

Performance of the Rowland Universal Dementia Assessment Scale in Screening Mild Cognitive Impairment at an Outpatient Setting

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Keywords

Aging and cognition · Cognitive assessment · Cognitive disorders · Mild cognitive disorder

Abstract

Introduction: Mild cognitive impairment (MCI) is defined as the symptomatic pre-dementia phase on the continuum of cognitive decline. Early recognition and application of potential interventions could prevent or delay the progression to dementia. The Rowland Universal Dementia Assessment Scale (RUDAS) shows good performance in the screening of dementia but has limited data regarding its diagnostic properties in the screening of MCI. The objectives of this study were to assess the psychometric properties of the Thai version of the RUDAS (RUDAS-Thai) in the screening of MCI, identify associated factors for the RUDAS performance, and determine the optimal cutoff point in detecting MCI. **Methods:** This was a cross-sectional study conducted from January 2020 to March 2021. Older patients at the outpatient clinic of an internal medicine department at a tertiary care hospital in Thailand were examined. Baseline data were collected, and the RUDAS-Thai was administered to each patient. Afterward, a geriatrician assessed each patient for MCI. **Results:** A total of 150 patients were included, of whom 42

cases (28%) had MCI. The overall performance of the test using an area under the receiver operating characteristic curve (AUC) was 0.82 (95% confidence interval 0.75–0.89). At the optimal cutoff point of 25/30, the AUC was 0.76 with sensitivity and specificity of 76.2 and 75%, respectively. The educational level affected the test performance according to regression analysis. For patients with years of education ≤ 6 and >6 , the optimal cutoff points were 25/30 and 26/30, respectively. **Conclusion:** The RUDAS-Thai performed well in differentiating patients with MCI from normal cognition; however, it was affected by educational level. A score of 25/30 or lower for persons with ≤ 6 years of education or 26/30 or lower for persons with higher than 6 years of education is the optimal cutoff point for indication of developing MCI.

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Introduction

Mild cognitive impairment (MCI) is a transitional phase between normal cognitive aging and dementia. It is unlinked to any certain etiology; however, in the context of Alzheimer's disease (AD) biomarkers, it is considered

to be a prodromal phase of AD. There are several etiologies of MCI such as systemic diseases, neurological diseases, medications, and psychiatric disorders that can cause diverse outcomes [1]. The prevalence of MCI in older adults is around 6.7–25.2%. It increases with age, lower educational level, and more predominant in men [2–5]. Since MCI was defined differently in most reports, there are wide ranges of its prevalence. The outcomes of MCI can be mainly classified into 3 groups by pathogenesis; reversion to normal aging, stability, or progression to dementia [1, 6–8]. The annual rate of progression to dementia is approximately 5–17% [1, 3, 8, 9]. Risk factors for predicting progression from MCI to AD include a positive amyloid PET scan, apolipoprotein E4 genotype, abnormal CSF tau levels, and a positive PET scan due to tau deposition into the lateral temporal lobe structures [1, 4, 9–11]. Once dementia is diagnosed, it is usually incurable and associated with unfavorable health outcomes as a result of cognitive and functional decline and can complicate other health conditions. Additionally, it can lead to significant health-care costs, socioeconomic, and disability burden, especially in severe cases [12]. Currently, there are only 2 strategies to deal with dementia as follows: symptomatic relief and behavioral intervention [13].

The diagnosis of MCI is primarily on clinical judgment. The 2 main targets are for differentiating MCI from normal aging or dementia and to identify potentially treatable causes of MCI such as depression, medication effects, thyroid disorder, and B12/folate deficiency [5, 14]. In the area of cognitive function assessment, the Montreal Cognitive Assessment (MoCA) is the recommended screening tool for MCI. At a cutoff point of 24/30, its sensitivity and specificity were 80.48 and 81.19% [15], whereas at the cutoff point of 25/30 had sensitivity of 80–100% and specificity of 50–76% [5]. The Rowland Universal Dementia Assessment Scale (RUDAS) is a cognitive screening tool that measures 6 cognitive domains as follows: memory, visuospatial orientation, praxis, visuoconstructional drawing, judgment, and language [16]. It exhibits a good validity, test-retest reliability, and inter-rater reliability [16–21]. It has been translated in many languages and is not influenced by sex and language, but the educational level affects the test performance in some studies [17, 18]. The RUDAS score variation with educational attainment; however, it was significantly lesser than MoCA score variation ($p < 0.01$) [22]. The majority of the existing reports study the diagnostic properties in screening dementia, but there is a paucity of data regarding its performance in distinguishing MCI from normal

