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Review Paper

Validity of screening tools for dementia and mild cognitive impairment among the elderly in primary health care: a systematic review

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ABSTRACT

Objectives: This systematic review aims to provide updated and comprehensive evidence on the validity and feasibility of screening tools for mild cognitive impairment (MCI) and dementia among the elderly at primary healthcare level.
Study design: A review of articles was performed.
Methods: A search strategy was used by using electronic bibliographic databases including PubMed, Embase and CENTRAL for published studies and reference list of published studies. The articles were exported to a bibliographic database for further screening process. Two reviewers worked independently to screen results and extract data from the included studies. Any discrepancies were resolved and confirmed by the consensus of all authors.
Results: There were three screening approaches for detecting MCI and dementia – screening by a healthcare provider, screening by a self-administered questionnaire and caretaker informant screening. Montreal Cognitive Assessment (MoCA) was the most common and preferable tool for MCI screening (sensitivity [Sn]: 81–97%; specificity [Sp]: 60–86%), whereas Addenbrooke's Cognitive Examination (ACE) was the preferable tool for dementia screening (Sn: 79–100%; Sp: 86%).
Conclusion: This systematic review found that there are three screening approaches for detecting early dementia and MCI at primary health care. ACE and MoCA are recommended tools for screening of dementia and MCI, respectively.

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Introduction

Globally, the estimated prevalence of dementia is around 5–7% in most regions, with the highest in Latin America (8.5%). The number is estimated to increase as the population of the world's elderly continues to increase.[1] It is currently estimated that 35.6 million people live with dementia worldwide and that the number will double by 2030 and more than triple by 2050, with the majority living in developing countries.[2]

Dementia is a broad syndrome ranging from mild to severe cognitive impairment that significantly causes disability in older people.[2] The cognitive impairment may include memory loss, difficulty in understanding or using words, inability to carry out motor activities despite adequate motor function and failure to identify or recognize objects.[3,4] Routine clinical practice shows that the cognitive and functional changes of dementia are typically accompanied by changes in behaviour and personality, but these conditions have not become core criteria as they have been considered to lack sufficient diagnostic specificity.[5] About one in 10 people aged 65 years had dementia, and the prevalence increases by age. However, there was no gender difference for incidence of dementia.[6]

There are various types of dementia such as Alzheimer's disease (AD) dementia, vascular dementia, frontotemporal dementia and Lewy body dementia. AD is known as the most common cause of dementia, and it is an irreversible, progressive brain disorder that mostly starts in those aged in their mid-60s.[7] Vascular dementia commonly occurs due to blockage of blood vessels in the brain, leading to the death of tissues or infarction in the affected region. Frontotemporal dementia primarily affects regions of the brain governing planning, social behaviour and language perceptions.[3,8] Lewy body dementia is characterized by the presence of Lewy bodies, protein in the cerebral cortex and brain stem.[3] Some of these forms of dementia can be reversed through timely interventions. Thus, public health interventions to raise awareness of the importance of early screening for cognitive impairment among the elderly are necessary.[3]

Screening for dementia and early diagnosis among those who are at risk are important in managing the disease and ensuring preparedness among caregivers.[9,10] Various screening tool modalities, including self-administered questionnaires, face-to-face assessment, telephone-based assessment and iPAD version of assessment, have been introduced for screening patients who have subjective memory complaints.[11–13] Studies have also been carried out to evaluate the most suitable screening tools for dementia in primary care practice. These need to be brief, be easy to administer, be acceptable to the elderly and have high sensitivity and specificity.[14]

At present, one of the commonly used screening tools for dementia is the Mini-Mental State Examination (MMSE).[15] However, the MMSE is known to have a long administration time and is difficult to interpret by general practitioners.[14,16] As such, it is not the most efficient or feasible screen for use in primary care. Fortunately, other options exist, such as the General Practitioner Assessment of Cognition (GPCOG), the Memory Impairment Screen (MIS) and the Mini Cognitive Assessment Instrument (Mini-Cog).[16] These tools have been validated; are brief and easy to administer and have a negative predictive value similar to the MMSE.[16,17]

