Screening a heterogeneous elderly South African population for cognitive impairment: the utility and performance of the Mini-Mental State Examination, Six Item Screener, Subjective Memory Rating Scale and Deterioration Cognitive Observee

S Ramlall[1], J Chipps[2], AI Bhigjee[3], BJ Pillay[4]
[1]Department of Psychiatry, College of Health Sciences, University of KwaZulu-Natal, Durban, South Africa
[2]Department of Nursing, College of Health Sciences, University of KwaZulu-Natal, Durban, South Africa
[3]Department of Neurology, College of Health Sciences, University of KwaZulu-Natal, Durban, South Africa
[4]Department of Behavioural Medicine, College of Health Sciences, University of KwaZulu-Natal, Durban, South Africa

Abstract
Objective: The aim of this study was to report on the prevalence of cognitive impairment, and to assess the performance and utility of subjective, objective and informant screening tools in a heterogeneous community sample. **Method:** A sample of 302 elderly participants (>60 years) living in residential homes in a large city in South Africa were screened for the presence of cognitive impairment using objective (Mini-Mental State Examination [MMSE] and Six Item Screener-[SIS]), subjective (Subjective Memory Complaint [SMC]and Subjective Memory Rating Scale [SMRS]) and informant (Deterioration Cognitive Observee [DECO]) screening tools. All tools were compared to the MMSE and the influence of demographic variables on the performance on these tools was considered. **Results:** Significantly lower MMSE scores were found in participants aged 80-89 years (p=.023) and those who had 8-11 years of education (p=.002). For every one additional year of education, participants were 0.71 times less likely to screen positive on the MMSE. Differential item functioning on various components of the MMSE was demonstrated due to the effects of education, race and gender. There was significant differential performance between the recommended and alternate attention/concentration items (p<.001) with the alternate item favouring better performance. Based on the MMSE cut-off score of < 23, the prevalence of cognitive impairment was 16.9%; the prevalence yielded by the remaining tools ranged from 10.5% using the DECO to 46% as determined by the presence of a SMC. Using the MMSE as the reference standard for the presence of cognitive impairment, the SIS, SMC, SMRS and DECO had sensitivities of 82.3%, 54.6%, 17.0% and 37.5%, and specificities of 71.3%, 57.6%, 87.4% and 96.7% respectively. Age and race influenced performance on the MMSE, SIS and SMRS. **Conclusion:** Different types of cognitive screening tools yielded varying sensitivities and specificities for identifying cognitive impairment when compared to the MMSE. The influence of race, age and education on test performance highlights the need for suitable, culture-fair screening tools. Locally, the alternate item for attention/concentration should be preferred.

Keywords: Screening; Dementia; MMSE; Subjective Memory Complaints; South Africa

Received: 24-10-2012
Accepted: 28-01-2013
doi: http://dx.doi.org/10.4314/ajpsy.v16i6.57

Introduction

South Africa has the second largest elderly population in Sub-Saharan Africa[1] with the population aged 60 years and older projected to increase from 7.1% in 1996 to 8.4% in 2014.[2]

Correspondence
Dr S Ramlall
P.O. Box 65810, Reservoir Hills, Durban, 4090, South Africa
email: ramlalls4@ukzn.ac.za

However, the serious consequences of population ageing do not appear to be planned for as evidenced by the lack of a national dementia care policy. There is a lack of recent data on morbidity as well as a paucity of research particularly in the areas of cognitive, mental and physical functioning of the elderly.[3] Dementia, a condition largely affecting the aged, requires specialised services, few of which exist either in the public or private health sector in South Africa. The projected increase in the prevalence of

dementia, especially in lower and middle income countries (LAMIC), and the resultant increase in demand for services 'needs to be met by adequately prepared and resourced services…'.[4] The Kyoto Declaration identified the recognition and treatment of dementia at primary health care level as a first priority.[5] Recognition of dementia requires the use of screening tools to identify individuals who warrant intensive clinical diagnostic evaluation. The validation of screening tools in the local context is an important first step in this process.

Dementia poses a significant health and economic burden to society.[6] It is the 11th leading cause of years lived with disability (YLDs) at a global level, and accounts for 2% of total YLDs.[7] The annual cost of caring for people with dementia in the UK and USA are $10 billion and $100 billion respectively.[8] Economic models suggest that early dementia diagnoses are more cost effective[4] and that a delay of progression from Mild Cognitive Impairment (MCI) to Alzheimer's Disease (AD), even by one year, could have significant cost implications for health and social services.[9] Early diagnosis and intervention is therefore recommended[10] and actively promoted in high-income countries (HIC)[4], despite widespread routine screening not being recommended by the United States Preventive Services Task Force.[11] MCI, an intermediate stage between normal age-associated cognitive decline and dementia, shows substantial variation in reported prevalence, but may be present in up to 42% of elderly populations.[12] It is associated with disability and neuropsychiatric symptoms.[13] Together with dementia, it therefore also requires early detection if any significant impact is to be made on the burden posed by cognitive impairment in the elderly.

Screening initiatives are compounded by refusal rates as high as 50%[14], with a survey conducted in the USA and Europe revealing low levels of acceptance by the elderly and the perception that screening was harmful.[15] Dementia screening enjoys a low priority in low and middle income country (LAMIC) healthcare systems that face considerable burdens relating to communicable diseases.[16,17] Fifty-eight percent of people with dementia currently live in LAMIC and this figure will increase to 70% in 2025 and to 71% by 2050.[12] The treatment gap for dementia is as high as 90%[18] in these countries compared to 20%-50% in HIC.[19] Empirical data on dementia in LAMICs is limited[6], with a dearth of large community-based epidemiological studies[20] and only seven methodologically robust studies being identified by the 10/66 Dementia Research Group in 2000.[21]

Due to existing resource constraints and competing health priorities, a cost-effective strategy for dementia is needed. Screening tools, largely the product of Western psychological paradigms[22], are ability assessments that are not culture-fair[23], and they therefore pose challenges to being used among diverse cultural, ethnic, language and literacy populations in LAMIC, as well as within and between HIC.[24,25] Screening tools need to be brief, easy to administer, clinically acceptable, effective, minimally affected by education, gender and ethnicity[26], and have sound psychometric properties. At the same time, it is recommended that similar screening tools should be used in LAMIC and HIC to facilitate comparisons between studies, and that such tools should be reliable and administrable by both paraprofessionals and trained non-professionals.[20]

To date, few studies have been conducted in SA to evaluate the performance of screening tools that are commonly in use. The MMSE has been used in a homogenous population as a diagnostic tool without comment on its psychometric properties.[27] In another study involving ten patients, it was concluded that the MMSE was an 'out-dated and inadequate' screening tool.[28] The utility of the DECO[29] as an informant screening tool has been assessed in a pilot study and found to be a sensitive measure for mild and moderate dementia and its use recommended, with minor modifications, in community studies.[30]

The aims of this study were to calculate the prevalence of cognitive impairment, evaluate the performance of the Mini-Mental State Examination (MMSE)[31], the Six Item Screener (SIS)[32], the presence of a subjective memory complaint (SMC), Subjective Memory Rating Scale (SMRS)[33] and the Deterioration Cognitive Observee scale (DECO) in identifying cognitive impairment in a heterogeneous elderly South African population. We also sought to establish the degree to which race, age, education level and depression may influence the performance of these screening tools.