cognitive function [16–21]. The Chinese version of the RUDAS exhibited test-retest reliability of 0.90 with an internal consistency reliability of 0.71, inter-rater reliability (kappa value) of 0.88, and a content validity index of 0.97. The area under the receiver operating characteristic (ROC) curve (AUC) for the MCI assessment was 0.92, and the optimal cutoff point of 24/25 gave sensitivity and specificity of 79 and 91%, respectively. The positive and negative predictive value was 0.99 and 0.96 [20]. Other studies in patients with low- and middle-level education in Peru also showed good diagnostic properties in discrimination patients with MCI from normal cognition and dementia. For the low-educated older adults, the AUC of the RUDAS was 98% at the optimal cutoff point <23 (sensitivity 89 and specificity 93%) in differentiation MCI from dementia, and it was 98% at the optimal cutoff point <19 (sensitivity 95 and specificity 97%) in differentiation dementia from MCI [23]. The AUC of the RUDAS among the middle-education older adults in discrimination patients with MCI from normal cognition was 0.99 at the optimal cutoff point of <24 (sensitivity 96 and specificity 90.24%), whereas the AUC to discriminate patients with MCI from dementia was 0.89 at the optimal cutoff point of <21 (sensitivity 90.24 and specificity 73.81%) [19].

In Thailand, the MoCA had been the most commonly used test in detecting MCI though it is influenced by level of education, lifestyle factors, and ethnic diversities [24, 25]. It also consumes time to administer in real practice. It might not be suitable for bedside and outpatient settings in Thailand. The RUDAS demonstrates good diagnostic performance in MCI detection. As it is shorter than the MoCA, it might be used as an alternate tool. However, its performance in the Thai context has not been addressed. Since early detection of cognitive impairment by a suitable screening tool is crucial and beneficial to global aspects, the study regarding the diagnostic performance of the RUDAS should be performed to lessen the gap of knowledge, identification, and application of potential interventions to prevent or delay the onset of dementia can be established. Additionally, the proceeding of MCI to dementia might be lessened and minimized adverse outcomes of dementia [26]. Therefore, the primary objective of this study was to assess the performance of the RUDAS in discriminating between patients with normal cognitive function and MCI. The secondary objectives were to demonstrate the factors associated with the RUDAS and determine its optimal cutoff point in detecting MCI.

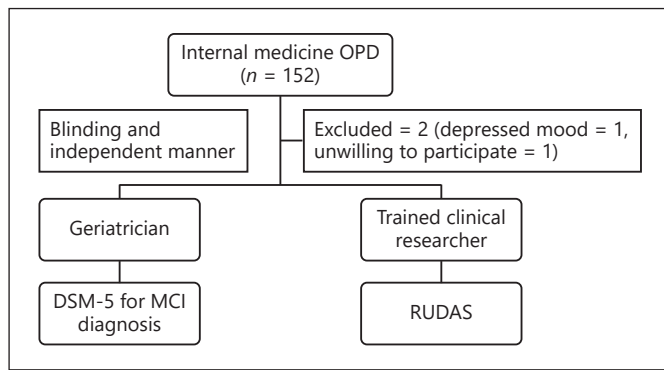


Fig. 1. Study flow. DSM-5, Diagnostic and Statistical Manual of Mental Disorders; MCI, mild cognitive impairment; RUDAS, Rowland Universal Dementia Assessment Scale.

