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REVIEW

Cognitive assessment tools in Asia: a systematic review

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ABSTRACT

Background: The prevalence of dementia is increasing in Asia than in any other continent. However, the applicability of the existing cognitive assessment tools is limited by differences in educational and cultural factors in this setting. We conducted a systematic review of published studies on cognitive assessments tools in Asia. We aimed to rationalize the results of available studies which evaluated the validity of cognitive tools for the detection of cognitive impairment and to identify the issues surrounding the available cognitive impairment screening tools in Asia.

Methods: Five electronic databases (CINAHL, MEDLINE, Embase, Cochrane Library, and Science Direct) were searched using the keywords dementia Or Alzheimer Or cognitive impairment And screen Or measure Or test Or tool Or instrument Or assessment, and 2,381 articles were obtained.

Results: Thirty-eight articles, evaluating 28 tools in seven Asian languages, were included. Twenty-nine (76%) of the studies had been conducted in East Asia with only four studies conducted in South Asia and no study from northern, western, or central Asia or Indochina. Local language translations of the Mini-Mental State Examination (MMSE) and Montreal Cognitive Assessment (MoCA) were assessed in 15 and six studies respectively. Only three tools (the Korean Dementia Screening Questionnaire, the Picture-based Memory Intelligence Scale, and the revised Hasegawa Dementia Screen) were derived *de novo* from Asian populations. These tools were assessed in five studies. Highly variable cut-offs were reported for the MMSE (17–29/30) and MoCA (21–26/30), with 13/19 (68%) of studies reporting educational bias.

Conclusions: Few cognitive assessment tools have been validated in Asia, with no published validation studies for many Asian nations and languages. In addition, many available tools display educational bias. Future research should include concerted efforts to develop culturally appropriate tools with minimal educational bias.

Key words: Asia, cognition, dementia, aged, assessment tool

Introduction

Dementia is a syndrome characterized by loss of cognitive function, severe enough to interfere with an individual's daily functioning. The World Health Organization (WHO; 2012) recognizes dementia as an international health challenge and has called on countries to include dementia in public health planning. Dementia in developing countries, particularly in Asia, constitutes an even greater challenge as populations in many such countries are aging rapidly (Aggarwal *et al.*, 2012). East Asia now possesses the world's largest population aged 60 years and above, with a further 279 million people expected to fall into this age group between 2010 and 2050 (Catindig *et al.*, 2013). The fastest growth in the older population has been in China and India, and their South Asian and Western Pacific neighbors (World Health Organisation, 2011; Duthey, 2013). Based on the World Alzheimer's report in 2009 (Alzheimer's Disease International, 2009), Western Europe was estimated to have the highest number of people with dementia (7.0 million), followed by East Asia with 5.5 million, South Asia with 4.5 million, and

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North America with 4.4 million (World Health Organisation, 2012). The Asia Pacific region, however, is expected to overtake Western Europe as the region with the highest number of people with dementia in the next decade, with an increase from 2.83 million in 2010 to 7.03 million in 2050 (Prince *et al*., 2013).

A survey conducted among general practitioners (GPs) in the United Kingdom found that GPs felt there were few screening tools available and more information was required about the full range of instruments available (Milne *et al*., 2008). A survey of doctors in Asian countries would likely echo this. As such, a comprehensive list identifying available validated cognitive assessment tools will be invaluable to clinicians assessing older patients having dementia on a regular basis as well as researchers. Such a list will also identify gaps that need to be filled.

The accurate identification of cognitive impairment (CI) using appropriate assessment tools is vital if effective strategies for the management of dementia in Asia are to be developed. Cognitive assessment tools have been developed to measure memory and how well individuals perform in other cognitive areas, including attention, decision-making, and language use. While many cognitive assessment tools exist, most of these have been designed and validated for use in populations in developed countries. As a consequence, the applicability of existing cognitive assessment tools may be limited in developing countries due to differences in educational levels and cultural factors (Verghese *et al*., 2012). For example, the clock-drawing test, which is a commonly used cognitive assessment tool, may not be an appropriate test for those with low levels of formal education (de Jager *et al*., 2008). Previous studies have suggested that conceptual errors may result in lower than expected scores in people with low levels of formal education (Kim and Chey, 2010). Translated versions of tools designed for use in developed countries may also require appropriate adaptation and validation for the population in which they are to be used (Dominguez *et al*., 2013). The aim of this systematic review was to rationalize the results of studies conducted to evaluate the validity of screening tools for the detection of cognitive impairment in Asia and to identify any issues surrounding the screening or assessment of cognitive impairment using these tools.

Methods

Search strategy

We search the CINAHL, MEDLINE, Embase, Cochrane Collaborative Library, and Science Direct databases for relevant articles published between September 1989 and June 2014.

Relevant articles were identified by searching titles and abstracts using keywords containing dementia Or Alzheimer Or cognitive impairment And screen Or measure Or test tool Or instrument Or assessment. Searches were limited to the Asian continent and people aged 65+ years (e.g. for MEDLINE, CINAHL, and Science Direct). Truncation of search terms was used as appropriate (e.g. screen* and measure*). We did not limit our search to any language. The keywords used varied slightly between databases depending on the requirements of each search engine. A flowchart of studies identified at all stages is shown in Figure 1.

Eligibility criteria

Cognitive tools were defined as any assessment, measurement, questionnaire, interview, or test used for screening with the intention of identifying individuals with cognitive impairment. The inclusion criteria were (1) studies including any participants aged 18 years and above, (2) involving cognitive tools used for detection of dementia/cognitive impairment/Alzheimer's Disease (AD), and (3) including participants of Asian ethnic origin resident within the Asian continent. Exclusion criteria included (1) studies which only included participants aged below 18 years, (2) tools not intended for use by non-specialist healthcare workers or intended to aid detailed assessment by a physician or designed for the identification of dementia subtype, (3) studies which were conducted outside the geographical location of the Asian continent.

