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Rowland Universal Dementia Assessment Scale, Mini-Mental State Examination and General Practitioner Assessment of Cognition in a multicultural cohort of community-dwelling older persons with early dementia

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Abstract

Early dementia can be difficult to diagnose in older persons from culturally and linguistically diverse (CALD) backgrounds. The Folstein Mini-Mental State Examination (MMSE), the General Practitioner Assessment of Cognition (GPCOG) and the Rowland Universal Dementia Assessment Scale (RUDAS) were compared in 151 older, community-dwelling persons. Receiver operating characteristic (ROC) curve analysis was used to evaluate diagnostic accuracy, while logistic regression was used to evaluate the influence of age, gender, CALD status and years of education. All three instruments were equally accurate in predicting dementia (ROC area under curve 0.92–0.97, $p > 0.05$ for all comparisons). At the recommended cut-offs, the RUDAS was best for ruling in dementia (positive $LR = 8.77$), while the GPCOG was best for ruling out dementia (negative $LR = 0.03$). All three instruments were influenced by concomitant depression. Whereas the MMSE was influenced by CALD status, the RUDAS and GPCOG were not. While the GPCOG combines participant and informant data, the RUDAS is a stand-alone measure specifically designed for, and validated in, multicultural populations.

Key words: *Cultural diversity, dementia, geriatric assessment, GPCOG, MMSE, RUDAS, scale.*

The need for accurate detection of early dementia in community-dwelling older persons from culturally and linguistically diverse (CALD) backgrounds requires screening tools with good cross-cultural linguistic and psychometric properties. When a cognitive instrument, such as the Folstein Mini-Mental State Examination (MMSE) (Folstein, Folstein, & McHugh, 1975), becomes a standard in one culture, it is tempting to translate it immediately to other languages and to use it without further attempts at cross-cultural validation (Flaherty et al., 1988). There are many problems with this approach, and a better method may be to start afresh and develop new instruments for multicultural populations. The Rowland Universal Dementia Assessment Scale (RUDAS) (Storey, Rowland, Basic, Conforti, & Dickson, 2004) was developed specifically for this purpose. Because the RUDAS was designed to be a stand-alone measure, a useful strategy is to evaluate its performance against dementia screening tools that have an informant component, such as the General Practitioner Assessment of Cognition (GPCOG) (Brodaty et al., 2002). This study compared the RUDAS, the MMSE and the GPCOG in community-dwelling persons with early dementia.

While available treatments for early dementia are few and offer only limited benefits, many new treatments are in early development (Golde, 2006). In neurodegenerative dementias such as Alzheimer's disease, the underlying pathology precedes the onset of clinical symptoms, often by several years. Hence, identifying the disease at an early stage is important

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because treatments to prevent or slow the disease are likely to be more effective than those attempting to reverse it (Golde, 2006). Furthermore, early detection allows earlier treatment of potentially reversible causes of cognitive impairment, as well as enabling people to participate more fully in planning and documenting their future care (Leifer, 2003).

Early dementia may be difficult to diagnose in older persons from CALD backgrounds. Normalisation of cognitive symptoms, alternative views on dementia, limited English-language proficiency, lack of information, insufficient culturally or linguistically appropriate services, and economic factors all contribute to delayed diagnosis (Ayalon & Arean, 2004; Ortiz & Fitten, 2000). Studies of help seeking among minority groups in the United States found that many do not prioritise dementia as a major health problem in the face of more pressing concerns (Daker-White, Beattie, Gilliard, & Means, 2002). In Queensland Davis, Wilson, and McCarthy (1996) found that people from CALD backgrounds were underreferred to aged care assessment teams compared to their proportion in the community. They were more likely to be recommended for nursing home care because of more advanced disease at the time of referral. These are important health issues in many countries because the prevalence of dementia in people from diverse cultures is likely to increase substantially, due to the rapidly ageing population and high levels of international migration (Martin, 2001).

Flaherty et al. (1988) described several cultural, linguistic and psychometric dimensions on which to evaluate cross-cultural equivalence. According to Flaherty et al. (1988), each item of the instrument should be scrutinised by a team of content experts from multiple cultures to determine whether the phenomenon it describes is relevant to each culture. The meaning of each item should remain the same after translation, and the method of assessment should be comparable in each culture. The interpretation of the result from the instrument should be similar across cultures, and the instrument should measure the same basic construct. Establishing cross-cultural equivalence according to these criteria is difficult. Multiple translation methods have been proposed (Brislin, 1970; Cha, Kim, & Erlen, 2007; Jones, Lee, Phillips, Zhang, & Jaceldo, 2001), without a clear consensus on the best method. Ensuring criterion validity requires a gold standard, but there is no established gold standard for dementia diagnosis in culturally heterogeneous populations (Prince, 2000). Certain cultures may be uncomfortable and unfamiliar with the data collection methods that seem natural in Western culture. These include lengthy instruments using repetitious and probing questions (Flaherty et al., 1988), and those with many paper-and-pencil items (Vernon & Roberts, 1981).

Establishing cultural, linguistic and psychometric equivalence is therefore challenging and rarely implemented in cross-cultural research. Although existing tools developed in English-speaking populations can be translated into other languages, literal translation may produce items with different connotations and levels of difficulty (Manly & Espino, 2004). Examples in the MMSE include words such as ''no ifs, ands or buts'' and the ''backward spelling'' and ''serial 7s'' tasks. MMSE scores are influenced by age, gender, education, country of birth and language of the interview (Anderson, Sachdev, Brodaty, Trollor, & Andrews, 2007; Escobar et al., 1986; Tombaugh & McIntyre, 1992). Even after adjusting for these variables, discrepancies among CALD groups persist, such that cognitively normal minority groups are more likely to be misdiagnosed as impaired compared with majority groups (Manly & Espino, 2004). Although establishing separate test norms may help with misdiagnosis, this is clearly impractical given the large numbers of cultures and languages. This is particularly pertinent in countries such as Australia, where more than 20% of the population is born overseas (Australian Bureau of Statistics, 2006). Even within similar cultures and languages there is often enormous within-group heterogeneity that may directly affect test performance (Teng & Manly, 2005). The variety in the different Spanish translations of ''no ifs, ands or buts'' is a good example of the different cultural and idiomatic nuances that could potentially exist within populations that share the same language (Ramirez, Teresi, Holmes, Gurland, & Lantigua, 2006). In a comprehensive review of the psychometric properties of the MMSE, Tombaugh and McIntyre (1992) found that measures of criterion validity showed high levels of sensitivity for moderate to severe cognitive impairment but significantly lower levels for mild impairment. While reliability and construct validity were judged to be satisfactory, content analysis indicated that the MMSE was highly verbal. A further limitation of the MMSE is its poor sensitivity to frontal lobe dysfunction (Slachevsky et al., 2004).