Method

Sites

This study was conducted in a group of retirement homes administered by a non-governmental organisation (NGO) in Durban, KwaZulu-Natal, South Africa between August and October 2010. The residential facilities ranged from frail care to independent living, and cater for all ethnic groups and socio-economic classes, representing a cross-section of the local elderly population.

Sample

A sample of 302 was assessed to have adequate power to provide caseness in screening. Inclusion criteria were: residents who were 60 years and older, with a minimum of 8 years of formal schooling, the ability to speak, read and write in English and the ability to give written, informed consent. Exclusion criteria were residents with severe physical, mental or sensory handicaps that precluded their engagement in the assessment procedures. A random sample was initially selected electronically from a database of the 1371 residents. There was a high refusal rate and many residents were not at home which resulted in a low yield of participants. To address this, the approach was revised to a door-to-door convenience sampling method that included all residents who were available on the day of screening and who agreed to participate. A total of 733 residents were screened of which 302 met the inclusion criteria. Of the remaining 431 (58.8%), 155 failed to meet the inclusion criteria, 227 declined and 49 were unavailable.

Assessments

Screening assessments were conducted at the participants' residences by a trained senior psychiatric registrar using the MMSE, SMRS and the DECO. The Six Item Screener

(SIS), comprising a subset of the MMSE items was also analysed separately as it has the potential to substitute the MMSE, especially in resource-constrained clinical environments where lengthy administration time may be a significant deterrent to regular screening. The SMRS was administered to those participants who replied 'yes' to the question: 'Are you experiencing any difficulty with your memory?' The SMRS defines five specific contexts of memory impairment with respect to duration (last 10-20 years) whereas the SMC documents the presence of subjective awareness of memory problems in general. In the MMSE, the terms for orientation to place were modified to accommodate the local geographical context and two of the three registration/recall items were substituted. The DECO was administered to available informants who had monthly contact with the study participants for at least two years. Depression was identified using the Geriatric Depression Scale (GDS)[34] employing a cut-off score of >11. The psychometric properties of the tests are reported in Table I.

Statistical analysis

The data for all tools were analysed using IBM® SPSS®19, and the significance for all tests set at $p<.05$. Cognitive impairment cases were classified using the identified cut-off scores for 'cases' for each test as indicated in Table 1. Sensitivity and specificity (95% Confidence Intervals (CIs)) of the SMRS, SMC, SIS and DECO were calculated against the MMSE cognitive impairment 'cases'. Numerical variables were tested for normality using Kolmogorov-Smirnov Z. Data were then compared for differences between 'cases' and non-cases for cognitive impairment for all tests using parametric-tests and non-parametric tests (Chi-square or Fisher Exact Test (X^2), Mann Whitney (U) and Kruskall Wallis (K) tests),and for related samples the Wilcoxon signed-rank test (W). Direct logistic regression was performed to assess the impact of race, age and years of education on the classification of cognitive impairments as defined by MMSE 'cases'.

Ethics

The study received ethical approval from the Biomedical Research Ethics Committee of the University of KwaZulu-Natal.

Results

Following an analysis of the participants' race, age and education levels, the results for each of the tools are presented separately.

Demographics

The age of the participants ranged from 60 to 94 years (mean 73.5 ± 7.7) and the female to male ratio was 2.6. More than half of the participants were white (168, 55.6%), followed by coloureds (67, 22.2%), Asian (58, 19.2%) and 9 (3.0%) were black. The mean number of years of formal education was 10.4 ± 2.2 years and ranged from a minimum of eight years to a maximum of 19 years. Seventy per cent of

Table I: Psychometric properties of dementia screening tests

Domains measured	*Method of administration*	*Sensitivity & Specificity*	*Reliability*	*Validity*
MMSE[31]				
11 items: Orientation, registration, attention/ concentration, calculation, recall, naming, repetition, comprehension, writing, construction.	Interviewer administered 7-10 Minutes Cut-off score: 23/24	85.1% & 85.5%[35]	Cronbach α = .54-96[36] Interrater=.9 Test Retest =.80-.95 Kendall Coefficients= .7[31]	Content: Good: Concurrent: Correlates with WAIS[31], Reisberg Global Deterioration Scale & Blessed Dementia Scale[37]
SIS[32]				
6 items 3 item temporal orientation and 3 item recall	Interviewer administered 3 minutes Cut-off score: 4/5	88.7% & 88.0%	Test-retest moderate (Kappa=.52) (Shah)	Not available
DECO[29] Changes in behaviour noticed over 1 year in-activity level, semantic and visual memory, memory for places, events and procedures, visuo-spatial performance and new skill learning	Informant administered 11-15 minutes Cut-off score: 24/25	79% & 90%	Inter-rater =.87 Test Retest = .92	Not available
SMRS[33]				
Changes in remembering names, faces, friends, appointments and judging the time	Self-administered 5 minutes Cut-off score: 19/20	43.0% (pooled) & 85.8%[38]	Cronbach α = .6[33]	Face validity at 70,75, and 80, Hazard ratios: 6.0 (95% CI 52.1–18), 3.2 (95% CI 51.6–6.2) and 1.6 (95% CI 50.86–3.1)[33]

participants had a high-school education and 8.9% had a tertiary education.

There was a significant association between race and age (white 75.1 and Asian 70.9 years of age, K=15.8, p=.001) and race and years of education (white 10.8 and coloured 9.6, K=22.6, p<.001). Years of education was also associated with gender (Male 10.7 and Females 10.3 years, U=1.0, p=.047).

Mini Mental State Examination (MMSE) and Six Item Screener (SIS)

The MMSE was administered to all 302 participants and scored using both the recommended and the alternate items for the assessment of attention/concentration (Copyright restrictions preclude further description of these items). Over half of the participants (184, 60.9%) scored higher on the alternate item, 92 (30.5%) scored the same and 26 (8.6%) lower. This resulted in a significantly higher MMSE total using the alternate (mean 26.0 ±3.0 95%CIs [25.7, 26.4]) compared to the recommended item (mean 24.8 ± 3.4 95%CIs [24.4, 25.2]) Wilcoxon Signed-Ranks Test, T=9.9, p<.001. The final MMSE score was based on the better score between the recommended and alternate items.[37] Using a cut-off score of <23, 51 (16.9%) participants screened positive for cognitive impairment and 251 (83.1%) screened negative.