Evaluating dementia-screening tests is a complex task. Reports of excellent sensitivity and specificity for a given instrument must take into account whether performance may be inflated by high rates of dementia in the study sample, by high average severity of cognitive impairment among affected persons or by exclusion of subjects with demographic characteristics that compromise many screens.[14] On the whole, effectiveness, freedom from biases irrelevant to dementia status, brevity and simplicity are the key characteristics of an ideal dementia-screening tool. It is not easy for clinicians to detect mild dementia because most patients present when they are in the moderate to severe stages.[11,16] In addition, as discussed in a previous study,[18] several barriers related to patients' caregivers and the healthcare system have been identified as contributing factors for missed or delayed diagnosis of dementia in the primary care setting.

Various reviews have been published on screening for MCI and dementia using various approaches and in various settings.[19–23] A systematic review for the United States Preventive Services Task Force based on data sources and searches until 10th December 2012 found that brief instruments to screen for cognitive impairment can adequately detect dementia, but it is unclear whether the screening improves decision-making.[24,25] In addition, a more recent systematic review on cognitive assessment tools in Asia (databases searched between September 1989 and June 2014) reported that validated cognitive assessment tools in Asia are limited and subjected to cultural as well as educational bias.[26] However, most of these reviews are based on articles published before 2013.[20,21,23–25]

Therefore, we carried out this systematic review to update current knowledge on the validity and feasibility of screening tools for dementia and mild cognitive impairments (MCIs) among the elderly at primary care level covering literature from 2012 to 2017.

Methods

The present systematic review was conducted based on the Cochrane Handbook for Systematic Review of Interventions guidelines[27] and Strengthening the Reporting of Observational Studies in Epidemiology (STROBE).[28] The review included all validity studies assessing the sensitivity and specificity of various screening tools. We also looked for information on the feasibility of each tool, if available. The population considered in this study was the elderly aged 60 years and above who were screened at primary health care settings using three approaches – screening by a healthcare provider, screening by a self-administered questionnaire or by caregiver informant screening.

Search strategy

A search strategy was developed to identify studies for this review. The search strategy contained population, intervention

and outcome terms. The search terms 'dementia', 'screening' and 'validity' included Medical Subject Headings (MeSH) as well as title and abstract text searches. Searches were limited to elderly aged 60 years and above. Electronic searches for eligible articles were conducted for articles published in 2012 through 2017 in three databases: PubMed, Embase and CENTRAL. Then, we searched for reference lists of published studies and looked for further work done by correspondence authors.

Inclusion and exclusion criteria

Studies that validate any screening tools delivered by a healthcare provider in primary care, self-administered by patients or delivered by an informant as well as studies that were written in English only were included. Studies written in other languages were excluded.

Screening and review process

The studies identified through the search process were exported to a bibliographic database (EndNote version 7) for duplicates identification. Two reviewers (F.A.A.A. and R.J.) independently reviewed the titles, abstracts and keywords of electronic records for eligibility according to all inclusion criteria of this review. The initial screening results were compared and discussed among all reviewers. Where possible, full texts of screened titles and abstracts were obtained, and two reviewers (N.A.A. and C.Y.Y.) independently reviewed the full texts. The potential full texts were rescreened by other reviewers for inclusion in the final review by using a screening data form. Any disagreements were discussed and resolved among all reviewers. By using the Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA)[29] method of screening, reviewers eliminated articles not related to the study. Fig. 1 illustrates the process of data collection and study selection methods. Two reviewers (M.A.A.R. and N.M.K.) independently performed data extraction by using a standardized data extraction form. The data extraction form included variables such as research questions, study designs, participants, study outcomes, sensitivity (Sn), specificity (Sp) and feasibility of the screening tools. Any issues at this stage were resolved by discussion among all reviewers using our own appraisal format based on sensitivity, specificity and feasibility of the tools. The appraisal format has a maximum score of 25 with 5 points for each criterion: 1, Sn $\geq$ 90%; 2, Sp $\geq$ 80%; 3, acceptable by patients; 4, can be assessed by a non-physician; 5, short administration time of 15 min or less. Feasibility was ascertained based on three criteria – acceptability, judgement required and cost – as mentioned in the article