While both inherited and environmental factors probably influence cognition, human populations have common experiences that should allow cognition to be measured independent of cultural differences. The challenge is to find test items that exploit these common experiences. In response to all these issues, Storey et al. (2004) developed the RUDAS, which was designed to be a stand-alone measure specifically for multicultural populations, not requiring an informant. After comprehensive review of the literature, two advisory groups helped to identify and

appraise potential cognitive domains and test items. The first advisory group included professionals from eight health disciplines, whose role was to advise on the measurement validity of potential items. The second advisory group included workers representing 22 CALD groups, whose role was to advise on the cultural and linguistic equivalence of proposed items. Following initial testing in an outpatient setting, the RUDAS was validated in the southwest of Sydney, Australia, where 40% of the population are born in non-English-speaking countries and more than 80 languages are spoken. The six-item instrument is a simple, portable scale for dementia screening (Storey et al., 2004). Items address executive function, praxis, gnosis, recent memory and category fluency; the diverse response formats (verbal, non-verbal, written and praxic) allow more comprehensive assessment of overall cognition than other commonly used tools. It can be directly translated to other languages, without the need to change the structure or the format of any item. Both the inter-rater (intraclass correlation coefficient [ICC] 0.99) and the test–retest (ICC 0.98) reliabilities are very high (Storey et al., 2004). It has high diagnostic accuracy in community-dwelling persons with mild dementia, and appears not to be influenced by age, gender, years of education or CALD status (Basic et al., in press).

The RUDAS, however, is a relatively new instrument compared with the MMSE. Whereas the RUDAS was developed in a multicultural population, the MMSE was not. The MMSE was designed and validated as a brief screening measure to quantitatively assess the severity of cognitive impairment. While it screens global cognition in a reliable manner and is easy to use, the application of the MMSE for diagnosis of dementia goes beyond the original purpose of the test as designed by the authors (Oksengard & Winblad, 2004).

The GPCOG (Brodaty et al., 2002), also recently developed in Australia, combines items testing patient cognition with historical questions asked of an informant. It has been validated (as a screening measure for the detection of dementia) in a primary care setting and can be administered in $\leq$5 minutes. The cognitive and the informant sections can be scored separately, together, or sequentially. The informant section is used for those who score in the ''intermediate'' range on the cognitive section. The inter-rater ICC for the cognitive section is 0.75 and the test–retest ICC is 0.87. The corresponding coefficients for the informant section are 0.56 and 0.84. Both the cognitive and informant sections have good internal consistency (Cronbach's $\alpha = 0.84$ and 0.80, respectively) (Brodaty et al., 2002). The GPCOG has high sensitivity and specificity for dementia diagnosis, and performs at least as well as the MMSE (Brodaty et al., 2002). The cognitive section is influenced by age, while the informant section appears free of bias (Brodaty, Kemp, & Low, 2004). Although the presence of an informant is an asset to overall cognitive assessment, a substantial proportion of older persons (approx. 20–30%) do not have an informant (Brodaty et al., 2002).

Given the problems with the use of the MMSE in cross-cultural dementia research, the main aim of the present study was to evaluate the RUDAS against the MMSE. Because the RUDAS was designed specifically for cross-cultural dementia screening, it should be at least as good as the widely used MMSE in older persons with early disease, when interventions are likely to be of greatest benefit. Because the RUDAS was designed to be a stand-alone measure, a secondary aim was to compare its performance against the GPCOG, which has an informant component. The effects of depression and function on the three instruments were also evaluated, because these variables may be confounders or independent predictors of early dementia.

Method

Study participants

The study participants were 151 older, community-dwelling persons living in Melbourne ($n = 75$) and Adelaide ($n = 76$), Australia. Of the 151 participants 65 (43.0%) were born in non-English-speaking countries. Of those, 57 (87.8%) were born in one of 10 European countries, three (4.6%) in the Middle East, three (4.6%) in Africa, one (1.5%) in Asia, and one (1.5%) in South America. Between September 2005 and November 2006, 78 participants (51.7%) were recruited from three memory clinics, 18 (11.9%) from an Alzheimer's disease respite program, and 55 (36.4%) from other clinics. Most referrals to the memory clinics were made by general practitioners ($n = 32$), the participants or their relatives ($n = 15$), or the community-based aged care team ($n = 10$). In Melbourne, those with normal cognition were enrolled from a falls and balance clinic and a community rehabilitation service. In Adelaide, they were enrolled from community therapy and rehabilitation centres, day respite programs and Alzheimer's disease carer groups. Consecutive, consenting persons were studied, provided they were not delirious and had no severe visual, hearing or physical impairment. Eighty-nine (58.9%) of the 151 study participants were accompanied by an informant. A further 19 informants (12.6%) were contacted by phone, leaving 43 (28.5%) without an informant. Consent was obtained from the participant, or the next of kin or

guardian when cognition was impaired. Details of study participant characteristics by cognitive status are shown in Table 1. The procedures for establishing cognitive status are described in the next section. The study protocol was approved by the Melbourne Health Human Research Ethics Committee and the Research Ethics Committee of the Royal Adelaide Hospital.

Procedure

In both Melbourne and Adelaide, potential participants attending the memory clinics underwent routine clinical assessment, after which they were invited to participate in the study. According to the usual memory clinic protocol, all study participants had their cognition assessed by a senior aged care clinician (geriatrician, aged care psychiatrist, or a senior registrar in geriatric medicine or psychiatry) before they were recruited. They were then seen by a research assistant at the clinic, their home or other suitable location, depending on preference. In Melbourne, most participants with normal cognition were recruited from the aforementioned falls and balance clinic or community therapy service. In Adelaide, they were enrolled from various community programs (detailed above). At both sites participants with normal cognition were assessed by an aged care clinician and a research assistant. Professional health interpreters were used when necessary.