The mean MMSE score was 26.2 ±2.9, with scores ranging from 15 to 30. Lower MMSE scores were significantly associated with increased age groups (K=9.6, p=.023), lower education groups (K=12.5, p=.002) and race (whites scoring higher) (K=25.3, p<.001). Age groups were 60-69, 70-79, 80-89, >90 years and education groups were 8-11, 12, >12 years. Comparing the performance of different participant age groups on the recommended vs the alternate attention/concentration items of the MMSE, no significant differences were noted (K=2.8, p=.422 and K=3.6, p=.311 respectively). However, participants with 8-11 years' education scored significantly lower on the recommended (K=22.3, p<.001) compared to the alternate item (K=7.3, p=.03). Similarly, there were significant differences for the race groups in the recommended item score (blacks scoring lower) (K=23.0, p<.001) but not for the alternate item score (K=3.6, p=.315). The mean score for blacks on the recommended item was 1.7±1.5 compared to a mean score of 4.8±0.7 on the alternate item (W=2.6, p=.011).

Direct logistic regression was used to report the effect of race, age and education together, and the relative contribution of each of the variables to the MMSE categories. The full model containing all the predictors were statistically significant (X^2 (n=302, 5) =19.8 p<.001), indicating that the model was able to distinguish between cases with and without cognitive impairment. It explained between 6.4% (Cox and Snell R square) and 10.7% (NagelKerke R Squared) of the variance in classification of cognitive impairment, correctly classifying 82.8% of cases. As shown in Table II, only education made a statistically significant contribution to the model. The odds ratio of 0.71 for years of education was less than one, indicating that for every additional year of education, respondents were 0.71 times less likely to be classified as suffering from cognitive impairment as identified by the MMSE.

In considering the effect of these variables on individual items, education levels significantly influenced the performance on the following: geographical orientation (K=8.1, p=.017), recommended (K=22.3, p=.001), and alternate attention/concentration (K=7.3, p=.026), repetition (K=7.3, p=.026) and construction items (K=13.5, p=.001).

There were significant differences between the race groups (with Black participants scoring consistently lower than other race groups) on 3 orientation items (K=9.3, p=.025; K=9.3, p=.025; K=16.3, p=.001), as well as on the attention/concentration (K=23.0, p=.000), naming (K=10.7, p=.014), repetition ' (K=21.4, p=.001), comprehension of verbal (K=17,0, p=.001), and written command (K=12.7, p=.005) items.

Gender accounted for significant differences in 2 orientation items (K=2.7, p=.006) and (K=2.1, p=.036), the recommended (K=2.7, p=.007), and the alternate attention/concentration items (K=2.5, p=.015). Females performed better on all these items except for the recommended attention/concentration item.

In comparing the screen positives on the MMSE (n=51) with the screen negatives (n=251), there were significant differences in the positive and negative screen group for years of education, MMSE, SIS and GDS scores,

Table II: Logistic regression predicting likelihood of classification as dementia using the MMSE score

*Step 1**	*B*	*se*	*Wald*	*df*	*p-value*	*Exp(B)*	*95% C I for EXP(B)*	
							Lower	*Upper*
Age	.03	.02	1.50	1	.22	1.03	.98	1.07
Years of education	-.35	.10	11.57	1	.001*	.71	.58	.86
Race (White)			3.35	3	.34			
Race (Asian)	.48	.42	1.320	1	.25	1.61	.71	3.65
Race (Coloured)	.03	.42	.01	1	.94	1.03	.46	2.33
Race (Black)	1.16	.77	2.26	1	.13	3.19	.71	14.43
Constant	-.25	1.89	.02	1	.90	.78		

* Significance set p<.05. Variable(s) entered on step 1: age, race, and years of education. B=un standardized coefficients; se=standard error; Wald=Wald test; df-degrees of freedom; Cp-value= significance; Exp (B) = odd ratios and CI=confidence intervals

but there was no significant association between MMSE screen positives and GDS positive categories (Table III).

In addition to the full MMSE, the SIS was analysed to determine its sensitivity and specificity to screen for cognitive impairment. The SIS score was significantly affected by race (K=8.2, p=.041) and age groups (K=7.8, p=.049) but not by gender (U=-0.3, p=.806,) or education groups (K=1.1, p=.578). Using the SIS with a cut of < 4, 114 (37.7%) participants screened positive for cognitive impairment. Testing whether the SIS categories could be used to predict cognitive impairment as measured by the MMSE resulted in a sensitivity of 82.3 %, 95% CIs[68.7%, 91.1%] and a specificity of 71.3%, 95% CIs[65.2%, 76.7%].

Subjective Memory Complaint (SMC) and Subjective Memory Rating Scale (SMRS)

Subjective memory complaints were reported by one hundred and forty participants (46%) but its presence was not significantly associated with race (X^2=4.7, p=.193), gender (X^2=0.8, p=.438), age (U=1.8, p=.07) or education (U=0.8, p=.426). There was no significant association between the presence of SMCs and MMSE scores (U=1.2 p=.235). SMCs were significantly associated with depression (X^2=18.4, p<.001).

Using the MMSE scores to assign caseness, the presence of SMCs had a sensitivity of 54.6%, 95% CIs [44.2%, 64.7%] and a specificity of 57.6%, 95% CIs [50.5%, 64.4%] in identifying possible cognitive impairment cases.

The SMRS was administered to 140 participants who reported a SMC, with the mean SMRS score being 17.7, ±1.9, and a range of 15-24. The distribution of scores was not influenced by gender (U=0.9, p=.389) or educational level (K=5.5, p=.07) but was significantly associated with race (K=8.9, p=.03) and age group (K=14.7, p=.02). There was no significant association between SMRS categories and MMSE scores (U=0.6 p=.548).

Using the recommended cut-off of >20 to determine screen positives, 20 (14.3%) screened positive on the SMRS and 120 (85.7%) screened negative. There was a significant association between age, race and depression (Table IV) and screen categories.

Using the MMSE scores to assign caseness, the SMRS had a sensitivity of 17.0%, 95% CIs [8.5%, 30.3%] and specificity of 87.4%, 95% CI [78.1%, 93.2%].

Deterioration Cognitive Observee (DECO)

Of the 207 participants (64.7%) who provided details of eligible informants, 76 (36.7%) were contactable and were able to complete a DECO. Of these, 20 (9.7%) completed all 19 items on the DECO. This was due to two DECO items consistently having high missing values. These were writing letters (37, 48.7% completion rate) and reminding a person of a conversation (39, 51.3% completion rate). Adjusting for the denominator to take into consideration missing items, made no difference to caseness, and the decision was made to assign all missing data a score of zero.

The average DECO score was 30.9 ± 5.8, ranging from 4 to 38. Using the recommended cut off score of <24 (maximum score=38), eight (10.5%) screened positive for cognitive impairment. There were significant differences between the screen positives and screen negatives for gender and the DECO score (Table V).

Using the MMSE scores to assign caseness, the DECO was found to have a sensitivity of 37.5%, 95% CI [6.3%, 64.2%] and specificity of 96.7%, 95% CI [87.5%, 99.4%].