Study screening and selection

Titles and abstracts of retrieved articles were independently evaluated by two investigators (Roshaslina Rosli and Maw Pin Tan). For articles thought to be of interest, full-text versions were retrieved and examined for eligibility (Roshaslina Rosli and Maw Pin Tan). Discrepancies were resolved by discussion until a consensus was reached between the investigators on the articles that should be included (see Figure 1).

Quality assessment

Risk of bias was evaluated using the Quality Assessment of Diagnostic Accuracy Studies version 2 (QUADAS-2) tool. QUADAS-2 comprises 14 items assessing the risk of bias, sources of variation, applicability, and quality. Each item is scored as "yes," "no," or "unclear" (Whiting *et al*., 2011). Two reviewers (Roshaslina Rosli and Maw Pin Tan) independently evaluated each of the

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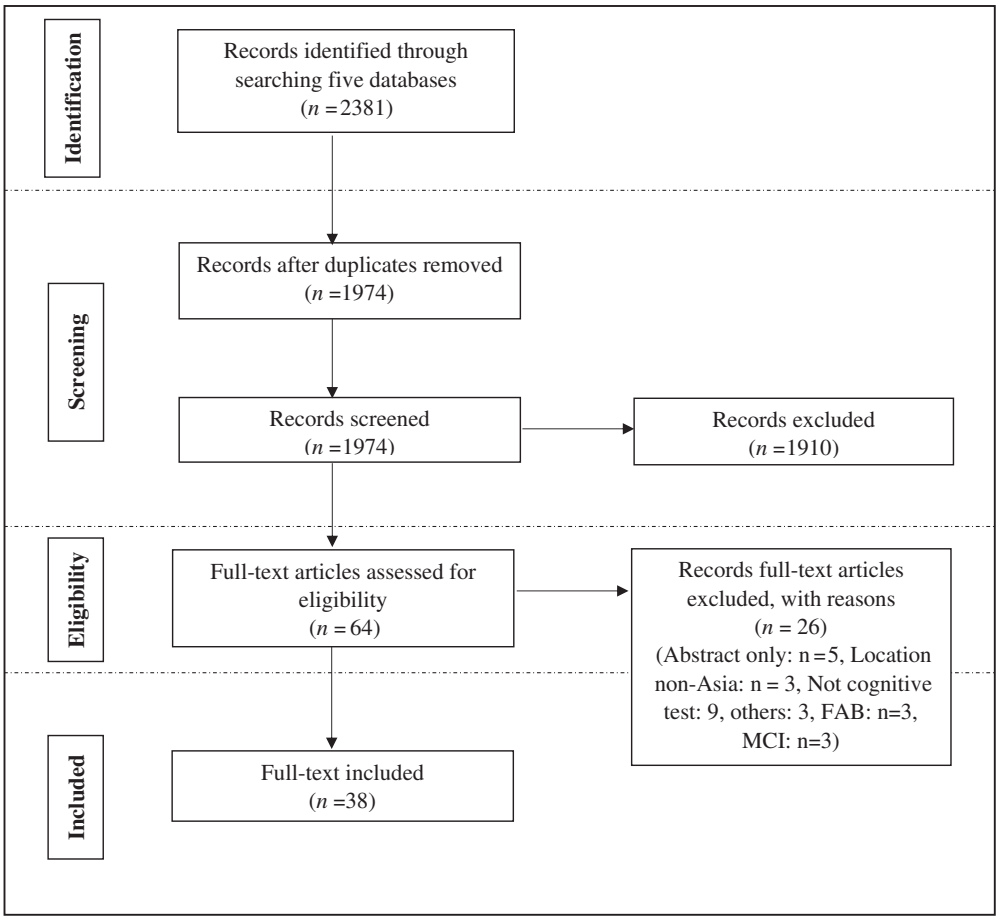


Figure 1. PRISMA flow chart for cognitive tools for dementia review.

included studies using agreed criteria based on the QUADAS-2 core signaling questions and concerns of applicability. The signaling questions used to assess the risk of bias were based on each of the following domains: (1) method of patient selection (consecutive or random selection, study design, and inclusion/exclusion criteria); (2) index test used, and blinding to results of the reference standard assessment; (3) is the reference standard appropriate, and were assessors blinded to the index test result; and (4) flow and timing (was there an appropriate interval between index test and reference standard, were all participants assessed with the same reference standard, and were all participants included in the analysis).

The applicability judgment was made with reference to review questions developed by the reviewers (Roshaslina Rosli and Maw Pin Tan) based on each domain: (1) patient selection (inclusion and exclusion criteria were appropriate, sampling procedure and age of participants were reported); (2) index test (was the index test score compared with a reference standard or any other cognitive screening tool, was there a comparison between people with and without dementia, and was the validity of the index test assessed with reference to the reference standard); and (3) reference standard (was the reference standard used to assess all participants before the index test). Any disagreement in the evaluation of quality was addressed through discussion until agreement was reached.

Data extraction

Data regarding country, language, study design, sample size, and population were extracted. The sensitivity and specificity of a tool at a given cut-off was also extracted. The cut-off value was defined as a point chosen along a score range that distinguished clearly and consistently the absence or presence of cognitive impairment.