Cognitive disorder (not otherwise specified), henceforth called cognitive impairment not dementia (CIND), and dementia were diagnosed by various aged care clinicians. Criteria of the *Diagnostic and statistical manual of mental disorders* (4th ed.; DSM-IV) (American Psychiatric Association, 1994) were used to make these diagnoses. They also rated the severity of dementia using the Clinical Dementia Rating Scale (CDR) (Morris, 1993) and administered the MMSE (Folstein et al., 1975). The ''backward spelling'' task of the MMSE was used in preference to the ''serial 7s'' item because the former inflates scores by an average of 1.5 points (out of 30) (Rosselli, Tappen, Williams, & Salvatierra, 2006). The cognitive and informant sections of the GPCOG were administered by the aforementioned medical staff in 97.9% and of 76.5% of cases, respectively. The remainder were administered by other clinic and project staff. Because data from the MMSE and GPCOG were used to arrive at DSM-IV diagnoses, the accuracy of the MMSE and GPCOG for dementia detection may be overestimated (compared with the RUDAS, which was administered in a blinded fashion).

The RUDAS was administered by a research assistant in a blinded and independent manner. All participants were screened for non-cognitive disorders that might affect the RUDAS score, including vision and hearing impairment, anxiety, depression, musculoskeletal disorders, fatigue, dysarthria and dysphasia (performance factors). The Modified

Table 1. Characteristics of study participants by cognitive status ($N = 151$)

Characteristic	All participants	Normal ($n = 60$)	CIND ($n = 33$)	Dementia ($n = 58$)
Age (years) ($M \pm SD$)	77.1 ± 8.9	72.6 ± 9.5	80.7 ± 7.3	79.7 ± 7.1
Age range	45.6–96.5	45.6–89.8	65.1–96.5	59.7–93.3
Female (%)	69.5	80.0	63.6	62.1
Married (%)	45.7	48.3	66.7	31.0
Living alone (%)	33.3	38.3	24.2	33.3
Has carer (%)	60.7	31.7	63.6	89.5
CALD background (%)	42.4	33.3	33.3	56.9
Has informant (%)	71.5	41.7	84.9	94.8
Interpreter used (%)	32.5	23.3	24.2	46.6
Years Australia (*Mdn*, *Q1–Q3*)	50, 43–79	50, 40–70	53, 47–81	50, 45–82
Preferred language English (%)	61.8	71.2	71.0	46.3
Years education (*Mdn*, *Q1–Q3*)	8, 5–10	9, 5–12	9, 5–10.5	7, 6–8
Type education (%)				
None	4.1	3.3	9.7	1.9
Primary	40.0	28.3	25.8	61.1
Secondary	42.8	50.1	51.6	29.6
More than secondary	13.1	18.3	12.9	7.4
Literate (%)	96.0	96.7	90.9	98.3

Notes. CALD = culturally and linguistically diverse; CIND = cognitive impairment not dementia; Literate = ability to read and write at any time in the preferred language; *Q1–Q3* = interquartile range.
Missing data (numbers in parentheses refer to number of participants with missing data for characteristic, by cognitive status): Living alone (dementia 1); Has carer (dementia 1); Years Australia (normal 20, CIND 5, dementia 12); Preferred language English (normal 1, CIND 2, dementia 4); Years education (normal 1, CIND 1, dementia 8); Type education (CIND 2, dementia 4); Literate (dementia 1).

Barthel Index (MBI) (Wade & Collin, 1988) and the Lawton Instrumental Activities of Daily Living Scale (Lawton) (Lawton & Brody, 1969) were administered by clinical staff from the Cognitive, Dementia and Memory Service or the research assistant. The 15-point Geriatric Depression Scale (GDS) (Yesavage et al., 1982) was completed by medical staff or the research assistant. Scores on the GDS and the Lawton were measured because both variables are potential confounders or independent predictors of early dementia. The Lawton and the MBI also help to define the study population by showing the effect of cognition on function. Table 1 shows the characteristics of the study participants by cognitive status.

Based on DSM-IV criteria, 58 (38.4%) of the 151 participants had dementia, 60 (39.7%) were normal and 33 (21.9%) had CIND. Of those with dementia, 25.9% had questionable dementia according to the CDR, while 58.5%, 12.1% and 3.5% had mild, moderate and severe dementia, respectively. Of those born in English-speaking countries, 29.1% had dementia, 45.3% were normal and 25.6% had CIND. The corresponding percentages in the European CALD subgroup were 50.9%, 31.6% and 17.5%, and were significantly different to the English-speaking subgroup ($p = 0.03$), with more participants diagnosed with dementia. More participants in Melbourne had dementia and CIND ($p = 0.046$).

Instruments

General Practitioner Assessment of Cognition. The GPCOG (Brodaty et al., 2002) consists of cognitive test items and historical questions asked of an informant. The cognitive section has a maximum score of nine. It includes items testing time orientation (1 point), clock drawing (1 point for correct numbering and spacing, 1 point for hands marked to show 10 minutes past 11 o'clock), awareness of a news story within the previous week (1 point) and recall of a name and an address (5 points), with ''John, Brown, 42, West Street, and Kensington'' each scoring 1 point.

The historical component requires an informant to know the participant for several years (five in the initial publication). The informant is asked to make a comparison between the participant's current function and that from a few years ago. Six questions (listed below) are asked, with each scoring 1 point (maximum score of 6) if the participant has no difficulty with the task in question (Brodaty et al., 2002).

1. Does the patient have more trouble remembering things that have happened recently?
2. Does he or she have more trouble recalling conversations a few days earlier?
3. When speaking, does the patient have more difficulty in finding the right word or tend to use the wrong words more often?
4. Is the patient less able to manage money and financial affairs (e.g., paying bills, budgeting)?
5. Is the patient less able to manage his or her medication independently?
6. Does the patient need more assistance with transport (either private or public)?

The cognitive and the informant sections can be scored separately, together, or sequentially (Brodaty et al., 2002). The sequential, or two-stage, method categorises participants who score >8 or <5 on the cognitive section to be cognitively intact or impaired, respectively (with informant section not required). For participants who score 5–8 (inclusive) on the cognitive section, scores of ≤ 3 on the informant section indicate cognitive impairment.

Rowland Universal Dementia Assessment Scale. The RUDAS has six items, administered in the following order, for a maximum score of 30. Scores of ≤ 22 indicate cognitive impairment (Storey et al., 2004).