Methods

Population and Setting

This is a diagnostic cross-sectional study which was a sub-study of the project entitled “The performance of the RUDAS, Recall test and Mini-Cog in the screening of mild cognitive impairment.” The data were collected from older patients who visited the outpatient clinic, Department of Internal Medicine of the Srinagarind University Hospital, Khon Kaen University, Thailand. The study period was between January 2020 and March 2021. The clinic is a tertiary care referral center located in the Northeastern part of Thailand to which patients are sent from other departments and other community hospitals. The inclusion criteria were older adults with age ≥ 60 years by Thai definition who had no apparent acute illness that can contribute to the performance of the RUDAS such as infection, acute stroke, acute coronary syndrome, and delirium. The exclusion criteria were patients with a psychiatric history, congenital mental retardation, or mental diseases; patients with long-term use of antipsychotic drugs; and patients with severe visual, hearing, or limb dysfunction. Patients with depressed mood determined by the Thai version of the Patient Health Questionnaire-9 >9 [27], patients with impaired instrumental activities of daily living determined by the Chula ADL index <9 [28], patients who were unable to communicate with Thai or the local language, and the ones who were reluctant to complete the tests were also excluded. The eligible patients were 152 cases where 2 cases were withdrawn due to unwillingness to participate and had one had depressed mood, respectively. The study flow is shown in Figure 1.

Operational Definition

Mild Cognitive Impairment

The diagnosis of MCI is based on the definition of the Diagnostic and Statistical Manual of Mental Disorders criteria which were operationalized as follows: (a) evidence of modest cognitive decline from a previous level of performance in one or more cognitive domains which are learning and memory, complex attention, executive function, language, perceptual-motor function, and social cognition, (b) the cognitive deficits do not interfere

with the capacity for independence in everyday activities, (c) the cognitive deficits do not occur exclusively in the context of delirium, and (d) the cognitive deficits are not better explained by another mental disorder [29]. The examples of the neuropsychological battery tools used to define impairment of cognitive domains include Mini-Mental State Examination (MMSE), MoCA for global mental functioning, Rey auditory verbal learning test (immediate and delayed recall), short story, Rey-Osterrieth complex figure (recall) for learning and memory domain, trail making test (parts a and b), visual search, symbol digit modalities test, stroop and color-word test for attention/executive function domain, phonemic and semantic verbal fluency for language domain, Rey-Osterrieth complex figure (copy) for perceptual motor function domain, and the face and emotion recognition, Faux Pas, or reading the mind in the eyes tests for social cognition domain [30, 31].

Instrument

Rowland Universal Dementia Assessment Scale

The RUDAS is a 6-item cognitive screening test that was developed and validated by Rowland et al. [16, 32] in Australia. This screening tool measures a variety of cognitive domains which tasks included body orientation, praxis (coordination between both hands), copy of cube, a problem-solving task, memory (remembering a shopping list), and semantic verbal fluency (animals). It is easy to administer and can be complete in 10–15 min. The maximum score is 30, with a higher score reflecting better cognitive performance, and the cutoff points for the Thai version of the RUDAS (RUDAS-Thai) for screening dementia is 23/30 in patients with 6 years of education or lower (sensitivity of 71.4 and specificity of 76.9%) and 24/30 in patients with >6 years of education (sensitivity of 77 and specificity of 70%) [17, 33].

Procedure

The potential patients were asked to enroll in the study by a team of researchers. In total, 150 older patients were recruited using convenience sampling. The performance factors including vision, hearing, depression, anxiety, musculoskeletal disorders, fatigue, dysarthria, and dysphasia were reviewed in the medical chart and evaluated by clinical assessment. After consent, demographic information was collected. The RUDAS-Thai version was administered by a trained clinical researcher to the participants where test-retest reliability of the test by the trained clinical researcher was assessed prior to the main study by giving scores to the same patient from the VDO recorder 1 week apart. Then, MCI was assessed by a geriatrician. The trained clinical researcher and the geriatrician were blinded to the results of each other.

Sample Size Calculation

The required sample size was calculated based on the AUC according to the methodology of Hanley and McNeil [34]. This method altered the sample size until a sufficiently small standard error of the AUC is achieved. A Web-based calculator (www.an-aesthetist.com/mnm/stats/roc/#stderr) was used to determine the standard error because of the complexity of the formula. Ultimately, a sample size of 150 patients was acceptable and feasible to conduct in clinical practice at the AUC of 0.9 and a standard error of 0.04.