Finally, data on educational bias were collected. Educational bias in this study refers to any significant influence of literacy level among the sample population on test performance. Education bias was classified as "affected by level of education," "not affected by level of education," and "not reported," based on whether educational bias was evaluated, and whether the statistical

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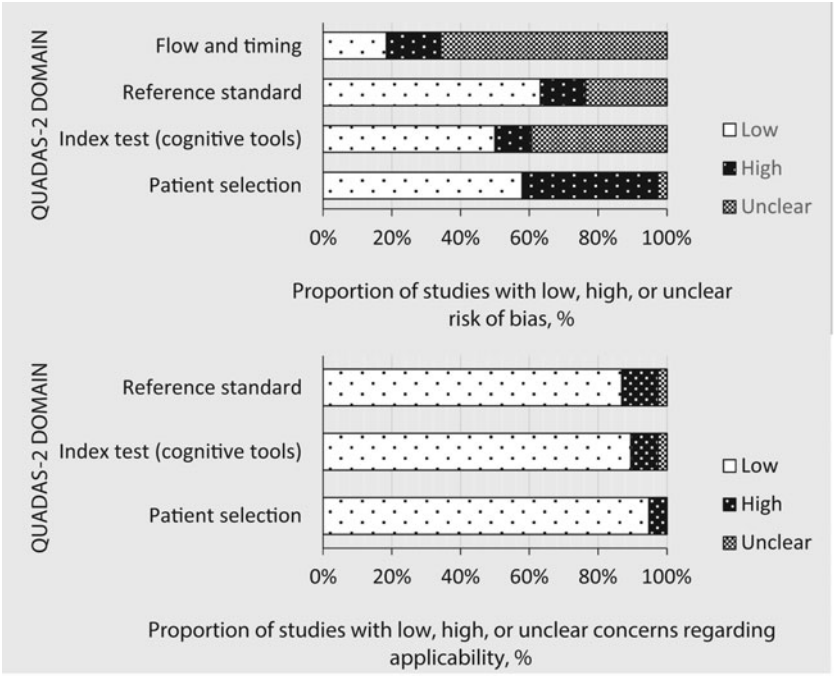


Figure 2. Quality of assessment (QUADAS-2).

analysis revealed the presence or absence of differences in test scores based on the level of education.

Data analysis

Data for all included studies were extracted and summarized with reference to mean value, standard deviation, median, inter-quartile range, and/or frequency as appropriate (Roshaslina Rosli and Maw Pin Tan). Pooled analysis was not possible due to the large variation in study design and populations between studies.

Results

Studies

Altogether 2,381 citations were obtained from the initial keyword search from the five databases (Figure 1). Following the removal of duplicates, 1,974 articles were screened by title and abstracts, and 1,910 records were excluded due to age of participants, geographical location, and papers written as letters to the editor and review articles. Sixty-four full-text articles were obtained and assessed for eligibility. Twenty-six articles were excluded after full-text evaluation. The reasons for exclusion are given in Figure 1. Thus, 38 full-text articles were selected for further evaluation.

Twenty nine studies (76%) included were conducted in East Asia, with nine studies conducted in South Korea in the Korean language, seven studies in China in the simplified Chinese language, six studies in Hong Kong in the traditional Chinese language, five studies in Japan in the Japanese language, and two studies in Taiwan in the traditional Chinese language. Cognitive tools had also been assessed in three South East Asian countries: Malaysia in the Malay language (two studies), the Philippines in Tagalog (one study), and Singapore in English, Malay, and Chinese languages (two studies). The remaining studies evaluated cognitive tools in Southern Asia: India in Malayalam language (three studies) and Sri Lanka in Singhalese language (one study).

Quality assessment

Selected articles were screened with the QUADAS-2 checklist to determine risk of bias (Table 1 and Figure 2). The reference standards used to diagnose dementia and patient selection methods were generally considered at low risk of bias with low concern regarding applicability. The index test used showed a generally high risk of bias, but risk of bias in terms of applicability was low. Fifty-eight percent of the studies did not clearly report the interval and sequence of testing, and so the risk of bias was considered unclear within the flow and timing domains. In addition, many studies did not clearly report whether the cognitive tools had been interpreted without knowledge of results of the reference standard.

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Table 1. Quality assessment for risk of bias using QUADAS-2 ($n = 38$)

	RISK OF BIAS				APPLICABILITY CONCERNS		
STUDY	PATIENT SELECTION	INDEX TEST	REFERENCE STANDARD	FLOW AND TIMING	PATIENT SELECTION	INDEX TEST	REFERENCE STANDARD
Ahn *et al.* (2007)	?	?	?	–	–	–	–
Chan *et al.* (2006)	–	?	?	?	–	–	–
Cho *et al.* (2002)	+	?	–	?	–	–	–
Chung (2009)	+	–	–	–	–	–	–
de Jager *et al.* (2008)	+	+	+	?	+	–	+
de Silva and Gunatilake (2002)	–	–	–	+	–	+	+
Dong *et al.* (2010)	–	?	?	?	–	–	–
Dominguez *et al.* (2013)	+	+	+	–	+	+	–
Fuh *et al.* (1995)	+	?	–	?	–	–	+
Fujiwara *et al.* (2010)	+	?	–	?	–	–	–
Gao *et al.* (2014)	–	?	–	?	–	–	–
Hanyu *et al.* (2011)	+	?	–	+	–	–	–
Heo *et al.* (2012)	–	?	–	?	–	–	–
Hu *et al.* (2013)	+	–	–	+	–	–	–
Ibrahim *et al.* (2009)	+	?	–	+	–	–	+
Inoue *et al.* (2011)	–	–	?	?	–	–	–
Iype *et al.* (2006)	+	–	–	+	–	–	–
Jeong *et al.*(2007)	–	–	–	?	–	–	–
Kim *et al.* (2005)	–	–	–	?	–	–	–
Konagaya *et al.* (2007)	+	?	–	?	–	–	–
Lam *et al.* (1998)	+	–	–	?	–	+	–
Lam *et al.* (2006)	–	?	?	?	–	–	–
Li *et al.* (2006)	–	–	–	?	–	–	–
Lin *et al.* (2003)	–	–	?	+	–	–	–
Maki *et al.* (2000)	+	+	+	?	–	–	–
Na *et al.* (2009)	–	?	–	?	–	–	–
Poon *et al.* (2008)	–	–	–	?	–	–	–
Razali *et al.* (2014)	–	–	?	?	–	–	–
Shi *et al.* (2012)	–	–	–	?	–	–	–
Shin *et al.* (2011)	–	?	–	?	–	–	–
Suh and Kang (2006)	–	–	–	–	–	–	–
Tsai and Gao (1989)	–	–	?	?	–	?	?
Verghese *et al.* (2012)	–	–	–	–	–	–	–
Yang *et al.* (2006)	–	–	–	?	–	–	–
Yip and Man (2010)	–	+	+	–	–	–	–
Youn *et al.* (2002)	+	?	+	–	–	–	–
Yu *et al.* (2012)	–	–	?	?	–	–	–
Zhou and Jia (2008)	+	–	–	?	–	–	–

Notes: "+" = High risk.
"–" = Low risk.
"?" = Unclear risk.