1. Body orientation. Although eight instructions may be given, only five correct responses are needed for a maximum score of 5 points. The participant is asked to do the following in the order stated: (a) show me your right foot; (b) show me your left hand; (c) with your right hand, touch your left shoulder; (d) with your left hand, touch your right ear; (e) point to or indicate my left knee; (f) point to or indicate my right elbow; (g) with your right hand, point to or indicate my left eye; (h) with your left hand, point to or indicate my left foot.
2. Fist–palm alternation task. This involves imitating a motor task, beginning by placing both hands palm down on the table (or the lap). One hand is then placed in a fist (in the vertical position) while the other remains palm down. Both hands are then simultaneously alternated between the two positions. Having learned the task, the participant is asked to maintain it at a moderate pace for approximately 10 seconds. The task is rated as normal (2 points), partially adequate (1 point) or failed (0 points).
3. Cube copying. Three components are needed for a maximum score of 3 points (based on a square, all internal lines drawn, and all external lines drawn).
4. Crossing the road. The participant is asked to describe how he or she would go about safely

crossing a very busy street, or similar thoroughfare (with no pedestrian crossing or traffic lights). Looking for traffic and an additional safety response each score 2 points where no prompt is required (1 point with a prompt).

5. Animal generation. Although 1 minute is allocated to name as many animals as possible, only eight are needed for a maximum score of 8 points.
6. Recall (after 5 minutes) of four grocery items (tea, cooking oil, eggs and soap), presented at the beginning of the assessment. Each correct response scores 2 points (maximum of 8 points, 6 if the prompt ''tea'' is used). When the items are initially presented, up to five repetitions are allowed to ensure item registration (not scored).

GDS, MBI and Lawton. The GDS (Yesavage et al., 1982) is an ordinal scale that is commonly used to screen for depression in older people. It consists of 15 questions requiring ''yes'' or ''no'' answers. All questions relate to mood (e.g., loss of interests, helplessness, hopelessness and worthlessness) rather than to physical symptoms. A score >5 points is suggestive of depression. Depression frequently coexists with dementia, and many depressed individuals have a measurable decline in cognition (Burns & Morris, 2008) that may be identified using screening tools. Older persons with depression and even mild cognitive impairment (MCI) may have preclinical dementia. They also have an increased risk of developing Alzheimer's disease (Burns & Morris, 2008; Reifler, 2000). Depression may therefore confound the relationship between dementia screening tools and dementia diagnosis.

The MBI and the Lawton are also ordinal scales, and both are commonly used to screen for functional impairment. The MBI (Wade & Collin, 1988) consists of 10 basic activities of daily living. These include bowel continence, bladder continence, grooming, toilet use, feeding, transfer ability, mobility, dressing, use of stairs, and bathing. It is scored out of 20, with higher scores indicating better function. The Lawton (Lawton & Brody, 1969) consists of eight instrumental activities of daily living. These include telephone use, shopping, preparing food, housekeeping tasks, doing the laundry, transport use, handling medications, and handling finances. It is scored out of 8, with higher scores indicating better function. Because instrumental activities of daily living are usually lost before basic activities of daily living, the Lawton may identify incipient decline (cognitive or physical) in an older person who might otherwise appear capable and healthy (Graf, 2008). Like the GDS, the Lawton also predicts dementia, including mild dementia (Juva et al., 1997). The informant component of the GPCOG has three questions that also comprise part of the Lawton scale (handling finances and medications, and needing assistance with transport). For these reasons the Lawton is a potential confounder between the GPCOG (informant component and total score) and dementia diagnosis.

Sample size

The calculation of the sample size was based on the standard error for the area under a receiver operating characteristic curve (AUC). This method varies the sample size until a sufficiently small standard error is achieved. The calculations are complex, and we used a web-based calculator (www.anaesthetist.com/mnm/stats/roc/#stderr) to determine the standard error, assuming an AUC of 0.9 for the RUDAS. If normal participants ($n=60$) and those with definite dementia ($n=58$) are included, the standard error for the AUC is small at 0.03. The website also discusses the rationale underlying this method of sample size calculation.

Statistical analysis

We used receiver operating characteristic (ROC) curve analysis (Hanley & McNeil, 1982) to measure the accuracy of the RUDAS, the MMSE and the GPOCOG for dementia diagnosis. The sensitivity, specificity, positive likelihood ratio and negative likelihood ratio of the three measures were calculated based on the published cut-offs. For the GPCOG, the cognitive and the informant sections were evaluated separately and together. Likelihood ratios incorporate both the sensitivity and specificity of a test (at a particular cut-off) to directly estimate the effect of the test on the odds of having a disease. The positive likelihood ratio measures the increase in the odds of a disease when a test is positive, while the negative likelihood ratio measures the decrease in the odds when a test is negative. Post-test probabilities of dementia (for positive results on the screening tools) were determined using the post-test odds (pre-test odds multiplied by *LR*) and the following equation: post-test probability = post-test odds/(1 + post-test odds).

The effects of CALD status, age, gender, education, depression (GDS score) and performance factors on the RUDAS, the MMSE and the GPCOG were evaluated using multivariate logistic regression. The influence of the Lawton score on the GPCOG (total score and informant component) was similarly evaluated. We measured the degree of confounding exerted by a variable by calculating the change in the value of the parameter estimate for the study factor (RUDAS, MMSE or GPCOG score) when the

variable was excluded from the analysis. A ≥10% change in the parameter estimate was needed for a potential confounder to be retained in the model. The linear associations between the instruments were measured using the Spearman's rank-order correlation coefficient. Differences between participant groups were tested using Fisher's exact tests (for dichotomous variables). Mantel–Haenszel trend analysis was used to evaluate trends between the three cognitive groups (normal, CIND and dementia). Internal consistency of the RUDAS and MMSE was measured using Cronbach's coefficient alpha. ROC curve analysis was performed using MedCalc for Windows version 9.3.0.0 (MedCalc Software, Mariakerke, Belgium). SAS software (version 9.1, SAS Institute, Cary, NC, USA) was used for all other analyses.

In cross-sectional samples such as the present one it is difficult to categorise participants with CIND. While 10–15% progress to Alzheimer's disease each year, a few improve, some remain static, and others go on to develop non-Alzheimer's disease dementias (Schott, Kennedy, & Fox, 2006). To minimise misclassification bias, the ROC curve and logistic regression analyses included only participants with normal cognition and those with definite dementia.

Results

Functional characteristics and cognitive measures

Table 2 shows the functional characteristics and the cognitive measures of the 151 participants by cognitive status (normal, CIND and dementia). The three groups were similar with respect to MBI ($p = 0.29$) and GDS ($p = 0.17$) scores, and the presence of a performance factor ($p = 0.12$). The Lawton score and all measures of cognition were significantly different among the groups (all $p < 0.001$).