Table 1. Demographic data and RUDAS scores of the participants

Variable	Normal cognitive function (<i>n</i> = 108) (72%)	MCI (<i>n</i> = 42) (28%)
Age, med (IQR 1, 3)	67 (62.5, 73.5)	72 (66, 75)
Men, <i>n</i> (%)	55 (50.9)	17 (40.9)
Years of education, <i>n</i> (%)		
0	0 (0)	3 (7.1)
≤6	34 (31.5)	25 (59.5)
6–12	28 (25.9)	7 (16.7)
>12	46 (42.6)	7 (16.7)
Marital status, <i>n</i> (%)		
Single	3 (2.8)	2 (4.8)
Married	82 (75.9)	26 (61.9)
Divorce	8 (7.4)	1 (2.4)
Widow	15 (13.9)	13 (30.9)
Underlying disease(s), <i>n</i> (%)		
DM	43 (39.8)	23 (54.8)
HTN	81 (75)	33 (78.6)
DLD	72 (66.6)	15 (35.7)
CKD	27 (25)	4 (9.5)
AF	7 (6.5)	4 (9.5)
IHD	2 (1.9)	2 (4.8)
CVA	5 (4.6)	4 (9.5)
OSA	7 (6.5)	2 (4.8)
RUDAS score, med (IQR 1, 3)	27.5 (25.5, 28)	24 (22, 25)

n, numbers of participants; med, median; IQR, interquartile range; DM, diabetes mellitus; HTN, hypertension; DLD, dyslipidemia; CKD, chronic kidney disease; AF, atrial fibrillation; IHD, ischemic heart disease; CVA, cerebrovascular accident; OSA, obstructive sleep apnea; RUDAS, Rowland Universal Dementia Assessment Scale; MCI, mild cognitive impairment.

Statistical Analysis

Test-retest reliability of the RUDAS-Thai by a single rater (the trained clinical researcher) was validated by an analysis of limits of agreement, using the Bland and Altman [35] method, by plotting between difference and mean of the RUDAS' scores in a different time. The method of implementation was adjusted until the mean difference from a single rater on 2 separate occasions was not greater than a score of 2 prior proceeding to the main study.

Demographic data variables were summarized using descriptive statistics and were presented as percentage, mean, and standard deviation. If the distribution of these data was not normal, median and interquartile range were used instead. The ROC curve was used to summarize the overall accuracy of RUDAS-Thai for detecting MCI. Then an optimal cutoff point was determined. The performance of the test was summarized by the sensitivity, specificity, positive predictive value, negative predictive value, and likelihood. The effects of age, gender, and education on the RUDAS-Thai were evaluated using linear regression analyses. Variables with *p* values <0.05 were considered to indicate statistically significant coefficients, and 95% confidence interval were used to determine the strength of association. In addition, an exploratory

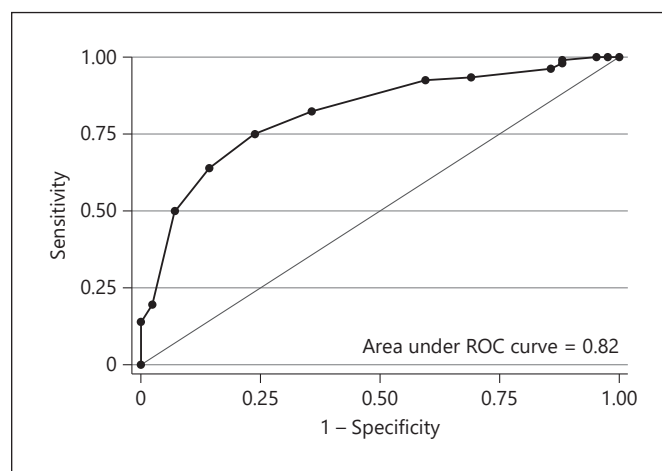


Fig. 2. ROC curve of the RUDAS-Thai for MCI detection. MCI, mild cognitive impairment; AUC, area under the receiver operating characteristic curve; RUDAS, Rowland Universal Dementia Assessment Scale.

data analysis of the RUDAS-Thai performance based on years of education was performed. All of the data analysis will be performed by using STATA version 10.0 (StataCorp, College Station, TX, USA).