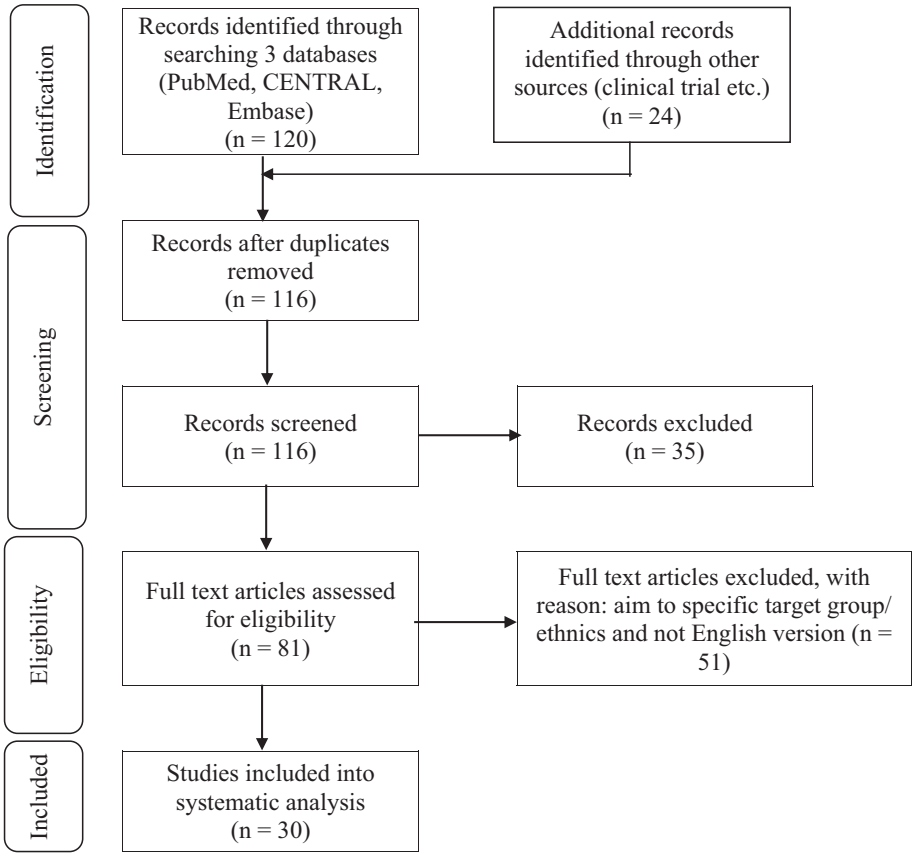

Fig. 1 – Study selection flow diagram (PRISMA). PRISMA, Preferred Reporting Items for Systematic reviews and Meta-Analyses.

Table 1 – Included studies characteristic.