Correlations and internal consistency

The RUDAS correlated highly with both the MMSE ($r_s = 0.78$, 95% confidence interval [CI] = 0.70–0.84, $p < 0.0001$, $n = 137$) and the total GPCOG ($r_s = 0.78$, 95%CI = 0.70–0.84, $p < 0.0001$, $n = 131$). The correlation between the MMSE and the total GPCOG was also high ($r_s = 0.80$, 95%CI = 0.73–0.86, $p < 0.0001$, $n = 122$). While the RUDAS correlated highly with the cognitive component of the GPCOG ($r_s = 0.76$), the association with the informant component was lower ($r_s = 0.61$). Similar findings were obtained for the MMSE ($r_s = 0.83$ for cognitive component, $r_s = 0.55$

Table 2. Functional and cognitive measures by cognitive status ($N = 151$)

Characteristic	All participants	Normal ($n = 60$)	CIND ($n = 33$)	Dementia ($n = 58$)
MBI (*Mdn*, *Q1–Q3*)	20, 18–20	20, 19–20	20, 19–20	19, 16–20
Lawton (*Mdn*, *Q1–Q3*)	6, 3–8	8, 6–8	6, 4–7	3, 2–6
GDS (*Mdn*, *Q1–Q3*)	3, 1–6	3, 1–7	3, 1–6	3, 1–6
GDS > 5 (%)	34.7	39.0	31.3	32.1
Performance factor (%)	28.5	21.7	36.4	31.0
RUDAS (*Mdn*, *Q1–Q3*)	23, 19–27	27, 25–28	23, 21–26	18, 13–20
MMSE (*Mdn*, *Q1–Q3*)	25, 19–29	29, 27–30	27, 23–28	19, 14–23
GPCOG (*Mdn*, *Q1–Q3*)				
Cognitive	6, 2–8	8, 7–9	6, 4–8	2, 0–4
Informant	3, 1–4	4, 3–6	2, 1–4	1, 0–2
Combined	8, 4–12	12, 11–14	8, 7–9	3, 1–5
CDR (%)				
No dementia	31.8	80.0	0.0	0.0
Questionable dementia	37.8	20.0	90.9	25.8
Mild dementia	24.5	0.0	9.1	58.6
Moderate dementia	4.6	0.0	0.0	12.1
Severe dementia	1.3	0.0	0.0	3.5

Notes. CIND = cognitive impairment not dementia; CDR = Clinical Dementia Rating Scale; GDS = 15-point Geriatric Depression Scale (range 0–15, scores >5 suggest depression); GPCOG = General Practitioner Assessment of Cognition (see text for explanation of scores); Lawton = Lawton Instrumental Activities of Daily Living Scale (range 0–8, higher scores indicate better function); MBI = Modified Barthel Index (range 0–20, higher scores indicate better function); MMSE = Folstein Mini-Mental State Examination (range 0–30, higher scores indicate better cognitive function); *Q1–Q3* = interquartile range; RUDAS = Rowland Universal Dementia Assessment Scale (range 0–30, higher scores indicate better cognitive function).

Missing data (numbers in parentheses refer to number of participants with missing data for characteristic, by cognitive status): MBI (dementia 1); Lawton (dementia 1); GDS (normal 1, CIND 1, dementia 2); RUDAS (dementia 1); MMSE (normal 2, CIND 5, dementia 7); GPCOG cognitive (normal 2, CIND 1, dementia 3); GPCOG informant (normal 7, CIND 6, dementia 6).

Performance factors (potential) include visual or hearing impairment, psychiatric disease (depression, anxiety or psychosis), dysarthria or dysphasia, neurological disease, musculoskeletal disorders, fatigue, and use of certain medications.

for informant component). The correlation between the two components of the GPCOG was moderate ($r_s = 0.57$). The internal consistencies of both the RUDAS (Cronbach's $\alpha = 0.80$) and the MMSE (Cronbach's $\alpha = 0.84$) were good.

ROC curves and likelihood ratios

The AUCs were similar for the RUDAS, the MMSE and the three GPCOG measures ($p > 0.05$ for all comparisons; Table 3; Figure 1). At the published cut-off of <23/30, the sensitivity of the RUDAS for dementia diagnosis was 87.7 (95%CI = 76.3–94.9), while the specificity was 90.0 (95%CI = 79.5–96.2). A RUDAS score <23/30 multiplies the pre-test odds of dementia by approximately 9 (positive *LR* = 8.77), while a higher score divides the pre-test odds by approximately 7 (negative *LR* = 0.14). Table 3 shows the sensitivities, specificities and likelihood ratios for the MMSE and GPCOG. While the MMSE (positive *LR* = 6.99, negative *LR* = 0.18) was similar to the RUDAS, the total GPCOG and its subscales were more sensitive but less specific, with lower positive and negative likelihood ratios. Table 4 shows the post-test probabilities of dementia (for positive results on the screening tools) for underlying population prevalence rates of dementia of 1%, 5%, 10%, 20%, 30% and 40%.

Logistic regression analyses

The univariate predictors of dementia were total MMSE score, GPCOG score (cognitive component, informant component, and combined score), total RUDAS score, age, presence of an informant, total Lawton score (all $p < 0.001$), years of educa-

Table 3. ROC curve data (normal vs. definite dementia)

Measure	RUDAS	MMSE	GPCOG Patient section	GPCOG Informant section	GPCOG Combined
AUC (95%CI)	0.94 (0.88–0.97)	0.93 (0.87–0.97)	0.95 (0.89–0.98)	0.92 (0.85–0.96)	0.97 (0.91–0.99)
Cut-off	≤22/30	≤23/30	≤7/9	≤4/6	≤10/15
Sensitivity (95%CI)	87.7 (76.3–94.9)	84.3 (71.4–93.0)	98.2 (90.2–99.7)	94.2 (84.0–98.7)	98.1 (89.7–99.7)
Specificity (95%CI)	90.0 (79.5–96.2)	87.9 (76.7–95.0)	67.2 (53.7–79.0)	49.1 (35.1–63.2)	77.4 (63.8–87.7)
Positive *LR*	8.77	6.99	3.00	1.85	4.33
Negative *LR*	0.14	0.18	0.03	0.12	0.03

Note. CI = confidence interval; GPCOG = General Practitioner Assessment of Cognition; MMSE = Folstein Mini-Mental State Examination; ROC = receiver operating characteristic; RUDAS = Rowland Universal Dementia Assessment Scale.