Table III: Comparison of Participants with positive vs negative screen on MMSE

Item		*Screen positive MMSE <24 N=51 (16.9 %)*	*Screen negative MMSE >24 N=251 (83.1%)*	*Statistic*	*P*
Age		74.2 ± 7.6	73.4 ± 7.8	T=0.66	.51
Race	Asian Black Coloured White	13 (25.5%) 3 (5.9%) 12 (23.5%) 23 (45.1%)	45 (17.9%) 6 (2.4%) 55 (21.9%) 145 (57.8%)	X^2=4.3	.182
Gender	Female Male	32 (62.7%) 19 (37.3%)	187 (74.5%) 64 (25.5%)	X^2=2.9	.086
Years of education		9.4 ±1.7	10.6 ±2.2	T=3.6	<.001*
Depression (GDS positive >11)		20 (40%)	80 (31.9%)	X^2=1.2	.265
MMSE /30		21.0 ±2.2	27.2 ±1.7	U =11.4	<.001*
SIS score /6 SIS positive <=4		3.2 ±1.5 42 (82.4%)	4.9±0.9 72 (28.75)	U =8.0 X^2=52.0	<.001* <.001*

Age and Years of Education were compared using Independent Samples T-Tests. MMSE, SIS scores were compared using Independent Samples Mann-Whitney U Tests. Gender, Race, GDS and SIS categories were compared using Pearson Chi-square Tests. *Significance level set as p<.05.

Table IV: Comparison of Participants with positive vs negative screen on SMRS

Item		*Screen positive SMRS >20 N=20 (14.3%)*	*Screen negative <19 SMRS N=120 (85.7%)*	*Test*	*P*
Age		69.3 ±6.5	75.2±7.7	T=3.3	.001*
Race	Asian Black Coloured White	9 (45%) 1 (5%) 6 (30%) 4 (20%)	15 (12.5%) 5 (4.2%) 31 (25.8%) 69(57.5%)	X^2=14.1	.002*
Gender	Female Male	15 (75%) 5 (25%)	90 (75%) 30 (25%)	X^2=0.2	.681
Years of education		10.6 ±2,6	10.2 ±1.9	U=0.3	.753
Depression (GDS)		14(70%)	50(41.7%)	X^2=5.5	.019*
SMRS score		21.2±1.3	17.1±1.2	U=7.3	<.001*

Age was compared using Independent Samples T-Tests. Years of Education, SMRS and MMSE were compared using Independent Samples Mann-Whitney U Tests. Gender and race were compared using Pearson Chi-square Tests.*Significance level set as p< .05.

Table V: Comparison of Participants with positive vs negative screen on DECO

Item		*Screen positive =<24/38 N=8(10.5%)*	*Screen negative >24/38 N=68 (89.5%)*	*Statistic*	*P*
Age		75.3 ±8.5	70.5±6.4	T=1.9	.06
Race	Asian Coloured White	1 (13%) 4 (50%) 3(37%)	A 18 (26.5%) C 16 (23.5%) W 34(50%)	X^2=2.4	.338
Gender	Female Male	2 (25%) 6 (75%)	43 (63.2%) 25 (36.7%)	X^2=4.3	.06*
Years of education		10.6 ±3.3	9.8 ±1.6	U=0.3	.807
DECO score		16.6 ±5.9	32.5 ±2.6	U=4.6	<.001*

Age was compared using Independent Samples T-Tests. Years of Education, and DECO were compared using Independent Samples Mann-Whitney U Tests. Gender and race were compared using Pearson Chi-square Tests. *Significance level set as p< .05.

Discussion

The benefits of early identification of dementia, even in the absence of disease-modifying pharmacological agents, are well-recognised.[4] MCI, while regarded as a pre-dementia stage, has been shown to have a variable course and lends itself to implementation of risk management if diagnosed early.[39] There is therefore a need for the early recognition of cognitive impairment (dementia and MCI) at community and primary care level for which validated and simple tools are necessary. This study provided measures of prevalence of cognitive impairment using different tools, assessed the performance of a number of cognitive screening instruments and quantified the degree to which race, age and education level influenced their performance. It also highlighted the challenges associated with screening.

Prevalence estimates of cognitive impairment

Using the different tools, the 'prevalence' of cognitive impairment in this population was 16.9% using the MMSE and ranged from 10.5% (DECO) to 46.3% (SMC). The tools also had widely varying sensitivities (17%-82%) and specificities (57.6%-96.7%) when compared with the MMSE.. These discrepant figures suggest that the various instruments, while measuring cognitive impairment, may have different underlying constructs and hence may not be readily comparable with each other. The detail of the performance of each test is discussed below.

Performance of Tools

The first set of screening tools was objective measures of cognitive impairment. The MMSE is the most widely used

cognitive screening test[35] and may remain the best screening tool for primary care clinicians to rule in or rule out a diagnosis of dementia.[40] In our study, the MMSE identified 51 while the SIS identified twice the number (114) of participants with possible cognitive impairment. Compared with the MMSE, the SIS showed good sensitivity and specificity suggesting that it may be a useful screening tool as an alternative to the MMSE locally. This confirms findings from an international study where a good correlation was demonstrated between the MMSE and SIS in a community-based sample.[32] Subsequent studies have been divided on its efficacy with one study yielding lower sensitivities[41] and another finding it a reliable and effective tool for dementia but not MCI detection.[42] In view of the large difference in case identification between the MMSE and the SIS, the relative merits of using the MMSE or the SIS locally is best determined once the validity of the MMSE is established against the gold standard of a clinical diagnosis of cognitive impairment.

The second set of screening tools assessed subjective cognitive impairments. Subjective knowledge and awareness of memory deficits (meta-memory)[38] are frequently reported by the elderly. In our study a prevalence of 46% of SMC was found. A UK study, using a primary health-care sample, reported a 46.5% prevalence of any cognitive complaint in the elderly, with an increase in prevalence occurring with increasing age and among females.[43] Conversely, a recent study reports the prevalence of a lack of awareness of memory deficits ranging from 63% to 81% across three LAMICs and that absence of awareness is associated with depression, dementia severity, socio-economic status and education in different sites.[44] In community settings, 20% of individuals with SMC are likely to have dementia and 30% MCI.[38] Establishing the presence of SMCs may prove useful as they have been associated with characteristic neuro-imaging changes in the temporal and hippocampal regions[45], and may represent a degree of cognitive impairment that is not currently measurable by objective tests.[46] SMCs may therefore represent a simple and cost-effective way of identifying underlying impairment which would obviate the need for validated tools and trained administration staff. However, despite SMCs being a diagnostic criterion for MCI[10], there is a lack of consistency in how SMCs are defined.[47] The construct underlying subjective impairment may be influenced by cultural variables and may account for the large variation in MCI prevalence across LAMIC.[13] The implication of the lack of a consistent definition of subjective memory impairment is illustrated in our findings where two subjective measures yielded markedly different results.

In our study, 46.3%of participants reported the presence of a subjective memory complaint (SMC) and of these the SMRS identified 14.3% as being possibly cognitively impaired. While the discrepancy could be attributed to the SMRS being a more specific and detailed measure of subjective cognitive impairment, this is not supported by the differences in sensitivities of the two measures as compared against the MMSE.