Number	Tool	Authors, Place, Year	Setting	Age eligibility, years	Approaches
1	Montreal Cognitive Assessment-Basic (MoCA-B)	Parunyou J et al., Bangkok, 2015[30]	Hospital	55–80	Screening by a healthcare provider
	Montreal Cognitive Assessment (MoCA)	Felicia C.G et al. Africa, 2014[31]	Clinic	≥50	
		Yan H.D et al. Singapore, 2012[32]	Clinic	[a]	
		Larner A.J, UK, 2012[33]	Clinic	20–87	
		Freitas S et al. Portugal, 2013[34]	Community	70.52	
		Roalf D.R et al. USA, 2013[35]	Clinic	52–88	
2	Short Portable Mental Status Questionnaire, SPMSQ	Chetna M et al., Singapore, 2013[36]	Clinic	[a]	
3	Memory, fluency and orientation (MEFO)	Delgado D.C et al., Santiago, 2013[37]	Clinic and community	≥60	
4	Addenbrooke's Cognitive Examination III (ACE-III)	Michael T.J et al., United Kingdom 2015[38]	Community	[a]	
		Hsieh S et al., Australia, 2013[39]	Community	66 ± 6.25	
5	A Quick Test of Cognitive Speed (AQT-CF)	Takahashi F et al. Japan, 2012[40]	Hospital and community	[a]	
6	Saint Louis University Mental Status (SLUMS)	Cummings-Vaughn L.A et al. United States, 2014[41]	Community	≥60	
7	5 Object Test	Papageorgiou S.G et al. Greece, 2013[42]	Hospital	[a]	
8	Brief Neuropsychological Battery (BNB)Semantic Fluency	Serna A et al. 2015[43]	Community	[a]	
9	The Subjective Memory Complaint Clinical (SMCC) compare to MMSE and CDT	Ramlall et al. 2013[44]	Community	≥60	
10	Cognitive Abilities Screening Instrument-Short (CASI-S)	Martins de Oliveira G et al., 2015[45]	Clinic	≥60	
11	Rapid Cognitive Screen (RCS)	Malmstrom T.K et al., 2015[46]	Hospital, Clinic	65–92	
				60–90	
12	Cognitive Performance Scale (CPS) which is generated from five items of the interRAI Acute Care	Wellens N.I.H et al., 2013[47]	Hospital	≥75	
13	Literacy Independent Cognitive Assessment	Shim Y.S et al. 2015[48]	Hospital, community	≥60	
14	Brief Interview for Mental Status (BIMS)	Mansbach W.E et al. United States 2014[49]	Clinic	≥60	
15	Brief Cognitive Assessment Tool (BCAT)		Clinic	≥60	
16	Modified Mini-Mental State Examination (3MS)	Holsinger T et al., USA 2012[50]	Clinic	≥65	
17	Mini-Cog		Clinic	≥65	
18	Memory Impairment Screen (MIS)		Clinic	≥65	
19	Memory Function 2 administered to the participant (MF-2)		Clinic	≥65	
20	Virtual Reality (VT) technology: Virtual supermarket (VSM)	Zygouris S et al., Greece, 2014[51]	Clinic	>56	Self-administered screening
21	Virtual Reality Day-Out-Task (VR-DOT)	Tarnanas I et al. Switzerland, 2013[52]	Clinic	>60	
22	Computerized Cognitive Screening Tests (CCS)	Scanlon L et al. Ireland, 2015[53]	Hospital	≥55	
23	Computerized Assessment of Mild Cognitive Impairment (CAMCI)	Tierney M.C et al., Canada, 2014[54]	Clinic	≥65	
24	Cognitive Assessment for Dementia, iPad version (CADi)	Onoda K et al., Japan, 2013[55]	Hospital, community	≥65	
25	Revised Cognitive Assessment for Dementia, iPad version (CADi-2)	Onoda K et al., Japan, 2014[56]	Clinic	78.1 ± 4.4	
				76.0 ± 3.0	
26	Dementia Risk Assessment (DRA)	Brandt J et al., USA, 2013[57]	Community	≥50	
27	Participant-rated (p-AD8)	Chin R et al., Singapore, 2013[58]	Community	66.7 ± 10.08	
28	Informant Questionnaire on Cognitive Decline in the Elderly individuals (IQCODE)	Li F et al., China, 2012[59]	Hospital, community	≥55	Screening by a caretaker informant

[a] Age was not mentioned.