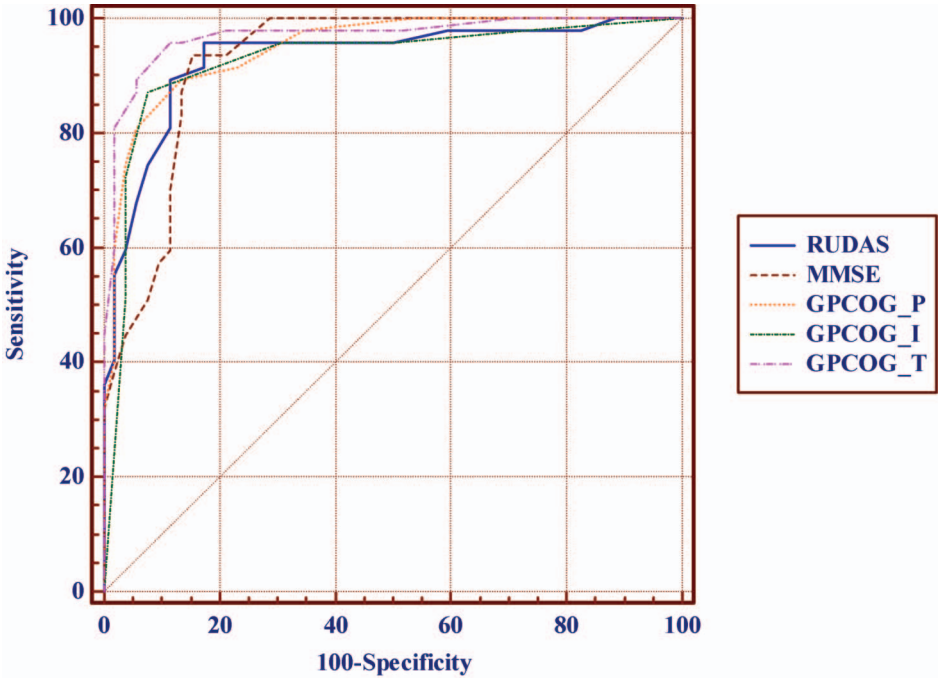

Figure 1. Receiver operating characteristic curves for Rowland Universal Dementia Assessment Scale (RUDAS), Folstein Mini-Mental State Examination (MMSE) and General Practitioner Assessment of Cognition (GPCOG-I, -P, -T) (P = Patient, I = Informant, T = Total). Dementia vs. normal (cognitive impairment not dementia, excluded).

tion, total MBI score (both $p < 0.01$), CALD status ($p = 0.01$), hearing impairment and gender (both $p = 0.03$).

Rowland Universal Dementia Assessment Scale. The final logistic regression analysis for dementia diagnosis identified only two significant variables: the RUDAS score and the presence of an informant (Table 5). In preliminary models, non-significant variables were removed (based on the value of the Wald χ^2) in the following order: total MBI score, total Lawton score and hearing impairment. Depression (GDS score >5) was a confounder in the dataset. The explanation for this is stated in an earlier section describing the GDS. Although age, gender, years of education and CALD status were included in the final model because they were known risk factors for dementia (and we were studying an instrument for use in multicultural populations), none was a significant predictor or confounder in our dataset.

Folstein Mini-Mental State Examination. The final logistic regression analysis for dementia diagnosis identified two significant variables: the MMSE score and the presence of an informant (Table 6). In preliminary models, non-significant variables were removed in the following order: total MBI score, total Lawton score and hearing impairment. While CALD status and depression were confounders in the dataset, age, gender and years of education were not. Although not significant, CALD status is a confounder because it influences the outcome variable (clinical diagnosis of dementia) and is associated with the MMSE score. CALD status therefore distorts the relationship between the MMSE score and dementia diagnosis, and it becomes difficult to separate the individual contribution of each variable (MMSE vs. CALD status). This implies that CALD status influences the ability of the MMSE to detect dementia.

General Practitioner Assessment of Cognition total score. The primary analysis of the GPCOG evaluated the total score (cognitive score plus informant score). The final logistic regression analysis for dementia diagnosis identified two significant variables: the total GPCOG score and the presence of depression (Table 7). In preliminary models, non-significant variables were removed in the following order: presence of an informant, total MBI score, total Lawton score and hearing impairment. The presence of an informant was a confounder (because it influences the outcome variable and is part of the GPCOG total score), while age, gender, CALD status and years of education were not. Although the presence of an informant would ordinarily be included in the final logistic model shown in Table 7 (because it is a confounder), we were unable to do

Table 4. Post-test probability of dementia for a positive result on the screening tool

Dementia prevalence (%)	RUDAS (%)	MMSE (%)	GPCOG Patient section (%)	GPCOG Informant section (%)	GPCOG Combined (%)
1	8	7	3	2	4
5	32	27	14	9	19
10	49	44	25	17	32
20	69	64	43	32	52
30	79	75	56	44	65
40	85	82	67	55	74

Notes. Dementia prevalence = underlying prevalence of dementia in the study population; GPCOG = General Practitioner Assessment of Cognition; MMSE = Folstein Mini-Mental State Examination; RUDAS = Rowland Universal Dementia Assessment Scale.
All percentages are rounded to nearest percent.

Table 5. Multivariate logistic regression for dementia diagnosis: RUDAS ($N = 106$)

Variable	PE	*SE*	*p*	OR (95%CI)
RUDAS score	−0.62	0.15	<0.0001	0.54 (0.40–0.72)
Age	0.04	0.07	0.50	1.05 (0.92–1.19)
Female gender	−0.60	0.85	0.48	0.55 (0.10–2.89)
CALD status	0.58	1.02	0.57	1.78 (0.24–13.16)
Years of education	0.09	0.12	0.44	1.09 (0.87–1.37)
Informant present	2.89	1.00	0.004	18.00 (2.52–128.90)
GDS score >5	−1.67	0.95	0.08	0.19 (0.03–1.20)

Note. CALD = culturally and linguistically diverse; CI = confidence interval; GDS = 15-point Geriatric Depression Scale (range 0–15, scores >5 indicate depression); PE = parameter estimate; OR = odds ratio; RUDAS = Rowland Universal Dementia Assessment Scale.

