rating or Global Deterioration Scale are commonly used in clinical trials and research projects but require extensive clinician training and an extended period of time with the patient and caregiver. This is impractical for recruitment and eligibility screening for studies or in clinical practice.
2. Interpretation: Our findings support the Quick Dementia Rating System (QDRS), may provide a rapid method to determine eligibility for clinical trials and research projects; stage patients in clinical practice; and improve case ascertainment and staging in population studies.
3. Future directions: These results highlight future studies including the validation of the QDRS in other settings where dementia prevalence is lower (community cohort, primary care), and examining the longitudinal properties of the QDRS and examine its sensitivity to change, response to interventions, and as a prognostic tool.

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