Table 2 – Validity and feasibility of screening tools to detect dementia and MCI.

Number	Tool	Authors, Place, Year	MCI		Dementia		Feasibility		
			Cut-off point	Sn/Sp (%)	Cut-off point	Sn/Sp (%)	Acceptability	Judgement	Duration (minutes)
1	Montreal Cognitive Assessment-Basic (MoCA-B)	Parunyou J et al. Bangkok, 2015[30]	25/30	86/86	++	++	Yes	Yes	15–21 m
	Montreal Cognitive Assessment (MoCA)	Felicia C.G et al. Africa, 2014[31]	≤24	95/63	≤22	96/88	Yes	Yes	10–15 m
		Yan H.D et al. Singapore, 2012[32]	≤ 19	83/86	19/20	83/86			
		Larner A.J, UK, 2012[33]	≥26	97/60	++	++			
		Freitas S et al. Portugal, 2013[34]	<22	81/77	++	++			
		Raolf D.R et al. USA, 2013[35]	25	84/79	++	++			
2	Short Portable Mental Status Questionnaire, SPMSQ	Chetna M et al. Singapore, 2013[36]	≥5	78/75	++	++	Yes	Yes	10–15 m
3	Memory, fluency and orientation (MEFO)	Delgado D.C et al. Santiago, 2013[37]	<70	81/63	<7	86/96	Yes	Yes	10–15 m
4	Addenbrooke's Cognitive Examination III (ACE-III)	Michael T.J et al. United Kingdom 2015[38]	++	++	<81	79/96	Yes	Yes	15 m
		Hsieh S et al. Australia, 2013[39]	++	++	88	100/96	Yes	Yes	15 m
5	A Quick Test of Cognitive Speed (AQT-CF)	Takahashi F et al. Japan, 2012[40]	++	++	71/72	85/76	Yes	Yes	3–5 m
6	Saint Louis University Mental Status (SLUMS)	Cummings-Vaughn L.A et al. United States, 2014[41]	≤26	74/65	≤20	93/96	Yes	Yes	7 m
7	5 Object Test	Papageorgiou S.G et al. Greece, 2013[42]	3/5 per trial	23/98	++	++	Yes	Yes	<5 m
8	Brief Neuropsychological Battery (BNB) Semantic Fluency	Serna A et al. 2015[43]	11.5	62/67	10.5	79/76	Yes	Yes	31 m
9	The Subjective Memory Complaint Clinical (SMCC) compare to MMSE and CDT	Ramlall et al. 2013[44]	++	++	>0 ≤ 24 ≤5	90.9/45.7 63.6/ 76 44.4/88.9	Yes	No	NA
10	Cognitive Abilities Screening Instrument-Short (CASI-S)	Martins de Oliveira G et al., 2015[45]	++	++	22/23	93/81	Yes	Yes	NA
11	Rapid Cognitive Screen (RCS)	Malmstrom T.K et al., 2015[46]	≤7 ≤7	87/70 69/82	≤5 ≤5	89/94 92/94	Yes	Yes	<3 m
12	Cognitive Performance Scale (CPS) which is generated from five items of the interRAI Acute Care	Wellens NIH et al., 2013[47]	≤2 ≤ 1	51/95 73/68	++	++	NA	NA	NA
13	Literacy Independent Cognitive Assessment	Shim Y.S et al. 2015[48]	202/203 187/188 209/210	76/72.7 76/ 70.3 75.5/71.4	++	++	Yes	Yes	20 m
14	Brief Interview for Mental Status (BIMS)	Mansbach W.E et al. United States	++	++	<13	66/88	Yes	Yes	3 m
15	Brief Cognitive Assessment Tool (BCAT)	2014[49]	++	++	<36	99/81	Yes	Yes	10–15 m
16	Modified Mini-Mental State Examination (3MS)	Holsinger T et al., USA 2012[50]	++	++	<83	86/79	Yes	Yes	17 m
17	Mini-Cog		++	++	<3	76/73	Yes	Yes	3 m
18	Memory Impairment Screen (MIS)		++	++	<5	43/93	Yes	Yes	4 m
19	Memory Function 2 administered to the participant (MF-2)		++	++	Both Yes	38/87	Yes	Yes	<2 m