Characteristics of cognitive tools

A total of 28 different cognitive assessment tools were assessed within the studies included (Table 2). The Mini-Mental State Examination (MMSE) was the most widely evaluated tool (included in 15 studies), followed by the Montreal Cognitive Assessment (MoCA) tool (six studies), the Hasegawa Dementia Scale-Revised (HDS-R; three studies), and the Clock Drawing Test (CDT; two studies). The number of items and domains, score range, cut-off score, and administration time for each tool are presented in Table 2.

Only five studies evaluated tools which were designed *de novo* within Asian populations: the Korean Dementia Screening Questionnaire (KDSQ; one study), the Picture-based Memory Intelligence Scale (PMIS; one study), and the revised Hasegawa Dementia Screen (HDS-R; three studies). The remaining 33 (87%) articles evaluated tools that had been translated into languages

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Table 2. Characteristics of cognitive tools, cut-off score, and education bias based on studies ($n = 28$)

TOOLS, INDICATION, AND SPECIFIC FEATURES	NO. ITEMS AND DOMAINS	MAXI.—MUM. SCORE	STUDY, COUNTRY, AND LANGUAGE	STUDY DESIGN, SAMPLE SIZE, AND POPULATION	CUT-OFF SCORE	SENSI-TIVITY (%)	SPECI-FICITY (%)	ADMINI-STRATION TIME (MIN)	EDUCA-TION BIAS
7 MS Alzheimer's Disease (AD) Temporal orientation	19 items (i) Benton's temporal orientation (ii) Visual Busschke cued recall (iii) Verbal fluency (iv) Clock drawing	113 16 5 Not re-ported (NR) 7	de Jager *et al.* (2008) Kerala, India Malayalam	Case-control 178 young controls\40 low-risk older participants 61 high-risk older participants	AD: Lower risk Older and higher risk older participants (i) Benton's temporal orientation: 2.5 (ii) Enhanced cued recall: 14.5 (iii) Verbal category fluency test: 14.5 (iv) Clock drawing test: 4.5	 95.0 48.0 79.0 79.0	 95.0 95.0 83.0 85.0	NR	+
ACE AD Screening	9 parts (i) Attention (ii) Orientation (iii) Memory (iv) Verbal fluency (v) Language ability (vi) Visuospatial ability	100 8 10 35 14 28 5	Heo *et al.* (2012) Seoul, South Korea Korean	Cross-sectional 39 normal control (NC) 50 AD 26 MCI	AD: 68/69 MCI: 80/81	90.0 67.0	84.0 65.0	NR	?

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Table 2. Continued

TOOLS, INDICATION, AND SPECIFIC FEATURES	NO. ITEMS AND DOMAINS	MAXI.—MUM. SCORE	STUDY, COUNTRY, AND LANGUAGE	STUDY DESIGN, SAMPLE SIZE, AND POPULATION	CUT-OFF SCORE	SENSI-TIVITY (%)	SPECI-FICITY (%)	ADMINI-STRATION TIME (MIN)	EDUCA-TION BIAS
ADAS AD Screening, diagnosis, and tracking	11 cognitive (i) Word recall task (ii) Naming objects and fingers (iii) Following commands (iv) Constructional praxis (v) Ideational praxis (vi) Orientation (vii) Word recognition task (viii) Remembering test directions (ix) Spoken language (x) Comprehension (xi) Word-finding difficulty 10 non-cognitive Observational-based behavioral rating items	70	Youn *et al.* (2002) South Korea Korean	Case-control 5 Non-demented (ND) 84 AD	AD: (i) ADAS-K-total: 18/19 (ii) ADAS-K-cog: 15/16	86.3 90.4	90.4 82.5	30–45	?

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Table 2. Continued

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BDRS Dementia (D) Screening	22 items (i) 8 items: Changes in performance of everyday activities (ii) 3 items: Changes in habits, including self-care (iii) 11 items: Changes in personality, interest, and drives	28	Yang *et al.* (2006) Taiwan	Cross-sectional 1,143 NC 50 MCI 18 dementia	MCI: (i) 65–74 years and literate: 1 (ii) 65–74 years and less-education: 1.5 (iii) ≥75 years and literate: 1 (iv) ≥75 years and less-education: 2 D: (i) 65–74 years and literate: 2.5 (ii) 65–74 years and less-education: 2.5 (iii) ≥75 years and literate: 2.5 (iv) ≥75 years and less-education: 3	68.05 69.47 62.25 70.86 72.73 72.29 75.00 79.71	78.79 51.81 58.33 52.17 61.11 70.27 72.73 7.26	10–15	+