The third set of tools included the informant questionnaire, the DECO. Informant assessments have several advantages over patient administered screening tools. Direct information about a decline in daily functioning can be elicited from those who know the patient well.[30] While brief cognitive screening tests, short neuro-psychological batteries and informant questionnaires have comparable discriminability, informant observations are less influenced by the educational levels of subjects being screened and retained discriminability in mild dementia.[48] Informant questionnaire may therefore prove valuable for local community screening where informants may be more readily available than in residential facilities; they may also have utility in settings where low educational levels of the elderly may limit the use of the MMSE.

Of the 76 respondents on the DECO, 73.7% were unable to respond to all 19 items. Informants were unable to respond to letter writing and remembering a conversation items which may be similar to other studies which identified the items pertaining to household appliances, handling of money and writing as necessitating replacement with culturally suitable alternatives[29] to improve the potential of the DECO to be a 'useful instrument to diagnose dementia cross-culturally in SA'.[30] Using the MMSE as a gold standard, our study revealed a much lower sensitivity than that obtained in a pilot study in a small cross-cultural South African sample. The DECO in the latter study had a sensitivity of 79% and a specificity of 90%, a good correlation with the MMSE ($r=0.625$; $p<0.01$) and validity for the diagnosis of mild and moderate dementia.[30]

The unavailability of informants for 75% of the participants in the study, including none for black participants, is much higher than that reported in the literature (viz. 19%[49] and 5%[50]) and limits proper evaluation of the validity of the DECO and the generalizability of our findings. However, the substantial lack of informants raises the question of the utility of this tool in a residential setting. Social support in the elderly has clinical implications, identifying this group as being at risk for cognitive disorders. Studies confirm the role of social integration and the quality and quantity of social relationships in maintaining cognitive vitality[51], reducing the risk for AD[52,53] decreasing psychiatric morbidity[54,55], influencing physical health55 mortality risk[55,56], predicting quality of life[57], and reducing the rate of memory decline[58] in the elderly. On the basis of the implied low levels of regular family contact, subsequent low response rate and low sensitivity, the utility of the DECO as a screening instrument suitable for use in this population appears to be limited.

Influence of demographic variables and depression

Race, age and years of education were shown to affect the performance of the measures used in our study.

Race: There was a significant association between race and the SIS, SMRS and specific items of the MMSE. The recommended and alternate attention/concentration items ' are not equivalent[37] and this was evidenced in the poorer performance of participants of different races on the recommended item and suggesting that the alternate item should be preferred in this heterogeneous sample . However, there were two issues to consider here namely, there were only 9 black participants in the study and there were significant differences between race groups in terms of age and years of education. Replication of these results in a larger sample will confirm the validity of these associations.

The differences between race groups for individual items on the MMSE largely disappeared with the use of the better

score between the 2 attention/concentration items. This suggests that, in the local population, the use of the recommended attention/concentration item of the MMSE does not demonstrate cross-cultural equivalence[59], and may need to be adapted according to the cultural, demographic and educational profile of the population being screened. Age, educational level, ethnicity and language of administration have been shown to influence frequency of errors and scores on the MMSE.[60] Attempts have been made in many countries to translate and adapt the MMSE for local use.[20,61] The relative difficulty of certain items has been shown to vary between ethnic groups within the United States[24] and a study comparing UK and USA dementia populations suggested that the MMSE items may not be dynamically equivalent even within Western race groups.[25] Establishing separate test norms for different racial groups may help to improve the accuracy of tools. Alternatively, direct and more meaningful and predictive variables that underlie test performance across cultural groups may serve to increase the validity of the instruments used to diagnose dementia.[62]

Age: Although age is a risk factor for dementia, dementia is not an inevitable consequence of ageing, and its effects cannot be dismissed as representing psychometric bias. In keeping with previous studies that showed a decrease in MMSE scores as age increases[37], scores in our sample were significantly lower in older participants (p=.023) although the mean age of those screening positive was not significantly greater than those screening negative (p=.74). There exists a complex relationship between MMSE scores, age and educational level which may have implications for the cut-off score.[37] Age effects were also evident with the SIS (p=.049) and SMRS scores where screen positives were significantly younger (p=.001); however, no age effect was evident with the SMC measurement. This could possibly be explained on the basis of younger participants retaining awareness of the details of their subjective cognitive status (measures on the SMRS) while the simpler measure of SMC was not confounded by age-effects.

Education: Education has been found to be the most important non-biological correlate of cognitive performance[63-65] and the 'cultural variable,' which includes education and urbanization, making it the largest contributor to performance variance on psychometric tests[66,67] more so than ethnicity or the traditional variables of age, sex and socio-economic status.[68] MMSE scores were confounded by the level of education (p=.02) of participants in this study. A previous local study found no correlation between education and MMSE scores[30], which could be attributed to the adaptations (especially on the educationally biased items) made to the MMSE administered in that study. Education levels significantly influenced the performance on individual MMSE items which confirms earlier research on the differential item performance attributable to education, race, ethnicity and language, and its use in educationally disadvantaged populations has been questioned.[69] Given the significantly poorer performance of participants with lower education levels on the recommended attention/concentration item the alternate item would preferred for local MMSE administration. Performance on the SIS was not significantly associated with education (p=.578) suggesting that this subset of MMSE items are less influenced by education effects and that it could be a useful alternative to the MMSE locally.

General population studies have consistently demonstrated that a lower educational level is associated with an increased probability of scoring below the recommended MMSE cut point[70], and literacy is suggested to be a more sensitive proxy for cognitive reserve than years of education.[71] Although the MMSE (with modifications) has been used in illiterate populations[72], there are reports of numerous challenges[20,72] due to the complex relationship that exists between literacy and dementia risk and prevalence.[62] As there is a higher prevalence of illiteracy among the elderly in LAMIC[73] these challenges may be compounded.

Discrepancies in both the quantity and quality of education[62] between racial groups, especially among the elderly in South Africa who would have been exposed to education during the apartheid era, will impact on test performance. Among South Africans aged 60 years and older, two-thirds of blacks and Asians and half of coloureds had less than five years of education and rural blacks had a literacy rate of 29%.[74] In our study, each year of formal education was found to reduce the likelihood of screening positive on the MMSE by a factor of 0.71 thus warranting caution in its widespread local use without further evaluation and possible adaptation. The finding also highlights the important role of education and cognitive stimulation in increasing brain reserve capacity and protecting against disease manifestation. The SMCs (p=.426) and SMRS scores (p=.07) were not significantly influenced by the level of education of participants and assessments of subjective memory may offer a possible solution to the challenges posed by educational influences on test performance.

Cognitive impairment has been documented in geriatric depression[75,76] and the frequent co-existence of dementia and depression suggests that the two conditions share a complex association with each other.[77] Depression may be an early manifestation of dementia[78] or a risk factor for its development.[79,80] However, in our study, a screen positive on the MMSE was not significantly associated with depression (p=.109). SMCs have also been shown to be associated with depression[81,82] and this was evident in our study where the presences of SMCs(p<.001) as well as screen positives on the SMRS (p=.019) were found to be significantly associated with depression. The utility of subjective measures of cognitive impairment should therefore always be assessed in conjunction with mood disorders in the elderly.