20	Virtual Reality (VT) technology: Virtual supermarket (VSM)	Zygouris S et al., Greece, 2014[51]	++	82.4/95.2	++	++	Yes	Yes	>12 m
21	Virtual Reality Day-Out-Task (VR-DOT)	Tarnanas I et al. Switzerland, 2013[52]	20	100/74.2	++	++	No	Yes	NA
22	Computerised Cognitive Screening Tests (CCS)	Scanlon L et al. Ireland, 2015[53]	++	++	<4	94/60	Yes	Yes	3 m
23	Computerized Assessment of Mild Cognitive Impairment (CAMCI)	Tierney M.C et al., Canada, 2014[54]	≤2	80/74	++	++	No	Yes	30 m
24	Cognitive Assessment for Dementia, iPad version (CADi)	Onoda K et al., Japan, 2013[55]	++	++	≤7.6	90/84	No	Yes	10 m
25	Revised Cognitive Assessment for Dementia, iPad version (CADi-2)	Onoda K et al., Japan, 2014[56]	++	++	++	85/81–96/93	No	Yes	10–40 m
26	Dementia Risk Assessment (DRA)	Brandt J et al., USA, 2013[57]	++	++	<29	68/67	Yes	Yes	NA
27	Participant-rated (p-AD8)	Chin R et al., Singapore, 2013[58]	≥1	85/74	++	++	Yes	NA	NA
28	Informant Questionnaire on Cognitive Decline in the Elderly individuals (IQCODE)	Li F et al., China, 2012[59]	3.19	97.9/71.4	++	++	Yes	Yes	10 m

++ Cut-off point, Sn and Sp were not applicable for the study.
MCI, mild cognitive impairment; NA, not available; Sn, sensitivity; sp, specificity.

published by The Canadian Review of Alzheimer's Disease and Other Dementias.[11] Acceptability was assessed using the question 'Are the items on the test acceptable to patients?'. Judgement required was assessed using the question 'Can the test be interpreted by non-physicians?'. Cost was assessed using the question 'What is the cost of the time and staffing required to administer the test?'.[11]

Results

In total, 144 articles published in the five-year period were retrieved. After removing duplicate articles, only 116 remained. These remaining articles were screened for title and abstract, and another 35 articles were excluded due to language, article types and studies of non-primary care settings. After evaluating the full text, only 30 articles were included in this review.[30–59]

This review describes the validity of screening tools for dementia and MCI among the elderly at primary healthcare level. Three types of screening approaches were found: (1) screening by healthcare providers; (2) screening by a self-administered questionnaire; and (3) screening by information from caretakers. Out of the 30 articles included in this review, 21 studies were based on screening by healthcare providers,[30–50] eight studies were of self-administered screening[51–58] and only one study was of caretaker informant screening.[59] In terms of the setting where the studies were undertaken, 12 studies were conducted in primary care clinics, four in hospital-based clinics, eight at community-based settings and the rest at two or more different settings. The results are summarized in Table 1.

Dementia

Seventeen of the 30 articles were aimed at describing screening tools to detect dementia among the elderly. These articles covered 19 screening tools for detecting dementia. The Montreal Cognitive Assessment (MoCA) and Addenbrooke's Cognitive Examination III (ACE-III) were described in more than one article. Comparing both screening tools, ACE-III reported higher sensitivity and specificity than the MoCA in detection of dementia.[31,32,38,39] Other screening tools reported with high sensitivity and specificity were the Saint Louis University Mental Status (SLUMS), Rapid Cognitive Screen (RCS) and Brief Cognitive Assessment Tool (BCAT).[41,46,49] However, these screening tools were less sensitive than ACE-III (Sn = 100%). Most of the screening tools for detecting dementia were reported to be feasible for use in community-based screening.