Results

Participant Characteristics

The demographic data and RUDAS scores of the studied population are demonstrated in Table 1. The prevalence of patients with MCI was 28% (42/150 cases). The majority of them were women, and they were older and had diabetes mellitus more than the normal cognitive function group. The normal cognitive function group performed higher RUDAS scores than the MCI group.

Performance of the RUDAS-Thai in Detecting Patients with MCI

The AUC of the RUDAS-Thai was 0.82 (95% confidence interval 0.75–0.89). The ROC curve is shown in Figure 2. The optimal cutoff point of the test was 25/30, which showed good sensitivity and specificity for MCI detection. The other performances of the test are demonstrated in Table 2.

Effects of Age, Gender, and Educational Level on the RUDAS-Thai

Only years of education affected the performance of the RUDAS-Thai score on the probability of having MCI,

Table 2. Optimal cutoff point and its performance of the RUDAS-Thai in detecting of MCI

Measure	RUDAS-Thai	95% CI
Optimal cutoff point	≤25/30	
At optimal cutoff point		
AUC	0.76	0.68–0.83
Sensitivity, %	76.2	60.5–87.9
Specificity, %	75	65.7–83.3
PPV, %	54.2	40.8–67.3
NPV, %	89	80.7–94.6
Positive LR	3.1	2.1–4.4
Negative LR	0.32	0.18–0.55

AUC, area under the receiver operating characteristic curve; CI, confidence interval; PPV, positive predictive value; NPV, negative predictive value; LR, likelihood ratio; MCI, mild cognitive impairment.

Table 3. Factors associated with the performance of the RUDAS-Thai

Variable	Coefficients	95% CI	p value
Age, years	−0.05	(−0.12 to 0.03)	0.23
Men	−0.34	(−1.32 to 0.63)	0.49
Years of education			
0	1	–	–
≤6	4.6	(1.3–7.8)	0.01
6–12	5.9	(2.6–9.2)	0.001
>12	6.8	(17.1–30.1)	0.00

CI, confidence interval.

Table 4. Optimal cutoff points of the RUDAS-Thai for MCI detection based on years of education

Measure	Six years or lower	Higher than 6 years
AUC	0.74 (95% CI 0.63–0.84)	0.70 (95% CI 0.57–0.84)
Optimal cutoff point	25/30	26/30
At optimal cutoff point		
Sensitivity	85.7% (67.3–96)	71.4% (41.9–91.6)
Specificity	61.8% (43.6–77.8)	68.9% (57.1–79.2)
PPV	64.9% (47.5–79.8)	30.3% (15.6–48.7)
NPV	84% (63.9–95.5)	92.7% (82.4–98)
Positive LR	2.24 (1.42–3.53)	2.3 (1.42–3.69)
Negative LR	0.23 (0.09–0.60)	0.42 (0.18–0.96)

AUC, area under the receiver operating characteristic curve; CI, confidence interval; PPV, positive predictive value; NPV, negative predictive value; LR, likelihood ratio; MCI, mild cognitive impairment.

according to the linear regression analysis (Table 3). The performance of the score based on years of education was then analyzed; the AUC of the group with 6 years or lower of education was 0.74, whereas the other was 0.7. The optimal cut points were 25/30 and 26/30, respectively. The other performances of the test were shown in Table 4.

Discussion

The prevalence of MCI in this study was about a third (28%) which appears to be higher than general reports that found approximately 6.7–25.2% [2–5]. This difference could be explained by the differences of the studied population. This study was conducted in an outpatient setting of the Internal Medicine department of a tertiary

hospital where patients are likely to have more complicated diseases particularly high prevalence of atherosclerotic risk such as diabetes mellitus, hypertension, and dyslipidemia which are the known risk factors for MCI [2]. However, one study regarding the prevalence of MCI in rural Thai older people in the northern part of Thailand reported a very high prevalence of MCI (71.4%) [36]; the explanation might be due to the criteria for MCI diagnosis in this report (using MoCA-B, Thai version) and characteristics of studied patients (low education and having an underlying disease associated with MCI). Those factors could contribute to the high proportion of MCI in that study.