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Table 2. Continued

TOOLS, INDICATION, AND SPECIFIC FEATURES	NO. ITEMS AND DOMAINS	MAXI.—MUM. SCORE	STUDY, COUNTRY, AND LANGUAGE	STUDY DESIGN, SAMPLE SIZE, AND POPULATION	CUT-OFF SCORE	SENSI-TIVITY (%)	SPECI-FICITY (%)	ADMINI-STRATION TIME (MIN)	EDUCA-TION BIAS
BPMSE Severe stages of AD Patient-derived rating scale	25 items (i) Orientation (ii) Language (iii) Attention (iv) Motor functioning 10 items dichotomous behavior subscale (BPMSE-behav) 2 descriptive questions on communication and social interactions	25 5 11 4 5	Na *et al.* (2009) Seoul, South Korea Korean	Case-control 91 AD	NR	NR	NR	5	?
CDT CI and dementia Screening	2 parts (i) Drawing part (CTD-D) (ii) Copy part (CTD-C)	16 16	Lin *et al.* (2003) Taipei Chinese	Cross-sectional 80 NC 80 vascular cognitive impairment no dementia (VCIND)	Early to mild AD: CDT-drawing part: 10/11 CDT-copy part: 12/13	67.0 51.0	75.0 74.0	NR	-
			Zhou and Jia (2008) Beijing Chinese	Case-control 80 NC 80 VCIND	VCIND: CDT10 (with Rouleau method): ≤8 CDT5 (with AD cooperative study method): ≤4	68.7 65.0	78.7 86.2	NR	?

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CFT Dementia Screening	3 parts (i) Clock-drawing test (ii) Clock reading (iii) Clock setting	10	Lam *et al.* (1998) Hong Kong Chinese	Case-control 53 NC 53 D 39 AD 14 non-AD	D: 3/4	83.0	79.0	NR	+
CDST MCI, early dementia required Computerized	4 parts (i) Spatial span (ii) Memory impairment screen of Buschke (iii) Judgment of the line orientation test (iv) Go No-go test	12 8 10 20	Cho *et al.* (2002) South Korea Korean	Case-control 103 NC 41 MCI/early D	D: 0.5	75.6	94.2	13–16	?
CVFT MCI and AD Semantic memory and executive function	30 items (i) Animals (ii) Fruit (iii) Big and small	NR	Lam *et al.* (2006) Hong Kong Chinese	Cross-sectional 118 NC 150 questionable dementia (QD) 63 mild AD	NR	NR	NR	3	+
EXIT25 Bedside evaluation Executive cognitive function	25 items (i) Preservation (ii) Imitation behavior (iii) Echopraxia (iv) Echolalia (v) Intrusions (vi) Frontal release signs (viii) Lack of spontaneity (ix) Prompting (x) Disinhibited behavior and utilization behavior	50	Chan *et al.* (2006) Hong Kong Chinese	Cross-sectional 85 elderly ≥65 years	D: 15	93.0	83.0	15	+

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FOME Older patients Episodic memory function	6 items (5 recall trials and 1 delay recall) (i) Total retrieval (TR) (ii) Delayed recall (DR)	50 10	Chung *et al.* (2009) Hong Kong Chinese	Cross-sectional 135 NC 57 D	D: (i) Total retrieve: 31 (ii) Delayed recall: 7	93.0 91.0	90.0 82.0	NR	-
Hasegawa DS Dementia Screening	11 items (i) Orientation (ii) Judgement (iii) Memory (iv) Language	30.5	Tsai and Gao (1989) China Chinese	Cross-sectional 2,573 participants	Non-D: 31–32.5 Sub-normal: 22–30–5 Early D: 10.5–21.5 D: 0–10	NR	NR	NR	+
Hierarchic DS Cognitive function Screening, diagnosis, and tracking	20 subscales (i) Orientation (ii) Observation (iii) Memory (iv) Praxis (v) Gnosis (vi) Language (vii) Concentration (viii) Cognition (ix) Motor function	200	Poon *et al.* (2008) Hong Kong Cantonese	Case-control 62 D	NR	NR	NR	NR	?
HDS-R Dementia Screening	6 items (i) Memory (ii) Body orientation (iii) Praxis (iv) Drawing (v) Judgment (vi) Language	30 8 5 2 3 4 8	Jeong *et al.* (2007) South Korea Korean	Cross-sectional 803 elderly ≥55 years	NR	NR	NR	10	+
			Kim *et al.* (2005)	Case-control 82 NC 82 AD	AD: 17/18 Mild AD: 18/19	90.2 88.6	92.7 89.0	10	-

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Table 2. Continued

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			Fujiwara *et al.* (2010) Tokyo, Japan Japanese	Cross-sectional 36 NC 30 MCI 30 mild AD	AD: 26/27 MCI: 28/29	97.0 87.0	97.0 61.0	NR	?
HVLT Dementia Screening	2 tasks (i) Free recall for 12 words, repeated for 3 times (ii) Recognition of 24 words, includes 12 precious words	36	Shi *et al.* (2012) Beijing Chinese	Cross-sectional 249 NC 134 MCI 97 AD	AD: 25.5 All types of D: 26.5	93.5 95.5	93.9 96.0	NR	+
IQCODE Changes in cognition Rates change in past 10 years	26 items Domain NR	5	Fuh *et al.* (1995)	Cross-sectional 399 NC 61 D	NR	NR	NR	10–15	-
ICAS Cognitive functions Screening, diagnosis, and tracking	65 items (i) Working memory (ii) Orientation to time (iii) Semantic memory (iv) Calculation (v) Visual interference (vi) Abstract thinking (vii) Attention span (viii) Executive function (ix) Visual inattention (x) Similarity categorization (xi) Sequence (xii) Memory	NR	Yip and Man (2010) Hong Kong Chinese	Prospective Cohort 41 non-CI 25 CI	CI: 3.02	80.5	96.0	NR	?