Challenges of screening

The study faced two challenges in conducting screening in this population, one being the refusal of residents to participate, and the other being the low number of contactable informants on which to conduct the DECO. Nearly a third of the local residents refused to participate in the study; this is contrary to the view that the elderly in developing countries are more likely to co-operate in studies due to the attraction of 'free' health care and other incentives for participation.[20] In a recent comparison between the elderly in the US and the UK, 39.4% and 32.1% of respondents respectively found screening to be unacceptable.[15] Refusal

rates in high income countries vary from 19%[83] to 50%[84], and among those agreeing to be screened, 47.7% of those screening positive refused further assessments, perceiving themselves to have no cognitive deficits; older blacks were more likely than whites to refuse screening.[84] Due to the low numbers of blacks in our sample, racial differences in acceptance of screening is yet to be determined locally. A lack of awareness of dementia and possible anxiety about being diagnosed may have contributed to the low level of acceptance in our sample. However, it is important, if screening initiatives are to be successful, that reasons for refusal are formally identified so that they can be addressed. A second challenge was the low numbers of contactable informants (N=76; 25.2%), which posed a significant constraint on both screening and diagnostic activities, as the information provided by collateral sources are invaluable for the diagnosis and management of cognitive disorders. In a local study among a Xhosa-speaking black sample, a 69.4% agreement was reported between clinicians' and relatives' perceptions of normal and abnormal cognition[85], highlighting the importance of caregivers' observations about cognitive decline when making an assessment of cognitive decline.

Limitations

This study had a number of limitations which affects the generalizability of the findings. Firstly, the sample represented an urban setting within a non-governmental organization in KwaZulu-Natal. Secondly, the restricted inclusion criteria may have precluded participation of the elderly with severe dementia. Thirdly, there was a high participant refusal rate. Fourthly, the majority of the sample was white. Fourthly, the validity of the various instruments is better measured against the gold standard of a clinical diagnosis of cognitive impairment. Lastly, the low number of respondents on the DECO, including the lack of black respondents, limits the generalizability of its performance.

Recommendations

The study highlights the need for further investigation in the use of screening measures in other populations, using larger sample sizes and conducting household surveys among the elderly who are cared for by family-members. This will be especially important since collateral information may be more easily obtained from their care givers. In view of the widely discrepant performance between the attention/concentration items it is recommended that the alternate item be used when administering the MMSE locally.

Conclusion

Despite the identified limitations, the study is the first South African study to estimate the prevalence of cognitive impairment in this setting and to evaluate the performance of different types of screening instruments for cognitive impairment among the diverse race groups in the country. The performance of the screening tools in this study confirms the concerns raised about the validity of instruments developed for culturally homogeneous Western populations that are used in populations that are demographically and educationally heterogeneous.[30] In addition, the estimated burden of cognitive impairment is significant and highlights the need for increased awareness in a 'super-aging society 86 of the importance of screening and the need for an appropriate, valid screening tool for health workers in clinical settings and for cross-cultural research.[21]

Acknowledgments

The authors would like to thank Dr Lon White for permission to use the SMRS, and acknowledge Dr Shirlony Morgan for her contribution to the field work and Ms Tonya Esterhuizen for initial statistical support.

References

1. *The Socio-Economic Status of the South African Elderly Population: 2007-2014 IPMS; 2009.*
2. *Department of Social Development. DRAFT: Progress Review of the Implementation of: White Paper on Population Policy for South Africa(1998). The ICPD Programme of Action. South Africa, 2009.*
3. *Joubert J, Bradshaw D. Population Ageing and Health Challenges in South Africa. In: Steyn K, Fourie J, Temple N, editors. Chronic Diseases of Lifestyle in South Africa:1995-2005.Technical Report. Cape Town: Medical Research Council, 2006:204-19.*
4. *Prince M, Bryce R, Ferri C. World Alzheimer Report 2011: The Benefits of Early Diagnosis and Treatment. Alzheimer's Disease International, 2011.*
5. *Alzheimer's Disease International. Kyoto Declaration-Minimum actions for the care of people with dementia. http://www.alz.co.uk/adi/pdf/kyotodeclaration.pdf 2010.*
6. *Ferri CP, Prince M, Brayne C, Brodaty H, Fratiglioni L, Ganguli M, et al. Global prevalence of dementia: a Delphi consensus study. Lancet 2005;366(9503):2112-7.*
7. *WHO. The Global Burden of Disease. Geneva: WHO, 2002.*
8. *Brayne C, Fox C, Boustani M. Dementia screening in primary care: is it time? JAMA : the journal of the American Medical Association 2007; 298(20):2409-11.*
9. *Petersen RC, Smith GE, Waring SC. Mild Cognitive Impairment. Clinical Characterization and Outcome. Archives of neurology 1999;56:303-08.*
10. *Petersen RC, Stevens JC, Ganguli EG. Practice parameter: Early detection of dementia: Mild cognitive impairment (an evidence-based review) : Report of the Quality Standards Subcommittee of the American Academy of Neurology. Neurology 2001;56(9):1133-42.*
11. *Boustani M, Peterson B, Hanson L, Harris R, Lohr KN. Screening for dementia in primary care: A summary of the evidence for the United States Preventive Services Task Force. Annals of internal medicine 2003;138(11):1-60.*
12. *Ward A, Arrighi HM, Michels S, Cedarbaum JM. Mild cognitive impairment: disparity of incidence and prevalence estimates. Alzheimer's & dementia : the journal of the Alzheimer's Association 2012;8(1):14-21.*
13. *Sosa AL, Albanese E, Stephan BC, Dewey M, Acosta D, Ferri CP, et al. Prevalence, distribution, and impact of mild cognitive impairment in Latin America, China, and India: a 10/66 population-based study. PLoS medicine 2012;9(2):e1001170.*
14. *Boustani M, Watson L, Fultz B, Perkins AJ, Druckenbrod R. Acceptance of dementia screening in continuous care retirement communities: a mailed survey. International Journal of Geriatric Psychiatry 2003;18(9):780-6.*
15. *Justiss MD, Boustani M, Fox C, Katona C, Perkins AJ, Healey PJ, et al. Patients' attitudes of dementia screening across the Atlantic. International journal of geriatric psychiatry 2009;24(6):632-7.*
16. *Prince M, Acosta D, Albanese E, Arizaga R, Ferri CP, Guerra M, et al. Ageing and dementia in low and middle income countries-Using*