Mild cognitive impairment

A total of 19 articles within the five years of review described 14 different screening tools for detecting MCI. The MoCA was the most common tool used. There were six studies using MoCA with different cut-off points and different results for sensitivity, specificity and feasibility.[30–35] Besides its feasibility, the MoCA was reported with the highest sensitivity and specificity ranges (Sn = 81–97%; Sp = 60–86%). Other studies described different tools as listed in Table 2. The Virtual Reality Day-Out-Task (VR-

DOT) and the Informant Questionnaire on Cognitive Decline in the Elderly (IQCODE) were among the most sensitive tools to detect MCI.[52,59] However, they were less specific than the MoCA. Finally, the 5 Objects Test, Rapid Cognitive Screen (RCS), Cognitive Performance Scale (CPS) and virtual reality technology: virtual supermarket (VT-VSM) were among the most specific tools but have low sensitivity.[46,47,51]

Discussion

This systematic review evaluated the validity of various screening tools for dementia and MCIs used on the elderly at primary care level. We categorized our selection of the tools by three different approaches in screening – screening by healthcare providers, by a self-administered questionnaire or by an informant.

Based on our review, the ACE-III proved to be the ideal screening tool for detecting dementia based on test accuracy and predictive ability. The ACE-III was observed to be having the highest sensitivity and specificity (Sn/Sp = 100%/96%).[39] The ACE-III is the latest version of the Addenbrooke's Cognitive Examination Revised (ACE-R).[38,39] Reviews based on articles published before 2015 found that the ACE-R is the best screening tool in terms of sensitivity and specificity.[60,61] The ACE-III was compared favourably with the ACE-R with extremely high correlation between the scores.[39] Sensitivity and specificity of ACE-III remain high using previously recommended cut-off scores.[39]

For detecting MCI at primary care settings, the MoCA appeared to be a better screening tool than others. With a high sensitivity of 83–97%, the MoCA is considered the screening tool of choice for MCI screening at primary care level. A screening tool should be highly sensitive, but not necessarily specific, to ensure high yield. Those noted as positive from screening should be referred to a second stage for confirmation or diagnosis of MCI. A review by Tsoi et al.[60] also supports the use of the MoCA as a screening tool for MCI at primary care settings. By using the MMSE as a gold standard, the MoCA reported to have better performance than other MCI screening tests, with 89% sensitivity and 75% specificity.[60]

However, an earlier review published in 2010 found that different screening tools have different advantages.[62] For instance, the MoCA has high sensitivity, the Rowland Universal Dementia Assessment Scale (RUDAS) ignores the influence of culture and education and cognitive drawing test (CDT) is more feasible.[62] In the primary care setting, Mini-Cog, MIS or General practitioner assessment of cognition (GPCOG) were the screening tools of choice.[62] Another review published in 2009 found inconclusive evidence about screening tools that fulfilled the criteria for MCI screening.[63]

The limitation of this review is that we did not include grey literature and articles in non-English language which may be able to provide a broader scope of information relevant to this review. Nevertheless, this systematic review provides the updated information on dementia or MCI screening tools for use at primary care settings based on the most recent published literature. The information will be useful to healthcare providers in planning their services towards the aims of early detection and treatment.

Conclusion

This review found that the ACE-III is a better screening tool for detection of dementia and that the MoCA is the preferred tool for screening of MCIs. This update concurred with previous reviews and was able to illustrate that both tools are still relevant to be used as screening tools for detection of MCI and dementia at primary care level.

Author statements

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Ethics approval

This study was approved by the Medical Research Ethical Committee of the National Institute of Health, Ministry of Health Malaysia.

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Competing interests

The authors declare that they have no competing interests.

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