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KDSQ Dementia Screening	15 items Domain NR	30	Shin *et al.* (2011) South Korea Korean	Longitudinal cohort 1,120 patients without D 908 patients with D	D: 8/9	75.2	73.2	NR	?
MMSE Dementia Diagnosis and monitoring	30 (i) Orientation (ii) Registration (iii) Attention (iv) Recall (v) Language (vi) Visuospatial	30	de Silva and Gunatilake (2002) Sri Lanka Sinhalese	Cross-sectional 380 elderly ≥65 years	CI: 17	93.5	84.6	5–10	?
			Iype *et al.* (2006) Kerala, India Malayalam	Case-control 58 NC 58 D	D: 24 AD: 24 Vascular disease (VD): 24	90.0 96.0 99.0	48.0 39.0 47.0		?
			Ibrahim *et al.* (2009) Malaysia Malay	Case-control 227 NC 73 D	D: Male (i) M-MMSE-7: 23/24 (ii) M-MSE-3: 22/23 (iii) M-MMSE-S: 19 Female (i) M-MMSE-7: 19/20 (ii) M-MSE-3: 18/19 (iii) M-MMSE-S: 18/19	 86.2 97.3 100.0 82.7 93.9 91.7	 84.1 91.7 100.0 72.4 87.5 100.0	5–10	+

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Table 2. Continued

TOOLS, INDICATION, AND SPECIFIC FEATURES	NO. ITEMS AND DOMAINS	MAXI.—MUM. SCORE	STUDY, COUNTRY, AND LANGUAGE	STUDY DESIGN, SAMPLE SIZE, AND POPULATION	CUT-OFF SCORE	SENSI-TIVITY (%)	SPECI-FICITY (%)	ADMINI-STRATION TIME (MIN)	EDUCA-TION BIAS
			Razali *et al.* (2014) Malaysia Malay	Case-control 189 elderly ≥60 years	MCI: 22/23	NR	NR	NR	+
			Li *et al.* (2006) Singapore Chinese	Cross-sectional 88 NC 37 MCI 19 mild/ moderate AD	MCI-AD: ≤25	69.6	65.9	5–10	?
			Dong *et al.* (2010) Singapore English, Malay, Chinese	Case-control 41 acute VCIND Moderate 19 acute VCIND Mild 40 no cognitive impairment (NCI)	CI: 24/25	85.5	82.1	NR	?
			Heo *et al.* (2012) Seoul, South Korea Korean	Cross-sectional 39 NC 50 AD 26 MCI	AD: 23/24 MCI: 26/27	82.0 62.0	62.0 65.0	NR	?
			Kim *et al.* (2005) Seoul, South Korea Korean	Case-control 82 NC 82 AD	AD: 20/21 Mild AD: 20/21	82.9 60.0	87.8 81.7		?
			Shin *et al.* (2011) South Korea Korean	Prospective cohort 1,120 NC 908 D	D: 24/25	86.0	71.2		?
			Gao *et al.* (2014) China Chinese	Cross-sectional 260 NC 44 D 81 neurological	D: 24.5	90.9	75.9		?
			Hu *et al.* (2013) Eastern China Chinese	Case-control 146 NC 72 AD 84 MCI	AD: 24/25 MCI: 28/29	92.0 85.0	100.0 53.0		?

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			Shi *et al.* (2012) Beijing Chinese	Cross-sectional 249 NC 134 MCI 97 AD	AD: 24/25 MCI: 28/29	92.0 85.0	100.0 53.0		+
			Zhou and Jia (2008) Beijing Chinese	Case-control 80 NC 80 VCIND	VCIND: ≤28	80.0	70.0		?
			Fujiwara *et al.* (2010) Tokyo, Japan Japanese	Cross-sectional 36 NC 30 MCI 30 mild AD	AD: 28/29 MCI: 29/30	97.0 89.0	89.0 58.0		?
			Konagaya *et al.* (2007) Obu, Japan Japanese	Case-control 86 NC 49 AD	AD: 26	91.8	695.3		?
MoCA MCI Screening, diagnosis, and tracking	30 items (i) Visuospatial/ executive (ii) Naming (iii) Memory (vi) Attention (v) Language (vi) Abstraction (vii) Delayed recall (viii) Orientation	30	Dominguez *et al.* (2013) Manila, Philippine Filipino	Cross-sectional 25 elderly	Not conducted	Not con-ducted	Not con-duc-ted	10	?
			Fujiwara et al. (2010) Tokyo, Japan Japanese	Cross-sectional 36 NC 30 MCI 30 mild AD	AD: 25/26 MCI: 25/26	89.0 93.0	89.0 100.0		?

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			Hu *et al.* (2013) Eastern China Chinese	Case-control 146 NC 72 AD 84 MCI	AD: 25/26 MCI: 26/27	92.0 92.0	96.0 85.0		+
			Razali *et al.* (2014) Malaysia Malay	Cross-sectional 189 elderly ≥60 years	MCI: 22/23	NR	NR	NR	+
			Yu *et al.* (2012) Beijing Chinese	Cross-sectional 865 NC 115 MCI 21 D	MCI: 21/22	68.7	63.9		+
NUCOG Cognitive screening in psychiatry and neurology Brief, portable, and easy-to-administer	21 items (i) Attention (ii) Visuoconstruc-tional (iii) Memory (iv) Executive (v) Language	100 20 20 20 20 20	Gao *et al.* (2014) China Chinese	Cross-sectional 260 NC 44 D 81 Neurological 144 Epilepsy	D: 70.7	95.5	87.5	NR	?
PMIS Dementia Diagnosing	3 parts 4 pictures, each in different category	8	Verghese *et al.* (2012) Kerala, India Malayalam	Cross-sectional 239 NC 65 D	AD: ≤5 Mild cases (CDR 0.5/1): ≤5 MCI: ≤5	94.1 99.2 95.4	82.4 99.2 99.5	3–4	-
RUDAS Dementia Screening	6 parts (i) Body orientation (ii) Praxis (iii) Drawing (iv) Judgment (v) Memory (vi) Language	30	Iype *et al.* (2006) Kerala, India Malayalam	Case-control 58 NC 58 D	D: 23 AD: 23 VD: 23	88.0 100.0 82.0	76.0 74.0 88.0	20	-