Table 6. Multivariate logistic regression for dementia diagnosis: MMSE ($N = 99$)

Variable	PE	*SE*	*p*	OR (95%CI)
MMSE score	−0.71	0.19	0.0001	0.49 (0.34–0.71)
Age	0.04	0.07	0.52	1.04 (0.92–1.19)
Female gender	–0.28	0.97	0.77	0.75 (0.11–5.08)
CALD status	–1.82	1.22	0.14	0.16 (0.02–1.77)
Years of education	0.11	0.12	0.37	1.11 (0.88–1.40)
Informant present	3.98	1.28	0.002	53.39 (4.34–656.94)
GDS score >5	–1.46	1.03	0.16	0.23 (0.03–1.77)

Note. CALD = culturally and linguistically diverse; CI = confidence interval; GDS = 15-point Geriatric Depression Scale (range 0–15, scores >5 indicate depression); MMSE = Folstein Mini-Mental State Examination; PE = parameter estimate; OR = odds ratio.

Table 7. Multivariate logistic regression for dementia diagnosis: Total GPCOG ($N = 94$)

Variable	PE	*SE*	*p*	OR (95%CI)
GPCOG total score	−1.17	0.31	0.0002	0.31 (0.17–0.58)
Age	0.02	0.06	0.72	1.02 (0.90–1.16)
Female gender	−0.64	1.39	0.64	0.53 (0.03–8.07)
CALD status	0.29	1.38	0.83	1.34 (0.09–20.06)
Years of education	0.11	0.16	0.49	1.11 (0.82–1.51)
GDS score >5	−3.81	1.59	0.02	0.02 (0.001–0.51)

Note. CALD = culturally and linguistically diverse; CI = confidence interval; GDS = 15-point Geriatric Depression Scale (range 0–15, scores >5 indicate depression); GPCOG = General Practitioner Assessment of Cognition; PE = parameter estimate; OR = odds ratio.

so. Its inclusion resulted in quasi-complete separation of data points, suggesting that the maximum likelihood estimate may not exist.

GPCOG cognitive and informant components. Analysis of the cognitive component of the GPCOG ($n = 102$) identified three significant variables: the cognitive score ($p = 0.0006$), the presence of an informant ($p = 0.004$) and the presence of depression ($p = 0.049$). Age, gender, CALD status and years of education were neither significant nor confounders (data not shown). Evaluation of the informant component ($n = 94$) identified two significant variables: the informant score ($p < 0.0001$) and the Lawton score ($p = 0.04$). The presence of an informant and depression were confounders in our dataset (data not shown). The informant component of the GPCOG has three questions that also comprise part of the Lawton scale (handling finances and medications, and needing assistance with transport).

Discussion

The data show that the RUDAS is at least as accurate as the MMSE for detecting dementia in community-dwelling persons with early dementia. Unlike the MMSE, the RUDAS does not appear to be influenced by CALD status. The RUDAS also appears to be as accurate as the GPCOG, with the advantage that it was designed specifically for multicultural populations to be a stand-alone measure not requiring an informant. The RUDAS compares favourably with the MMSE and GPCOG despite the circularity of the process by which data from the MMSE and GPCOG were used to arrive at DSM-IV diagnoses. This may have overestimated the accuracy of the MMSE and the GPCOG for dementia detection.

The MMSE, the RUDAS and all three GPCOG measures had similar values for the AUC, ranging from 0.92 to 0.97, confirming the excellent accuracy of all three instruments for detecting early dementia. ROC curve analysis is an effective, unbiased method for evaluating the performance of a diagnostic test. It shows the relationship between sensitivity and specificity across all possible instrument cut-offs. The AUC is a summary measure, with higher values indicating better test performance. A perfect test has an AUC of 1.0, while a test with zero discrimination has an AUC of 0.5 (Hanley & McNeil, 1982).

Although the AUC is independent of the decision criterion, in practice each measure has only one recommended cut-off for dementia screening (determined by the developers of the instrument). Likelihood ratios incorporate both the sensitivity and specificity of a test (at a particular cut-off) to directly estimate the effect of the test on the odds of having a disease. Screening tools with positive likelihood ratios between 5 and 10 are regarded as moderately good, whereas those with scores >10 are convincingly good (Fagan, 1975). While the MMSE (positive $LR = 6.99$, negative $LR = 0.18$) was similar to the RUDAS (positive $LR = 8.77$, negative $LR = 0.14$), each of the three GPCOG measures had a lower positive likelihood ratio, ranging from 1.85 (informant component) to 4.33 (combined score). Although not as good as the MMSE and the RUDAS for ruling in dementia, both the cognitive component of the GPCOG and the combined score were excellent at ruling out dementia. The negative likelihood ratio of 0.03 for both measures divided the pre-test odds of dementia by 33. While the positive and the negative likelihood ratios are both useful measures, the former is probably more intuitive to most clinicians (i.e., if you score badly and have a high positive *LR* you are likely to have dementia).

Whereas the MMSE was influenced by CALD status, the RUDAS and GPCOG were not. Some components of the cognitive section of the GPCOG, however, such as the name, address, and awareness of a recent news story may not be familiar concepts for many persons from CALD backgrounds. It may well be that the present CALD sample, being relatively well educated, was less affected by this component of the GPCOG.

MMSE scores are known to be influenced by age and education (Anderson et al., 2007; Escobar et al., 1986). We were unable to show this, most likely reflecting the unique characteristics of our participants. These included higher rates of literacy (96%), years of education ($Mdn = 8$) and type of education (secondary or higher in 60%). In the present sample neither the GPCOG nor the RUDAS were influenced by age, gender or education. The Lawton score predicted dementia independent of the informant component of the GPCOG. This may be an

unrelated association between physical disability and dementia, both of which are prevalent in older age.

All three instruments were influenced by the presence of concomitant depression. Depression frequently coexists with dementia, and many depressed individuals have a measurable decline in cognition (Burns & Morris, 2008). Surprisingly, in the case of the GPCOG (total score and cognitive component), depression independently predicted the absence of dementia. Possible reasons include reluctance by clinicians to make a diagnosis of dementia in the presence of depression, or the attribution of symptoms of dementia to depression.

Other investigators have devised instruments for use in cross-cultural settings. These are described by Storey et al. (2004), and include the Fuld Object-Memory Evaluation (FOME) (Fuld, Muramoto, Blau, Westbrook, & Katzman, 1988), the Cross-Cultural Cognitive Examination (CCCE) (Glosser et al., 1993), the Cognitive Abilities Screening Instrument (CASI) (Teng et al., 1994), the Community Screening Interview for Dementia (CSI-D) (Hall et al., 2000), and the Mini-Cog (Borson, Scanlan, Chen, & Ganguli, 2003). The CASI and CSI-D are lengthy and are more appropriate for research settings than for routine clinical practice. The FOME is difficult to standardise and is not easily portable, and the CCCE was validated in an unusually young population. While short and simple to administer (three-item recall and clock drawing), the clock drawing task of the Mini-Cog appears to have limited utility in multicultural samples (Storey, Rowland, Basic, & Conforti, 2002). Although the same may be true of the cube copying task of the RUDAS, the inclusion of a category fluency task and the nature of the memory item favour the RUDAS. Word generation tasks, such as letter fluency and category fluency, measure aspects of language and executive retrieval function. Although both are affected in Alzheimer's disease, category fluency is disproportionately affected and is superior in predicting disease (Duff Canning, Leach, Stuss, Ngo, & Black, 2004). The memory task of the RUDAS (shopping list of familiar items) has better face validity and is more equitable across cultures than a list of concrete and abstract words (Teng & Manly, 2005).