research to engage with public and policy makers. International Review of Psychiatry 2008;20(4):332-43.
17. Kalula S, Petros G. Responses to dementia in Less Developed Countries with a focus on South Africa. IFA Global Ageing 2011;7(1):31-39.
18. Dias A, Patel V. Closing the treatment gap for dementia in India. Indian journal of psychiatry, 2009:S93-7.
19. Prince M, Acosta D, Ferri CP, Guerra M, Huang Y, Jacob KS, et al. A brief dementia screener suitable for use by non-specialists in resource poor settings--the cross-cultural derivation and validation of the brief Community Screening Instrument for Dementia. International journal of geriatric psychiatry 2011;26(9):899-907.
20. Chandra V, Ganguli M, Ratcliff G, Pandav R, Sharma S, Gilby J, et al. Studies of epidemiology of dementia: comparisons between developed and developing countries. Aging 1994;6(5):307-21.
21. Prince M. Methodological issues for population-based research into dementia in developing countries. A position paper from the 10/66 Dementia Research Group. International journal of geriatric psychiatry 2000;15(1):21-30.
22. Ardila A. Cultural Values Underlying Psychometric Cognitive Testing. Neuropsychology Review 2005;15(4):185-95.
23. Greenfield PM. You can't take it with you: Why ability assesments don't cross cultures American Psychologist 1997;52:1115-24.
24. Teresi JA, Golden RR, Cross P, Gurland B, Kleinman M, Wilder D. Item bias in cognitive screening measures: comparisons of elderly white, Afro-American, Hispanic and high and low education subgroups. Journal of clinical epidemiology 1995;48(4):473-83.
25. Gibbons LE, van Belle G, Yang M, Gill C, Brayne C, Huppert FA, et al. Cross-cultural comparison of the Mini-Mental State examination in United Kingdom and United States participants with Alzheimer's disease. International journal of geriatric psychiatry 2002;17(8):723-28.
26. Culverwell.A, Milne.A, Guss.R, Tuppen J. Screening for dementia in primary care: how is it measuring up? Quality in Ageing 2008;9(3):39-44.
27. Ben-Arie O, Swartz L, Teggin AF, Elk R. The Coloured elderly in Cape Town- a psychosocial, psychiatric and medical community survey. South African Medical Journal 1983;64:1056-61.
28. Oliver J. Evaluating the efficacy of the Mini-Mental State Examination. University of Cape Town, 2007.
29. Ritchie K, Fuhrer R. The validation of an informant screening test for irreversible cognitive decline in the elderly: performance characteristics within a general population sample. International journal of geriatric psychiatry 1996;11:149-56.
30. Lenger V, deVilliers C, Louw SJ. Informant questionnaires as screening measures to detect dementia. A pilot study in the South African context. South African Medical Journal 1996;86(6):737-41.
31. Folstein MF, Folstein SE, Mc Hugh PR. A practical method for grading the cognitive state of patients for the clinician. Journal of psychiatric research 1975;12(3):189-98.
32. Callahan CM, Unverzagt FW, Hui SL, Perkins AJ, Hendrie HC. Six-item screener to identify cognitive impairment among potential subjects for clinical research. Medical care 2002;40(9):771-81.
33. Li Wang MS, van Belle G, Crane PK, Kukull WA, Bowen JD, Mc Cormick WC, et al. Subjective Memory Deterioration and Future Dementia in People Aged 65 and Older. Journal of American Geriatric Society 2004;52:2045-51.
34. Brink TL, Yesavage J, Lum O, Heersema PH, Adey M, Rose TL. Screening tests for geriatric depression. Clinical gerontologist 1982;1:37-43.
35. Mitchell AJ. A meta-analysis of the accuracy of the mini-mental state examination in the detection of dementia and mild cognitive impairment. Journal of Psychiatric Research 2009;43(4):411-31.
36. Tombaugh TN MIN. The MMSE: A comprehensive review. Journal of American Geriatric Society 1992;40:922-35.
37. Tombaugh TN, Mc Intyre NJ. The MMSE: A comprehensive review. Journal of American Geriatric Society 1992;40:922-35.
38. Mitchell AJ. The clinical significance of subjective memory complaints in the diagnosis of mild cognitive impairment and dementia: a meta-analysis. International journal of geriatric psychiatry 2008;23(11):1191-202.
39. Panza F, D'Introno A, Colacicco AM, Capurso C, Parigi AD, Capurso SA, et al. Cognitive frailty: Predementia syndrome and vascular risk factors. Neurobiology of aging 2006;27(7):933-40.
40. Mitchell AJ, Malladi S. Screening and case finding tools for the detection of dementia. Part I: evidence-based meta-analysis of multidomain tests. The American journal of geriatric psychiatry : official journal of the American Association for Geriatric Psychiatry 2010;18(9):759-82.
41. Wilber ST, Carpenter CR, Hustey FM. The Six-Item Screener to detect cognitive impairment in older emergency department patients. Academic emergency medicine : official journal of the Society for Academic Emergency Medicine 2008;15(7):613-6.
42. Chen MR, Guo QH, Cao XY, Hong Z, Liu XH. A preliminary study of the Six-Item Screener in detecting cognitive impairment. Neuroscience bulletin 2010;26(4):317-21.
43. Westoby CJ, Mallen CD, Thomas E. Cognitive complaints in a general population of older adults: prevalence, association with pain and the influence of concurrent affective disorders. Eur J Pain 2009;13(9):970-6.
44. Mograbi DC, Ferri CP, Sosa AL, Stewart R, Laks J, Brown R, et al. Unawareness of memory impairment in dementia: a population-based study. International psychogeriatrics / IPA 2012;24(6):931-9.
45. Stewart R DC, Godin O, et al. Neuroimaging correlates of subjective memory deficits in a community population. Neurology 2008;70(18):1601-7.
46. Coley N OP, Andrieu S,et al. Memory complains to the general practitioner: data from the GuidAge Study. Journal of Nutrition, Health and Aging 2008;12(1):66S-72S.
47. Abdulrab K, Heun R. Subjective Memory Impairment. A review of its definitions indicates the need for a comprehensive set of standardised and validated criteria. European psychiatry : the journal of the Association of European Psychiatrists 2008;23(5):321-30.
48. Ritchie K, Fuhrer R. A comparative study of the performance of screening tests for senile dementia using receiver operating characteristics analysis. J Clin Epidemiology 1992;45(6):627-37.
49. Boustani M, Callahan CM, Unverzagt FW, Austrom MG, Perkins AJ, Fultz BA, et al. Implementing a screening and diagnosis program for dementia in primary care. Journal of general internal medicine 2005;20(7):572-7.
50. Hall KS, Gao S, Emsley CL, Ogunniyi AO, Morgan O, Hendrie HC. Community screening interview for dementia (CSI 'D'); performance in five disparate study sites. International journal of geriatric psychiatry 2000;15(6):521-31.
51. Fillit HM, Butler RN, O'Connell AW, Albert MS, Birren JE, Cotman CW, et al. Achieving and maintaining cognitive vitality with aging. Mayo Clinic proceedings. Mayo Clinic 2002;77(7):681-96.
52. Williams JW, Plassman BL, Burke J, al. e. Preventing Alzheimer's Disease and Cognitive Decline: Reports/Technology Assessments, No. 193.): Rockville (MD): Agency for Healthcare Research and Quality (US), 2010.
53. Gureje O, Ogunniyi A, Kola L, Abiona T. Incidence of and risk