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Table 2. Continued

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SIB-S Severe dementia Unable to complete conventional tests	26 items (i) Social interaction (ii) Memory (iii) Orientation (iv) Language (v) Attention (vi) Praxis (vii) Visuospatial ability (viii) Construction (ix) Orienting to name	50	Ahn *et al.* (2007) South Korea Korean	Case-control 84 AD	Severe D: 32.5	91.0	80.0	10–15	-
			Suh and Kang (2006) South Korea Korean	Case-control 65 AD	Not conducted	Not con-ducted	Not con-duc-ted		?
SMQ Memory disturbance Informant-based	14 items Concerning everyday memory	46	Maki *et al.* (2000) Japan Japanese	Case-control 62 NC 26 Cerebral vascular disease (CVD) 58 VD	VD: 39/40	NR	NR	NR	?
TICS Cognitive function Telephone interview-based	11 items (i) Orientation (ii) Attention (iii) Short-term memory (iv) Repetition (v) Comprehension and conceptual knowledge (vi) Mathematical skill (vii) Praxis	41	Konagaya *et al.* (2007) Obu, Japan Japanese	Case-control 86 NC 49 AD	AD: (i) TCIS-J: 33 (ii) TCIS-J and category fluency: 43	 98.0 85.7	 90.7 93.0	NR	?

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TYM AD/MCI Screening	10 tasks (i) Orientation (ii) Copy a sentence (iii) Semantic knowledge (iv) Calculation (v) Verbal fluency (vi) Similarities (vii) Naming (viii) Visuospatial (ix) Recall of copied sentence (x) Ability to do the test	50	Hanyu *et al.* (2011) Tokyo, Japan Japanese	Case-control 34 NC 46 MCI 79 AD	AD: 42/43 MCI: 44/45	96.0 76.0	91.0 74.0	5–21	?
TDAS Rate cognitive dysfunction Computerized	9 tests (i) Word-recognition (ii) Following a command (iii) Orientation (iv) Visual-spatial perception (v) Naming fingers (vi) Object recognition (vii) Accuracy if the order of a process (viii) Money calculation (ix) Clock time recognition (non-digital)	101 72 2 4 4 5 3 5 3 3	Inoue *et al.* (2011) Japan Japanese	Case-control 34 AD	Not conducted	Not conducted	Not conducted	30	?

Notes: 7 MS = 7-Minute Screen, ACE = Addenbrooke's Cognitive Examination, ADAS = Alzheimer's Disease Assessment Scale, BPMSE = Baylor Profound Mental Status Examination, BDRS = Blessed Dementia Rating Scale, CVFT = Category Verbal Fluency Test, CDT = Clock-Drawing Test, CFT = Clock-Face test, CDST = Computerized Dementia Screening Test, ECR = Enhanced Cued Recall, EXIT25 = Executive Interview, FOME = Fuld Object Memory Evaluation, Hierarchic DS = Hierarchic Dementia Scale, Hasegawa DS = Hasegawa Dementia Scale, HDS-R = Revised Hasegawa Dementia Scale, HVLT = Hopkins Verbal Learning Test, IQCODE = Informant Questionnaire on Cognitive Decline in the Elderly, ICAS = Intelligent Cognitive Assessment System, KDSQ = Korean Dementia Screening Questionnaire, MMSE = Mini-Mental State Examination, MoCA = Montreal Cognitive Assessment, NUCOG = Neuropsychiatry Unit Cognitive Assessment Tool, PMIS = Picture-based Memory Impairment Screen, RUDAS = Rowland Universal Dementia Assessment Scale, SIB-S = Short form version of the Severe Impairment Battery, SMQ = Short-Memory Questionnaire, TICS = Telephone Interview for Cognitive Status, TYM = Test Your Memory, TDAS = Touch Panel-type Dementia Assessment Scale, M-MMSE-7: Malay Mini-Mental State Examination – Serial 7, M-MSE-3: Malay Mini-Mental State – Serial 3, and M-MMSE-S: Malay Mini-Mental State Examination – spell "dunia" backwards.
"+" = effects of education, "–" = no effects of education, and "?" = not reported.

relevant to their populations by the method of forward and backward translations. The validity and reliability of the translated version of each tool was reported in most of the included studies as showing good internal consistency in that setting, and therefore considered suitable.

Cut-off scores

The sensitivity and specificity of the reported scores are summarized in Table 2. The cut-off scores for the diagnosis of AD alone or the presence of dementia using the MMSE were reported by 14 studies (3 Korean, 4 Chinese, 2 Japanese, 2 Singaporean, 1 Malaysian, 1 Indian, and 1 Sri Lankan). One Malaysian study only reported the cut-off score for the diagnosis of mild cognitive impairment (MCI) using the MMSE. The proposed cut-off scores varied from 17 in Sri Lanka to 28 in one Chinese and one Japanese study. Within countries, the proposed cut-off scores differed between studies, with the range of cut-offs proposed from Chinese studies being 19 to 28. Shi *et al.* (2012) proposed a variable cut-off for the MMSE based on the level of education. Five studies defined cut-off scores for the diagnosis of dementia using MoCA. The proposed cut-off scores varied from 21/22 to 25/26, with substantial variation within countries.

Sensitivity and specificity were highest for the Malay-MMSE spell "dunia" backwards (M-MMSE-S) (100.0%; 100.0%), while sensitivity was lowest for the Malayalam 7-minute Screen (7 MS; 48.0%), and specificity lowest for the Malayalam-MMSE (M-MMSE; 48.0%). Four included studies did not report sensitivity and specificity for their proposed cut-off score (Tsai and Gao, 1989; Maki *et al.*, 2000; Shi *et al.*, 2012; Razali *et al.*, 2014).