While the RUDAS was designed to be a stand-alone measure, the presence of an informant independently predicted a clinical diagnosis of dementia. This was also true for the MMSE and the cognitive component of the GPCOG. Although an informant may provide additional information disparate to that obtained by direct testing (suggested by the modest correlation between the cognitive and informant components of the GPCOG), 30% or so of older people do not have an informant, a pertinent issue in day-to-day practice. People with dementia without informants are less likely to have carers, and are therefore at higher risk of the adverse consequences of dementia. Although the presence of an informant is an asset to overall cognitive assessment, the RUDAS, as a stand-alone measure, appears to perform at least as well as the combined GPCOG (similar AUC and a higher positive *LR*).

Strengths of the GPCOG are that it combines participant and informant data (when available), is quick to administer, and has better psychometric properties than the 10-item Abbreviated Mental Test (Hodkinson, 1972). Its psychometric properties are at least as good as the MMSE (Brodaty et al., 2002). It was designed specifically for use by general practitioners and has been validated in this setting (Brodaty et al., 2002). The development of a screening tool specifically for use by general practitioners is important, given that general practitioners may be the most appropriate clinicians to detect dementia in its early stages (Brodaty, Low, Gibson, & Burns, 2006). In the development of the GPCOG, however, participants were excluded if they had poor English language skills (Brodaty et al., 2002).

The RUDAS and the GPCOG are relatively new instruments but both have conceptual advantages over the MMSE. Despite this, both the RUDAS and the GPCOG must be judged against the MMSE in order to be accepted for wider usage. The MMSE is recommended by the American Academy of Neurology and others for early detection of dementia (Petersen et al., 2001), and is used to determine eligibility for subsidised Alzheimer's disease drugs (in Australia). The MMSE was developed in an English-speaking population but has been translated to many other languages (Ramirez et al., 2006). Direct translation, however, does not address the broader and more complex issue of culture. Culture may be broadly defined as a social construct characterised by the behaviour and attitudes of a social group. Culture is constantly changing (McKenzie & Crowcroft, 1994), particularly in an era of rapid globalisation. The fabric of culture includes ideas, symbols, meanings, shared understandings, morals, values and beliefs (Janes, 2006). The diversity of elements that define culture explains some of the difficulty in applying certain concepts within screening instruments to people from CALD backgrounds. Evaluating test scores in CALD populations may be difficult because low scores may be due to the effects of dementia or to factors associated with cultural background. Access to formal education must also be considered when interpreting test scores, because many instruments were developed with an assumption of baseline literacy. Many older persons from CALD backgrounds have minimal education and speak little

English (Hassett & George, 2002), and decisions based on the MMSE can be misleading.

Mild cognitive impairment (MCI) describes a state of cognitive functioning that is below defined norms, yet falls short of dementia in severity. It exists across a cognitive continuum with borders that are difficult to define precisely (Feldman & Jacova, 2005). Longitudinal studies have shown that persons with MCI progress to a clinical diagnosis of Alzheimer's disease at approximately 10–15% per year (Schott et al., 2006). Not all people with MCI go on to develop Alzheimer's disease; a few improve, some remain static, while others progress to dementias other than Alzheimer's disease (Schott et al., 2006). A number of subtypes of MCI are recognised, including CIND, a subtype developed by the population-based Canadian Study of Health and Ageing (Ebly, Hogan, & Parhad, 1995). The CIND grouping is the most broad-based and inclusive of the entities within MCI, because it has virtually no exclusions and allows a classification of all persons with MCI (Feldman & Jacova, 2005). Despite its increasing recognition and importance, in the absence of longitudinal data we had no way of determining whether or not patients with CIND were at the earliest stage of dementia. While we describe the characteristics of these patients (Tables 1,2), to minimise misclassification bias the analyses included only participants with normal cognition and those with definite dementia.

The present study has several limitations. First, the majority of the CALD sample were born in one of 10 European non-English-speaking countries (particularly Greece and Italy), partly reflecting the demographics of Melbourne and Adelaide, but nonetheless reducing the generalisability of the findings. Only three participants were born in the Middle East and one in Asia. One reason may be the under-utilisation of dementia services by minority ethnic groups (Daker-White et al., 2002). Normalisation of cognitive symptoms, belief systems, language proficiency, lower health literacy on the part of caregivers, economic factors, and lack of culturally appropriate care all play important roles (Ayalon & Arean, 2004; Davis et al., 1996; Ortiz & Fitten, 2000). A second limitation was that we could not evaluate the RUDAS and the GPCOG across the full spectrum of early dementia syndromes, due to insufficient numbers of participants. A third limitation was that we may have overestimated the utility of the MMSE and GPCOG for dementia diagnosis due to circularity of process. Finally, in the absence of longitudinal follow-up and brain pathology, we may have misclassified some participants as having dementia, particularly because more participants born in non-English speaking countries were diagnosed with the disease, compared with those born in English-speaking countries. The diagnosis of dementia may be problematic in culturally heterogeneous populations (Prince, 2000), given that there is no gold standard for diagnosis. However all decisions were based on DSM-IV criteria, 72% of participants had informants, those with CIND were excluded from the main analyses, and all were assessed by experienced clinicians, making misclassification unlikely.

In summary, the present data suggests that the RUDAS is at least as accurate as the MMSE in detecting early dementia. Unlike the MMSE, the RUDAS does not appear to be influenced by CALD status, age or education, and all items can be directly translated to other languages, without the need to change the structure or the format of any item. The RUDAS also appears to be as accurate as the GPCOG, with the advantage that it was designed specifically for multicultural populations to be a stand-alone measure. Further studies, however, are needed in the primary care setting to determine whether it has similar properties to the GPCOG. Notwithstanding this important issue, we recommend its use over the MMSE and the GPCOG in culturally heterogeneous populations.

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