factors for dementia in the Ibadan study of aging. Journal of the American Geriatrics Society 2011;59(5):869-74.
54. Silveira ER, Ebrahim S. Social determinants of psychiatric morbidity and well-being in immigrant elders and whites in east London. International journal of geriatric psychiatry 1998;13(11):801-12.
55. Umberson D, Montez JK. Social relationships and health: a flashpoint for health policy. Journal of health and social behavior 2010;51 Suppl:S54-66.
56. Holt-Lunstad J, Smith TB, Layton JB. Social relationships and mortality risk: a meta-analytic review. PLoS medicine 2010;7(7):e1000316.
57. Gureje O, Kola L, Afolabi E, Olley BO. Determinants of quality of life of elderly Nigerians: results from the Ibadan study of ageing. African journal of medicine and medical sciences 2008;37(3):239-47.
58. Ertel KA, Glymour MM, Berkman LF. Effects of social integration on preserving memory function in a nationally representative US elderly population. American journal of public health 2008;98(7):1215-20.
59. Flaherty JA, Gaviria M, Pathak D, Mitchell T, Wintrob R, Richman JA, et al. Developing Instruments for Cross-Cultural Psychiatric Research. The Journal of Nervous and Mental Diseases 1988;176(5):257-63.
60. Escobar JI, Burnam A, Karno M, Forsythe A, Landsverk J, Golding JM. Use of the Mini-Mental State Examination (MMSE) in a community population of mixed ethnicity. Cultural and linguistic artifacts. The Journal of nervous and mental disease 1986;174(10):607-14.
61. Kabir ZN, Herlitz A. The Bangla adaptation of Mini-Mental State Examination (BAMSE): an instrument to assess cognitive function in illiterate and literate individuals. International journal of geriatric psychiatry 2000;15(5):441-50.
62. Manly JJ, Espino DV. Cultural influences on dementia recognition and management. Clinical Geriatric Medicine 2004:93-119.
63. Ostrosky-Solis F, Ramirez M, Ardila A. Effects of Culture and Education on Neuropsychological Testing: A Preliminary Study With Indigenous and Nonindigenous Population. Applied neuropsychology 2004;11(4):186-93.
64. Ardila A. Directions of Research in Cross-Cultural Neuropsychology. Journal of Clinical and Experimental Neuropsychology 1995;17(1):143-50.
65. Ardila A. Directions of research in cross-cutural neuropsychology. Journal of clinical and experimental neuropsychology 1995;17(1):143-50.
66. Nell V. Westernization, Racism, and the Politics of Culture. In: Nell V, editor. Cross-Cultural Neuropsychological Assessment. New Jersey: Lawrence Erlbaum Associates, Inc., Publishers, 2000.
67. Ogunniyi A, Lekwauwa UG, Osuntokun BG. Influence of education on aspects of cognitive functions in non-demented elderly Nigerians. Neuroepidemiology 1991;10:246-50.
68. Caetano C. Qualitative Assessment Within and Across Cultures. In: Uzzel BP, Ponton M, Ardila A, editors. International Handbook of Cross-Cultural Neuropsychology. New Jersey: Lawrence Erlbaum Associates, Inc., Publishers, 2004.
69. Ramirez M, Teresi JA, Holmes D, Gurland B, Lantigua R. Differential item functioning (DIF) and the Mini-Mental State Examination (MMSE). Overview, sample, and issues of translation. Medical care 2006;44(11 Suppl 3):S95-S106.
70. Simpao MP, Espino DV, Palmer RF, Lichtenstein MJ, Hazuda HP. Association between acculturation and structural assimilation and Mini-Mental State Examination-assessed cognitive impairment in older Mexican Americans: Findings from the San Antonio Longitudinal Study of Aging. Journal of American Geriatrics Society 2005;53:1234-39.
71. Pittman J, Andrews H, Tatemichi T, Link B, Struening E, Stern Y, et al. Diagnosis of dementia in a heterogeneous population. A comparison of paradigm-based diagnosis and physician's diagnosis. Archives of neurology 1992;49(5):461-7.
72. Ogunniyi A, Osuntokun BG, Lekwauwa UG. Screening for dementia in elderly Nigerians: Results of the pilot test of a new instrument. East African medical journal 1991;1(68):448-54.
73. Scazufca M, Almeida OP, Vallada HP, Tasse WA, Menezes PR. Limitations of the Mini-Mental State Examination for screening dementia in a community with low socioeconomic status: results from the Sao Paulo Ageing & Health Study. European archives of psychiatry and clinical neuroscience 2009;259(1):8-15.
74. Ferreira M, Moller V, Prinsloo FR, Gillis LS. Multidimensional Survey of Elderly South Africans,1990-1991; Key Findings, Monograph No. 1. Cape Town: HSRC/UCT Centre for Gerontology, University of Cape Town, 1992.
75. Burt DB, Zembar MJ, Niederehe G. Depression and Memory Impairment: A meta-analysis of the Association, its Pattern, and Specificity. Psychological Bulletin 1995;117(2):285-305.
76. Kramer-Ginsberg E, Greenwald BS, Krishnan KR, Christiansen B, Hu J, Ashtari M, et al. Neuropsychological functioning and MRI signal hyperintensities in geriatric depression. The American journal of psychiatry 1999;156(3):438-44.
77. Steffens DC, Potter CG. Geriatric depression and cognitive impairment. Psychological Medicine : 2007;38:163-75. .
78. Chen P, Ganguli M, Mulsant BH, DeKosky ST. The temporal relationship between depressive symptoms and dementia: a community-based prospective study. Archives of general psychiatry 1999;56(3):261-6.
79. Ownby RL, Crocco E, Acevedo A, John V, Loewenstein D. Depression and risk for Alzheimer disease: systematic review, meta-analysis, and meta-regression analysis. Archives of general psychiatry 2006;63(5):530-8.
80. Jorm AF. History of depression as a risk factor for dementia: an updated review. The Australian and New Zealand journal of psychiatry 2001;35(6):776-81.
81. Schmand B, Jonker C, Geerlings MI, Lindeboom J. Subjective memory complaints in the elderly: depressive symptoms and future dementia. The British journal of psychiatry : the journal of mental science 1997;171:373-6.
82. Zandi T. Relationship between subjective memory complaints, objective memory performance, and depression among older adults. American journal of Alzheimer's disease and other dementias 2004;19(6):353-60.
83. Holsinger T, Boustani M, Abbot D, Williams JW. Acceptability of dementia screening in primary care patients. International journal of geriatric psychiatry 2011;26(4):373-9.
84. Boustani M, Perkins AJ, Fox C, Unverzagt F, Austrom MG, Fultz B, et al. Who refuses the diagnostic assessment for dementia in primary care? International Journal of Geriatric Psychiatry 2006;21(6):556-63.
85. de Villiers C, Bryer A, Louw SJ. The Langa pilot study on dementia: preliminary report on the hospital-based diagnostic phase. South African Medical Journal 1998;88:459.
86. Maki Y, Yoshida H, Yamaguchi H. Computerized visuo-spatial memory test as a supplementary screening test for dementia. Psychogeriatrics 2010;10(2):77-82.