Educational bias

Educational bias was assessed by 19 (50%) of the included studies. Of these, 13 studies (74%) reported the presence of educational bias in the tools employed. The presence of educational bias was evaluated by these studies by comparing the difference between groups with lower and higher levels of education using different measures such as the total mean scores or domain scores (de Jager *et al.*, 2008), visual comparison of difference in cut-off scores (Yang *et al.*, 2006), and controlled or uncontrolled correlation analysis (Tsai and Gao, 1989; Lam *et al.*, 1998; Chan *et al.*, 2006; Lam *et al.*, 2006; Jeong *et al.*, 2007; Ibrahim *et al.*, 2009; Shi *et al.*, 2012; Yu *et al.*, 2012; Hu *et al.*, 2013; Razali *et al.*, 2014). Tools that showed the most bias were generally those that had been designed for populations from developed countries, which had assessments for drawing, language, or verbal fluency tasks. These included 7 MS, Blessed Dementia Rating Scale, Clock-Face Test, Category Verbal Fluency Test, Executive Interview 25, Hopkins Verbal Learning Test, MMSE, and MoCA as assessment tools. The HDS-R tool, which was developed in Japan, also showed educational bias. This may have been due to their participants' demographic characteristics, which included those from rural and urban areas. Tools that showed the least bias were tools developed using developing country populations (PMIS) or in multicultural settings (Rowland Universal Dementia Assessment Scale (RUDAS) (see Table 2).

Discussion

This systematic review collates a comprehensive list of cognitive assessment tools evaluated in the Asian population. Only four studies were from India and five from South East Asia (de Silva and Gunatilake, 2002; Iype *et al.*, 2006; de Jager *et al.*, 2008; Verghese *et al.*, 2012). We found no studies originating from northern, western, or central Asia or Indochina. While a large proportion of the older population in Asia currently reside in East Asia, where the population has aged rapidly in recent decades (Catindig *et al.*, 2013), the lack of validated cognitive assessment tools in Hindi and other South Asian languages, such as Urdu, Punjabi, Bengali, and Tamil, raises concerns for this highly populous region. We were unable to access non-English databases, which may have contained published data on validated tools in other Asian languages. However, all studies with an English translation of its title or abstract would have been retrieved and evaluated. Our findings highlight the lack of appropriate validated cognitive assessment tools and an urgent need to produce such tools for much of the Asian continent.

The risk of bias in cognitive tools was unclear in many studies since they had not reported whether the cognitive tool had been administered without knowledge of the findings from the reference standard. As most of the included studies had not clearly reported whether there were appropriate intervals between administration of index tests and reference standard assessment, the risk of bias from flow and timing was also unclear. We considered the risk of bias from patient selection as low and the applicability of the sample as high. However, the sampling methods used were mostly case-control, and so the participants were not necessarily representative of the background population. Moreover, sample sizes for some studies were relatively small (Inoue *et al.*, 2011). With a

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notable exception of one study from South Korea, few studies involved a robust large cohort of older participants (Shin *et al*., 2011).

The MMSE was validated most widely in Asia. Educational bias was, however, reported in all studies evaluating MMSE that had studied the influence of education on scores. Performance on the MMSE has been widely reported to be influenced by age and education as well as language, ethnicity, and cultural differences (Mathuranath *et al*., 2007; Ibrahim *et al*., 2009; Dong *et al*., 2010), which may affect the accuracy of results (Ridha and Rossor, 2005). The prevalence of cognitive impairment may, therefore, be overestimated in populations with low literacy rates (LoGiudice *et al*., 2010). In contrast, Sosa *et al.* (2012) reported that the effects of age and education on prevalence of mild cognitive impairment were not significantly different across low- and middle-income countries, with little heterogeneity between nations using standardized scores for each country. This may reflect lower variance in the exposure or weaker underlying associations between education and other risk factor profiles in these samples.

Although the MoCA has been validated in many languages and is widely recommended as a screening tool for dementia (Dominguez *et al*., 2013), the items used in parts of the test, such as picture naming, articulation, and word lists, require adaptation before they are applicable to other cultures. A number of validation studies in Asia have therefore specifically adapted the items to suit their local culture (Fujiwara *et al*., 2010; Yu *et al*., 2012; Dominguez *et al*., 2013; Hu *et al*., 2013; Razali *et al*., 2014). This can result in differences in test scores between countries. Indeed, we have observed large variations in published cut-off scores for MoCA between the studies evaluated with the lower cut-off scores of 21 to 22 reported in Singapore and Beijing and the higher cut-off scores of 25 to 26 advocated in Eastern China and Japan.

The presence of educational bias, found in most of the tools evaluated (including MMSE and MoCA), is of particular concern. Literacy rates among older people in many Asian countries remain low (Liebig and Rajan, 2013). This bias may result in an overestimation of prevalence of dementia, and lead to inappropriate referral or diagnosis. The two tools that displayed the least educational bias, the PMIS and the RUDAS, were either derived from developing country or multi-cultural settings. This suggests that the existing approach of adopting tools translated from western cultures, is not necessarily the most appropriate approach. There is therefore an urgent need to develop locally derived tools that are developed specifically for our culture and in Asian languages.

Conclusions

Validated cognitive assessment tools are required for most of the Asian region if cases of dementia are to be accurately identified. However, few of the assessment tools discussed in this review were non-educationally biased or took into account the cultural diversity and low literacy rates of some elderly Asian populations. The majority of screening tools used have been adapted and translated from the English language and were designed for use in European or North American populations. In order to produce robust, culturally and educationally sensitive instruments, new assessment tools derived from large Asian cohorts should be developed.

Conflict of interest

None.

Description of authors' roles

R. Rosli carried out literature searches, data extraction, quality assessment, wrote the draft, and edited the manuscript. Maw Pin Tan conceived the idea, carried out data extraction, quality assessment, reviewed the paper, and edited the manuscript. William K. Gray reviewed the paper and edited the manuscript. P. Subramanian supervised this work. Ai-Vyrn Chin conceived the idea, and supervised and reviewed the paper.

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