The overall performance of the RUDAS-Thai in MCI diagnosis in this study was very good based on the AUC (0.82), and the optimal cutoff point was 25/30. The result

supports the usefulness of the RUDAS, not only for dementia screening but also for MCI detection. Previous studies reported that the early symptoms of MCI and dementia can be effectively identified by assessing a person's visuospatial function which is one of the cognitive domains measured in the RUDAS [16, 32], whereas the MMSE does not measure this domain and the presence of ceiling and floor effects causes modest sensitivity in detecting cognitive decline [37]. However, the educational level, but not age or sex, did affect the performance of the test according to regression analysis. These findings supported the previous report that education influenced the diagnostic properties of the RUDAS-Thai [17]. One explanation could be including problems with visuospatial and visuoconstruction. In comparison to highly educated persons, illiterate persons performed poorer in those cognitive domains which were measured in the RUDAS because of spatial disorganization and lack of 3-dimensionality in this group [38]. The optimal cutoff points were 25/30 and 26/30 for subjects with 6 years or lower education and higher than 6 years of education, respectively. Overall, our finding exhibited rather lower psychometric properties than the previous studies. One study conducted at outpatient clinics of neurology and rehabilitation medicine of the Instituto Peruano de Neurociencias in Lima, Peru, showed the AUC of 0.99 at the optimal cutoff point <24, sensitivity 96, and specificity 90.24% [19]. Another study which took place at outpatient clinics of the neurology, geriatric, and geriatric psychiatry departments in Taiwan reported the AUC of 0.92 and recommended the cutoff point at 24/30 (AUC 0.85, sensitivity 79, and specificity 91%) [39]. These differences may be due to variation in cultural background and language of preference as a prior report regarding the RUDAS-Thai in detecting of dementia performed rather less diagnostic properties than other countries including English and non-English speaking background [39]. For example, some grocery item is not frequently consumed in South-east Asia [17].

This study revealed that the RUDAS-Thai has satisfactory diagnostic properties in MCI assessment though education did affect its performance where the original one did not [16, 32]. The RUDAS-Thai then could be an alternate cognitive screening test for MCI in Thai, apart from the MoCA. Further study regarding a direct comparison between the MoCA and the RUDAS is worthwhile. Our results showed that the RUDAS-Thai is an accurate tool for detecting MCI with different cutoff points by education level. Given the cutoff points of the RUDAS-Thai in dementia assessment in the former study [17]

were 23 and 24 for subjects with a 6-year or lower education and over a 6-year education, respectively [17], at applying a RUDAS-Thai score of 24–25 for subjects who have 6-year or lower education, and 25–26 for subjects who have over 6-year education are recommended as optimal cutoff points for detection of MCI.

There were some limitations of this study. First, diagnosis bias could be found as the diagnostic criteria for MCI are mainly on a clinical judgment without the accessibility of an easily available biomarker. Second, the prevalence of MCI is likely to have more than expected in general population since our setting is a tertiary care hospital. Subjects are likely to have more complicated illnesses that are at risk for having MCI. Last, as the nature of the study design lacks a longitudinal follow-up and brain pathology, misclassification bias could have occurred.

Conclusion

The RUDAS-Thai exhibited good diagnostic performance in identifying MCI patients. It was affected by educational level but not by age and sex. The optimal cutoff points at 25/30 for persons with 6 years or lower education and 26/30 for persons with higher than 6 years of education are recommended. The RUDAS-Thai could be an alternative screening test for MCI in an outpatient setting.

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Statement of Ethics

Ethical approval was provided by the Khon Kaen University Faculty of Medicine Ethics Committee as instituted by the Helsinki Declaration (reference number HE621529). All patients have given written informed consent.

Conflict of Interest Statement

The authors have no conflicts of interest to declare.

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Author Contributions

P.L. contributed to study design, acquisition of data, analysis and interpretation of data, drafting of the manuscript, and revision of the manuscript for intellectual content. M.M. contributed to study design, acquisition of data, and drafting of the manuscript. K.S. contributed to analysis and interpretation of data, drafting of the manuscript, and revision of the manuscript for intellectual content.

Availability of Data and Material

All data generated or analyzed during this study are included in its supplementary material file, available at www.karger.com/doi/10.1159/000517821. Further inquiries can be directed to the corresponding author.

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